First Results from AGATA-PreSPEC and the LYCCA ToF

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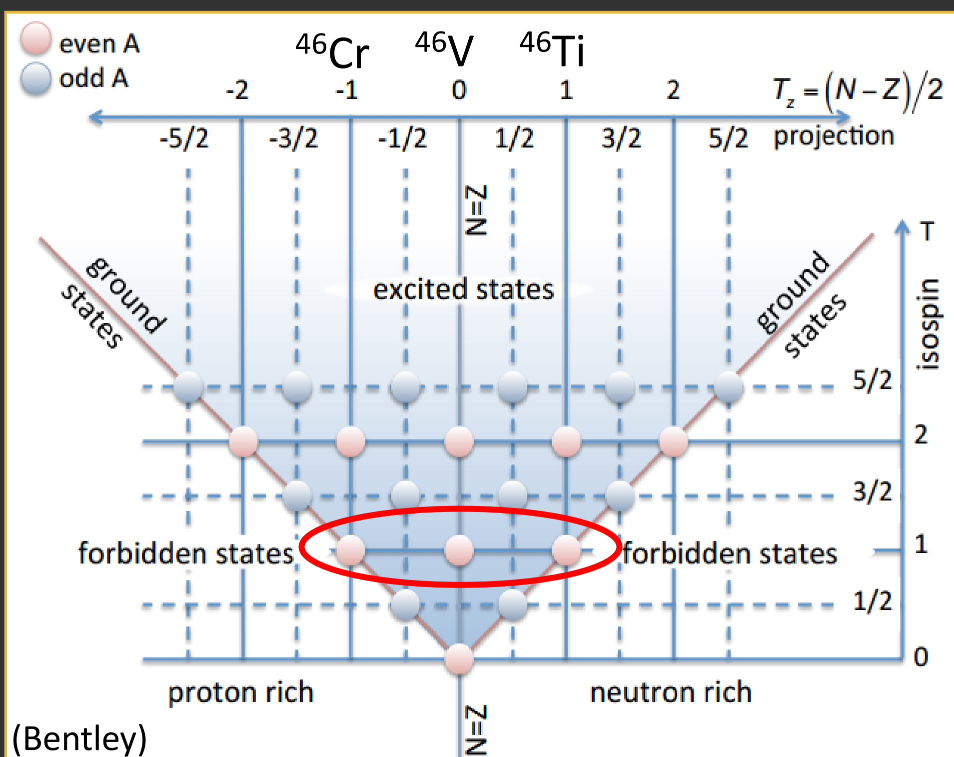
Outline:

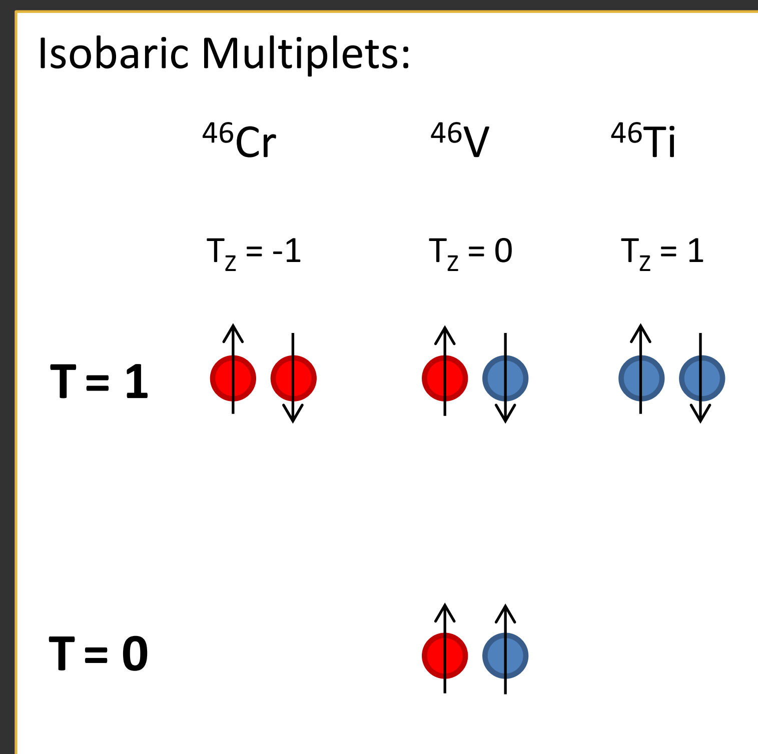
- Description of most recent AGATA-PreSPEC isospin experiment
- Preliminary results
- The LYCCA array – The Time-of-Flight (ToF) detectors
- ToF analysis and comparisons with simulation
- Outlook to the future

Motivation: Isospin Mixing in ^{46}V

- Isospin projection: $\boldsymbol{T_z = \sum_i t_{z_i} = \frac{(N-Z)}{2}}$ $\quad t_z = \frac{1}{2}$ for neutrons $\quad t_z = \frac{1}{2}$ for protons
- Isobaric multiplets have states that are almost identical due to the charge independence of nucleon-nucleon interaction.
- Presence of Coulomb interaction and possible charge asymmetry of nucleon-nucleon interaction causes isospin mixing.

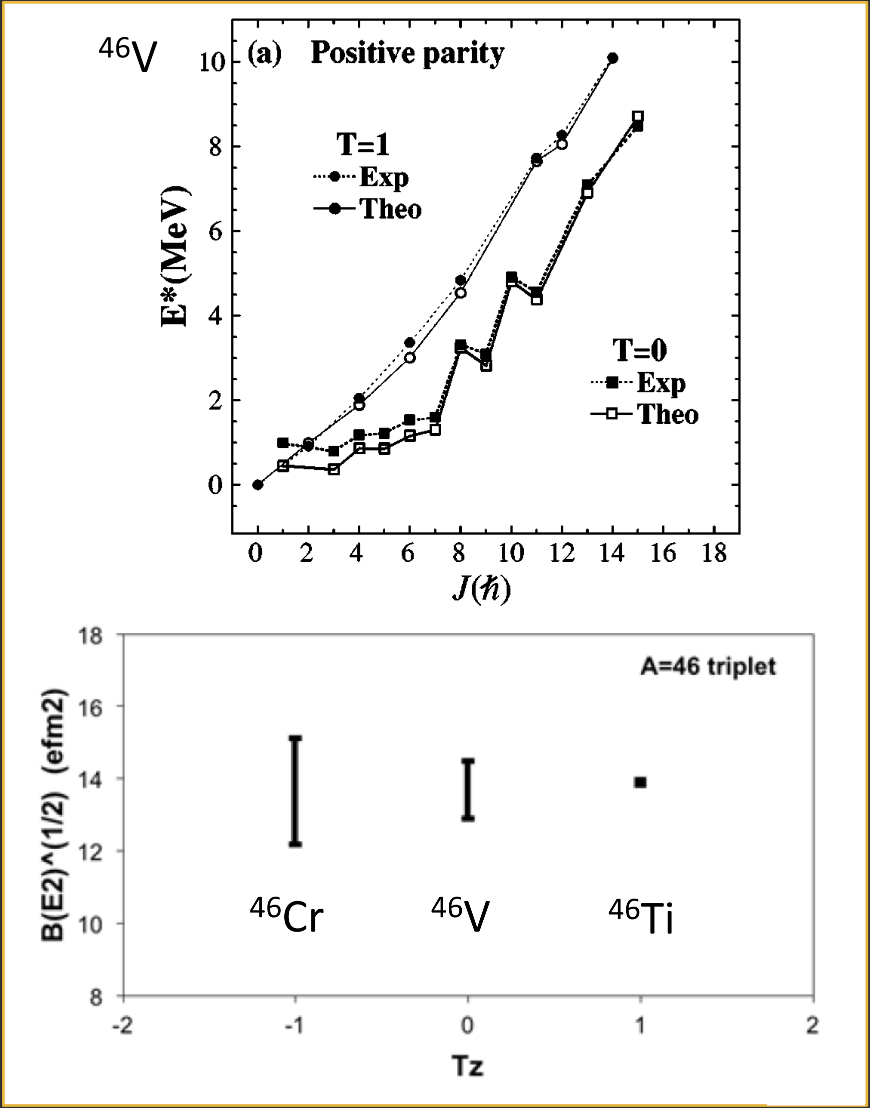


(Bentley)



Motivation: Isospin Mixing in ^{46}V

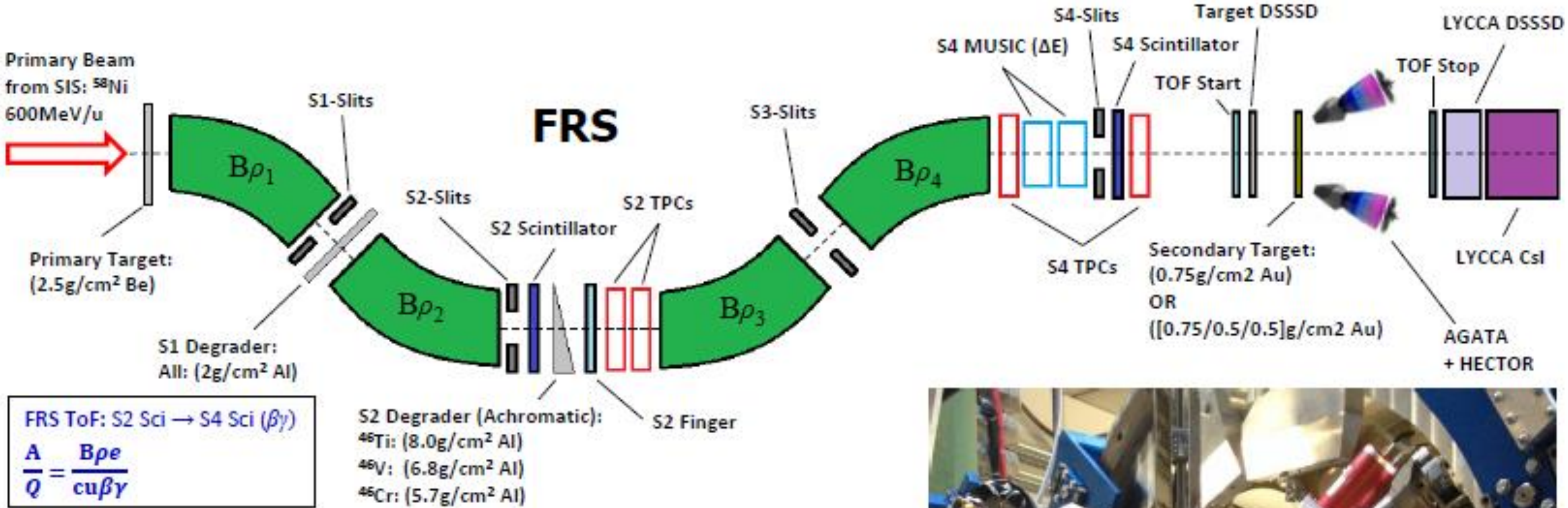
- The T=1 2^+ state in ^{46}V is a good candidate for isospin mixing as T=0 and T=1 states are close.
- How can we 'measure` the amount of isospin mixing? – EM transition strengths.
- Linear relationship between $B(E2)^{\frac{1}{2}}$ and T_Z shows that isospin mixing is not present in ^{46}V.
- Measure lifetimes of all three isobaric 2^+ states under exactly the same experimental conditions.

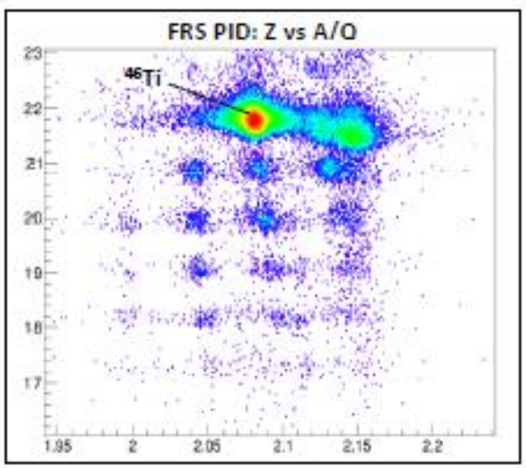


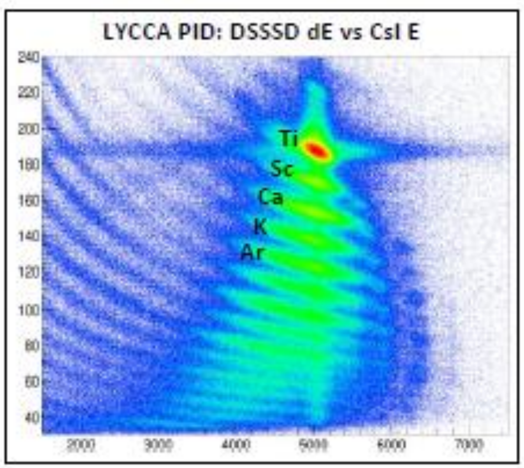
Top: (Lenzi 1999)
Bottom: Courtesy of S.Milne

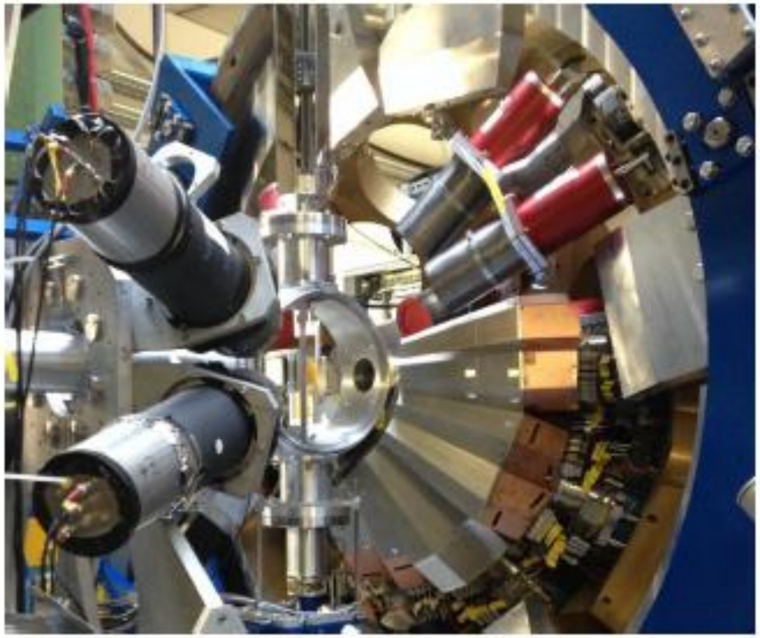
The Experiment:

(Courtesy of S.Milne)





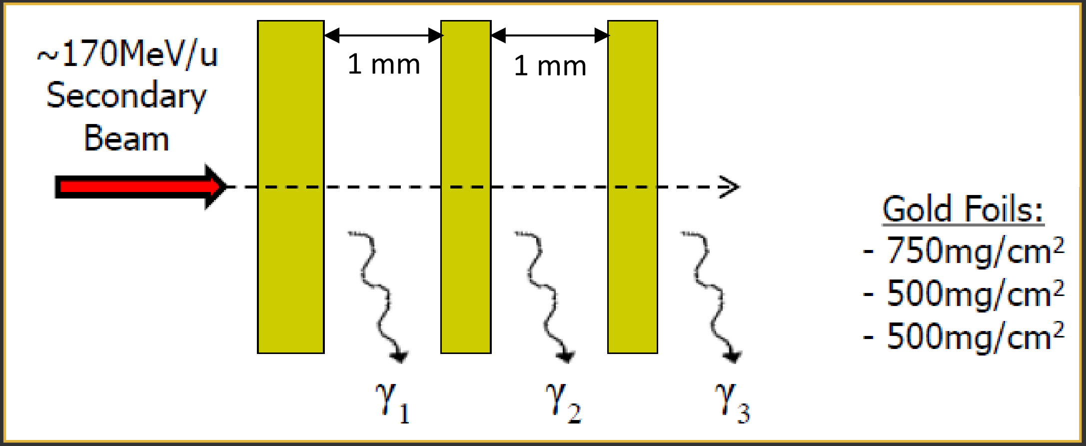


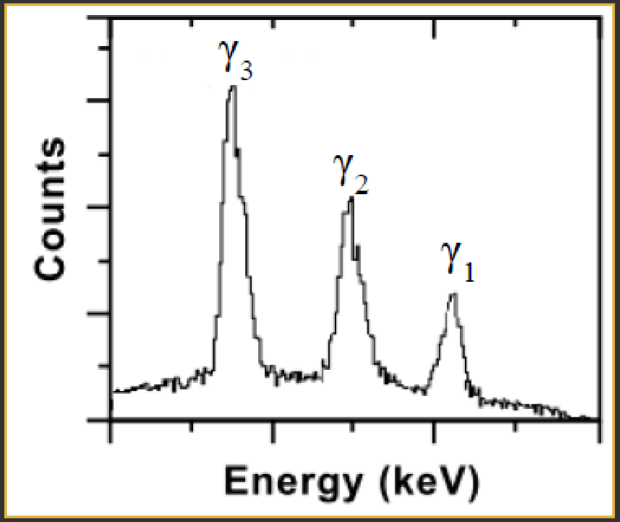


The Experiment:

(Courtesy of S.Milne)

- A novel Triple Gold Plunger was used to make lifetime measurements:

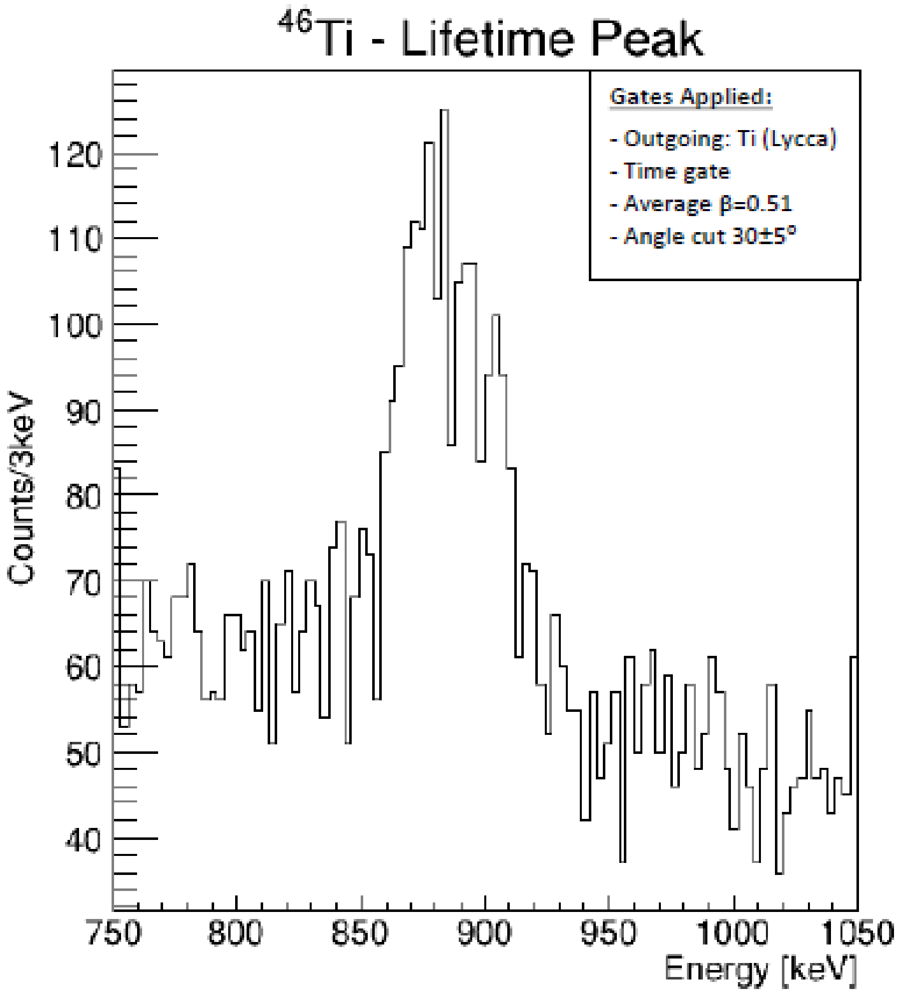


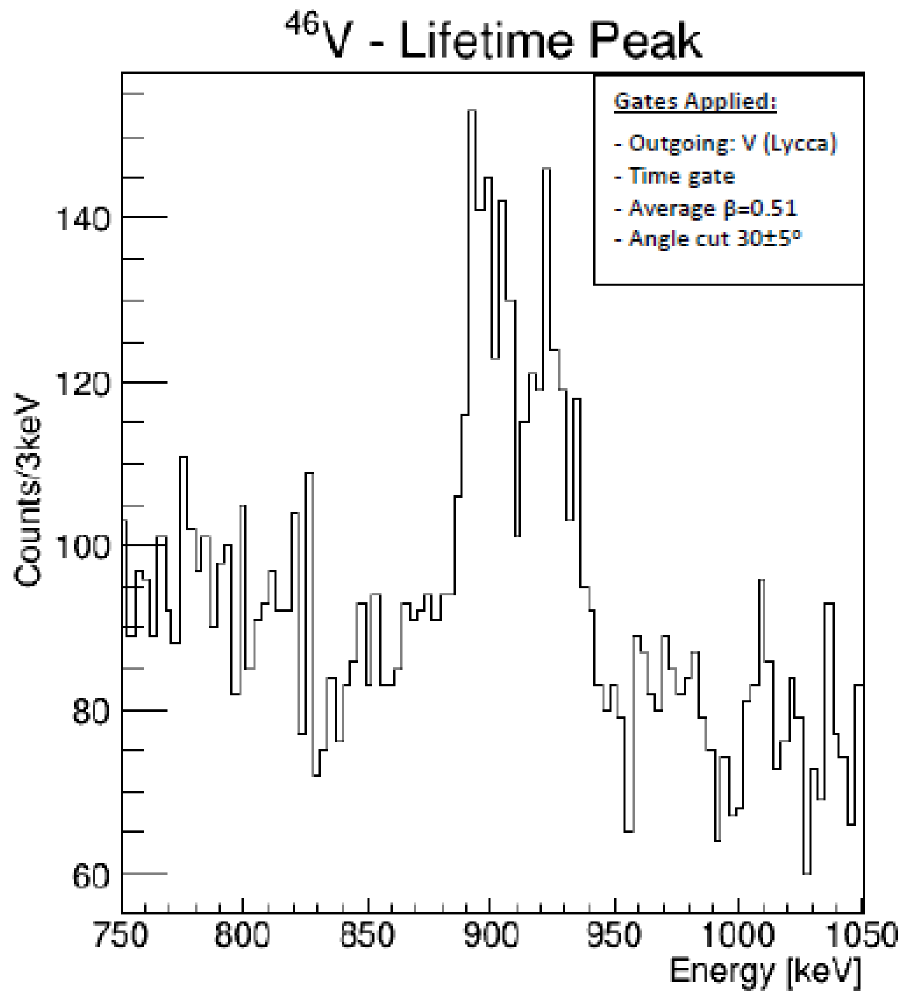


- Can exploit different beam velocities between each foil to obtain three gamma peaks and measure lifetime.
- Gamma tracking and high beam energies essential – good example of a NUSTAR technique.

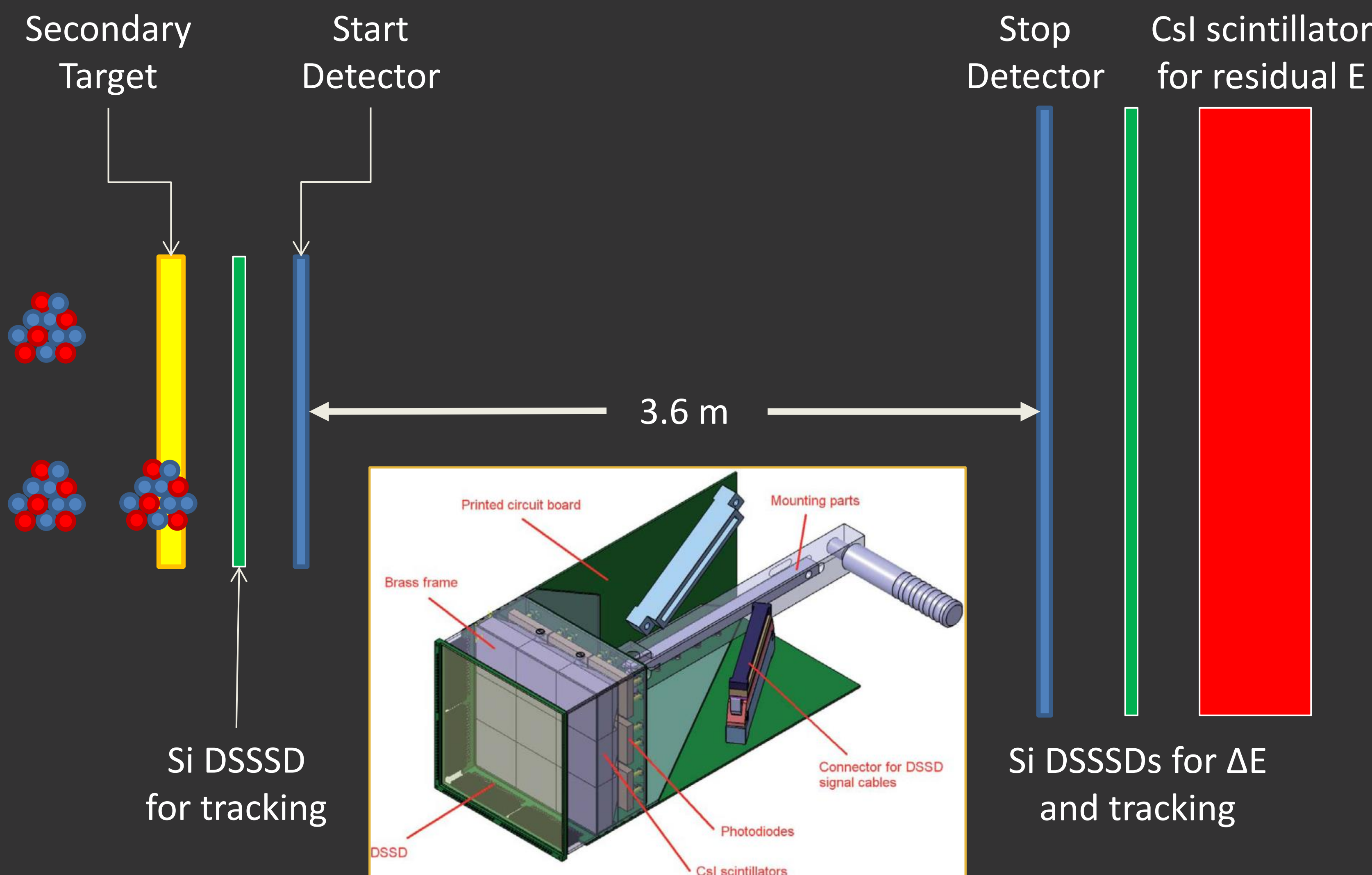
Preliminary Results: (Courtesy of S.Milne)

After Applying Angle Cuts



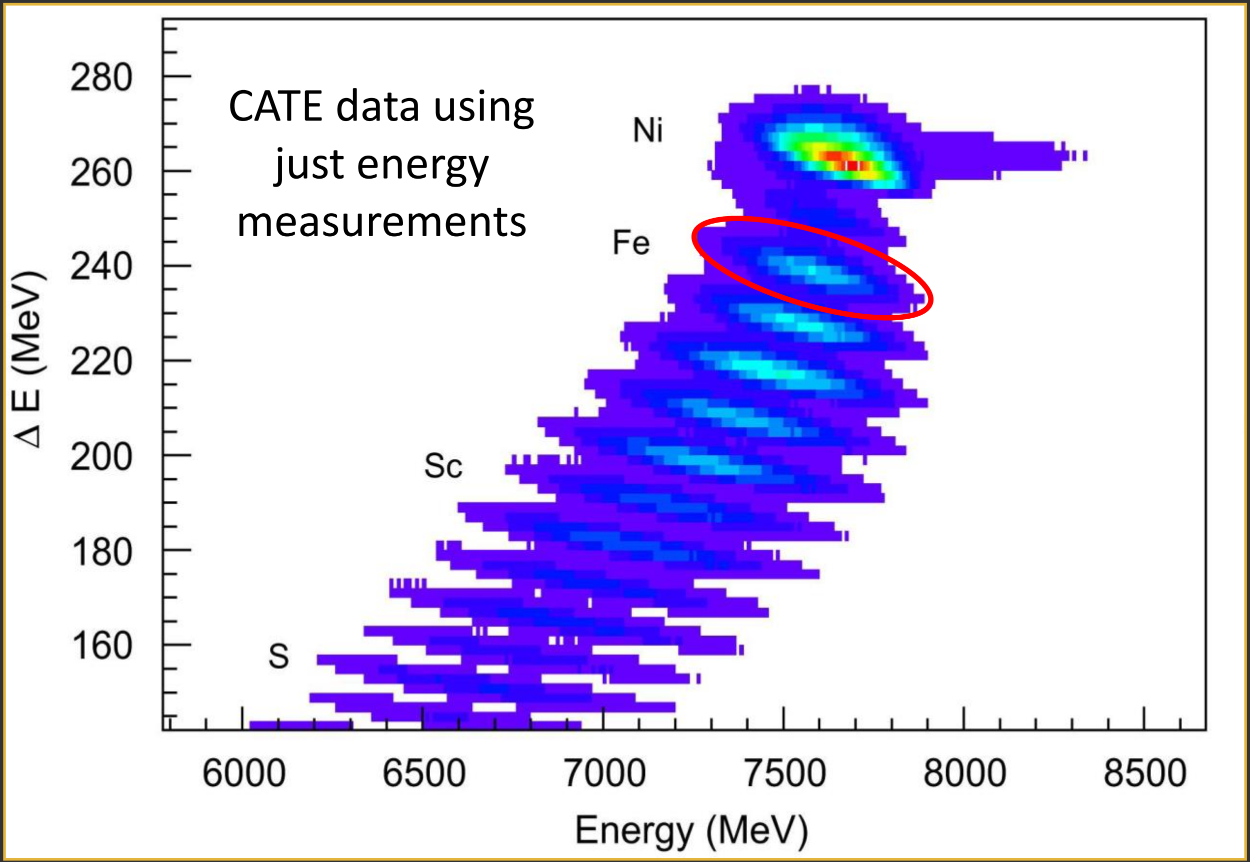


The LYCCA Array: Lund-York-Cologne CAlorimeter



Initial Simulations:

- Simulations were made at University of York to determine the performance required by LYCCA energy and ToF detectors:

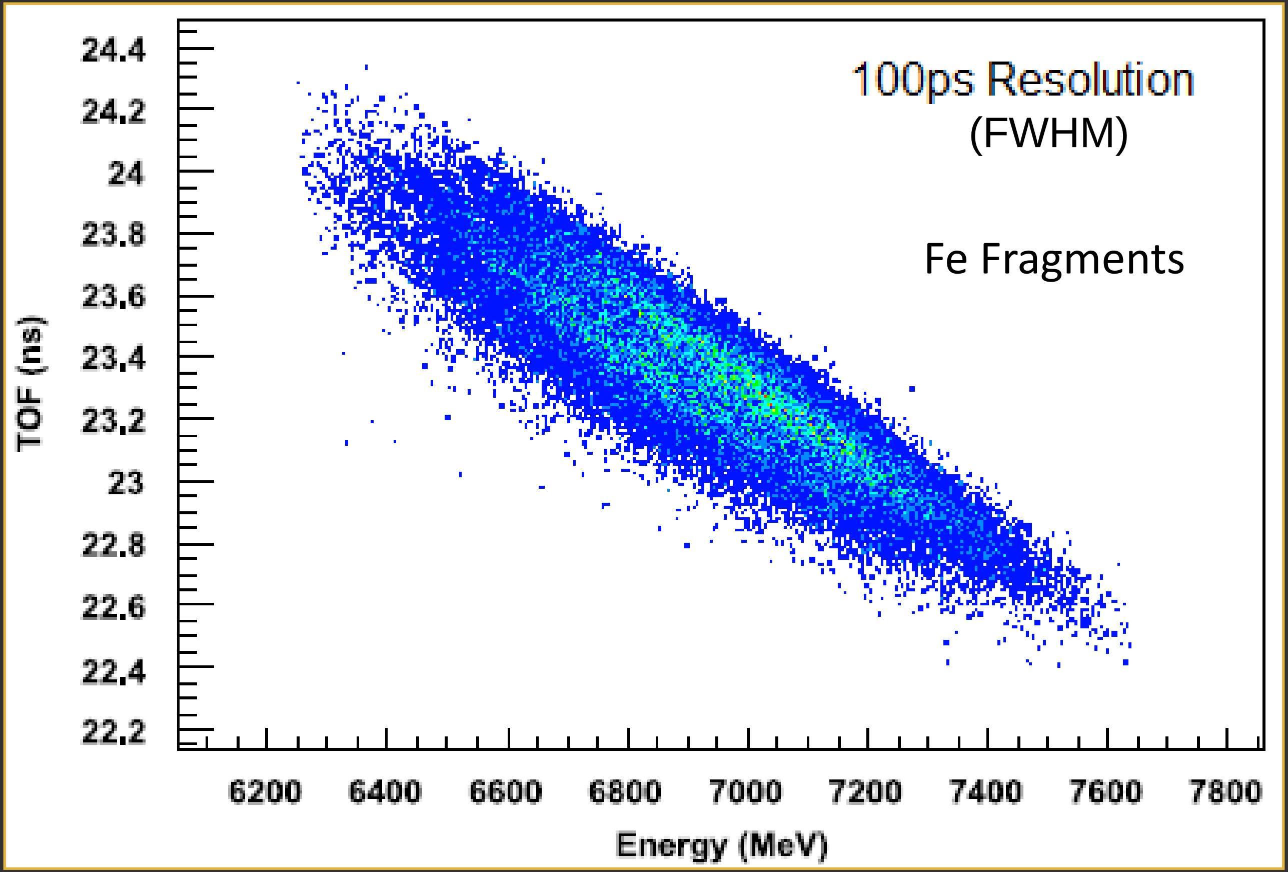


(Taylor 2009)

University of York

Initial Simulations:

- Simulations showed that including ToF measurements greatly improved the identification of fragments after the secondary target.



(Taylor 2009)

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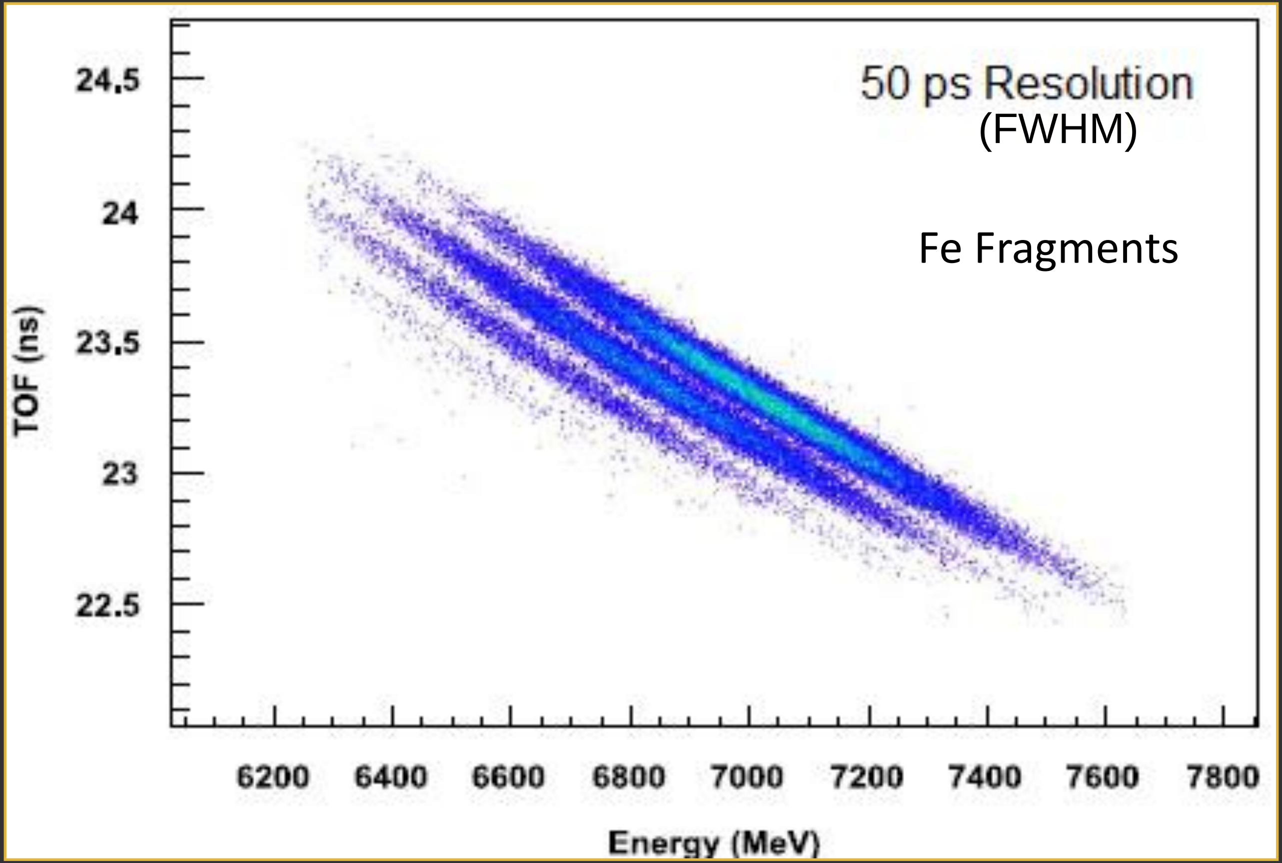
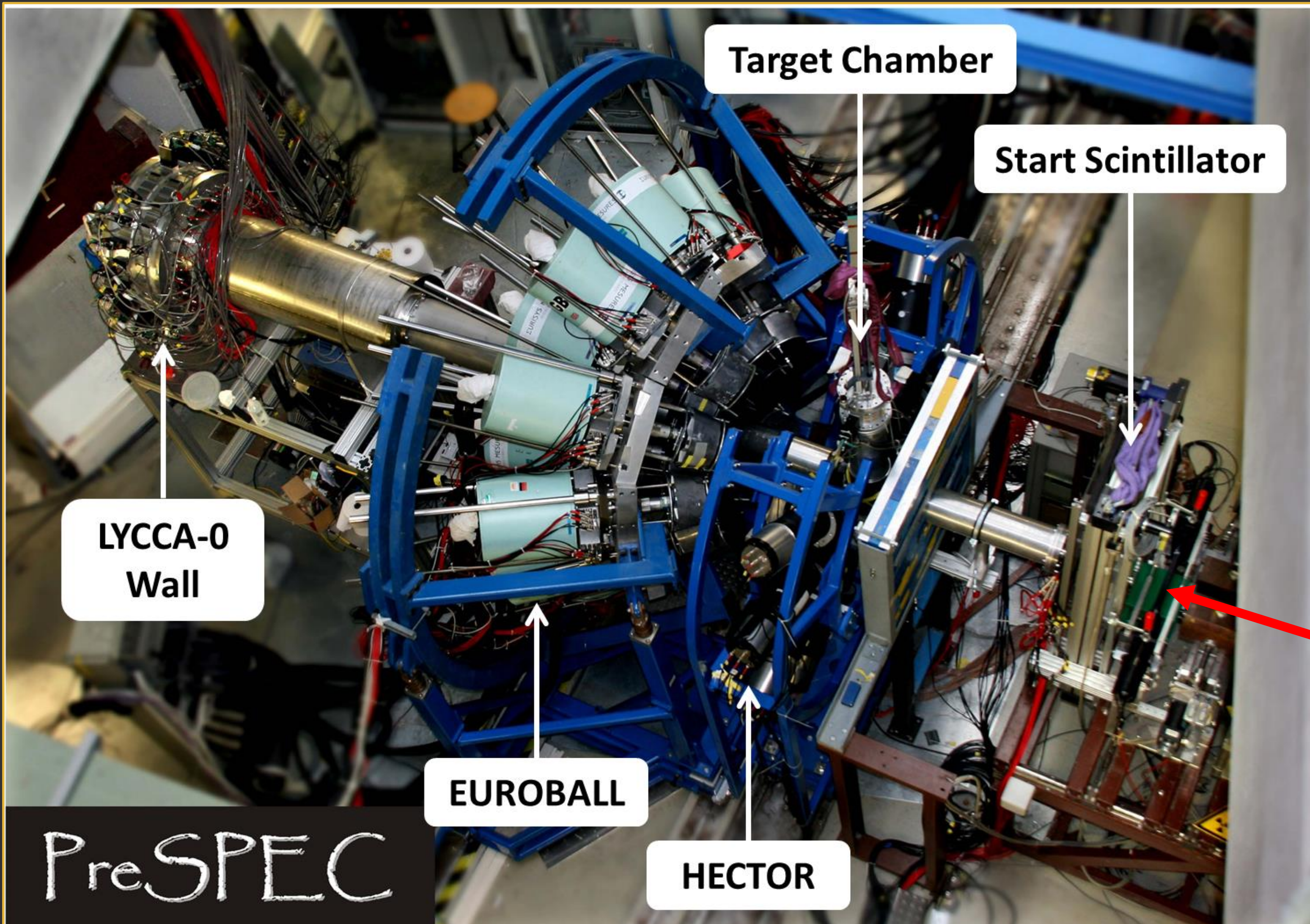


(Taylor 2009)

The LYCCA Array:



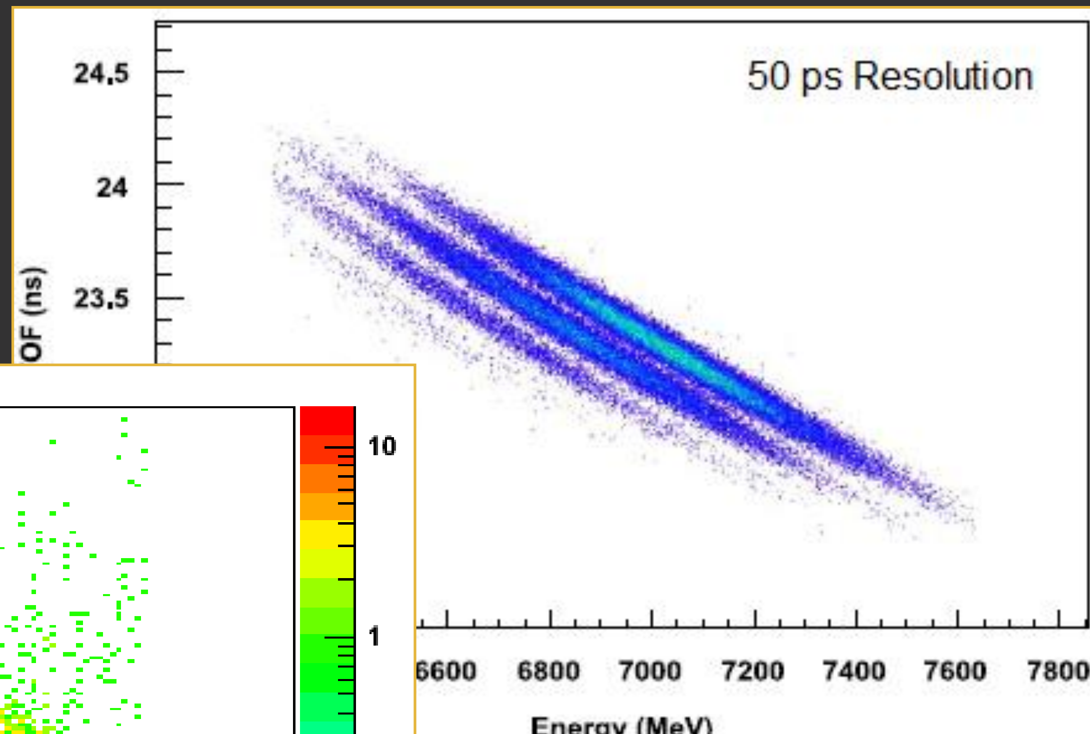
University of York

The LYCCA Array:

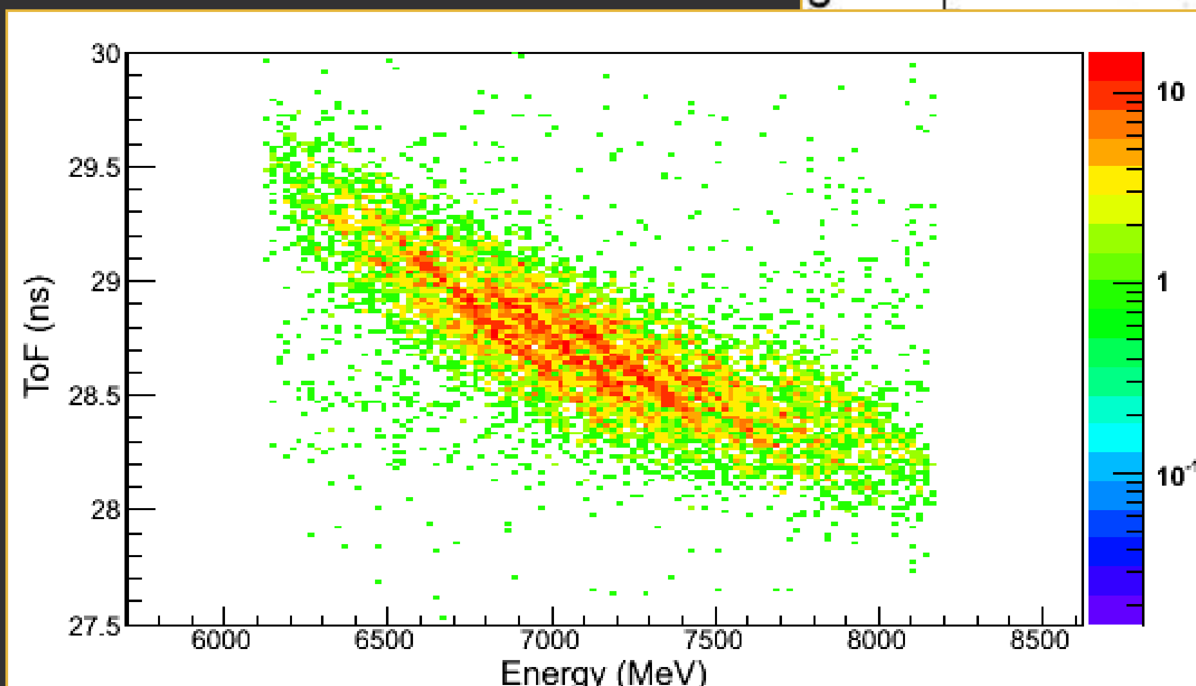
- Fast plastic scintillator – 27cm diameter
- Surrounded by 32 PMTs
- Multiple measurements of the same event greatly improves the accuracy of the measurement.

Mass Measurements:

- How did the data compare to simulation?



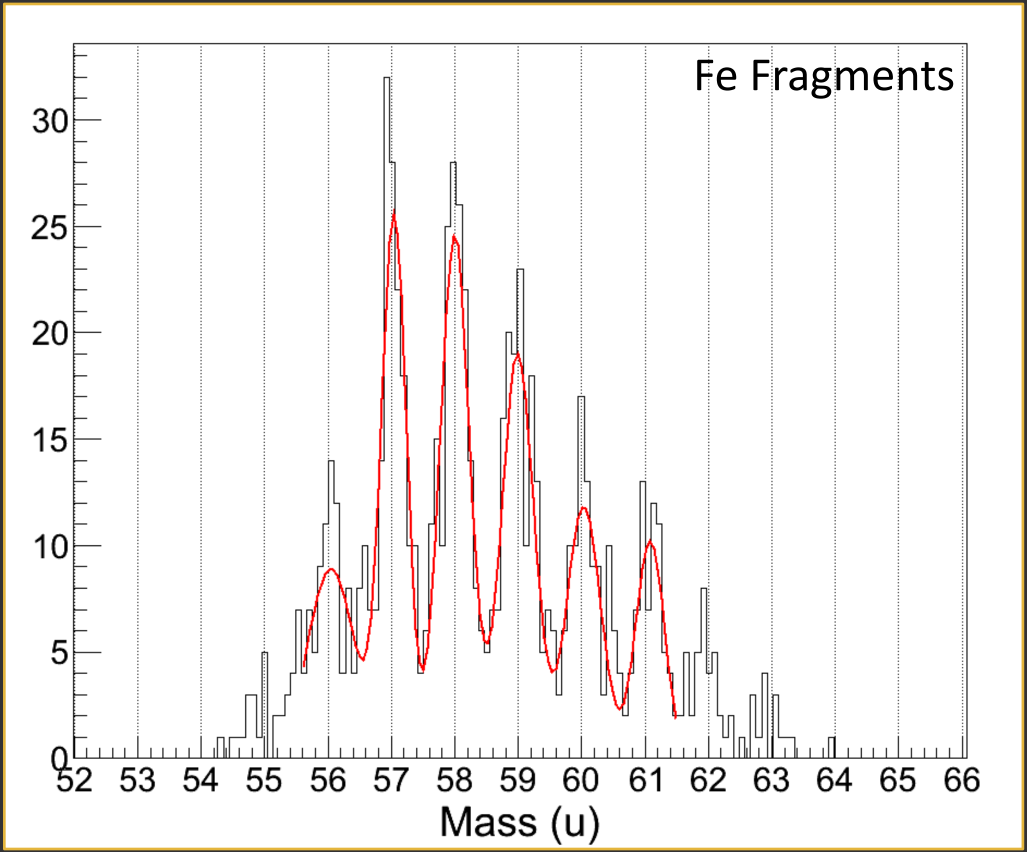
- Fe fragments selected in data:



Mass Measurements:

- Timing resolution determined by deconvoluting the contribution from the energy detectors from the mass resolution.
- Calculate mass event by event using :

$$A = \frac{E_{total}}{\frac{1}{\sqrt{1-\beta^2}} - 1} \cdot \frac{1}{931.5}$$



- Mass res: **0.55 ± 0.02 u**
- Timing res: **50.8 ± 2.4 ps**

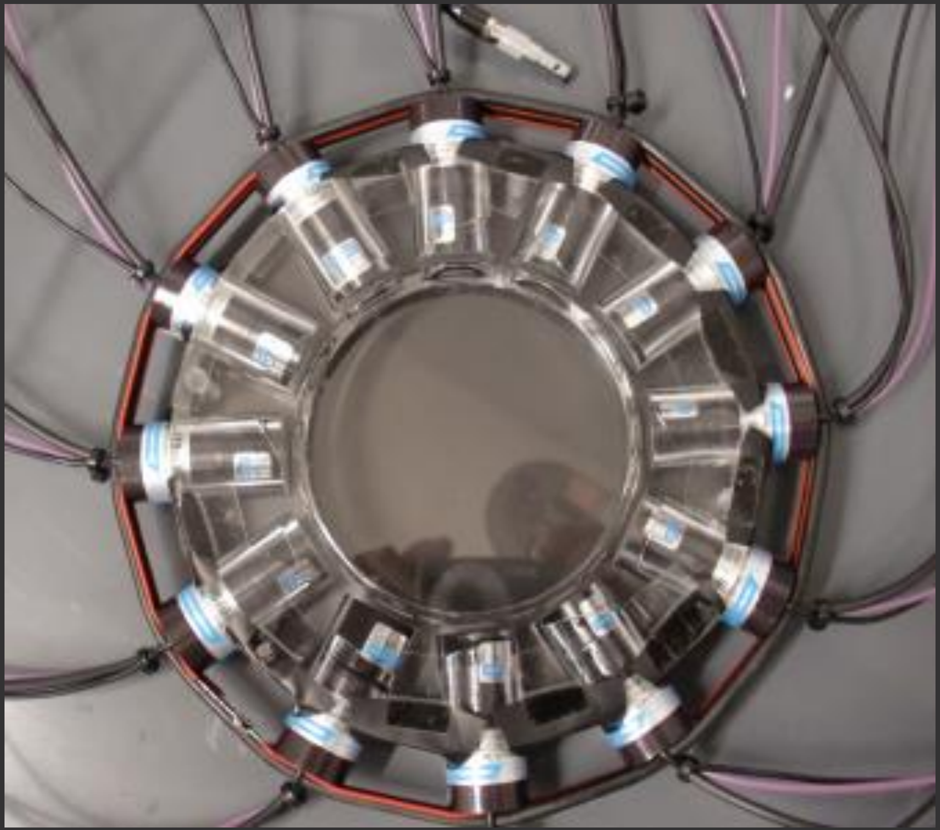
Target Scintillator

- Similar analysis is ongoing for a smaller scintillator that is positioned behind secondary target inside target chamber.

- Approx. 8cm in diameter, surrounded by 12 PMTs.

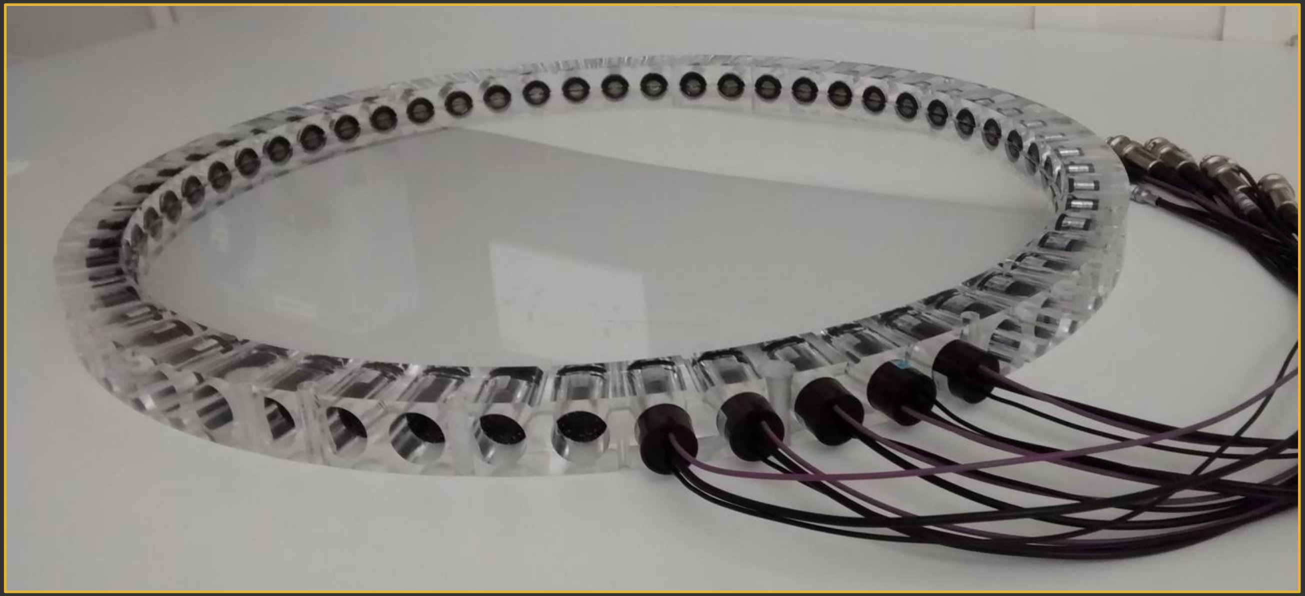
- ^{52}Fe coulex data (courtesy of A.Gadea) is being analysed.

- Similar mass region as previous analysis, so more direct comparisons can be made.



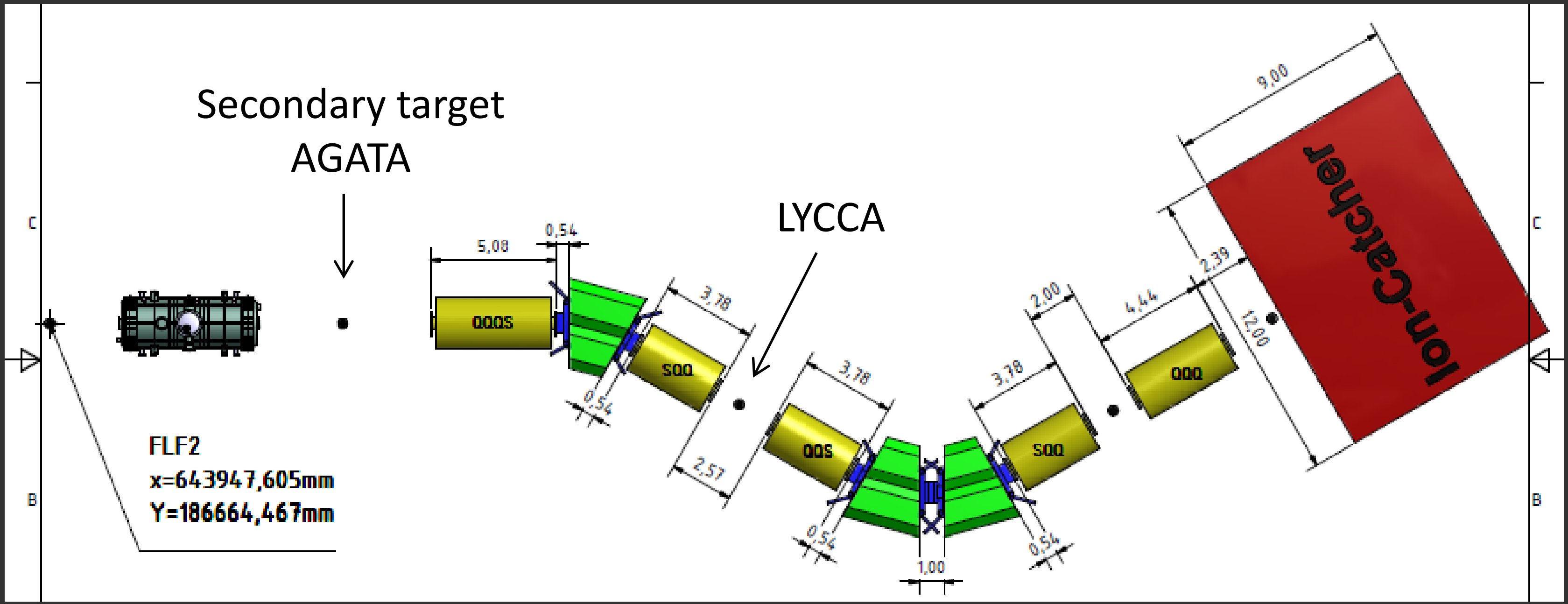
Future ToF Developments:

- A new, larger plastic scintillator has been constructed at York for use at FAIR that will cover all 26 modules of the LYCCA wall.
- Active area of 40 cm diameter, and is surrounded by 56 PMTs – should lead to improved timing resolution.
- Will be mounted and tested within LYCCA chamber in Nov.



Future LYCCA Developments:

- There are plans to place the LYCCA array further downstream of the secondary target, behind a magnetic spectrometer.
- This will increase the flight path of ToF measurements and improve the distinction between isotopes.
- Should make identification of nuclei of A > 100 much easier.



Thanks for Listening

Collaborators:

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Gamma Spectrometry and FRS Groups	GSI, Germany

References:

M J Taylor *et al. Nuclear Instruments and Methods A,* 606, pg 589-597 (2009)
P Golubev *et al. Nuclear Instruments and Methods A,* 723, pg 55-66 (2013)