Charged-particle array for HISPEC

(as yet unnamed!)

Lund University

Dirk Rudolph (WG leader) et al.

University of York

Mike Bentley, Bob Wadsworth, Dave Jenkins, et al.

+ ?

Physics drive…

Common areas of interest…

- particle- and gamma-spectroscopy of excited p-rich nuclei.
- proton drip-line / N~Z
- isobaric symmetry at large T and T_z
- collective excitations in n-deficient systems
- exotic particle decay modes of excited states (p, 2p, alpha..)

+ “NUSTAR” physics

- Only intermediate energy here (100 A MeV)
- Coulomb barrier array – see Agata?

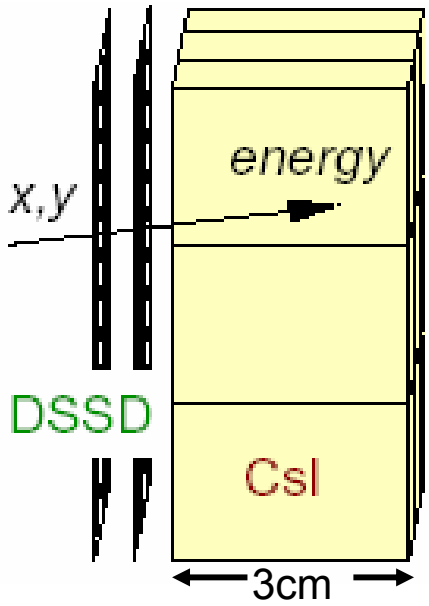
Requirements:

Reactions (~100 A MeV)

- knockout, relativistic Coulex, secondary-fragmentation
- For N~Z studies, up to at least A~100
- (key experiments to be defined soon)

Requirements (in addition to gamma-ray array!)

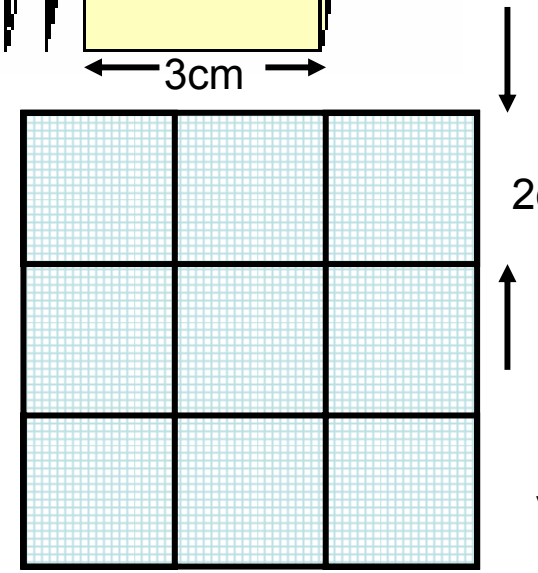
- Fragment-γ and fragment-particle-γ coincidences
- Z and A identification + energy + position of fragments
- Identification of reaction (prompt) or decay particles, angular distributions etc



Proposed layout:

Build on experience from CATE @RISING… (very similar layout) (Wollesheim et al NIM A 537 637-657 2005)

- ΔE-E or (ΔE-ΔE-E) telescopes
- Z from ΔE-E
- A from E + tracking + timing



× 9 telescopes (initially)

(13 eventually?)

Proposed layout:

DSSD:

- 9 × DSSD, each 32 × 32 strips, 6 × 6 cm
- Total lab angle (assume 2m from target) ± 2.6 deg
- ~2mm pixels, (lab) opening angle per pixel ~ 0.05 deg
- 500 μm thickness – energy loss of 0.7 MeV for 100MeV p

CsI

- 81 × crystals, each 2 × 2 × 3 cm
- stops 100MeV protons
- similar to CsI proposed for EXL…

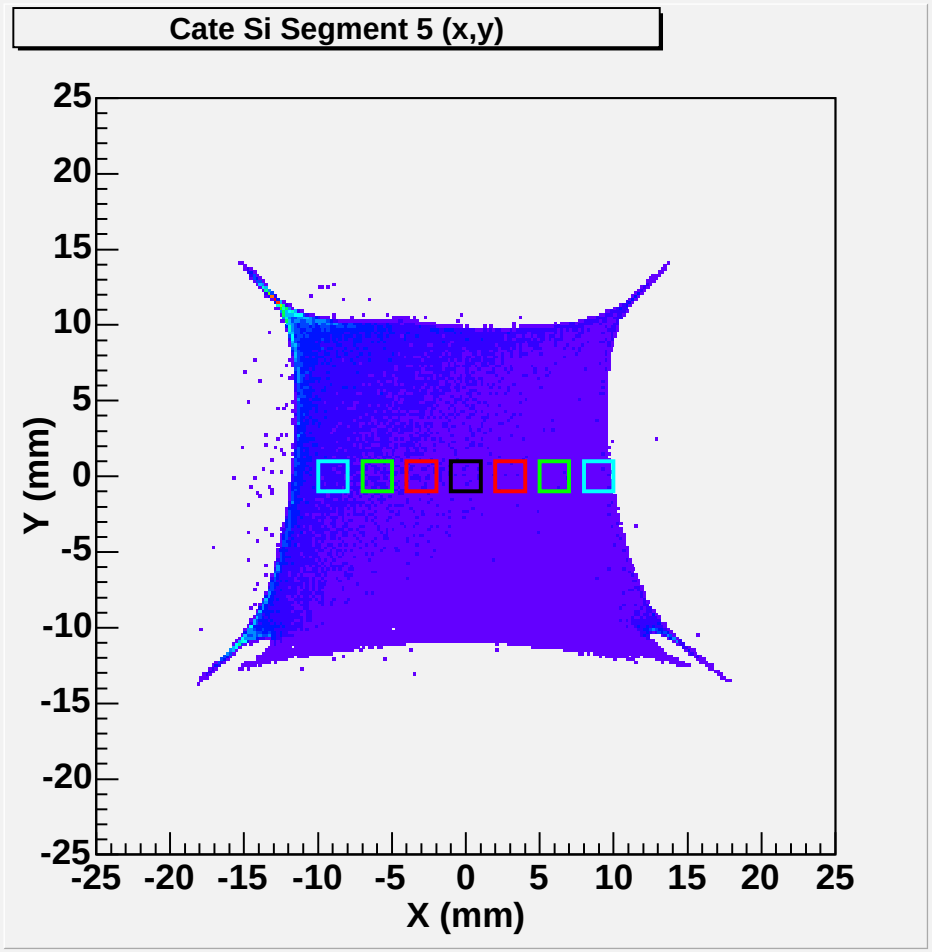
Experience from CATE@RISING:

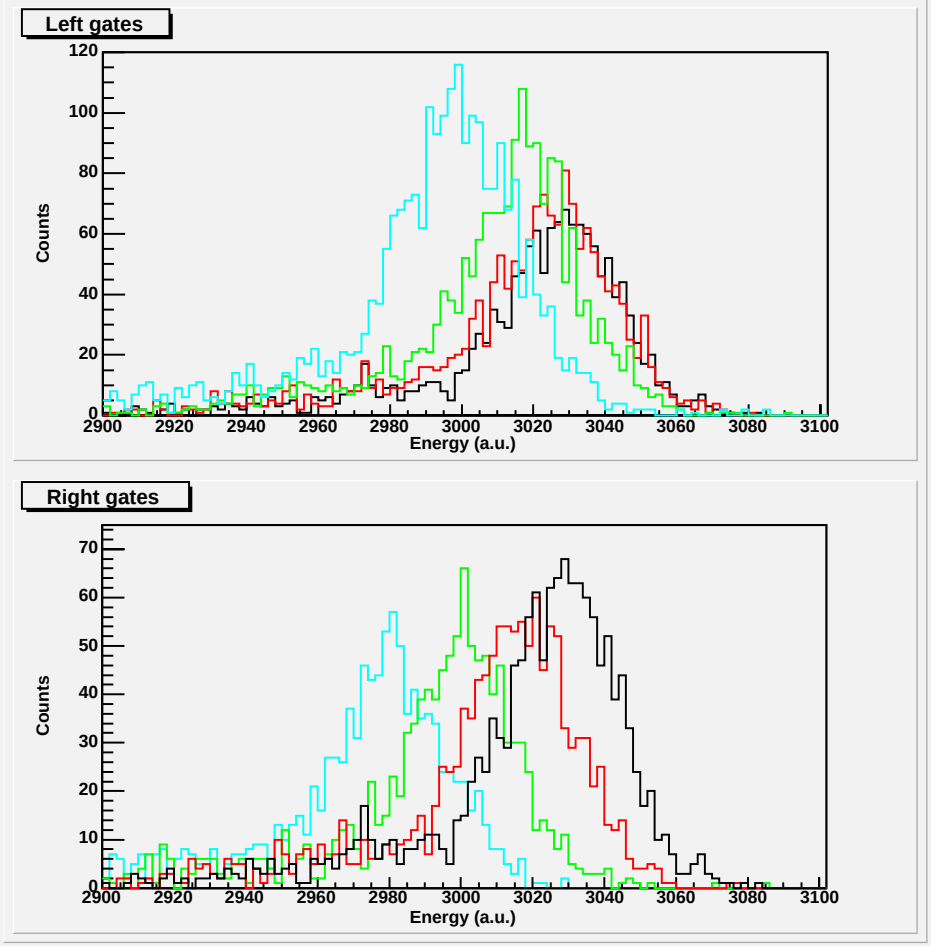
Position:

- x,y from fractional corner-charge collection – difficult, but not impossible.
- Position resolution measured ≤ 7mm (NIM A (537) 637-657 2005)

PID:

- Z from energy loss / ΔE-E in Si - straightforward
- A (heavy fragments) from total energy: difficulties…
  - needs <1% total energy resolution:
  - position dependence of CsI gain


Cate Si Segment 5 (x,y)
Y (mm)
X (mm)
25
20
15
10
5
0
-5
-10
-15
-20
-25


Left gates
Counts
Energy (a.u.)
Right gates
Counts
Energy (a.u.)

Experience from CATE@RISING:

Position:

- x,y from fractional corner-charge collection – difficult, but not impossible.
- Position resolution measured ≤ 7mm (NIM A (537) 637-657 2005)

PID:

- Z from energy loss in Si - straightforward
- A (heavy fragments) from total energy: difficulties…
  - needs <1% total energy resolution:
  - position dependence of CsI photo-diode gain
  - spread of secondary (RI) beam energy

...issues

"Beam" issues:

- good beam energy resolution required (<<1%)
- tracking onto target

Mass determination (heavy fragments):

- 2-3% mass "resolution" so far with CATE (Lozeva et al, Acta.Phys.Pol.B **36** 1245-1248 2005).
- detailed simulations needed


Electronics

≥ 580 channels Si + ≥ 81 channels CsI

- Can be instrumented “conventionally” (and quickly) using off-the-shelf electronics
- Modern conventional (VME) electronics solution in short term
- Parallel investigation of ASIC solution (Lund)

Time line

Present – early 2006	Simulations and specify design. Funding for prototype.
2006	Apply for major part of funding (Sweden+UK)
2007-2008	Purchase and testing. Use prototype-array
2008	Physics

Status:

Lund: Funding approved for electronics + detectors for one telescope. Simulations started.

York: Simulations (M.J.Taylor) – funding application to follow.

...for discussion

Experience from CATE

- Detailed learning from CATE experience

Mass separation

- determination of A from ΔE-E + tracking + timing….
- relation to reaction mechanism?

Classes of experiment:

- Envisaged uses for the array
- conjunction with magnetic spectrometer…?