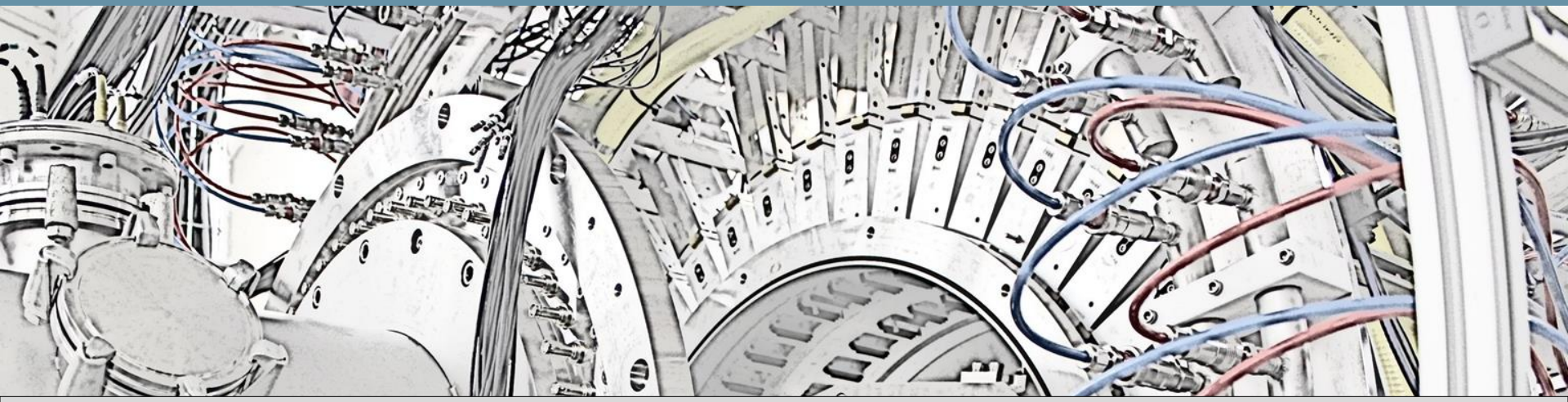


Report on the progress of the LYCCA Project

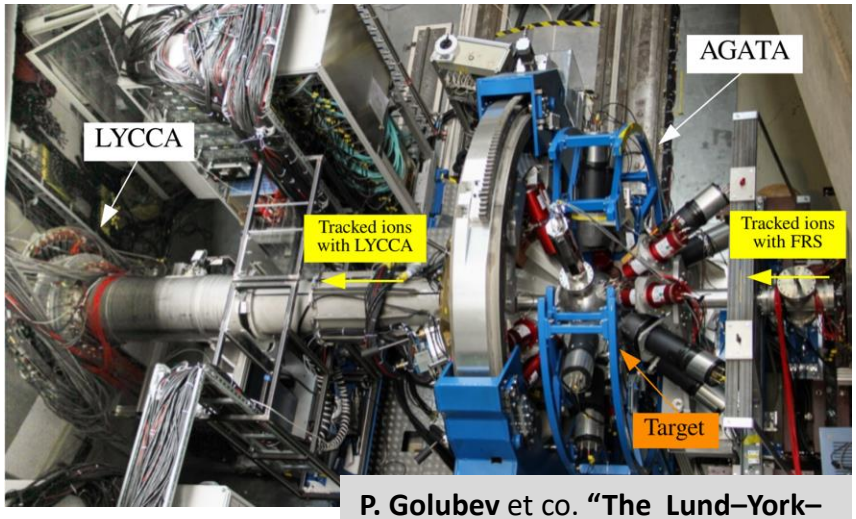
Mădălina Răvar – University of Cologne, IKP

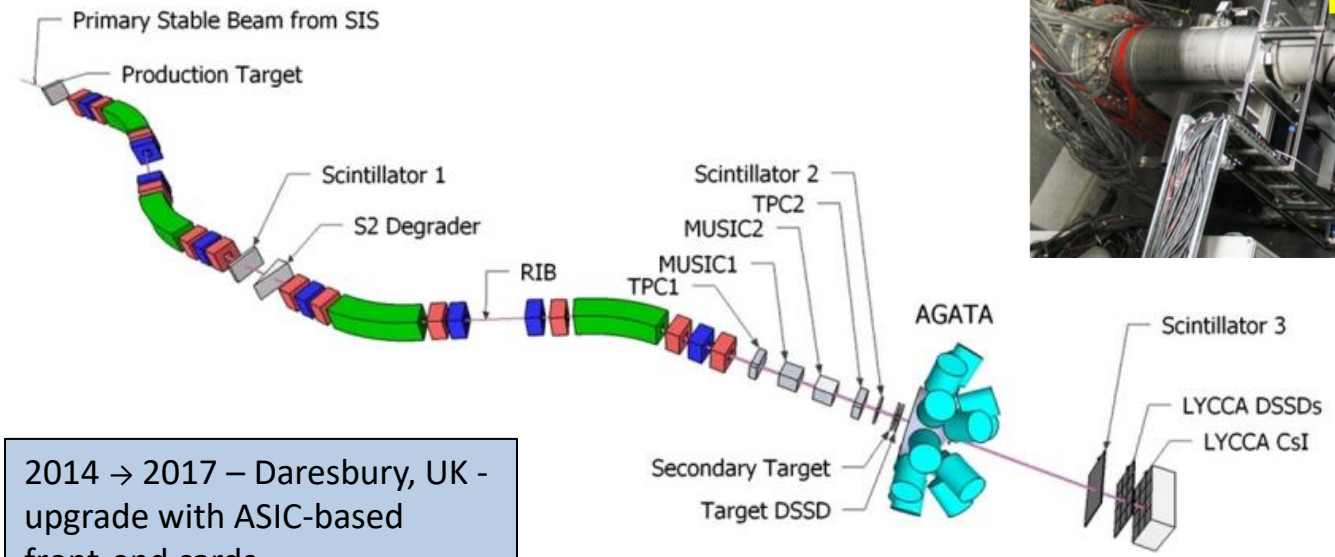
NUSTAR Collaboration Meeting - September 2019

LYCCA – Lund-York-Cologne Calorimeter

- HISPEC/DESPEC device
- Planned for NUSTAR@FAIR
- Designed to identify exotic nuclear reaction products (100 – 300 MeV/u)
- **Installed and used for commissioning and experiments at the 10-MV Tandem Accelerator of the University of Cologne, Germany** until the system can be moved to the FAIR-NUSTAR facility.
- Currently the low energy capabilities are exploited and used

PreSpec & PreSpec-AGATA Campaign – 2010 →2014 – LYCCA-0
Used together with the AGATA Germanium array.





2014 → 2017 – Daresbury, UK - upgrade with ASIC-based front-end cards

P. Golubev et co. **"The Lund–York–Cologne Calorimeter (LYCCA): Concept, design and prototype developments for a FAIR-NUSTAR detector system to discriminate relativistic heavy-ion reaction products"**. Nuclear Instruments and Methods in Physics Research **A 723 (2013) 55–66**

LYCCA – setup

DSSSDs – Lund University
AIDA modules - Daresbury

- **June 2018 – 13 DSSSDs**
  used for in-beam test commissioning

Forward wall + 1 Ring

- Fast-Discriminator ready
- 22 AIDA modules installed
- March 2019 + 9 new detectors received from the collaborators in Lund

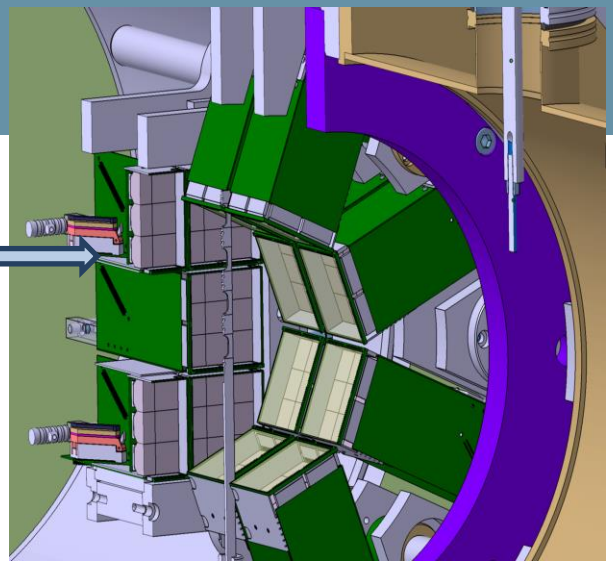
- **May 2019 – 22 DSSSDs**
  used for in-beam test experiment

Forward wall + 2 Rings

Complete Set-up:

- 24 DSSSDs can be installed **(Double-Sided Silicon Strip Detectors)**
  → Placed in a **forward wall** and **2 rings**

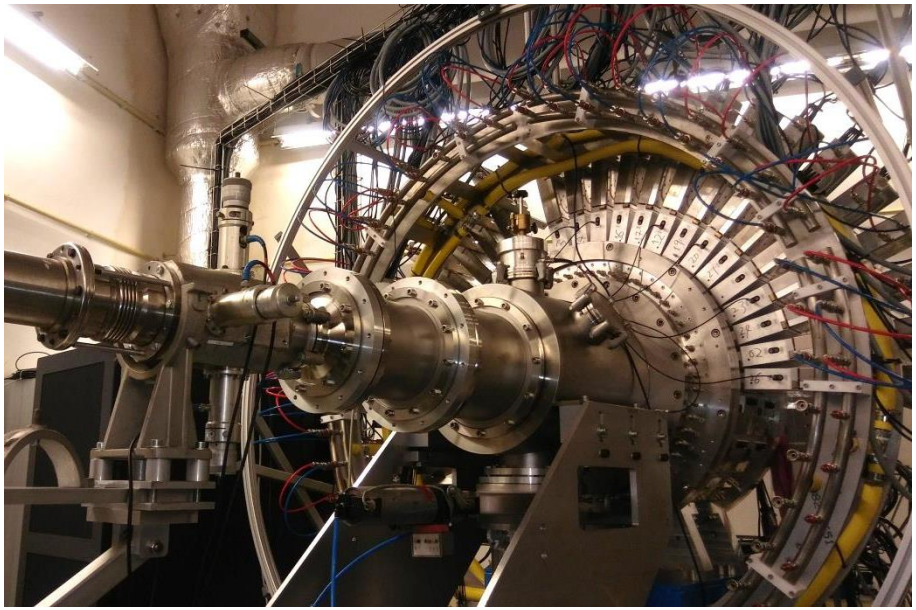
- Angular coverage:
  Forward wall: 10°- 40°
  First ring: 45°- 85°
  Second ring: 95°-135°

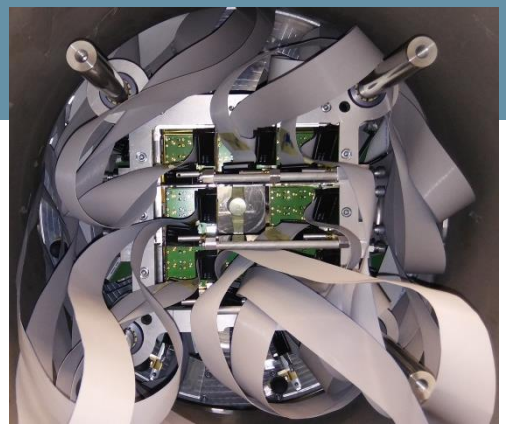


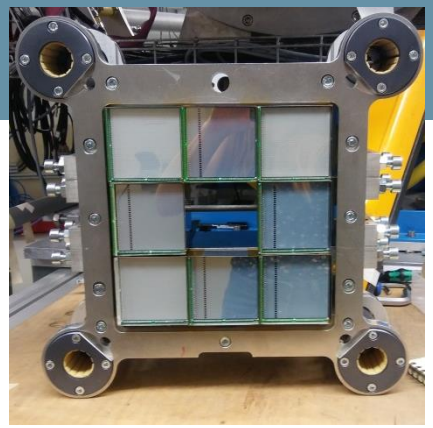
Each DSSSD has 32 front strips and 32 back strips
- 32x32 = **1 024 pixels / DSSSD**
- 24 DSSSDs = 24 576 pixels
- **angular size: ~ 1.5°** (for a pixel on a wall detector)

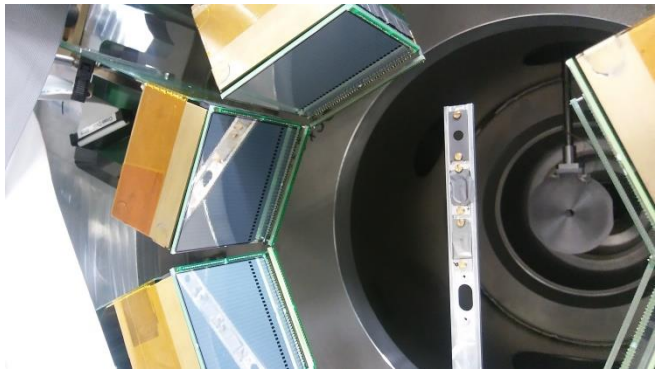
ADC signal		Discriminator signal	
Position (strip + detector)		Position (strip + detector)	
Time	ADC clock	**Time**	FEE clock
	500 kHz (**2 µs**)		100 MHz (**10 ns**)
Energy		-	

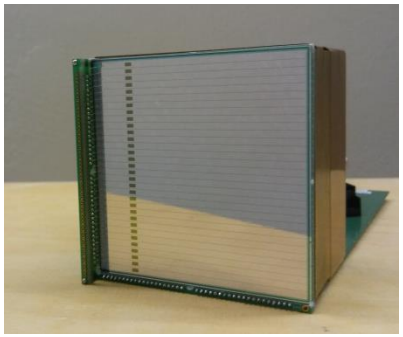
LYCCA - Characteristics

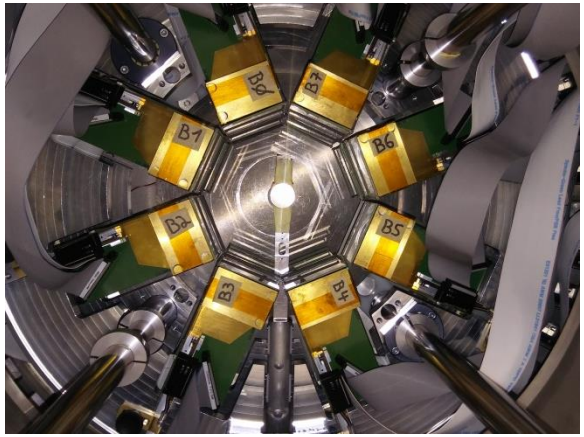








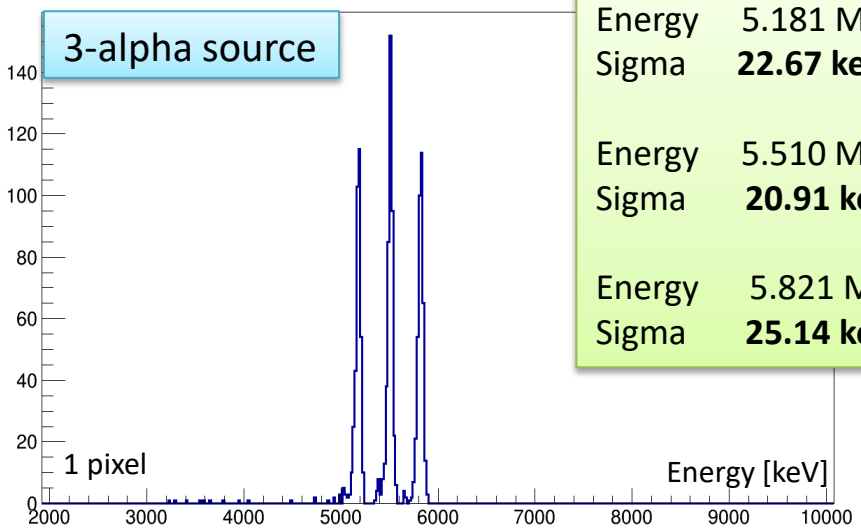




LYCCA - Characteristics

1 tick = 10 ns (Discriminator clock)

3-alpha source

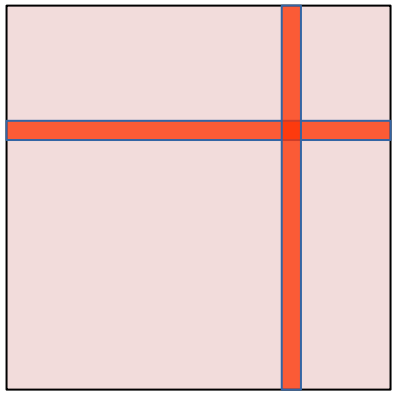


Energy 5.181 MeV
Sigma **22.67 keV**

Energy 5.510 MeV
Sigma **20.91 keV**

Energy 5.821 MeV
Sigma **25.14 keV**

One detector module:



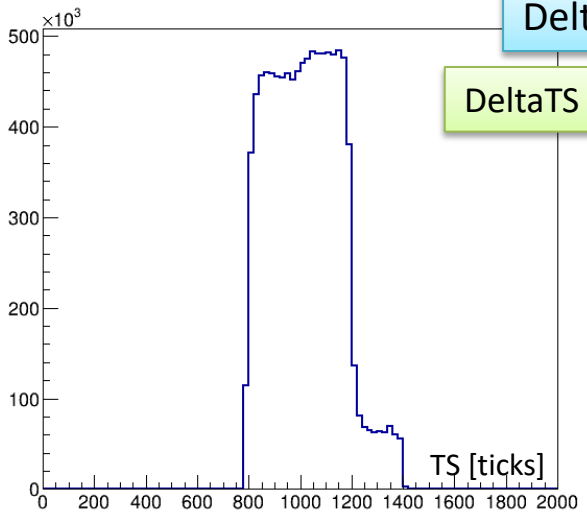
Strip no. # (back side)
Energy + Time Stamp

PIXEL

Strip no. # (front side)
Energy + Time Stamp

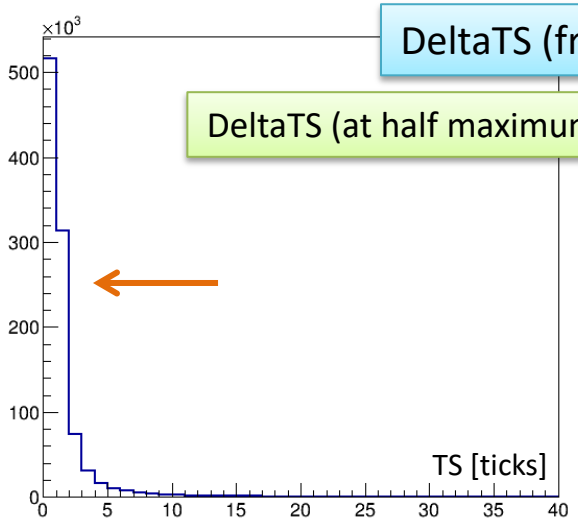
DeltaTS (ADC - Discr)

DeltaTS = 800 – 1400 ticks

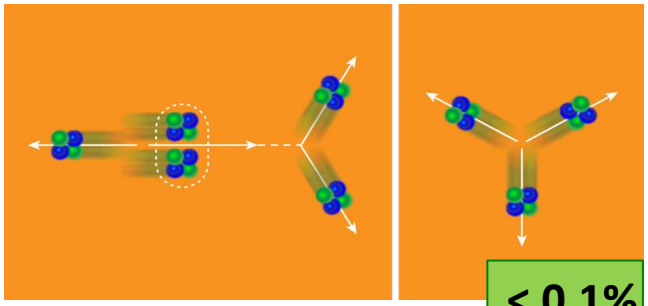


DeltaTS (front - back)

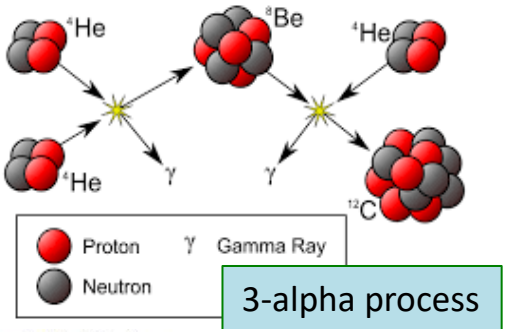
DeltaTS (at half maximum) = 1 tick



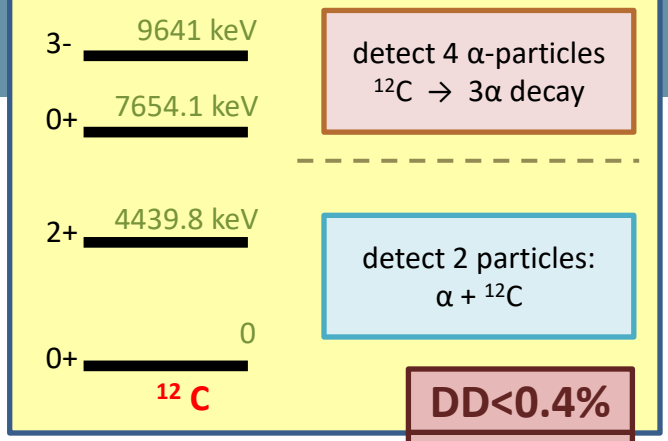
Direct 3α decay of the Hoyle State



< 0.1%



3-alpha process



DD<0.4%

DD: 17%

DD: 1.38%

DD: 0.28%

DD: 0.043%

DD: 0.047%

Selected for a Viewpoint in *Physics*
PHYSICAL REVIEW LETTERS
PRL 119, 132501 (2017) week ending 29 SEPTEMBER 2017

Selected for a Viewpoint in *Physics*
PHYSICAL REVIEW LETTERS
PRL 119, 132502 (2017) week ending 29 SEPTEMBER 2017

week ending
SEPTEMBER 2014

Physics Letters B 793 (2019) 130–133

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PHYSICS LETTERS B

New high precision study on the decay width of the Hoyle state in ^{12}C

T.K. Rana [a,*], S. Bhattacharya [a,1], C. Bhattacharya [a,b], S. Manna [a,b], Samir Kundu [a,b], K. Banerjee [a,b,2], R. Pandey [a], Pratap Roy [a,b], A. Dhal [a], G. Mukherjee [a,b], V. Srivastava [a,3], A. Dey [a], A. Chaudhuri [a,b], T.K. Ghosh [a,b], A. Sen [a,b], Md.A. Asgar [a,b], T. Roy [a,b], J.K. Sahoo [a], J.K. Meena [a], A.K. Saha [a], R.M. Saha [a], M. Sinha [a,4], Amit Roy [a,1]

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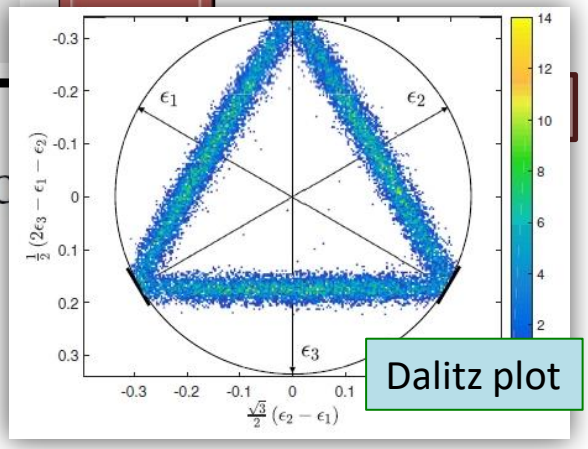
[b] *Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai 400094, India*



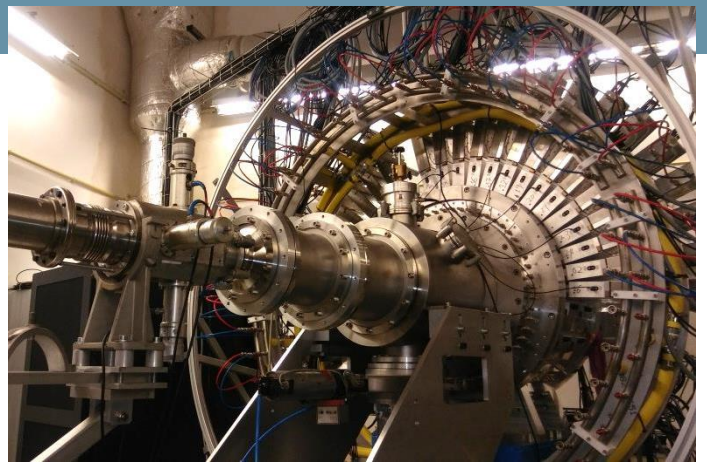
Dalitz plot

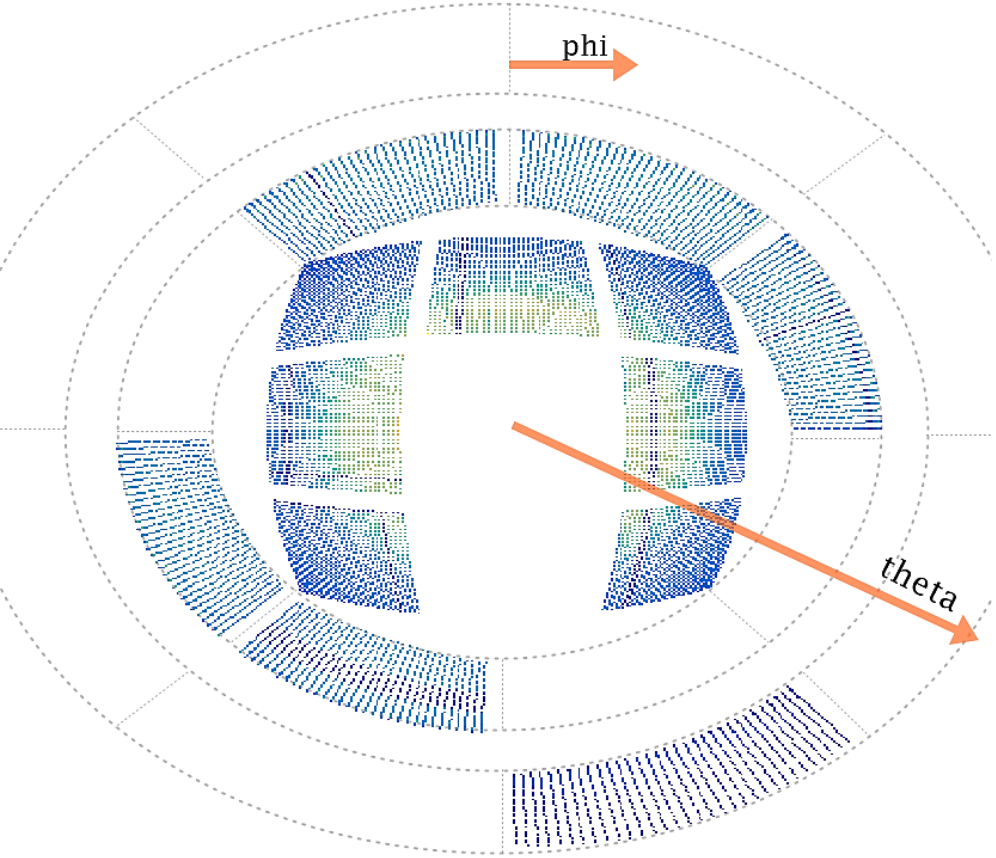
Hoyle State Decay Measurement

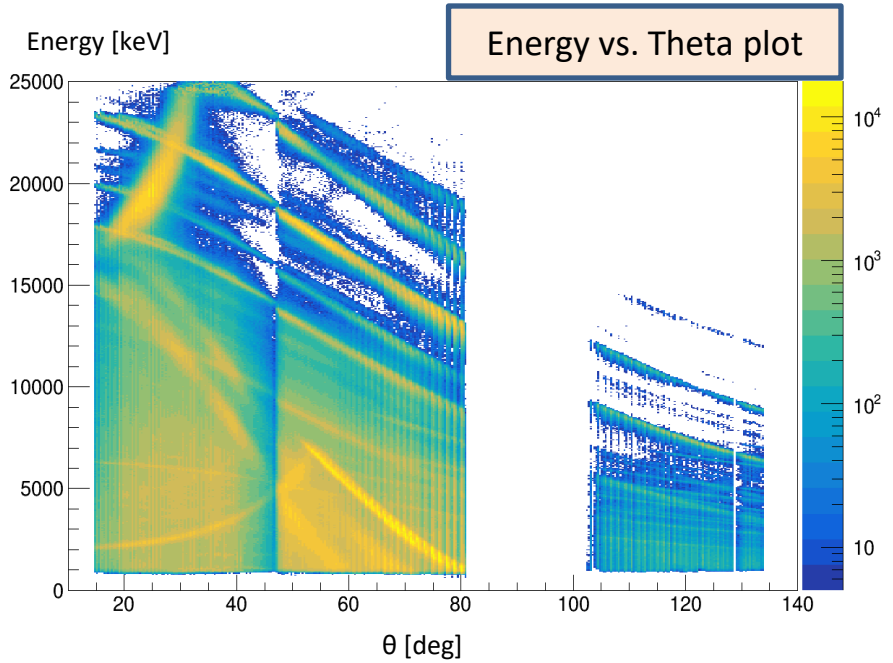
$^{12}C(\alpha,\alpha')^{12}C^{(*)}$

Experiment carried out in May 2019 (6 days)

- **Beam Energy: 28.5 MeV**
- Beam intensity (on target): 1.5 – 2.5 nA
- Natural carbon target: 0.12 mg/cm^2

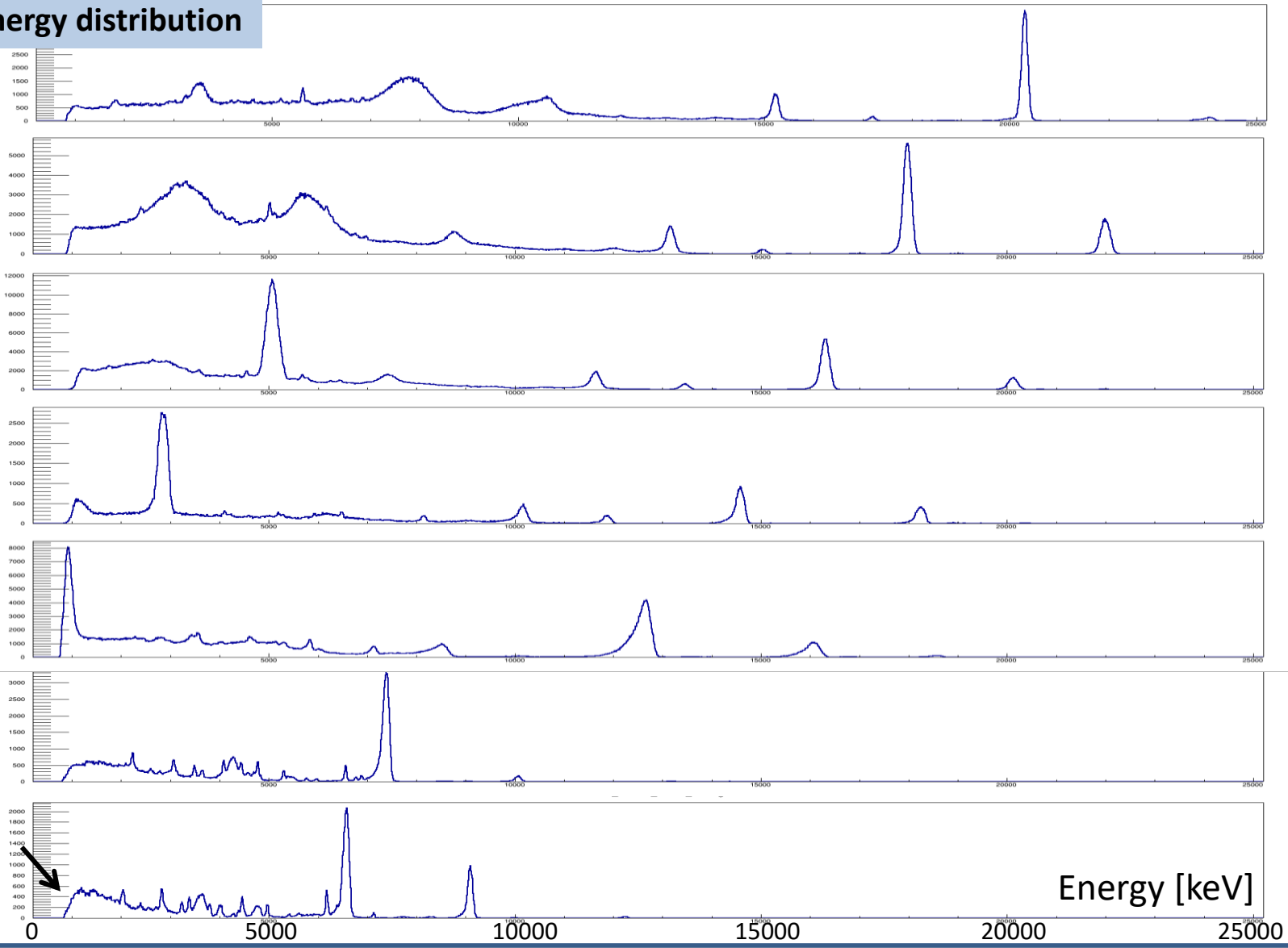






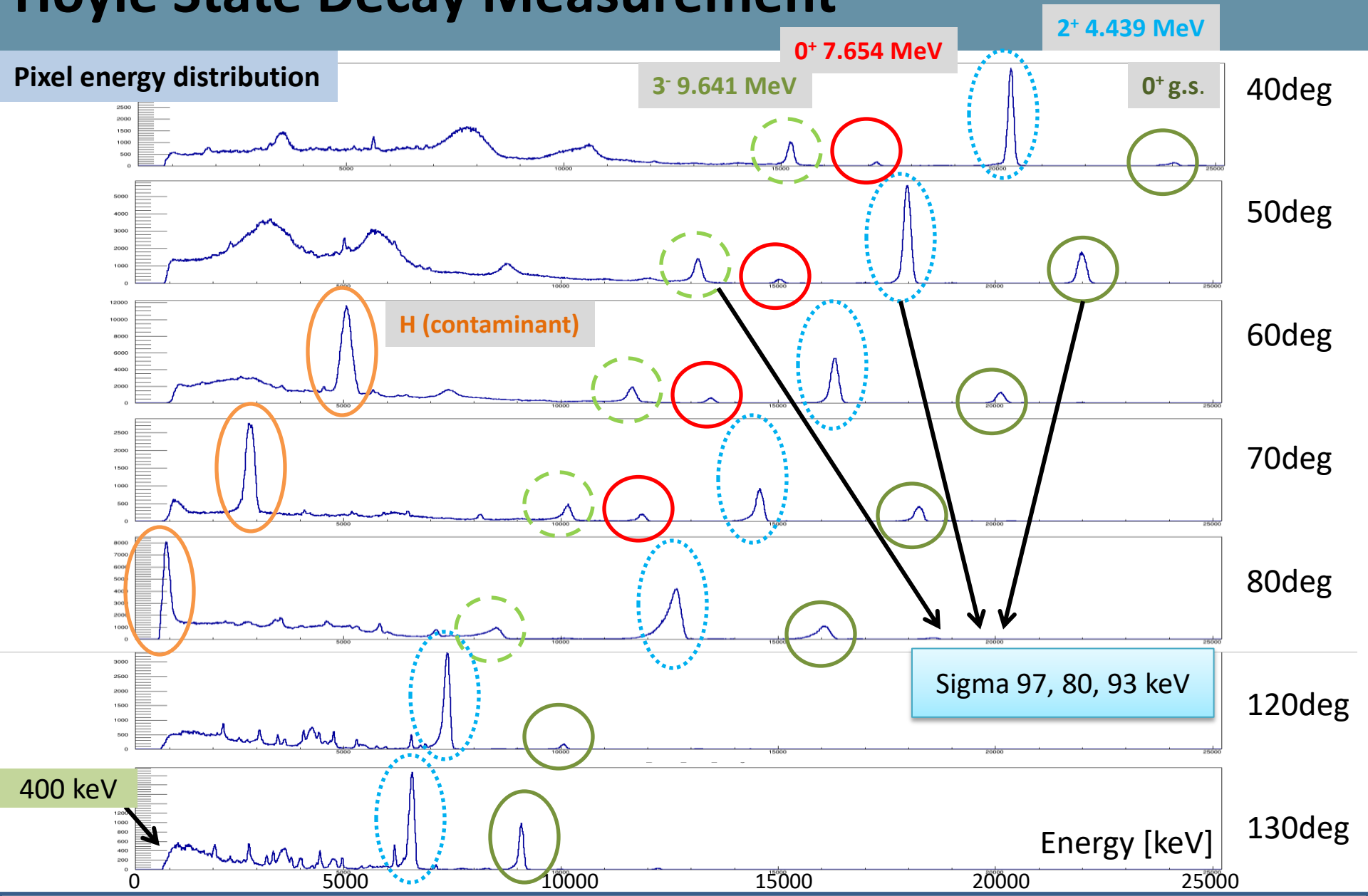
Hoyle State Decay Measurement

Pixel energy distribution



Hoyle State Decay Measurement

Pixel energy distribution



Plans

Done

- Test in-beam experiment with 12 DSSSDs (June 2018)
  - Only energy branch - successfully
- 9 new DSSSDs constructed and received from Lund University (March 2019)
- Installed 22 DSSSDs
- Test in-beam experiment with 13 DSSSDs (May 2019)
  - Fast Discriminator included – successfully
- Upgrade the target ladder of the chamber

To be done

- Solve the issues with the problematic AIDA modules
  - Observation: issues with the AIDA modules after the larger number of modules connected (idle rate too high).
- Reduce noise level (filtering, shielding, grounding)
- Reach lower energy threshold
- Test in-beam experiment with all 22 DSSSDs by the end of 2019

Thanks to the collaboration!

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Tz. Kokalova
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David Laff
Ian Lazarus
Paul Morrall
Vic Pucknell

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Dirk Rudolph
Luis Pico

University of York

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Lianne Scruton

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