Status of the GALILEO Project

Călin A. Ur
INFN Sezione di Padova

on behalf of the Galileo Collaboration

5th Meeting LEA-COLLIGA, IPN Orsay - Paris, November 14-16, 2011

OUTLINE

- Motivation
- The GALILEO project
  - Physics case
  - Mechanical design
  - Electronics R&D
  - Ancillary detectors
- Perspectives

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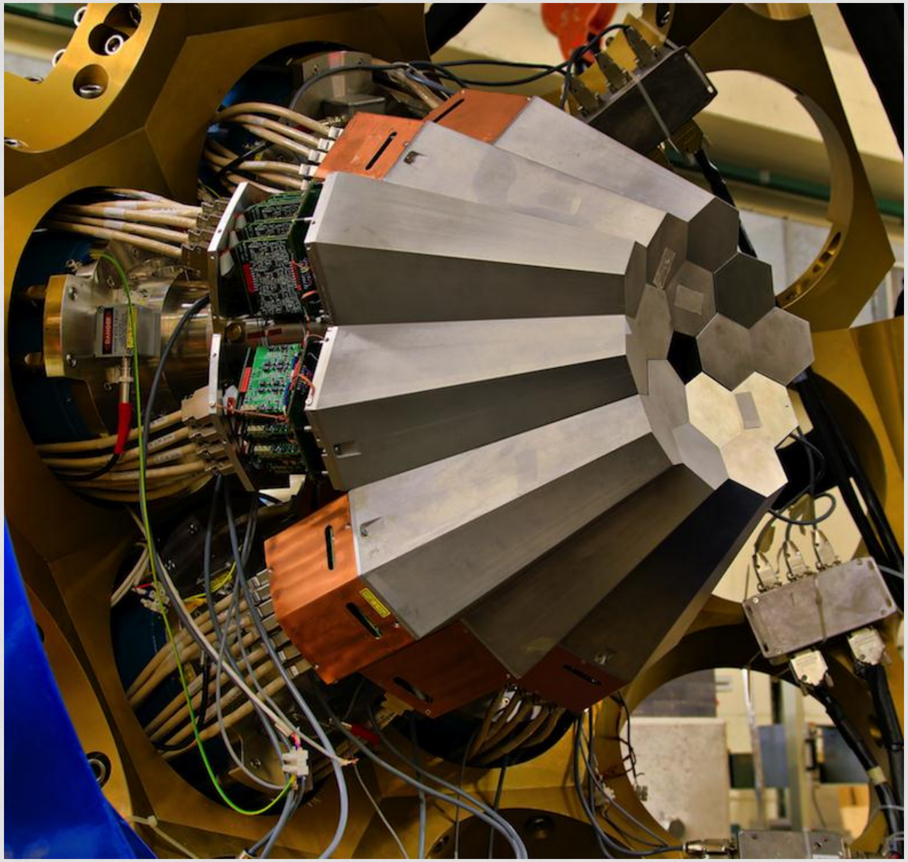
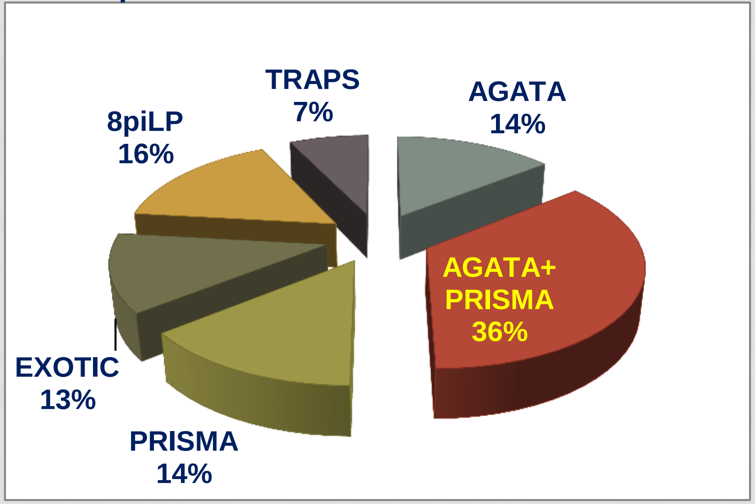
GAMMA–RAY SPECTROSCOPY AT LNL
nowadays



AGATA D – 2010
European Collaboration
5 triple cluster detector
ε_{ph} (1.3MeV) ~ 6%

Coupled to the PRISMA magnetic spectrometer

Beam time distribution
Sept. 28, 2011 – Mar. 14, 2012



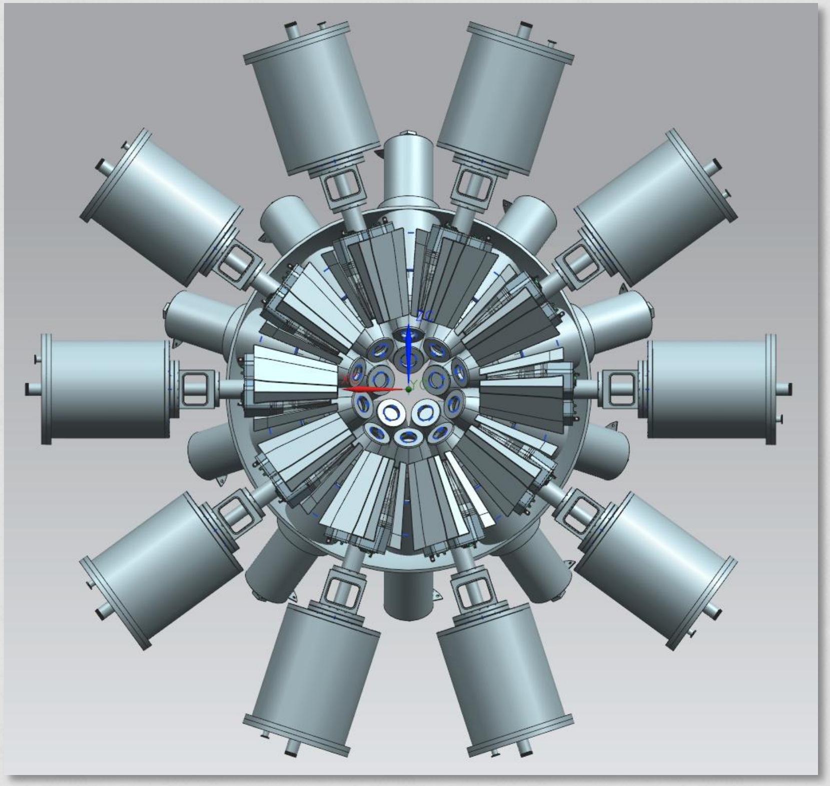
AGATA will conclude the physics campaign at LNL by the end of December

GAMMA–RAY SPECTROSCOPY AT LNL

sometime in the future

GALILEO – 2012

new gamma–ray array



European Collaboration

take advantage of the recent technical developments for AGATA
- preamplifiers, digital sampling, preprocessing, DAQ
- → **high counting rates (50 kHz/det)**

use of existing detectors
- EB cluster detectors capsules
- GASP detectors
- → **high photopeak efficiency**

use beam facilities at LNL
- Tandem, ALPI, PIAVE – stable
- SPES – RIB
- → **production of new nuclei**

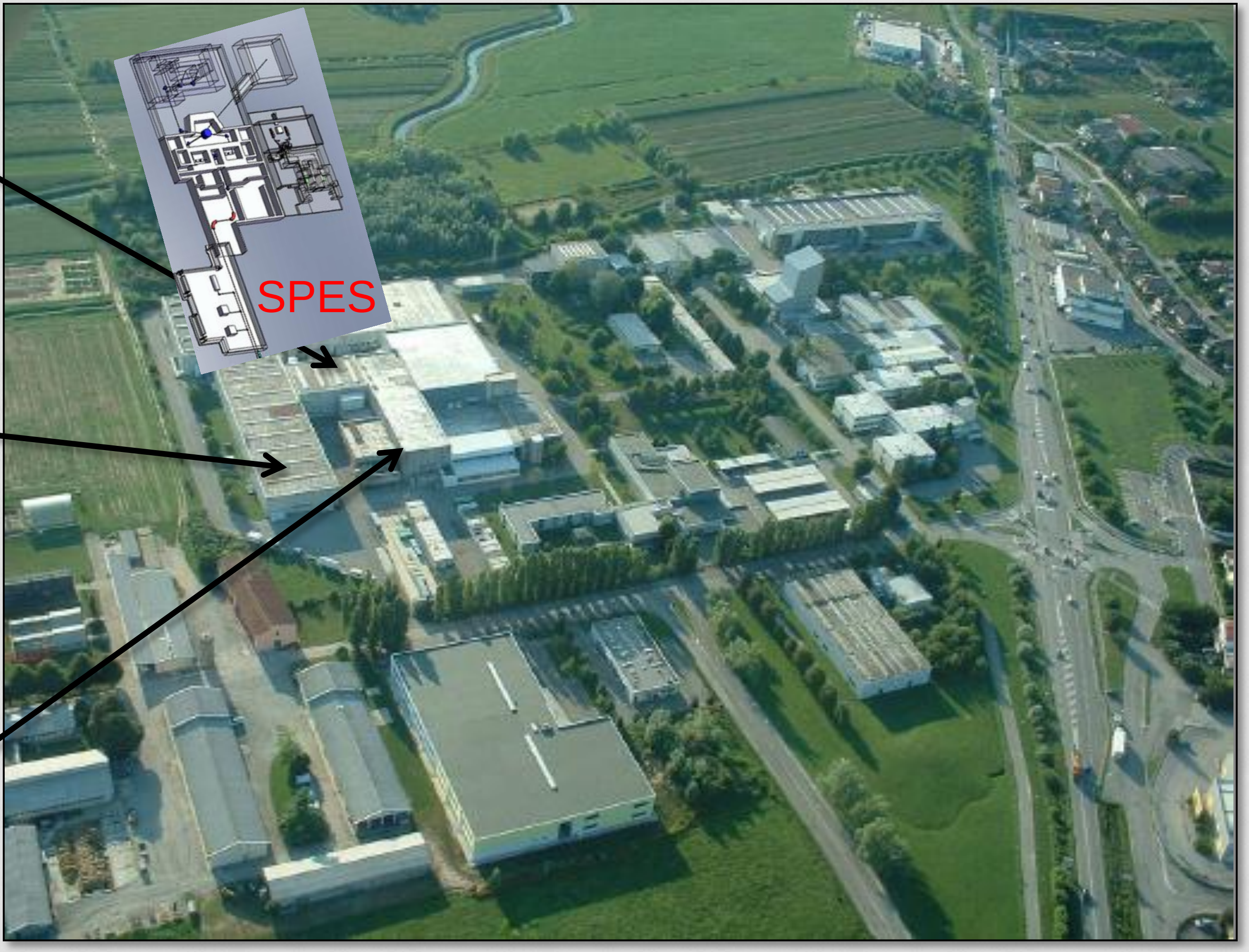
THE HEAVY IONS ACCELERATORS AT LNL

THE HEAVY IONS ACCELERATORS AT LNL

PIAVE HI Injector

ALPI Linac 40 MVeq

Tandem XTU 15 MV



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PHYSICS CASE

2009 – call for Letters of Intent

- INFN Sezione di Padova
- INFN Laboratori Nazionali di Legnaro, Legnaro
- INFN Sezione di Milano
- INFN Sezione di Firenze
- Univerita degli Studi di Padova
- Universita degli Studi di Milano
- Universita degli Studi Firenze
- Institut fur Kernphysik, Universität zu Köln
- The Niewodniczanski Institute of Nuclear Physics, PAN, Krakow, Poland
- CSNSM/IN2P3/CNRS, Orsay, France
- INRNE, BAS, Sofia, Bulgaria
- University of the West of Scotland, Paisley, UK
- Department of Physics, Lund University, Lund, Sweden
- Department of Nuclear and Particle Physics, Uppsala University, Uppsala, Sweden
- Royal Institute of Technology, Stockholm, Sweden
- Instituto de Fisica Corpuscular, Valencia, Spain
- Institut fur Kernphysik, Technische Universitat Darmstadt, Germany
- CISC and Departamento de Fisica Teorica C-IX, Universidad Autonoma de Madrid, Spain
- Physik-Department E12, Technische Universitat Munchen, Garching, Germany
- IPHC, Strasbourg, France
- Simon Fraser University, Burnaby, B.C., Canada
- TRIUMF, Vancouver, B.C., Canada
- Horia Hukubei National Institute for Physics and Nuclear Engineering, Bucharest–Magurele, Romania
- Universidade de Sao Paulo, Instituto de Fisica, Sao Paulo, Brasil
- University of Warsaw, Poland
- School of Physics and Astronomy, University of Birmingham, Birmingham B15 2TT, UK

PHYSICS CASE – MAIN TOPICS

- structure of N~Z nuclei
- isospin symmetry
- study of neutron–rich nuclei
- exotic decay of high–spin states
- nuclear structure close to ^{100}Sn
- cluster and highly deformed states in sd–shell nuclei
- giant resonances and warm rotations
- symmetries and shape–phase transitions in nuclei
- shape coexistence in neutron–deficient nuclei
- g – factor measurements
- measurement of astrophysical interest cross sections – surrogate NR method

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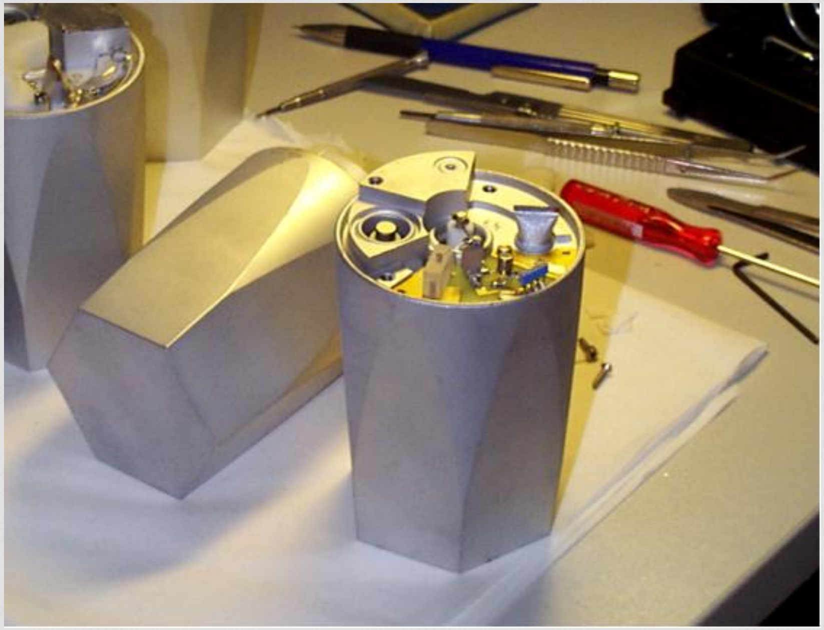
THE GALILEO ARRAY – DETECTORS

capsules of the EUROBALL cluster detectors



GASP tapered detectors

15 x 7– cluster detectors (GSI–RISING array)
encapsulated n–type HPGe detectors
FWHM < 2.4 keV @ 1332.5 keV
ε_{int} ~60% @ 1332.5 keV
common cryostat
HV/LV/FE independent → **New triple cryostat**

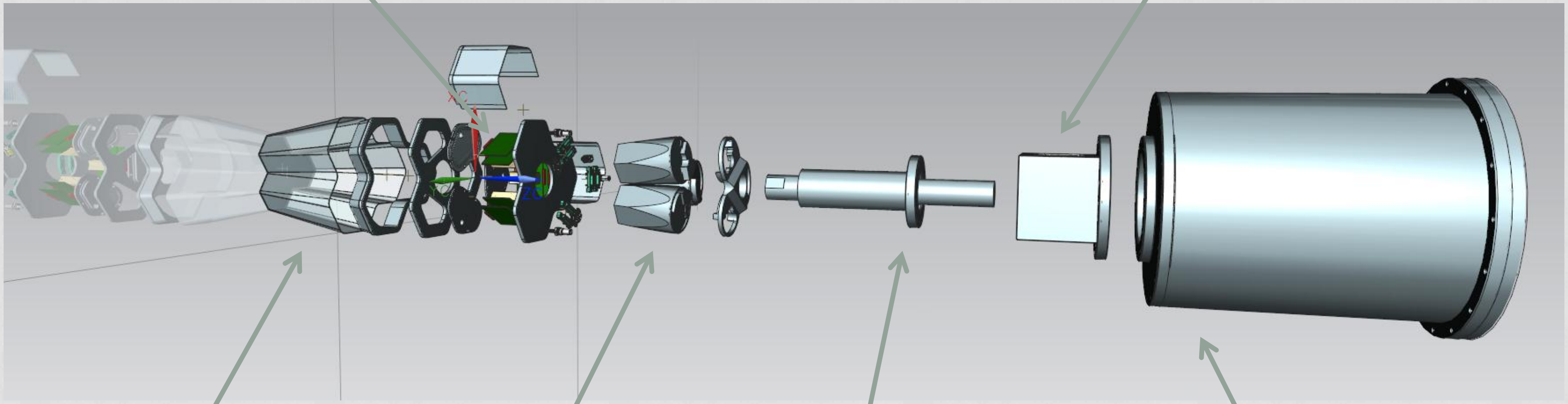
40 n–type HPGe detectors
FWHM < 2.4 keV @ 1332.5 keV
ε_{int} ~80% @ 1332.5 keV
P/T ~ 25% (^{60}Co source)

40 BGO anti–Compton shields
P/T ~ 60% (^{60}Co source)

GALILEO R&D - MECHANICS

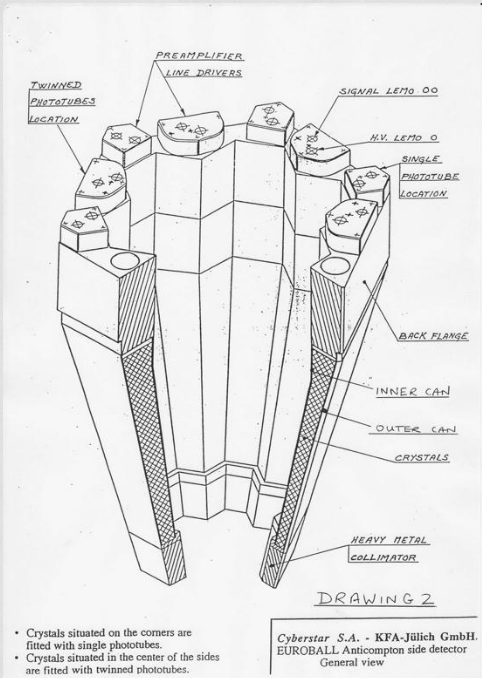
- Development of the triple cryostat
  - end–cap in carbon fiber
  - dewar
  - internal cabling
  - optimizing the thermal conduction (LN_2 consumption)
- Design of the anti–Compton shield
  - recovery of the individual EB cluster BGO crystals
- Design of the holding structure
  - more space for ancillary detectors
  - flexible configuration (modifiable target–detectors distance, easy mounting of ancillary detectors)
  - modify the LN_2 and vaccum system
- Design of the mechanical structure for G.GALILEO
  - g–factor measurement setup

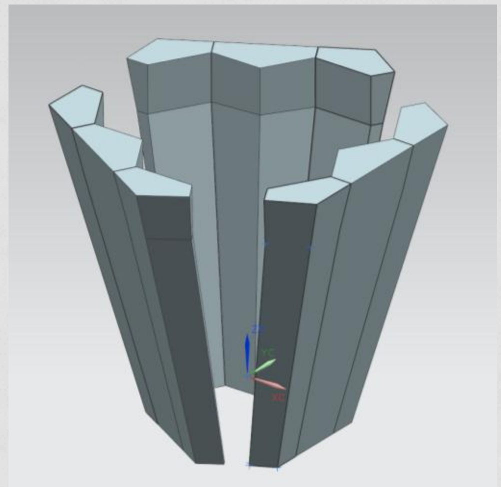
THE TRIPLE CRYOSTAT

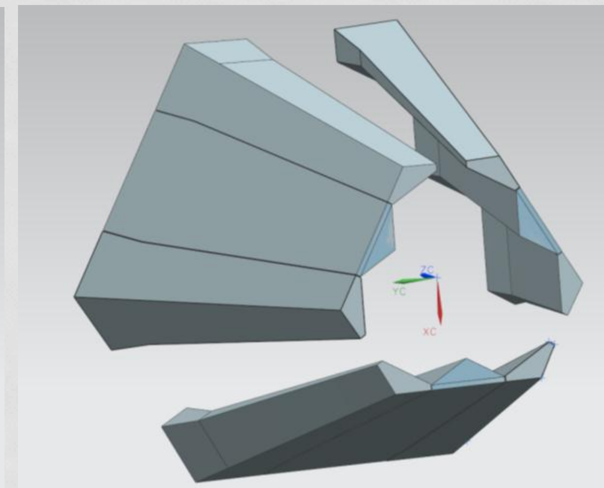


Technical design is ready ➡ started the prototype building

ANTI–COMPTON SHIELDS FOR THE TRIPLE CLUSTER DETECTORS



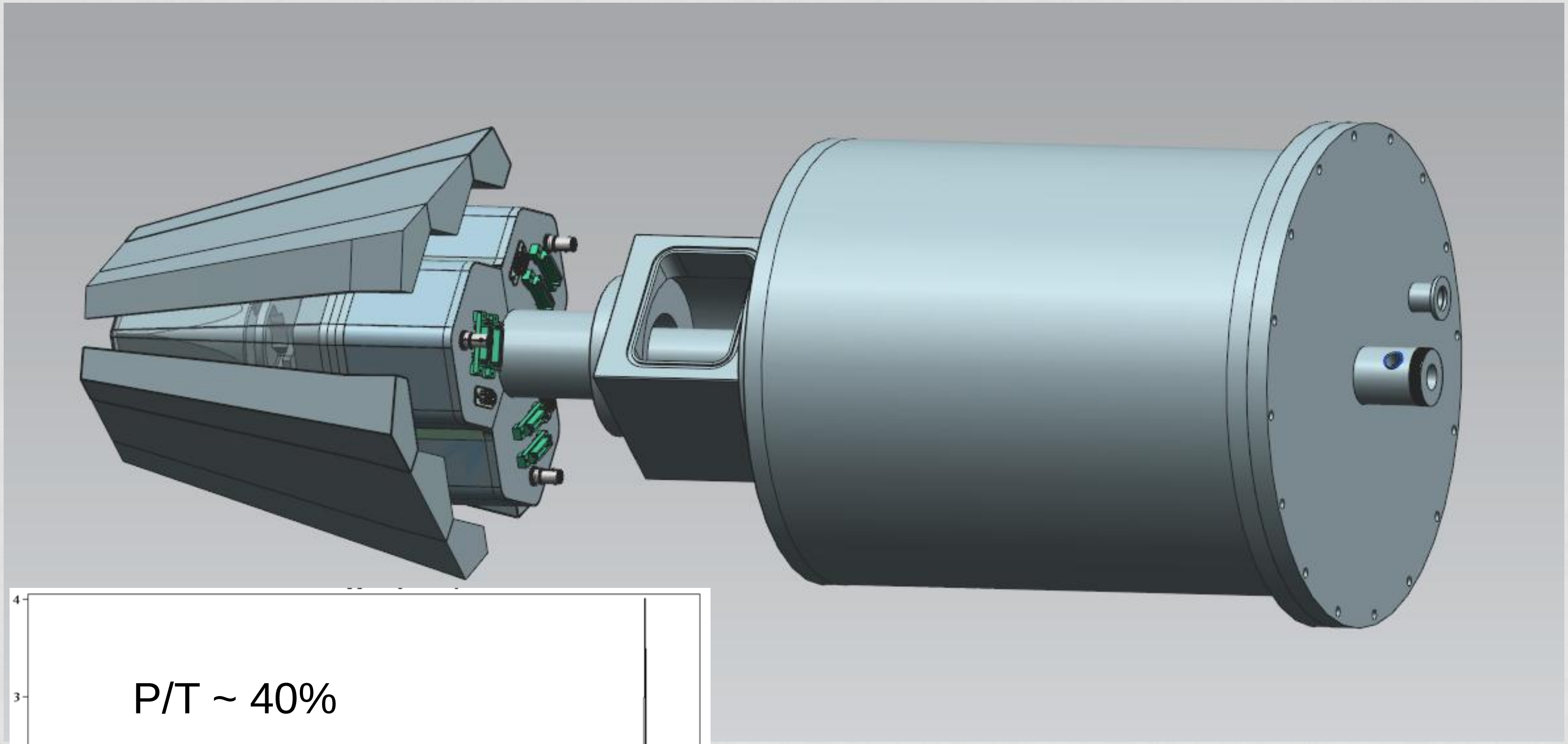


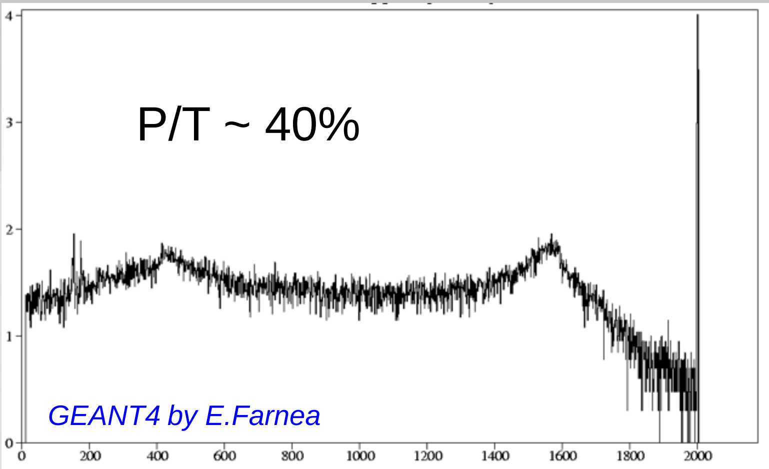


- ❑ a proposal for the construction of the triple cluster AC shield out of the individual crystals of the original EB cluster shield
  → **one can build only one new shield from the original one**

- ❑ recently moved one EB cluster AC shield to Legnaro
  → **investigate the possibility of safely dismounting the crystals and phototubes**

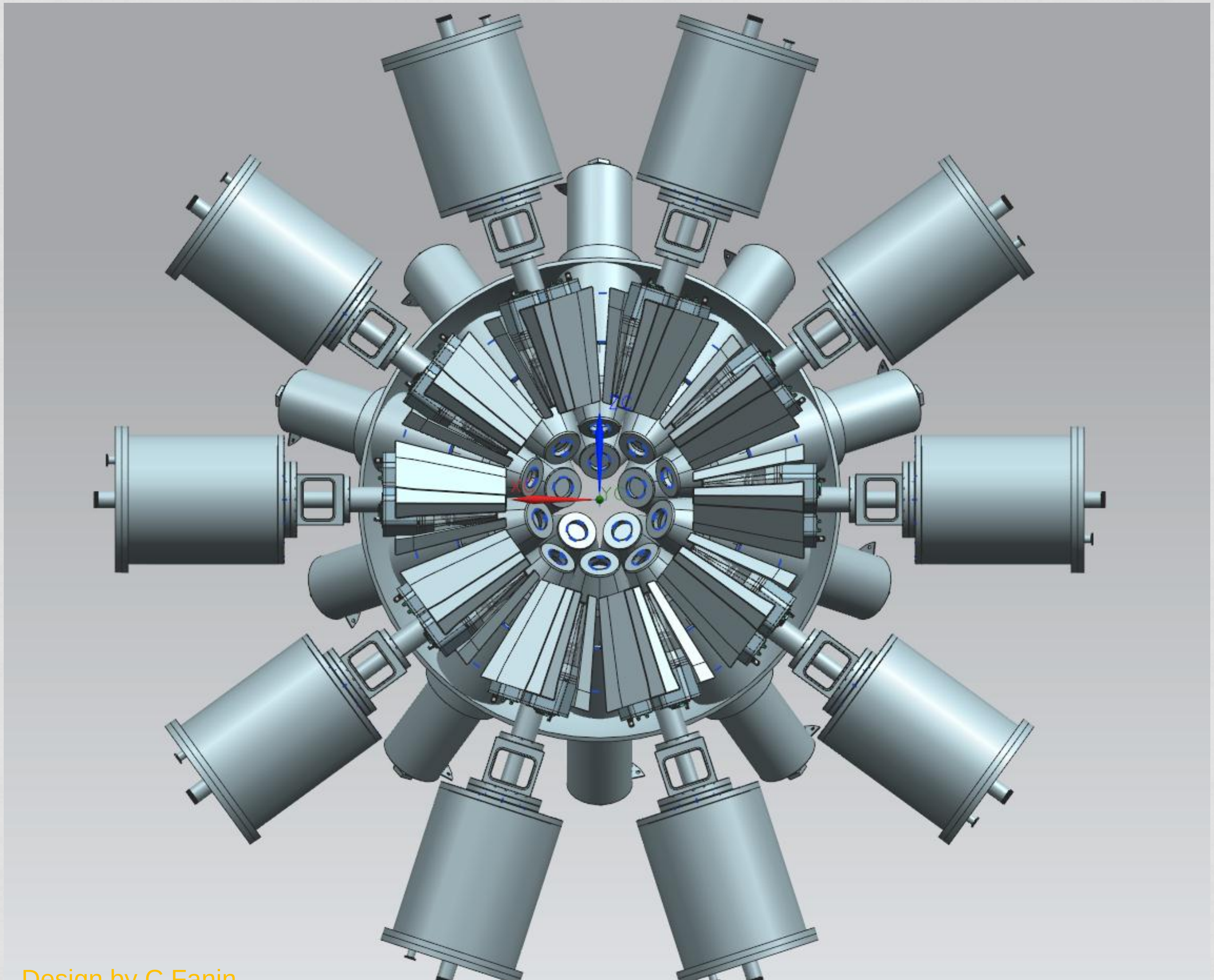
ASSEMBLED TRIPLE CLUSTER DETECTOR





Need of shared suppression among neighboring detectors to improve P/T

MOUNTING OF THE TRIPLE CLUSTERS



GALILEO – GEANT4 SIMULATION

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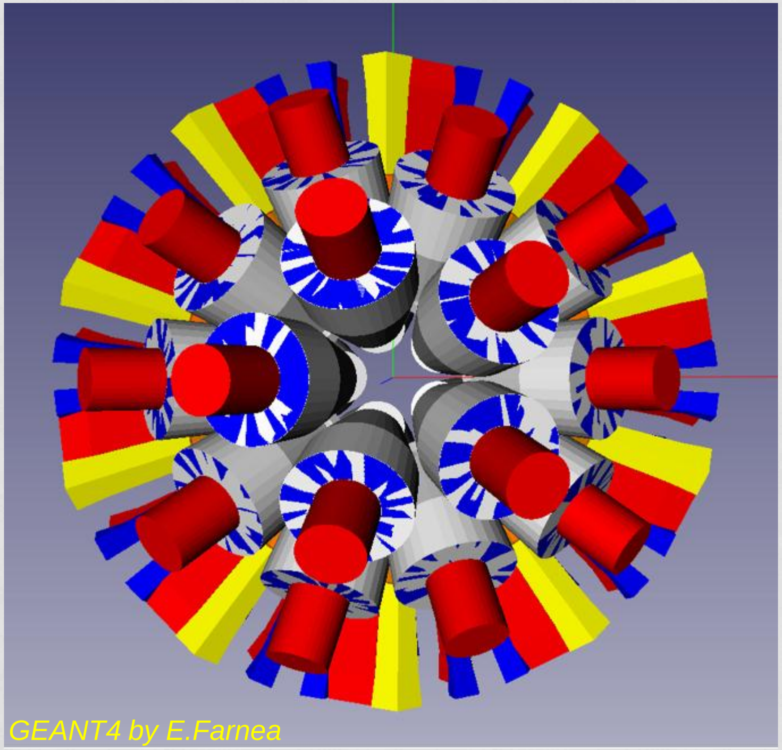


Mixed configuration

30 GASP detectors @ 22.5cm

5	5	5	5	5	5
29°	51°	59°	121°	129°	151°

10 triple cluster @ 24cm

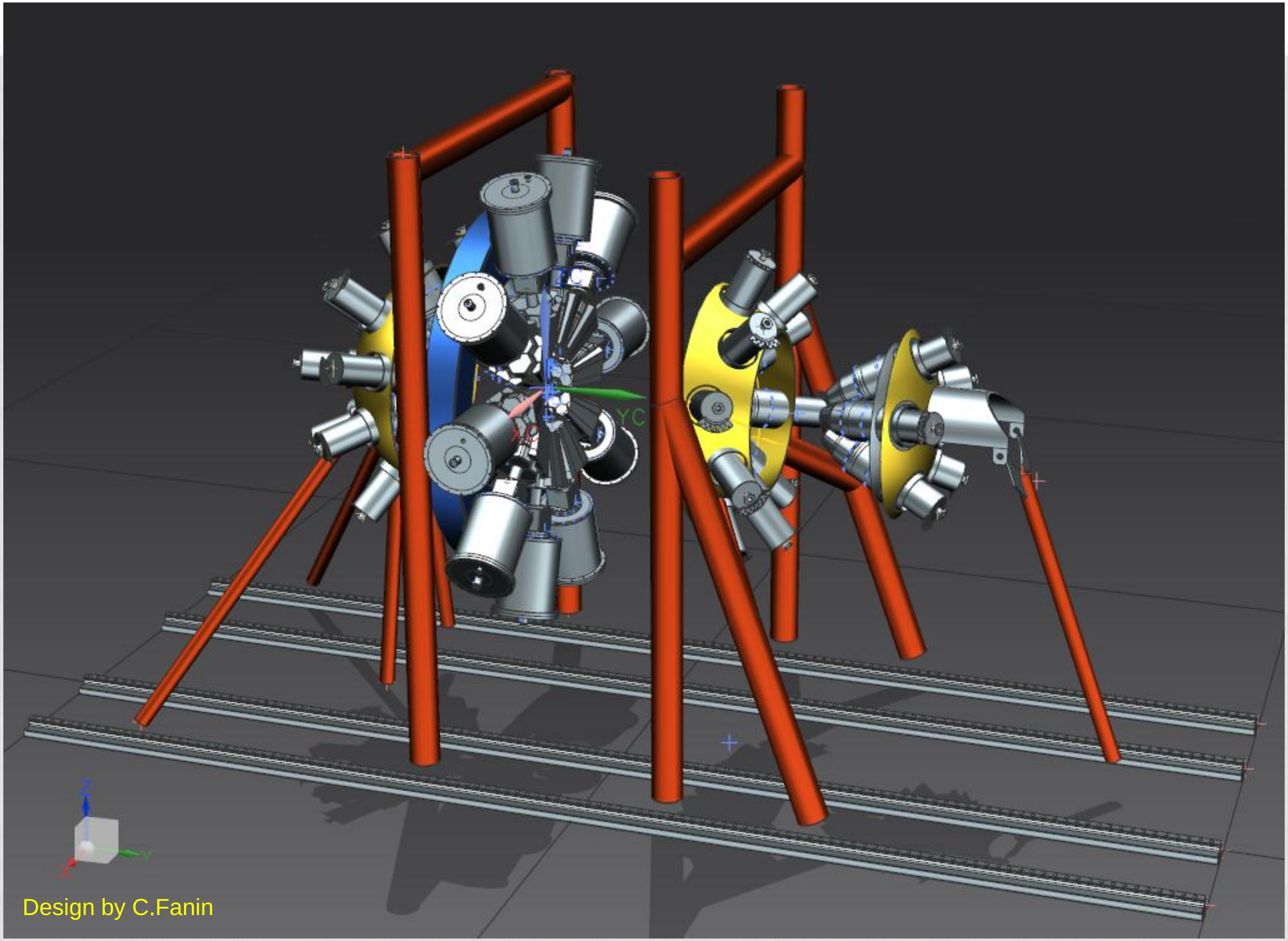
90°

Definition of the new triple cluster detectors

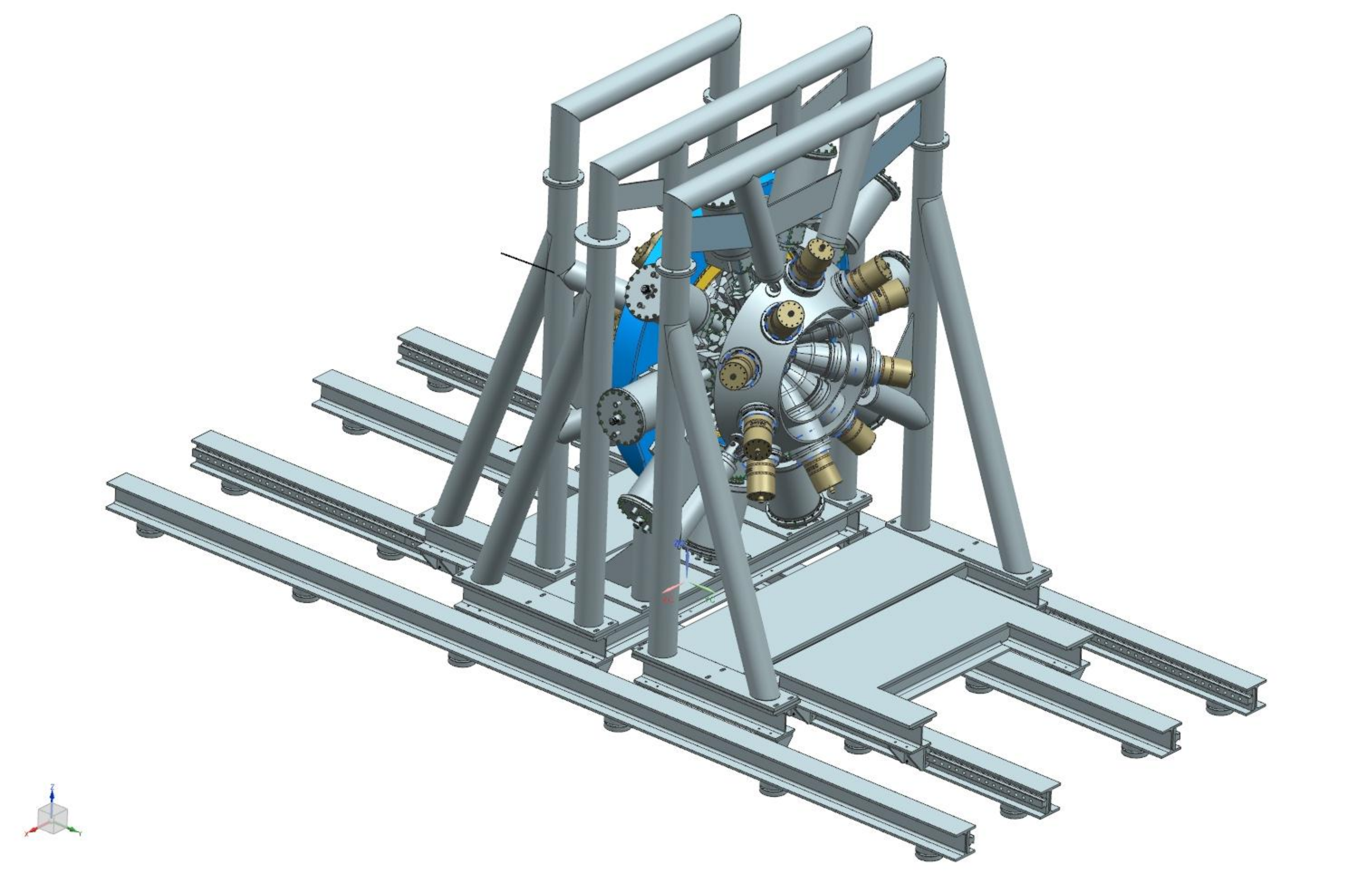
- symmetrical coverage of the solid angle (ang. distr., DSAM)
- good granularity
- at 90° detectors have relatively lower solid angle aperture
- anti–Compton shields
  - for GASP detectors already available
  - for the triple clusters new AC shields
- limited impact on the array performance when dismounting the first ring of detectors to allow insertion of ancillary detectors

ε_{ph} ~ 8%   P/T ~ 50%

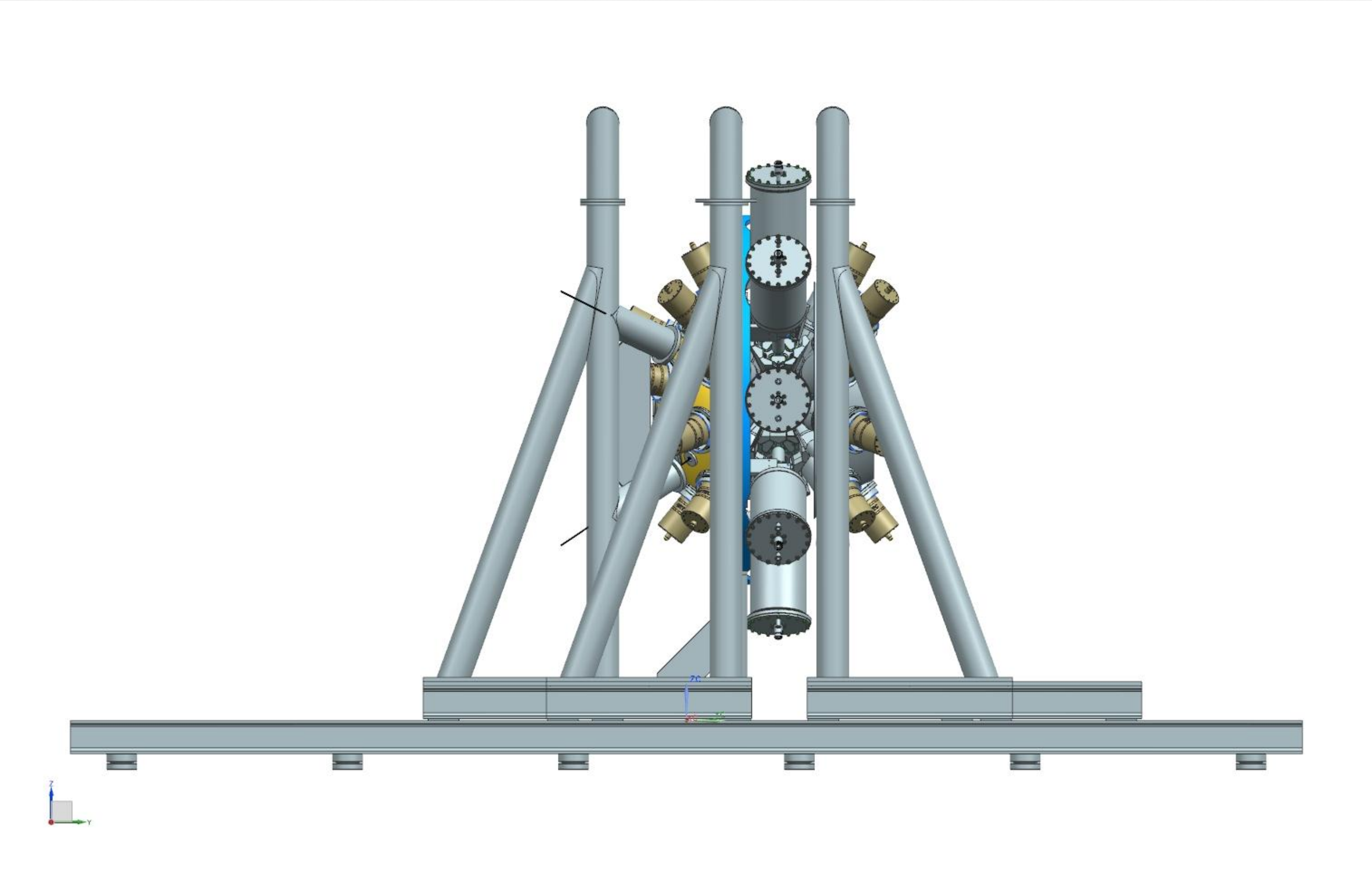
HOLDING STRUCTURE OF THE ARRAY



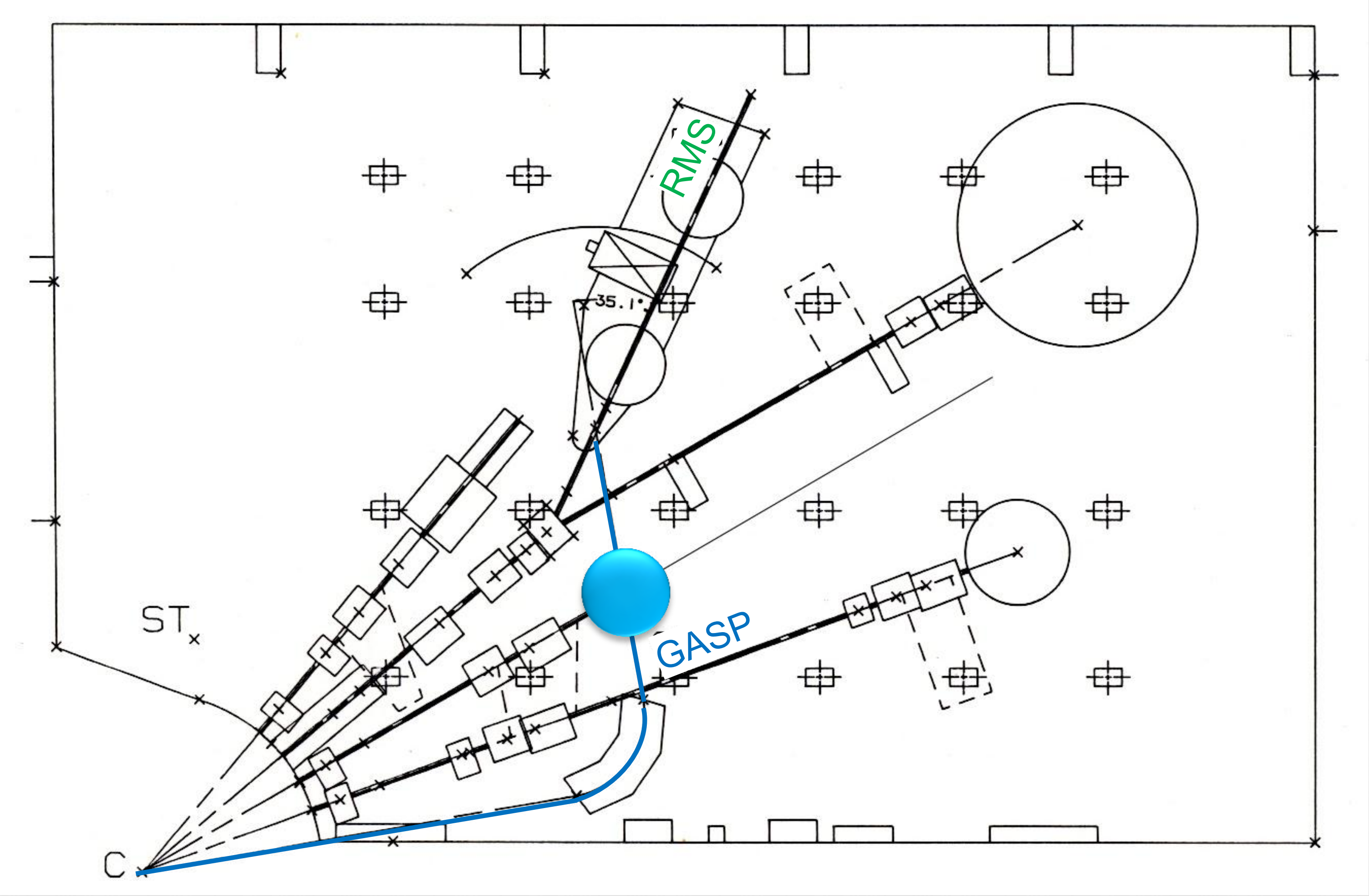
HOLDING STRUCTURE OF THE ARRAY



HOLDING STRUCTURE OF THE ARRAY

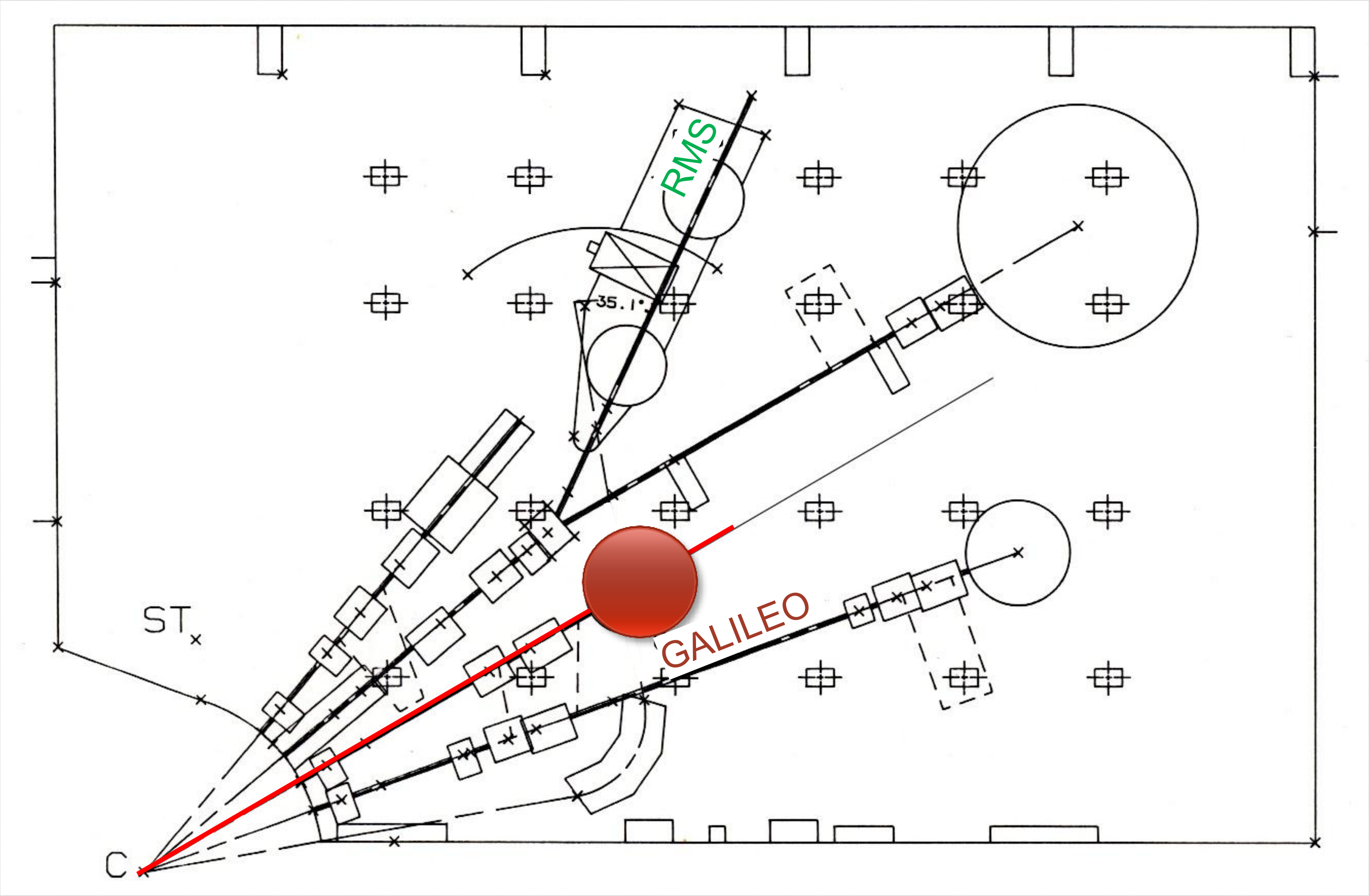


GALILEO – LOCATION



Experimental Hall II – replacing GASP

GALILEO – LOCATION



Experimental Hall II – replacing GASP

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GALILEO R&D – ELECTRONICS

- New electronics is being built in close synergy with AGATA
  - new cold part (AGATA FET)
  - use solutions already developed for AGATA
    - core type preamplifiers
      - differential output
      - one single range but extended to ~ 10 MeV
      - suitable also for the GASP detectors (mechanics, FET, AC/DC)
      - no pulser
    - GTS
    - AGAVA interface with the VME electronics (colab. With Kracow)
  - new developments for AGATA and GALILEO
    - low power digitizers
    - readout and preprocessing on PCI express boards
  - anti–Compton shields signal readout
    - digital (similar to the Ge detectors)

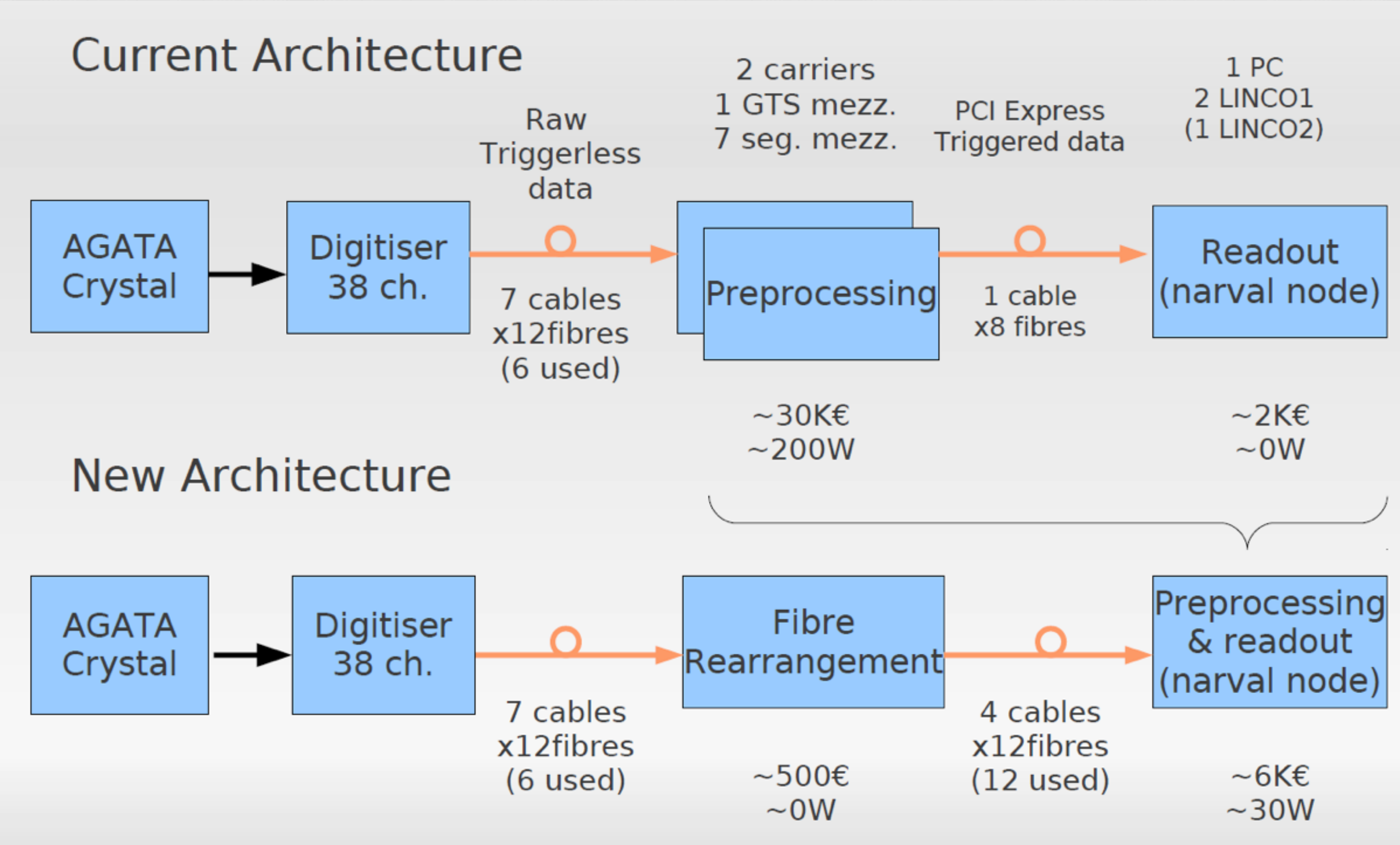
READOUT AND PREPROCESSING ELECTRONICS – PURPOSE

- Cost reduction
- Power consumption reduction
- Integrated compact solution: physically different objects integrated in one object (easier to scale and less cumbersome)

Requirements:

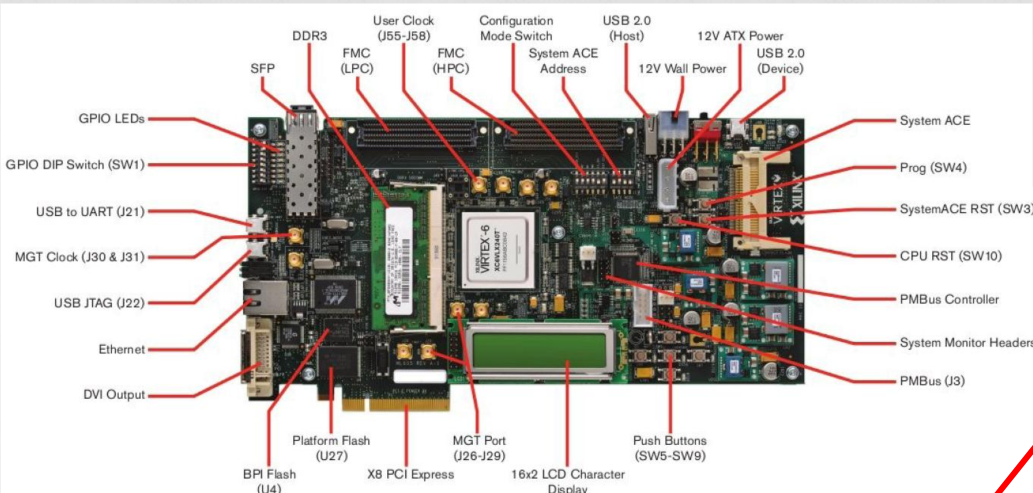
- Backward compatibility: new solutions must be back compatible with other existing AGATA subsystems (GTS, digitizers).
- Synergy and reuse of HW/FW/SW: the new acquisition system can be used for other projects (i.e. GALILEO and maybe others).

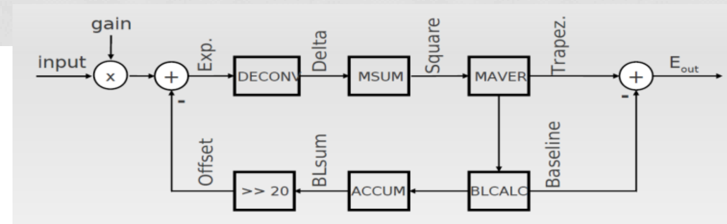
READOUT AND PREPROCESSING ELECTRONICS – PURPOSE



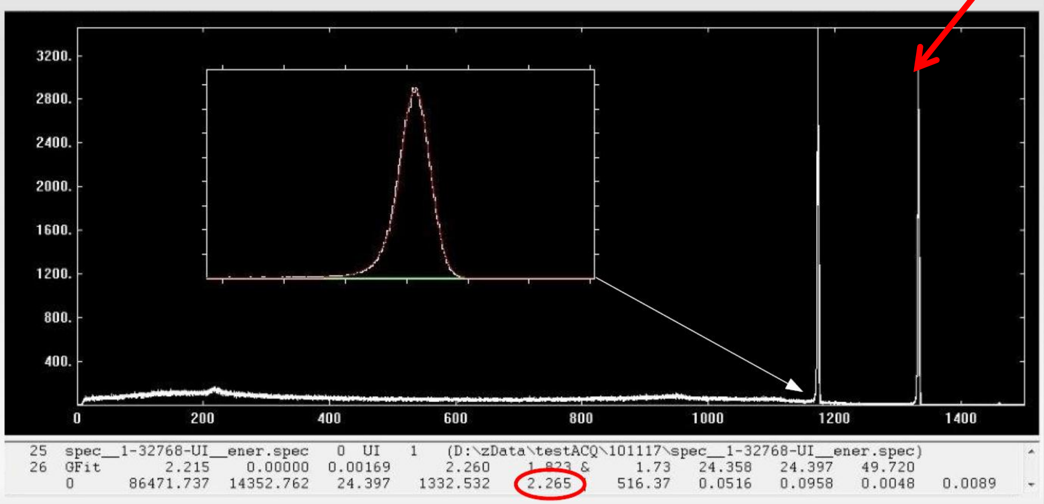
READOUT AND PREPROCESSING ELECTRONICS – TEST

Evaluation board for VIRTEX6

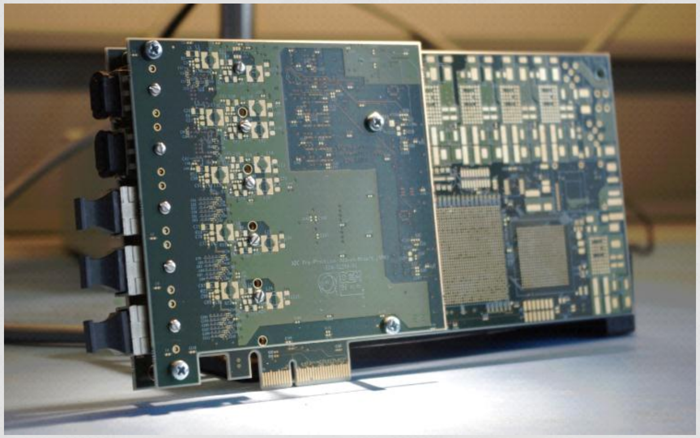




Implemented Energy Reconstruction Algorithm

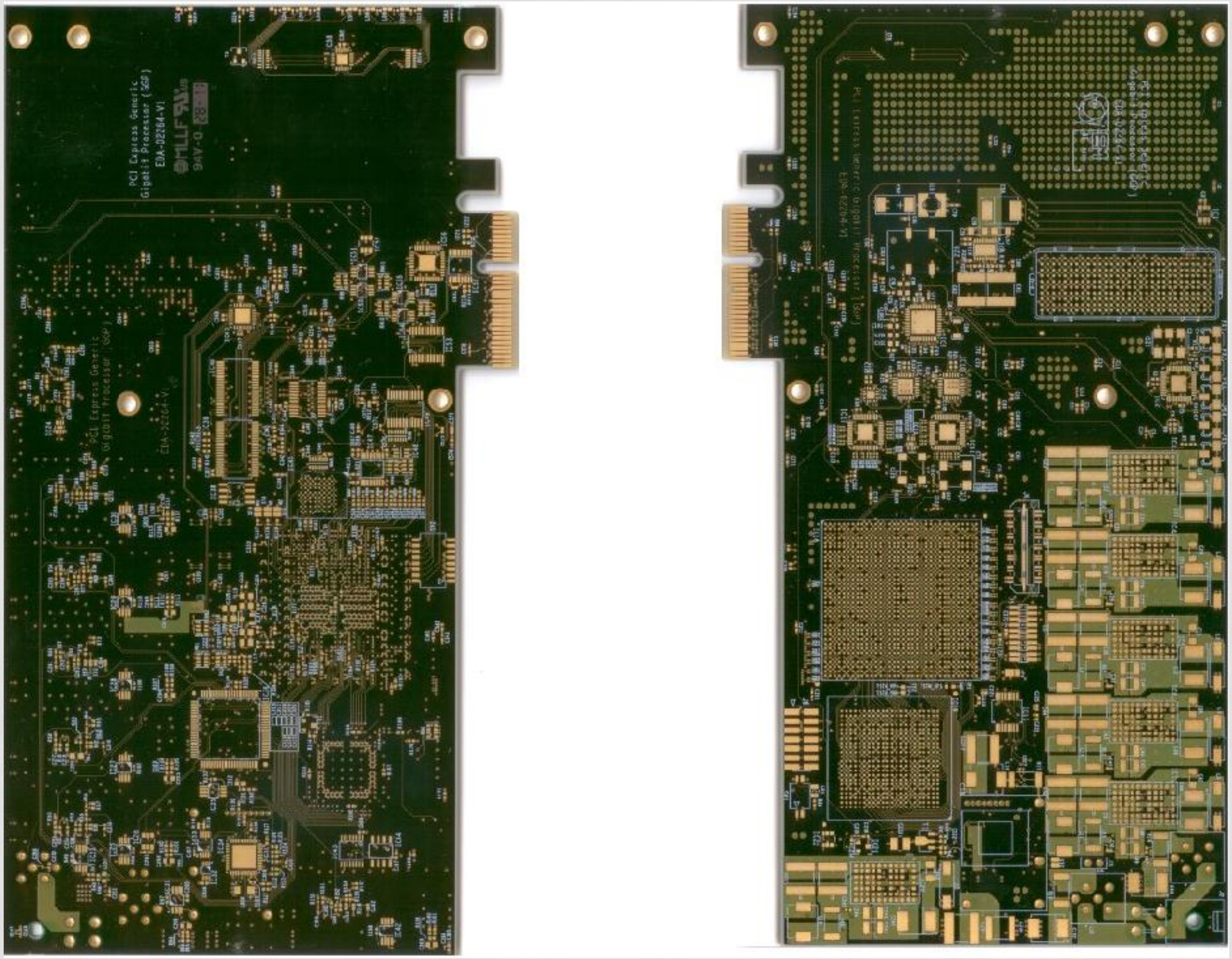


Prototype board layout @CERN



D.Bortolato

READOUT AND PREPROCESSING ELECTRONICS – TEST



D.Bortolato

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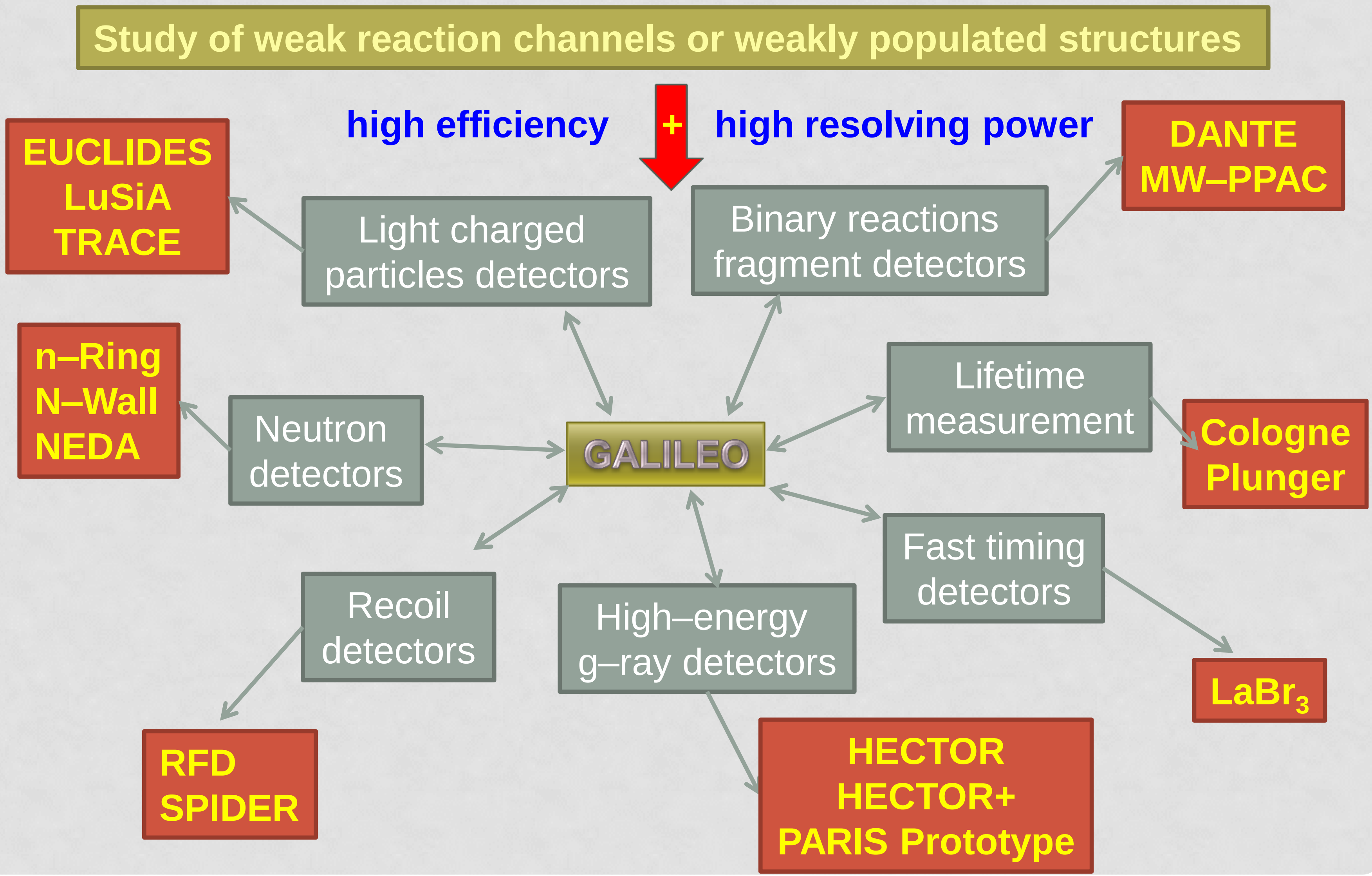
GALILEO AND ANCILLARY DETECTORS



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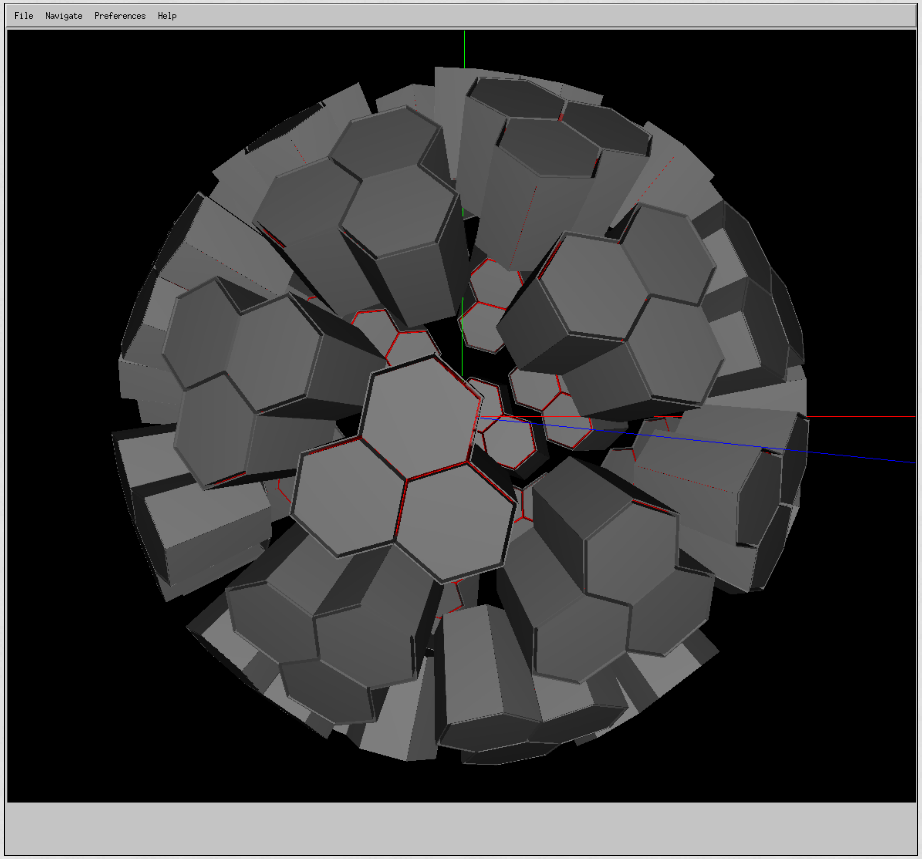
PERSPECTIVES



4π configuration with triple clusters

40 detectors@24cm – ε_{ph}~15%

Advantages:

- uniforme coverage of the solid angle
- anti–Compton shields more efficient
- removing detectors has less impact on the overall performace of the array
- good granularity

Disadvantages:

- anti–Compton shields not available

→ high cost

Need of a wide European collaboration

- initiated discussions inside the EGAN Scientific Committee (July 2011)
- collaboration with IPN Orsay for developing AC shields

TIME SCALE

- Technical design of the triple cryostat – **ready**
  - First prototype – **December 2011**
  - Second prototype – **June 2012**
- Readout board prototype – **September 2011**
- Digitizer prototype – **December 2011**
- Preamplifiers (cold and warm) production – **December 2011**
- Holding structure design
- definition – **July 2011**
- technical design – **beginning of 2012**
- Definition of the anti–Compton shield – **November 2011**
- Production (cryostats, anti–Compton shields, electronics, holding structure) – **2012**

Start operation of GALILEO at the end of 2012

COLLABORATORS

- Mechanical design and production
  - Technical Service – INFN Padova, Mechanical workshops – INFN Padova, Legnaro, Milan
  - C.Fanin, M.Turcato
- Electronics developments
  - Nuclear physics groups – INFN Padova and Milan
  - D.Bazzacco, M.Bellato, A.Pullia, D.Bortolato, R.Isocrate
- Vacuum and LN_2 filling systems
  - Users Service – INFN Legnaro
  - D.Rosso, L.Costa, P.Cocconi
- Ancillary detectors integration
  - Nuclear physics group – INFN Milan, IFJ PAN Cracow, Computing service– INFN Legnaro
  - S.Brambilla, N.Toniolo, P.Bednarczyk
- Beam line design
  - Accelerator Division – INFN Legnaro, Nuclear physics group – INFN Legnaro
  - A.Pisent, J.J.Valiente Dobon
- Monte Carlo simulations
  - Nuclear physics group– INFN Padova
  - E.Farnea