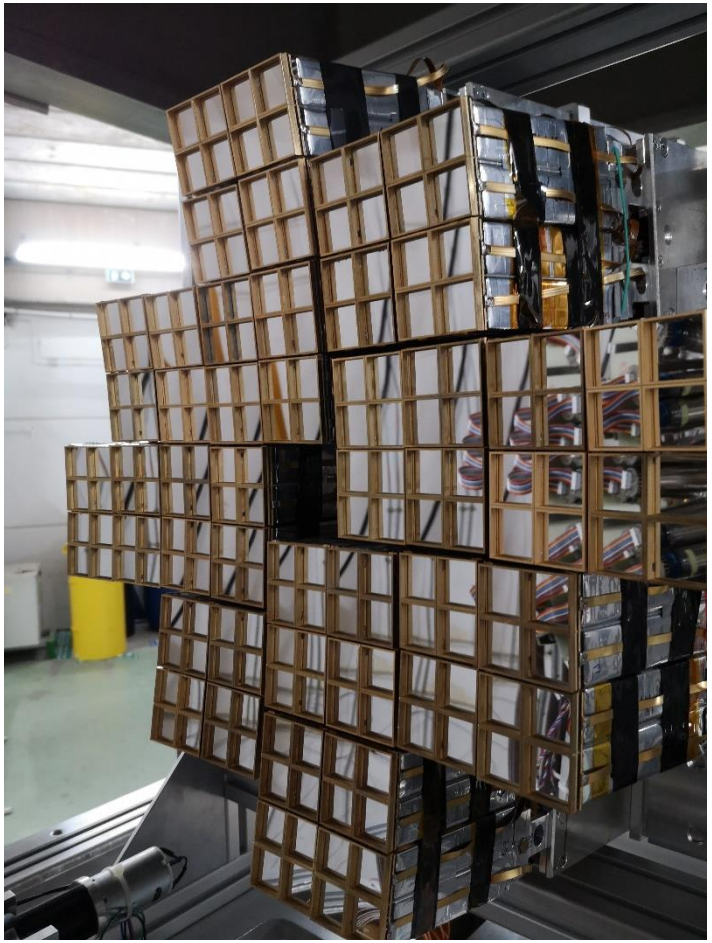
FAZIA: a new generation multi detector for heavy ion collision studies at intermediate energies



Nicolas Le Neindre, LPC CAEN, CNRS-IN2P3 and Caen University, FRANCE

Joint TYL/FJPPL and FKPPL workshop, May 10-13rd 2021

FAZIA : International structure





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- Toulouse, CNRS-IN2P3 Laboratoire des deux infinis, Université Paul Sabatier, L2IT Bat 3R1B4 118 route de Narbonne, 31062 Toulouse cedex 9

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- Laboratori Nazionali di Legnaro (INFN), Viale dell'Università 2, 35020 Legnaro PD
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- Cracow Institute of nuclear Physics PAN, Radzikowskiego 152, 31-342 Crakow
- Katowice Silesian University, Bankowa 12, 40-007 Katowice
- Warsaw University, Krakowskie Przedmiescie 26/28, 00-927 Warsaw

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Pietro Ottanelli *(student)*
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Domenico Santonocito
Giuseppe Verde

Legnaro-Padova
Marco Cinausero
Daniela Fabris
Fabiana Gramegna
Tommaso Marchi

~30 physicists
~10 students

Poland
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Tomasz Kosik
Sahil Upadhyaya (*student)*

Spain
José Dueñas

Korea
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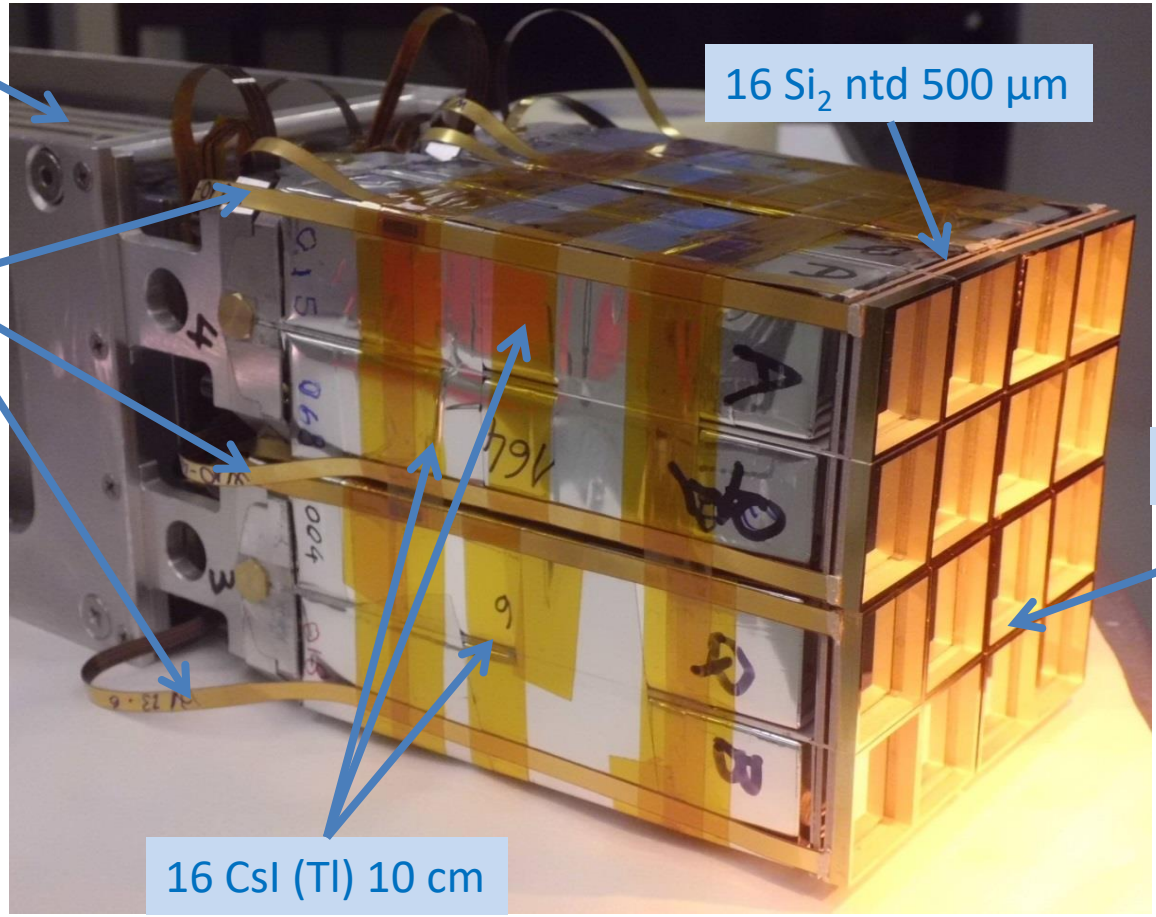
Seon Ho NAM (Ph.D. student)
Sunji KIM (Postdoc)
Kevin Insik HAHN (Professor)
MinJung KWEON (Professor)
HyungJun LEE (Master student)

FAZIA

Detectors: *Florence, Orsay, Caen, Legnaro, Bucharest*
Mechanics: *Bologna, Napoli, Caen*
FEE: *Orsay, Napoli*
Slow control: *Napoli, Ganil, Florence*
DAQ: Florence, *Napoli, Krakow*

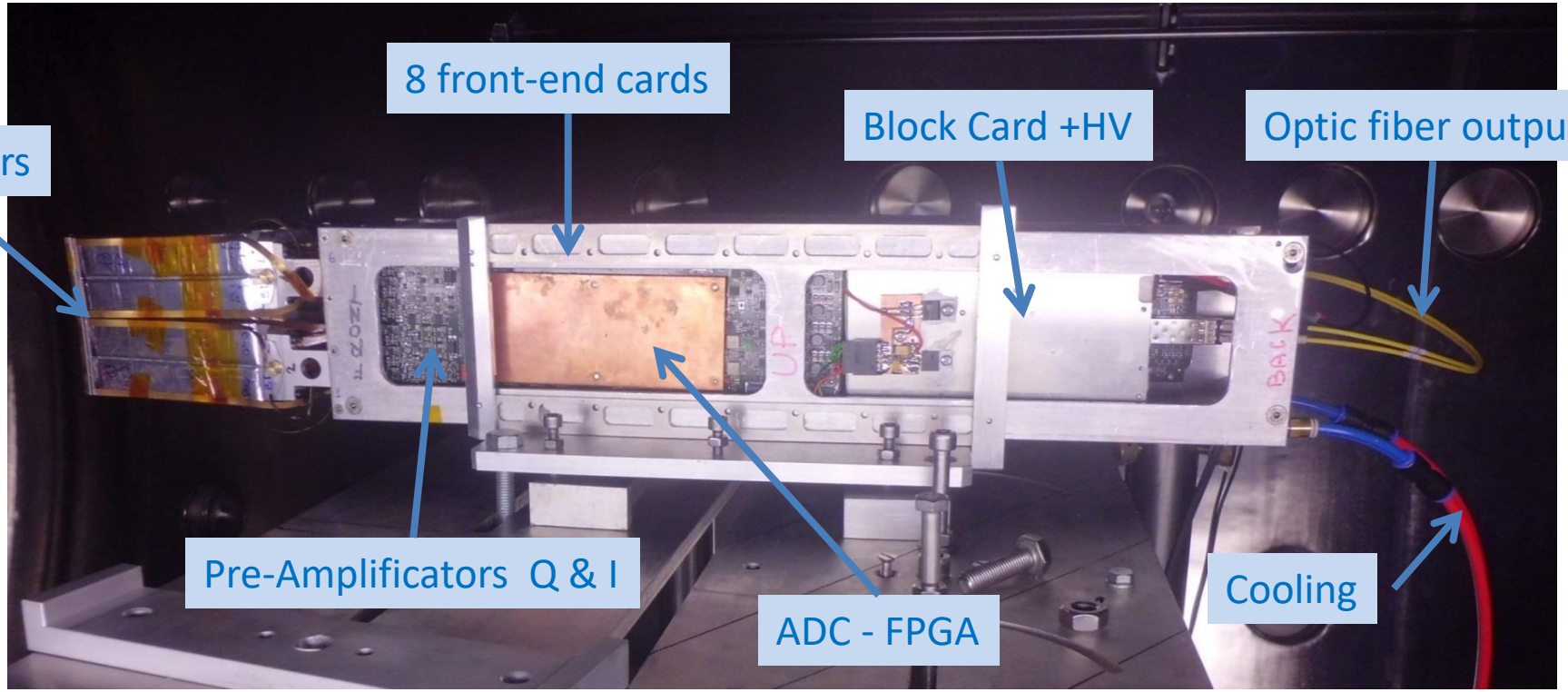
Front-end cards

One Fazia block is 16 telescopes Si_1-Si_2-CsI 20x20 mm²

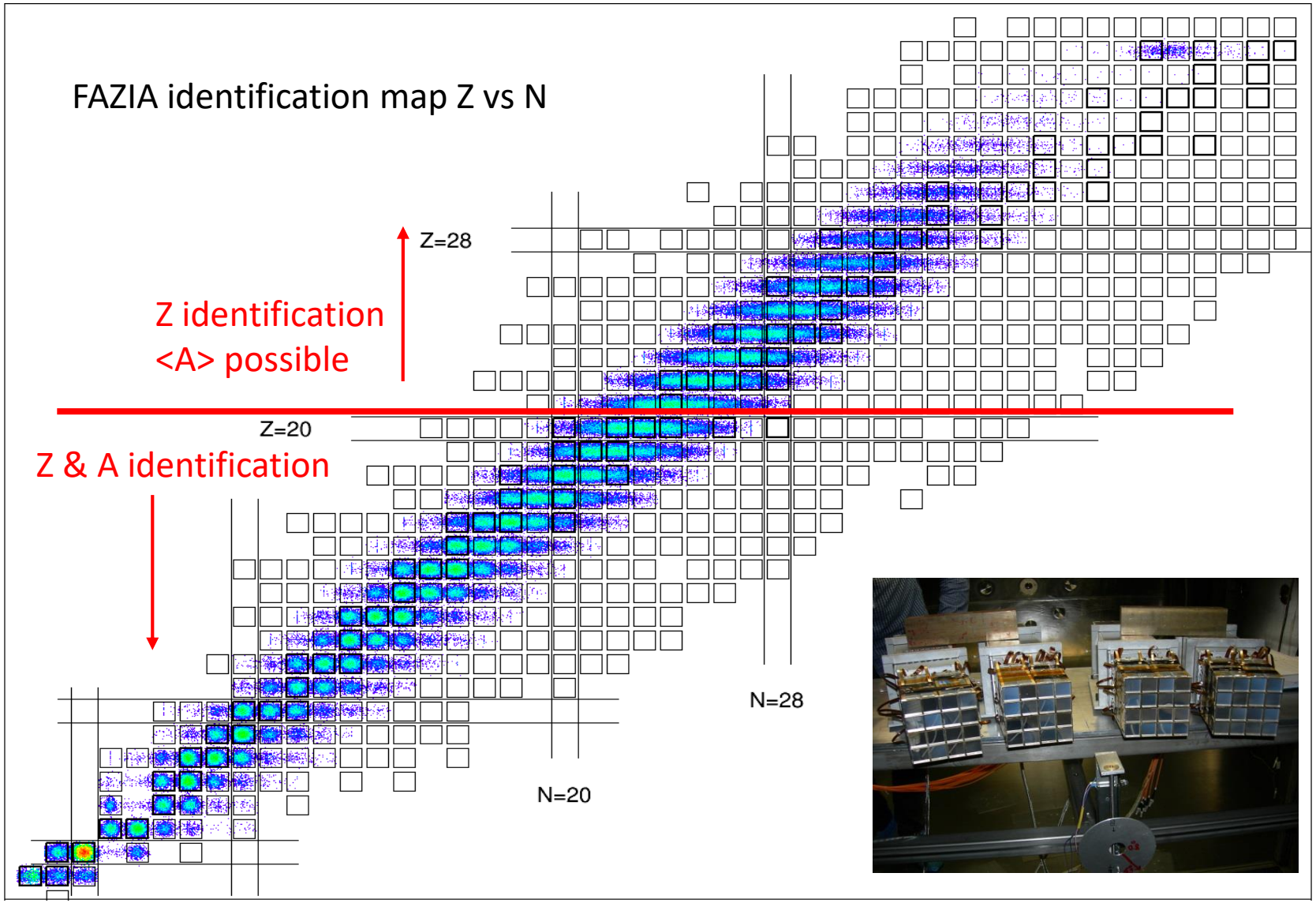


One Fazia Block:

- 16 telescopes Si(ntd 300µm)-Si(ntd 500µm)-CsI (10 cm)
- Digital electronic, optic fiber outputs
- 8 front end cards cooled under vacuum (integrated power supply PA and detectors)
- Si (300 µm) Charge 250 MeV full scale 250 Ms/s 14 bits
  Charge 4 GeV full scale 100 Ms/s 14 bits
  Current 250 Ms/s 14 bits
- Si (500 µm) Charge 4 GeV full scale 100 Ms/s 14 bits
  Current 250 Ms/s 14 bits
- CsI(photodiode) Charge 3 GeV full scale 100 Ms/s 14 bits



$^{80}Kr+^{40-48}Ca$ @ 35 A MeV IsoFazia experiment, June 2015, LNS Catania



FAZIA: experiments and scientific program

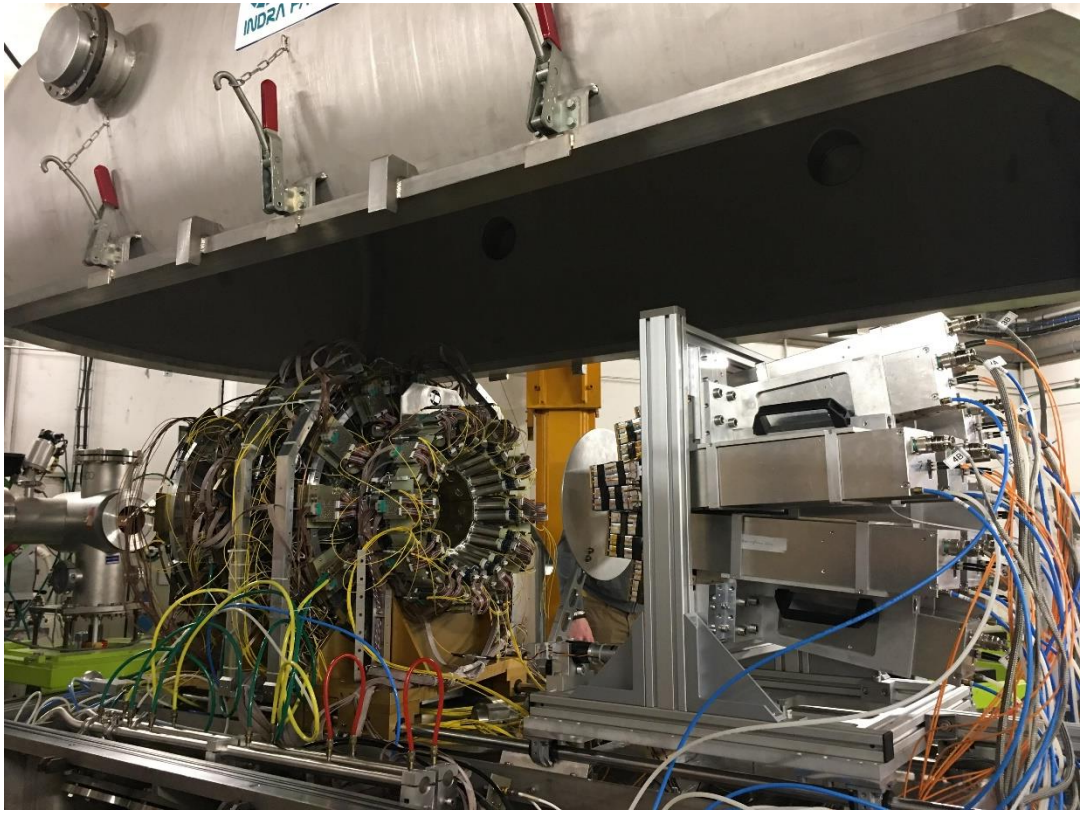
New identification capabilities, better granularity…
=> To bring constraints on the symmetry E of the EoS of nuclear matter for both microscopic and macroscopic physics (from nuclei to the stars).

Scientific program at Ganil 2019-2024 (already two experiments approved e789 & e818)

E789 : Isospin Transport and the Density Dependence of the Symmetry Energy
E818 : Extending our knowledge of warm dense nuclear matter in the low density region

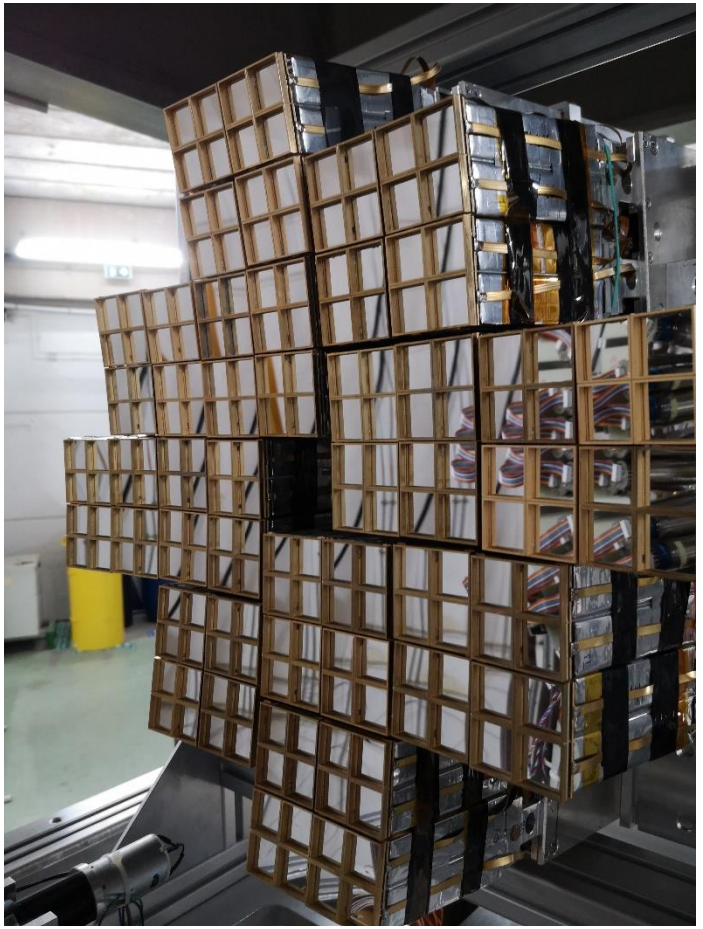
The first INDRA-FAZIA campaign: spring 2019, E789 experiment at GANIL

Full 4π coverage

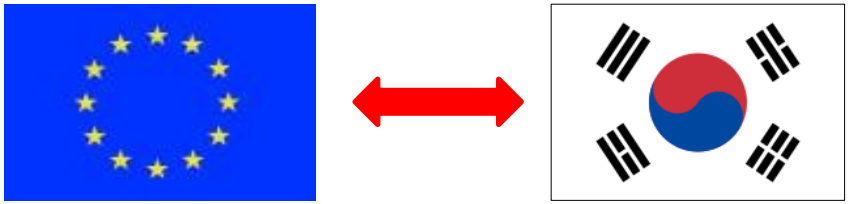


INDRA: 12 rings, 96 Si & 240 CsI
covering from 14°-176°
Z identification up to 50
A identification up to ~Z=4

INDRA FAZIA



FAZIA: 12 blocks, 192 telescopes Si-Si-CsI
covering from 1,5°-12,5°
Z identification up to 50
A identification up to ~Z=20



Korea has joined the FAZIA collaboration in 2019 and an addendum to the existing MoU (between the different parties) has been signed in 2020 with Korean institutions.

Since then different items have been taken in charge by our new colleagues in Korea:

- New silicon wafers and detectors production (750 µm, 1 mm thick)
- Study of possible thin silicon detectors ~100 µm for low energy beam experiments
- Study of new custom made photodiodes to equip our CsI(Tl)
- Updated version of the Front End Electronic (FEE) cards (new FPGA and components)

two prototypes have been delivered

- New version, more compact, new functionalities and upgraded FEE
- Exchange/partnership with young students

Short and mean term project: Duplicate some blocks in Korea to participate to the RAON commissioning phase, before experimental campaigns with RIBs.

FAZIA: some references

FAZIA list of publications:

- H. Hamrita et al. NIM A 531 (2004) 607
- S. Barlini et al. NIM A 600 (2009) 644
- L. Bardelli et al. NIM A 602 (2009) 501
- L. Bardelli et al. NIM A 605 (2009) 353
- M. Parlog et al. NIM A 613 (2010) 290
- H. Hamrita et al. NIM A 642 (2011) 59
- L. Bardelli et al. NIM A 654 (2011) 272
- S. Carboni et al. NIM A 664 (2012) 251
- G. Pasquali et al. European Physics Journal A 48 (2012) 158
- N. Le Neindre et al. NIM A 701 (2013) 145
- S. Barlini et al. NIM A 707 (2013) 89
- S. Barlini et al. Physical Review C 87 (2013) 054607
- S. Piantelli et al. Physical Review C 88 (2013) 064607
- R. Bougault et al. European Physics Journal A 50 (2014) 47
- G. Pasquali et al. European Physics Journal A 50 (2014) 86
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- F. Salomon et al. Journal of Instrumentation (2016) Vol. 11, JINST 11 C01064
- D. Gruyer et al. NIM A 847 (2017) 142
- G. Pastore et al. NIM A 860 (2017) 42
- S. Valdré et al. NIM A 930 (2019) 27
- C. Frosin et al. NIM A 951 (2020) 163018
- S. Piantelli et al. Physical Review C 101 (2020) 034613
- S. Piantelli et al. Physical Review C 103 (2021) 014603
- A. Camaiani et al. Physical Review C 103 (2021) 014605

FAZIA PhD Thesis

- L. Bardelli (2005)
- H. Hamrita (2005)
- S. Carboni (2012)
- G. Pastore (2017)
- A. Camaiani (2019)
- P. Ottanelli (2019)
- C. Frosin (2020)
- J. Quicray (2021)
- C. Ciampi (2021)
- J. Lemarié (2022)
- S. Upadhyaya (2022)
- S.H. Nam (2023)
- T. Génard (2023)

http://fazia.in2p3.fr

Conclusions

FAZIA has a good isotopic resolution for charged particles produced in heavy ion collisions at mid energy (from 15 to 100 A MeV).
Which is mandatory for radioactive ion beam experiments in the future.
It will bring constraints on the symmetry E of the EoS of nuclear matter for both microscopic and macroscopic physics (from nuclei to the stars).
But also it can also improve the detection set-up of various nuclear structure experiments.
$\Rightarrow$ In the future, the goal is to increase the number of FAZIA blocks available in different places (Eu-Korea) to benefit from any opportunities to perform great measurements.

감사합니다

Thank you

FAZIA Project management

http://fazia.in2p3.fr

Project organization