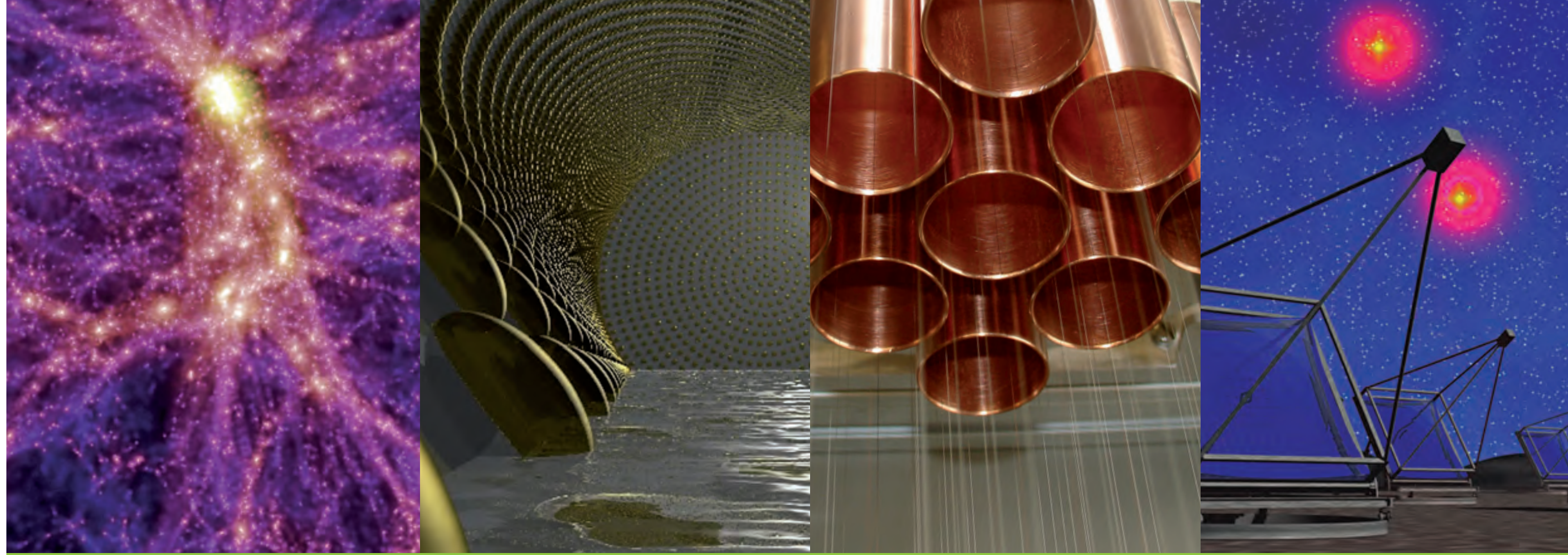
1st ASPERA Technology Forum 2010

ASPERA

Next Generation Projects of Astroparticle Physics
Focus on Photosensors and Auxiliary Electronics

SEVENTH FRAMEWORK PROGRAMME



Content




A View to the Future

Key Challenges and Prospects Evolved from the ASPERA Technology Forum on Photosensors and Electronics

"Have a closer look at each project, sometimes they are not so far from each other. There might be space for joint activities: Why not unify a PMT?"

Prof. Dr. Karl-Heinz Kampert

The wide interest in the event and the positive feedback by many of the participants of the ASPERA Technology Forum on photosensors and auxiliary electronics demonstrated the importance of this get-together of project representatives, industry, and funding agencies. As a general remark it shall be noted that the discussion during the hot seat sessions was dominated by photosensors and auxiliary electronics played only a minor role.

"I found the ASPERA Technology Forum useful both for information transfer and as an element of strategic planning. The major impact I see is a strengthening of the networking between projects with similar/overlapping technology requirements, plus potentially an enhanced cross-coordination between science community and industry."

Prof. Dr. Uli Katz

In addition to issues that are specific to the individual projects, which have been described in the project summaries, there are common aspects that shall be summarised in the following. It should be noted that the project summaries were prepared by the projects and reflect the technically feasible schedules. The structure is to first describe technological challenges driven by the needs of the projects. Second, challenges that arise from the production and companies have to cope with are summarised. Third, issues concerning the cooperation between scientific collaborations and companies shall be described to define ways of improvement. Finally, four, a feedback towards the funding agencies and a possible way to follow up the topic of photosensors and aux. electronics shall be given.

Cutting-Edge Technologies

Photomultiplier tubes (PMT) is the technology state of the art at present and foreseen to be installed in upcoming Astroparticle physics projects presented at the ASPERA Technology Forum. While since early 60's there was essentially no improvement of the performance of PMTs, during the last several years the PMT technology has been substantially improved. However, it is not clear whether or not further R&D efforts may lead to significant improvements anymore.

The technology of SiPM (pronounced as Silicon photomultipliers; these are matrixes of avalanche photo diodes with a common anode that are operated in Geiger mode) has been taken major steps towards a market available product. The hope is that this technology can be further developed for application in physics experiments and SiPMs can be cheaper produced in large quantities.

All representatives of future projects pointed out that the projects would benefit from PMT developments leading to quantum efficiencies (QE) comparable to (or even more than) 35 % in the range 300–600 nm and a reduction of the effect of after pulses well below 2 %, which is both challenging for industry. There is some expectation that newly developed Bialkali PMTs with providing high QE may become available on the market soon. On the other hand, present PMTs have reached a level of dark counts that projects can live with.

Important for some projects is the availability of PMTs with a reduced level of radioactivity resulting from the glass tube. According to statements made by representatives from industry current PMTs can be used in cryogenic detectors and low temperature environments are not an issue.

Especially by representatives of projects that need to install thousands of PMTs in a large vessels it was pointed out that a high pressure resistance is an important goal to reach for PMTs to minimize the catastrophic effect of implosions of PMTs in such large configurations. For these projects it is rather important to advance the currently developed architecture of PMT-arrays with a common read-out electronic. These developments may also expand the scope of application and thus may become important for industry.

"The Technology Forum was very useful for me to learn directly and in a nutshell about the needs of the various experiments and about the possibilities of industry. Leveling the mutual expectations was the main learning effect, essential for future cooperation and development of new projects."

Prof. Dr. Peter Grabmayr



Economical Aspects

Representatives from industry emphasized that it is very difficult to improve on the quality of PMTs. The demands are very specific and if there is not enough orders for these products it is difficult to justify development costs. For significant improvements it is necessary to produce small series of 10 tubes or better 100 tubes. However, it has been noted that the costs of such small series are difficult to be transferred to customers.

Concerning the astroparticle physics projects the challenge for industry is to develop and produce the right technology at the right time. To cope with the demand of several hundred thousands of PMTs within several years is not easy and new production capacities must be built up. To realise such big production capacities a concrete commercial prospect is required. Furthermore, for such numbers of quantity automation of the production processes is obviously needed.

"For Hamamatsu the participation in the Technology Forum implicated the necessity to summarize our projects in a very condensed manner. It clarified such needs for each project as development and production time, technical similarities or opposites for special developments."

Olga Stroh, Hamamatsu Photonics Deutschland GmbH

Cooperation Between Science Projects and Industry

Quoting representatives from industry, physics experiments are the drivers for developments in the field of photosensors and electronics. However, from the physics experiments alone companies cannot make their living. Developments made must pay off by selling products on other markets. For companies the time scales for a return of investment are shorter than in the academic world. R&D cooperation between scientific collaborations and industry are limited by this fact. It was discussed that it may be of help that the R&D efforts are joined; one or a small number of laboratories should take the lead on these activities in close cooperation with industry. Furthermore, some representatives from industry expressed that projects should be more open for developments made by companies or resulting from other fields and should consider taking advantage of that.
Several project representatives put forward the idea of standardizing PMTs when requirements of projects are close together. This may help to reduce costs on the production. In line with this idea, project collaborations may jointly carry out their R&D efforts on PMTs, again an argument to concentrate the R&D activities at a central institution. Concerning the cooperation on R&D topics intellectual property rights may place barriers in between companies and research institutions. However, project representatives expressed their hope for a stronger input from industry and more funding available for R&D activities on photo sensors and auxiliary electronics. The hope of project representatives is that the costs for PMTs can be reduced by further R&D and especially the technology of SiPMs may become a mass product to be applicable in science projects.

Prospects

During the final discussion it was suggested to ASPERA to form an expert group to address the following topics:

1. Determine overlapping R&D interests and activities on photosensors in between current astroparticle physics projects and identify ways of joining efforts.
2. Assess whether a streamlining of R&D activities in (a) main institution(s) in Europe may increase the overall efficiency and potentially strengthen cooperation with industry.
3. Suggest concrete R&D activities and necessary resources to cope with the technological challenges mentioned above.

To make use of the momentum gathered by the ASPERA Technology Forum the expert group will have its first meeting in the first half of 2011. This will be followed by the conference "Light 2011" at Ringberg Castle at the beginning of November 2011.

The impetus of the Technology Forum is already apparent, as the following statements of the participants show.

"First follow-up activities are becoming visible (e.g. a LENA-KM3NeT meeting on PMTs). It's too early to decide whether these are singular events or will have a longer-term perspective. In any case things have started to move which might not have started to move without the Technology Forum."

Prof. Dr. Uli Katz

"The minimum expectation for the future is a Technology Forum for discussion in order to optimize research and disseminate results in a more efficient manner. Higher flying wishes would be financial support for a well defined research line where industry and university research are strongly linked. Even as a small user I would support this idea – expecting benefits for other products even."

Prof. Dr. Peter Grabmayr

DARWIN

DARWIN (DARk matter WImp search with Noble liquids) is an R&D and design study towards the realization of a multi-ton scale dark matter search facility in Europe, based on the liquid argon and liquid xenon time projection chamber techniques. The DARWIN study has started in April 2010 and a technical design report is expected to be delivered in 2013.

http://darwin.physik.uzh.ch

Specifications

Photosensors
Goal: Investigate and develop new concepts for readout of ionization signal produced in keV energy events, independent of scintillation readout. QUPID (QUartz Photon Intensifying Detector);

- These are 3" sensors, composed of an APD and a photocathode coated on synthetic silica; typical QE is > 30 % at 175 nm and 25 % at 420 nm, the P/V-ratio is 5. The APD gain is > 200, the electron bombardment gain is > 800 at 6 kV. The radioactivity is < 1 mBq/sensor. The total number of sensors needs to be decided.
- It will depend on the exact geometry of the TPC and on the photo-coverage. An approximate number is 1000 sensors.

Auxiliary electronics
Goal: identify electronics, data acquisition systems (DAQ), and data processing solutions for large-scale noble liquid experiments

1. Low noise electronics for light and charge readout
- amplifiers for QUPIDs / charge readout structures
- FADCs: large bandwidth and fast sampling (100 MHz–1 GHz)
- intelligent data reduction algorithms (long drift times)
- cabling studies: purity, out-gassing, cross talk
- study the possibility to digitize directly on sensor

2. DAQ and trigger
- intelligent trigger, multi-stage trigger
- multi-hit veto, high-energy veto, first online analysis

3. Common computing resource center
- increased demand for computing power
- MC, data storage, duplication, processing, analysis

Requirements

Design phase
There is a need for R&D on alternative charge and light read-out (for instance, large-area, low-radioactivity PMTs as an alternative to QUPIDs; gas-PMs; MicroMegas as an alternative charge multiplier and GridPix), on low-noise, low-power and cost effective electronics for both read-out systems, on UV light-shifting (for LAr) and collection. Interaction with companies is needed.

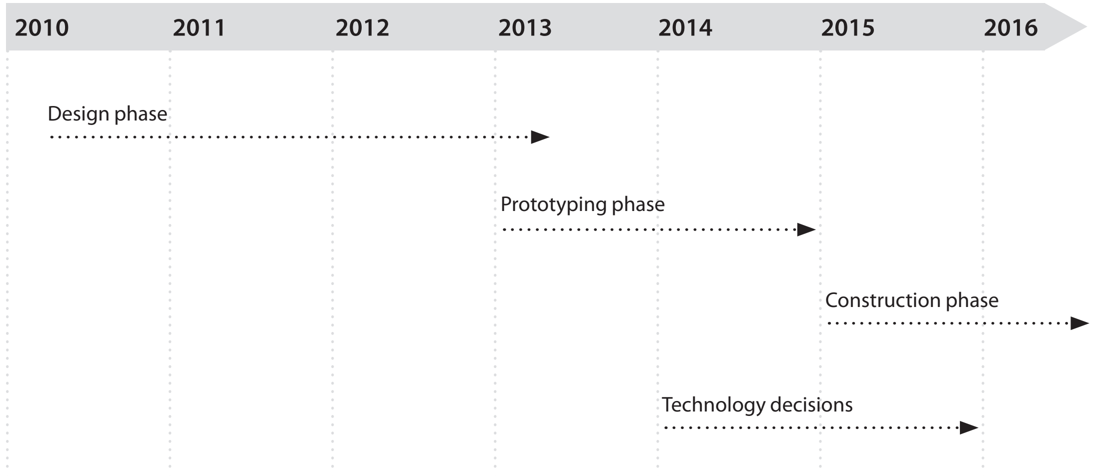
Approach
(a) Large cryogenic LEM / THGEM / Micromegas for noble liquids: charge amplification in holes (GEM)
(b) Gaseous PMTs without dead zone: separation with MgF_4 window allows use of quencher
(c) CMOS pixel detector coupled to electron multipliers (GridPix): low radioactivity is possible

Prototyping phase
Front-end electronics for both signal read-out, investigation of a 'hybrid' DAQ, in which the S1 signal is digitised at a very high sampling rate in order to exploit the PSA for background discrimination also in Xe, investigate the possibility of generating the HV at each individual device in order to avoid long HV lines; investigate a wider dynamic range for large area PMTs, while keeping an equivalent sampling frequency and bandwidth; cost issues.
Interaction with companies is needed.

Construction phase
Strategy of dealing with large numbers of photosenors (schemes for bundling, separately, HV and signal cables); intelligent trigger schemes and data treatment; storage, computer facility center.

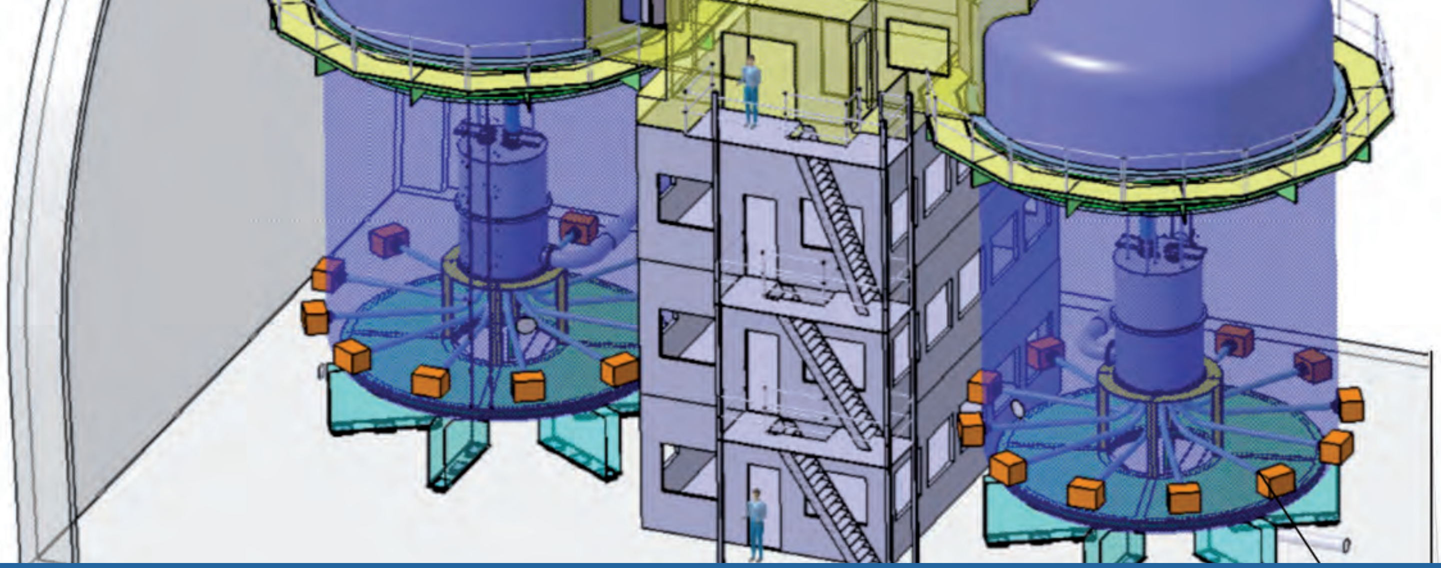
Critical parameters	Importance high (+++), low (–)	Comments
Quantum efficiency	+++	In order to reach a low energy threshold
Time resolution	++	in particular for LAr, but also in LXe
Backscattering	+	
After-/Prepulsing	+	
Radioactivity	+++	
Low temperature	++	in particular for LAr
Pressure	+	at ~ 2 atm
Lifetime	++	
SiPM an option	+	
Large number of channels		~ O (1000) -> large data amount in calibration mode

Schedule



EURECA

EURECA is a next generation direct Dark Matter search experiment based on low-temperature detectors. The European teams involved in direct dark matter searches based on cryogenic techniques are focussing their efforts towards a ton-scale detector, EURECA, the European Underground Rare Event Calorimeter Array.



http://www.eureca.ox.ac.uk/

PMT Specifications

Photosensors

- about 100 photo sensors for the active muon veto (water Cherenkov detector) of the EURECA detector
- 5"–8" diameter PMTs exhibiting high quantum efficiency in the ultraviolet
- Final number and exact type of PMTs depends on results of the design study for the active muon veto (water Cherenkov detector) of the EURECA detector

Auxiliary electronics issues

- PMT readout system will be integrated into readout system of ultra-low temperature detectors (bolometer readout), this might imply special requirements.
- R&D might be necessary e.g. for development of low-noise, low-power and high resolution analogue – to – optical coupling at T = 100 K for bolometer readout
- Option of conversion of pre-amplified signals analogue – to – optical via LEDs
- Extraction of bolometer signals via 10m of optical fibre in pipes through water tank to outside electronics for digitisation and further processing

Requirements

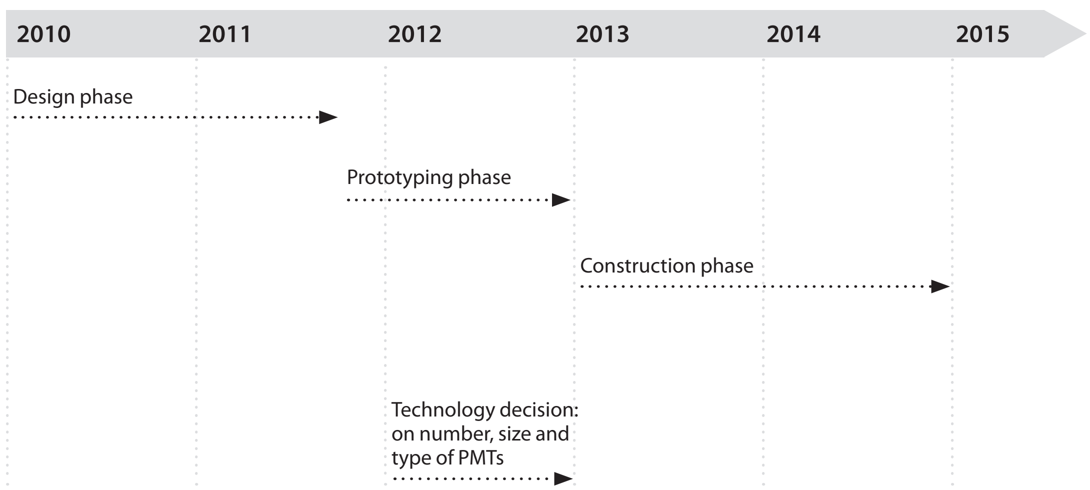
Design phase
PMTs from industry with best achievable quantum efficiency in the ultra-violet and cost-effective auxiliary electronics

Prototyping phase
~ 10 PMTs and auxiliary electronics for design confirmation -> decision on number of PMTs needed

Construction phase
Need for full number of PMTs (100–200) and auxiliary electronics

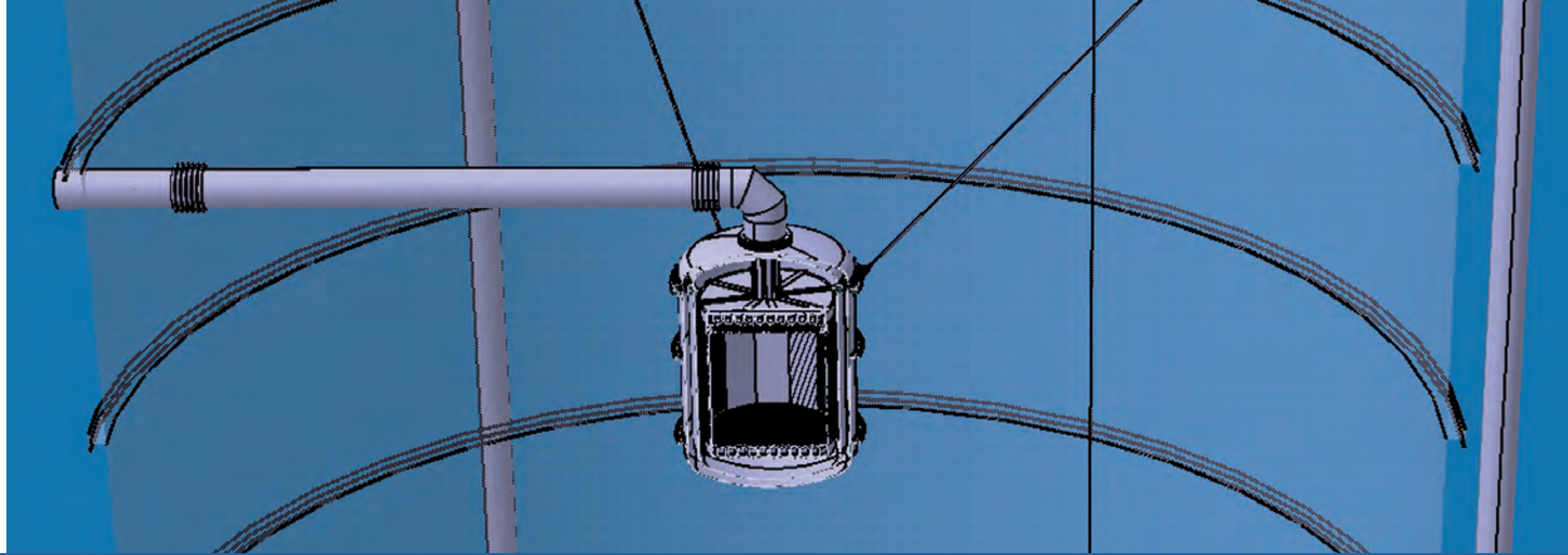
Critical parameters	Importance high (+++), low (–)	Comments
Quantum efficiency	++	
Time resolution	++	
Backscattering	–	
After-/Prepulsing	+	
Radioactivity	++	
Low temperature	–	
Pressure	+	
Lifetime	++	
SiPM an option	–	
Other reqiurements		choice of PMTs in terms of intrinsic purity, encapsulation of PMTs, no real R&D needed

Schedule



XENON1T

XENON1T is an experiment designed for the direct detection of Dark Matter. Its detectors will use a total of 2.5 tons of liquid xenon for the measurement of weak interacting massive particles (WIMPs).The USA-European experiment is operated in the Gran Sasso underground laboratory in Italy. The construction will likely start at the end of 2011 with a planned operation by 2014.



http://xenon.astro.columbia.edu/

Specifications

Photosensors
1st option: Quartz Photon Intensifier Detectors (QUPIDs) – 3 inch diamter, 30 % QE at 178nm, ultra low radioactivity, 300 units
2nd option: Hamamtsu R11410-MOD 3″ PMTs, optimised for operation in LXe. Modified version with lower radioactivity.
Other 2″ or 3″ tubes that meet the requirements (low radioactivity, high QE and response optimised for LXe) will also be tested.

Auxiliary electronics
- 250 channels, 14bit flash ADCs, digitization rate 100 MHZ, on board data size reduction capabilities necessary. Current choice is commercially available CAEN V1724
- QUPIDs need pre-amplifiers, PMTs might need standard PMT amplifiers (x 10)
- Some more standard VME electronics necessary (about 10 channels each), scalers, latches, low threshold discriminator
- HV supply (250 channels): QUPIDs 300 V APD bias voltage, 1 channel 6 kV photocathode PMTs: 1 500V bias voltage

Requirements

Design Phase
Completed for QUPID.
Alternative 3″ R11410-MOD PMT: Tube is commercially available with very high QE (> 35 %).
DAQ electronics: design based on experience with XENON100; improve data size reduction and data throughput capabilities

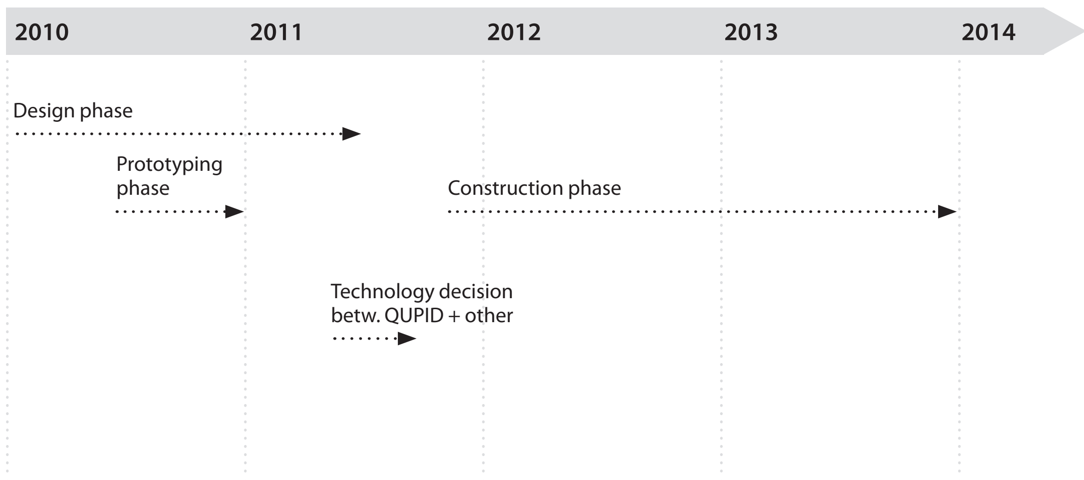
Prototyping phase
QUPID option: Currently working closely with Hamamatsu testing prototype QUPID, these tests includes uniformity scan of cathode and anode, linearity at various temperature including liquid xenon temperature at 165 K, quantum efficiency at low liquid xenon temperature.

A small scale LXe TPC with 7 QUPIDs is being set up in order to test the device under realistic conditions. QUPID screening for intrinsic radioactivity ongoing to reach better limits.
PMT R11410-MOD option: Performance tests at room temperature and in LXe.

Construction phase
XENON1T construction will start with the water tank for background shielding. Since the two photosensor options have similar dimensions, the final choice can be still made at a later stage depending upon the outcome of the performance tests, without significant impact on the cryostat design. Slight differences in signal/HV cabling requirement. Specific studies for QUPID assembly structure (HV distribution) are ongoing.

Critical parameters	Importance high (+++), low (–)	Comments
Quantum efficiency	++	> 30 % at 178 nm
Time resolution	+	
Backscattering	+	
After-/Prepulsing	++	
Radioactivity	+++	U/Th > 1 mBq/PMT
Low temperature	+++	- 110 °C to + 50 °C, operation in LXe possible
Pressure	+	have to resist 5 bar
Lifetime	++	
SiPM an option	–	No option for XENON1T, maybe for the next generation experiments, further R&D required
Other reqiurements		very good single photoelectron response Ideal geometry is 2″ PMT, VUV sensitive

Schedule



GERDA

The double beta decay experiment GERDA just got started to measure ^{76}Ge decays to search for the neutrino-less double beta decay. It is envisaged to extend the initial 18 kilogramme Germanium crystals to a larger mass and build a ton-scale detector with sensitivity for neutrino masses well below 0.1 eV.

http://www.mpi-hd.mpg.de/gerda/

Specifications

Photosensors
PMTs operated in water for Cherenkov light detection (muon veto system) ; typically 8 inch, currently 70 PMTs
Ultra-low background PMTs operated in liquid argon for scintillation light detection (R&D)
Ultra-low background silicon PM coupled to wavelength shifting fibres operated in liquid argon for scintillation light read out (R&D)

General wishes
PM in liquid Ar
1. QE & radioactivity !! Quartz needed ?
2. Low count rate and radio-purity needed!
3. Present problems: ramping-up of HV in cold phase
4. SiPM in liquid Ar: dark rate, sensitive wave lengths, coupling to WLS

Crucial is the 8″ muon veto, difficulties at low temperature, development is necessary
Now start with GERDA (phase I), need less than 1000 PMTs for phase III (Gerda 1t design)
Ultra-low background needed

Auxiliary electronics
FADC systems (100 MHz or faster) to digitize PMT and/or silicon PM signals ;
FADC (100 MHz, 14 bit) also used for recording germanium detector signals ; low-background front-end electronics operated with sensor in liquid argon.

Requirements

Is there a need for R&D on photosensors & aux. electronics? What kind of R&D?
Improved performance of light sensors in liquid argon; reduced radio-impurity levels in the glas of the PMTs; stable performance in liquid argon; low-background front-end electronics

Is there a need for an interaction with companies?
Yes. The current available light sensors which can be operated in liquid argon are not yet satisfactory.

How to ensure quality control?
Acceptance test of photo sensors in liquid argon; ICPMS for determination of uranium, thorium and potassium trace elements; low-background gamma spectroscopy.

What quantity of which parts is needed when?
This can be stated only at a later stage after completion of the R&D phase and after the technology selection.

Critical parameters	Importance high (+++), low (–)	Comments
Quantum efficiency	+++	high QE (angular independent)
Time resolution	+	
Backscattering	++	
After-/Prepulsing	+++	timing not important, as long as no tracking foreseen
Radioactivity	+++	low radioactivity of glass
Low temperature		important for lAr scintillation, not for GERDA Cerenkov
Pressure	++	up to ~ 2 bar
Lifetime	++	for lAr scintillation only
SiPM an option	+	
Other reqiurements		

Schedule

2010 | 2011/2012

GERDA phase I

Phase II

In parallel R&D on liquid argon scintillation detection is pursued on laboratory scale and in the GERDA-LArGe facility.

A follow-up one ton germanium experiment is conceived in collaboration with the US lead Majorana experiment. Precondition is a successful performance of the GERDA phase I/II and the Majorana demonstrator experiments.

Technology decisions will be based on the performance of those experiments.

SuperNEMO

SuperNEMO is a double beta decay experiment consisting of sandwiches of radioactive material with tracking chambers. The sensitivity in terms of neutrino mass is expected to be in the range of 0.03–0.1 eV.

http://nemo.in2p3.fr/supernemo/

Specifications

Photosensors

500 Photomultipliers 8″ coupled to plastic scintillator (~ 10 l volume, polystyren or polyvinyltoluen based).

- Energy resolution @ 1 MeV : < 8 % (FWHM)
- Quantum efficiency > 30 %, (332–482) pieces for the demonstrator (depending of scintillator blocks), (6640–9640) for the full detector.
- Scintillator + PMT : 1000 photoelectrons @ 1 Me€
- Gain of PMT : 10^5–10^6
- Charge at 1 MeV: ~ 100 pC
- Range for physics : 100 keV–10 MeV (10 pC –> 1000 pC)
- Electronics pedestal background < 2 mV
- Absolute timestamping ~ 100 ps
- Time resolution between 2 counters ~ 250 ps
- Total radioactivity of PMT Glass ~ 1 mBq/kg

Auxiliary electronics

Electronics developed by LAL Orsay and LPC Caen (France) for pulse shape analysis.

Critical parameters	Importance high (+++), low (–)	Comments
Quantum efficiency	+++	
Time resolution	++	
Backscattering	+++	
After-/Prepulsing	++	
Radioactivity	++	
Low temperature	–	
Pressure	–	
Lifetime	++	
SiPM an option	–	Not yet considered for SuperNEMO
Other reqiurements		Uniformity of photocathode for demonstrator

Requirements

Design phase

R&D needed for photomultipliers to improve energy resolution and to develop low radioactivity glasses. Developments done with Photonis and Hamamatsu companies. Contacts with ETL. Prototypes tests and Low background measurement performed at CENBG (France).

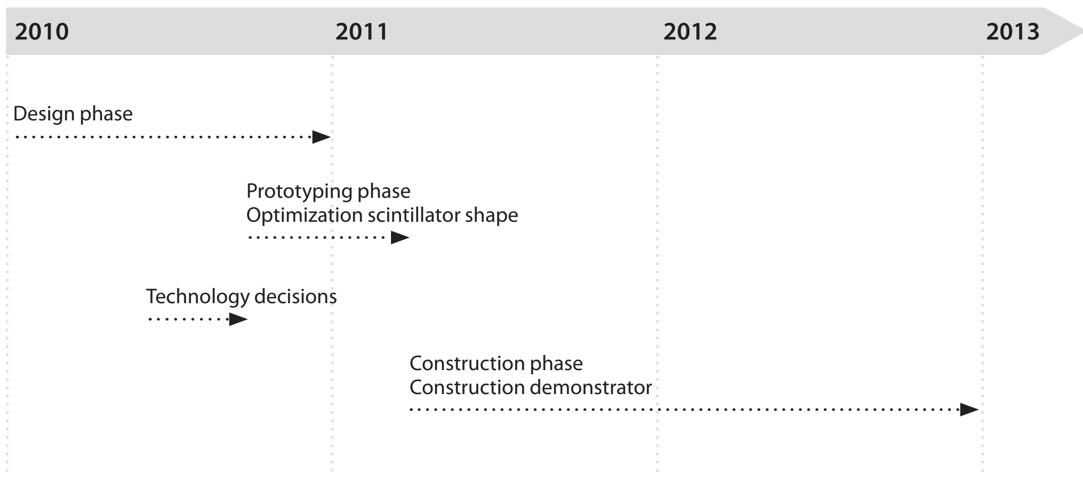
Prototyping phase

Purchase of (332–482) PMT and scintillator blocks. Control of the radioactivity of the PMT parts (glass, dynodes,…)
Each PMT and associated scintillator will be tested under a beta beam (0.4 –3 MeV)
2 years of running to test reliability, stability and long term performance of both PMT and scintillator. To be qualified for 10 years of operation.

Construction phase

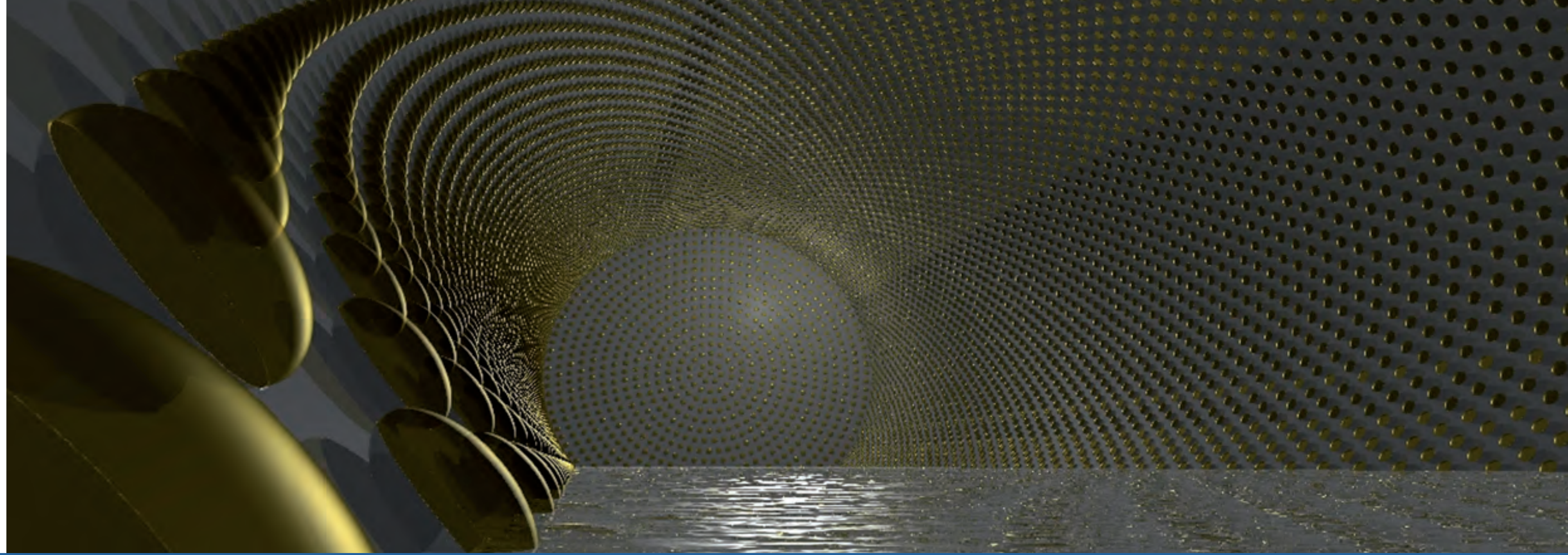
Purchase of 7000 –10 000 PMT and scintillator blocks. Control of the radioactivity of the PMT parts (glass, dynodes,…)
Each PMT and associated scintillator will be tested under a beta beam (0.4–3 MeV)

Schedule



LAGUNA LENA

LENA (Low Energy Neutrino Astrophysics) is a liquid scintillator detector with a multi-purpose approach. The research will cover a wide range of neutrino and particle physics from low-energies to GeV: Supernova neutrinos, solar neutrinos, geoneutrinos, reactor neutrinos, indirect dark matter search as well as proton decay.



http://www.e15.physik.tu-muenchen.de/research_and_projects/lena/

Design

- Inner detector: 46 kton unsegmented organic liquid scintillator (LAB + PPO + bisMSB) in cylindrical tank of 100 m height, 30 m diameter; 2 m of buffer (non-scintillating organic liquid) between scintillator and tank to shield from external radioactivity; photosensors with light concentrators installed at tank looking at scintillator volume
- Surrounded by Water Cherenkov muon veto (outer detector, blue in image); minimal width 2 m; equipped with the same photosensors, no light concentrators
- Underground facility: 4000 m.w.e. minimum

Specifications

Photosensors

- (High Quantum Efficiency) Bialkali PMTs, (low background) borosilicate glass, hemispherical window, 5″–10″ diameter (to be specified)
- PMTs in inner detector equipped with light concentrators, increasing the effective area by a factor of about 2.0
- Number of PMTs in inner detector, with light concentrators:
- 41 000 (10″) / 55 000 (8″) / 165 000 (5″)
- Number of PMTs in outer detector: 4000 (10″) / 5000 (8″) / 15 000 (5″) PMTs

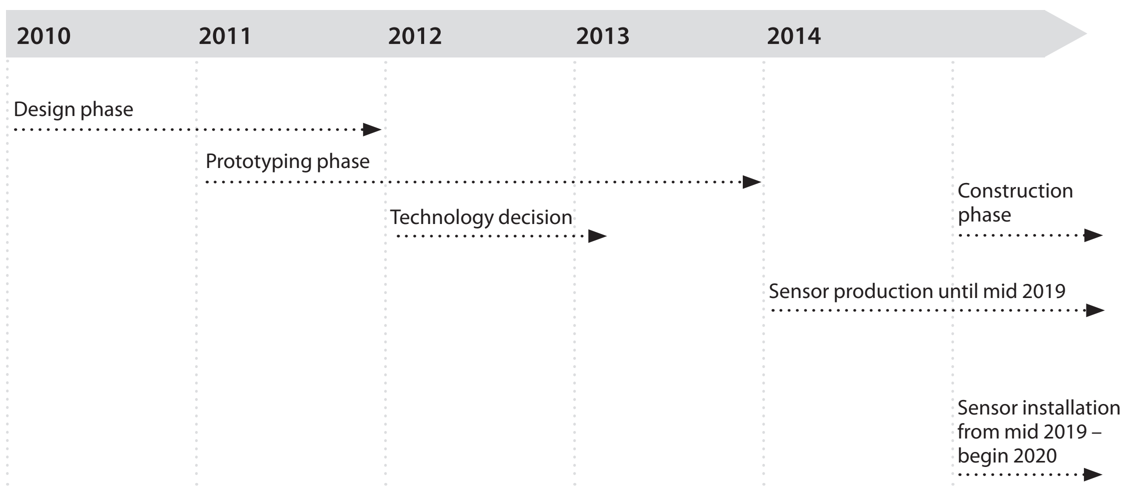
Critical parameters	Importance high (+++), low (–)	Comments
Pressure	+ w/ pressure encapsulations +++ without	>13 – 15 bar; design/testing of PMT pressure encapsulation with integrated light concentrator
Quantum efficency	++	Important for low energy neutrino physics
Collection efficency	++	Important for low energy neutrino physics
Backscattering	++	Limits photon detection efficiency
Time resolution	+++	Important for position reconstruc-tion, tracking and pulse shape discrimination
Early pulses	++	Important for position reconstruction and tracking
Ionic aferpulses	+/++	Still being evaluated
Fast afterpulses	+/++	Simulations ongoing
Dynamic range	++	Event energy range from 0.2 MeV to ~10 GeV
Radioactivity	+/++	Shielding by buffer
Low temperature	–	T fixed at 20 °C
Lifetime	+++	30+ years
SiPM an option	yes	Studied currently
Other requirements		

Auxiliary electronics

Between 30 000 and 100 000 channels (depending on PM size), information of pulse height, charge, and arrival time of photon. Sum of pulse shape (1 nsec resolution, 500 nsec length) of ca. 16 channels. Trigger electronics based on multiplicity of fired channels. Long lifetime and redundancy (supernova alert). Dead-time as small as possible. Cabling.

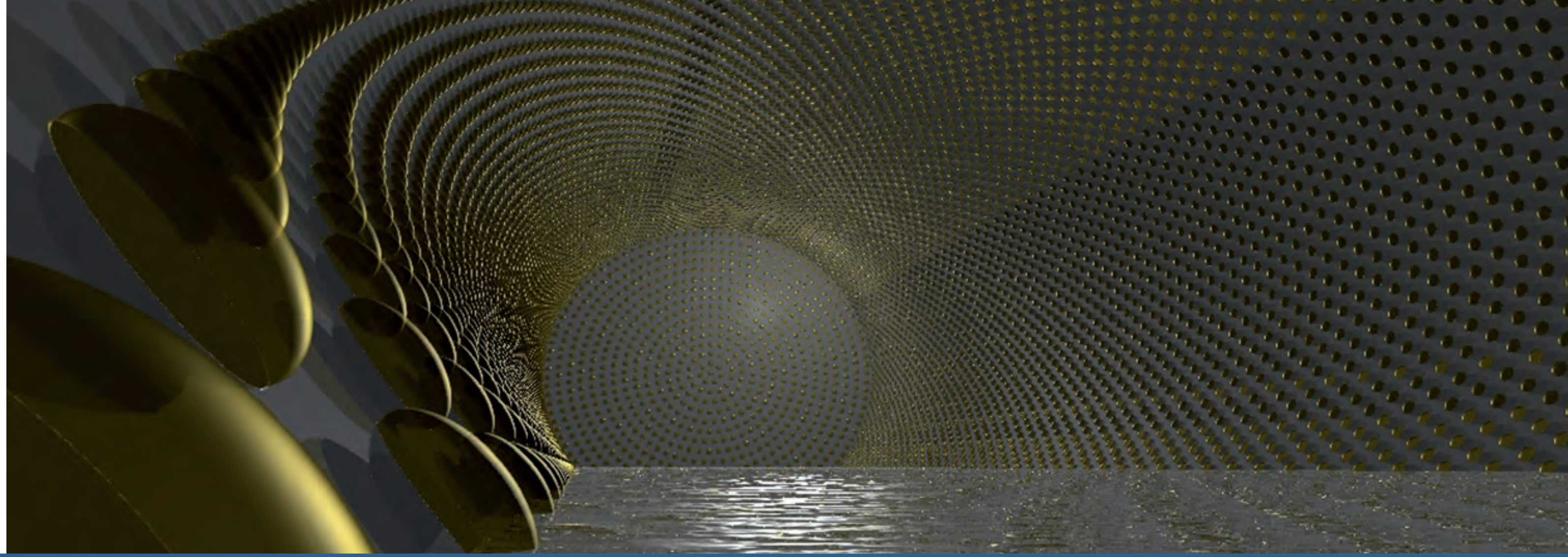
Sketch of the LENA detector

Schedule



LAGUNA MEMPHYS

The water Cherenkov detector of the MEgaton Mass PHYics experiment (MEMPHYS) is dedicated to nucleon decay, neutrinos from supernovae, solar and atmospheric neutrinos as well as Neutrinos from a future beta-beam coming from CERN. The detection principle consists in measuring Cherenkov rings produced by charged particles going faster than light in water. The Cherenkov light rings produced by fast particles moving within the inner water volume are reconstructed by PMTs placed in the inner tank wall.



http://www.apc.univ-paris7.fr/APC_CS/experiences/memphys

Specifications

Photosensors
The light sensors choice is to instrument the detector with photomultipliers tubes (PMTs) with a geometrical coverage of 30 %. In the order of 240 000 PMTs (12”) are needed. The QE should be the highest possible.

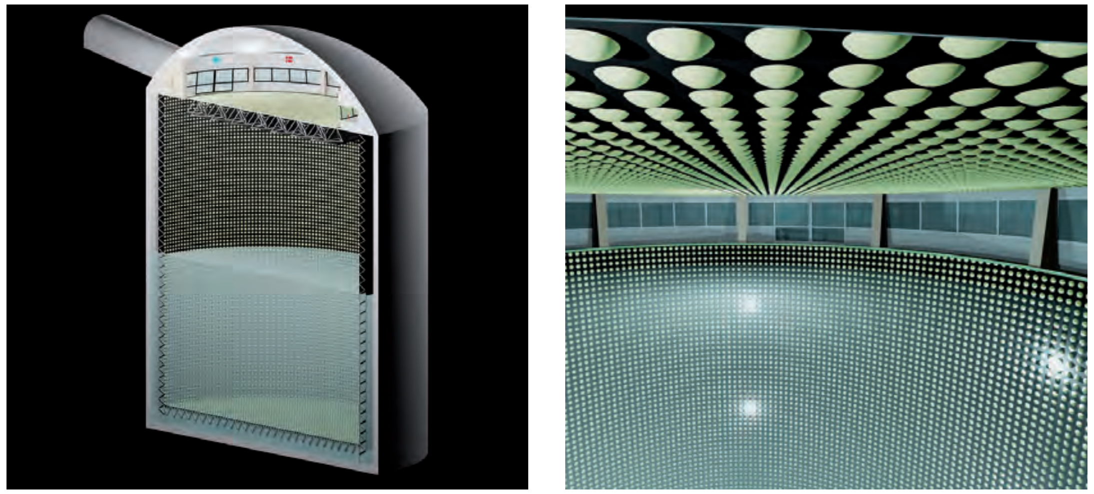
Auxiliary electronics
The development of such electronics is the aim of a dedicated French R&D program, called PMm2. The circuit under development allows to integrate for each group of 16 PMTs: a high-speed discriminator on the signal photoelectron (ph.e), the digitization of the charge (on 12 bits ADC) to provide numerical signals, the digitization of time (on 12 bits TDC) to provide time information, a channel-to-channel gain adjustment and a common high voltage.

Requirements

Design phase
R&D for the electronics. 13 000 electronics boards are needed for the final project. Interaction with companies is required.

Prototyping phase
16 PMTs and 16 electronics boards are required specially to test the synchronization between boards.

Construction phase
200 000 PMTs and 13 000 electronic boards are needed in continues flux as detector construction goes on.



Design of the MEMPHYS detector

Critical parameters	Importance high (+++), low (–)	Comments
Quantum efficiency	+++	> 25 %
Time resolution	++	1 ns
Backscattering	+	
After-/Prepulsing	++	
Radioactivity	+	
Low temperature	+	
Pressure	+++	min. 10 bars
Lifetime	+++	> 30 years
SiPM an option	–	
Other reqiurements		

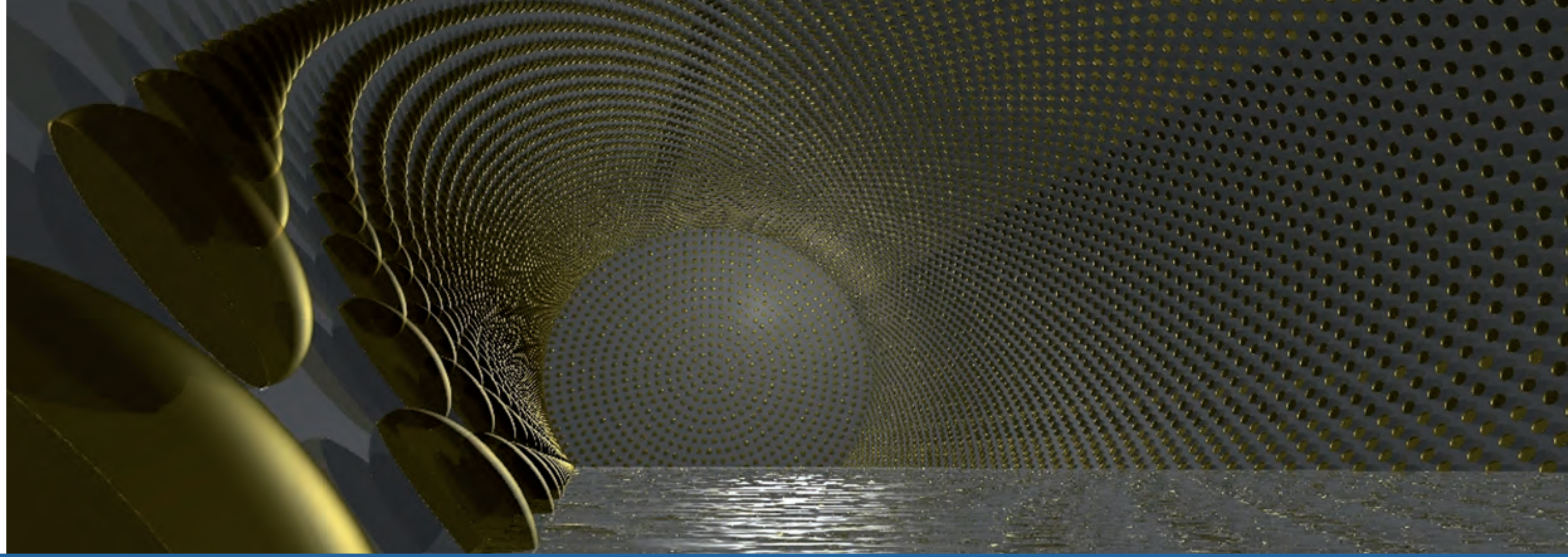
Schedule

2010	2011	2012	2013–2018
Design phase ··········►			
Prototyping phase ··········►			
			Construction phase ··········►

Underground Astroparticle Physics on the Megaton Scale

LAGUNA GLACIER

A large underground observatory for neutrino astrophysics based on a giant scale liquid argon time projection chamber (~ 100 kton) is a conceptual idea for next-generation very-massive, multi-purpose underground detector.



http://www.laguna-science.eu/

Specifications

Photosensors

- WLS-coated cryogenic 8″ PMTs, about 1000 for DUV light
- Uncoated cryogenic 8″ PMTs, about 27 000 for Cherenkov (visible to UV) light (optional)

Photomultiplier tubes (PMT) for cryogenic operation, 8 inch. 1000 to 10 000 PMTs with wavelength-shifter coating are to be used for the detection of deep ultraviolet scintillation light ($\lambda = 128$ nm) from the liquid argon, the number depending on the kinematic range of interest.

27 000 uncoated PMTs are required for the detection of Cherenkov light to cover 20 % of the surface, allowing a similar performance as Super Kamiokande with only the Cherenkov light. Existing 8-inch cryogenic PMTs (QE ≈ 20 %) is considered in the design study and in R&D so far. Development of high-QE (≥ 30 %) large area PMTs are of interest, which allows reduction of the number of PMTs.

Auxiliary electronics

As the PMTs are the only photosensors to be used, no special development of electronics is required.

Requirements

Design phase

Feasibility of the large area high-QE PMTs needs to be investigated. R&D of them in collaboration with manufacturers is possible.

Prototyping phase

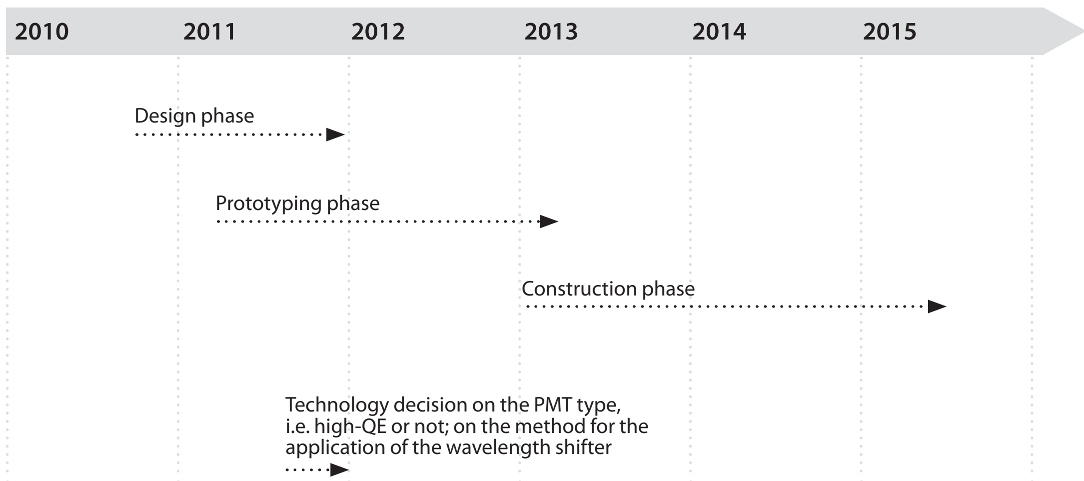
The concept of the light readout of the project is already under investigation in the ArDM Experiment (RE18), which is in operation at CERN. 3-inch high-QE PMTs (some have already been procured) are to be tested in the framework of ArDM.

Construction phase

The production of the PMTs should be started as early as the end of 2012. The full amount of the PMTs should be procured by the end of 2014. All the PMTs will be tested by the first quarter of 2015. A dedicated test facility should be built by June 2012.

Critical parameters	Importance high (+++), low (–)	Comments
Quantum efficiency	++	
Time resolution	+	
Backscattering	+	
After-/Prepulsing	+	
Radioactivity	+	
Low temperature	+++	
Pressure	++	
Lifetime	+++	
SiPM an option	–	
Other reqiurements		

Schedule



High Energy Universe

Pierre Auger Observatory

The Pierre Auger Observatory is a cosmic-ray experiment in Argentina consisting of an array of 1600 water Cherenkov tanks distributed over 3000 km^2 and four clusters of fluorescence telescopes which record cosmic-ray events up into the 10^{20} eV energy range. To reach full sky coverage and a substantially higher sensitivity the Pierre Auger collaboration envisages a complimentary but much larger array (~ 20 000 km^2) in the northern hemisphere.

http://www.auger.org/

Specifications & Requirements

Photosensors for water Cherenkov tanks (Surface Detector Array)

- Use one ~ 9" PMT per station -> 4000 9" PMTs
- test alternatives: multi-PMT spheres with smaller PMTs (e.g. 1.5–3"), if cheaper
- do not need ultra-fast response (≥ 5 ns)
- but good single photoelectron detection
- SBA photocathodes may have advantages, if collection efficiency remains good enough
- afterpulsing is an issue
- high dynamic range and linear response very important
- homogeneity of photocathode

Photosensors for Fluorescence telescopes (Fluorescence telescope cameras)

- 17 000 1.5" PMTs
- light spots of ~ ø 10 mm do not call for very small pixels (at present)
- no need for fast timing response (50 ns–µs scale)
- SBA photocathodes do have advantages
- drawbacks are being eliminated by manufacturers
- afterpulsing is still an issue
- collection efficiency seems to cause some extra electron-losses
- homogeneity of cathode response is of relevance
- hexagonal cathode makes life easier for the experimentalists
- high dynamic range and linear response very important
- no long-term experience yet with SBA cathodes (aging?)

Auxiliary electronics

Electronics for water Cherenkov tanks (Surface Detector Array) are powered by solar panels. Presently, low power DC-DC HV modules are being used (ETL PS2010/12). That drives the cost for the bases (more than 50 % of the cost!).

The Greinacher (Cockcraft Walton) base may be an alternative and useful to look into.

There are large needs for solar power driven electronics.

Electronics for Fluorescence Telescopes are connected to power lines.

The PMTs use classical voltage divider chain of low bleeder current. To save costs, presently 44 PMTs are connected to single HV channel. We wish to reduce this in the future by ~ factor 2 (still 800 channels).

Low cost HV power supplies will allow for more individual PMT settings.

Requirements: power consumption is a major issue and distributed DAQ systems.

SD-Electronics

- R&D and Prototyping on Auger-North has started ~ 3 years ago

Schematics of Prototype Board

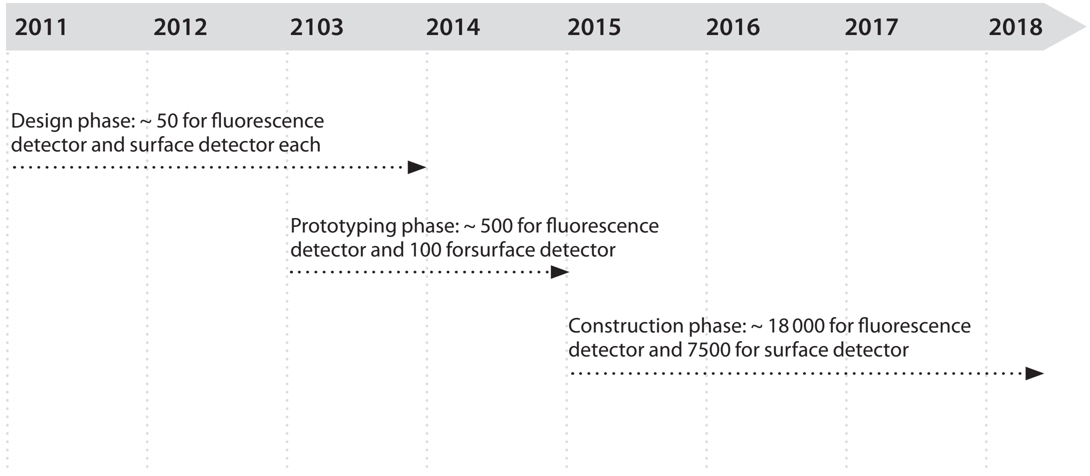
- A microcontroller, based on the ARM920 core plus an additional FPGA to perform the first level trigger and the time tagging.
- The microcontroller interfaces the GPS receiver, the trigger FPGA, communications and slow control devices.
- For time-tagging a rapid (100 MHz) counter will be latched by each local station trigger. The currently planned GPS clock is Motorola M12M.
- The time calibration across the array is better than 10 ns.

Comparison of Demands

- Fluorescence and Cherenkov Telescope Cameras (e.g. CTA) have very similar requirements; in fact Auger & CTA may use the same PMT
- Surface Water-Cherenkov Arrays and Neutrino Telescopes share similar demands, too, e.g. concept of single large vs. several small PMTs
- cooperations useful between major experiments and also between AP physicists and companies

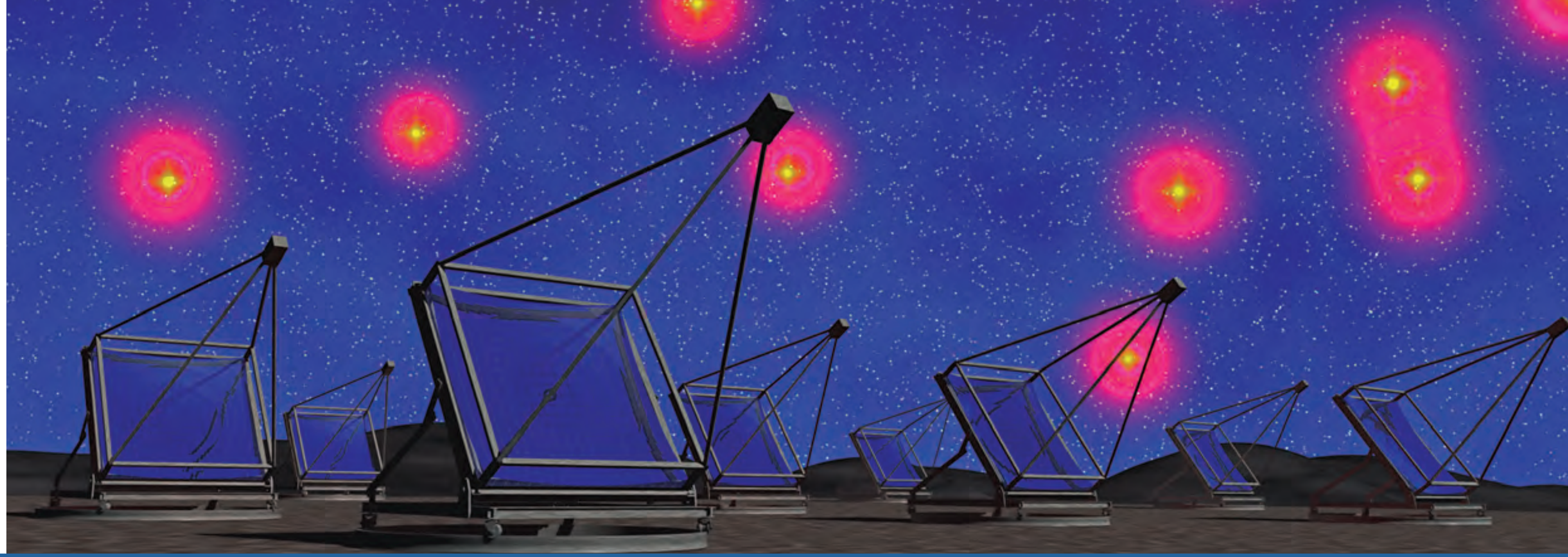
Critical parameters	Importance high (+++), low (–)	Comments
Quantum efficiency	++	
Time resolution	–	
Backscattering	++	
After-/Prepulsing	++	
Radioactivity	–	
Low temperature	–	
Pressure	–	
Lifetime	+++	
SiPM an option	–	Not with presently used optics
Other reqiurements		Dark current - should be < 20 nA, SBA: typically 4 %, initially 10 % !! BA: typically 1–2 %

Schedule



CTA

The Cherenkov Telescope Array CTA, succeeding the current gamma-ray telescope projects, shall be composed of a large number of Cherenkov telescopes covering the gamma-ray energy range from some 10 GeV to beyond 100 TeV. Combined with a 10-fold improvement of sensitivity and a significant improvement in resolution CTA shall be operated as an observatory.



http://cta-observatory.org/

Specifications

Photosensors

- Approx. 150 k channels, ~ 1.5″ sensors, enhanced QE, fast response, low afterpulsing rate
- For some subsystems also MAPMTs are considered, or SIPMT as upgrade options

Auxiliary electronics

Approx. 15 k waveform-recording channels, detailed specs still under evaluation
HV systems for PMT supply

Critical parameters	Importance high (+++), low (–)	Comments
Quantum efficiency	+++	Provided the very high QE PMTs, for the same energy range one could use a smaller size reflector (i.e., telescope) -> total cost reduction
Time resolution	++	Could help rejecting some type of background, specific studies are necessary
Backscattering	+++	It should be the main component contributing in (large F-factor) low amplitude resolution
After-/Prepulsing	+++	One of the main factors limiting the lower trigger threshold of telescopes
Radioactivity	–	When well-below noise induced by the Light of Night Sky, it is of low importance
Low temperature	–	Operation at T + 20 to 40 °C, therefore the low T is not important
Pressure	–	Operation at normal atmospheric pressure
Lifetime	+++	Very important. Every year we are increasing the applied HV by a few percent for compensating the gain loss.
SiPM an option	++	This is a serious candidate sensor but it needs to be matured, a few parameters (Photon Detection Efficiency, X-talk, noise) should be seriously improved before one can use them (expected time scale ~ 2 years).

Requirements

Design Phase and prototyping phase

R&D on PMTs concerns optimisation of QE, or collection efficiency, of afterpulsing rate, and of large-scale production costs.
R&D is carried out in interaction with companies
Various solutions for low-cost HV system are under study, in interaction with companies

Requested afterpulsing < 0.02 %.

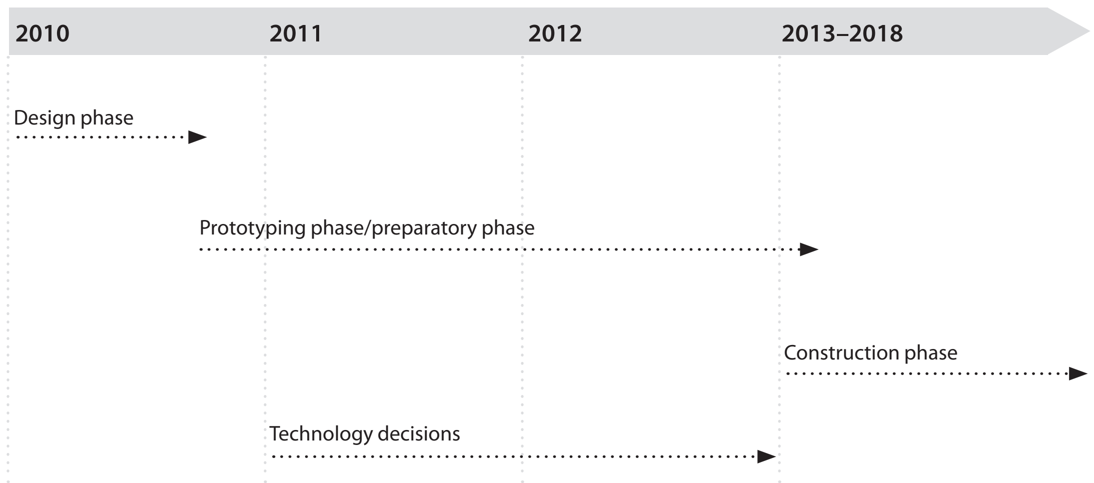
More improvements requested like much less variations in the gain of dynodes

Construction phase

Primary concern is probably the production rate of sensors

For further information on the CTA project please visit the following website:
http://aps.arxiv.org/abs/1008.3703
See "Design Concepts for the Cherenkov Telescope Array"

Schedule



KM3NeT

KM3NeT is a European initiative for a deep-sea research infrastructure hosting an underwater neutrino telescope in the Mediterranean Sea. A volume of several cubic kilometres shall be equipped with light sensors to detect Cherenkov light emitted by charged particles which have been produced in neutrino interactions. To reduce cosmic-ray induced background, in particular atmospheric muons, the light sensors look downward with having the Earth is a shielding and integral part of the telescope.

http://www.km3net.org

Specifications

Photosensors
The options currently being pursued are either ~ 300 000 PMTs (3 inch, peak QE above 32 %) or 30 000 PMTs (8 inch, peak QE above 30 % or 10 inch, peak QE above 20 %)
Most important specifications: small TTS, small single pe pulse time, short pulse rise time, sufficient peaktovalley ratio, high gain, low dark current.

- Use multi-PMT optical modules with 10", 8" or 3"
- Available 3" PMTs don't match the KM3NeT specifications, development urgently needed.
- Improvement is needed in the resolution.

Auxiliary electronics
Low power PMT base developed for the 3 inch option, to be developed for 8 or 10 inch option. Readout electronics based on custommade ASIC. Otherwise standard electronic electrooptical and optical components are used.

Critical parameters	Importance high (+++), low (–)	Comments
Quantum efficiency	++	Important: quantum efficiency times photocathode area
Time resolution	+++	Development needed, 2 ns/signal is ok, should be better
Backscattering	++	
After-/Prepulsing	+	
Radioactivity	–	It might be important to use low-radioactivity glass to avoid intrinsic background.
Low temperature	–	Operation at 14–20 °C or so
Pressure		PMTs inside pressure-resistent glass spheres
Lifetime	+++	The figure of merit is probably integrated charge/photo-cathode area
SiPM an option	no	Price
Other reqiurements		

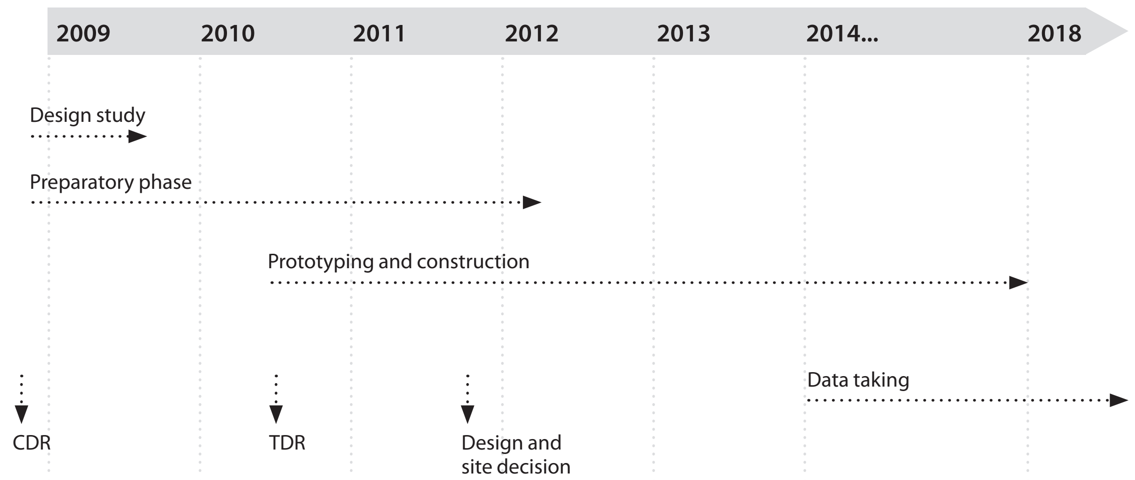
Requirements

Design phase
Adaptation of existing commercial models to specific needs (form factors, mass production suitability, costeffectiveness)
Interaction with companies established.
Quality control by lab tests of each individual PMT.

Prototyping phase
Sufficiently many closetofinal PMTs to construct, test and deploy prototype optical modules.
Discussions with providers ongoing.
Quality control by lab tests of each individual PMT. Specification of acceptance criteria

Construction phase
Provision of full quantity of PMTs over a period of 45 years.
A continuous contact with provider companies is mandatory. The exact implementation of quality control needs to be discussed.

Schedule



Companies Summarise the ASPERA Technology Forum

"I think a viewpoint shared by many in the forum is the following: So many of the "big" projects do not provide some of the project funding to detector companies to develop the technology ahead of the time when it is needed, or to make the investment in production equipment to make these thousands of detectors (PMT, SiPM etc). And of course this does not just apply to detector companies, but to all kinds of industry who would need to be involved in the eventual project- construction, electronics, IT.
As ever, team work form the earliest stages will maximise efficiency of spending and the quality of the end result. "

Arthur Barlow, Excelitas Technologies

"For Hamamatsu as a manufacturer is very important to be involved into the project information. The Forum helps us to understand the scientist's ideas, how the projects are going on. Especially for the European scientific projects it is a very good idea to get together and to find in the discussion to the essential points. The primary priorities become clear. This is the explicit impact which was definitely observed during the Technology Forum. From our site we hope we could show how Hamamatsu works, what we are doing for the cooperation with the scientific groups. It is important for us to make the researchers understand how we adopt the best scientific ideas to the industrial resources and possibilities.
Nevertheless, Hamamatsu is endeavor a very tight cooperation for newest scientific and technological developments. The ASPERA Technology Forum is a good platform to improve this cooperation."

Olga Stroh, Hamamatsu Photonics Deutschland GmbH

CAEN Electronic Instrumentation

CAEN SpA is leader in the design and manufacture of sophisticated electronic instrumentation for subnuclear, nuclear, and astroparticle physics: low voltage & high voltage power supply systems, signal conditioning, front-end, trigger, data acquisition electronics (VME, NIM, CAMAC standard) and powered crates.

CAEN activities are at the forefront of technology also thanks to years of intensive collaborations with the major Research Centers and Universities in the world. CAEN is also proud of its extensive collaboration with the most important HEP experiments world-wide: almost 40 % of our production is custom designed.
To provide its customers with better assistance and services CAEN opened its new branch companies in the United States (CAEN Technologies Inc., 2005) and in Germany (CAEN GmbH, 2006).

Products

For 30 years CAEN has been providing Scientists and Engineers with the most advanced electronic instrumentation for any particle or radiation detectors (Photomultipliers, Semiconductors, Gas, Liquid or Plastic).
Strong of an extremely close collaboration with the world major research laboratories CAEN is proud to produce the best tools for:
High Energy Physics, Neutrino Physics, Astrophysics, Dark Matter Investigation, Nuclear Physics Material Science, Medical Applications, Homeland Security, Industrial Applications and more …

With more than 250 products, our catalog offers complete lines including:

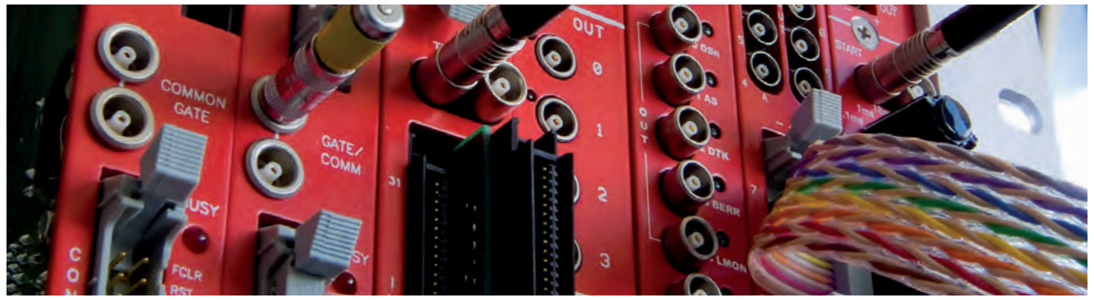
- NIM, VME and Mixed Powered Crates
- Power Supply Systems (Low-High Voltage)
- NIM, CAMAC and VME Front-End/Data Acquisition Module
- Preamplifiers

CAEN Network's Companies

CAEN SpA (Costruzioni Apparecchiature Elettroniche e Nucleari SpA) is one of the most important industrial spin-offs of the INFN (Istituto Nazionale di Fisica Nucleare) the Italian institute of nuclear physics. The company was founded in Viareggio (Italy) in 1979 by a group of senior engineers from the INFN, and it is recognized world wide as one of the leading companies in the electronic instrumentation field.
CAEN Network's Companies: the experience in its field allowed CAEN SpA to face new challenges in new sectors as Microelectronics and RFID (supported by autonomous operative Companies).

Microelectronics
Aurelia Microelettronica Srl provides a complete microelectronics design service for digital, mixed/analog ASICs and complex FPGA designs, with a wide offering of HW and SW Intellectual Properties (IP) blocks.

RFID
CAEN RFID Srl is a Europe's leading supplier of UHF RFID readers and tags. As an active participant of ETSI and EPC Global working groups since 2004, CAEN RFID is committed to provide customers with state-of-the-art readers and tags that meet ISO/EPC standards and ETSI requirements. Thanks to our R&D skills, CAEN RFID can also design specific equipment on a custom basis, thus providing RFID readers and tags for special applications on demand.



CAEN Tools for Discovery

CAEN SpA
Via Vetraia, 11
550049 Viareggio
Italy
Phone: +39 0584388398
Fax: +39 0584388959
E-mail: info@caen.it
Web: http://www.caen.it

ETEnterprises electron tubes

ET Enterprises Limited is a new UK company which manufactures and supplies the long established Electron Tubes brand of photomultipliers and associated signal processing hardware and electronics to meet the needs of low light level detector users in industry and research around the world.

ET Enterprises Limited is a newly formed company which acquired the photomultiplier and accessories business of Electron Tubes Limited at the beginning of May 2007 and will continue to manufacture, market and develop the Electron Tubes brand product range.

Although a new company, it's history can be traced back to the 1930s when, as part of EMI, it first became involved with light detection technologies. Specialisation in the development and manufacture of photomultipliers started in the late 1940s, and the company continued to grow to become a major international supplier of low-level light detection devices and systems. Now a subsidiary of Ludlum Measurements Inc, ET Enterprises Limited has the benefit of the combined resources of the production facilities of ADIT, a US based producer of photomultipliers, and ET Enterprises' UK based development facilities and experience in a wide range of different photomultiplier applications worldwide.

Pressure resistant hemispherical pmts

Low temperature pmts for operation to -196 deg. C

ET Enterprises electron tubes

We have a sales office in New Jersey USA, and a network of distributors covering most other parts of the world.

ET Enterprises Limited
Riverside Way
Uxbridge
UB8 2YF
United Kingdom
Phone: +44 1895 200880
Fax: +44 1895 270873
Email: sales@et-enterprises.com
www.et-enterprises.com

Electron Tubes
100 Forge Way, Unit F
Rockaway, NJ 07866=
USA
Phone: +1 973 5869594
Toll free:
+1 800 5218382
Fax: +1 973 5869771
Email: sales@electron-tubes.com
www.electrontubes.com

Products

Our photomultiplier range includes

- active diameters from 2.5 to 225 mm
- Spectral range options from 110 to 900 nm
- Operation from -196 to +175 deg. C
- High quantum efficiency with low dark noise
- Ultra-low background glass and all-quartz options
- Wide dynamic range from a few photons/s to >50 M/s

Photomultiplier manufacturing for 60 years

- As ET Enterprises – from 2007
- Electron Tubes – 1990's
- Thorn EMI Electron Tubes – 1970's
- EMI Electron Tubes – 1950's

Example ET pmts in HEP experiments

- Babar – 28 mm water resistant glass
- Borexino – 200 mm water resistant glass – ultra low background glass
- ICARUS – 200 mm – 186 deg. C – ultra low background glass
- WARP – 50 and 75 mm – 186 deg. C – ultra low background glass
- MAGIC – 25 mm 6 stage fast hemispherical
- ZEPLIN – 50 mm all-quartz - 110 deg C

Design and Manufacturing facilities in
Uxbridge, UK
Sweetwater, USA

FOTON

FOTON, s.r.o. is a company specialising in designing and manufacturing of advanced scientific instrumentation. Our activities include high voltage supplies, special electronics systems, optoelectronics, micropositioning automation, plasma diagnostics, vacuum control technology and instrumental engineering.

Our key strengths include the ability to accommodate a wide range of requirements, guarantee reliability and precision of every manufactured device and offer friendly communication.

Products

During our 10 year's existence we designed and manufactured more than 100 prototypes of various products, mainly special power supplies and vacuum controllers. High reliability, State-of-the-art design, long-time experience in scientific applications and professional approach guarantee high quality of all our products and customer satisfaction.
We specialize in: High Voltage Power Supplies, Micropositioning Control Units, Optical Generators and Photodetectors, Optomechanics, Plasma Diagnostics, Special Customised Systems, Vacuum Control Units, Voltage and Current Supplies, Industrial Automation

Parameters of Selected Products

High voltage supplies & generators

- 1 kV/2 kV/3 kV/4 kV/5 kV @ 5 W, DC, regulated
- 5 kV @ 10 mA, pulse generator, 1 ms–1.000 ms/30 steps up to 5 kV/30 mA/0,1 ms–255 ms /2 kV/1–255 ms generator
- standard supplies working on high potentials (60 kV)
- 8–15 kV & 8 mA DC/500–6.000 V @ 400 W DC

Special supplies and generators

- DC 100 V & 4 A/DC 300 A @ 1,8 kW/DC 400 A @ 2,5 kW
- waveform-generator 0–10 kHz, sin/sq/tri @ ±180V @ 3A
- pulse generator up to 100 A @ 400 V @ 50 ms
- AC 230 @ 160–260 VACinp / AC 0–30 A @ 0–20 V, 50 Hz, 2 kV wp
- DC 5 V & 5 A & 2 kV wp / AC 0–100 V @ 4 A
- DC 6 A @ 3 V, charge measurement mC to 1 kC
- 500 A @ 36 V power amplifier for plasma feed back

Special devices

- delay lines of analogue signals (0,1 us resolution, 5 MHz BW, 5th order active filers
- insulated current measurement modules
- system for measurement of magnetic field fluctuations
- various fibre-optic applications (signal distribution, fast detection (up to sub ns scale))
- photomultiplier tester; photodetection interfaces

Vacuum controllers
various systems, largest one for control of accelerator vacuum (pumps : 10 prim/18 turbo/10 ionic/30 gauges/70 valves)

Positioning
DC & stepper motor controllers/16 channels/micro to 4 A stepper motors/sequential control, for standard actuators

Industrial automation
design, PLC control, HW & SW , custom systems

Our products have been employed in many prestigious scientific and technical projects, e.g. vacuum control technology for high-power laser labs (PALS, Prague, IST, Lisbon) and particle accelerators (nuclotron, JINR, Dubna), high voltage suppliers for nuclear technology (NRI Rez, NRI, Kiev), as well as the high temperature plasma diagnostic instrumentation (tokamaks, stellarators). Our devices became a part of many major projects in various parts of the world. Since 2010 we have taken a part in European project ELI

Foton
Joy of Technology

FOTON, s. r. o.
Tesinska 1361
50901 Nova Paka
Czech Republic
Phone: +420 493 720451
Fax: +420 493 720454
E-mail: info@fotons.cz
www.fotons.cz

Hamamatsu Photonics

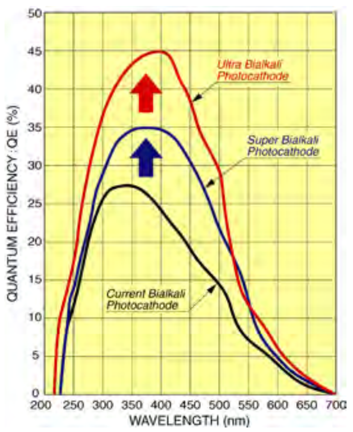
Hamamatsu Photonics is a worldwide leading manufacturer of opto-electronic components and systems. Among others we offer sensors and systems for spectroscopy (including ultra fast), scientific-grade cameras, beam monitoring solutions, photon counting detectors and systems, photomultipliers, photodiodes, IR detectors.

PMT Series

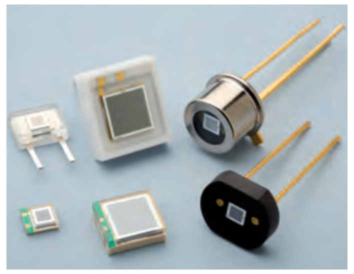
Features

- Fast time response
- Low after pulse noise
- Large active area: Active area from ½" to 18"
- High sensitivity: SBA cathode technology QE 36 %
- Diverse cathode material technology
- Multi anode technology
- Low cost for large area

Ultra/Super Bialkali Spectral response



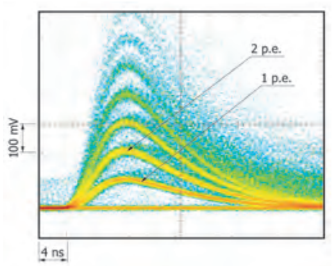
MPPC Modules



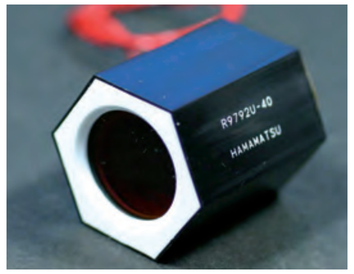
Features

- Geiger-mode APD
- Automatic mass production
- Low cost
- Not sensitive to magnetic field
- High sensitivity
- Single Photon Counting
- High time resolution

Measurement example: Analog output (C 10507-11-050U)



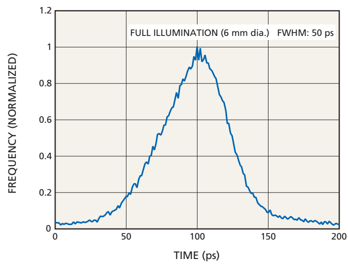
Hybrid Photo Detector



Features

- High gain
- Ultra fast time response
- No after pulse noise
- 3 cathode types: Bialkali, GaAsP, GaAs

T.T.S.: Transsit Time Spread (H10777-06) (single-photoelectron state)



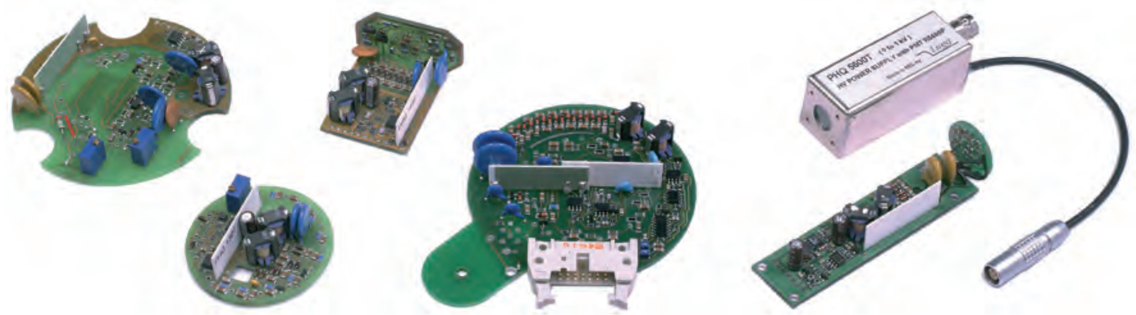
HAMAMATSU
PHOTON IS OUR BUSINESS

Hamamatsu Photonics Deutschland GmbH
Arzbergerstr.10
82211 Herrsching
Phone: +49 8152 375100
Fax: +49 8152 375111
Email: dialog@hamamatsu.de
Web: www.hamamatsu.de

iseg Spezialelektronik

The iseg Spezialelektronik GmbH company specialises in the development and production of high voltage power supplies for industry and research. This is based on 30 years of experience in the development and use of technologies of modern high voltage generation.

Selected Products
Photomultiplier Tube Base Integrated HV Power Supply – PHQs



Features

- HV power supplies for Photo Multiplier Tubes integrated into socket
- adapted to individual PMTs
- compact, low ripple and noise, low EMI
- actively stabilized dynodes for high linearity
- used in H.E.S.S. I + II, ANTARES, NEMO Prototype...

NIM, CAMAC, VME, Eurocrate Power Supplies

Features

- modular HV power supplies for different physics standards
- high variety of voltage/current combinations
- front panel and/or interface control
- low ripple and noise, high measurement resolutions
- voltages from 500 V up to 10 kV

For more information about our products please refer www.iseg-hv.com

iseg
Spezialelektronik GmbH

iseg Spezialelektronik GmbH
Bautzner Landstraße 23
01454 Radeberg/ OT Rossendorf
Germany
Phone: +49 351 269960
Fax : +49 35126 99621
Email: sales@iseg-hv.de
www.iseg-hv.com

LWL Sachsenkabel

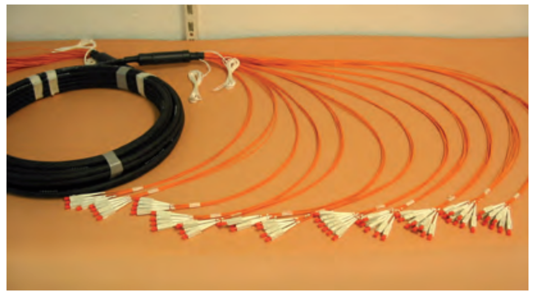
The fibre optic specialists: reliability, flexibility, speed.
We maintain what we connect.

The LWL Sachsenkabel GmbH is a leading assembly specialist of single-mode and multi-mode fibre optic cables.
Since the foundation of our company in 1991 we have been manufacturing pigtails, patch cords, preassembled connections as well as connection and distribution technology for fibre optic connections.

Our highly skilled technicians and engineers guarantee the highest possible standards of quality, the shortest delivery times and a high degree of professional competence.
In addition to certification according to DIN EN ISO 9001:2000, our proprietary quality management system ensures the quality of our entire range of products and services.
Since 2001 the LWL Sachsenkabel GmbH is a certified supplier of the Deutsche Telekom AG.

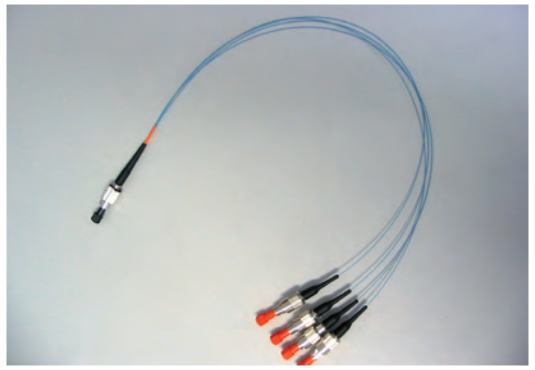
Application Specific Multi-Core Cables

Features
- Exact fibre lenghts by a nano second
- Experimental and appliction specific cables
- Fibre optic connectors of highest quality with detailed interferometry protocols



Special Cables and Special Fibres

Features
- Thick core fibres
- Polyamide coating, Aluminium coating et al.
- Fibres for the UV and IR spectrum
- POF, HCS
- Cables with heat protective conduits



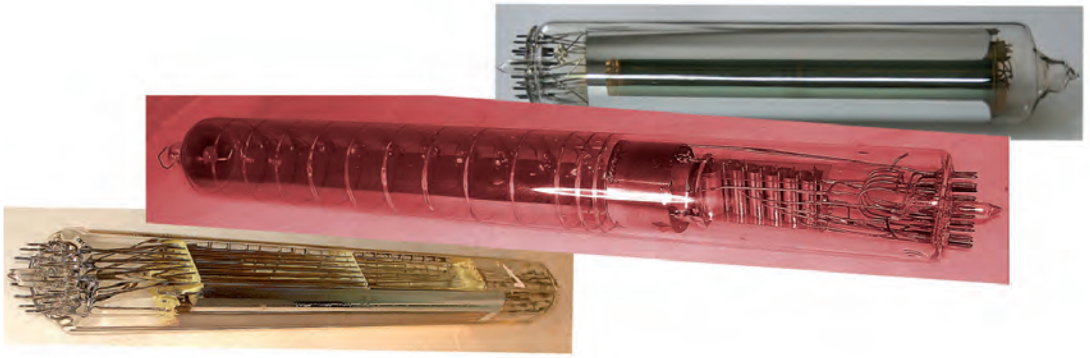
Assembly and Measurement of Multiplexing Devices

Features
- Customer specific connector assembly
- Measured with an optical spectrum analyser

LWL-Sachsenkabel GmbH
Auerbacher Str. 24
09390 Gornsdorf/ Erzgebirge
Germany
Phone: +49 3721 3988-0
Fax: +49 3721 3988-16
Email: info@sachsenkabel.de
Web: www.sachsenkabel.de

MELZ FEU

MELZ FEU is a Russian company with strong traditions and innovations in photomultiplier tubes production.



Profile

MELZ FEU is global supplier of Photomultiplier Tubes (PMT) and Accessories.
MELZ FEU works with its clients, identifies and understands clients needs and requirements for special task solutions.
We have more then 50 years experience in design and production of PMT.
Our plant combines R&D department and factory.
Quality MELZ FEU's devices is tested by long-time.

PMT R&D and Manufactures

PMT – for different applications
- Photo-, radio-, spectrometry
- Nuclear research, scintillators
- For high temperature media
- Solarblind, Large scale spectra
- For photon calculations
- etc.

Accessories – for PMT
- Adaptors, connectors, sockets
- Power supplies, amplifiers
- Magnetic shields

New & non-standard PMT
- Multichannel PMT for special applications.
- Ultra-short PMT (4 dynodes)
- The small-scale series PMT for individual projects

MELZ FEU, Ltd. (Russia)
124460, Moscow
Zelenograd
4922 st., b. 4/5
Phone/Fax:
+7 499 995-02-33
info@melz-feu.ru
www.melz-feu.ru

Excelitas Technologies (PerkinElmer)

Excelitas Technologies—previously the Illumination and Detection Solutions (IDS) business unit of PerkinElmer—is a global technology leader focused on delivering innovative, customized optoelectronics to OEMs seeking high-performance, market-driven technology solutions.

Our tagline embodies the spirit of Excelitas: Engage. Enable. Excel.

Engage

At Excelitas, we engage with our customers in collaborative engineer-to-engineer relationships. Our engineers are involved early in product design cycles, helping our customers to accelerate their new product introductions.

Enable

With our broad applications expertise and innovative technology solutions, we enable a diverse set of applications including surgical suite lighting, thermometry, molecular imaging, home security systems, energy-efficient indoor climate control systems, and space applications.

Excel

Our customized, market-driven solutions for each of our OEM customers' unique system requirements—coupled with a focus on excellence in all aspects of product performance, quality, reliability, delivery and service—help our OEM customers to excel in their specialty end-markets and applications.

Facts and Figures

- 2010 Revenues (Estimated): $ 300 million
- Manufacturing Locations 13: in the Americas, Europe and Asia
- Total Number of Employees: 3 000
- Ownership: Veritas Capital (Private Equity)

Selected Products

Excelitas' low light level detection solutions—dubbed L3D—leverages the company's growing range of photon detection technologies and products including avalanche photodiodes (APDs), single photon counting modules (SPCMs), channel photomultipliers (CPMs), and silicon photomultipliers (SiPMs), ideally suited to applications including confocal microscopy, fluorescence and luminescence, molecular/PET imaging, particle sizing, and research and scientific instrumentation.

Excelitas Technologies UK Ltd.
Dr. Arthur Barlow
Saxon Way, Bar Hill,
Cambridge, CB23 8SL,
U.K.
Phone: +44 1420 562410
Email: arthur.barlow@excelitas.com
Web: www.excelitas.com

Philips Digital Photon Counting

Philips Digital Photon Counting being a part of Philips Corporate Technologies is dedicated to designing and developing innovative digital detector solutions to revolutionize single photon counting in a broad range of applications such as medical imaging, high energy physics and analytical instrumentation.

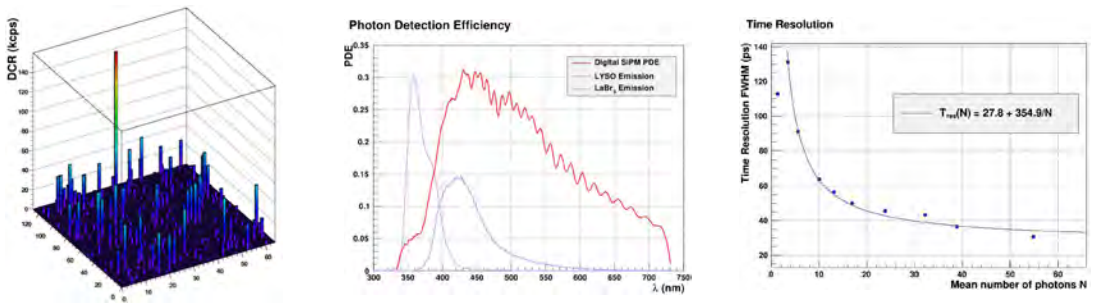
Selected Products

Although photon counting is by definition a digital task, conventional silicon photomultipliers combine the electrical pulses generated by multiple photon detections into a single analog output signal that has to be processed by expensive power-consuming electronics in order to recover the photon count.
By integrating low-power CMOS electronics into the silicon photomultiplier chip, the team at Philips has developed a silicon photomultiplier in which each photon detection is converted immediately into an ultra high speed digital pulse that can be directly counted by on-chip counter circuitry. Moreover, these revolutionary new silicon photomultipliers can be manufactured using a CMOS process technology.

In contrast to conventional silicon photomultipliers, the Philips silicon photomultiplier is therefore an all-digital (digital-in/digital-out) device. As a result, it produces faster and more accurate photon counts with extremely well-defined timing of the first photon detection, both of which are important factors in applications such medical imaging scanners and high-energy nuclear particle detectors.

Key Features

- 8 x 8 pixels
- Single photon counting capability
- Integrated Time-to-Digital converter
- First photon trigger
- Excellent timing resolution
- Fully digital interface
- Insensitive against electromagnetic interference and temperature variations



Th. Frach et al., "The Digital Silicon Photomultiplier – Principle of Operation and Intrinsic Detector Performance", NSS-MIC Conference Record, 2009

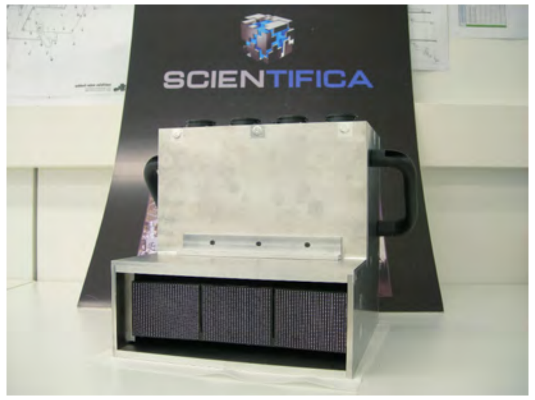
Philips Digital Photon Counting
Weisshausstraße 2
52066 Aachen
Germany
Phone: +49 241 6003613
Fax: +49 241 6003442
Email: digitalphotoncounting@philips.com
Web: www.philips.com/digitalphotoncounting

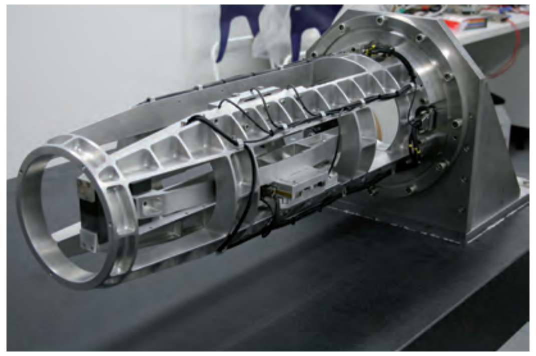
Scientifica International

Scientifica International is a company spun-off from AVS engineering company, based in Eibar and Itziar-Deba, in northern Spain.
It is devoted to the development, manufacturing and commercialisation of precision equipment for the Science Market.

Scientifica's knowledge base and industrial capabilities extend to three main core technologies:

- Precision mechanics: Ultra high precision mechanics that enables motion control and custom functionality even in hostile working environments as vacuum, radiation, cryogenic and high magnetic fields.
- Electronics and signal processing: High precision and custom functionality devices, with custom control and signal processing capabilities and algorithms.
- Composite materials: Custom structural and functional materials, with high performance for special purposes.





Neutron beam collimator

Neutron detector modules

With a strong commitment towards the development and commercialisation of its own proprietary product line, Scientifica can also deliver integration services to it's clients in order to give the best solution to their needs.

As matter of fact, Scientifica has developed a position sensitive neutron detection technology based in solid scintillator material. This development has enabled Scientifica to provide detector modules that have been successfully tested at the facilities of ISIS pulsed neutron source in Oxford, UK. It has become the first product in a forthcoming product range under development.

Scientifica International aims to be the preferred partner for world's most competitive and challenging Scientific Facilities, Laboratories, Research Institutions and Universities for the fields of precision mechatronics, electronics and composite materials.

Scientifica Internacional, S.L.
Main Offices: Polígono Industrial Azitain 3k - 2º J
20600 Eibar
Phone: + 34 943 127285
Email: info@scientifica.es

Manufacturing Premises: Poligono Industrial de Itziar Parcela M-4.3
20829 Itziar-Deba
Web: www.scientifica.es

List of Participants

Experiments

CTA	Dr. Eckart Lorenz	e.lorenz@mac.com
CTA	Dr. Razmik Mirzoyan	razmik@mppmu.mpg.de
EURECA	Dr. Jean-Come Lanfranchi	jean.lanfranchi@ph.tum.de
Gerda-1t	Dr. Jozef Janicsko-Csathy	janicsko@mppmu.mpg.de
Gerda-1t	Dr. Bayarto Lubsandorzhiev	lubsand@pit.physik.uni-tuebingen.de
Gerda-1t	Dr. Bela Majorovits	bela@mppmu.mpg.de
Gerda-1t	Prof. Peter Grabmayr	grabmayr@uni-tuebingen.de
KM3NeT	Dr. Oleg Kalekin	oleg.kalekin@physik.uni-erlangen.de
KM3NeT	Prof. Herbert Loehner	loehner@kvi.nl
KM3NeT	Prof. Mauro Taiuti	Mauro.Taiuti@ge.infn.it
KM3NeT	Prof. Uli Katz	katz@physik.uni-erlangen.de
LAGUNA GLACIER	Dr. Sosuke Horikawa	Sosuke.Horikawa@cern.ch
LAGUNA LENA	Dr. Paolo Lombardi	paolo.lombardi@mi.infn.it
LAGUNA LENA	Jürgen Winter	juergen.winter@ph.tum.de
LAGUNA LENA	Marc Tippmann	marc.tippmann@ph.tum.de
LAGUNA LENA	Michael Wurm	michael.wurm@ph.tum.de
LAGUNA LENA	Prof. Lothar Oberauer	Lothar.Oberauer@ph.tum.de
LAGUNA MEMPHYS	Alessandra Tonazzo	tonazzo@in2p3.fr
LAGUNA MEMPHYS	Michela Marafini	marafina@apc.univ-paris7.fr
LAGUNA MEMPHYS	Prof. Thomas Patzak	patzak@apc.univ-paris7.fr
Pierrre Auger Observatory	Dr. Andreas Haungs	haungs@kit.edu
Pierrre Auger Observatory	Martina Bohacova	bohacova@fzu.cz
Pierrre Auger Observatory	Prof. Karl-Heinz Kampert	kampert@uni-wuppertal.de
Pierrre Auger Observatory	Prof. Marc Weber	marc.weber@kit.edu
Pierre Auger Observatory	Prof. Michelangelo Ambrosio	Michelangelo.Ambrosio@na.infn.it
SuperNEMO	Dr. Fabrice Piquemal	piquemal@cenbg.in2p3.fr
SuperNEMO	Prof. Karol Lang	lang@physics.utexas.edu
XENON1T	Dr. Hanguo Wang	hanguo@ucla.edu
XENON1T	Dr. Marc Schumann	marc.schumann@physik.uzh.ch
XENON1T	Prof. Elena Aprile	age@astro.columbia.edu

List of Participants

Companies

AMS GmbH	Dr. Bernhard Sünder	Bernhard.Suender@jBeam.de
CAEN GmbH	Arp-Nico von Düring	n.vonduering@caen-de.com
CAEN S.p.A.	Dr. Franco Vivaldi	info@caen.it
CAEN S.p.A.	Gianni di Maio	g.dimaio@caen.it
ET Enterprises Ltd.	Andy Cormack	AndyCormack@et-enterprises.com
ET Enterprises Ltd.	Graham Sperrin	Graham.sperrin@et-enterprises.com
ET Enterprises Ltd.	Ron Stubberfield	Ron.stubberfield@et-enterprises.com
FOTON, s. r. o.	Dr. Jaroslav Moravec	moravec@fotons.cz
HAMAMATSU PHOTONICS Deutschland GmbH	Christian Dille	cdille@hamamatsu.de
HAMAMATSU PHOTONICS Deutschland GmbH	Marius Metzger	marius.metzger@hamamatsu.ch
HAMAMATSU PHOTONICS Deutschland GmbH	Olga Stroh	ostroh@hamamatsu.de
HAMAMATSU PHOTONICS Deutschland GmbH	Ruppert Maier	rmaier@hamamatsu.de
HAMAMATSU PHOTONICS Deutschland GmbH	Siegfried Schmid	sschmid@hamamatsu.de
HAMAMATSU PHOTONICS Deutschland GmbH	Yuji Hotta	hotta@etd.hpk.co.jp
HAMAMATSU PHOTONICS Deutschland GmbH	Yuji Yoshizawa	yuji.yoshizawa@etd.hpk.co.jp
ISEG Spezialelektronik GmbH	Stefan Jurk	support@iseg-hv.de
LWL-Sachsenkabel GmbH	Lars Schumann	l.schumann@sachsenkabel.de
LWL-Sachsenkabel GmbH	Silvia Duus	s.duus@sachsenkabel.de
LWL-Sachsenkabel GmbH	Steffen Luedemann	s.luedemann@sachsenkabel.de
MELZ-FEU, Ltd	Igor Fedorov	ifedorov@melz-evp.ru
MELZ-FEU, Ltd	Sergey Jakushov	lidok_011186@list.ru
Excelitas Technologies (PerkinElmer)	Dr. Arthur Barlow	arthur.barlow@excelitas.com
Excelitas Technologies (PerkinElmer)	Henri Dautet	Henri.Dautet@excelitas.com
Philips Technologie GmbH	Anja Schmitz	anja.schmitz@philips.com
Philips Technologie GmbH	Dr. Thomas Frach	carsten.degenhardt@philips.com
Scientifica Internacional, S.L.	Lander Gonzalez Larrea	lglarrea@scientifica.es
Struck Innovative Systeme	Matthias Kirsch	Matthias.kirsch@struck.de
Thales	Dr. Michel Caplot	michel.caplot@thalesgroup.com
Thales	Pascal Vairac	pascal.vairac@femto-st.fr

Speaker

Technische Universität München	Dr. Dieter Renker	dieter.renker@ph.tum.de
University of Split, Croatia (on leave of absence from UC Davis)	Prof. Daniel Ferenc	ferenc@physics.ucdavis.edu

List of Participants

Guests

CDTI/MICINN	Dr. Kauzar Saleh Contell	saleh_kauzar@cdti.es
CERN/ TTN	Dr. Hartmut Hillemanns	hartmut.hillemanns@cern.ch
ETH Zürich	Thomas Krähenbühl	thomas.kraehenbuehl@phys.ethz.cEhTH
Fraunhofer EMFT	Dr. Lars Nebrich	lars.nebrich@emft.fraunhofer.de
HV Sistems S.L.	Javier Herrero	jherrero@hvsistemas.es
INFN-Napoli	Dr. Carla Aramo	aramo@na.infn.it
INFN/ TTN	Prof. Massimo Caccia	massimo.caccia@uninsubria.it
INFN/Universita' di Catania	Dr. Nunzio Randazzo	nunzio.randazzo@ct.infn.it
KETEK GmbH	Dr. Florian Wiest	florian.wiest@ketek.net
LAPP	Prof. Roman Kossakowski	kossa@lapp.in2p3.fr
LIP	Pedro Assis	pedjor@lip.pt
LIP	Prof. Mario Pimenta	pimenta@lip.pt
Max-Planck-Institut für Physik	David Fink	fink@mppmu.mpg.de
Max-Planck-Institut für Physik	Dr. Josef Janisko	janicsko@mppmu.mpg.de
Max-Planck-Institut für Physik	Dr. Olaf Reimann	reimann@mpp.mpg.de
Max-Planck-Institut für Physik	Dr. Hans-Günther Moser	hgm@hll.mpg.de
Max-Planck-Institut für Physik	Michal Tesar	tesar@mpp.mpg.de
Max-Planck-Institut für Kernphysik	Dr. Elisa Resconi	elisa.resconi@mpi-hd.mpg.de
Max-Planck-Institut für Physik	Dr. Hsu Ching-Cheng	cchsu@mppmu.mpg.de
Technische Universität München	Dr. Andreas Ulrich	andreas.ulrich@ph.tum.de
Technische Universität München	Dr. Walter Potzel	wpotzel@ph.tum.de
Technische Universität München	Prof. Franz von Feilitzsch	franz.vfeilitzsch@ph.tum.de
Technische Universität München	Thomas Heindle	thomas.heindl@ph.tum.de

ASPERA

ASPERA	Dr. Thomas Berghöfer	thomas.berghoefer@desy.de
ASPERA	Prof. Stavros Katsanevas	katsan@admin.in2p3.fr
ASPERA	Katharina Henjes-Kunst	katharina.henjes-kunst@desy.de
ASPERA	Nadja Häbe	nadja.haebe@desy.de
ASPERA	Sandra Hesping	sandra.hesping@desy.de
ASPERA	Arnaud Marsollier	arnaud.marsollier@cern.ch

Experiments' Time Schedule

Imprint

Publisher
ERA-NET ASPERA –
Astroparticle Physics in Europe, 2011

Editorial Office
Thomas Berghöfer, Katharina Henjes-Kunst,
Sandra Hesping, Razmik Mirzoyan

Design and Layout
Christine Iezzi

Print
DESY, March 2011

Website
www. aspera-eu.org

Acknowledgement
Special thanks go to the Carl Friedrich von Siemens Stiftung in Munich for their great support of the ASPERA Technology Forum.

ASPERA is a European network of national government agencies responsible for coordinating and funding national research efforts in astroparticle physics.

ASPERA (AStroparticle Physics European Research Area network) started in July 2006 and has been extended for another three years in 2009. Currently the network comprises 22 national funding agencies.

The main achievements of ASPERA are the development of the European strategy for astroparticle physics and the preparation of a roadmap for this research field. The roadmap presented in September 2008 lists seven large infrastructures. To support the realisation of these projects, ASPERA is currently preparing a common action plan. Reaching into R&D cooperations with SMEs in Europe is one of its efforts.

So far ASPERA launched in 2009 the first European common call for R&D and design studies in the field of astroparticle physics and a second is currently under way. Projects have been commonly funded to support researchers all over Europe in developing detectors for the direct dark matter search and design study work for the Cherenkov Telescope Array.

ASPERA

www.aspera-eu.org