ASPERA
Innovation and Astroparticle physics

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PT-DESY/BMBF

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Aim of the task

Coordinate Astroparticle physics R&D with SME:

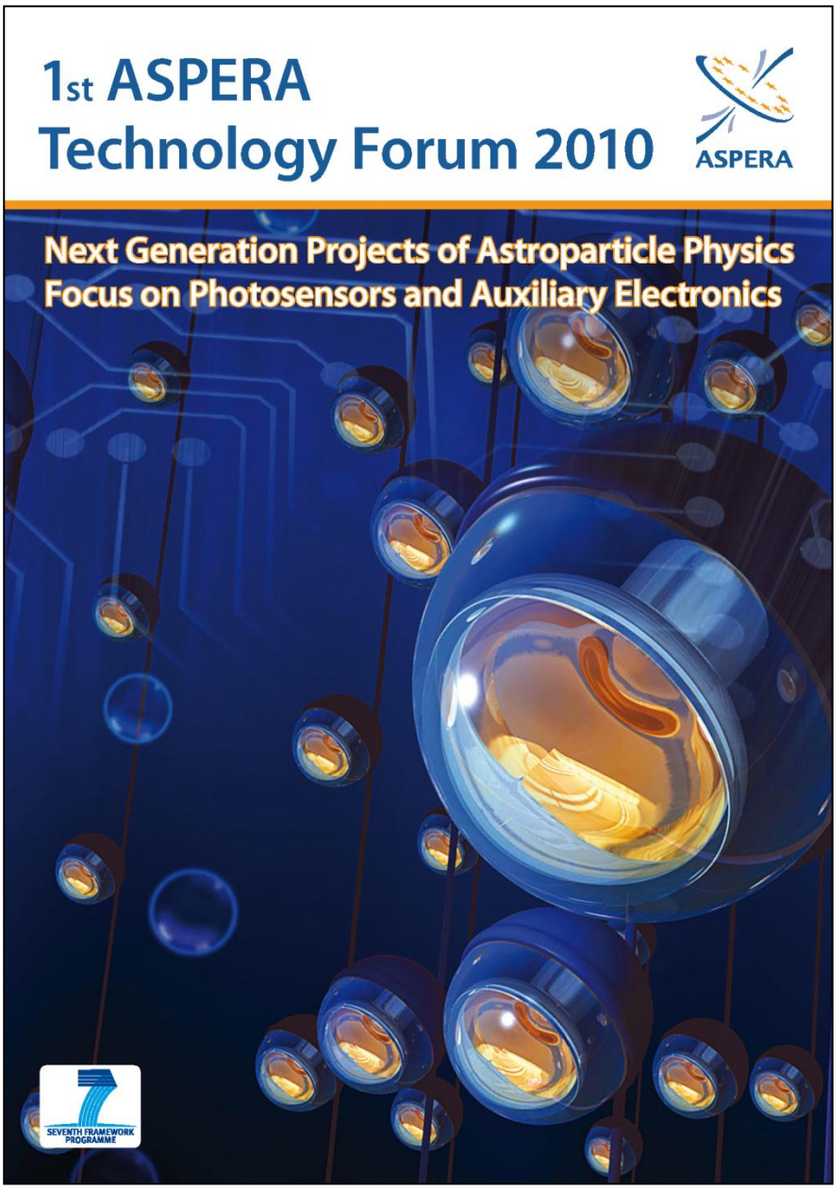
- support 7 big science infrastructures

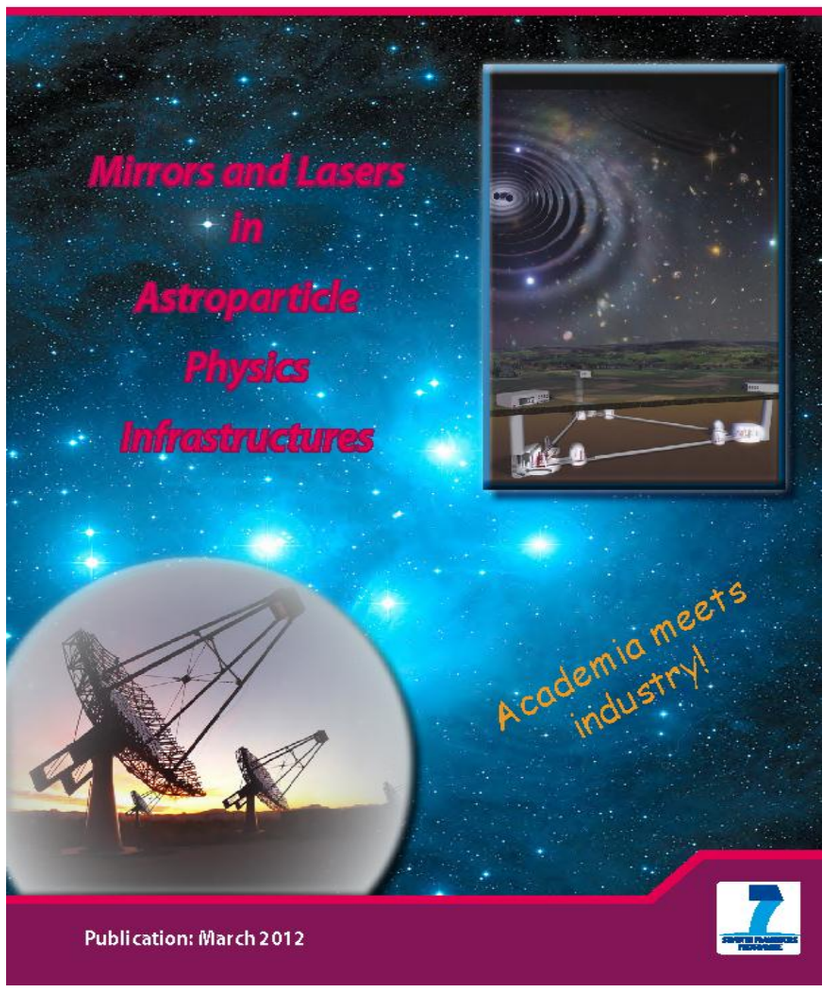
- foster R&D and industry innovation in Europe

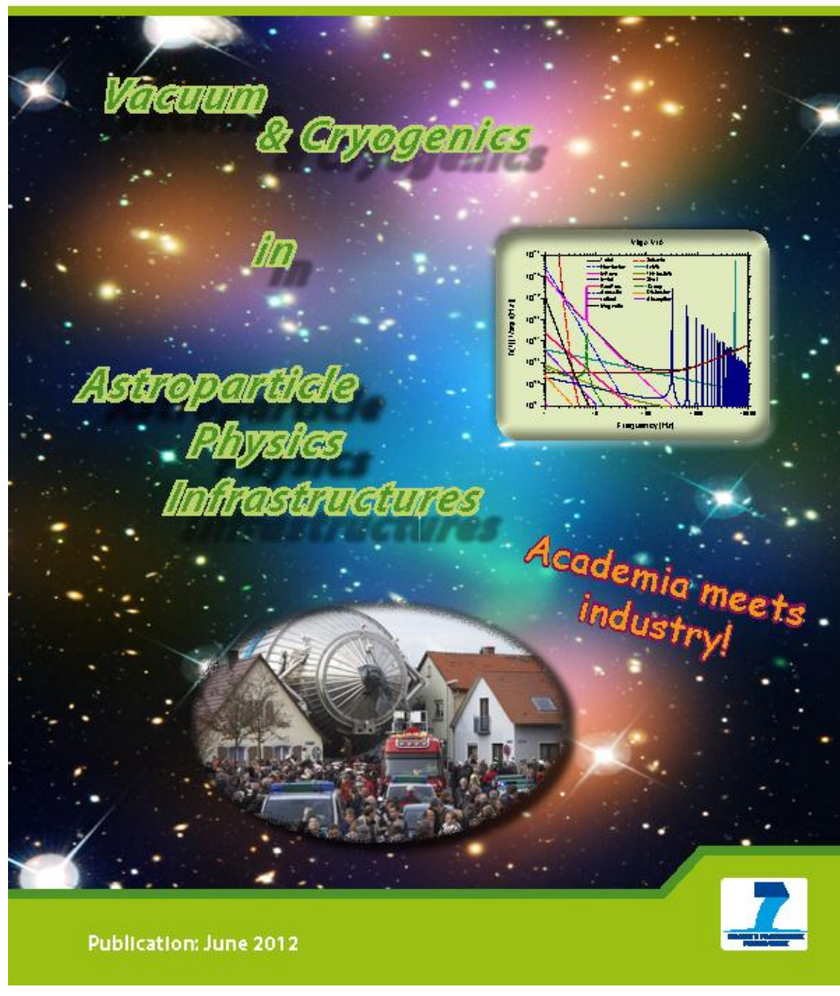
- promote European industry

How to get the ball rolling

- Identify main R&D topics
  - Photosensors
  - Mirrors & Lasers
  - Cryogenics & Vacuum
- Create an interface for R&D work with SME → ASPERA Technology Forum
- Initiate active interaction on ATFs to strengthen cooperation between ApP projects and companies







ATF 1
Photosensors
Munich, October 2010

ATF 2
Mirrors & Lasers
Pisa, October 2011

ATF3
Vacuum & Cryogenics
Darmstadt, March 2012

Questions to be discussed on ATFs

- Requirements of the coming projects
- What are the technological challenges?
- What products are available and what kind of R&D activities are required?
- What is the potential of joint research activities?
- Is there an R&D strategy that can be commonly followed by research institutes and SME?
- What is the impact of developments on other scientific fields or market ready products?
- What are the bottlenecks when scientists cooperate with industries?

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

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

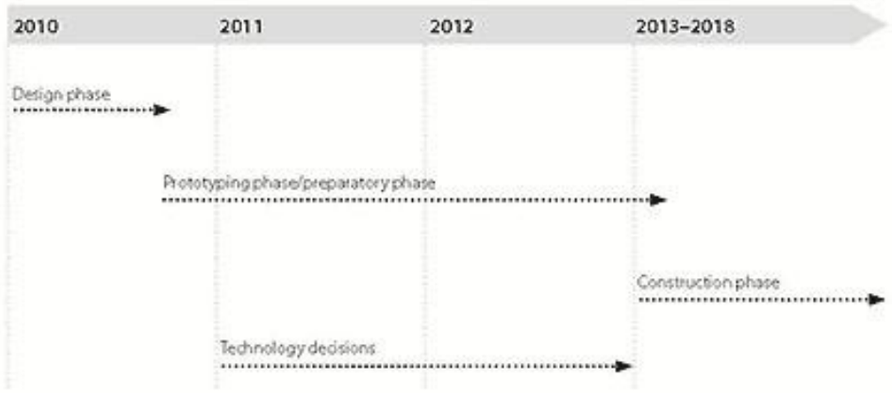
Requested afterpulsing < 0.02 %.

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



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

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

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

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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 @ ±180 V @ 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

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ASPERA Technology Forum online

- ASPERA website www.aspera-eu.org/SMEs_corner
- Brochure as pdf available
- Talks of the projects/companies
- Factsheets of participating companies

Knowledge and Technology Office

- Contact point for ApP projects and companies
- Improve communication between
  - Project to business
  - Project to project
  - Business to business
- ASPERA Technology Forum
  - review and improve concept
  - organise follow-up events
- Procurement

Comments of the participants

Prof. Dr. Uli Katz, KM3NeT

"The ASPERA Technology Forum is a useful element of strategic planning.
The major impact is a strengthening of the networking between projects with similar technology requirements, plus potentially an enhanced cross-coordination between science community and industry."

Comments of the participants

HAMAMATSU Photonics, Olga Stroh

„It is important for us to make the research-ers understand how we adopt the best scientific ideas to the industrial resources and possibilities…
The ASPERA Technology Forum is a good platform to improve this cooperation.”

Comments of the participants

Excelitas Technologies, Arthur Barlow

"Team work from the earliest stages will maximise efficiency of spending and the quality of the end result.
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"

Comments of the participants

Marc Tippmann, LENA, junior scientist

„First follow-up activities are becoming visible. After the ATF we met again (LENA-CTA meetings) and now we are already working on a joint paper to show our achievements.
This would never have happened if I had not met Razmik Mirzoyan at the ATF.”

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Thank you for your attention!