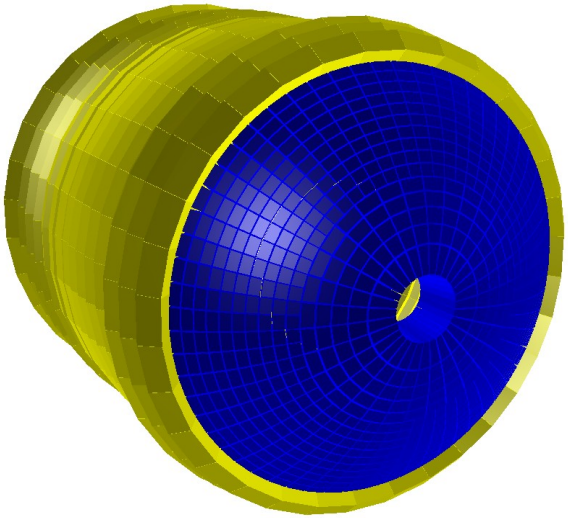
Status of the CALIFA detector for R^{3}B

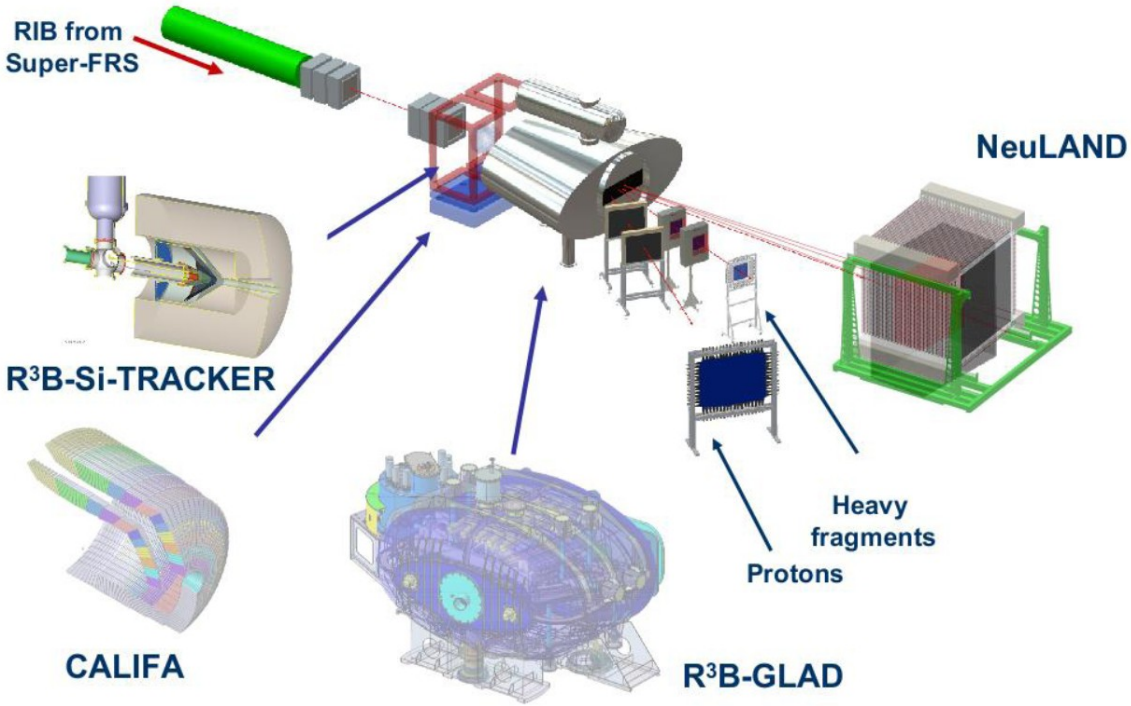
A. Ignatov (TU Darmstadt) for the R^{3}B collaboration and CALIFA WG



Work at TUD supported by BMBF (06DA9040I and 05P12RDFN8) and LOEWE / HIC for FAIR

CALIFA @ R^{3}B

(CALorimeter for In Flight detection of γ rays and high energy charged pArticles)



CALIFA working group

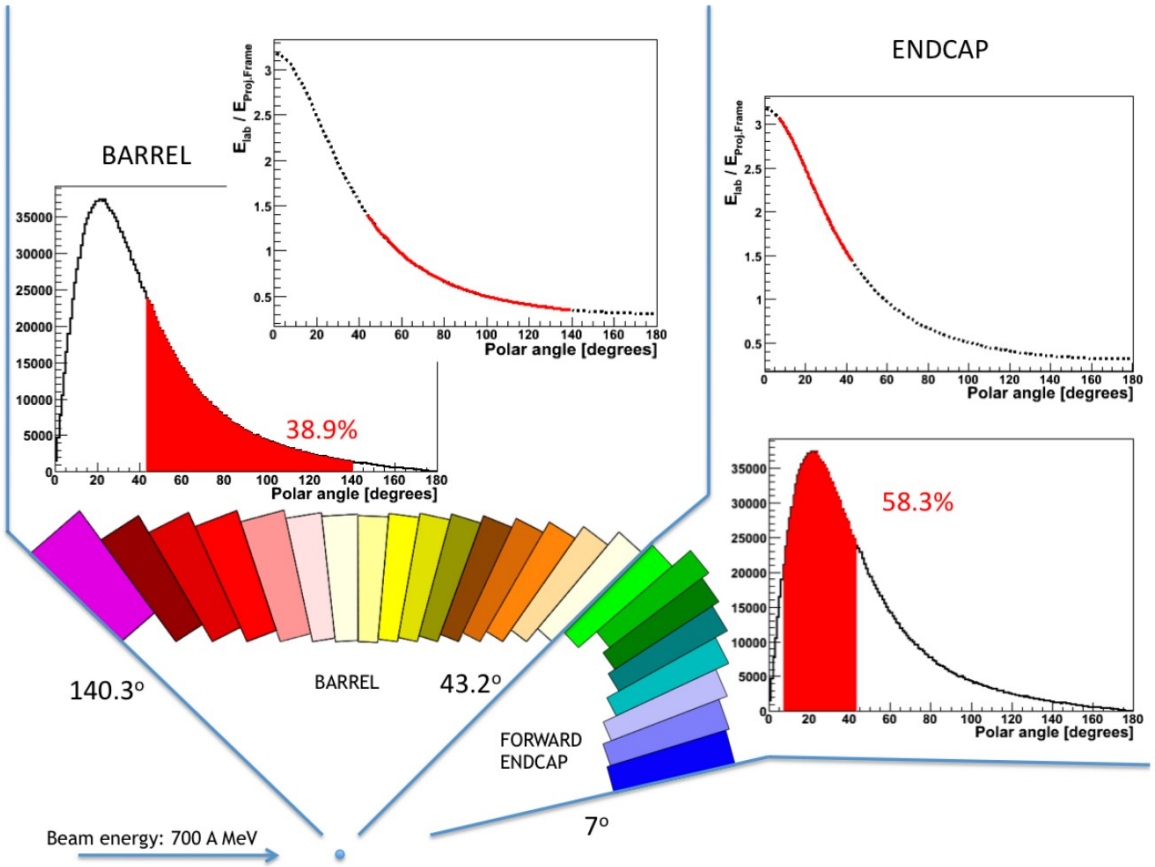
USC-IEM-UVigo | GSI-TUM-EMMI-TUD | Chalmers - Lund | CFNUL | JINR - NRC

CALIFA @ R^{3}B

(CALorimeter for In Flight detection of γ rays and high energy charged pArticles)

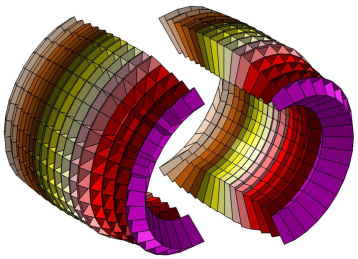
- Sum energy for the invariant mass analyses and energy of individual particles (γ and protons)
- Large dynamic range: from 100keV to 300MeV
- High efficiency and energy resolution (5-6% ΔE/E @ 1MeV γ)
- Light charged particles resolution ~2%
- Proton – γ separation for 1 – 30 MeV

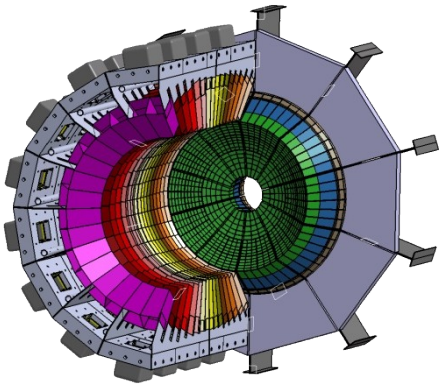
- Two parts: Barrel and the EndCap
- Based on scintillation detectors
- Granular design with minimum dead volume



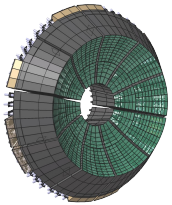
Outline

Barrel
(TDR accepted)





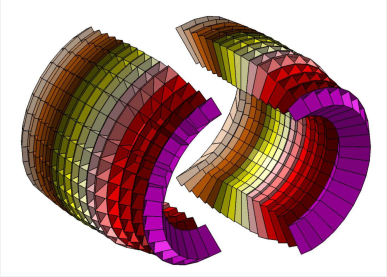
Endcap
(R&D)



- Scintillators and readout
- Electronics
- Gain monitoring
- Mechanics
- Barrel Demonstrator

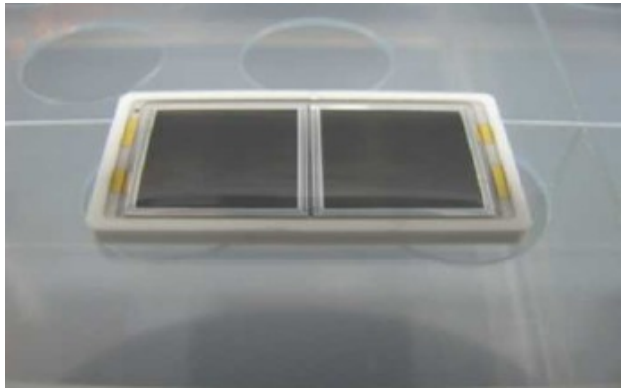
- Requirements
- Possible solutions
- Prototypes testing

CALIFA Barrel scintillators and readout



Inner radius	30cm
N of crystals	1952
Crystal geometries	11
Crystal volume/weight	285000cm^3 / 1300kg

CsI(Tl) crystals with LAAPD readout



HAMAMATSU
S8664-1010-2CH

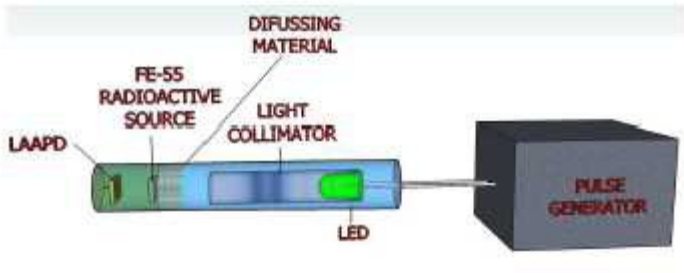
AMCRYS

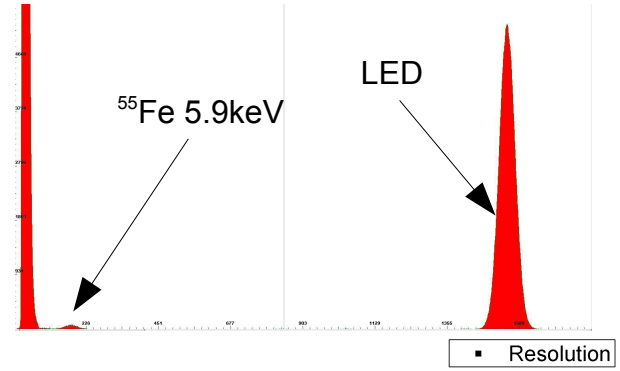
First APDs and crystals already delivered and are being tested!

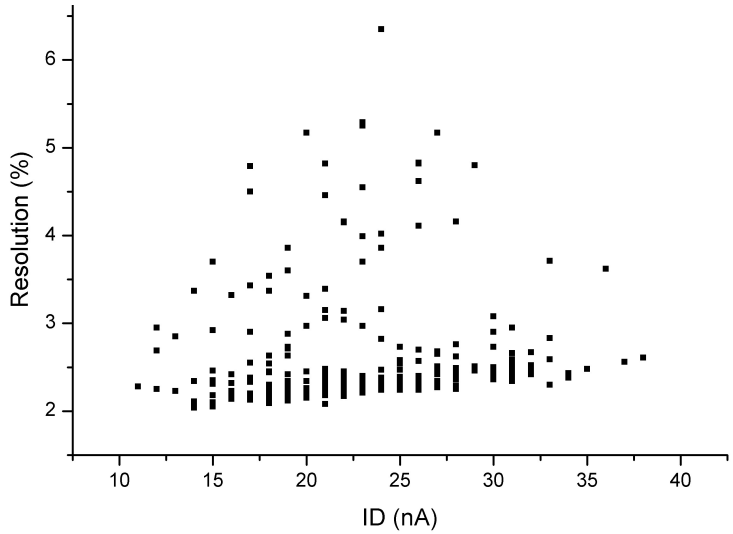
- Test of the APD (noise threshold, resolution, optimum V, T calibration)
- Test of the crystal (dimensions and weight control, visual inspection, light output uniformity, variation of light output)

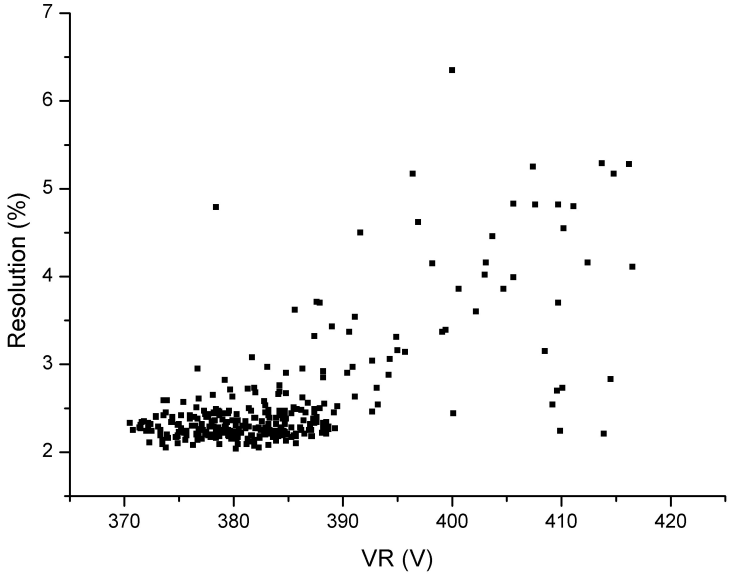
CALIFA Barrel – APD

APD tests performed at USC (Spain)



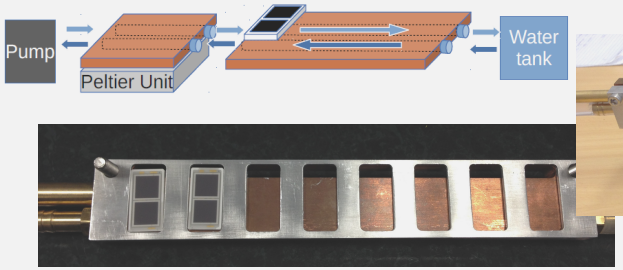


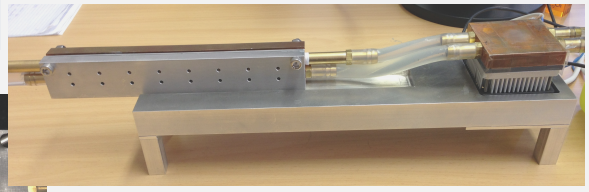




CALIFA Barrel - APD

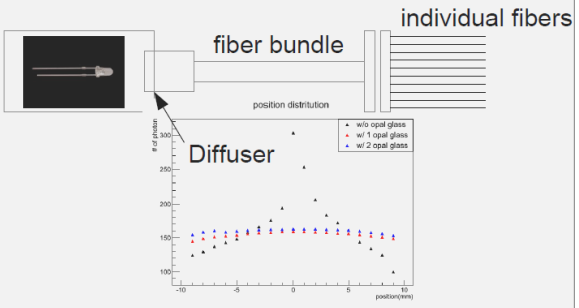
APD test stand for temperature controlled measurements





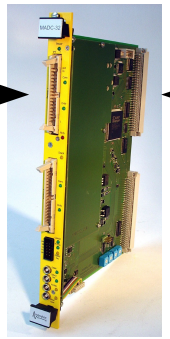
- 8 double APD units
- Peltier element with circulating liquid
- LED light source
- Temp. range 15 – 25 C
- Temp. controller + sensor accuracy 0.01C

LED light source with diffuser

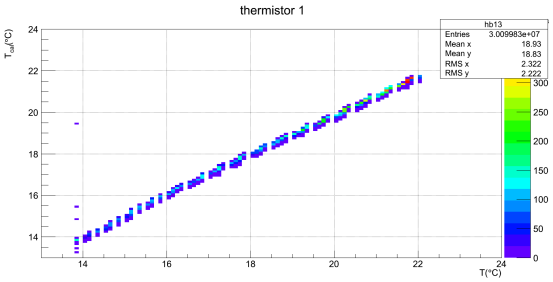


- Nichia green LED (525nm)
- Diffusing glass
- 2 fibers per double APD

Analogue readout
MPRB preamp + MSCF shaping amp + MADC



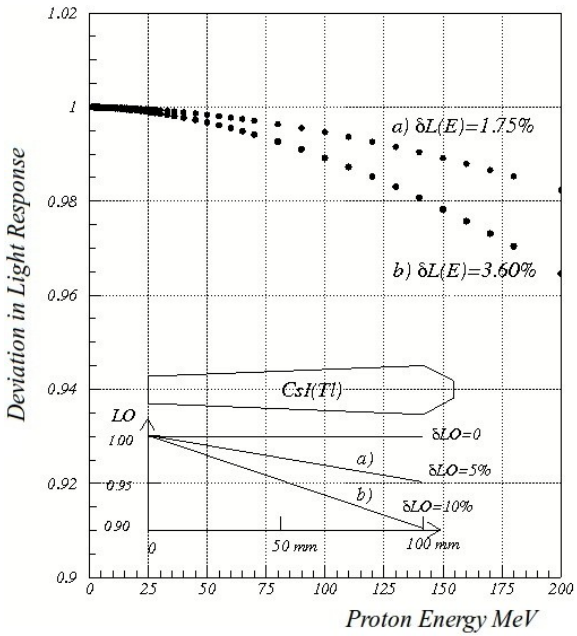
NTC thermistor interface



CALIFA Barrel – CsI(Tl) crystals

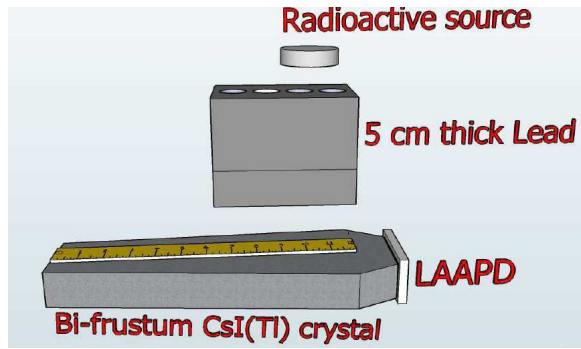
Non uniformity of the light output test

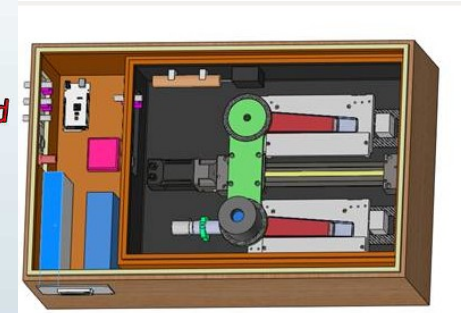
Focusing and attenuation in interplay



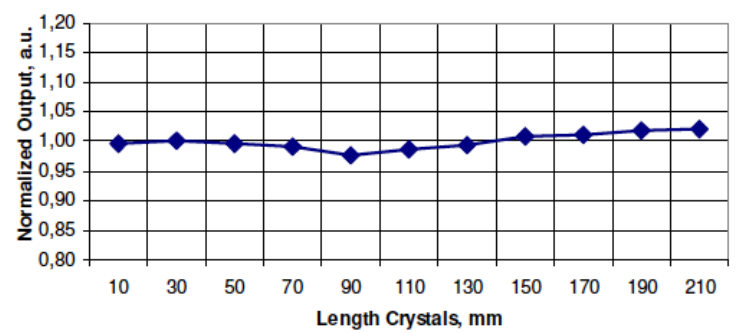
Lapping is used to retain the uniformity

NULO is characterized by $(LO_{max} – LO_{min}) / Lo_{ave}$
and is required to be <5% with the target value 3%
LO variation between crystals < 15%





NULO ~ 3.9%



CALIFA Barrel APD + CsI(Tl)

Crystal tests:

- Dimensions and weight
- NULO
- LO variations between crystals

APD tests:

- Optimum voltage
- Dark current
- Resolution
- Temp. calibration

Final steps:

- Gluing
- Wrapping
- Final tests

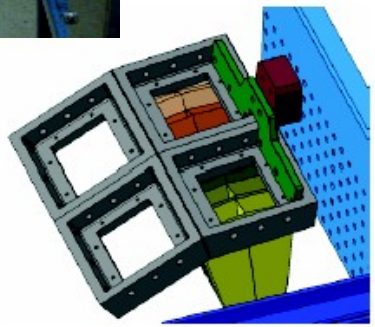
mounting

Database
Information of interest
For the analysis and slow control

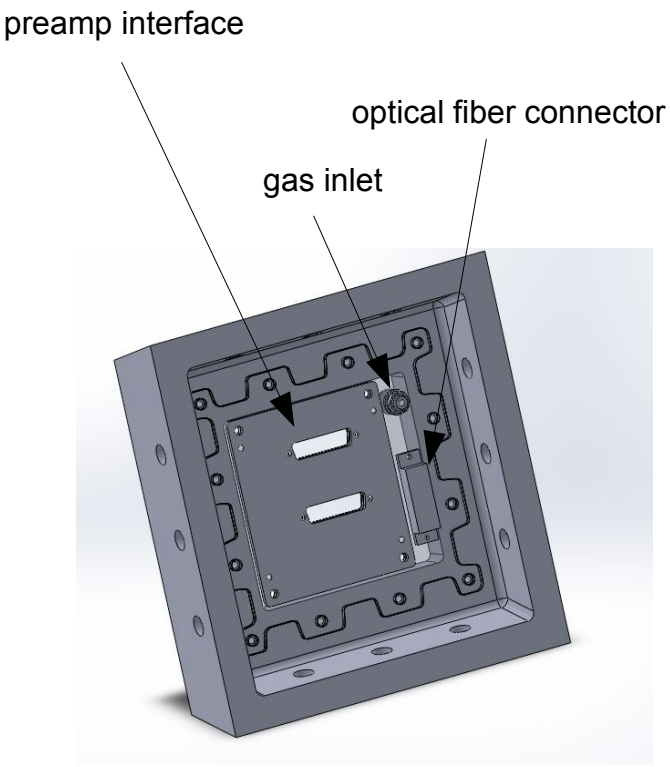
PETALs

PETALs will consist in a double tile estructure, holding 16 pockets (alveoli) and 64 crystals.
The structure will be clamp to the DMTR structure by a dedicated arm. The system will be isolated inside a (kind-of) box to make it gas and light-tigh.

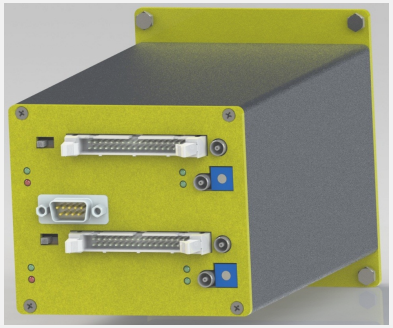
It would be possible to couple two PETALs into a double structure (partially shown in the drawings).



CALIFA Barrel electronics

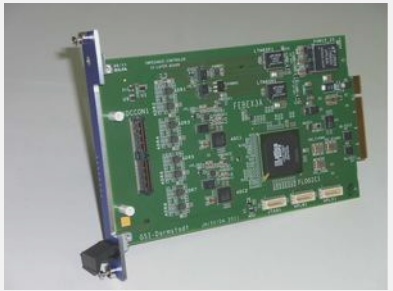


Dedicated electronics



Mesytec MPRB-16

- 2x16 channel CSP dual range 30/300MeV
- Individual voltages up to 600V with temperature compensation
- Remotely controllable

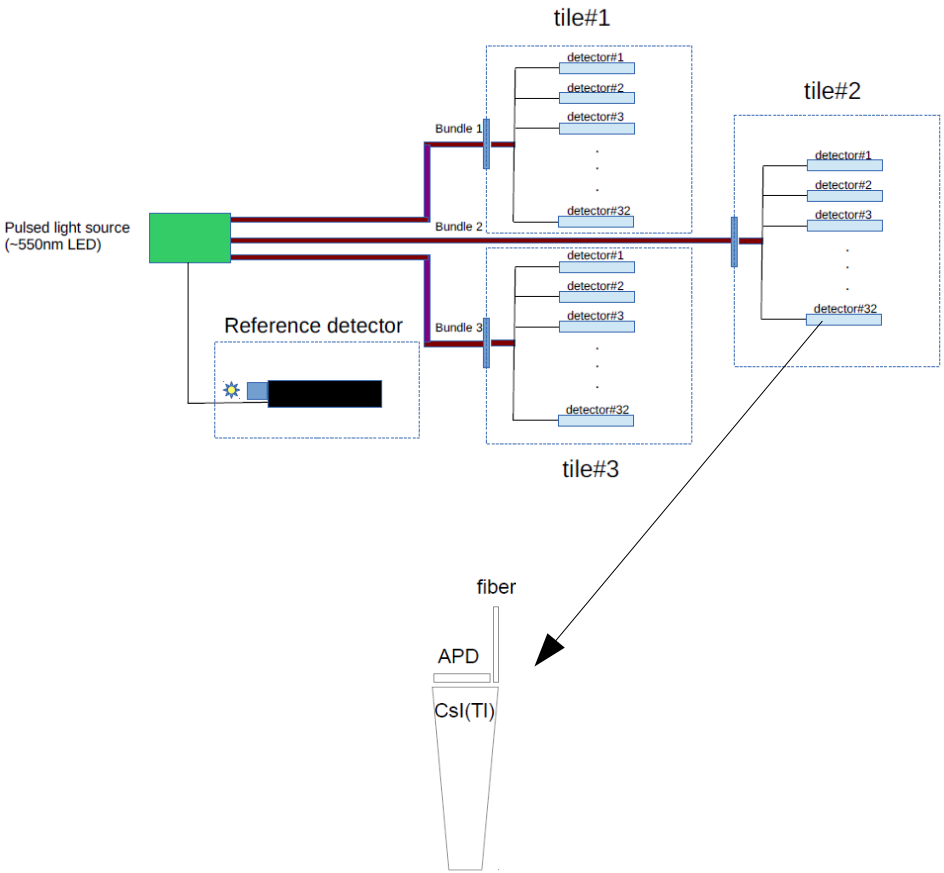


GSI FEBEX3

- 2x8-channel 50MHz sampling ADC sharing one FPGA

Electronics and readout development done by GSI & TUM

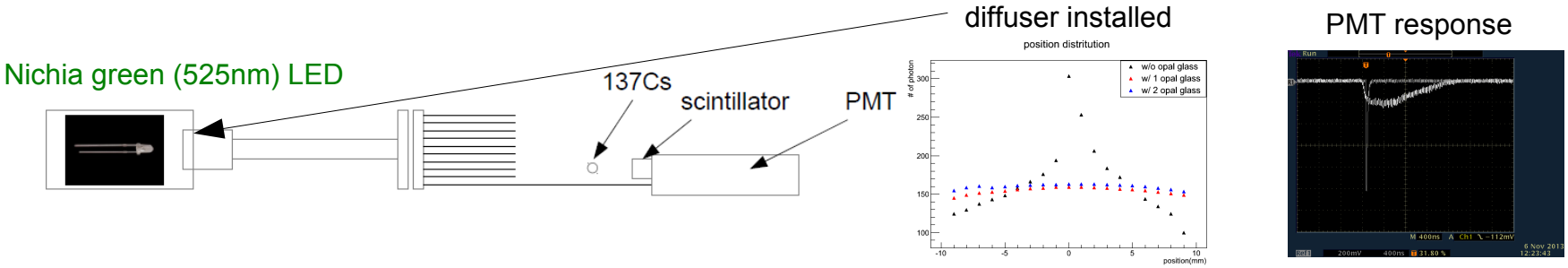
CALIFA Barrel gain monitoring

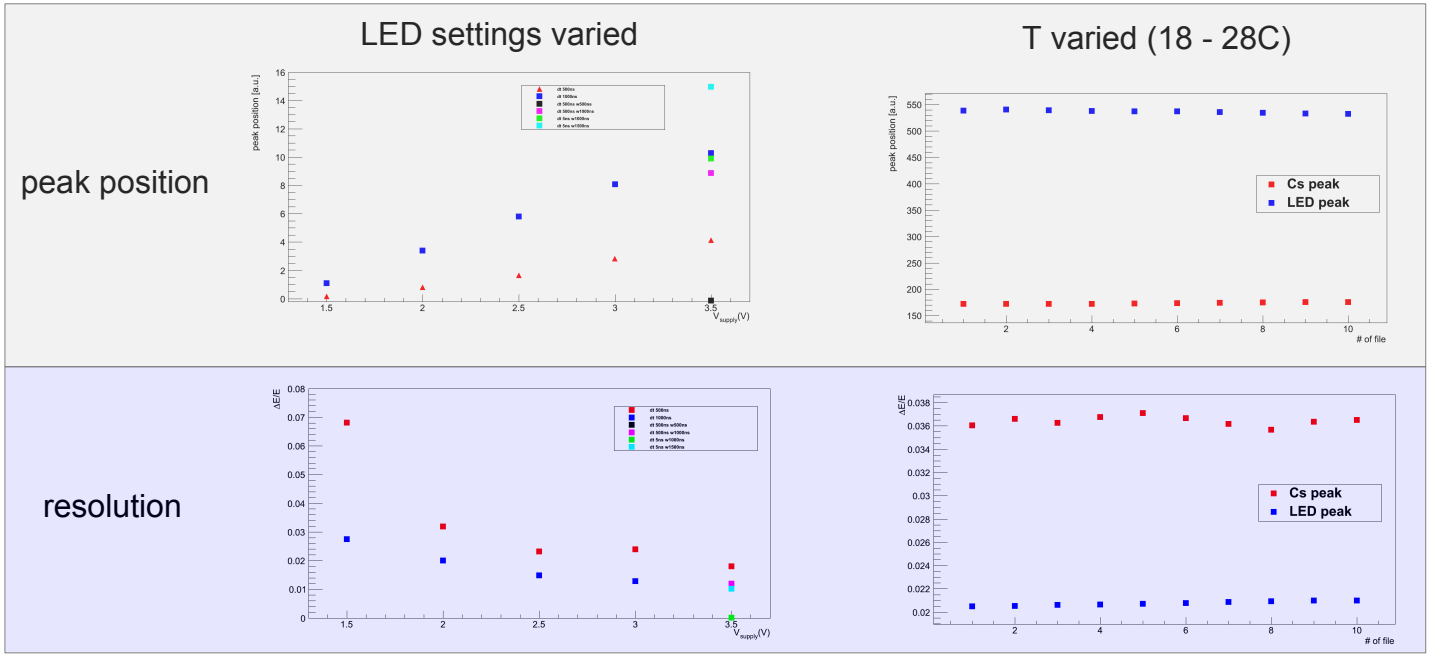


first prototype developed with Mitsubishi

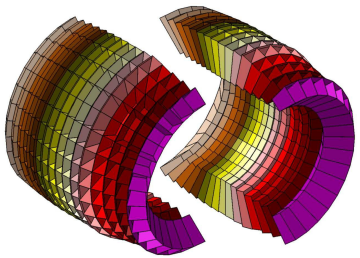
- 1mm diameter POF
- 5m bundle part
- 15cm individual fibers

CALIFA Barrel gain monitoring

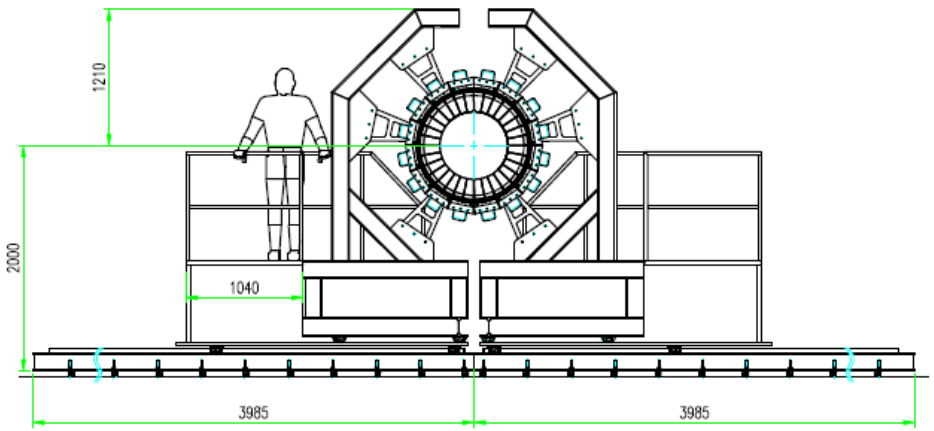


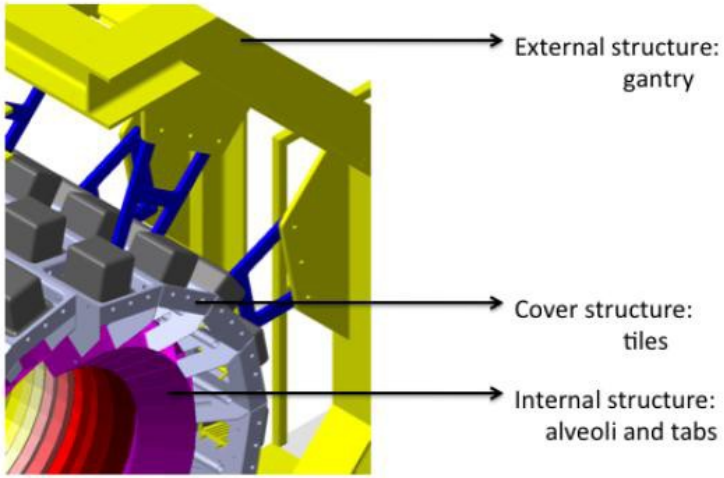


CALIFA Barrel mechanics



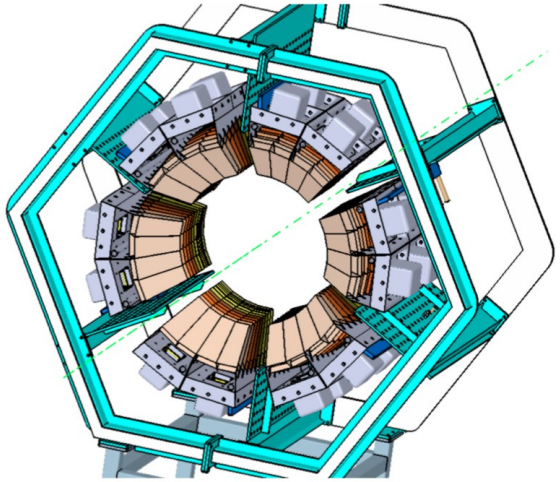
Developed in UVigo

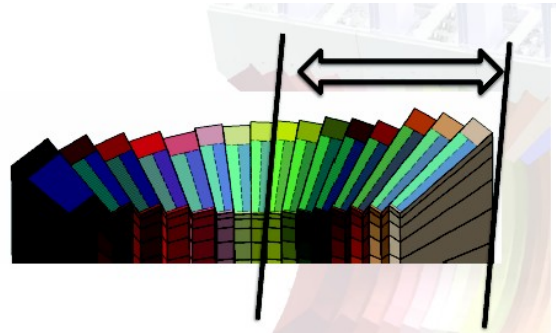




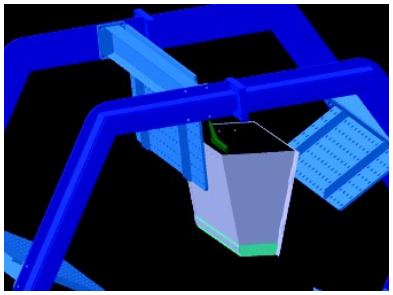
CALIFA Barrel Demonstrator

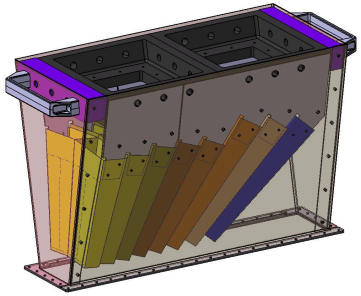
Demonstrator – up to 20% of the final Barrel
In beam test planned for this year





	pockets	crystals
Azimuthal Direction	2	4
Longitudinal Direction	8	16
Total	16	64





Petal is closed by the tile with the interface plate and the box enclosure

prototype is built

- gas flow test
- temperature test
- light test

CALIFA Endcap possible solutions

Requirements

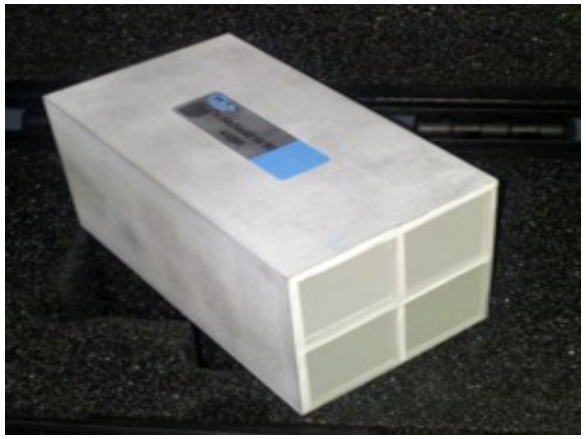
- punch-through protons
- proton – gamma separation

Work carried out in IEM

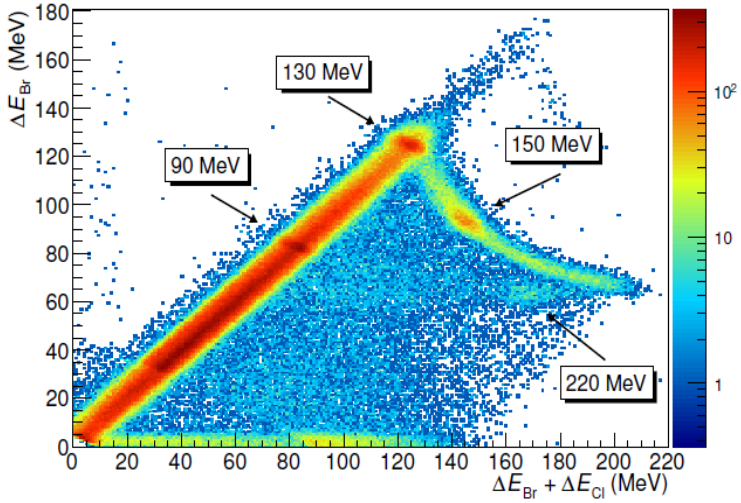
Phoswich detector

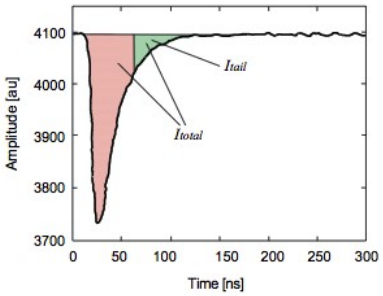
CEPA4 prototype

LaBr3 (4cm) + LaCl3 (6cm)



Tested at the Krakow cyclotron
70 – 230 MeV protons

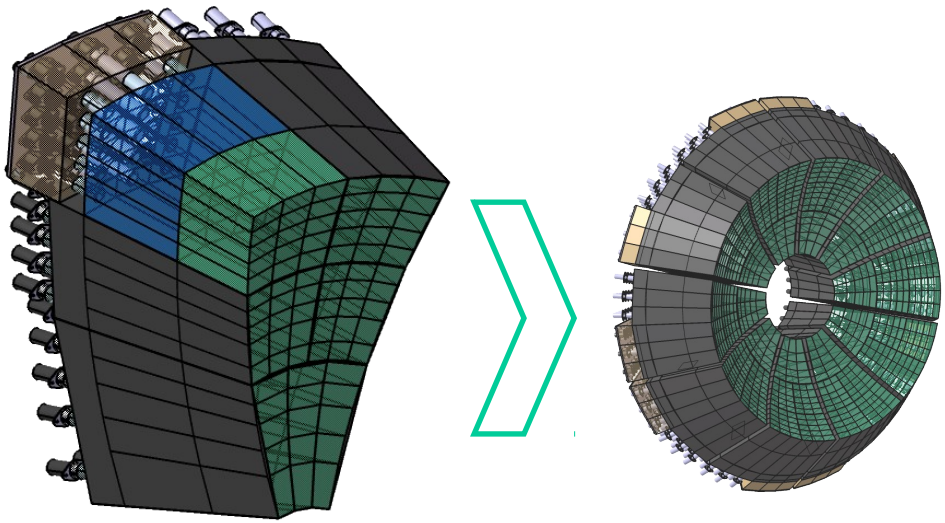




- 4 rectangular optically separated phoswich detectors
- one encapsulation (0.5mm Al & 5mm glass window)
- 4 optically independent PMT readout

CALIFA Endcap possible solutions

CEPA including mechanical structure implemented in the R3BROOT



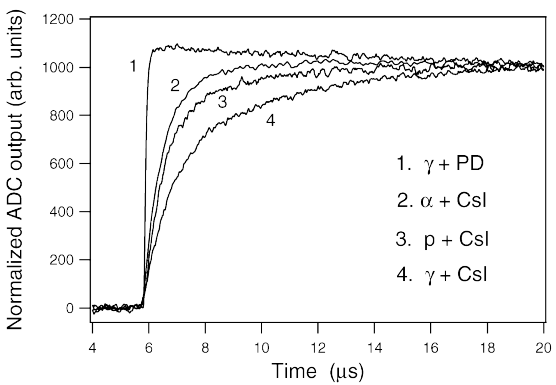
BRANCH

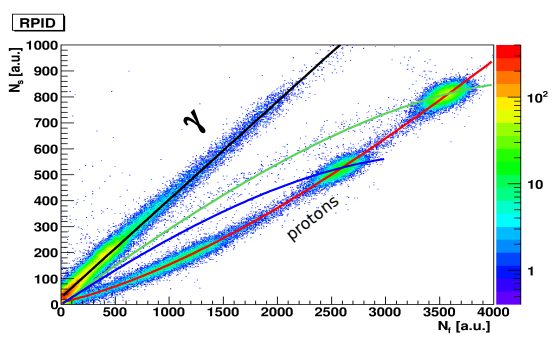
10 modules of 75 cystals

Rings (15)	θ(5%)
1	42.6º
2	40.5º
3	38.5º
....	....
14	12.7º
15	40.5º

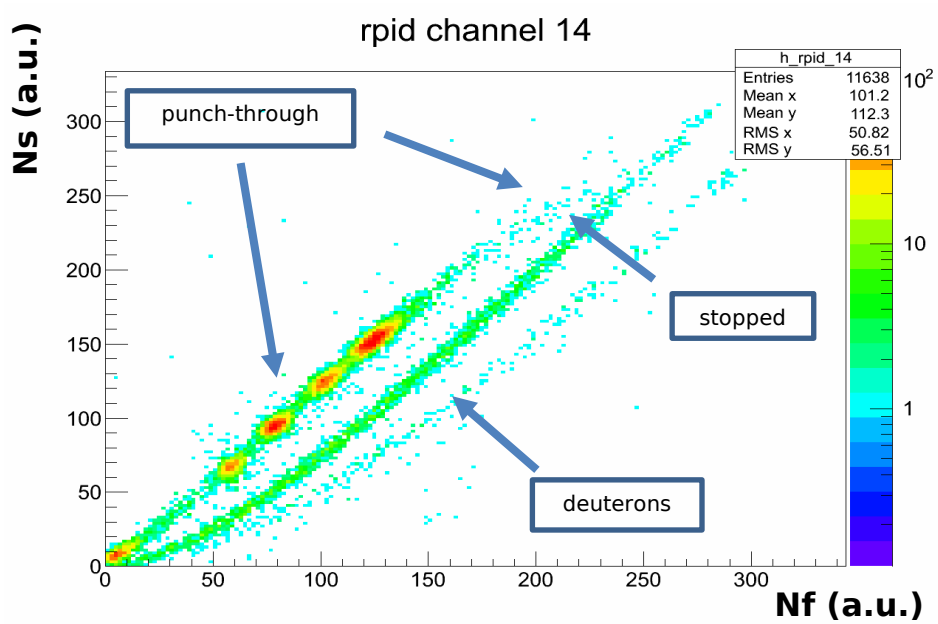
CALIFA Endcap possible solutions

Internal phoswich solution
using 2 decay constants of CsI(Tl)



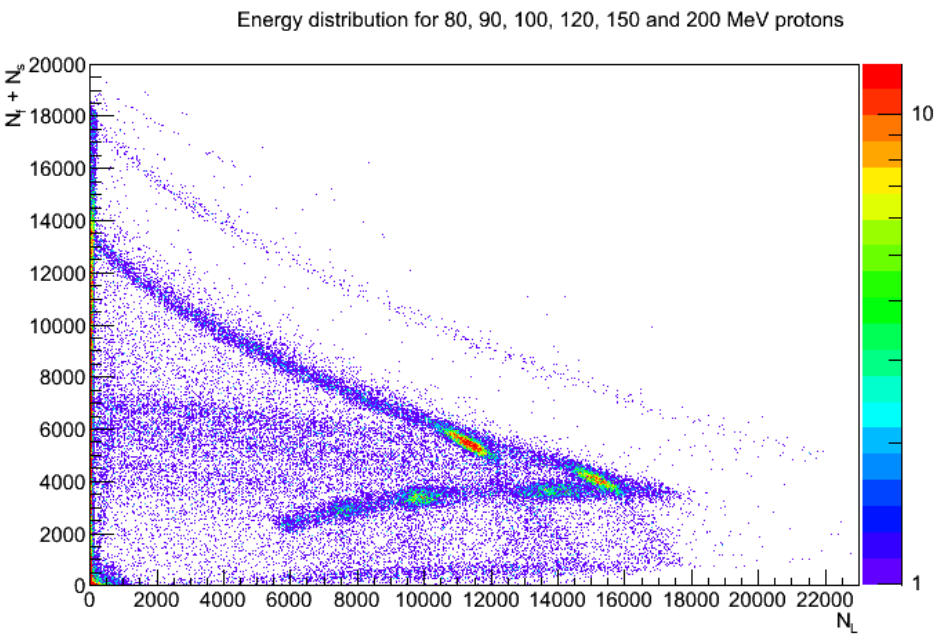


Is also capable of recognizing punch-through protons but the resolution below requirements



CALIFA Endcap possible solutions

LYSO - CsI(Tl) phoswich solution



It works! But

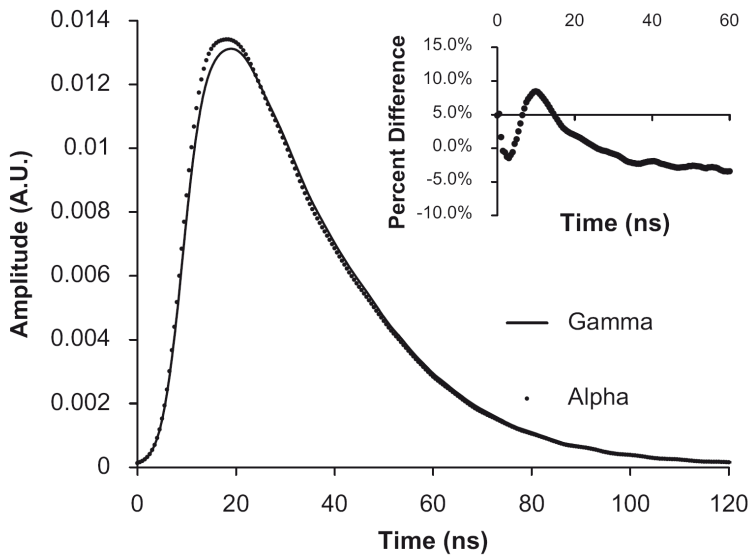
good energy resolution only up to 120MeV

intrinsic radioactivity could be a problem for large scale

CALIFA Endcap possible solutions

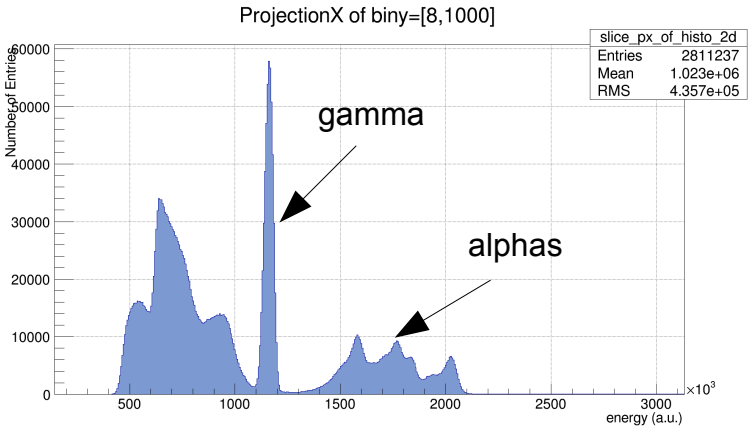
LaBr3 PSA for particles discrimination

Based on the difference in pulse shape induced by different incident particles



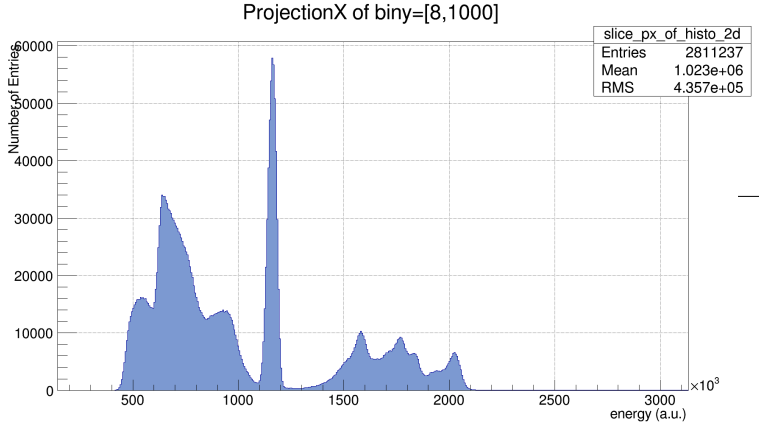
Test at TUD

using internal radioactivity of LaBr3

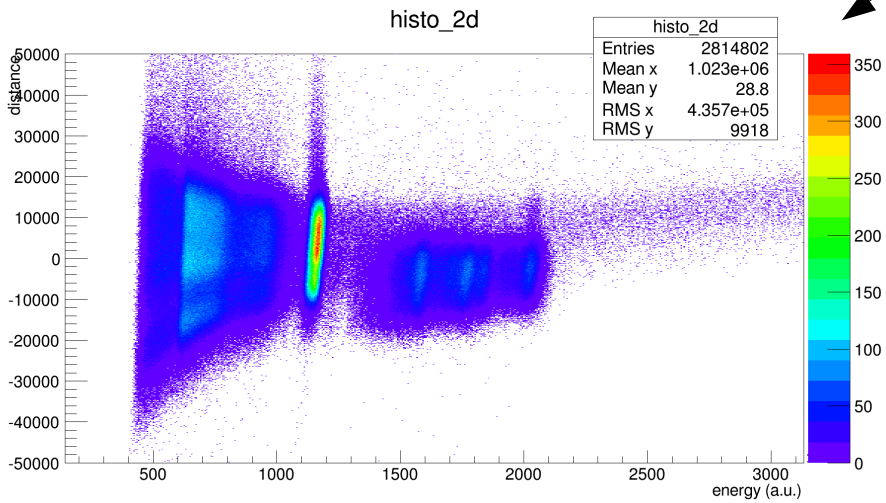


Particle identification by digital PSA
F. Crespi et al., NIM A 602, 520 (2009)

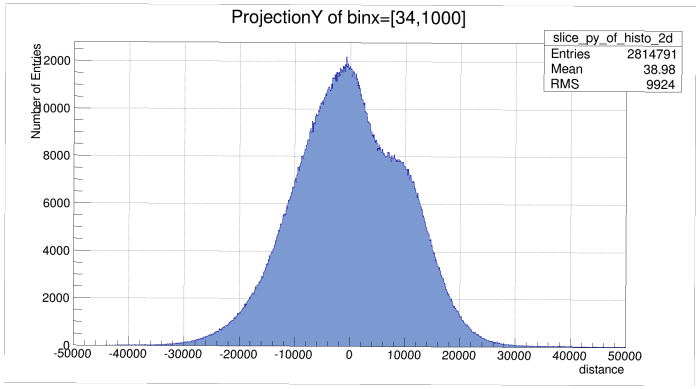
CALIFA Endcap possible solutions



- gamma trace taken as a reference
- all other traces normalized to the reference
- a parameter, characterizing matching of the trace to the reference calculated



Very preliminary results



Outlook

- In-beam test of the Demonstrator at GSI
- Endcap TDR submitted by the end of the year

Thank you!