Institutes interested in ePIC

Calorimeter (barrel)

Yonsei U, SKK U, KNU, PNU

(Dual readout + Si teams)

Calorimeter (ZDC)

Sejong U, Korea U

*ALICE Focal + LAMPS**

Si pixel

Yonsei U, PNU

ALICE ITS3 group

μRWELL

SNU, U of Seoul

Korean CMS group

LGAD

KNU, Korea U

Korean CMS group

* LAMPS: A detector for rare isotope collision experiment in Korea

Korean calorimeter interest group

Calorimeter (barrel)

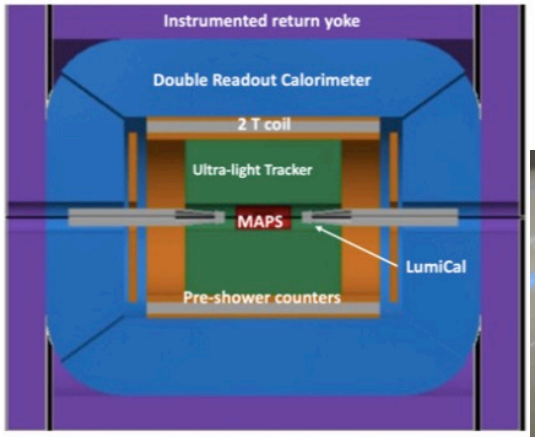
Yonsei U, SKK U, KNU, PNU

(Dual readout + Si teams)

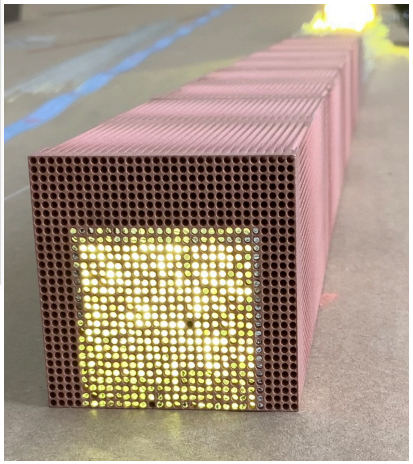
Calorimeter (ZDC)

Sejong U, Korea U

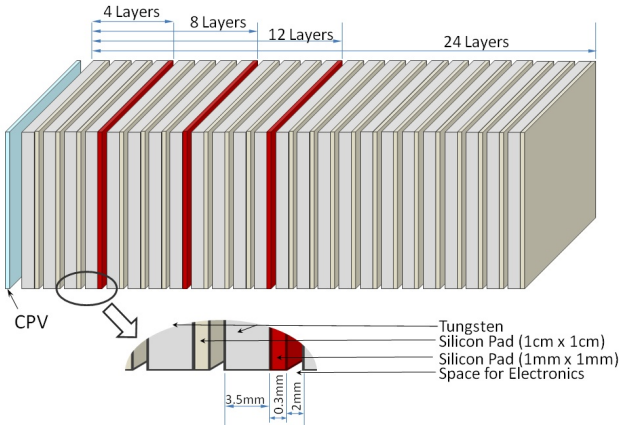
*ALICE Focal + LAMPS**



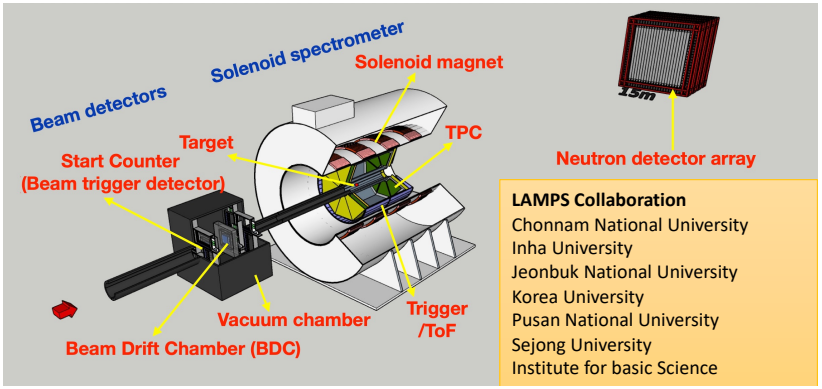
IDEA for FCC-ee & CEPC



3-d printed DRCALO tower (Yonsei U)



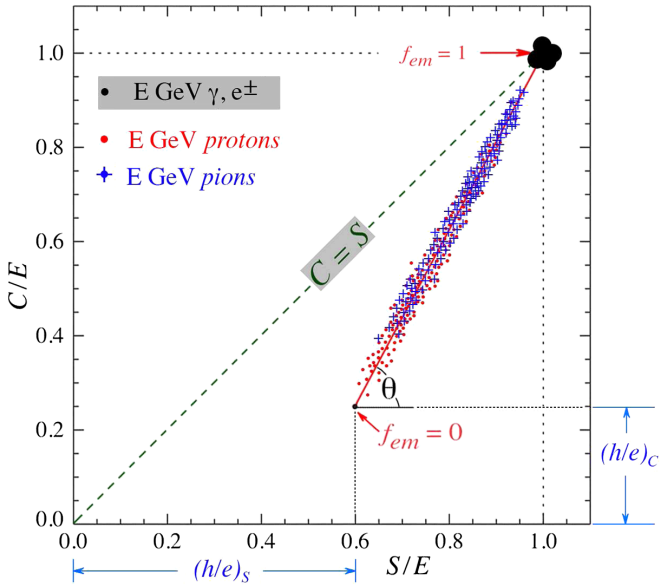
ALICE Focal-E

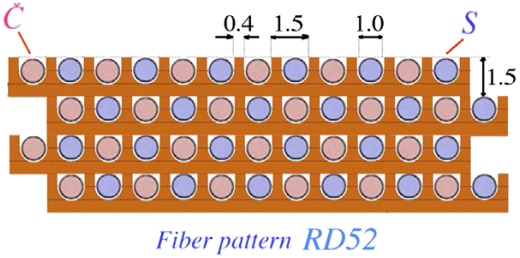


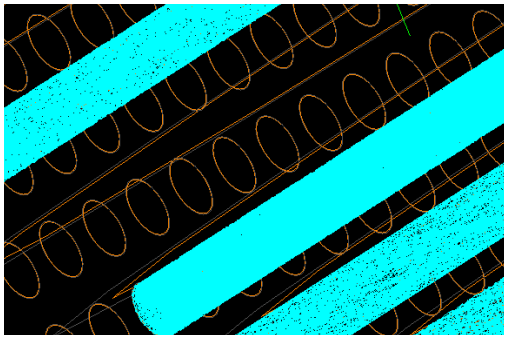
LAMPS experiment at RAON

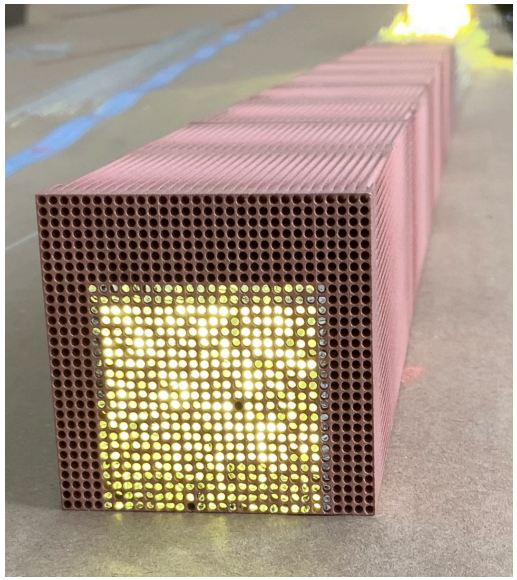
Dual readout calorimeter

- **Ch**erenkov and **Sc**intillation fibers combined in **dual**
- The main culprit of poor hadronic energy resolution is fluctuations of the EM shower components of hadron showers (f_{em})
- Offers high-quality energy measurement for both EM particles and hadrons
- Proposed for FCC-ee, CEPC **and EIC**
- Comprehensive R&D in design, engineering, readout, DAQ, fastSIM
- Technology can be applied to any detector made of fiber and metal



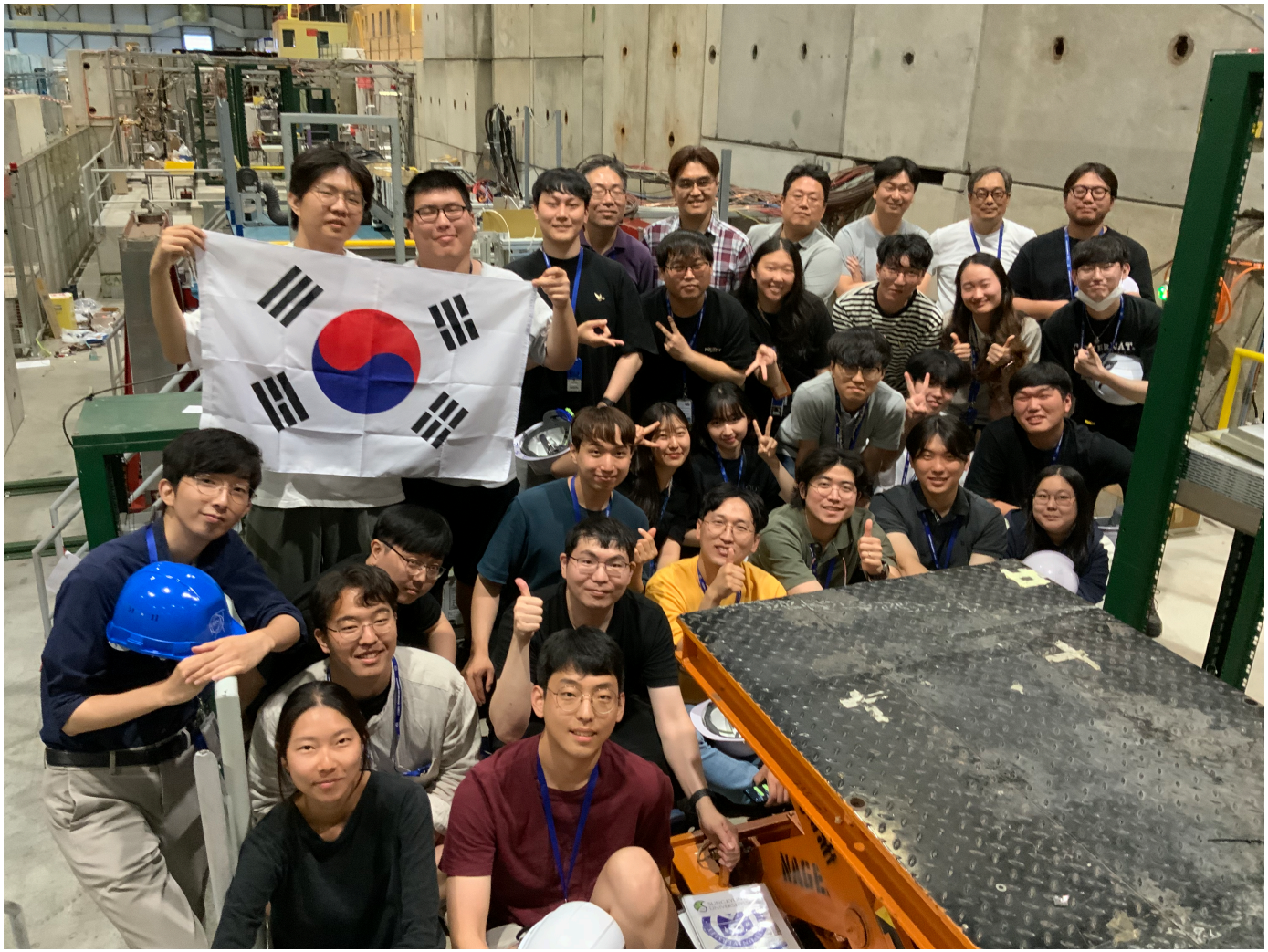


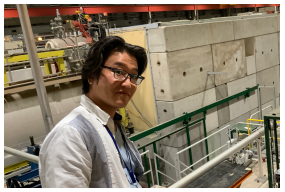


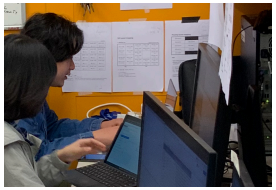


Dual readout calorimeter

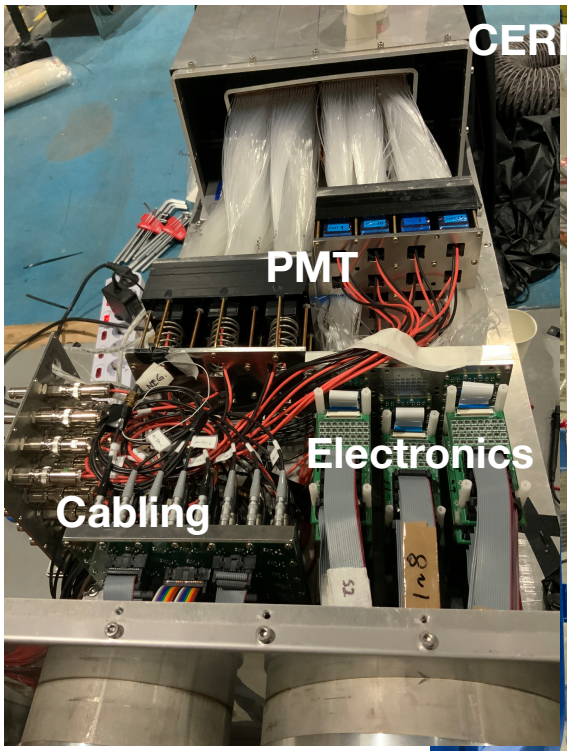
- 13 institutes 34 participants (including 23 students)







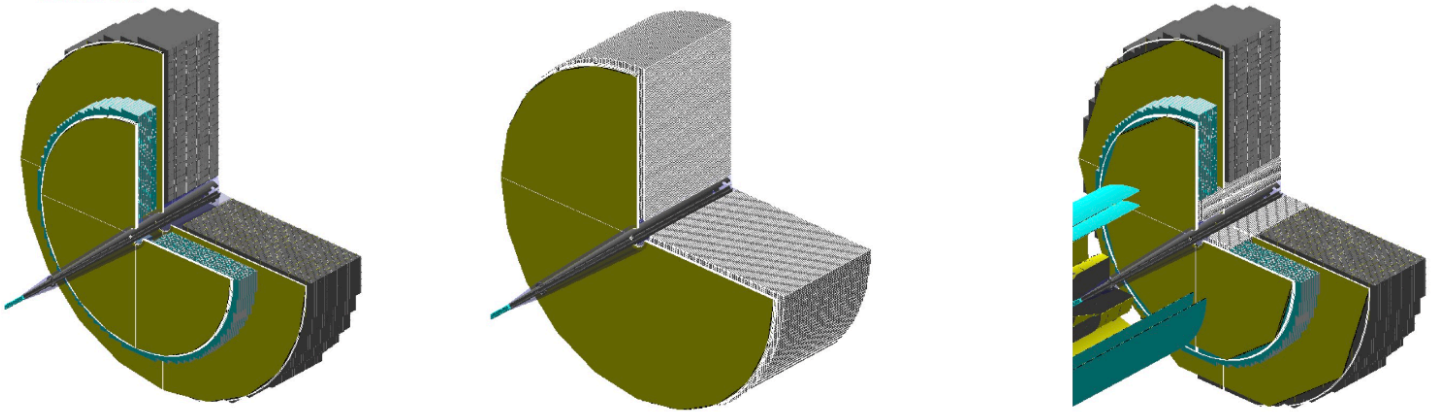
Dual readout calorimeter



Sci/fi for ZDC-h?

cost estimation for ECCE Forward calorimeter

Forward calorimetry options



detector	z [m]	depth [cm]	radial coverage [cm]	pseudorapidity	tower size [cm]
ECAL:					
PHENIX/ALICE reuse	$z = 2.9$	37.5	$20 < r < 183$	$1.24 < \eta < 3.50$	5x5 (6x6)
HCAL:					
LHCAL	$z < 3.5$	100	$20 < r < 262$	$1.11 < \eta < 3.47$	5x5
DRCALO :					
(full)	$3.0 < z < 4.5$	150	$20 < r < 220$	$1.11 < \eta < 3.47$	0.3x0.3
(inlay)	$3.0 < z < 4.5$	150	$20 < r < 50$	$2.70 < \eta < 3.70$	0.3x0.3

- 73300 * 4 fibers and 326 towers
- 1 tower = 30x30 fibers
- Cross-sectional area ~ 7,000 cm^2
- The cross section of ECCE ZDC was 60 x 60 = 3600 cm^2

Sci/fi for ZDC-h?

Copper 2.5m

Hadronic Energy resolution

$$S = E[f_{em} + (\frac{h}{e})_S (1 - f_{em})],$$

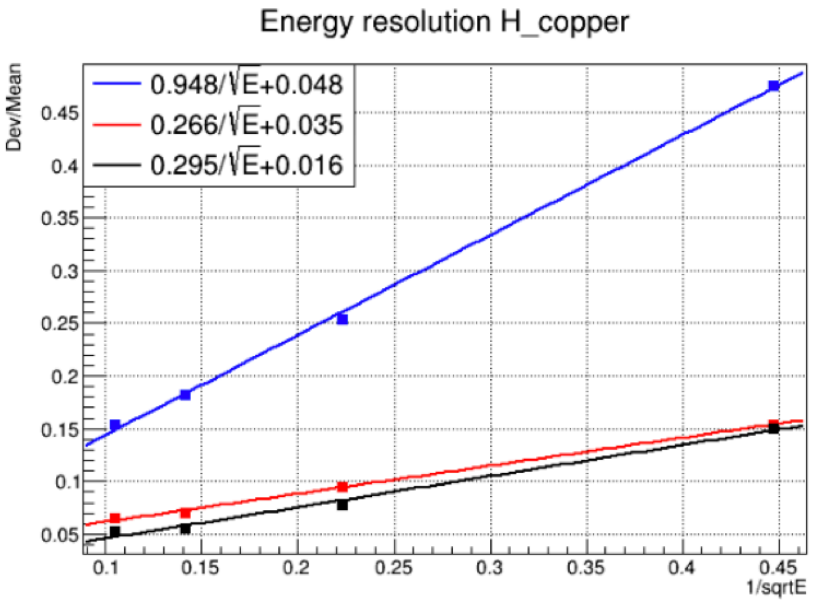
$$C = E[f_{em} + (\frac{h}{e})_C (1 - f_{em})]$$

$$f_{em} = \frac{(h/e)_C - (C/S)(h/e)_S}{(C/S)[1-(h/e)_S] - [1-(h/e)_C]}$$

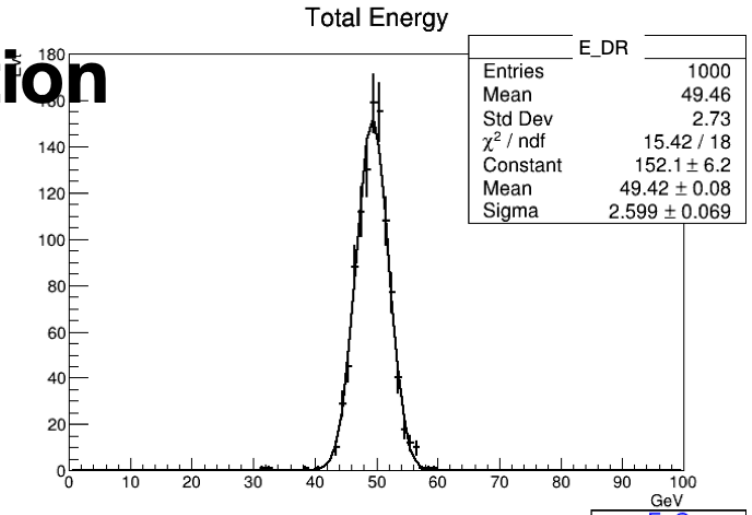
$$\cot\theta = \frac{1-(h/e)_S}{1-(h/e)_C} \equiv \chi,$$

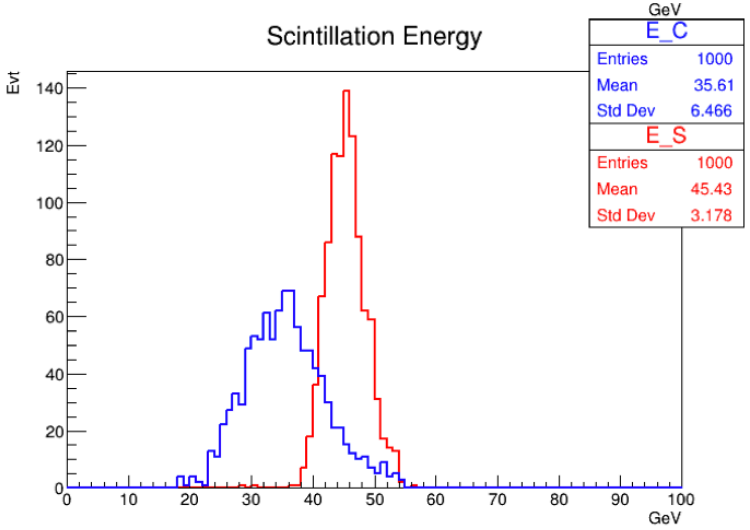
$$E = \frac{S - \chi C}{1 - \chi}$$

$$\chi = 0.291$$



- $\sigma = 26\%/\sqrt{E}$ for scintillation fiber





ALICE FoCal-h

instruments

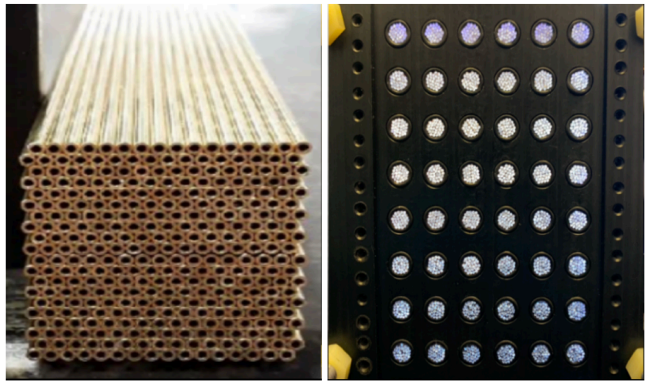
MDPI

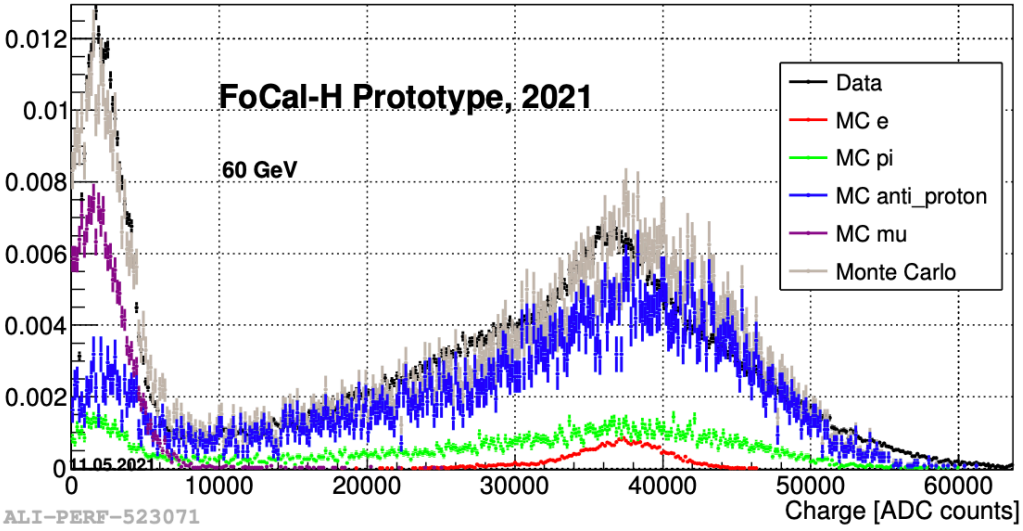
Article

Design and Test-Beam Results of the FoCal-H Demonstrator Prototype

Radoslav Simeonov on behalf of the ALICE Collaboration

Faculty of Physics, Sofia University "St. Kliment Ohridski", 5 J. Bourchier Blvd, 1164 Sofia, Bulgaria; radoslav.simeonov@cern.ch



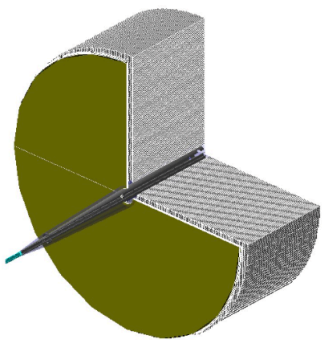


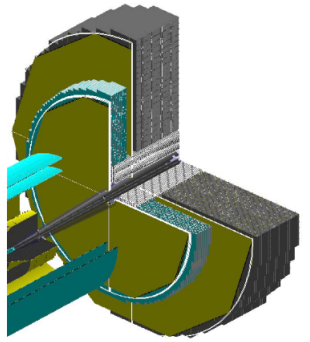
- Prototype FoCal-H
  - Copper tubes
  - SiPM
  - 1440 ch
  - 95 × 95 × 550 mm^3
- Radiation damage?

Sc/fi design for ZDC-h?

	$
Scintillation fiber (/m)	2
Cerenkove fiber (/m)	0.38
Cu (/kg)	9.75
W (/kg)	39.25
Generic PMT (/piece)	1122
SiPM (/piece)	10
Elecronics for generic PMT (/channel)	50
Elecronics for SiPM (/channel)	10

Forward calorimetry options





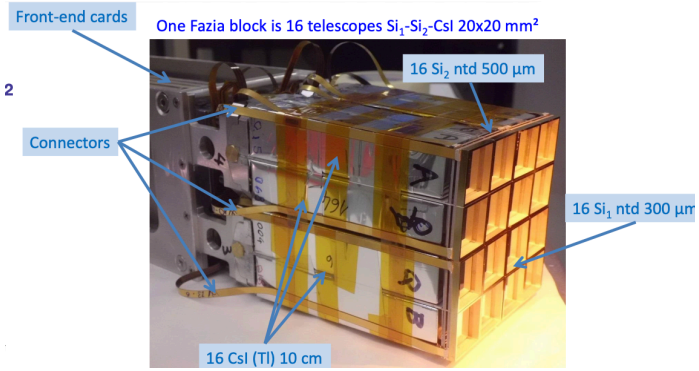
(million $)

	M$	Inlay	Full
Cu	Generic PMT	1.3	30.7
	1-on-1 SiPM	6.4	147.3
	Grouping SiPM	1.8	40.1
W	Generic PMT	1.8	40.6
	1-on-1 SiPM	6.9	157.2
	Grouping SiPM	2.2	50.0

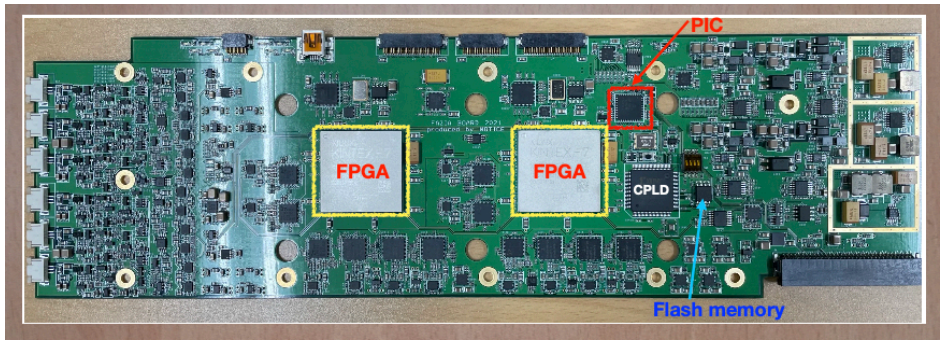
- Tower size: 46x46x250 mm^3
- Each tower has 30x30 fibers
- One PMT corresponds to 450 fibers
- 1-on-1 SiPM: Each SiPM connected to single fiber
- Grouping SiPM: Each SiPM to 9 fibers

PIN sensor type for ZDC-h?

- **Sc/fi with MCPPMT** (robust against radiation?)
  - Similar to ALICE Focal-h
  - Same technology with imaging calorimeter
- **Sampling w/ PIN sensor** (larger version of focal-e?)
  - Expertise in sensor fabrication (ETRI) and FEE board (NOTICE co.)
  - System for silicon sensor test is already setup
  - Large room to collaborate with Japanese and Taiwanese groups



FAZIA-type telescope
(Inha U & Korea U)

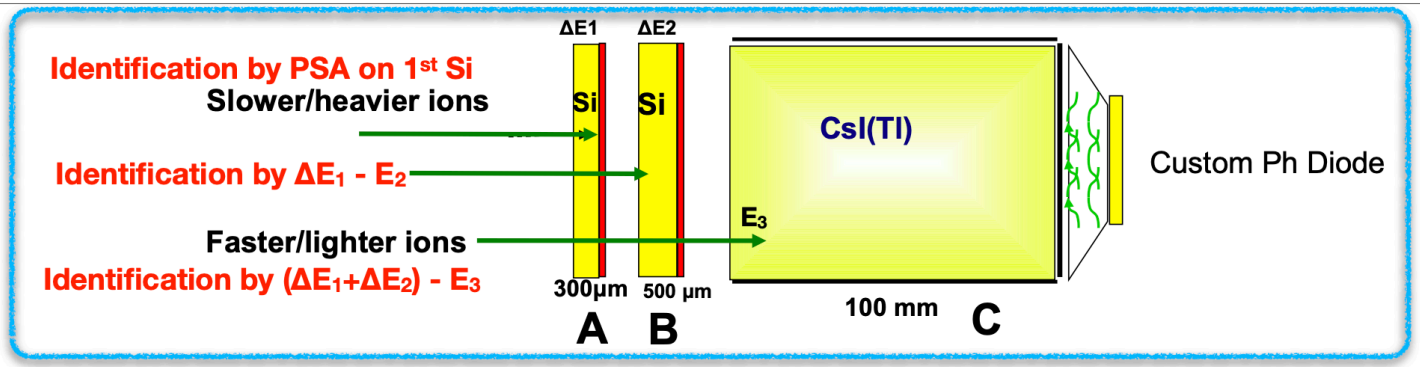


FEE board (NOTICE)

R&D for FAZIA-type Si sensor

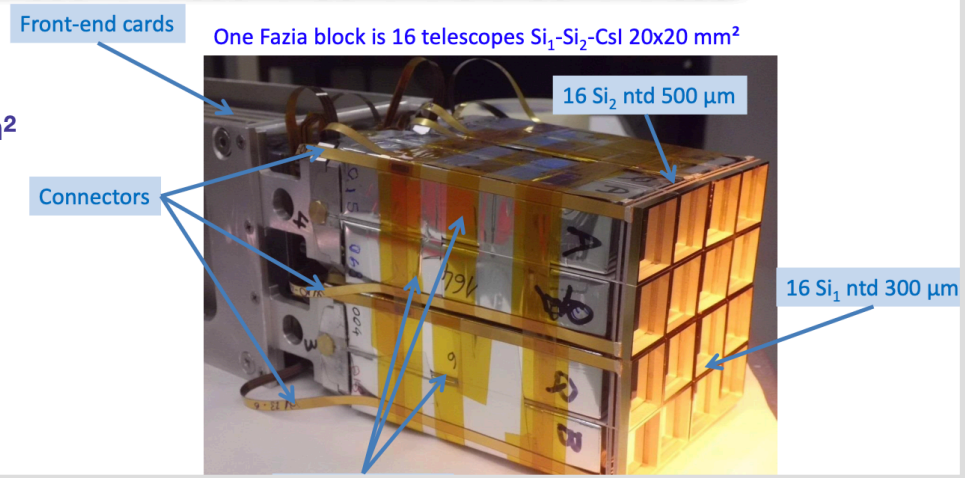
The FAZIA telescope

M. Kwon



One FAZIA block consists of 16 Si1 + Si2 + CsI telescopes with a cross-sectional area of 2 x 2 cm²

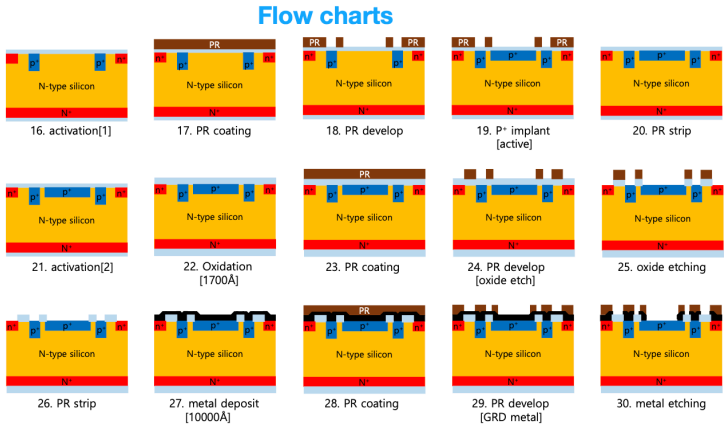
- Si1 (nTD): 300 μm thick
- Si2 (nTD): 500 μm thick
- CsI: 10 cm thick, photodiode readout
- Dedicated digital electronics with optical fiber outputs
- 8 FEE cards cooled under vacuum



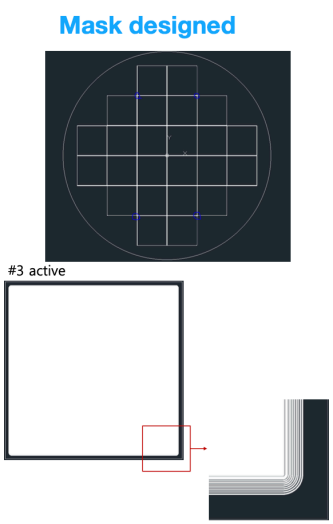
FAZIA project is international collaboration of 5 countries (Italy, France, Poland, Spain, Korea) led by GANIL for the study of EOS with rare isotope experiments

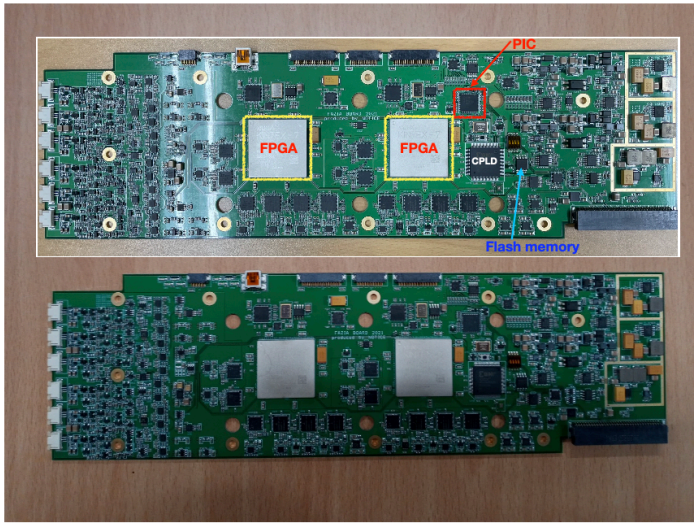
R&D for FAZIA-type Si sensor

Sensor fabrication



Fabrication done at ETRI.
Parallel fabrication at NNFC

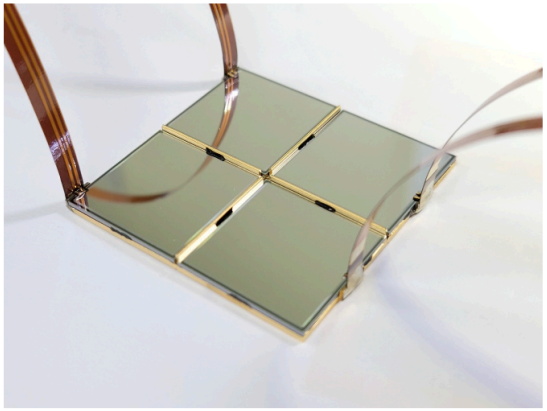


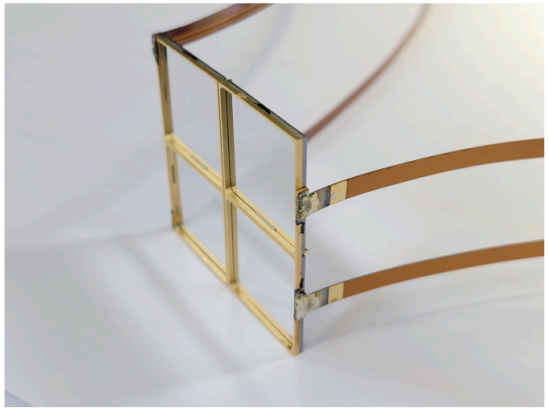


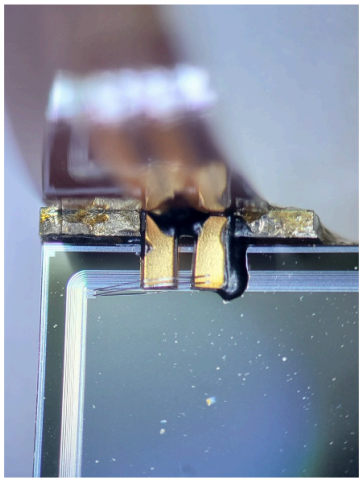
- Inha U and Korea U groups managed to produce sensor 6-inch wafers (ETRI) and FEE board (NOTICE)
- Production for 8-inch wafers is ongoing
- R&D for new FPGA chips for board upgrade

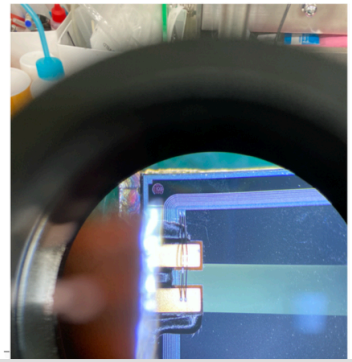
R&D for FAZIA-type Si sensor

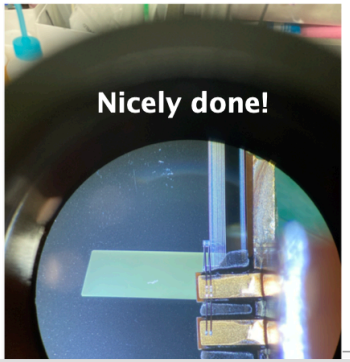
Quartetto production in Korea

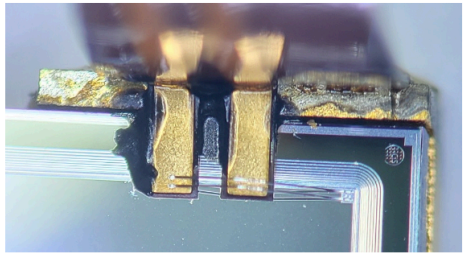








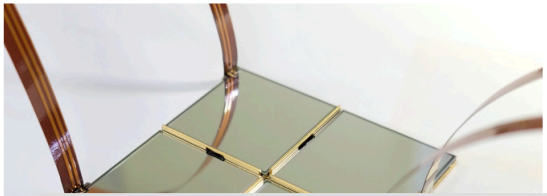




Chip mounting & wire-bonding by the company MEMSPACK
Quartetto frame from FRANCE

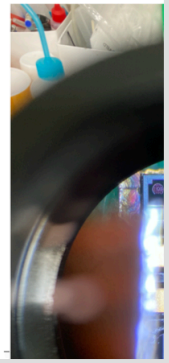
R&D for FAZIA-type Si sensor

Quartetto production in Korea



Source test setup in Korea

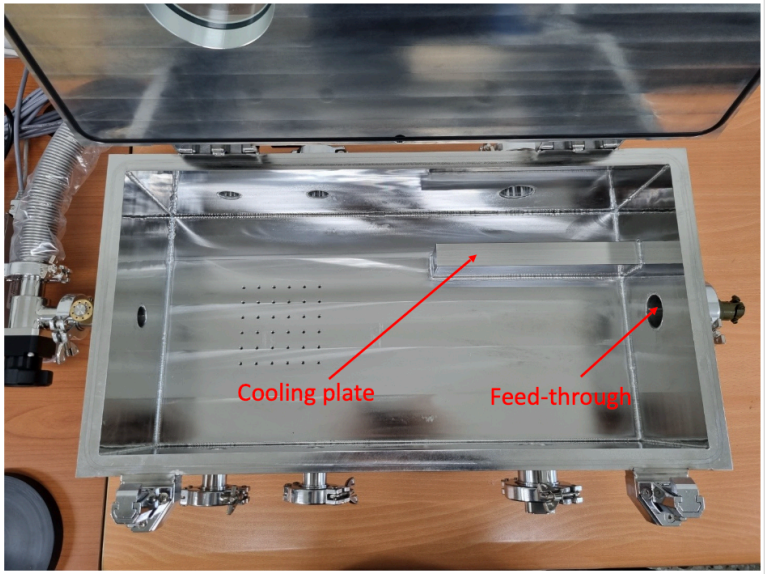
Constructing lab. test system for Silicon sensor characterization



Cooling machine

Vacuum chamber

Vacuum pump



Vacuum chamber interior

Special boards with preAmp ONLY were produced for the source test.

Summary

- Sci/fi type and Si sensor types are considered for ZDC-h
- Sci/fi: Radiation damage? what kind of fiber?
- Si sensor: Cost? readout?