

2nd Conference

First γ -decay studies with CARIBU low-energy exotic beams

AJ Mitchell

University of Massachusetts Lowell, USA

CARIBU: Californium Rare Isotope Breeder Upgrade

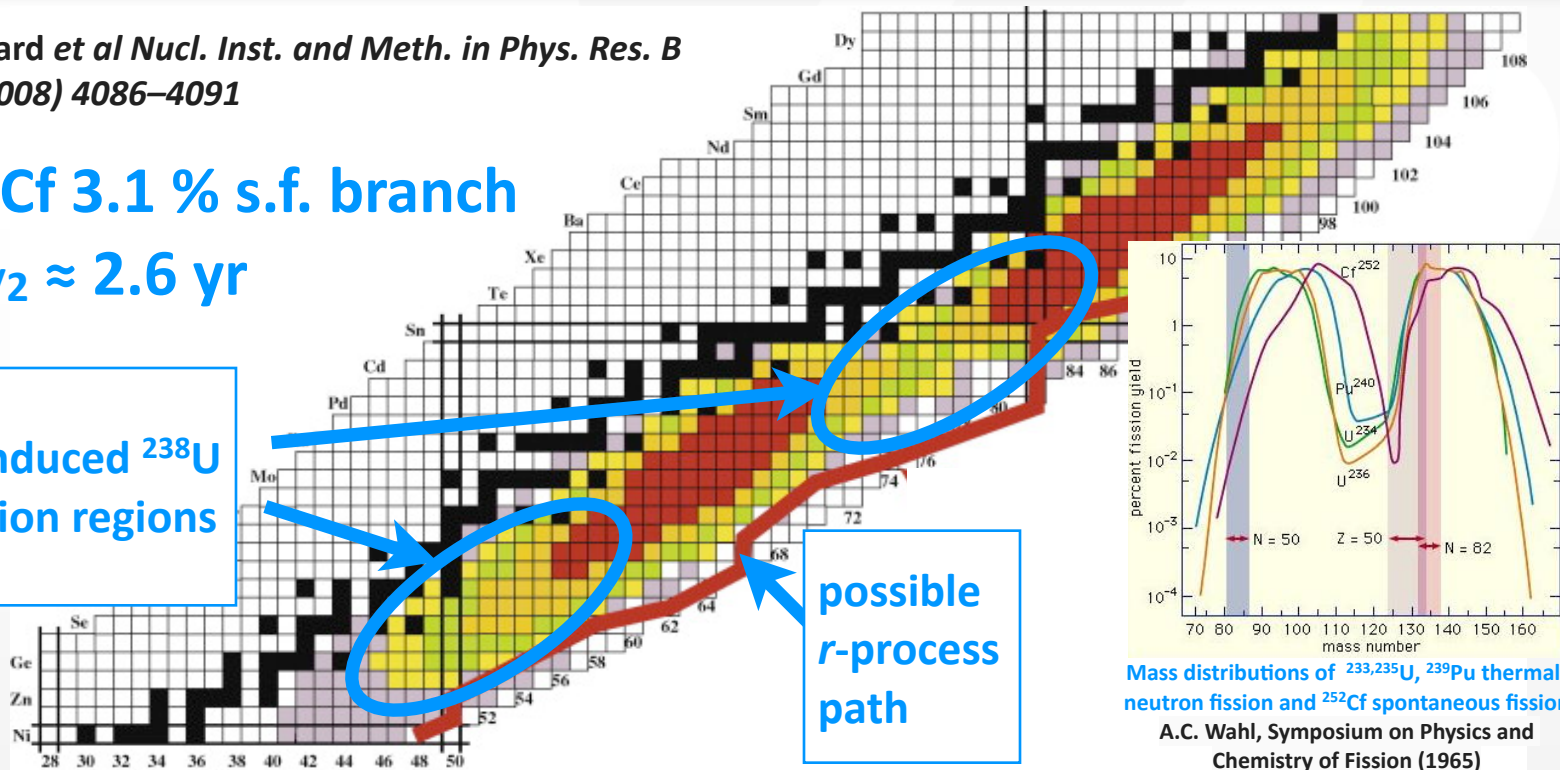
G. Savard *et al Nucl. Inst. and Meth. in Phys. Res. B*
266 (2008) 4086–4091

^{252}Cf 3.1 % s.f. branch

$T_{1/2} \approx 2.6$ yr

p -induced ^{238}U
fission regions

possible
 r -process
path



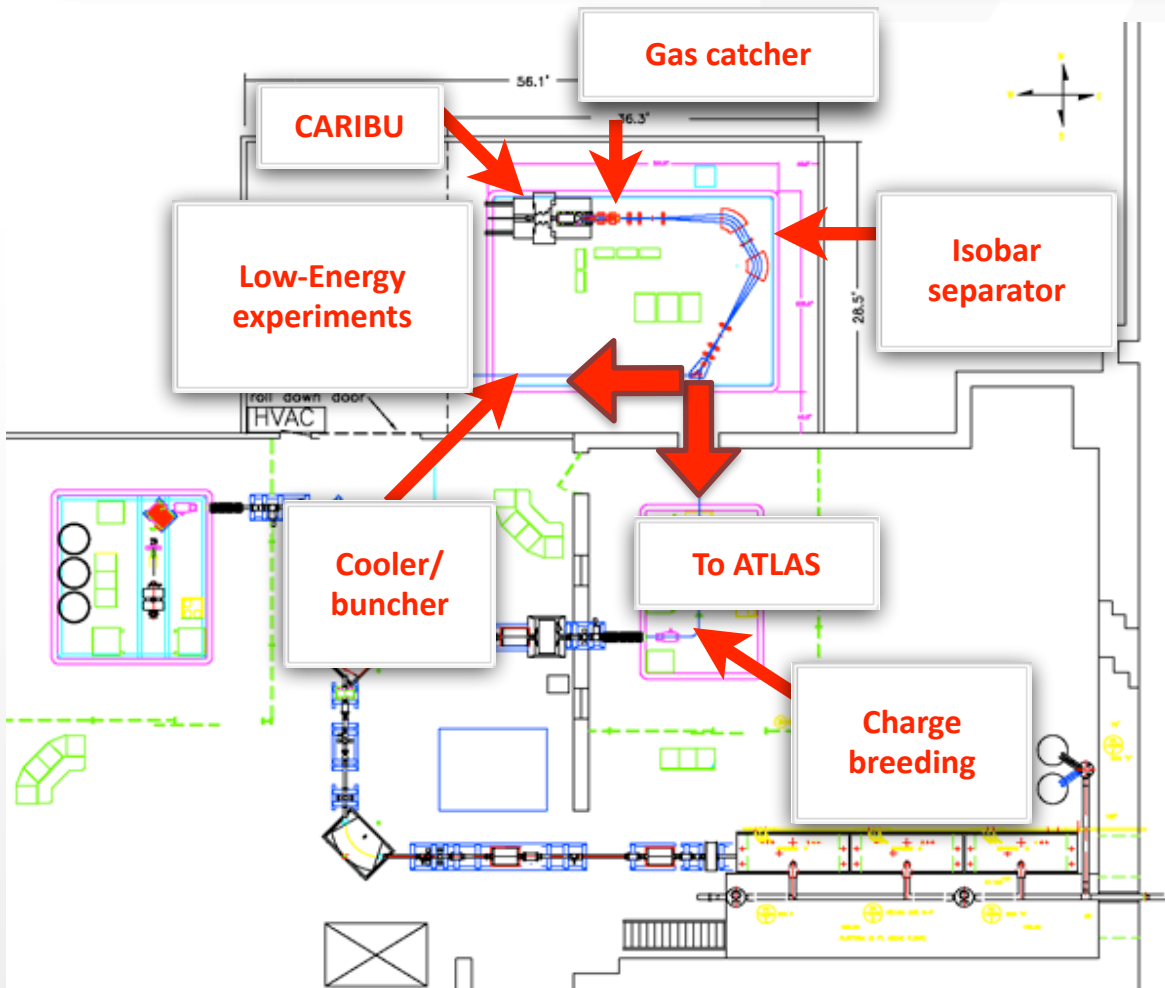
Mass distributions of $^{233,235}\text{U}$, ^{239}Pu thermal-neutron fission and ^{252}Cf spontaneous fission

A.C. Wahl, Symposium on Physics and Chemistry of Fission (1965)

- Opportunities for study in a range of areas:
- Structure -> features of large neutron excesses
- Astrophysics -> mass/half-lives of r -process nuclei
- Applications -> decay heat

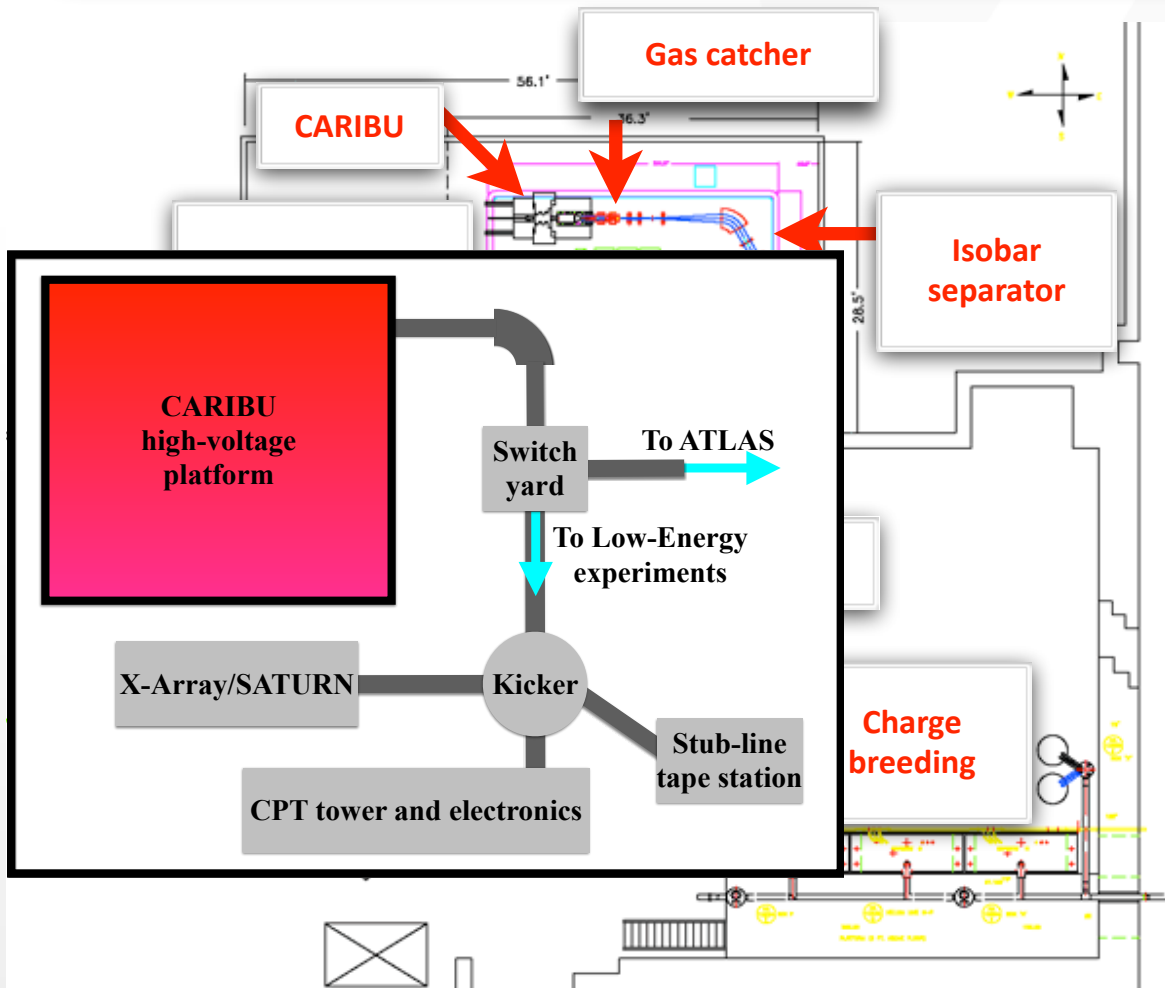
Guy Savard: The
CARIBU facility
(Tuesday Plenary 6)

The CARIBU hall @ ANL



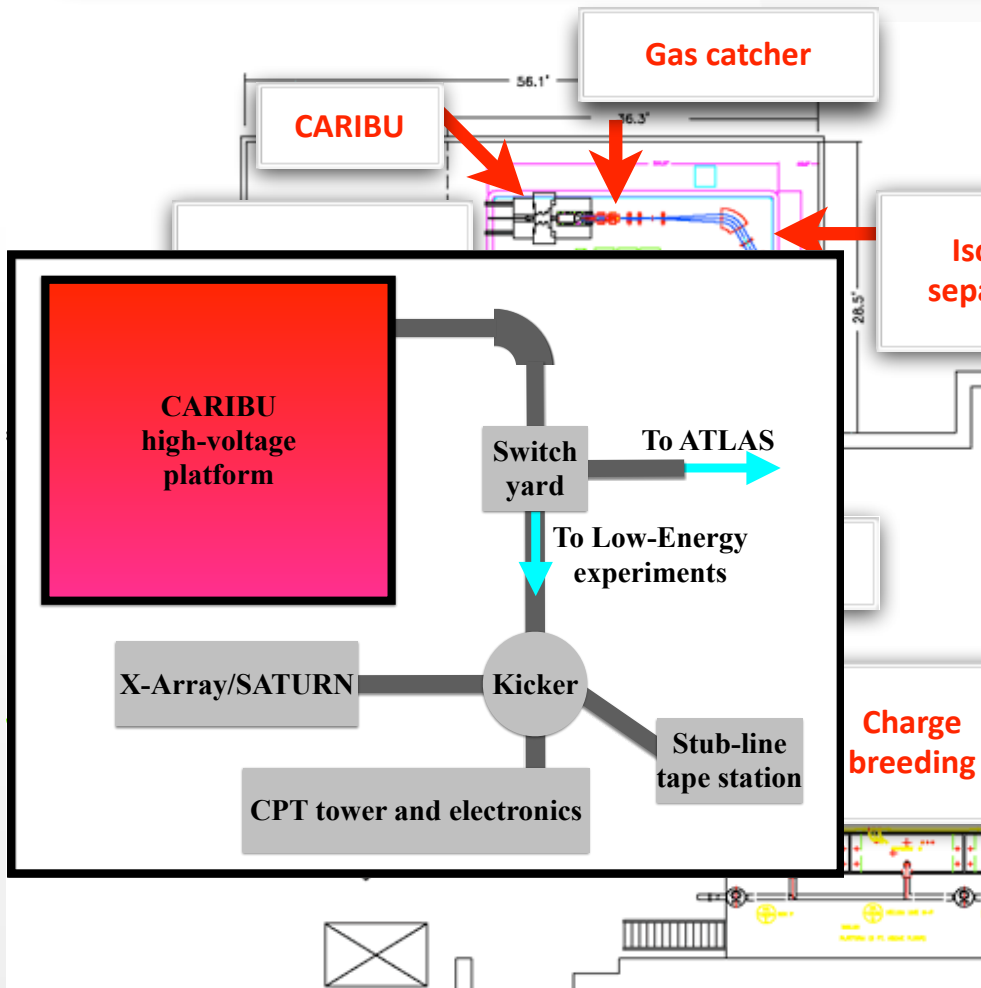
<https://www.phy.anl.gov/atlas/caribu/index.html>

The CARIBU hall @ ANL



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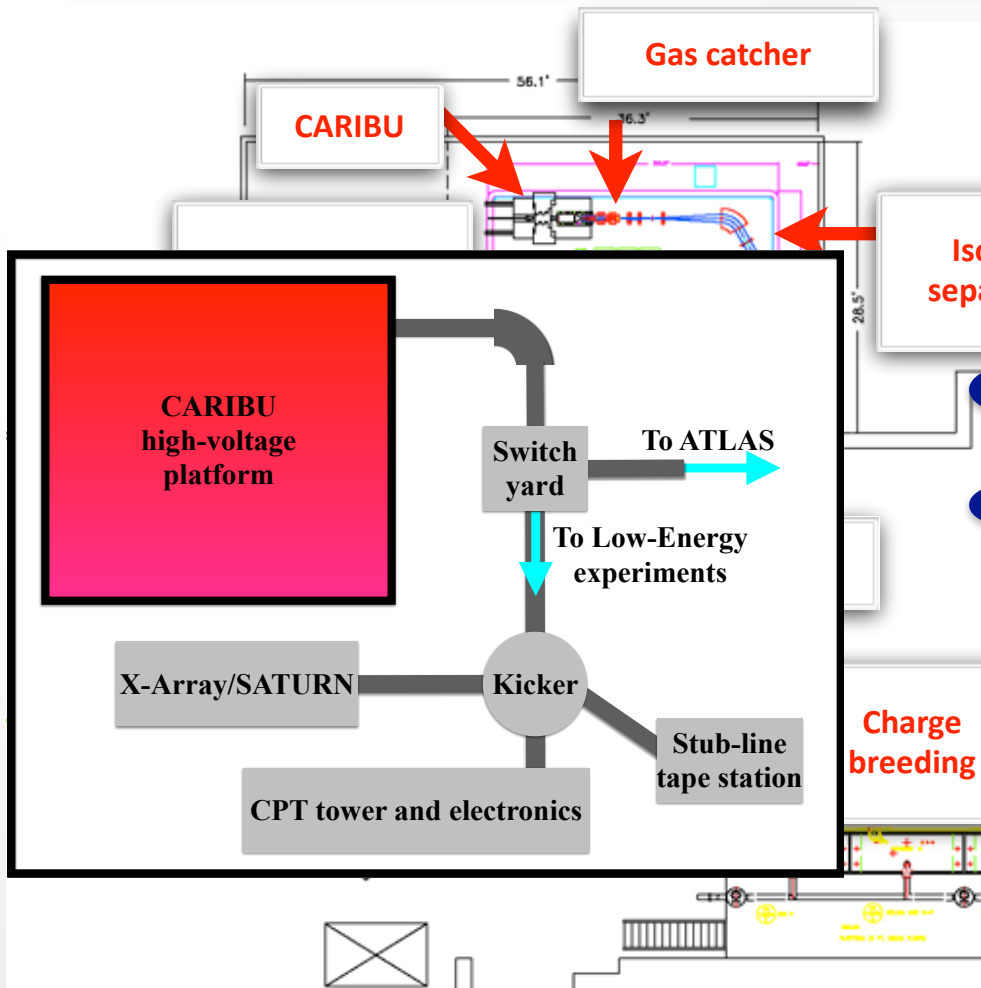


Low-energy Science

- β - γ -t and β - γ - γ spectroscopy
- $T_{1/2}$ measurements
- Mass measurements (CPT)
- β -delayed neutron emission (BPT)
- Total Absorption Gamma-ray Spectroscopy (TAGS)

<https://www.phy.anl.gov/atlas/caribu/index.html>

The CARIBU hall @ ANL

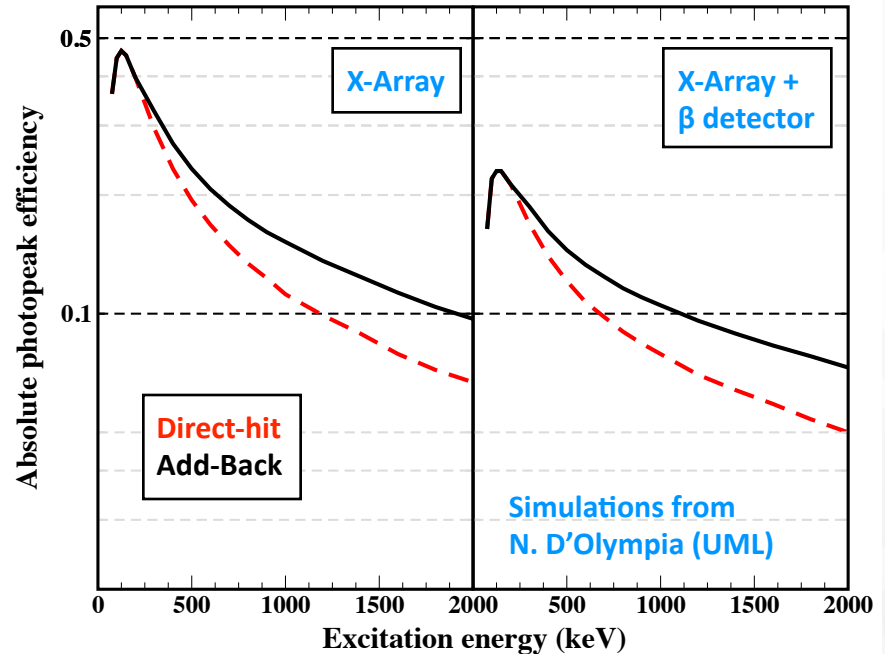
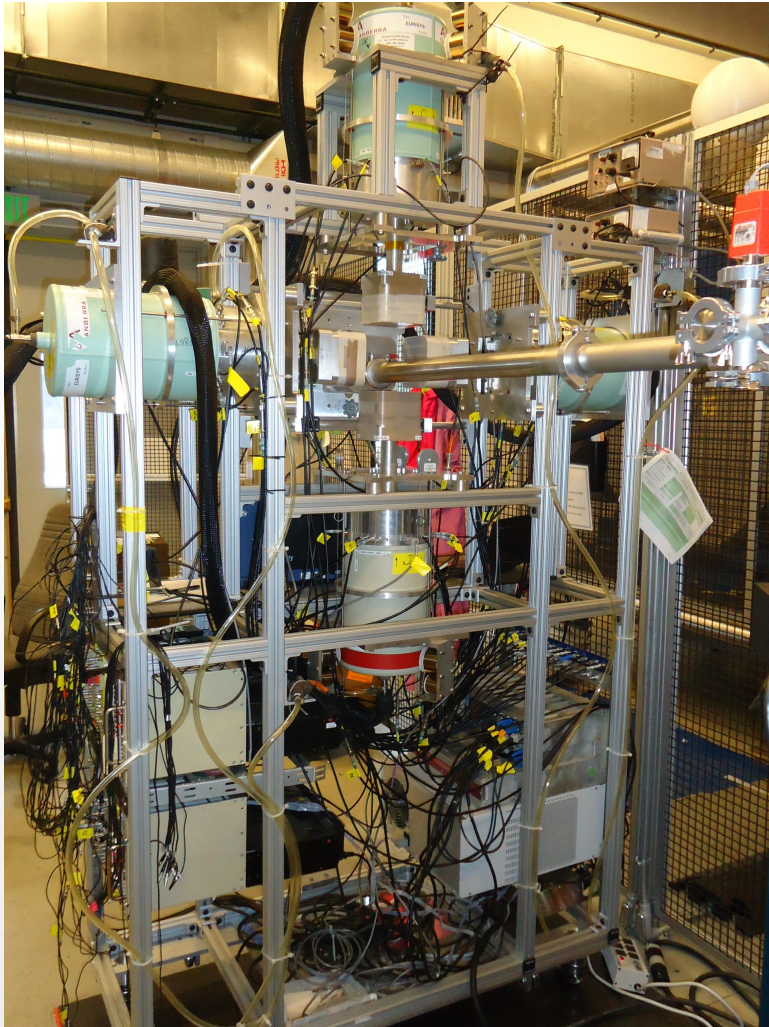


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The “X-Array” @ CARIBU



- **Five HPGe clover detectors**
4 of 60x60 mm and 70x70 mm SuperClover
- **Large solid-angle coverage**
~ 65 % of 4π
- **High photopeak efficiency**
~50 % @ 122 keV, ~10% @ 1332 keV

β -particle detection

“Mark 1” chamber

Collimation

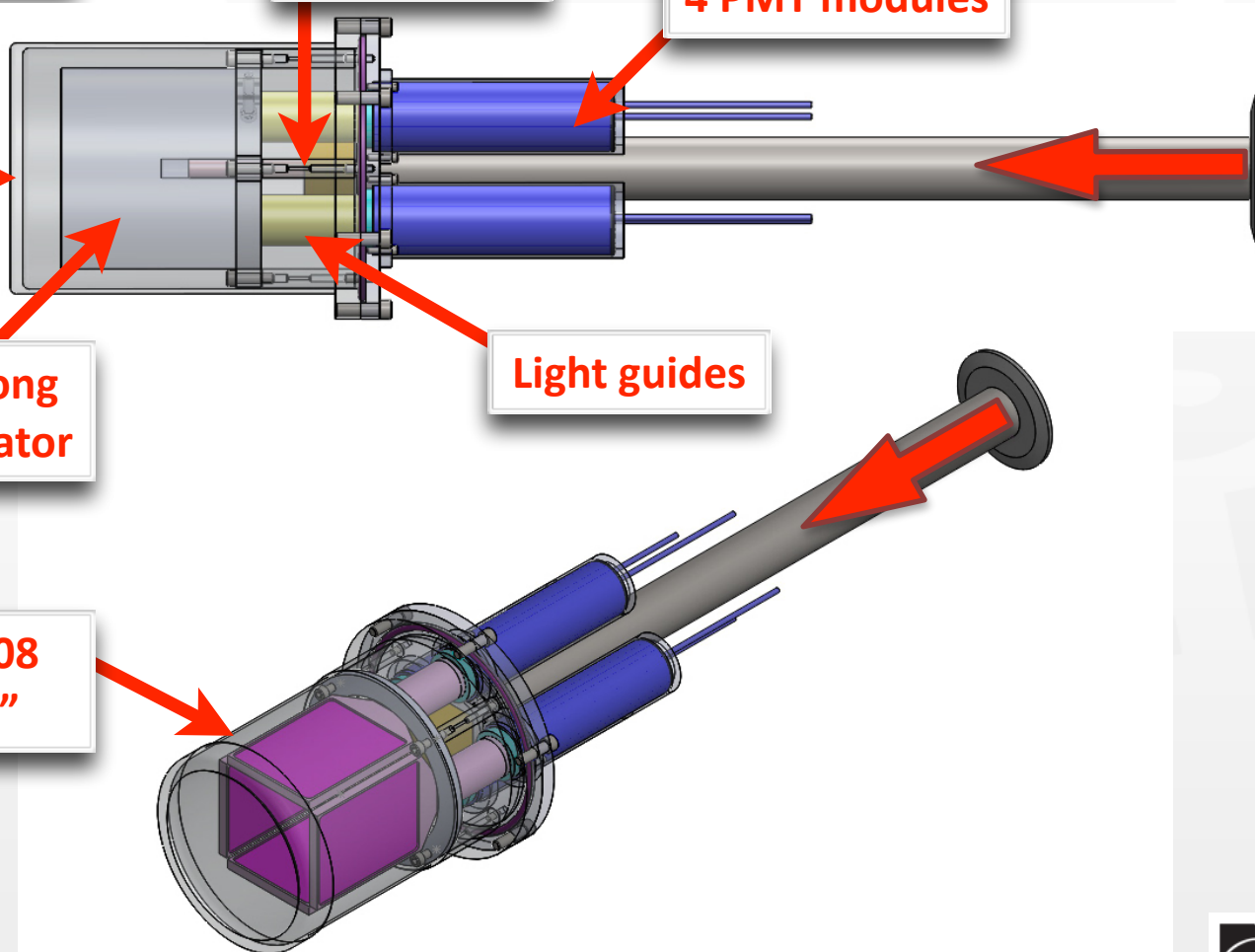
4 PMT modules

6-mm Al chamber

10-cm dia. x 10-cm long BC-408 plastic scintillator

Light guides

6-mm thick BC-408 plastic “paddles”



Long-lived radiation removal

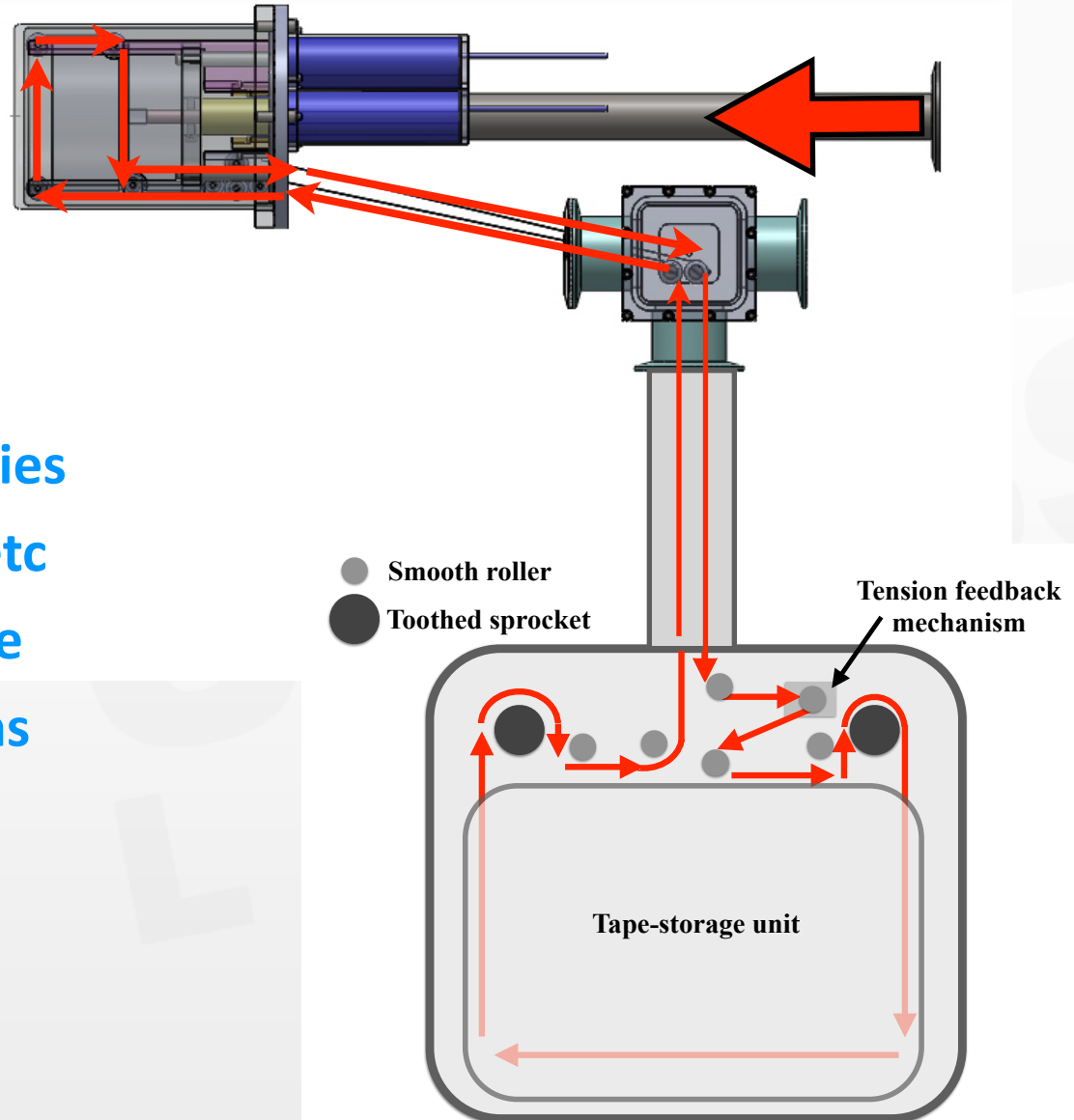
“SATURN: Scintillator And Tape Using Radioactive Nuclei”

- Hardware:

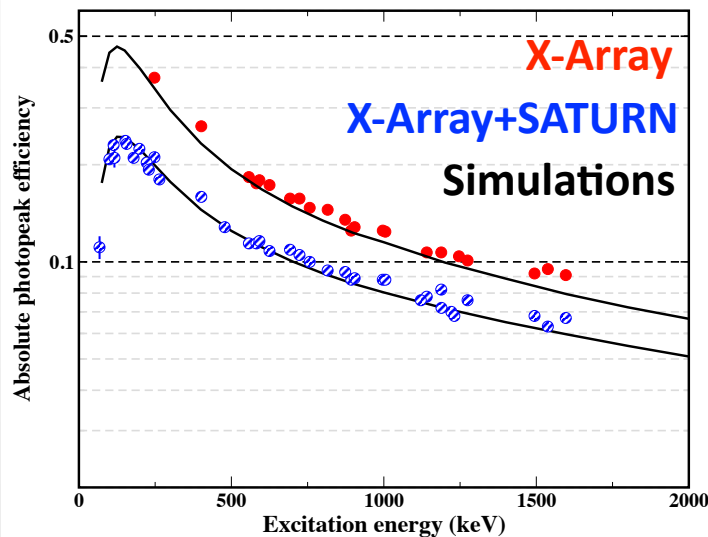
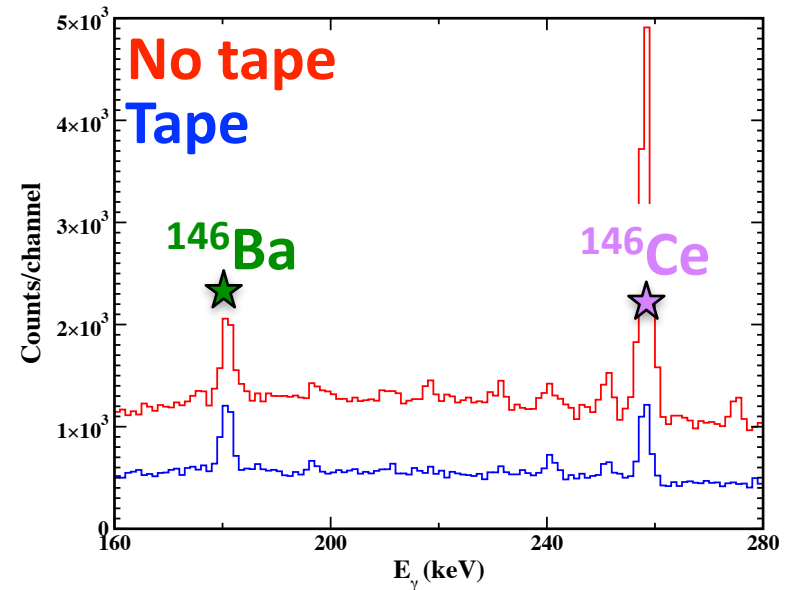
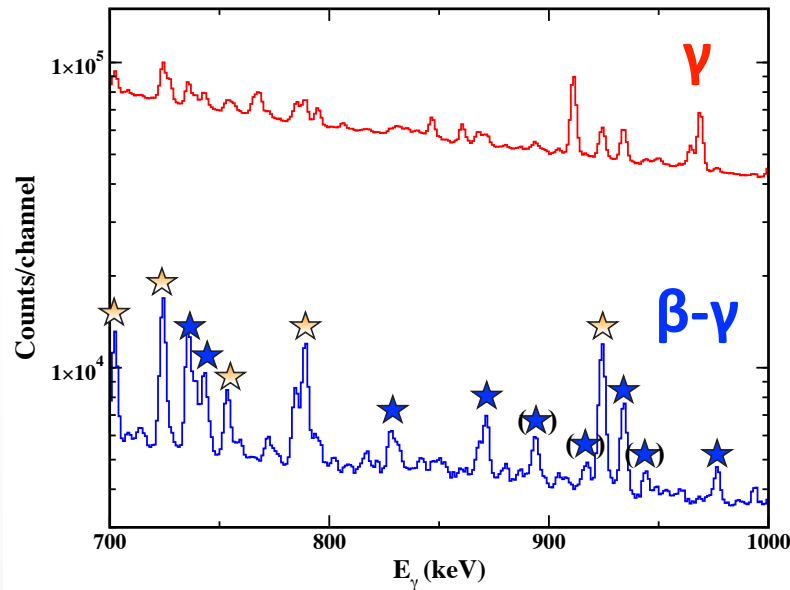
- ▶ Good vacuum properties
- ▶ Motor/pulleys/belts etc
- ▶ Storage for excess tape
- ▶ Chamber modifications

- Control system:

- ▶ Motor controller
- ▶ PLC
- ▶ DDAQ + electronics



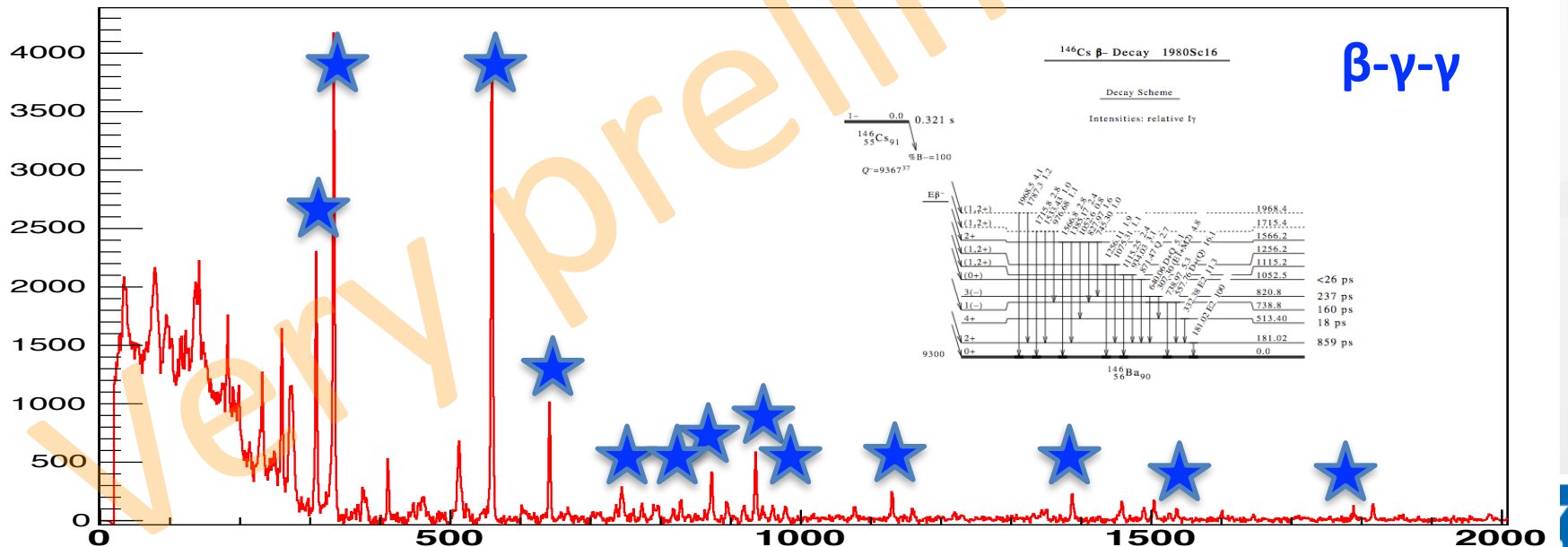
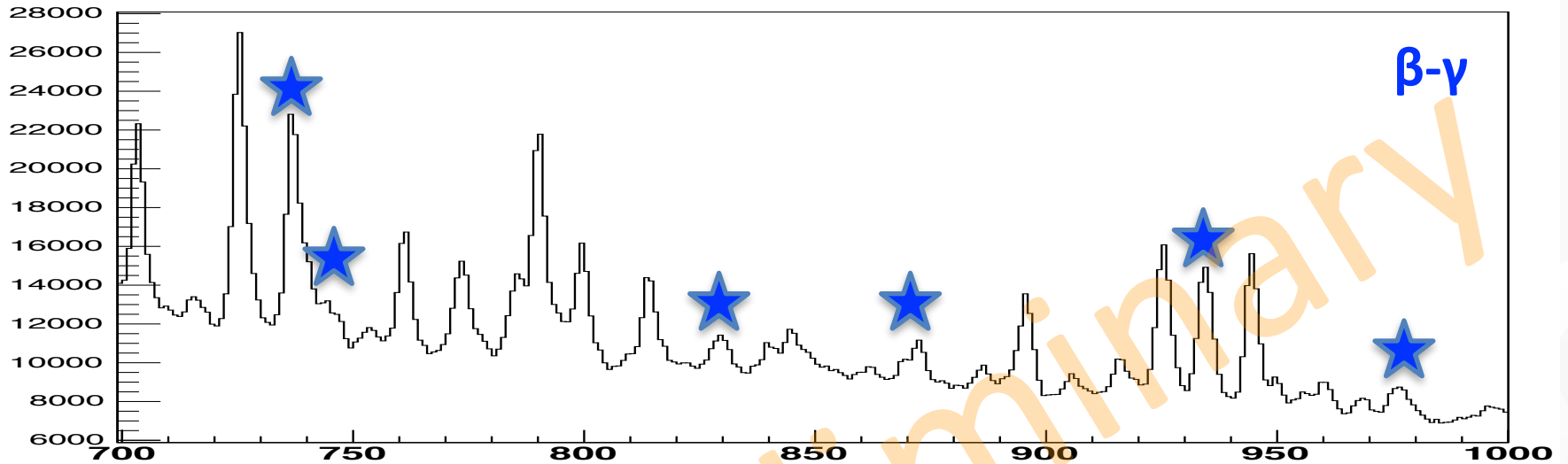
Commissioning (large-volume detector)



• $^{142-146}\text{Cs} \rightarrow ^{142-146}\text{Ba}$

- ▶ γ -singles, β - γ
- ▶ γ - γ , $\beta\gamma\gamma$ coincidences
- ▶ With/without tape
- ▶ γ -t, β - γ -t

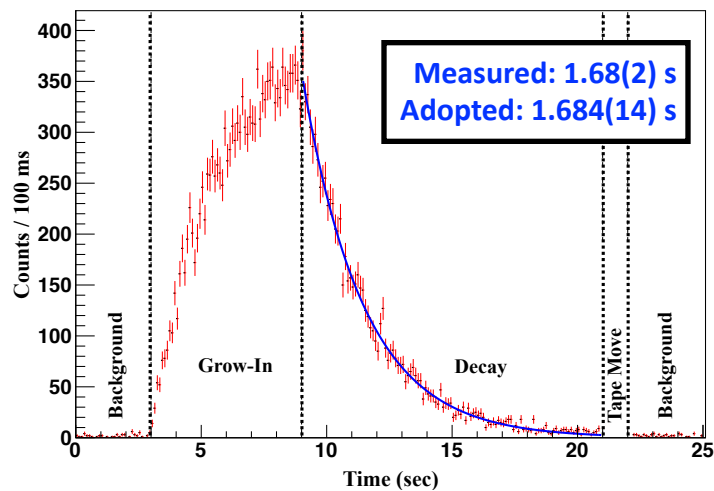
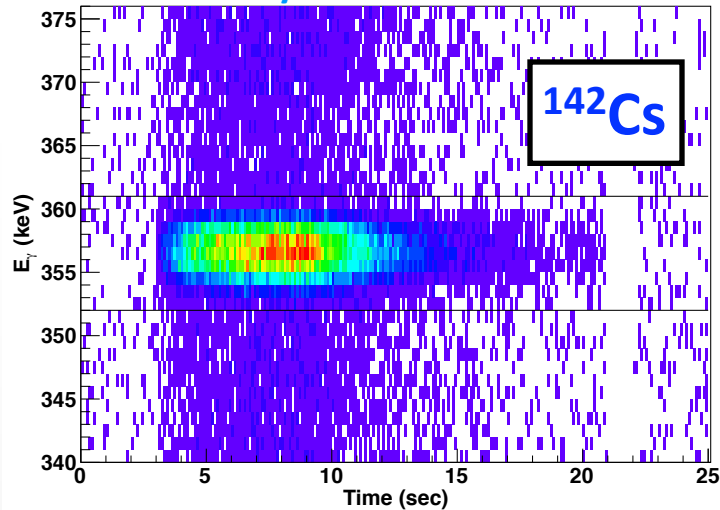
Commissioning (paddles — last week)



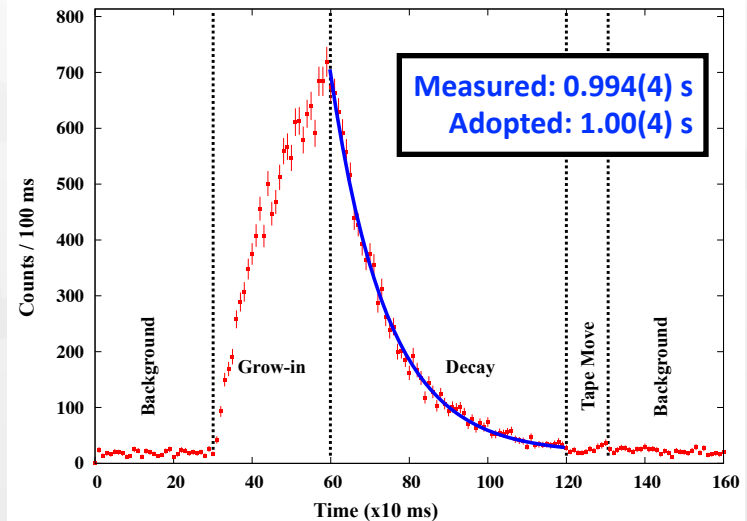
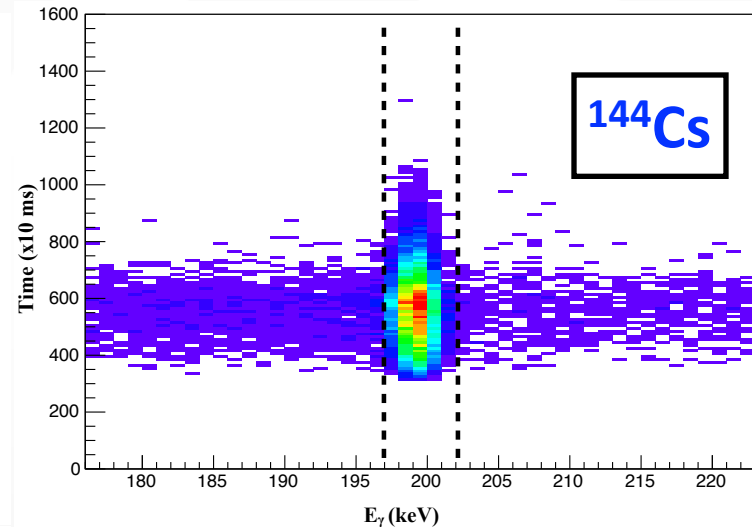
Determining decay half-lives

Stub-line tape station

Courtesy of Peter Bertone



X-Array/SATURN

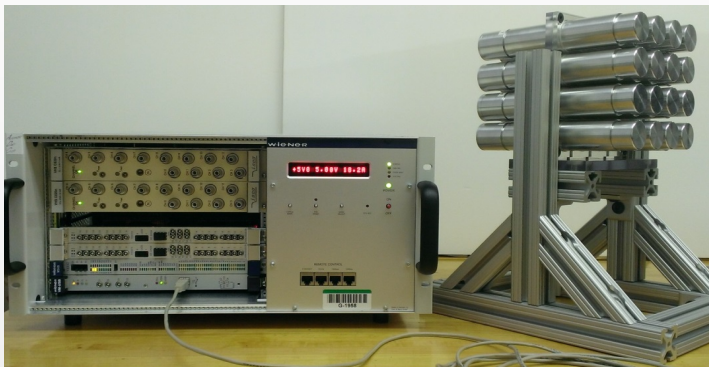


Modularity of the X-Array — CLYC

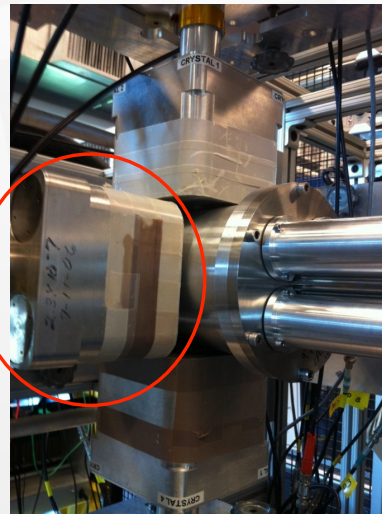
Cs₂LiYCl₆:Ce (CLYC)

${}^6\text{Li}(n,\alpha){}^3\text{H}$ - Thermal/fast n ${}^{35}\text{Cl}(n,p){}^{35}\text{S}$ - Fast n

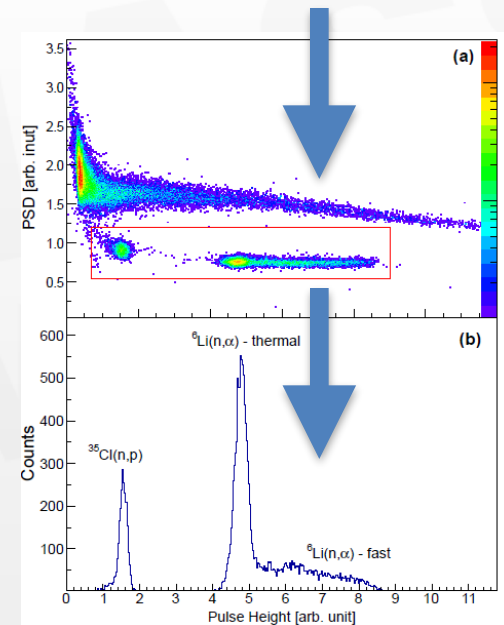
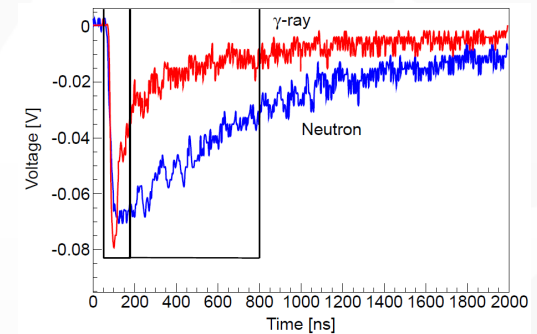
Optimized for fast neutron detection by using ${}^6\text{Li}$ -depleted ($\sim 99.3\%$ enrichment of ${}^7\text{Li}$).
Suppresses thermal and epi-thermal neutron response.



Crystals grown by Radiation Monitoring Devices Inc. (RMD)



Pulse-shape Discrimination (PSD)



Courtesy of Nathan D'Olympia

PAC-approved experiments ready to go

Available on the web @ http://www.phy.anl.gov/atlas/pac/app_exp.html

1434	A. Deo	Spin isomers in neutron-rich nuclei around doubly magic ^{132}Sn
1435	S. Zhu	beta-decay studies of neutron-rich $^{138-148}\text{Ba}$ isotopes
1423X	P. F. Bertone	Commissioning the X-Array and the Decay Beam Lines at CARIBU
1477	A. Sonzogni	Possible low-spin state in ^{104}Tc and its implications for decay heat
1480	F. Kondev	Discovery and Properties of New Isotopes using Mass and Decay Measurements at CARIBU
1457	J. Rissanen	Beta-decay studies of neutron-rich Zr and Y isotopes near the neutron mid-shell
1468	M. Carpenter	Study of Non-Yrast States in $^{100,102}\text{Zr}$ following beta decay of $^{100,102}\text{Y}$
1521	E. Merchan	Quantum Numbers of Single-Particle States of ^{132}Sn populated via b-decay
1526	V. Werner	Sub-shell closure, proton-neutron symmetry and shape coexistence in ^{98}Zr
1533x	C. J. Lister	X-Proposal: Commissioning the INEL TAGS Spectrometer at CARIBU
1535x	N. D'Olympia	X-Proposal: Beta-delayed neutron branching and energy measurements with a novel CYLC detector: A test and physics case in ^{94}Rb

Collaboration



UMass Lowell:

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Funded by the DOE Office of Science



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Please note...

To the experimentalists:

We welcome further collaboration, so if you are interested please let us know

To the theorists:

If you would like us to measure something, please let us know

Thank you for your attention

ありがとう。