Target detector system for SAMURAI

Livius Trache, Texas A&M University
for the ??? collaboration

JUSEIPEN workshop, Berkeley 09/10/09

(cont'd)

… Development of a position sensitive microstrip detector system and its readout electronics using ASICs technologies

Funding opportunity announcement by Office of Science, DOE, 2008:
"Research Opportunities at Rare Isotope Beam Facilities"

- Texas A&M University
- Washington Univ, St. Louis, MO
- Louisiana State Univ, Baton Rouge, LA
- RIKEN Nishina Center, CNS Univ of Tokyo
- LPC Caen, IFIN Bucharest, INFN Pisa, …

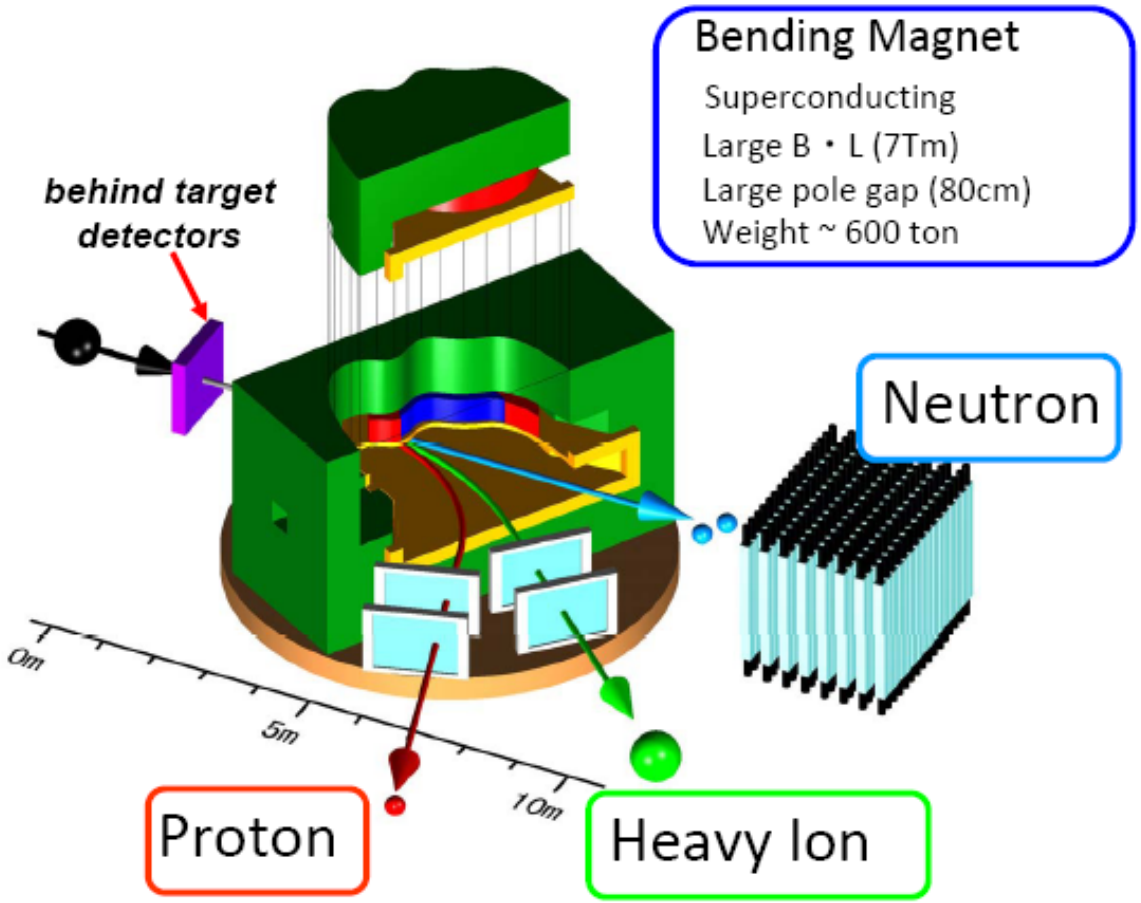
Letter of intent to DOE – June 2008, accepted to apply
Grant proposal – subm Dec 2008, to be evaluated and decided

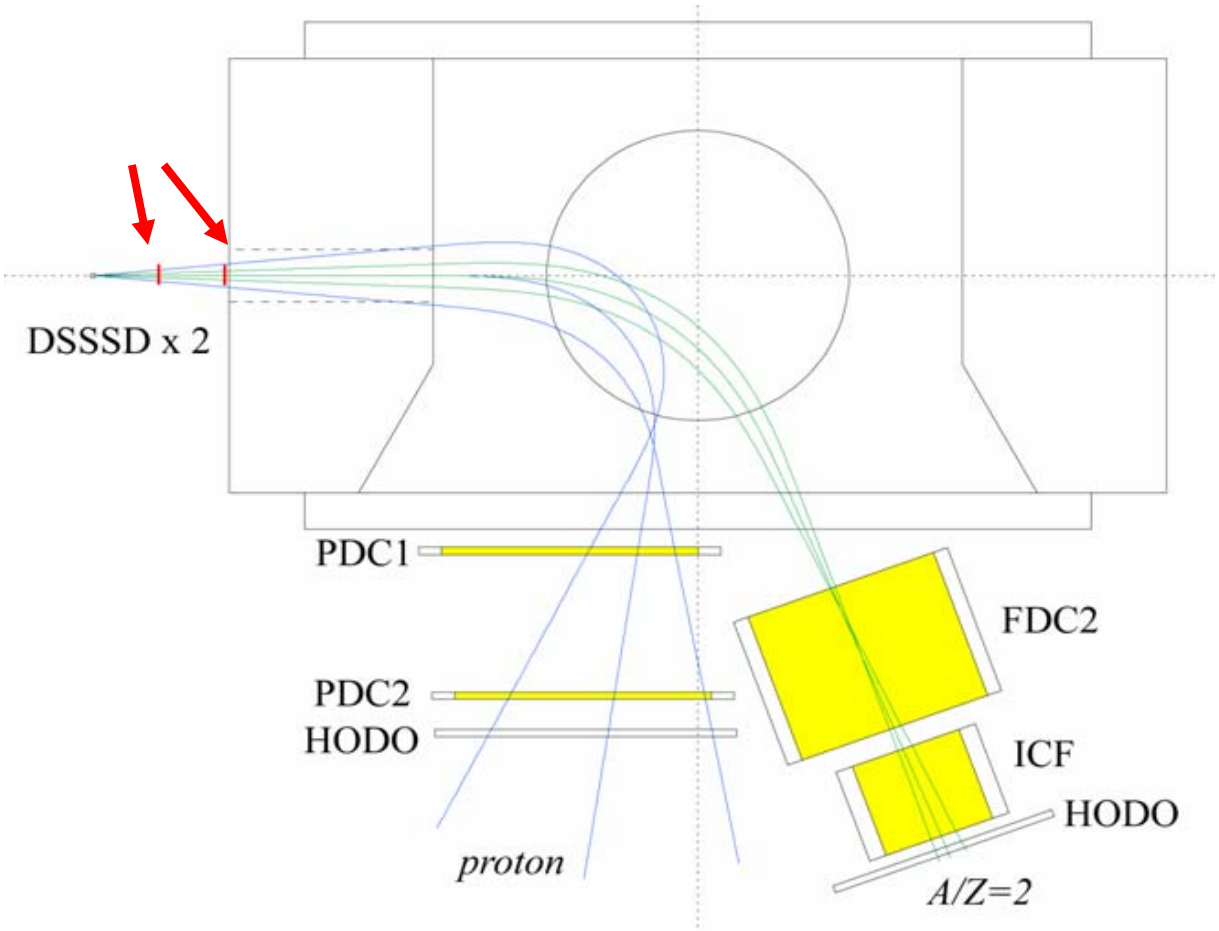
SAMURAI proposal specifications

- Position sensitive target detector system: after target, before magnet, to identify and provide initial track info for charged part from breakup: core + proton(s)
  - active area Ø~140 mm
  - multihit capability
  - particle identification
  - angle resolution: 2 mrad => microstrip Si det sets with 0.2 mm pitch ~ 15 cm apart
  - $\Rightarrow$ thousands of channels of electronics

SAMURAI

(Superconducting Analyser for MUlti-particles with Radio-Isotope beams)




DSSSD x 2
PDC1
FDC2
PDC2
HODO
ICF
HODO
proton
A/Z=2

Solution proposed:

Two sets of thin (200-300 μm) Si micro-strip detectors:

- First: X, Y and D
- Second: U, V (rotated 45° ?!)

– DS or not?! EEE by MicronSemicond Ltd or Hamamatsu ?!

– About 2500 channels in first stage

ASIC (application specific integrated circuit) solution proposed: use HINP16C designed by the WU collaboration for HiRA.

HINP16/32C

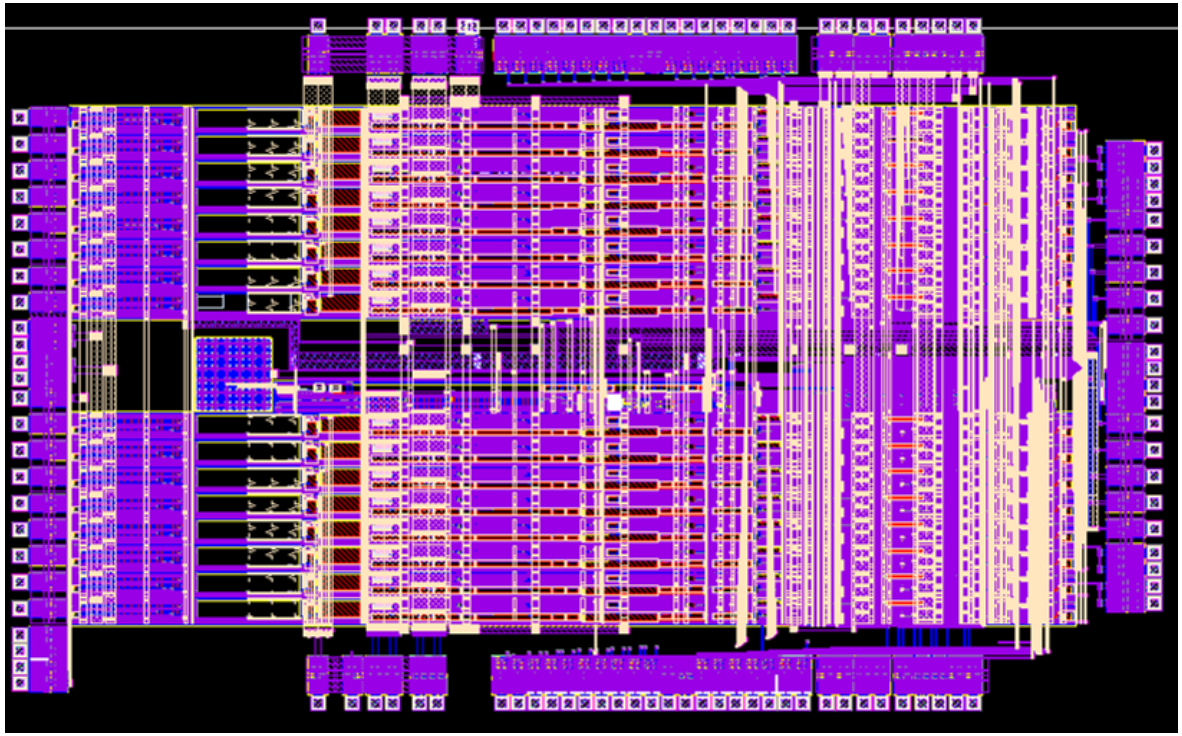
http://wunmr.wustl.edu/Faculty/Sobotka/rectalks.html

SIU
SOUTHERN ILLINOIS UNIVERSITY
EDWARDSVILLE

VLSI Design Research Laboratory

Washington University in St.Louis

Nuclear Reactions Group



Si ===> CSAs - Shaper - Peak Sen- DISC

6.6mm x 6.1mm

From L.G. Sobotka, WU, St. Louis, MO

University Collaboration

Prof. George L. Engel, Muthu Sadavisam, and Mythreyi Nethi
Department of Electrical and Computer Engineering
VLSI Design Research Laboratory
Southern Illinois University Edwardsville - **SIUE**
http://www.ee.siue.edu/~gengel/

Jon Elson, Lee Sobotka, and Robert Charity
Department of Chemistry
Nuclear Reactions Group
Washington University - **WU**
http://www/artsci.wustl.edu/~jmelson/nucinst.html
http://wunmr.wustl.edu/Faculty/Sobotka/rectalks.html

We have also benefited from discussions with:
Bill Lynch (MSU) and Romualdo deSouza (IU), Charles Britton (ORNL) and Helmuth Spieler (LBNL)

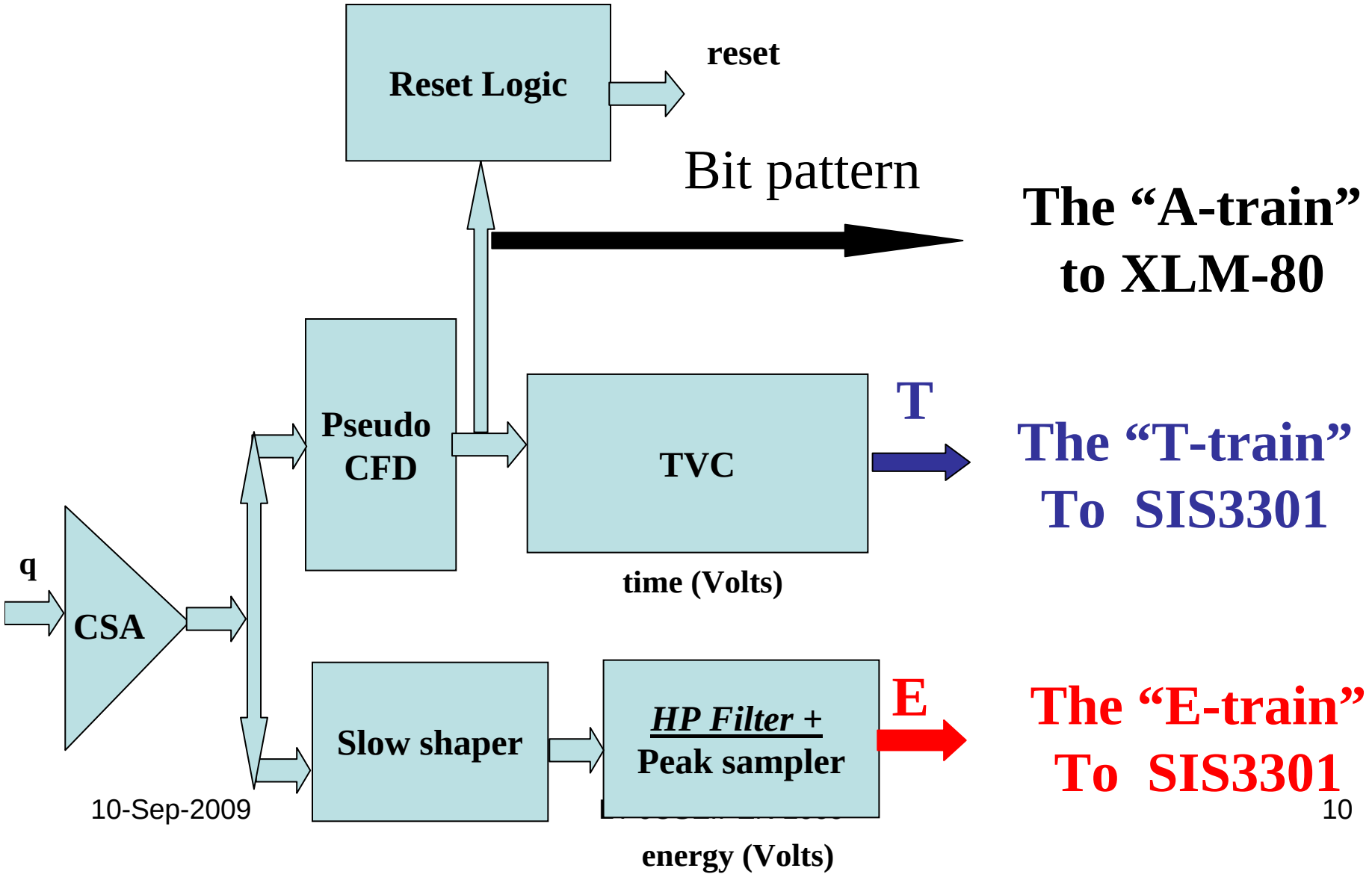
Specifications - result of *evolutionary* process

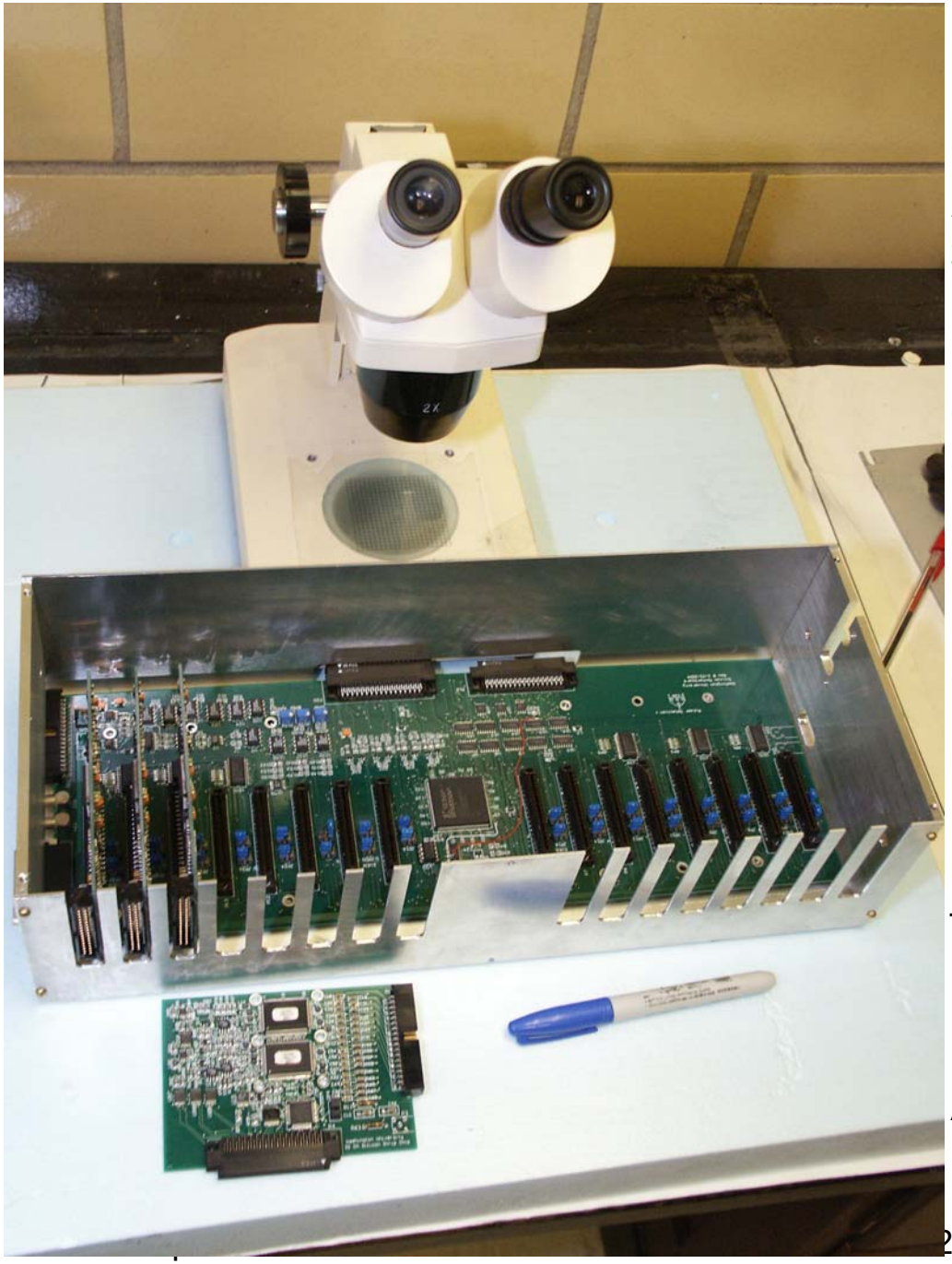
- **Multi range options**
  - **100 MeV full range with 30 keV (FWHM) resolution, 2.5 pF feedback**
  - **500 MeV full range with 150 keV (FWHM) resolution, 12.5 pF feedback**
  - **external preamp (CSA) capability**
- **Capable of processing either polarity**

- **Built in pseudo CFD with time resolution of ~ 1ns (FWHM)**
- **Time-to-voltage analog circuitry with two time measurement ranges: 250 ns or 1 μs**

- **Analog multiplicity output (and logical OR)**
- **Automatic reset of time-to-voltage and peak sampling circuits unless vetoed by user with variable decision time (300 ns – 30 ms)**
- **Data sparsification: Hit, ALL, or intelligent logic**
- **Compatibility with modern pipeline ADC's**

Channel Block Diagram





Cost (per 512 ch)

A. Chip

35 k$/100 chips

“extra” = 8 k$/100

B. Chip Board CB (32 ch)

0.5 k$/CB x 16 = 8 k$

C. MB (512 ch)+PS+BOX

2 k$ + 2 k$ +2k$ = 8k$

D. ADC (4*2*512 or more ch)

= 10 k$

C. System control (512 ch)

= 4 k$/sys

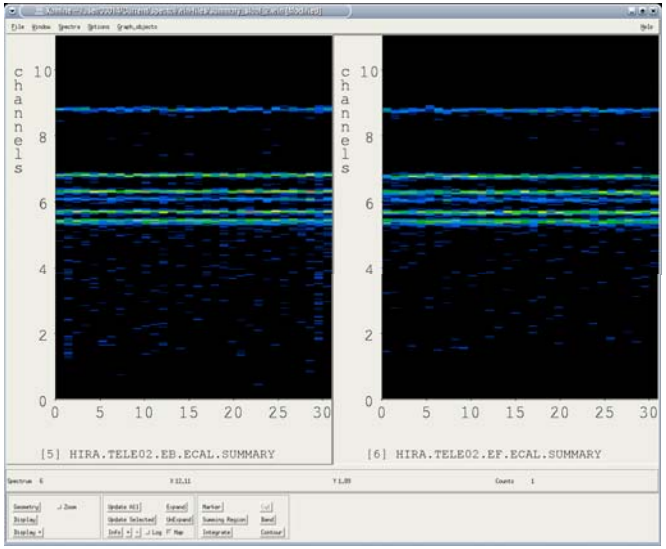
E. Misc NIM

= 6 k$

TOTAL (per 512 ch using “extra”)

~ 44 k$

but there would be enough chips and ADC channels for a 1000 ch sys.

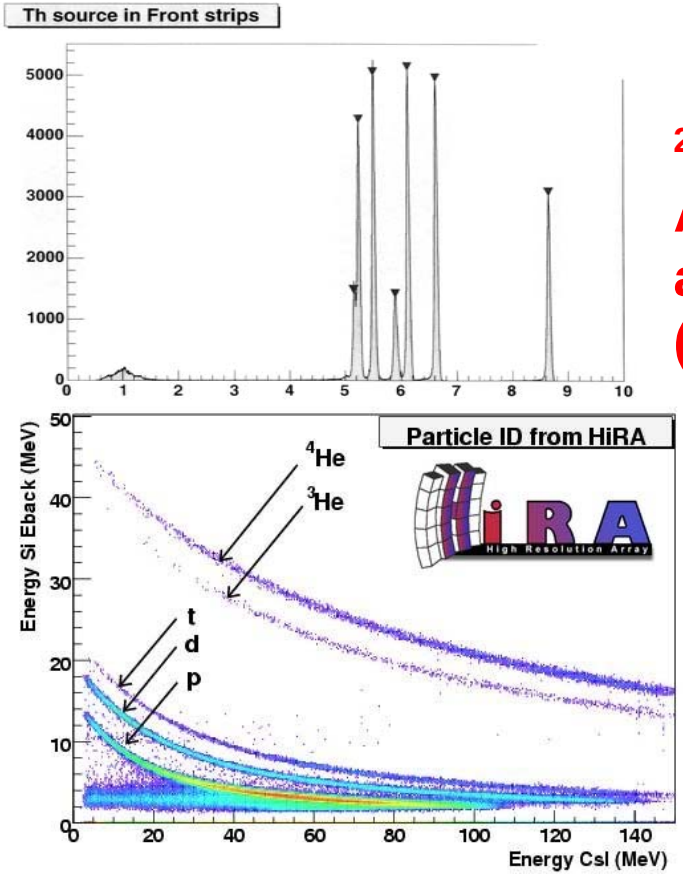


^{232}Th Source Summary sectrum (64 ch, 1 of 16 tels)

FWHM
~ 35 keV pulser
~ 50 keV ind. low cap det
~ 40 keV ext CSA
~ 65 keV HIRA dets.

First HiRA experiments 7/05

Only 1500 strips of Si



^{232}Th source ALL Fronts (~500) added together. (Device ~ 80 keV)

PID for most of HiRA (added together)

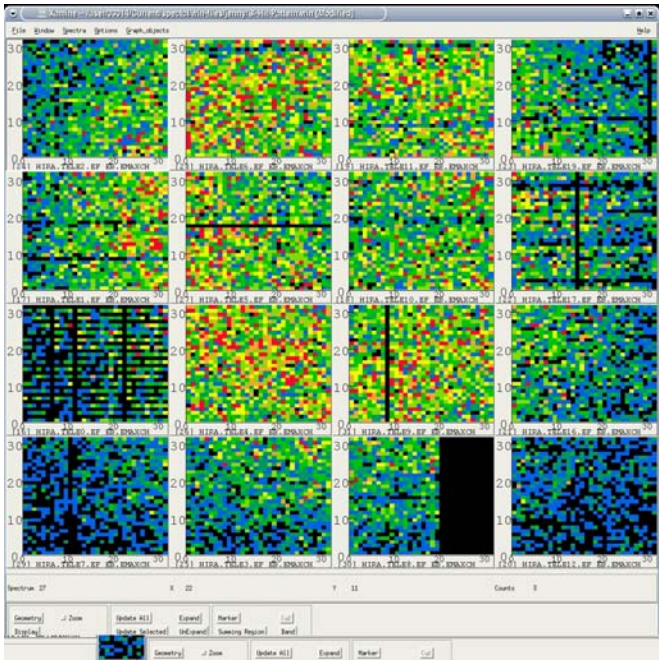
LT JUSEIPEN 2009

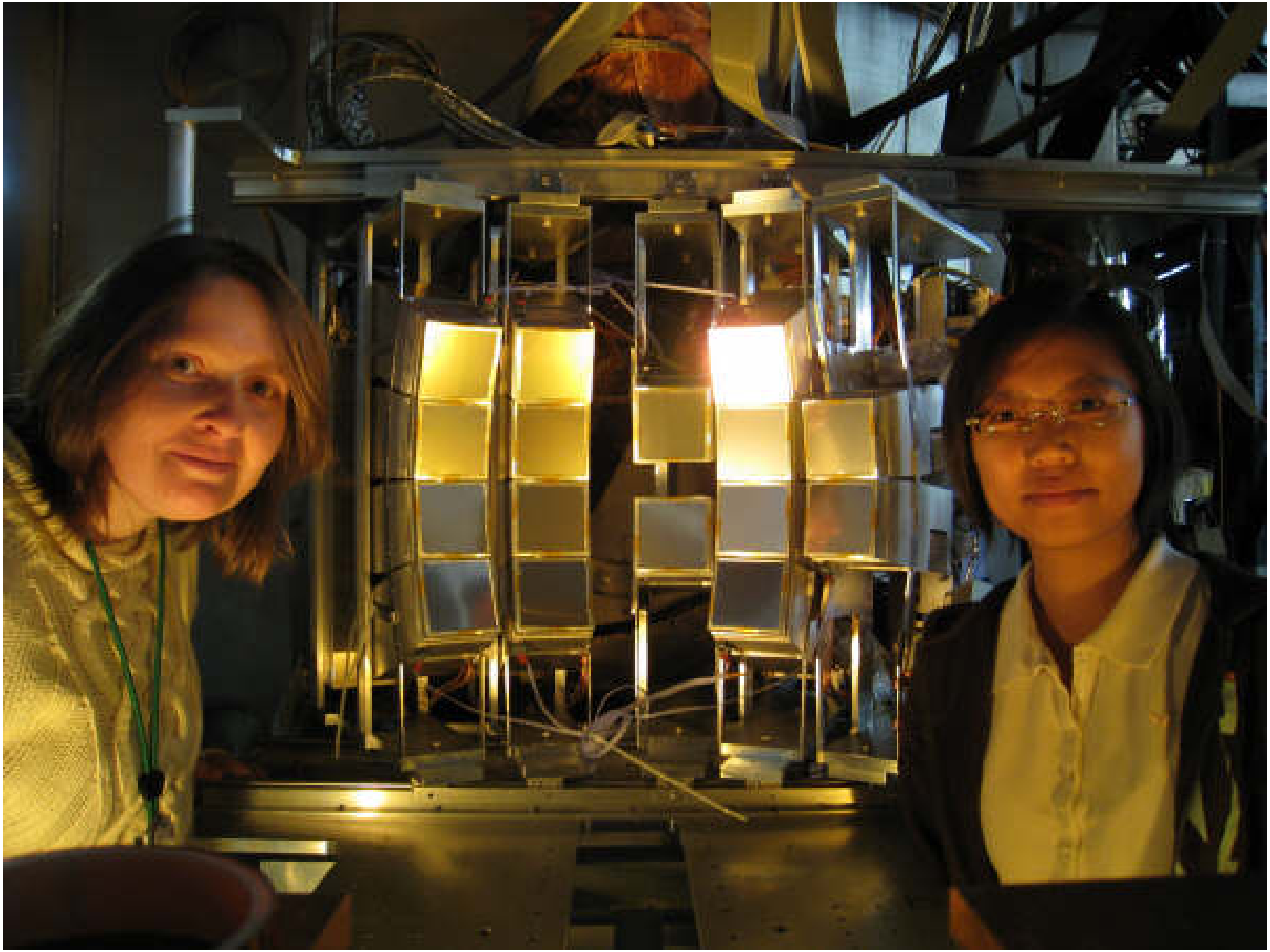
p (Coulomb ring) from:

^{71}Br => ^{69}Br + 2n

^{69}Br => ^{68}Se + p

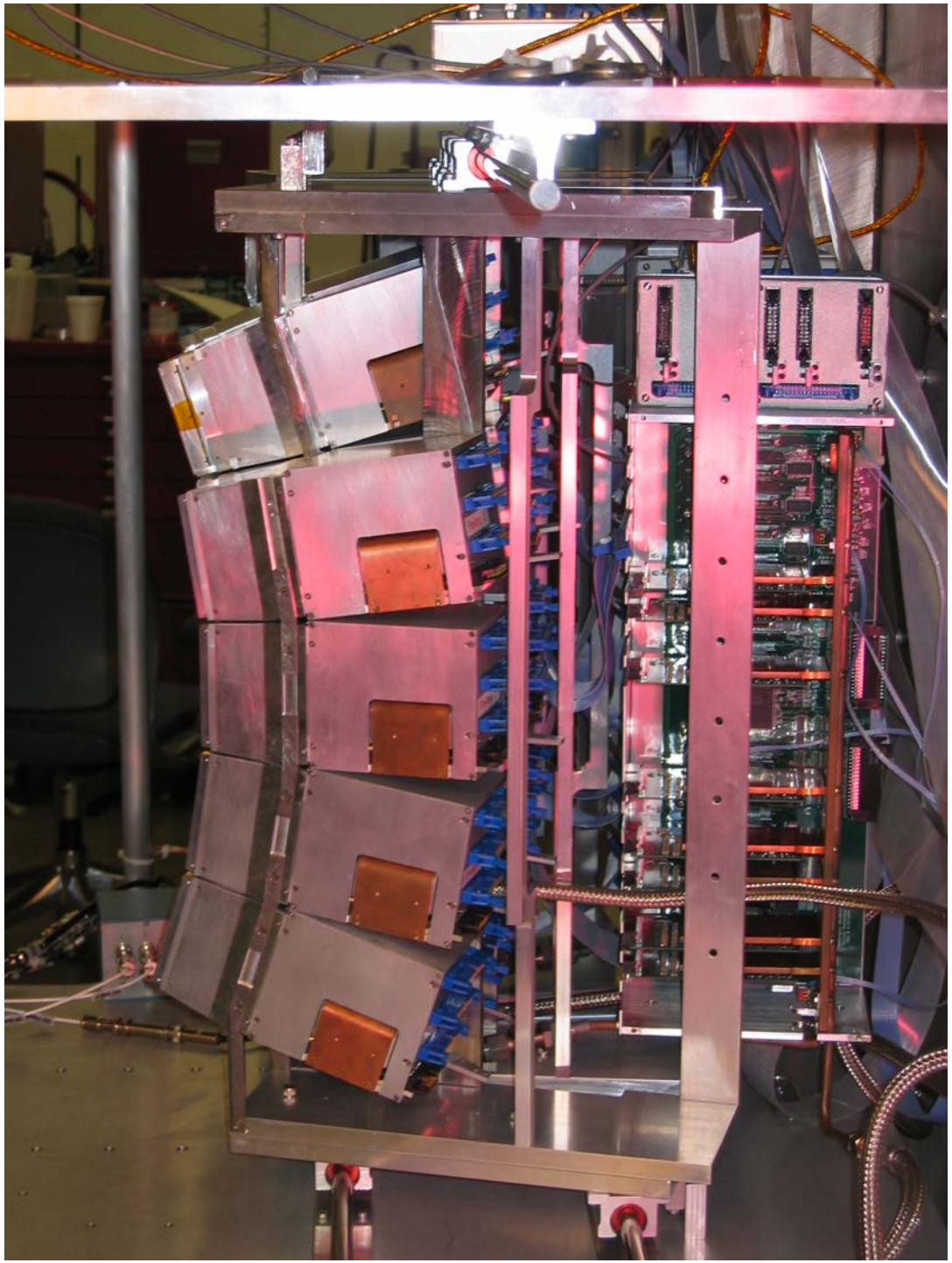
+ a hell of a lot of other crap.





Detectors

Si (64 um)
Si (1500 um)
CsI (4mm)



Chip electronics

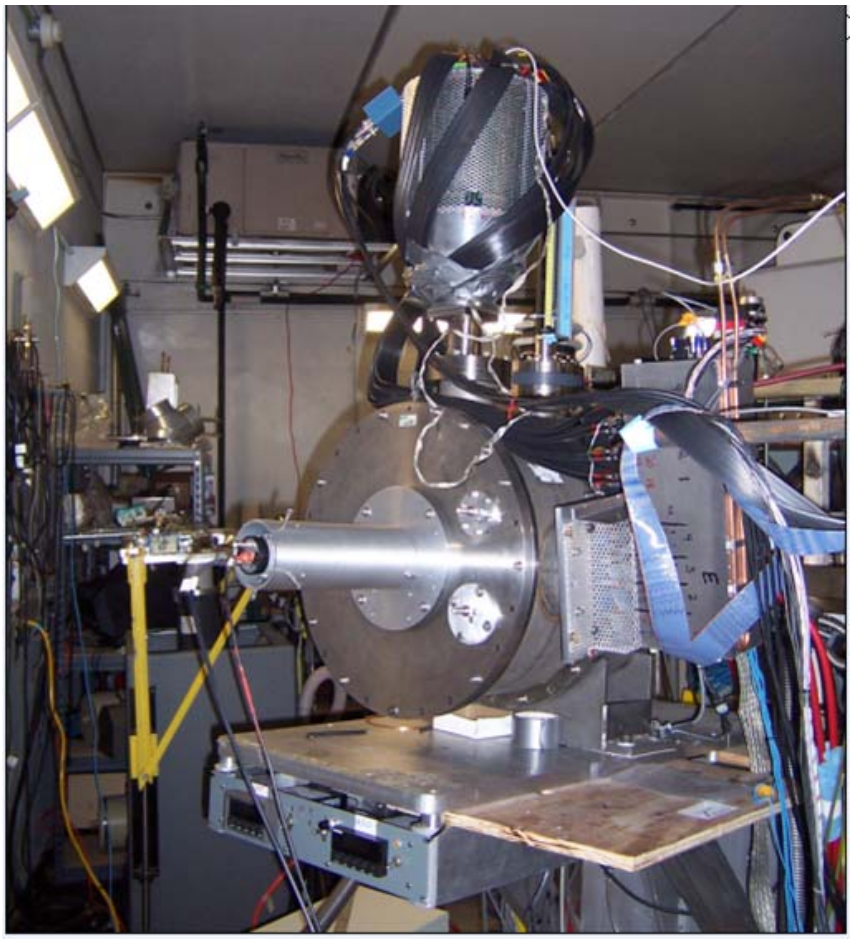
4 towers
Each running
Each a separate system

further uses: decay spectroscopy @TAMU

Exp: $^{10}C^{*} \rightarrow 2\alpha+2p$

Photograph of recent experiment at TAMU - the first version of the ASIC system.

The rectangular box to the right of the cylindrical chamber houses up to 512 channels of electronics. In this experiment, 384 channels were used, 2/3rds used the internal CSA and 1/3rds the external CSA. The latter are housed in the tube on the top, the outputs of which are carried by the black coaxial ribbon cables to the chip inputs.

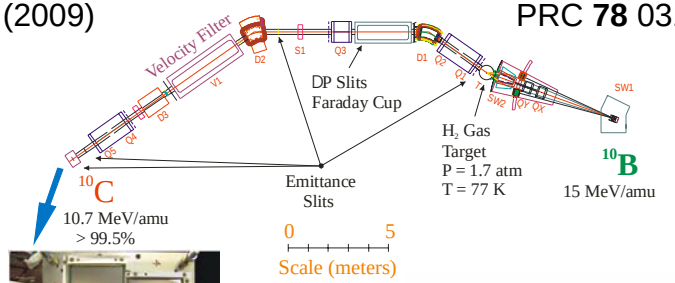


Decay Continuum spectroscopy — Using MARS-HiRA

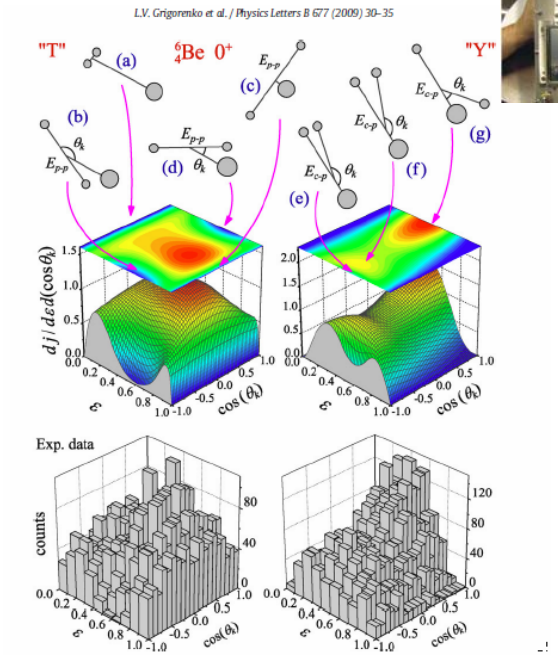
^{6}Be

PL B **677**, 30 (2009); PRC in press (2009)

Momentum Achromat Recoil Separator (MARS)

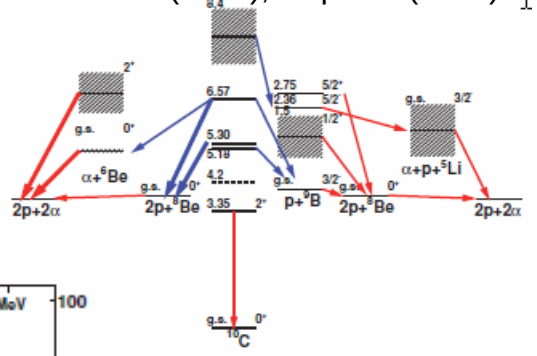


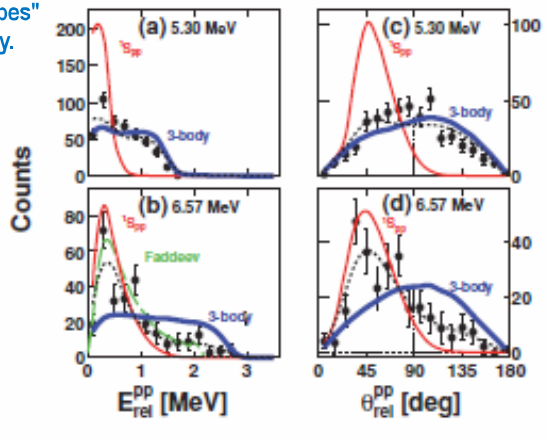
4 ΔE-E Si "telescopes" from the HiRA array.

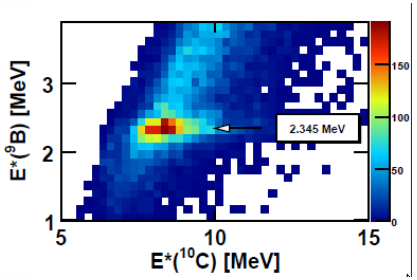


^{10}C

PRC **78** 031602 (2008); **75** 051304 (2007); in press (2009)

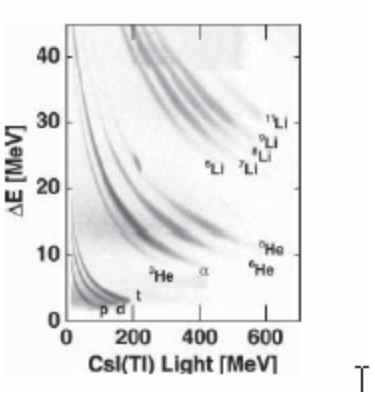






1. *Decay paths, branching ratios determined for all known levels.*
2. *A branch of the 6.57 MeV state has the best "diproton" correlation observed to date!*
3. *Did **NOT** confirm previous "identified" state at 4.2 MeV thought to be the 0+ (Curtis et al., PRC77, 021301 (2008).*
4. *Found new state at 8.4 MeV*

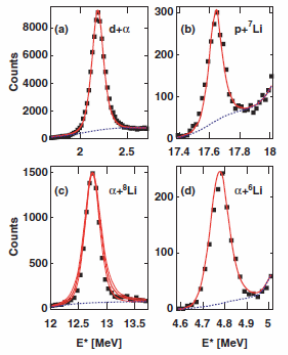
From L.G. Sobotka, ANL workshop 2009

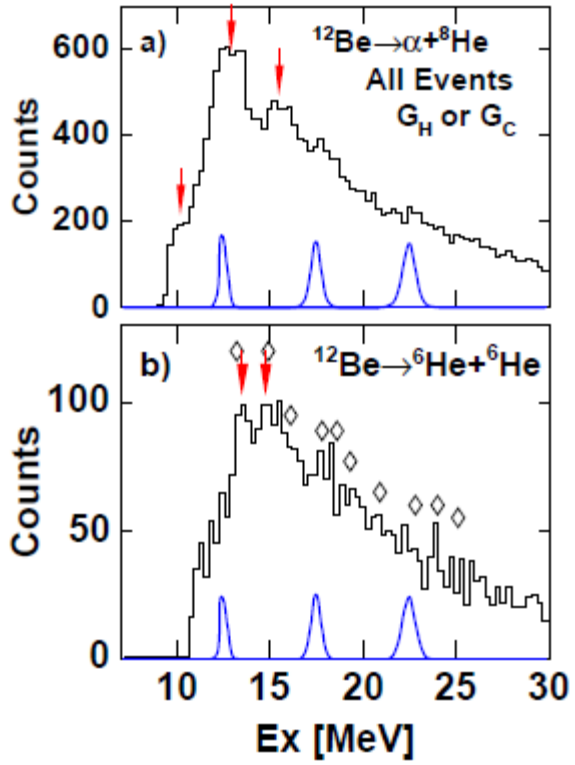


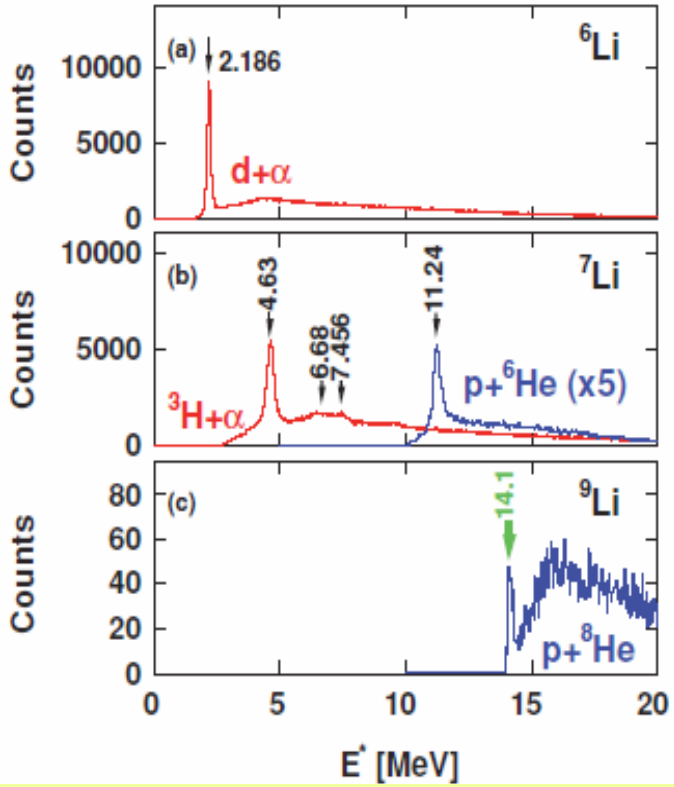
^{12}Be and misc

PRC **76**, 064313 (2007)

PRC **78**, 054307 (2008)







*Did **NOT** confirm previously "identified" cluster states by Freer et al., PRC 63, 034301 (2001).*
Did find what might be the analog of the ground state of 9He in 9Li, however the Thomas-Ehrman shift would have to be unusually small. The TE shift for a virtual state is a weird concept.

From L.G. Sobotka, ANL workshop 2009

Team

- Washington Univ: LG Sobotka, RJ Charity, JM Elson, students
- LSU: JC Blackmon, M. Matos, student
- *Texas A&M University*
- *RIKEN Nishina Center:* T. Motobayshi, K. Yoneda, H. Murakami