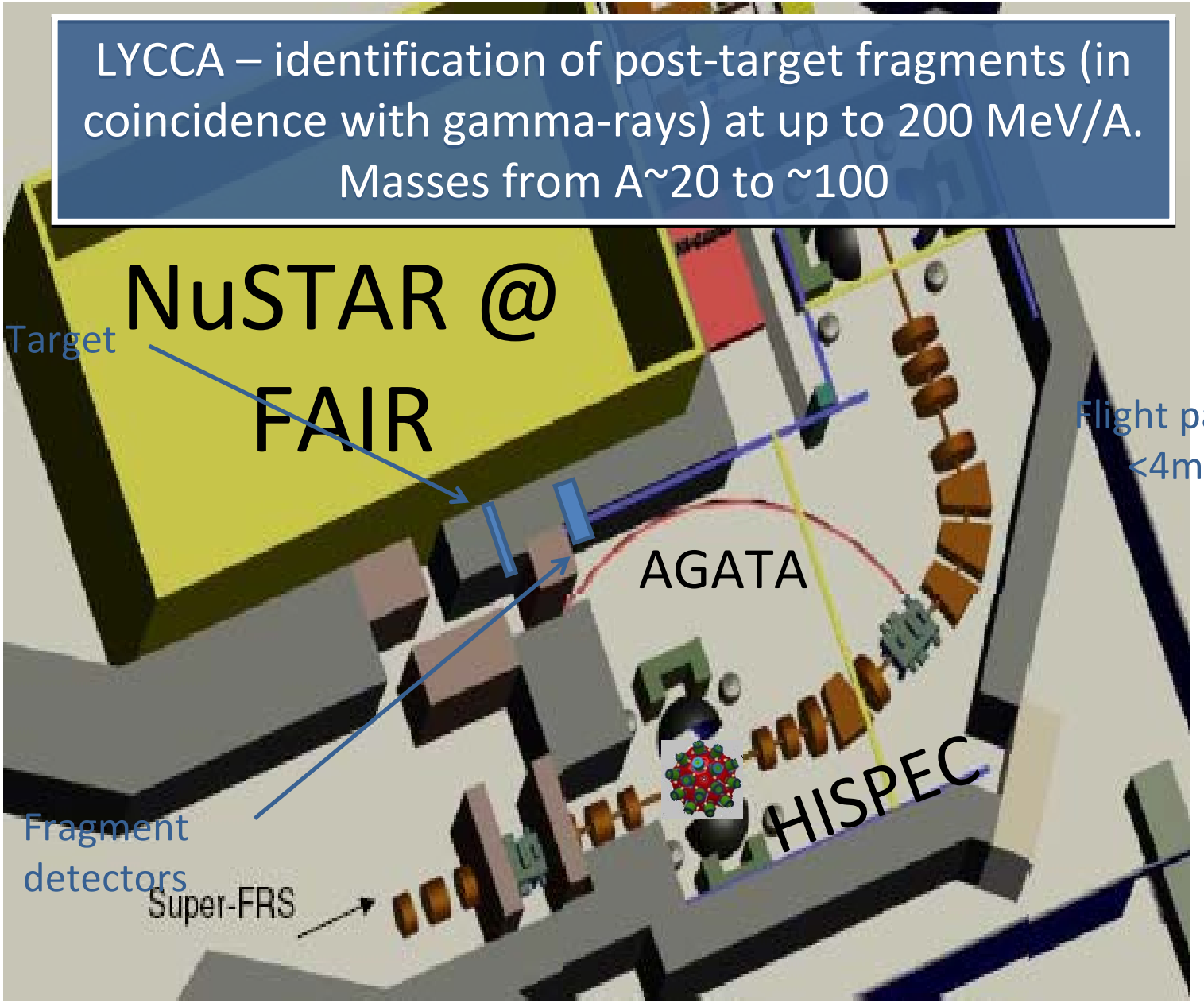
Time-of-flight measurements for the Lund-York-Cologne CAlorimeter (NuSTAR@FAIR)

Mike Bentley (Univ. of York, UK)

Collaborators:
Lund University
Univ. of Surrey
Cologne
GSI
and
HISPEC collaboration (NuSTAR)
RISING collaboration

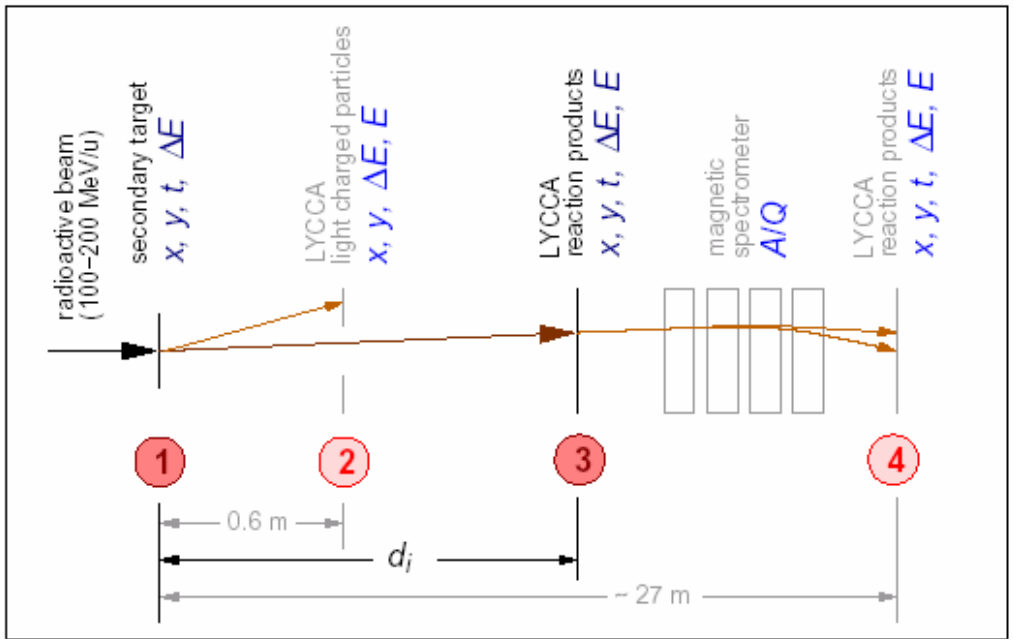
NuSTAR at FAIR



Lund-York-Cologne CAlorimeter (LYCCA)

- Core device for HISPEC.
- Identify reaction products by *A* and *Z*, 50-200 MeV/u.
- Modular, flexible system in different configurations.
- *ΔE* (DSSSD), *E* (CsI), *Δt* (CVD diamond, ultrafast scintillators, DSSSD).

LYCCA Scheme



1. Target (Be, Au..), position (DSSD) and time start (CVD diamond)
2. Light CP array (position, energy loss, energy) – prompt p, alpha decay
3. Main array (~26 LYCCA modules) – ~3.5-4.0 m downstream from target
4. Possible configuration of LYCCA modules at the focal plane of a spectrometer – add A/Q to measurement of position, ToF, energy loss, E etc.

Rising Fast Beam Campaign

^{58}Ni 600 MeV/u
~ 5x10^{8} pps

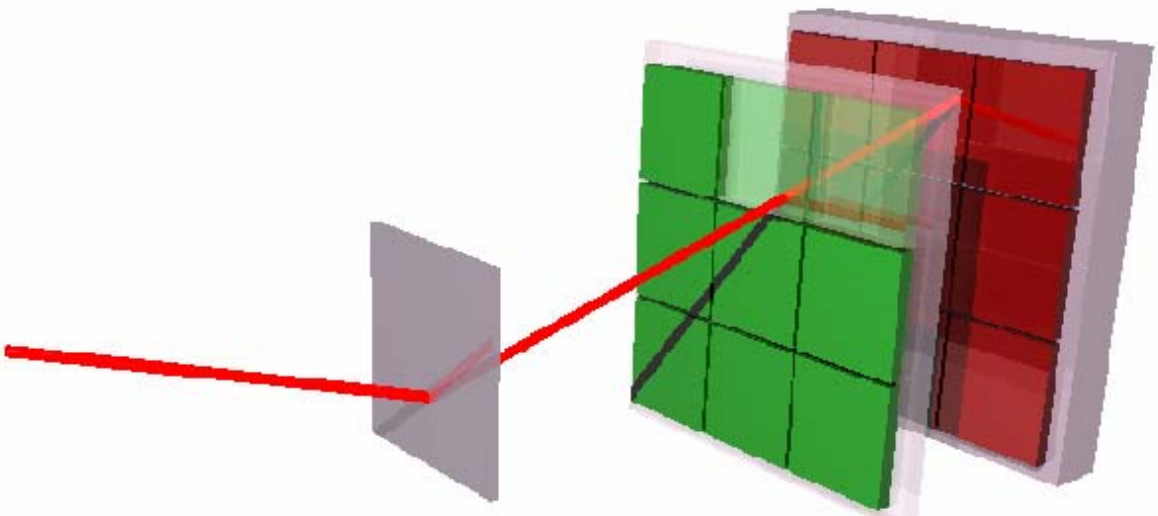
^{9}Be 4 g/cm^{2}
production target

Experience of this technique (without time-of-flight) – GSI 2003/4 RISING campaign

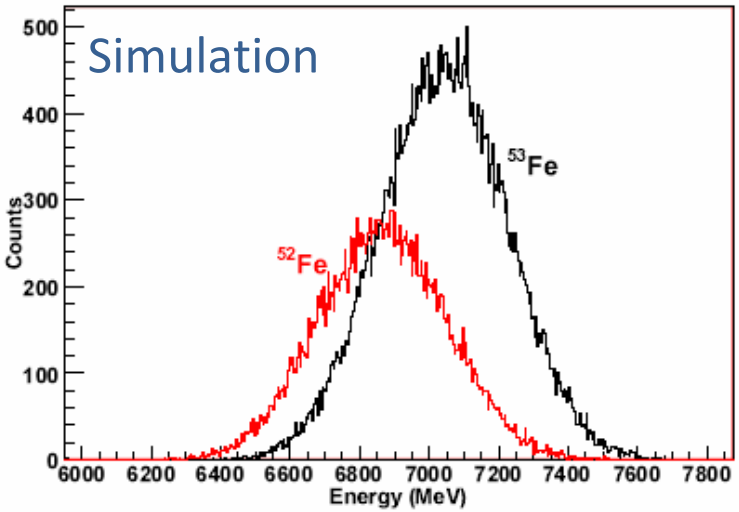
^{55}Ni ~ 175 MeV/u
~ 4x10^{3} pps

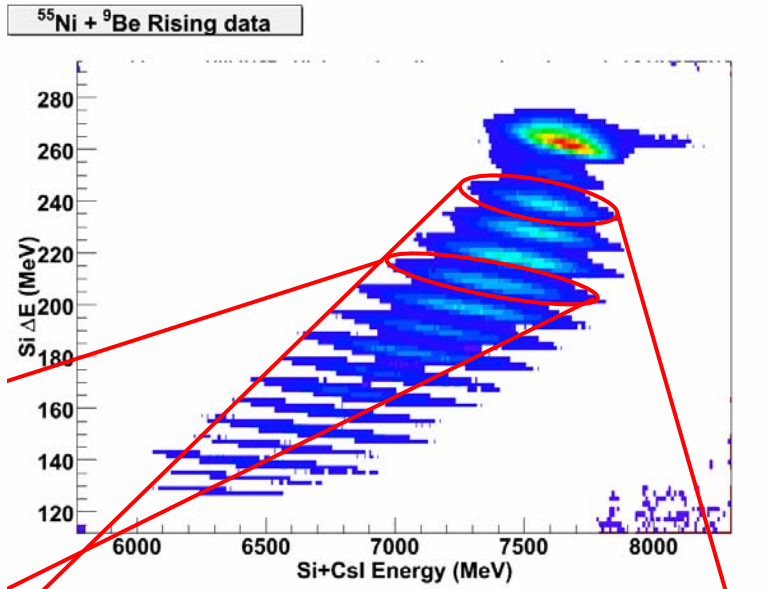
^{9}Be 700 mg/cm^{2}
secondary target

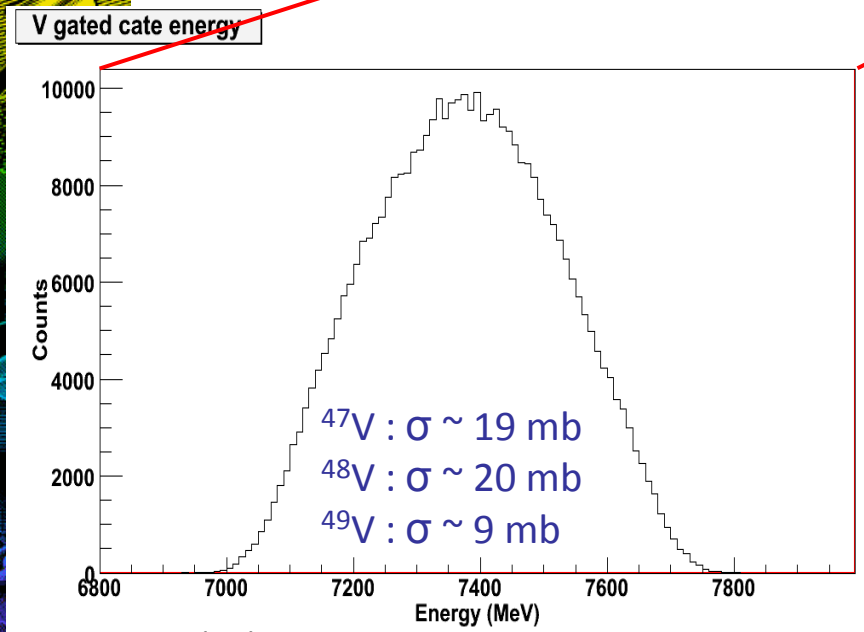
CATE detector (DSSSD and CsI) – Energy Loss and Energy only

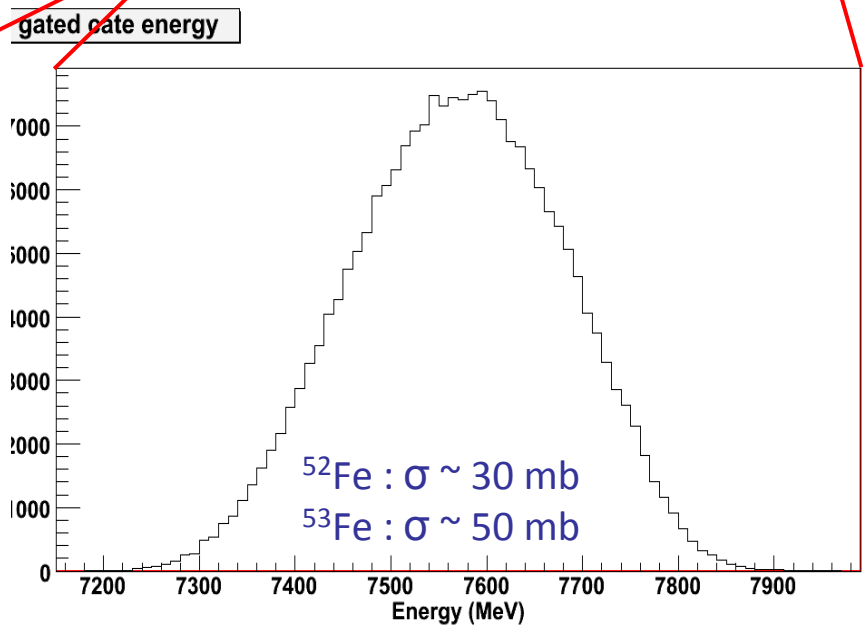


Isotope ID from Energy (Loss)



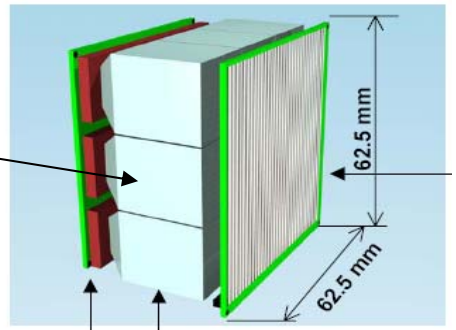


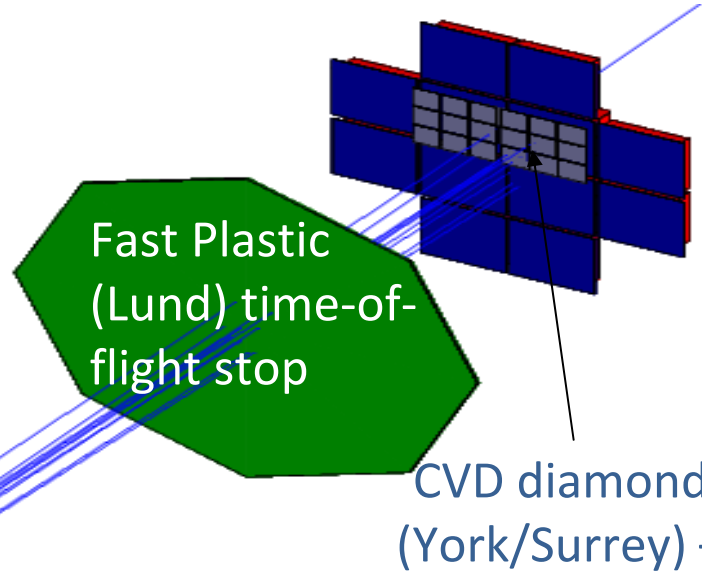




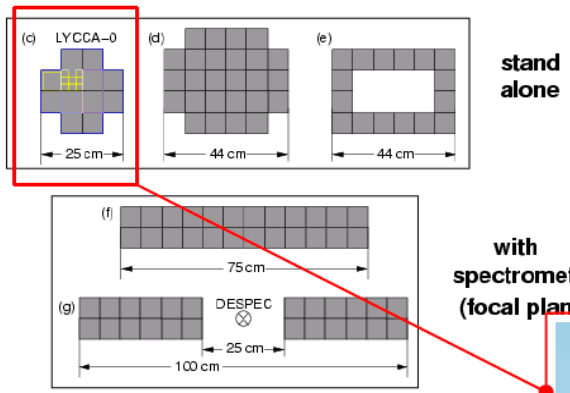
LYCCA-0 – prototype and ToF testing (2009/10)

A LYCCA module (LUND)

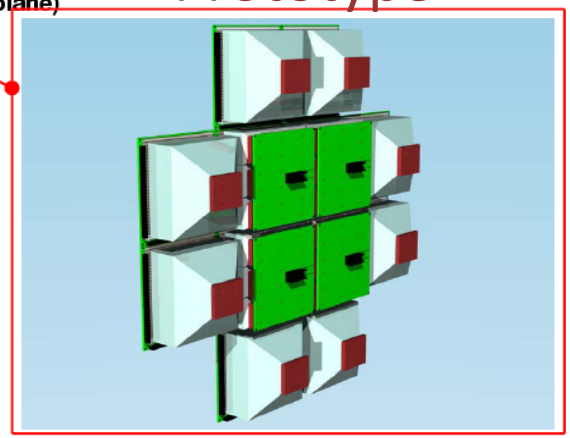


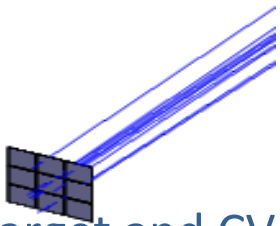


LYCCA Configurations



The LYCCA-0 Prototype

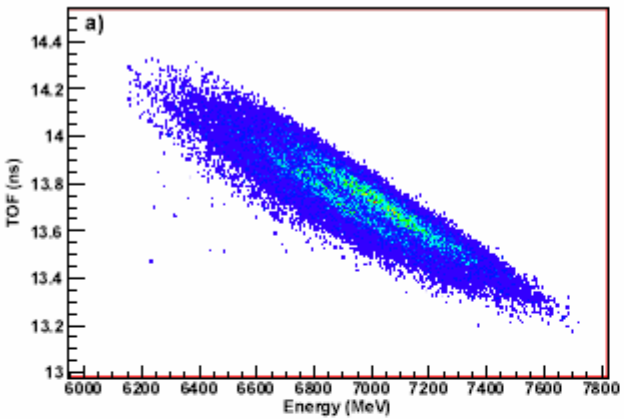


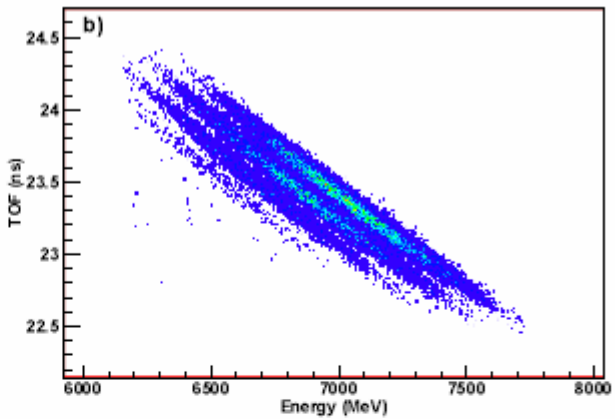


Target and CVD Diamond (ToF start)

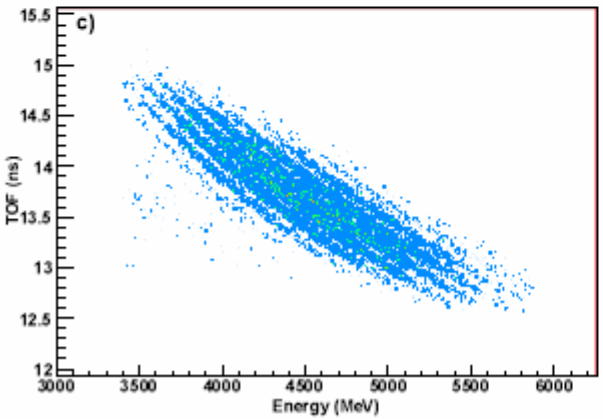
LYCCA-0 – prototype and ToF SIMULATION

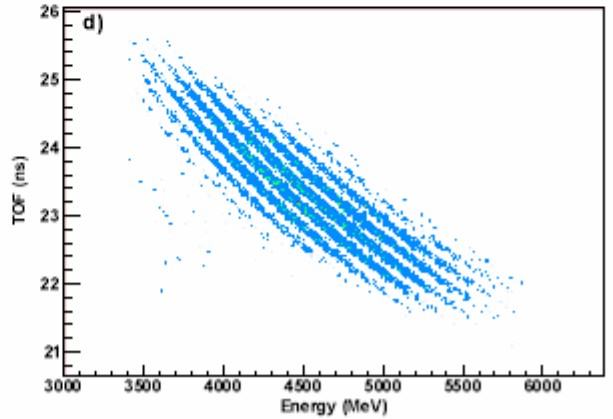
Simulation of Fragmentation of ^{58}Ni @ 170MeV/A





Fe Fragments



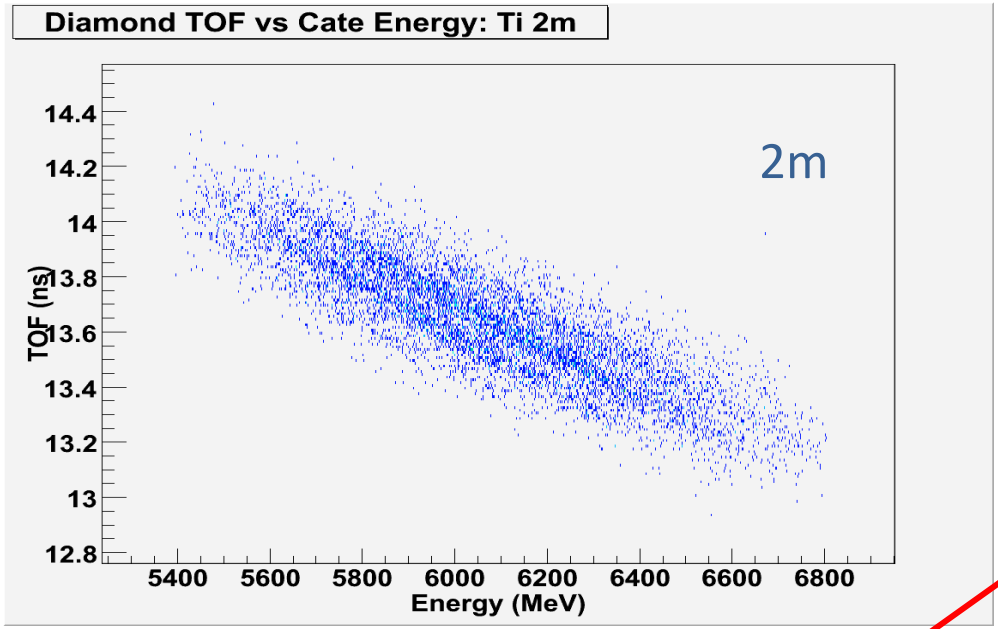


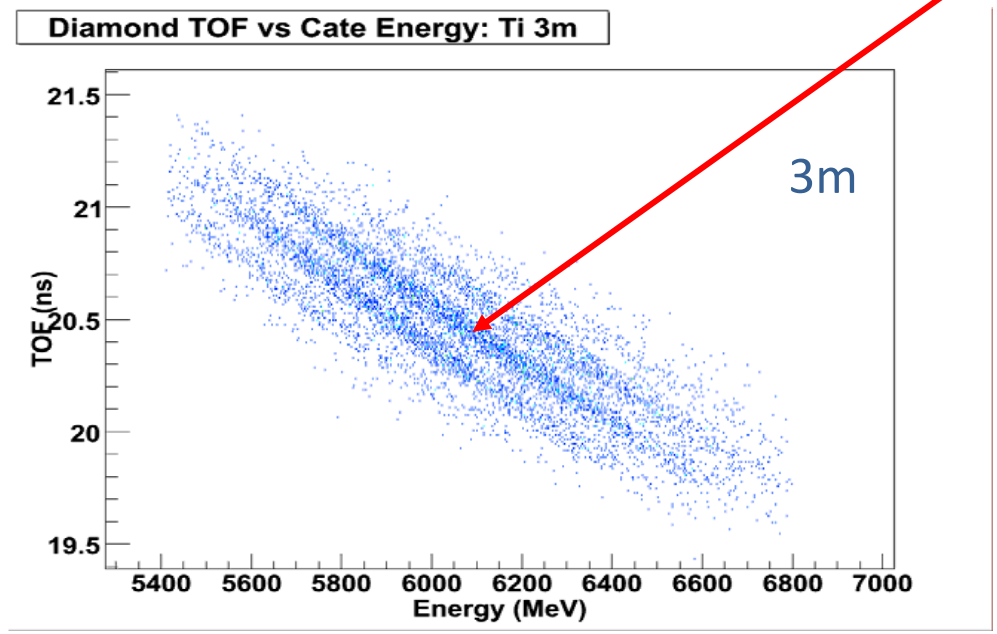
S Fragments

2m path, Δt=50ps

3m path, Δt=50ps

LYCCA-0 – prototype and ToF simulation



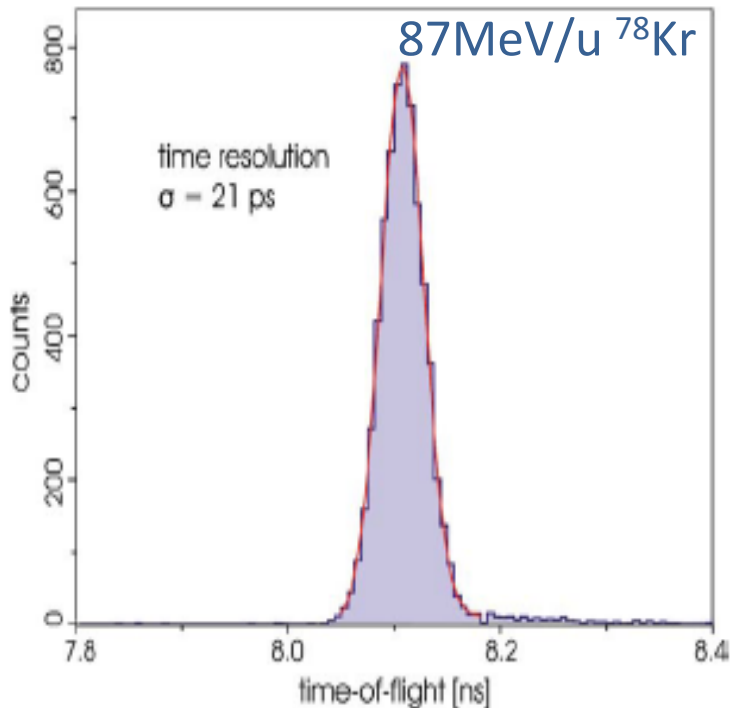


A	σ (mb)
42	0.0550
43	0.7896
44	5.3086
45	15.926
46	19.819
47	9.906
48	2.7932
49	0.4612

CVD Polycrystalline Diamond Project

Timing Detector Requirements:

- Sub 100ps FWHM timing (prefer 50ps)
- Robust, Radiation-Hard
- Large area (each module 6x6 cm^2)



A. Stolz et al. / Diamond & Related Materials 15 (2006) 807–810

Do not need:

- Good energy resolution
- Position measurement

Polycrystalline CVD Diamond

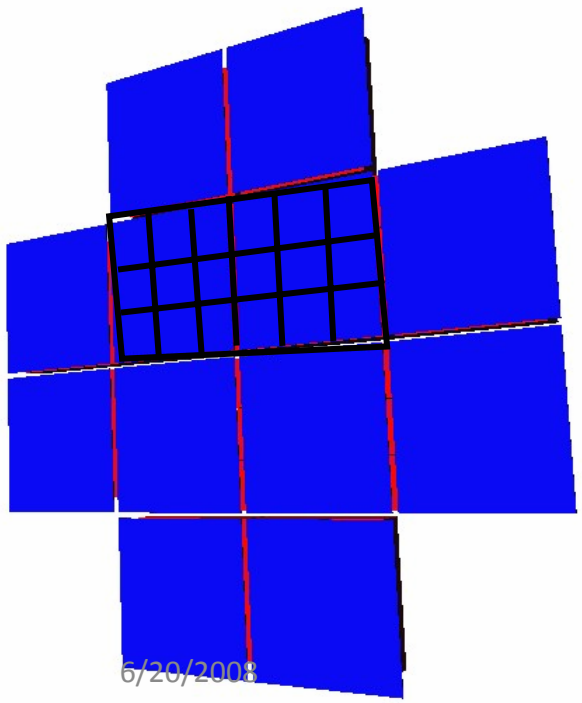
- Large area possible
- Proven good timing resolution
- Large-scale electronics solutions in development

CVD Polycrystalline Diamond Project

York, Surrey, Diamond Detectors Ltd, GSI

Stage 1: Fabrication and protoyping (Funding requested) 2008-2010

- Purchase Polycrystalline CVD material – 0.3 mm and 0.2 mm thickness (DDL)
- Lithography/metallization at Surrey detector lab (Sellin's group)
- Optimise contacts, masks, capacitance etc for fast timing (Surrey, DDL)
- Beam tests (Birmingham, Cologne) (York, Surrey)



- Fabricate detectors for LYCCA-0 commissioning and PRESPEC campaign (2009/2010)
- 4x(3cmx3cm) wafers at target position,
- 2 x [9x(2cmx2cm)] LYCCA-0 modules.

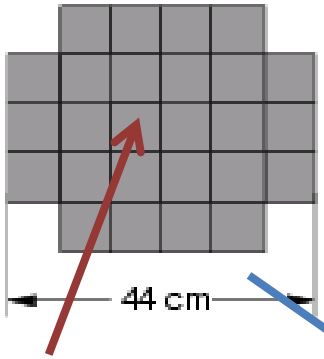
Timelines

2008	2009	2010	2011	2012	2013	2014
LYCCA – 0 Detector development, commissioning			(Development of CsI + DSSD modules, development of fast-timing solutions)			
		PRESPEC (RISING+ LYCCA-0)		(Fast in-beam Campaign – Letter of Intent Submitted)		
(AGATA at the FRS – increase in beam intensity by factor ~10 + early implementation LYCCA)				AGATA Demonstrator + LYCCA		
					HISPEC at SuperFRS FAIR	

Large-area array of fast-timing detectors required here...

The full LYCCA array – large area timing required

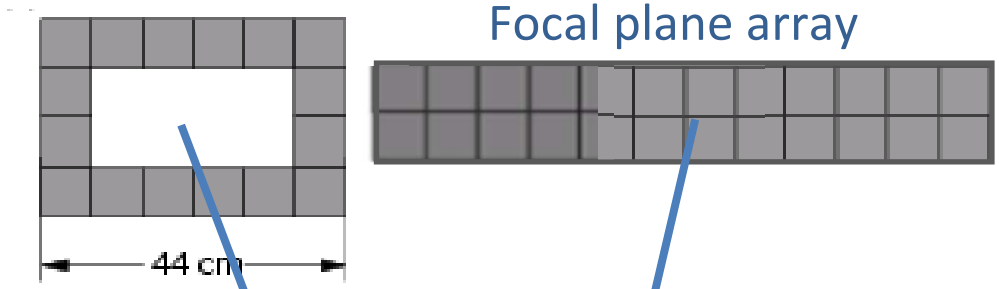
Stand-Alone



Each module = 6x6 cm

With Spectrometer

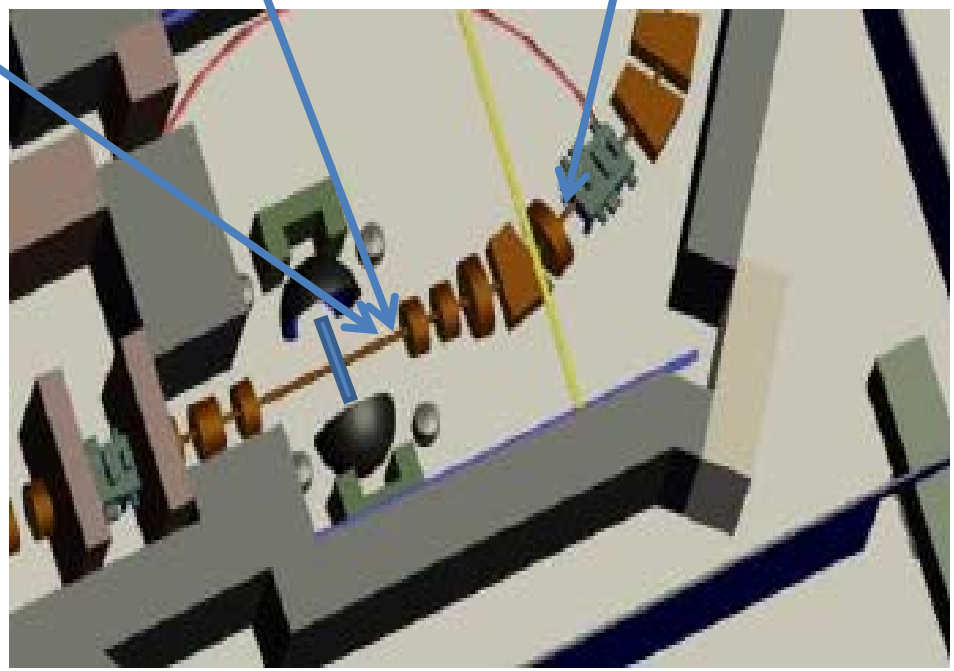
Focal plane array



Requirements:

- 900 cm^2 coverage of fast timing
- 250 detectors if CVD
- 250 x n channels of electronics

(n=segmentation)



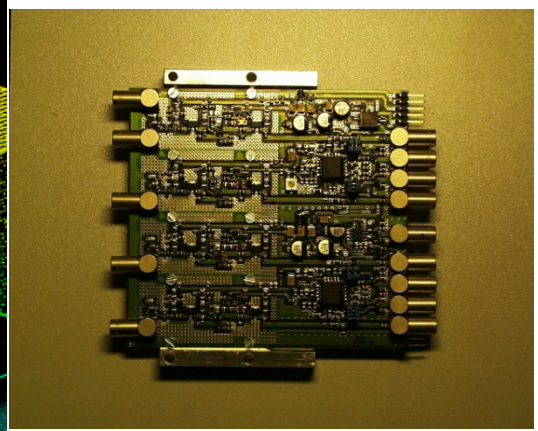
CVD Polycrystalline Diamond Project

Stage 2: Detector Production (Funding requested) 2011-2013

Specify target and detector design

Transfer fabrication process from Surrey to manufacturing company

Production run begins 2011



M. Ciobanu, et al, GSI

Electronics:

Some multi-channel solutions exists (will be tested)

E.g. Could use 4-channel FEE card developed for FOPI collaboration (GSI)

Design and Build dedicated FEE cards with GSI TAC chips (Lazarus, STFC Daresbury)

Collaborators

York: M.A.Bentley, S.P.Fox, M.J.Taylor

Surrey: P.Sellin, A. Lostroh, Zs. Podolyak,

DDL: K. Oliver, A. Galbiati

Lund: D.Rudolph, R.Hoschein, P.Golubev, C.Fahlander

+ GSI + RISING + HISPEC....