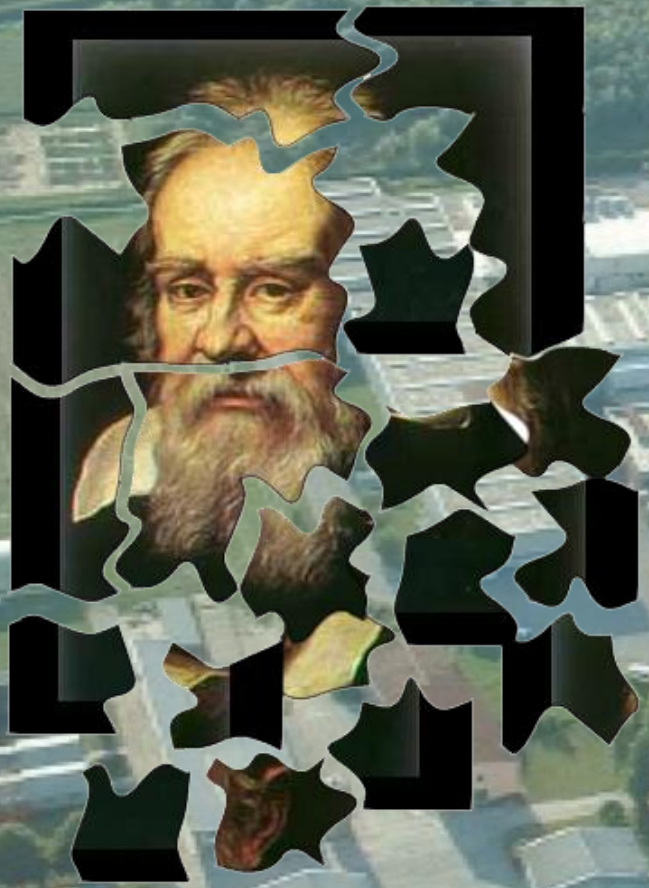
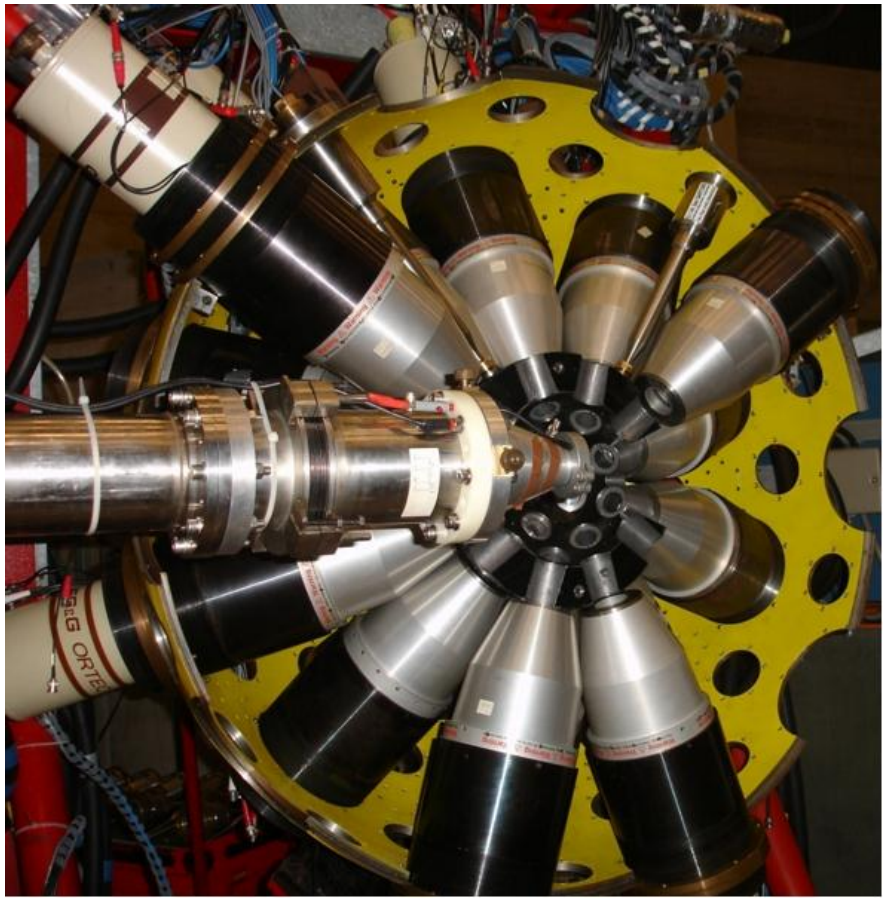
Status of the GALILEO Project at LNL



Calin A. Ur
INFN Sezione di Padova

The GASP Gamma–Ray Array



GASP
1992 – 2012

40 HPGe (80%) + AC
ε_{ph} (1.3MeV) ~ 3% (@ 27 cm) I
~ 5.8% (@ 22 cm) II
P/T ~ 60%

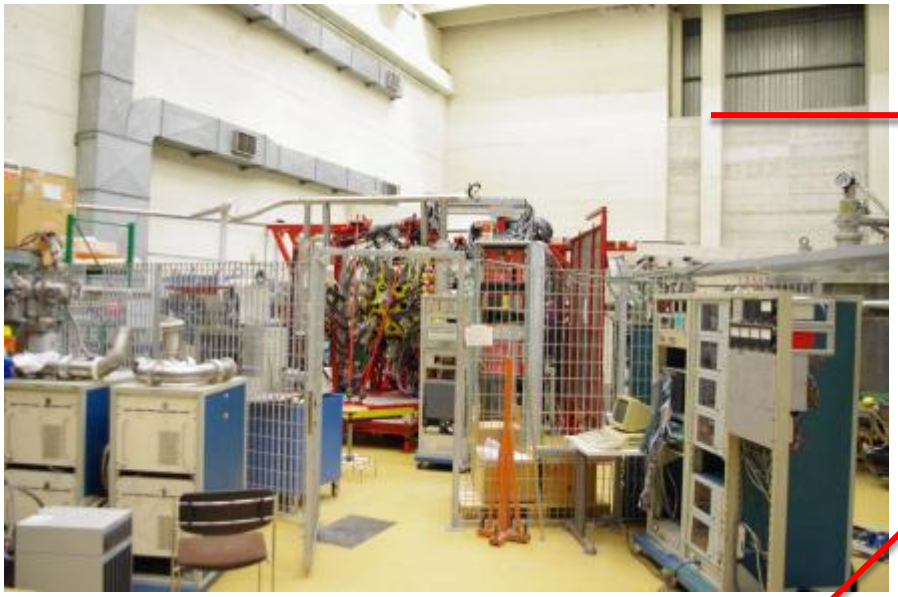
BGO multiplicity filter – 80 elements

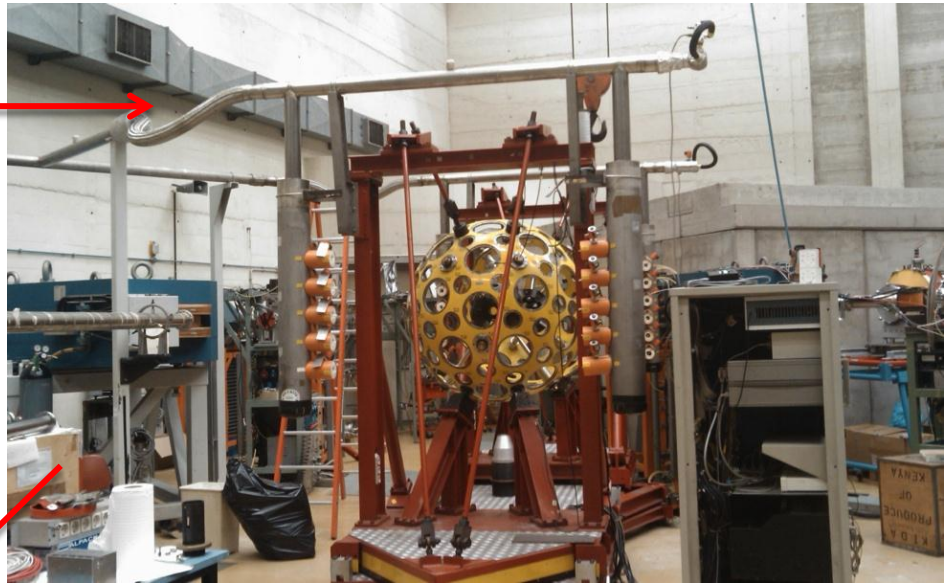
Mainly high–spin states populated in fusion–evaporation reactions coupled to ancillary detectors such as EUCLIDES, Plunger, n-Ring, RFD, LuSiA

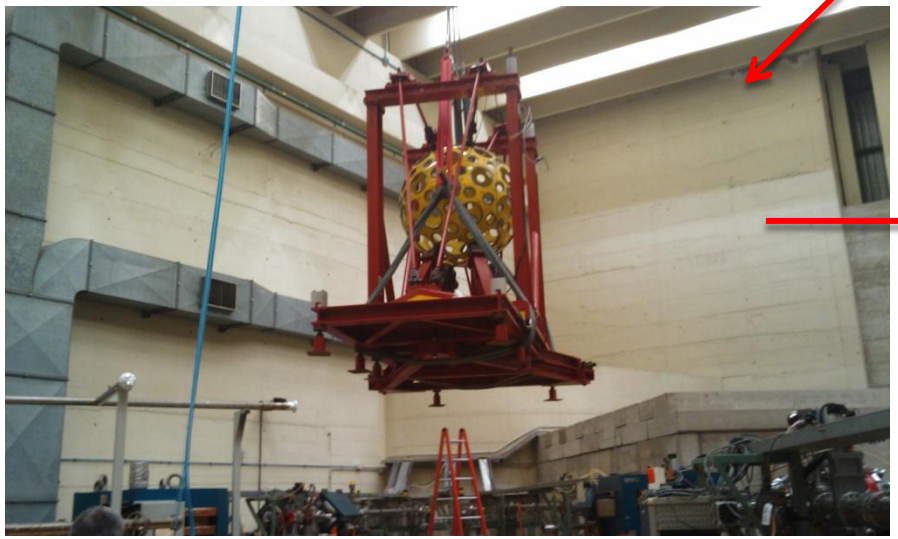
March 6 – 12, 2012 – last experiment

April 4, 2012 – official shutdown

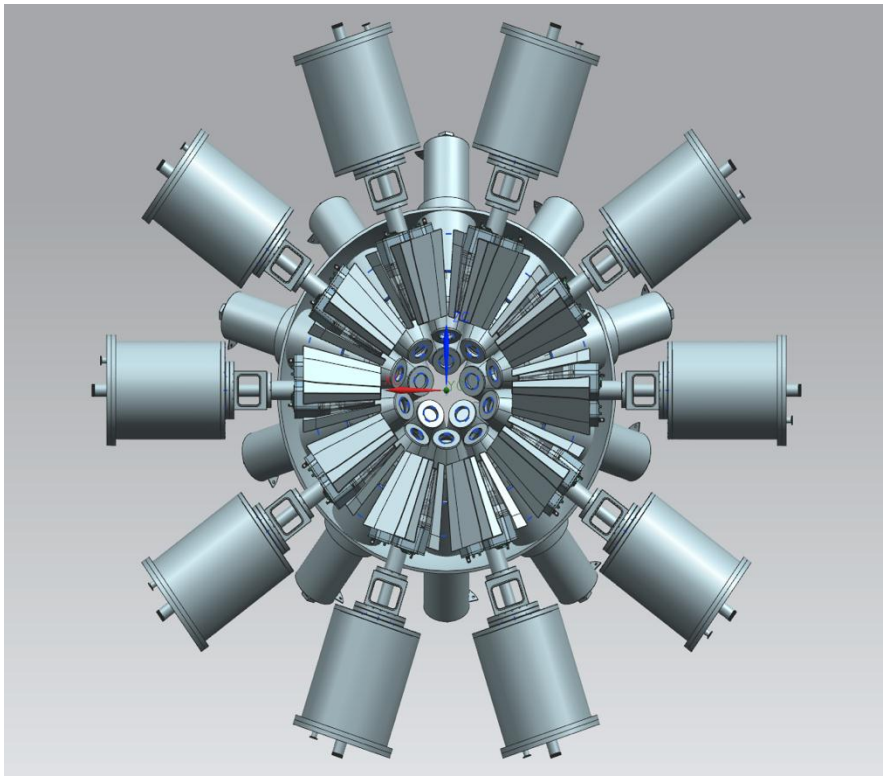
Dismounting of GASP







The GALILEO project



30 GASP detectors @ 22.5cm

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

10 triple cluster (EB clusters) @ 24cm

90°

take advantage of the recent technical developments for AGATA
- preamplifiers, digital sampling, preprocessing, DAQ
  - → **high counting rates (30–50 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

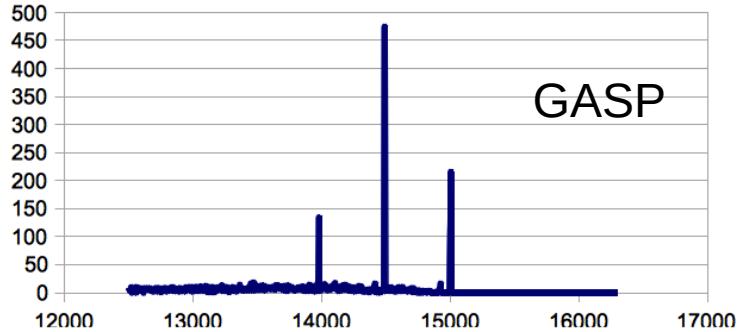
→ **production of new nuclei**

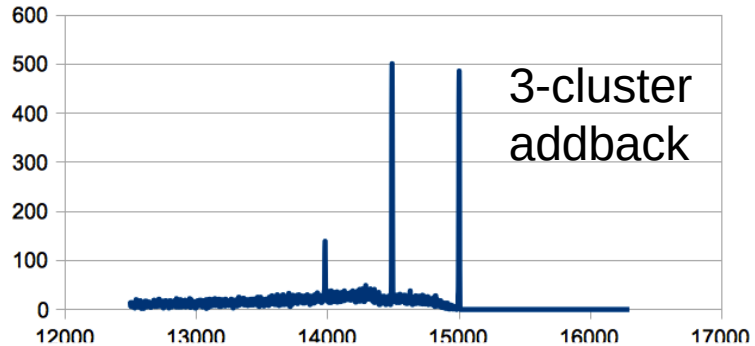
ε_{ph} ~ 8% P/T ~ 50%

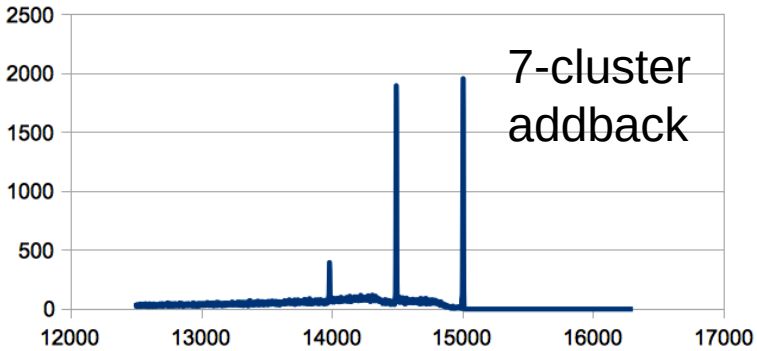
GALILEO – Mechanics

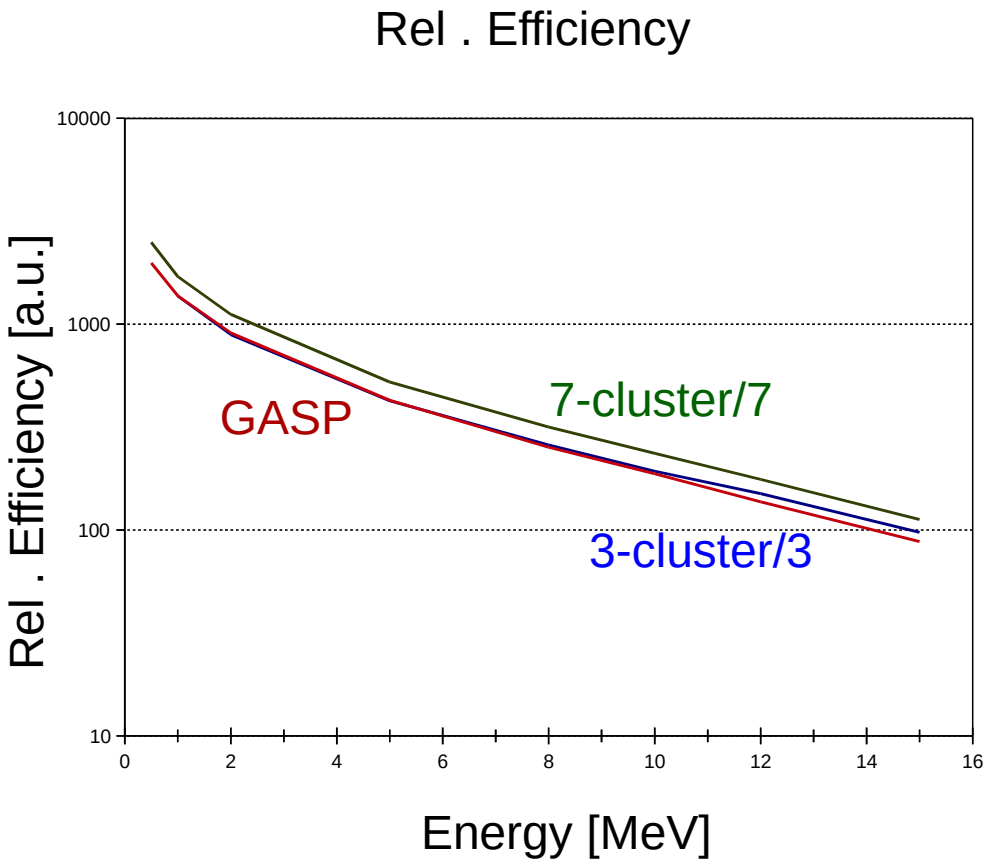
- Triple cluster cryostat
  - end–cap, cold finger, dewar
  - use of the EB cluster capsules
- Anti–Compton shield for the TC detector
  - recover the crystals from the original EB cluster shields
- Holding structure
  - highly flexible, space for ancillary detectors
- Pb collimator
  - divided in 4 parts
- Reaction chamber
  - accomodate different ancillary detectors
- Beam line
  - the structure opens along the beam line
- Ancillary detectors
  - integration with the holding structure

GALILEO – Triple cryostat









GEANT4 Simulations by E.Farnea

Triple Cluster Detector – R&D

Development of the triple cryostat

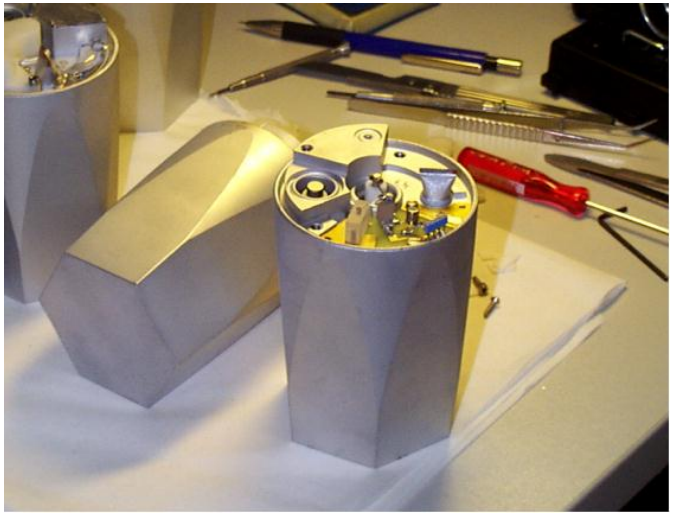
- end–cap in carbon fiber
- dewar
- optimizing the thermal conduction (LN_2 consumption)

EB cluster detectors

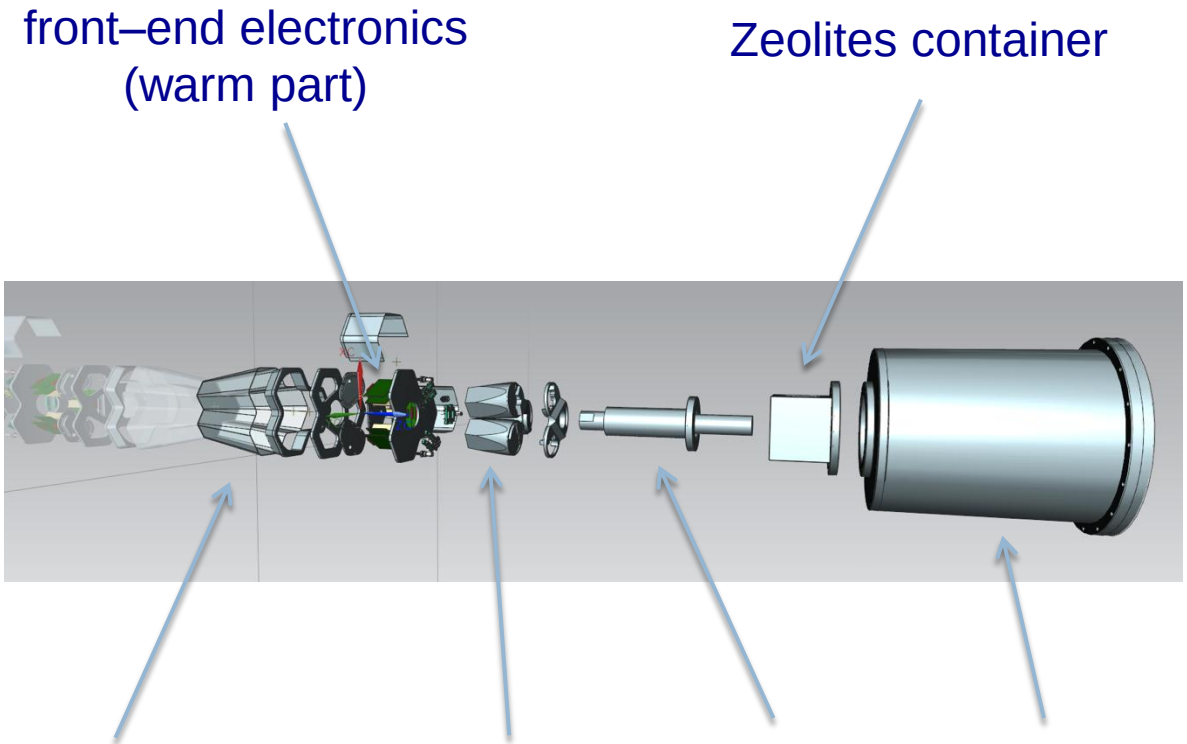
- 7 encapsulated n–type HPGe detectors
- FWHM < 2.4 keV @ 1332.5 keV
- ε_{int} ~60% @ 1332.5 keV

common cryostat

independent HV/LV/FE

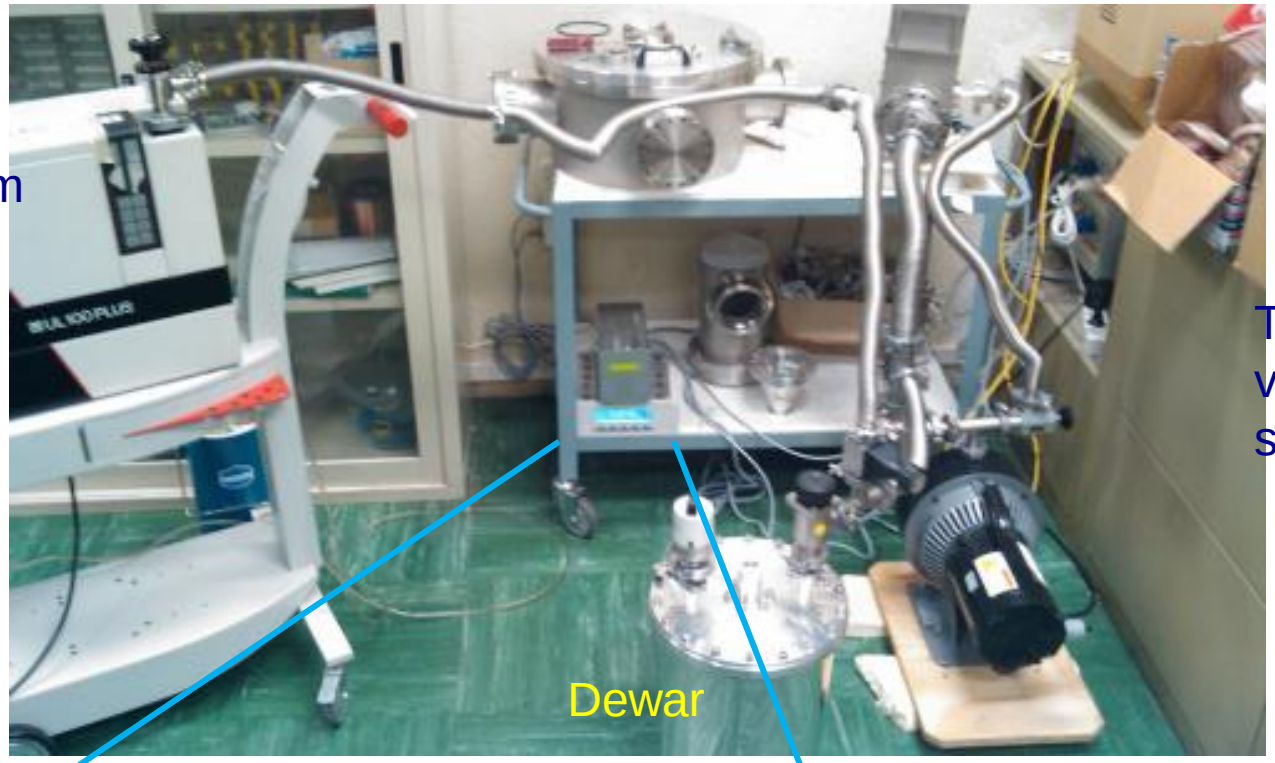


Triple Cluster Detector – First Prototype



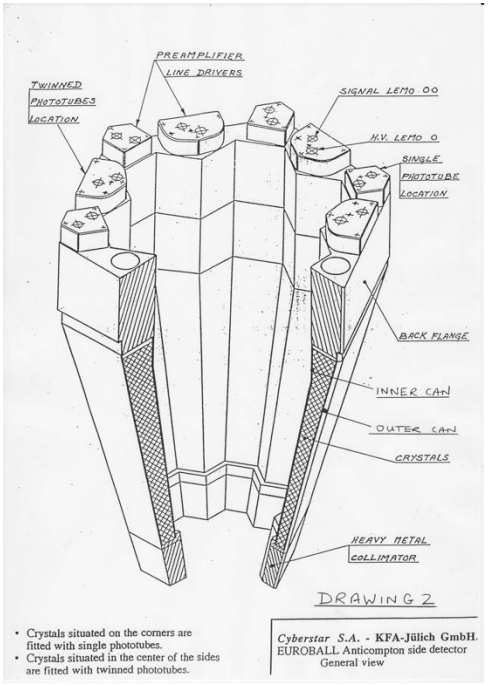
Testing of the TC Prototype

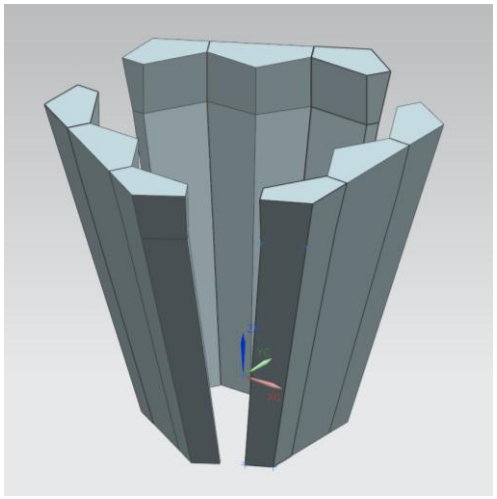
Vacuum leak testing system

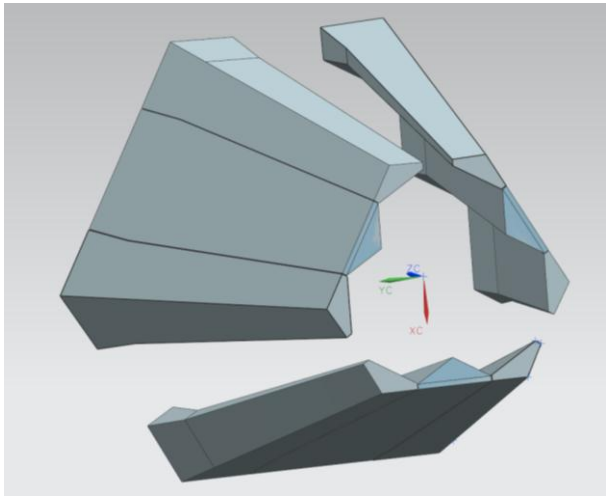


Turbo molecular vacuum pump system

AC shields for the triple TC detectors





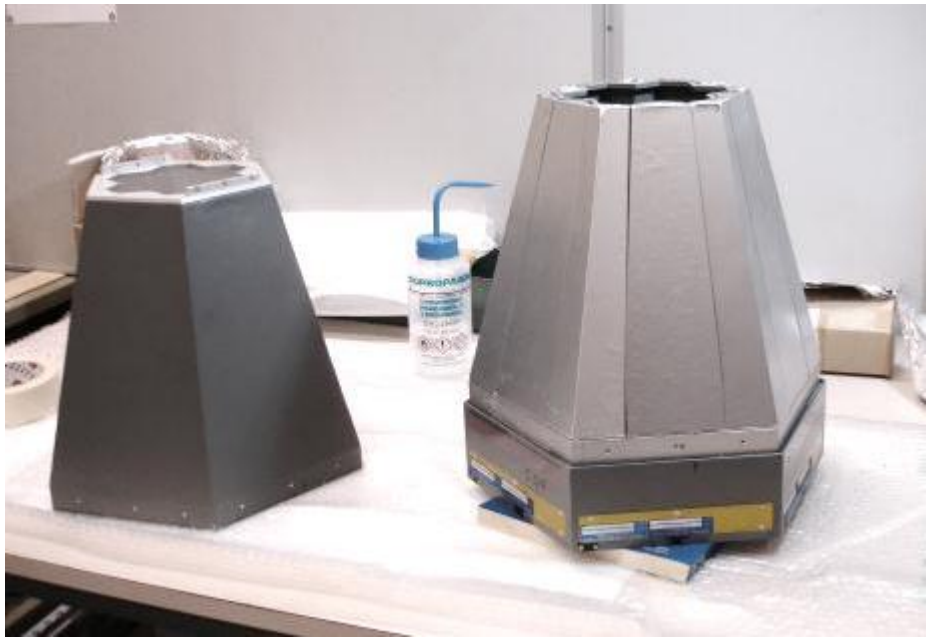


- a proposal for the construction of the triple cluster AC shield out of the individual crystals of the original EB cluster shield
  → **<u>one can build only one new shield from the original one</u>**

AC shields for the triple TC detectors

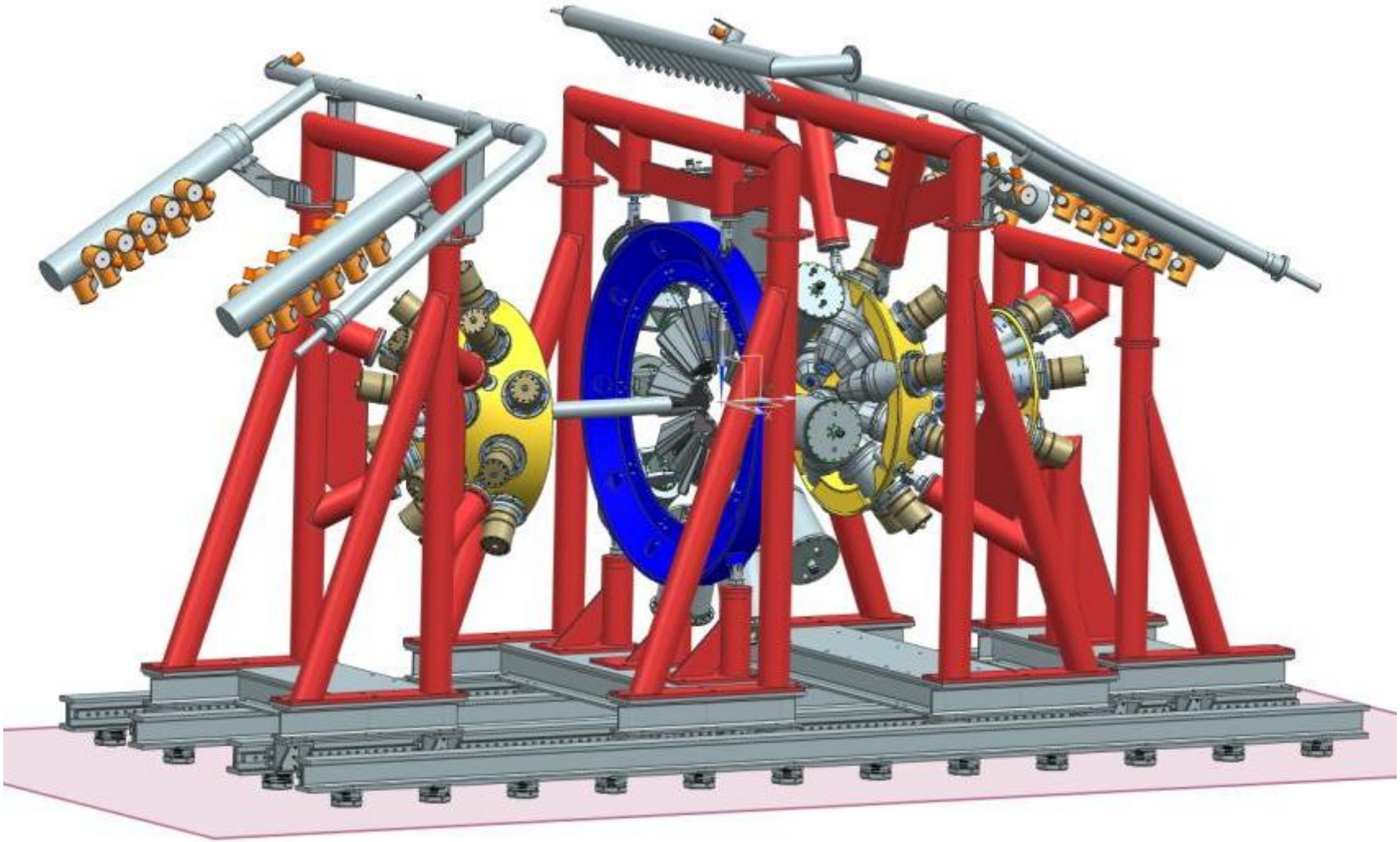
- moved one EB cluster AC shield to Legnaro
  → **demonstrate the possibility of safely dismounting the crystals and phototubes**

The Triple Cluster Detector AC Shields



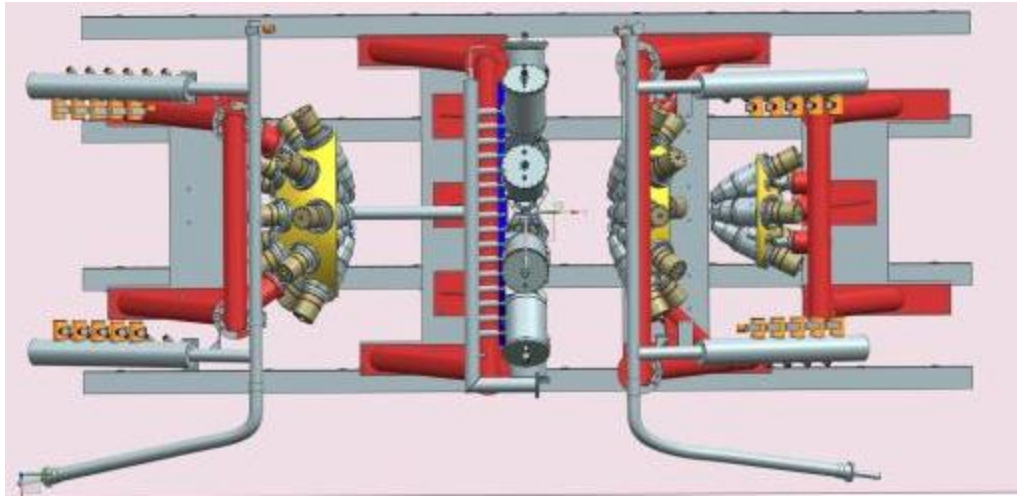
- **one can safely dismount the crystals and phototubes**
- **contacted Cyberstar Grenoble for information**

The GALILEO Gamma–Ray Array



Design by C.Fanin

The GALILEO Gamma–Ray Array



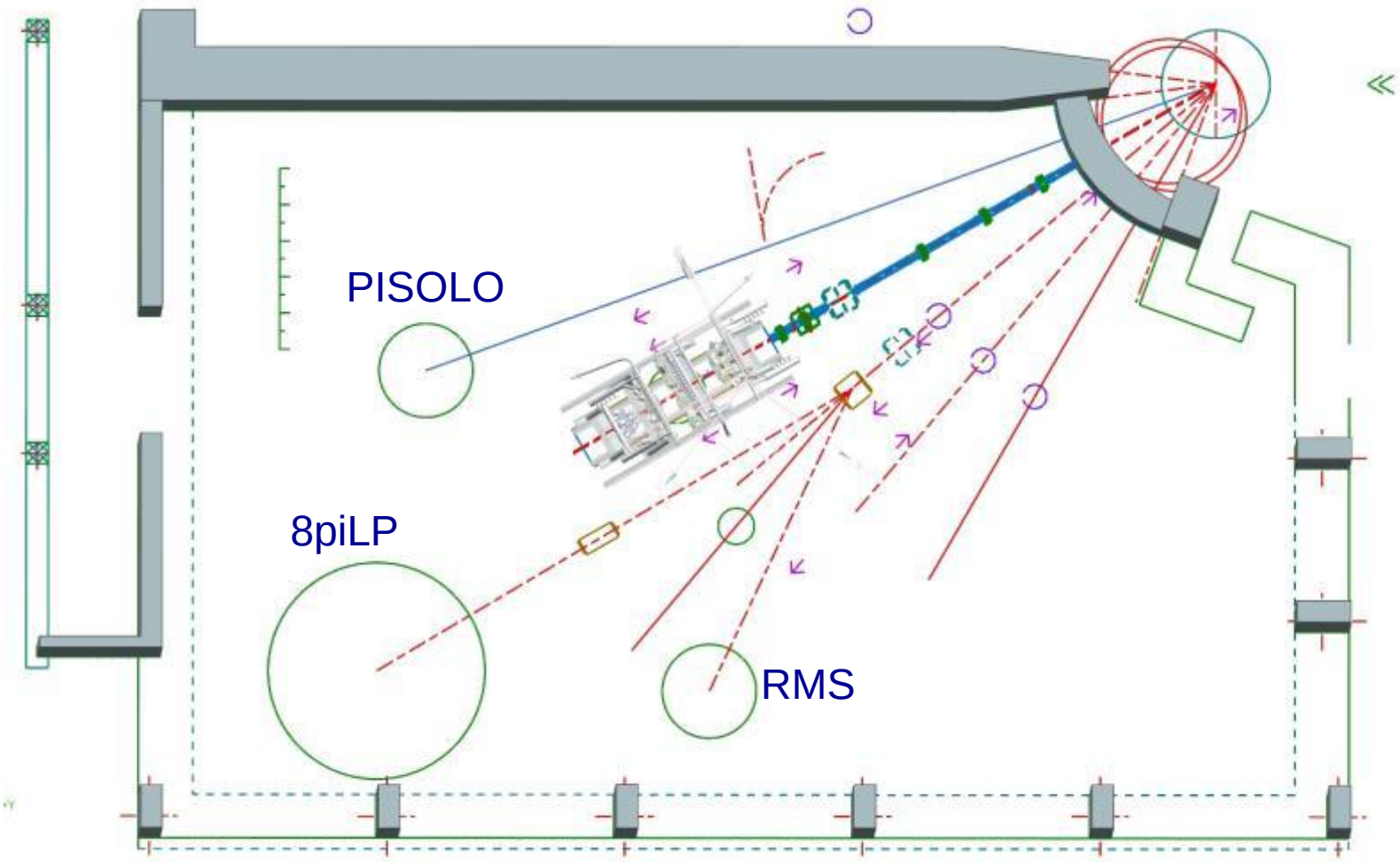
Design by C.Fanin

GALILEO – Parts

SCM
Modena

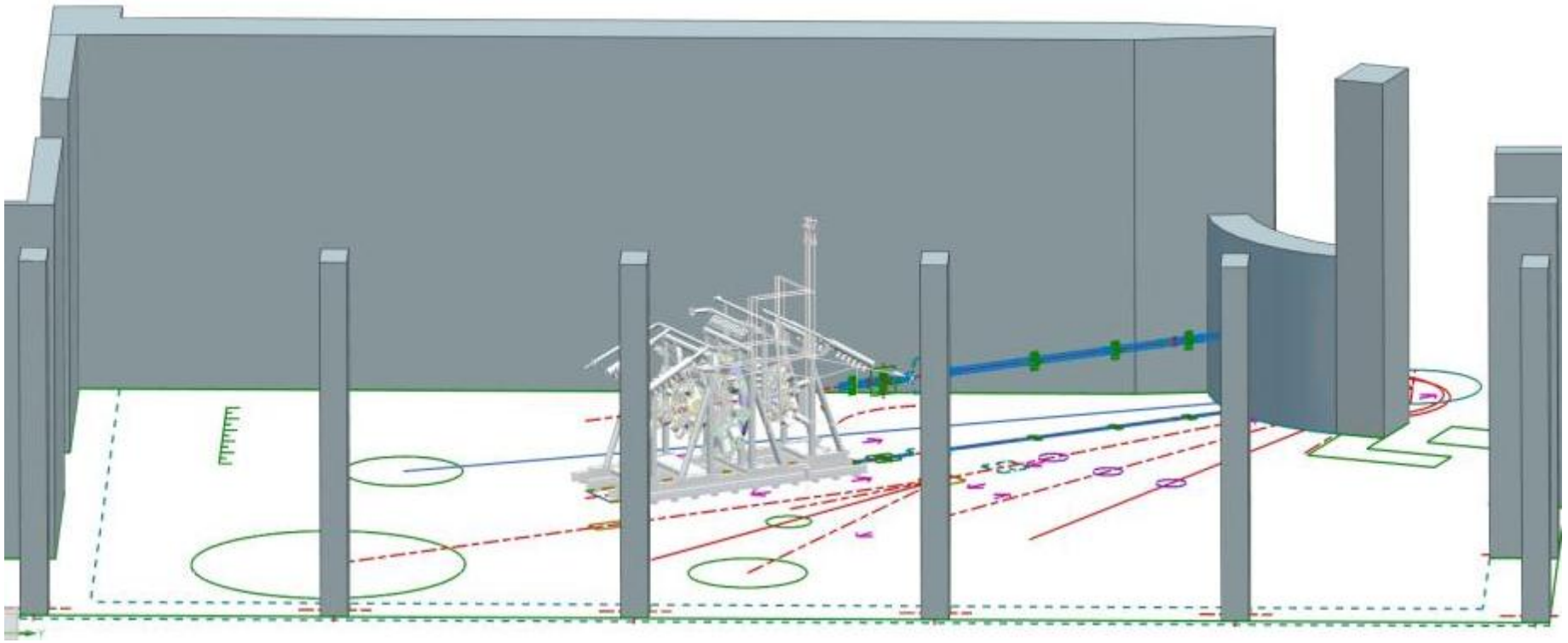
GALILEO – Parts

GALILEO – Location



Experimental Hall II – replacing GASP

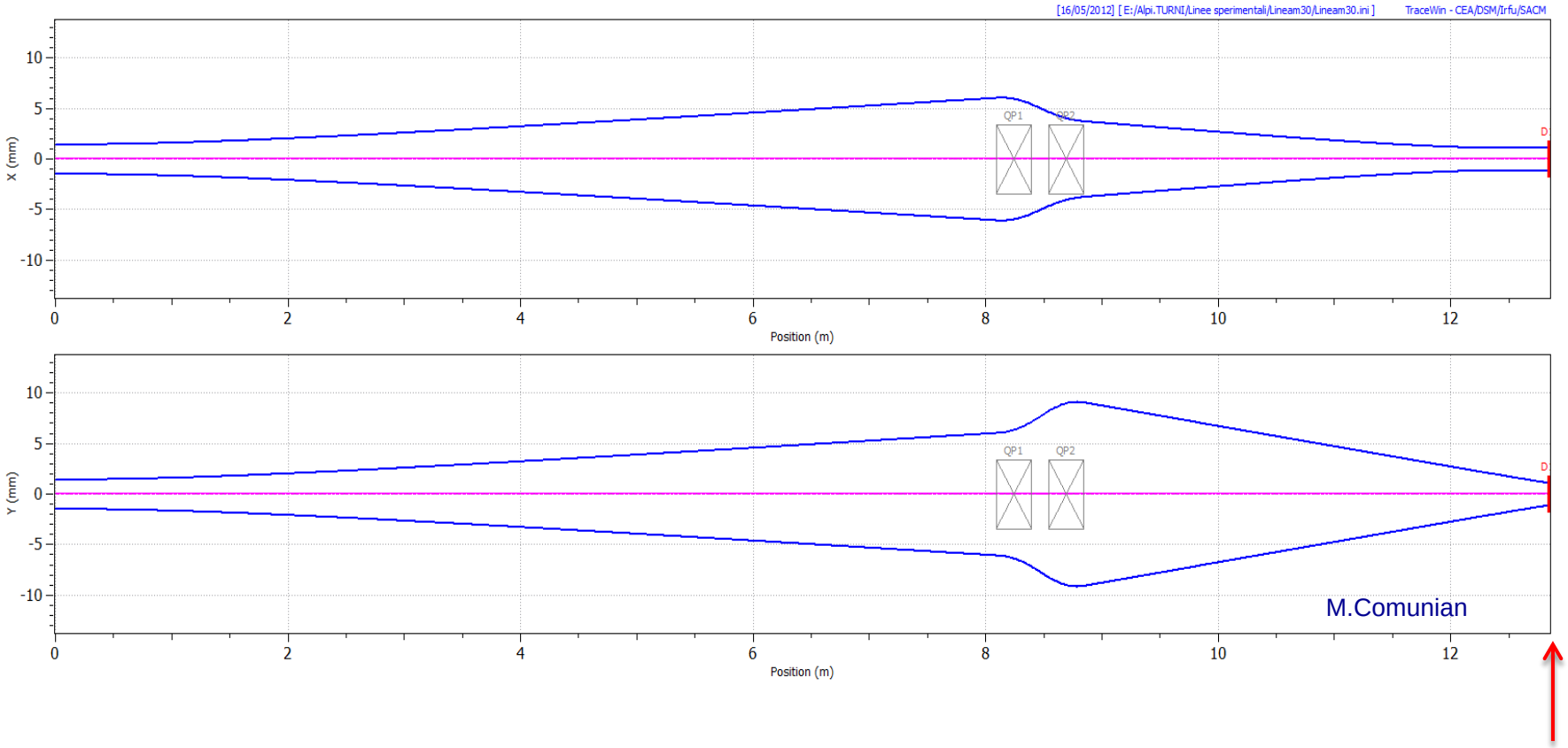
GALILEO – Location



July 2012 – beam time allocated for the alignment of the beam line and start installing the bins

GALILEO – Beam line design

^{82}Se beam @ 450 MeV



Ion optics calculations performed by the accelerator division at LNL

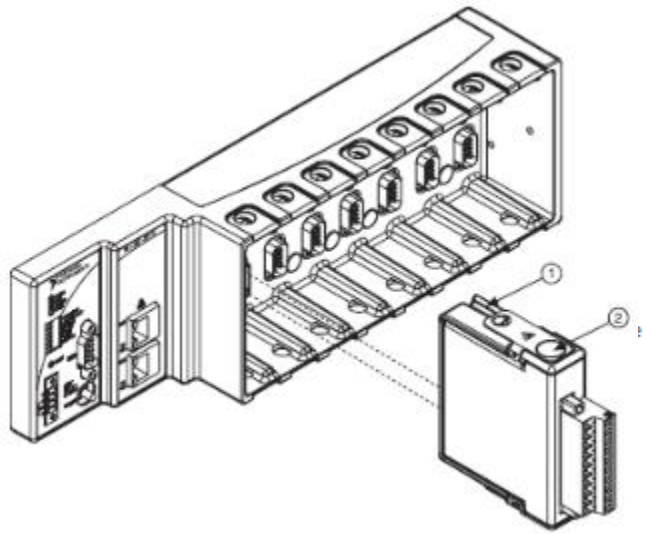
beam envelope in X (top) and Y (bottom) directions

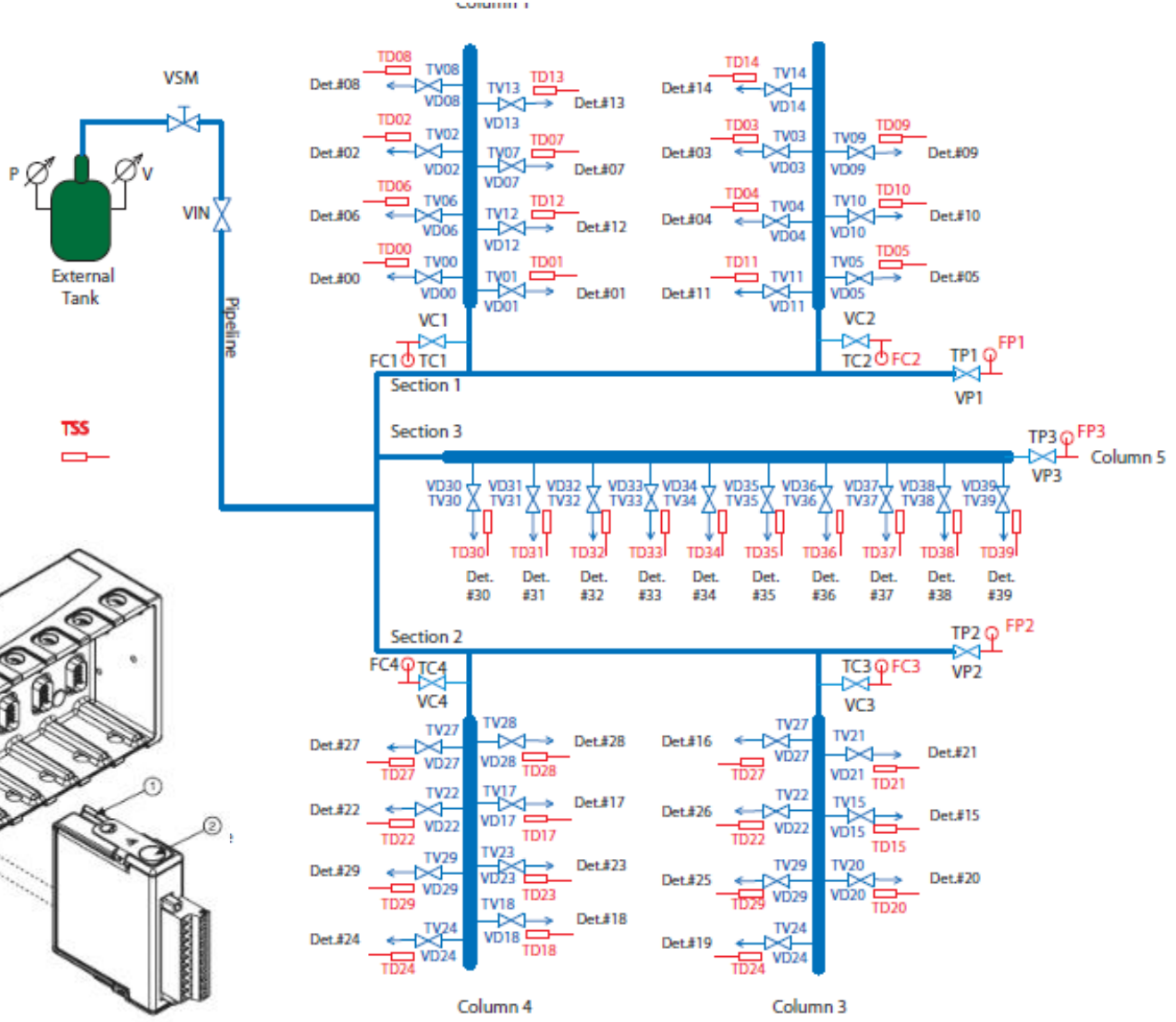
GALILEO target position

GALILEO – LN_2 Filling System

same logic flow
as for GASP and
EUROBALL

based on NI
CompactRio
architecture





Under construction at the electronics lab. of INFN Padova

GALILEO – Electronics R&D

New electronics is being built in close synergy with AGATA

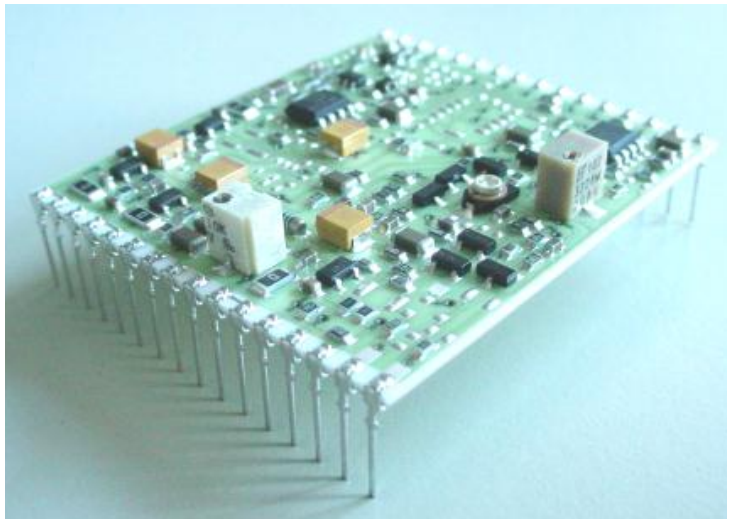
* low–noise, fast, low–power consumption *

- new cold part (AGATA FET) – ***to be done***
- use solutions already developed for AGATA
  - core type preamplifiers – ***done***
  - GTS – ***done***
  - AGAVA interface with the VME electronics (collab. with Kracow)
- new developments for AGATA and GALILEO
  - low power digitizers – ***prototype test***
  - readout and preprocessing on PCI express boards – ***prototype test***
- anti–Compton shields signal readout
  - digital (similar to the Ge detectors)

GALILEO – Preamplifiers

Property	Value	Tolerance
Conversion gain	100 mV / MeV (terminated)	±10 mV
Noise	0.6 keV FWHM (C_d=0 pF @ 150K)	
Noise slope	8 eV / pF	±2 eV
Rise time	~13 ns (0 pF)	±2 ns
Rise-time slope	~0.2 ns / pF	
Decay time	50 µs	±2 µs
Integral non linearity	< 0.025% (dyn.~3.5V)	
Output polarity	Differential, Z_o=100Ω	
Fast reset speed	10 MeV/µs	
Inhibit output	LVDS or CMOS	
Power supply	± 6.5 V, ± 12.5 V	±0.5V
Power consumption FET	< 20 mW	
Power consumption (except diff. buffer)	< 350 mW	
Supplementary power at very high counting rates	~230 mW	
Mechanical dimension	1.6 x 1.8 inch	

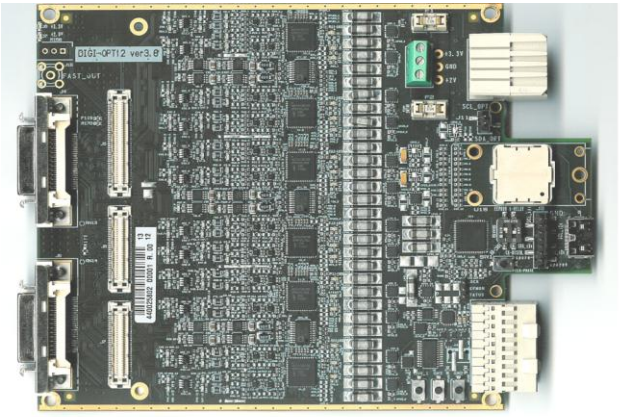
- a fast low–noise charge sensitive preamplifier based on the core–type AGATA preamplifier
- over–threshold fast reset circuitry – to reduce dead–time due to preamp/ADC saturation
- ToT signal – recover energy information up to 180 MeV
- a fast analog trigger signal can be produced – useful for ancillary detectors
- used for both tapered and triple cluster detectors

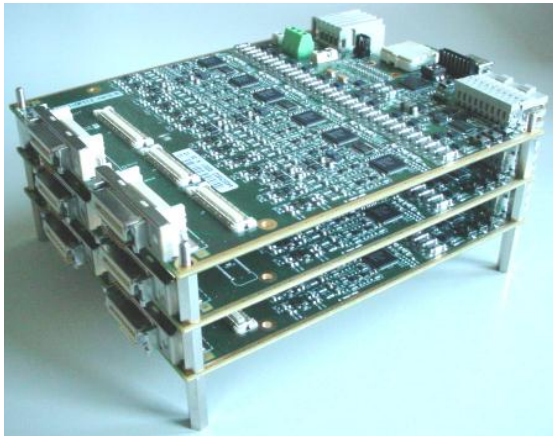


80 PA already built – tests with det. on-going

A.Pullia, G.Pascovici, C.A.Ur
submitted to IEEE Nuclear Science Symposium

GALILEO – Digital Sampling





5 boards built

Digi-opt12: 12-channel 14/16-bit 100/125-MS/s digitizer with optical output for GALILEO/AGATA

- single–ended/differential analog input signals
- end termination for both differential– and common–mode components of the input signals
- AC or DC coupling to the ADC,
- introduction and remotely-controlled adjustment of a differential DC offset, useful for dynamic range maximization
- remotely controlled dynamic-range selection,
- easily tuned anti-aliasing filter
- precise inter-channel time synchronization
- optional interleaved mode for equivalent sampling-frequency multiplication

Power consumption < 10 W / board

A.Pullia,

GALILEO – Readout & Preprocessing

Current Architecture

2 carriers
1 GTS mezz.
7 seg. mezz.

PCI Express
Triggered data

1 PC
2 LINCO1
(1 LINCO2)

Raw
Triggerless
data

AGATA Crystal → Digitiser 38 ch. → 7 cables x12fibres (6 used) → Preprocessing → 1 cable x8 fibres → Readout (narval node)

~30 k€
~320 W

~2K€
~0W

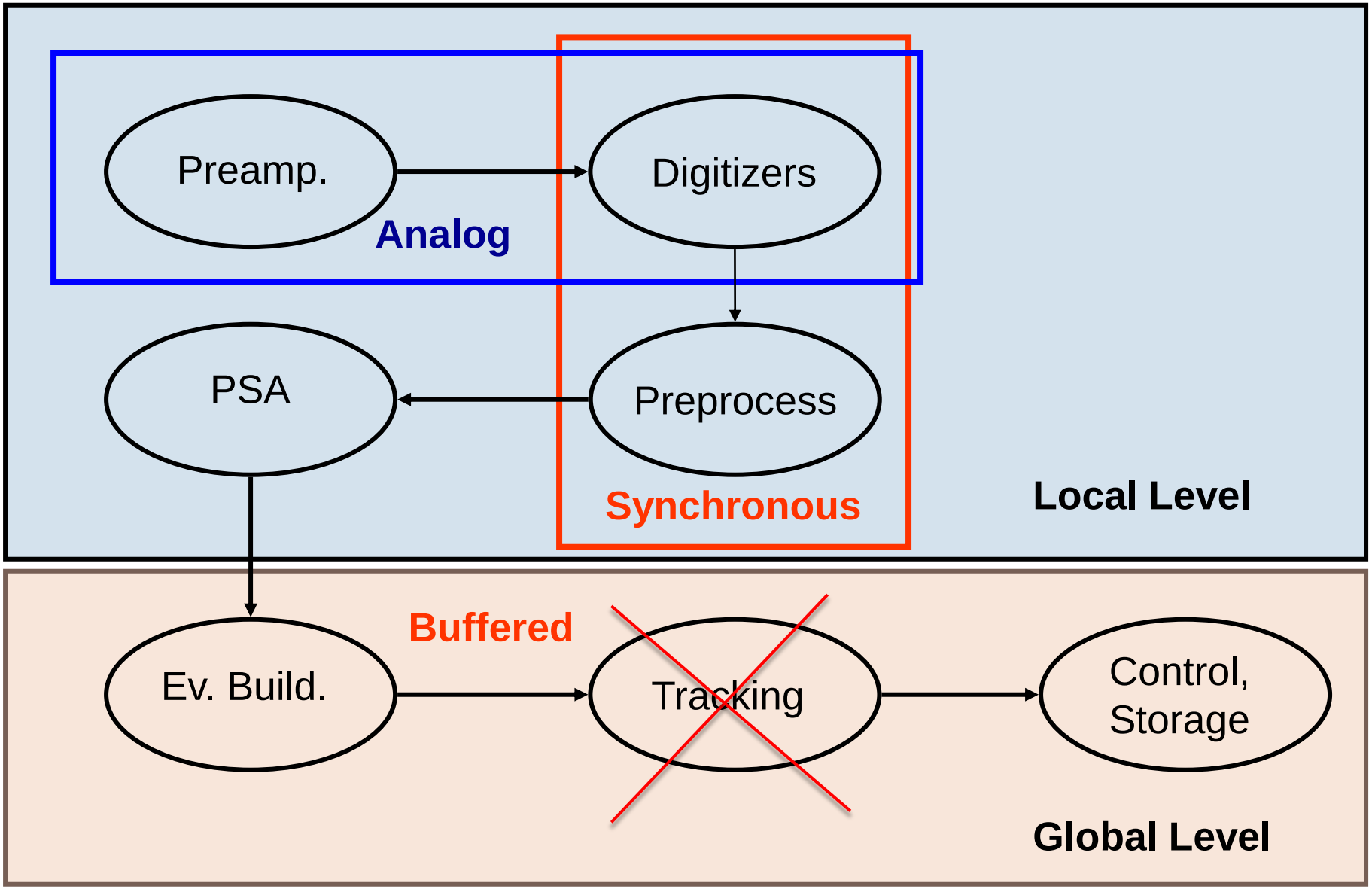
New Architecture

AGATA Crystal → Digitiser 38 ch. → 7 cables x12fibres (6 used) → Fibre Rearrangement → 4 cables x12fibres (12 used) → Preprocessing & readout (narval node)

~500€
~0W

~7 k€
~60 W

GALILEO – Electronics & DAQ



GALILEO – Electronics & DAQ

Fully synchronous system with global 100 MHz clock and time-stamp distribution

New AGATA core–like preamplifiers differential output, one 10 MeV range - done

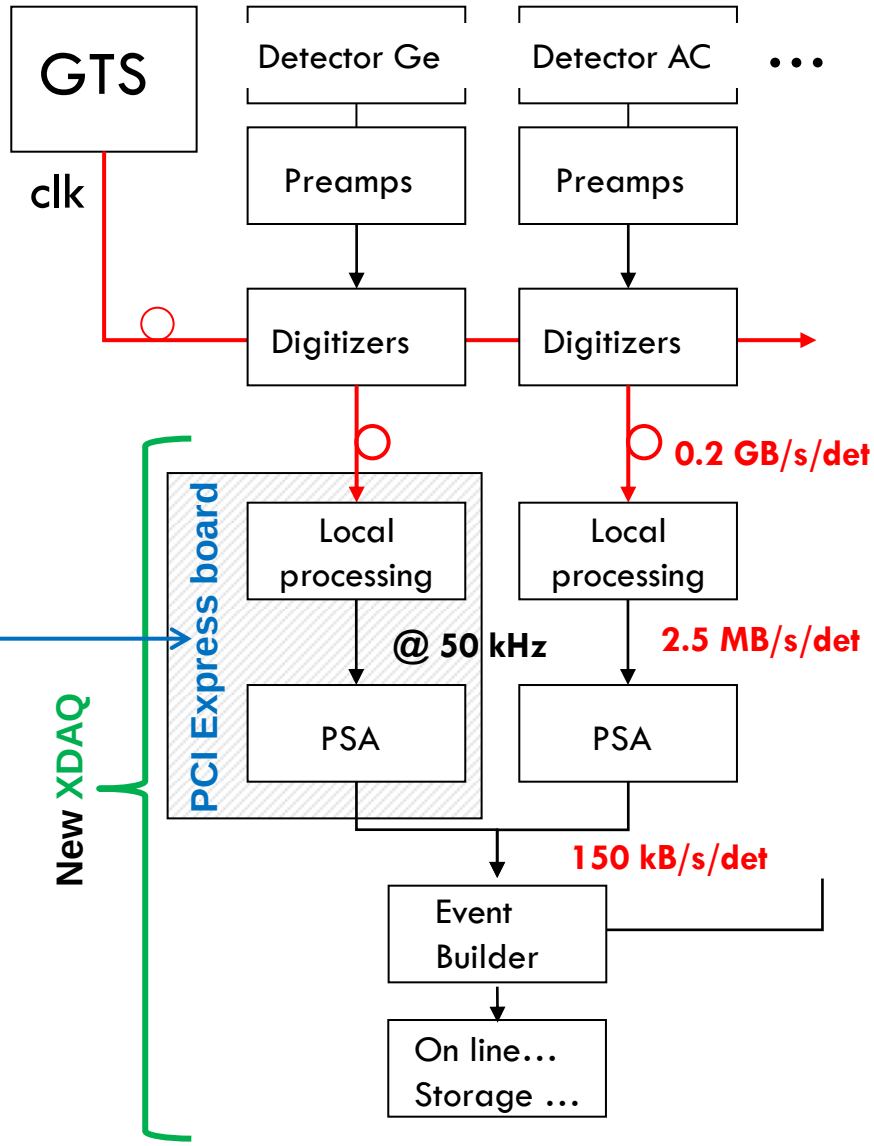
New Digitizers: 100 Ms/s, 14 bit – prototype ready
Optical fiber read-out of full data stream to pre-processing electronics

New local processing: determine energy, time and isolate ~ 600 ns of signal around rise-time
First prototype fully operational 38 channels

Buffers of time-stamped local events sent to PSA if needed neutron damage correction

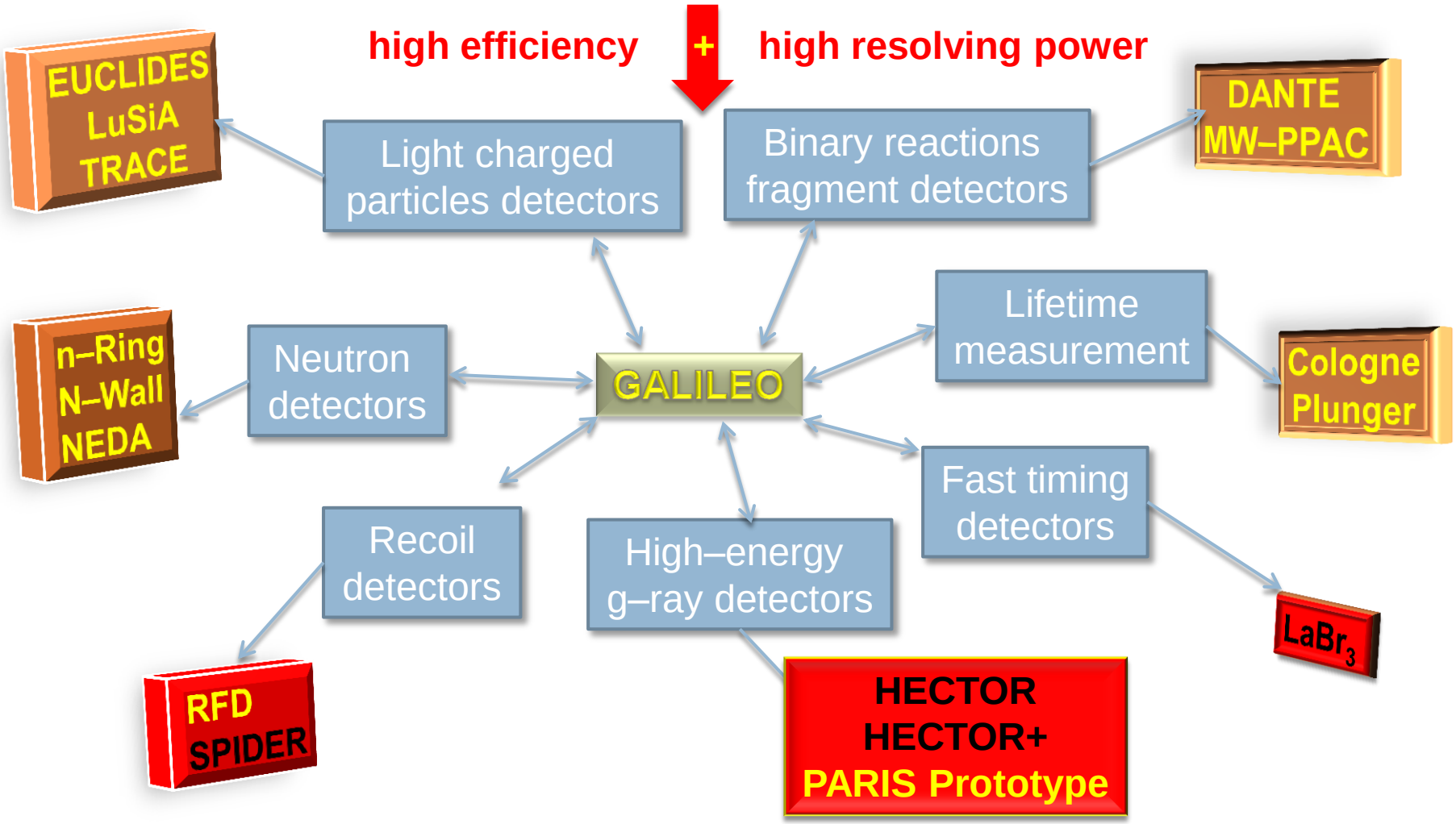
Global event builder and software trigger

Control and storage, …



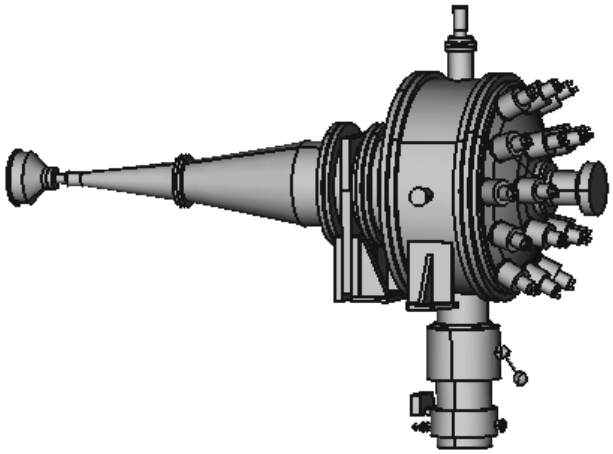
GALILEO – Ancillary Detectors

Study of weak reaction channels or weakly populated structures
LoI 2009–2012

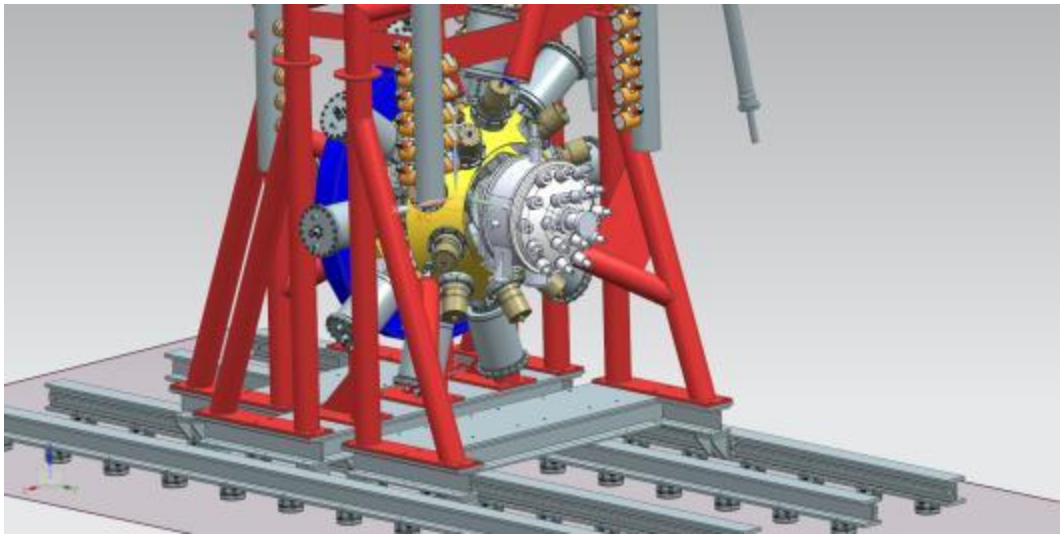


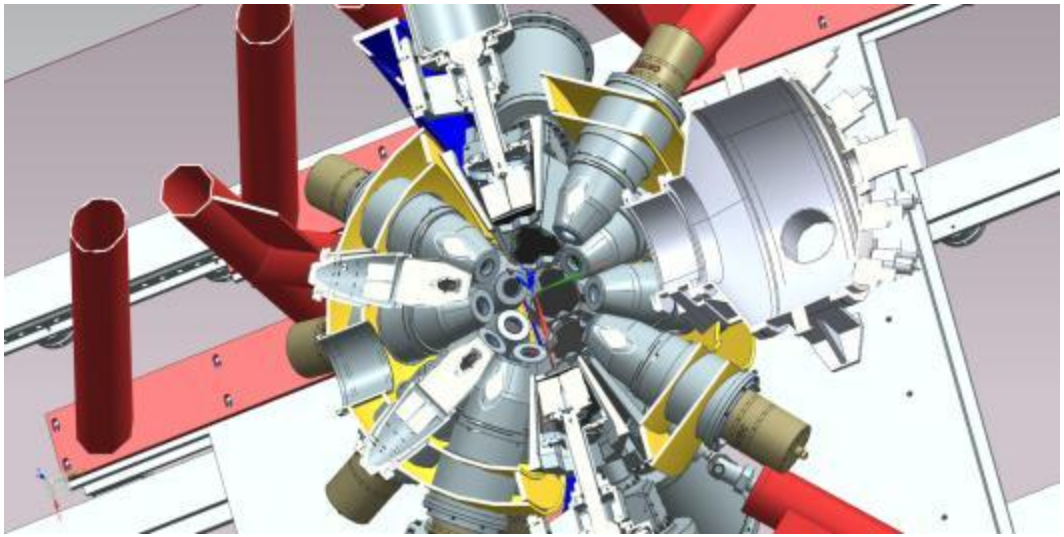
GALILEO – RFD

3D Model



RFD Kracow





Summary

R&D for improving detectors and electronics

- **higher detector granularity**
- **improved efficiency at high energies (composite configuration)**
- **low noise, fast electronics**
- **digital treatment of the signals**

The building of GALILEO proceeds

- **the holding structure**
- **triple cluster cryostats**
- **triple cluster anti–Compton shields**
- **LN_2 filling system**

Integration of ancillary detectors

- **RFD in advanced stage**
- **others – N–Wall, EUCLIDES, TRACE, SPIDER**

Expected to start the physics campaign in summer 2013

Symposyum on
Nuclear Structure with Large Gamma–Ray Arrays
NSP 2013
Padova, June 10 – 12, 2013

Collaborators

- Mechanical design and production
  - **Technical Service – INFN Padova, Mechanical workshops – INFN Padova, Legnaro, Milan**
  - C.Fanin, M.Turcato, M.Rampazzo, M.Romanato, L.Ramina, D.Conventi, E.Bissiato, S.Coelli
- Electronics developments
  - **Nuclear physics groups – INFN Padova and Milan, Computing service – INFN Legnaro**
  - D.Bazzacco, M.Bellato, A.Pullia, D.Bortolato, R.Isocrate, G.Rampazzo, L.Berti
- Vacuum, LN_2 filling systems, cabling
  - **Users Service – INFN Legnaro, Nuclear physics group & Electronic workshop – INFN Padova**
  - D.Rosso, L.Costa, P.Cocconi, R.Menegazzo, M.Nicoletto, M.Bettini
- Ancillary detectors integration
  - **Nuclear physics group – INFN Milan, Legnaro, IFJ PAN Cracow, Computing service – INFN Legnaro**
  - S.Brambilla, N.Toniolo, P.Bednarczyk, J.J.Valiente Dobon
- Beam line design
  - **Accelerator Division – INFN Legnaro, Nuclear physics group – INFN Legnaro**
  - G.Bisoffi, A.Pisent, M.Comunian, J.J.Valiente Dobon
- Monte Carlo simulations
  - **Nuclear physics group – INFN Padova**
  - E.Farnea
- DAQ
  - **Computing service – INFN Legnaro**
  - G.Maron, M.Gulmini, N.Toniolo, L.Berti