Gamma spectroscopy of heavy element nuclei in the BGS focal plane

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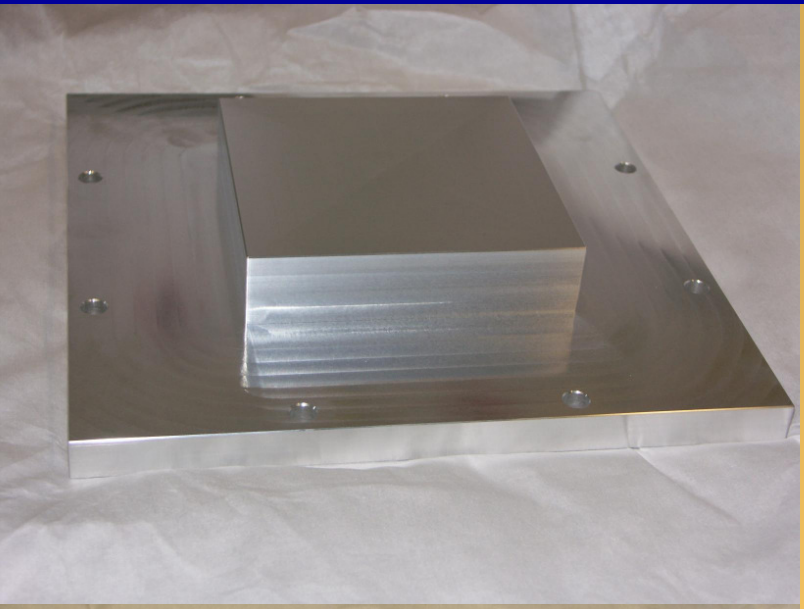
TASCA 07 September 28, 2007

Simple Modifications to BGS Focal Plane For K-Isomer Test Experiment

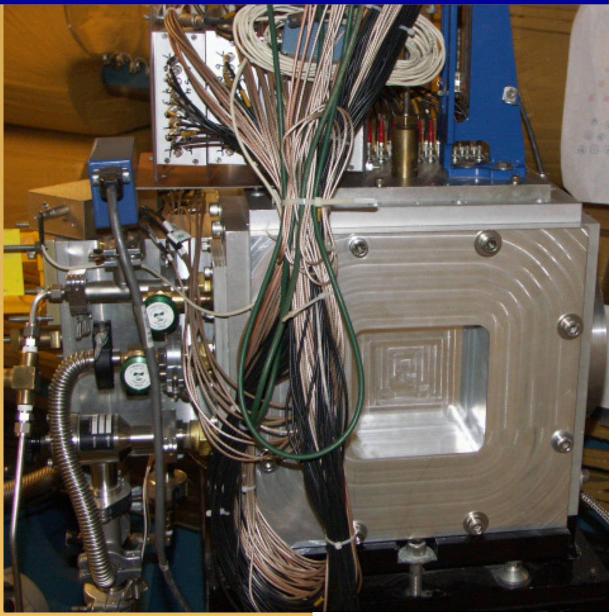


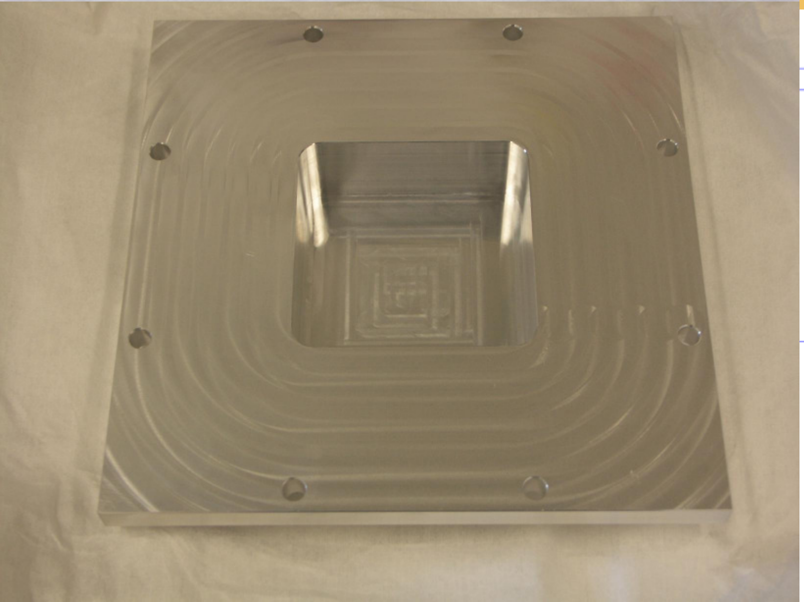
2-mm thick Al window on reentrant backplate

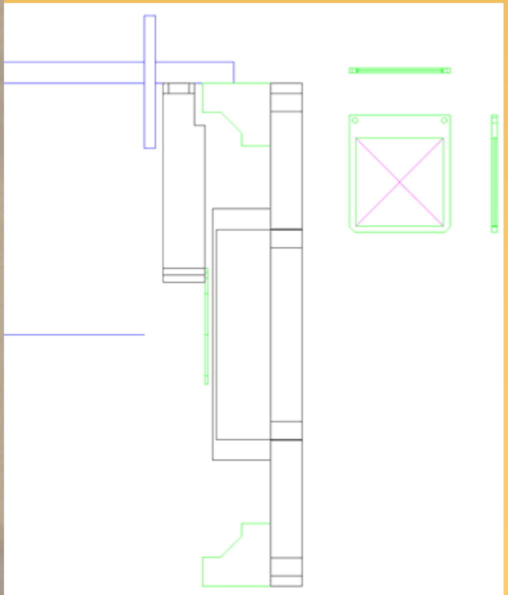
DSSD-on-a-stik holder

DSSD (Yale):
5-cm x 5-cm
16 x 16 strips
1-mm thick

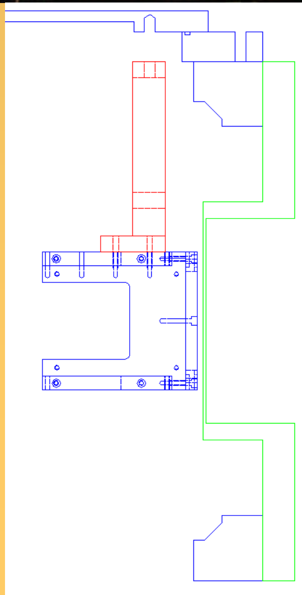
Eurysis Ge clover
4 x 5-cm dia. x 8-cm



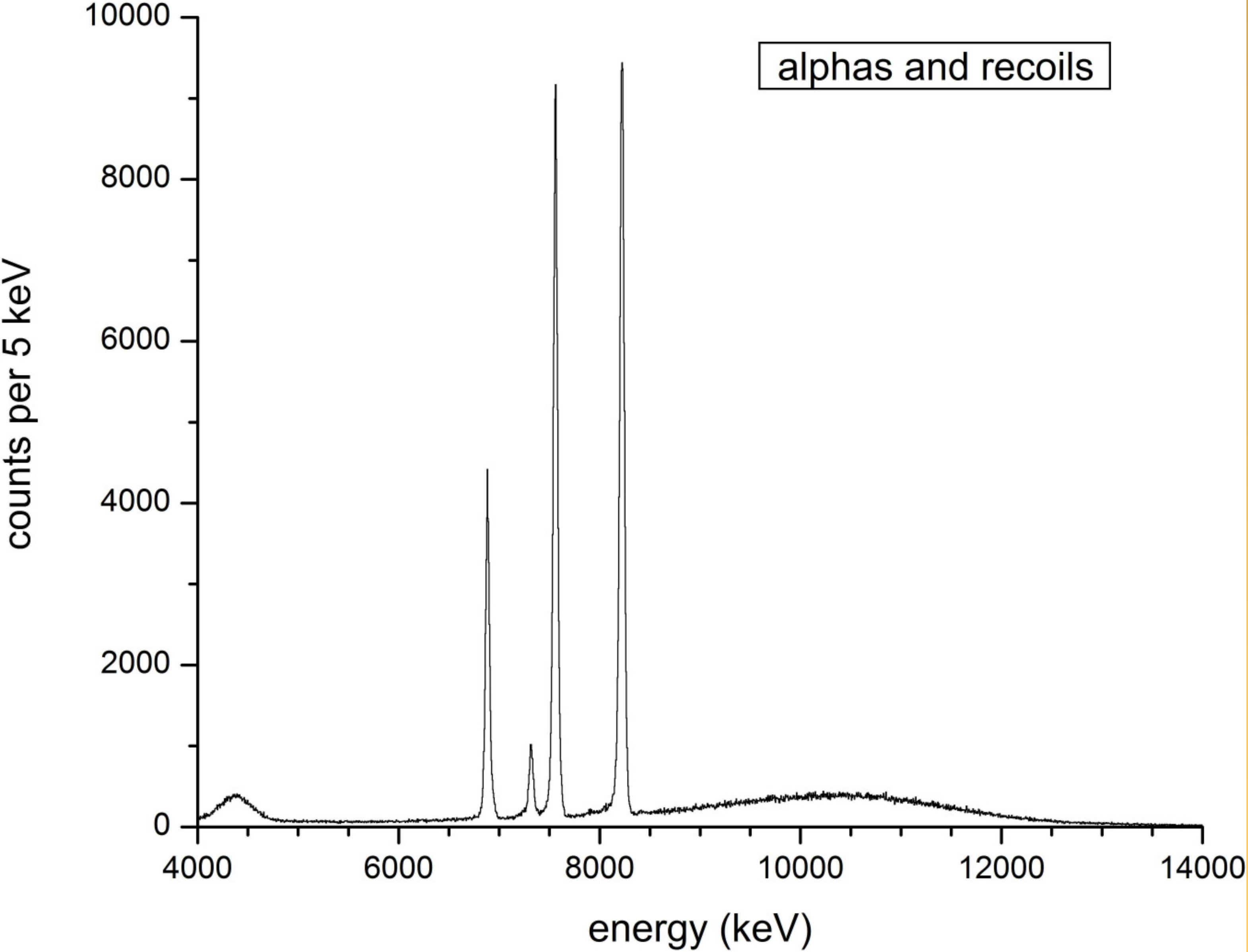




Can also be used with standard BGS focal plane detector



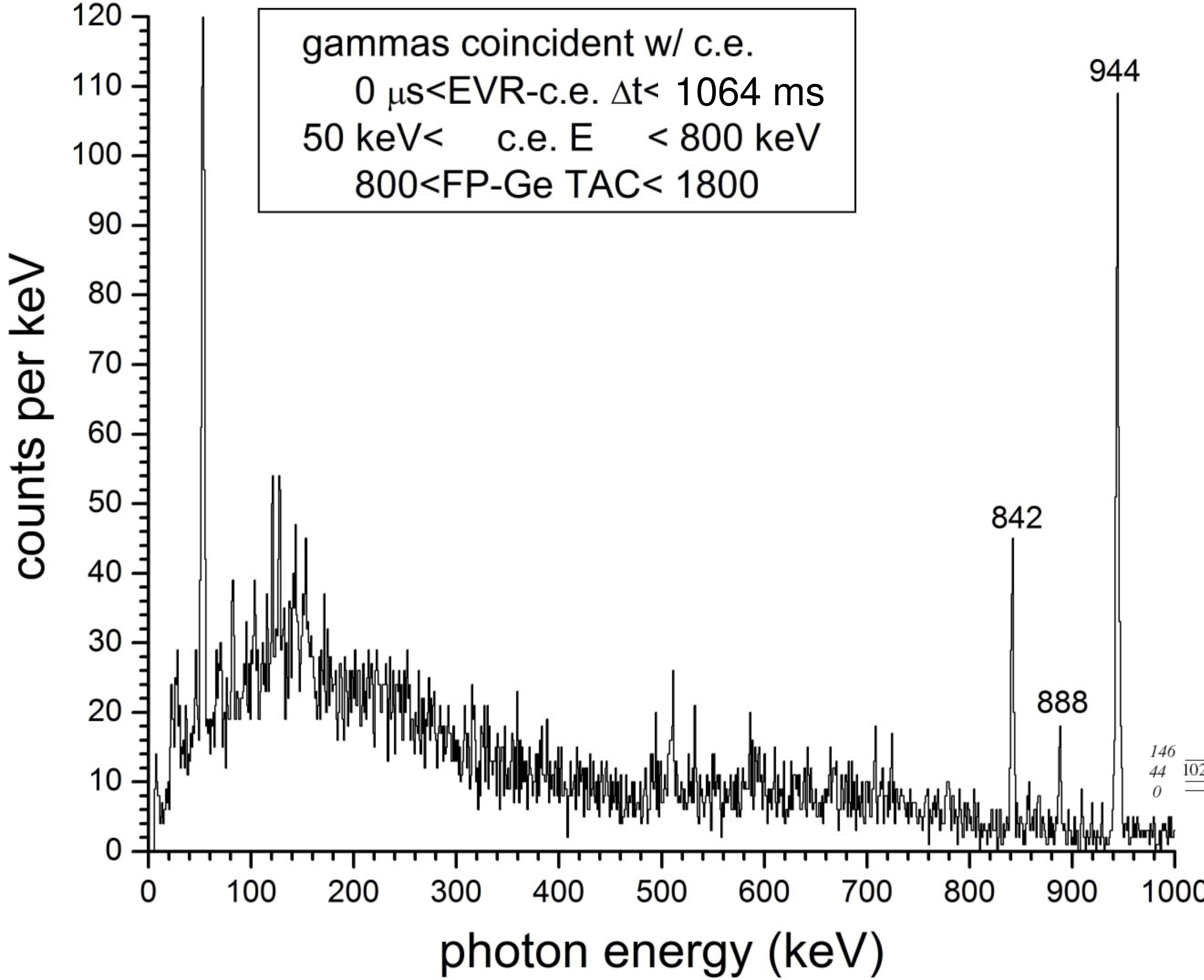
^{208}Pb(^{48}Ca,2n)^{254}No K-isomer Test Experiment



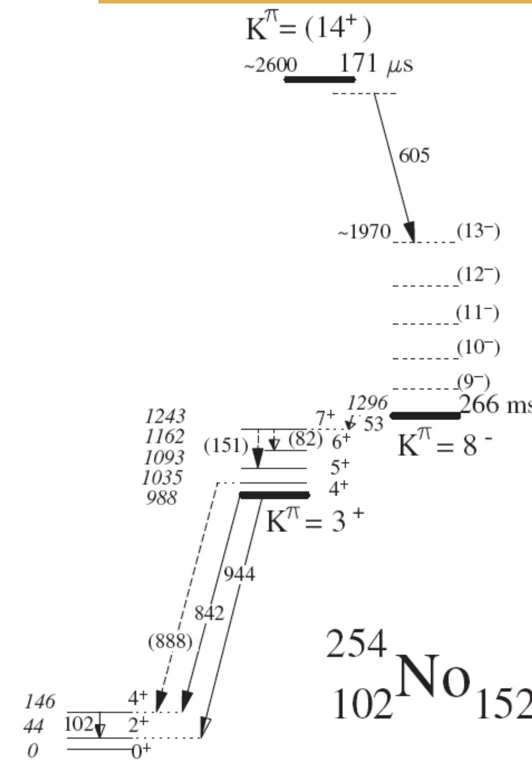
June 30, 2007
2.56 days

117k ^{254}No alphas

High-energy gammas from 266-ms isomer



Level scheme from
Tandel *et al.*,
PRL **97**, 082502 (2006)



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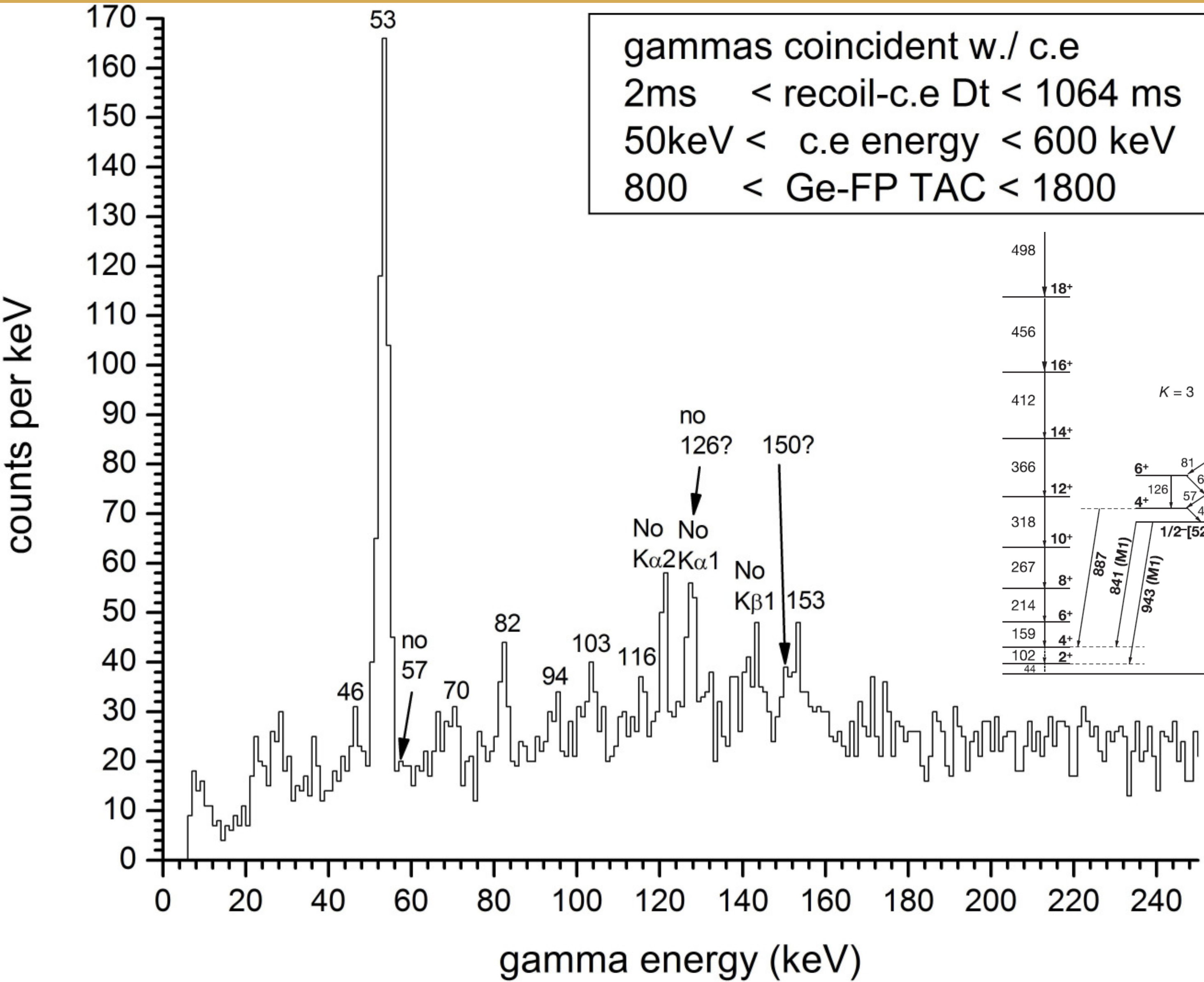
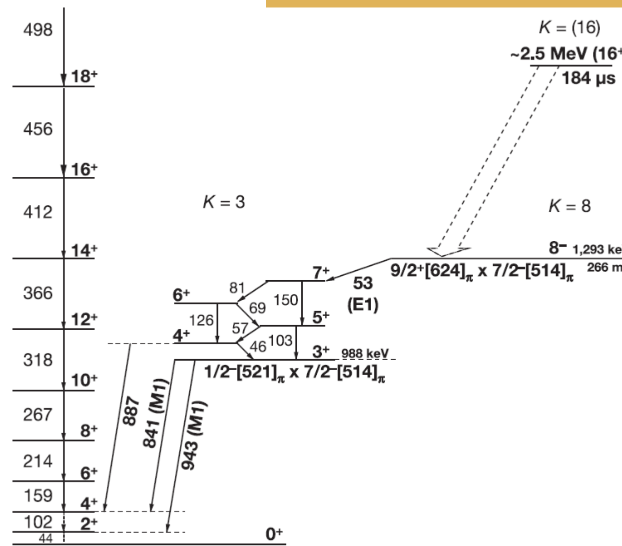
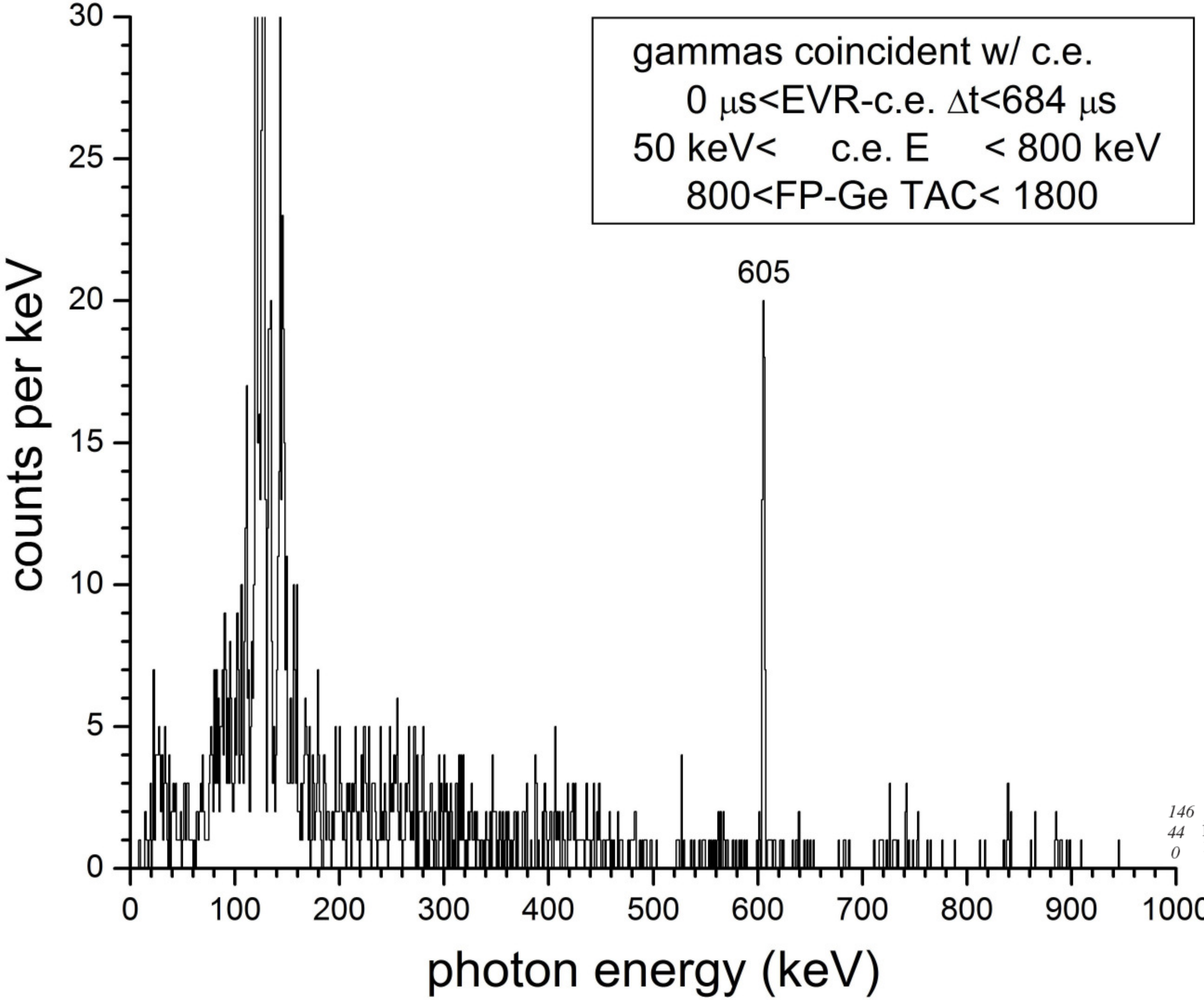


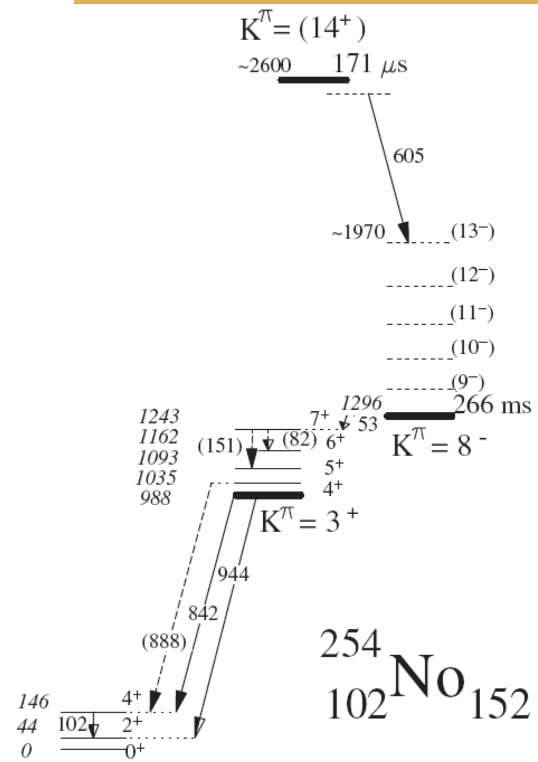
Level scheme from Herzberg *et al.*, Nature **442**, 896 (2006)



High-energy gammas from 171-μs isomer



Level scheme from Tandel *et al.*, PRL **97**, 082502 (2006)



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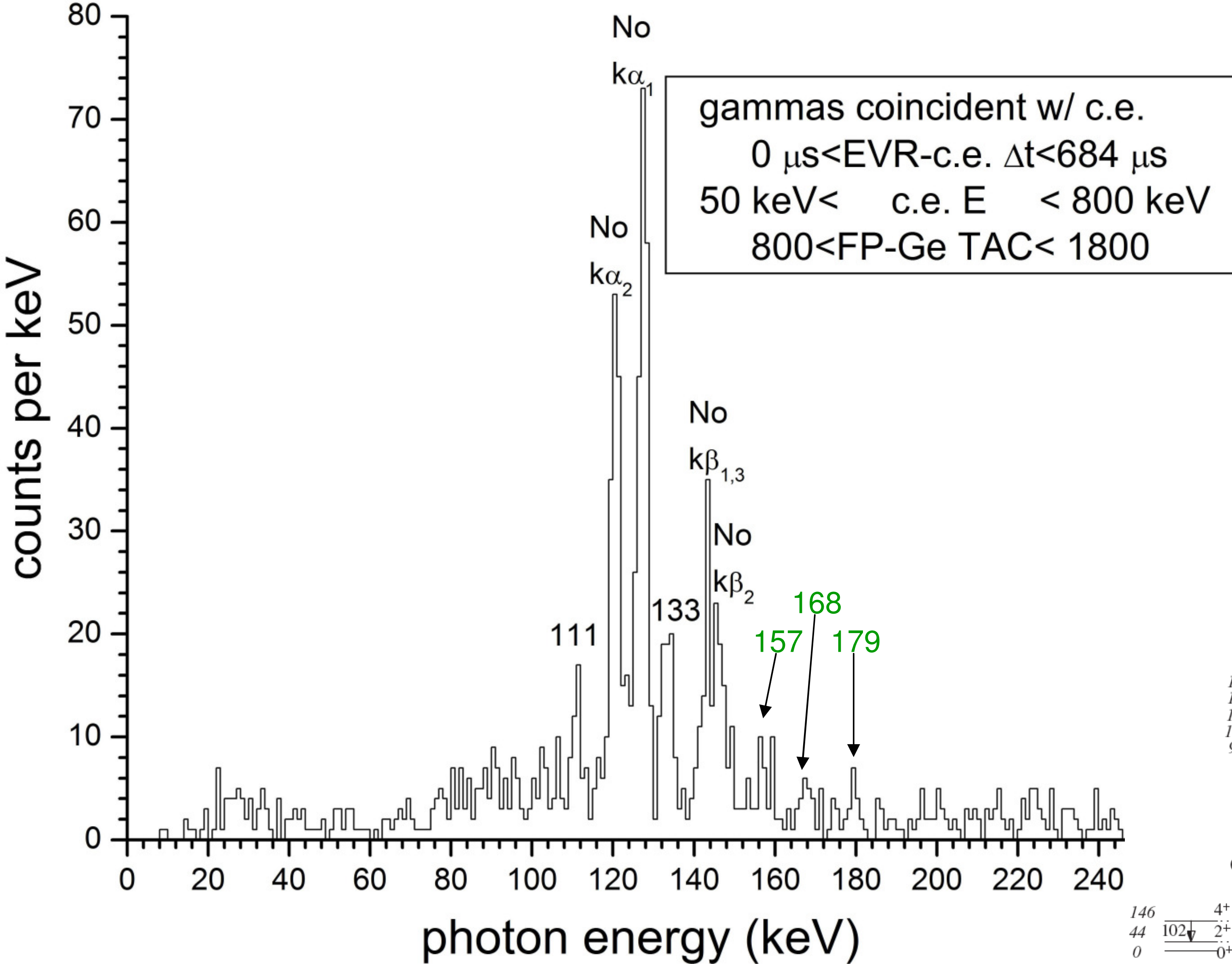
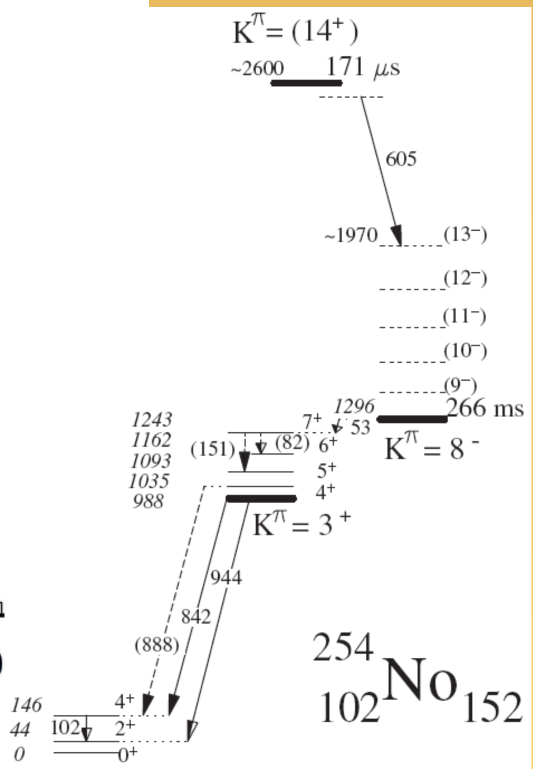
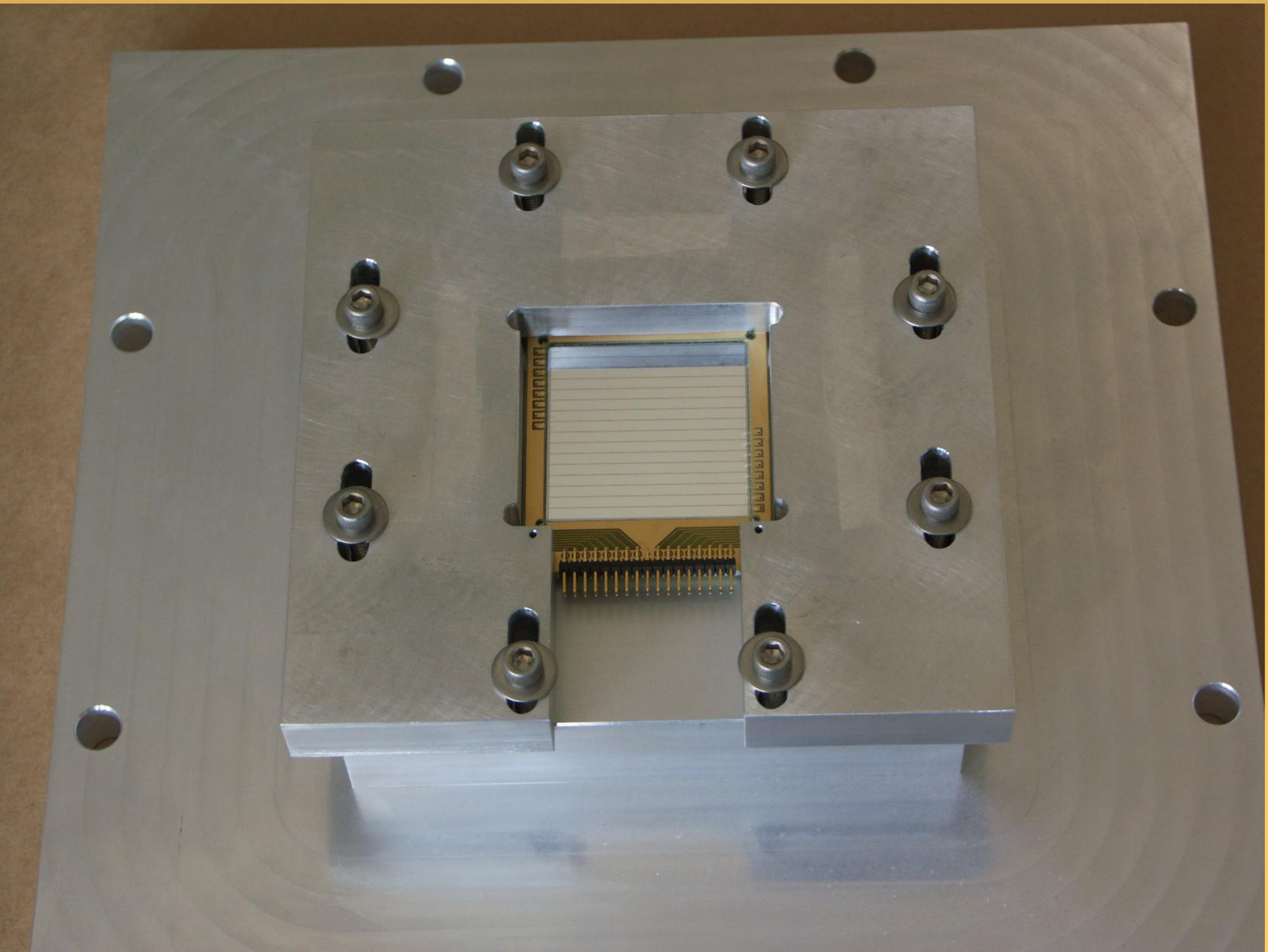


Level scheme from Tandel *et al.*, PRL **97**, 082502 (2006)



New DSSD holder for K-isomer Studies

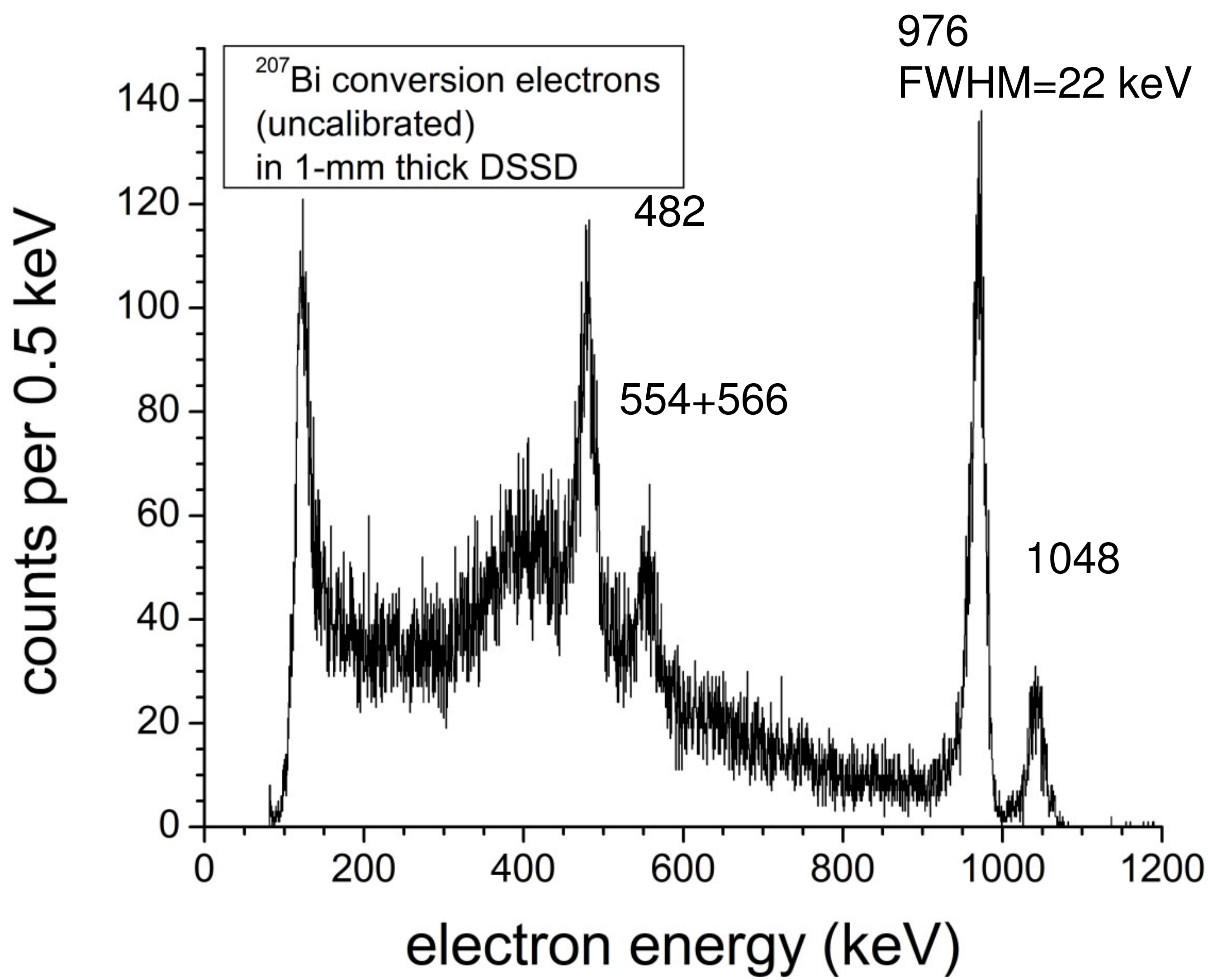


Front of DSSD is 3 mm from inside of 2-mm thick Al window (~10 mm from Ge)

2-cm thick Al plate provides shielding to reduce the singles rate in the Ge.

C.e. threshold is ~50keV. Noise from magnet power supply increases threshold to 100-150 keV

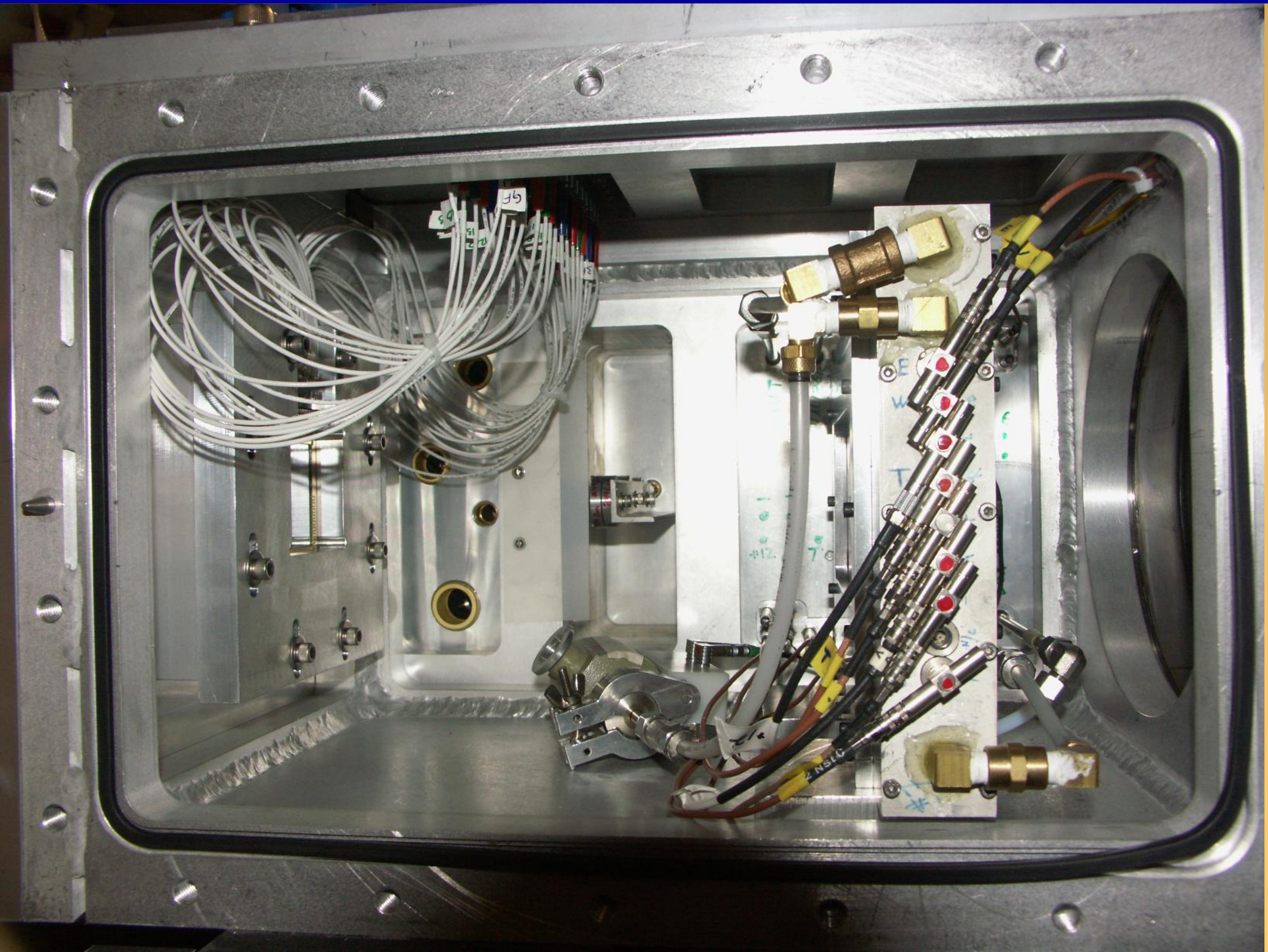
^{207}Bi DSSD Conversion Electron Calibration



Room temperature, Magnets on

c.e. threshold = 100 keV

DSSD and MWPC



$^{208}Pb(^{50}Ti,2n)^{256}Rf$ Experiment Begins Tuesday

Improvement Factors Relative to $^{208}Pb(^{48}Ca,2n)^{254}No$ Experiment:

F.P. – Ge distance reduced	1.5
DSSD operation and c.e. triggering	2.0
Length of experiment	4.0
F.P. image centering and focusing	1.2
$^{208}Pb(^{50}Ti,2n)$ 30 nb / $^{208}Pb(^{48}Ca,2n)$ 3μb	0.01
product of all factors	0.14

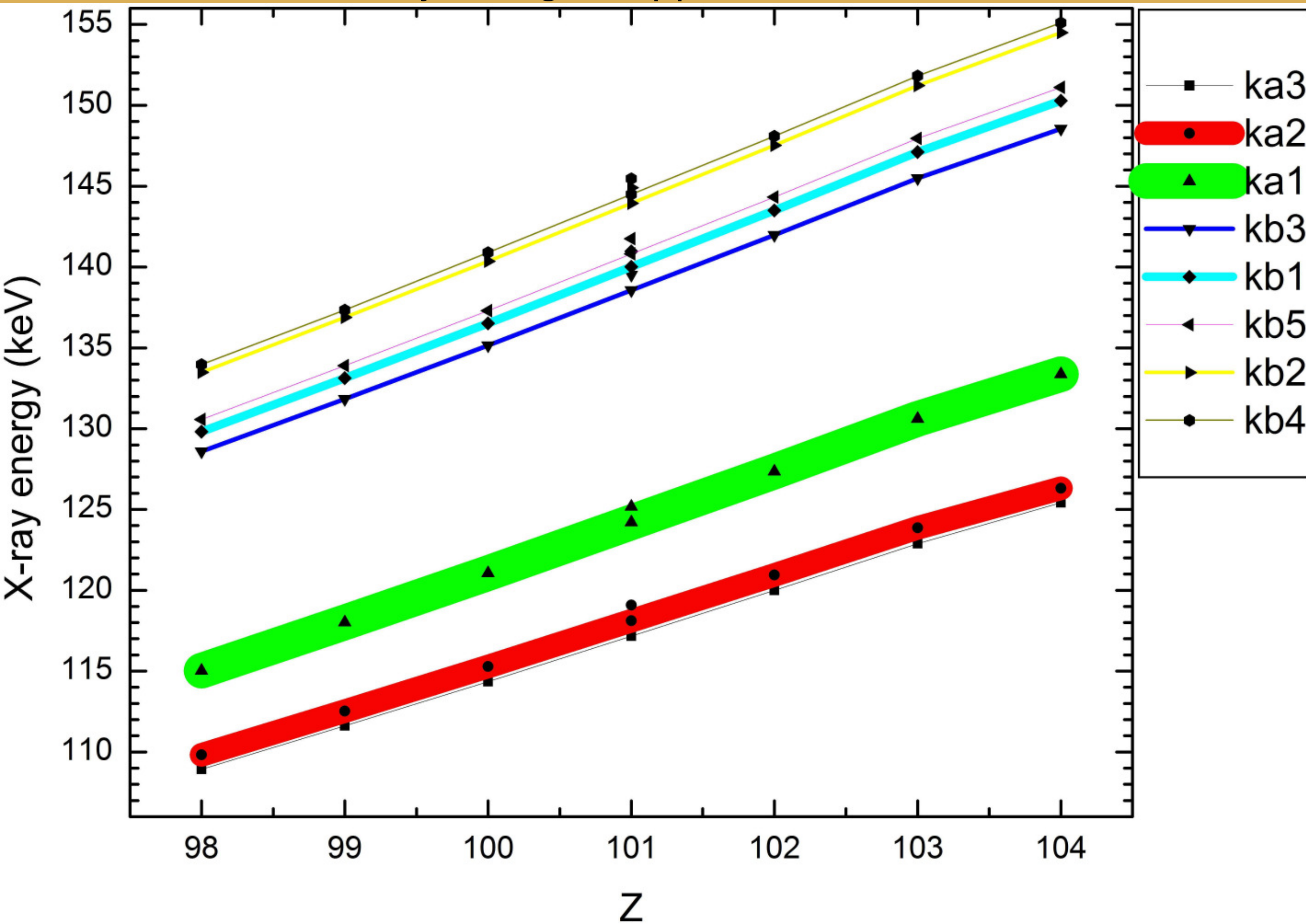
Backgrounds will be reduced because EVR-c.e.-SF with a 6-ms SF half-life is an extremely unique and sensitive decay sequence. We hope to see ~50 γ-rays in the largest peak.

What are the Rf K x-ray Energies?

Berkeley Lab

Accepted Md K x-ray energies are wrong (transcription error has propagated throughout the literature)

Predicted Rf K x-ray energies appear to be 0.5 keV below the Z=98-103 trend



Md K x-ray energies should be:

Kα3 = 117.17 keV

Kα2 = 118.119 keV

Kα3 = 124.205 keV

Kβ3 = 138.564 keV

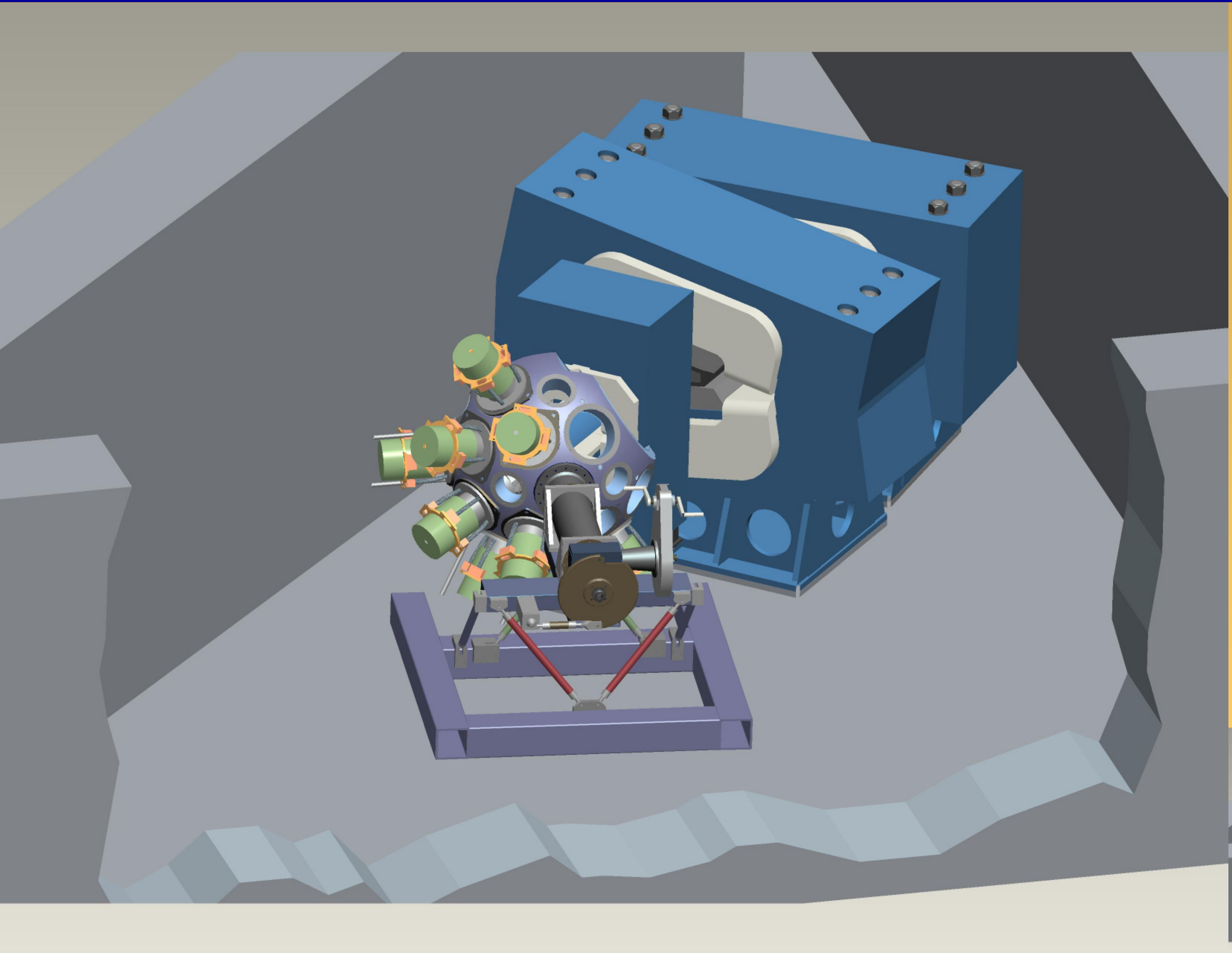
Kβ1 = 140.014 keV

Kβ5 = 140.814 keV

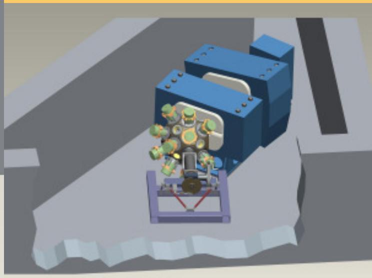
Kβ2 = 143.946 keV

Kβ4 = 144.496 keV

In-Beam γ-Spectroscopy with Gretina at BGS Target Position



We will propose a 6-month campaign for heavy element studies (2009?)



Determination of Z and A of Single Atoms

Addition of a RF gas-stopper cell to the BGS

Berkeley Lab

Produce SHE in reaction such as $^{244}Pu(^{48}Ca,3n)^{289}114$

Isolate with Berkeley Gas-filled Separator

$^{289}114$ passes through MYLAR window and stops in high-purity He (retains 1+ charge)

Focusing RF field directs 1+ ion toward exit orifice, where it is carried by gas flow

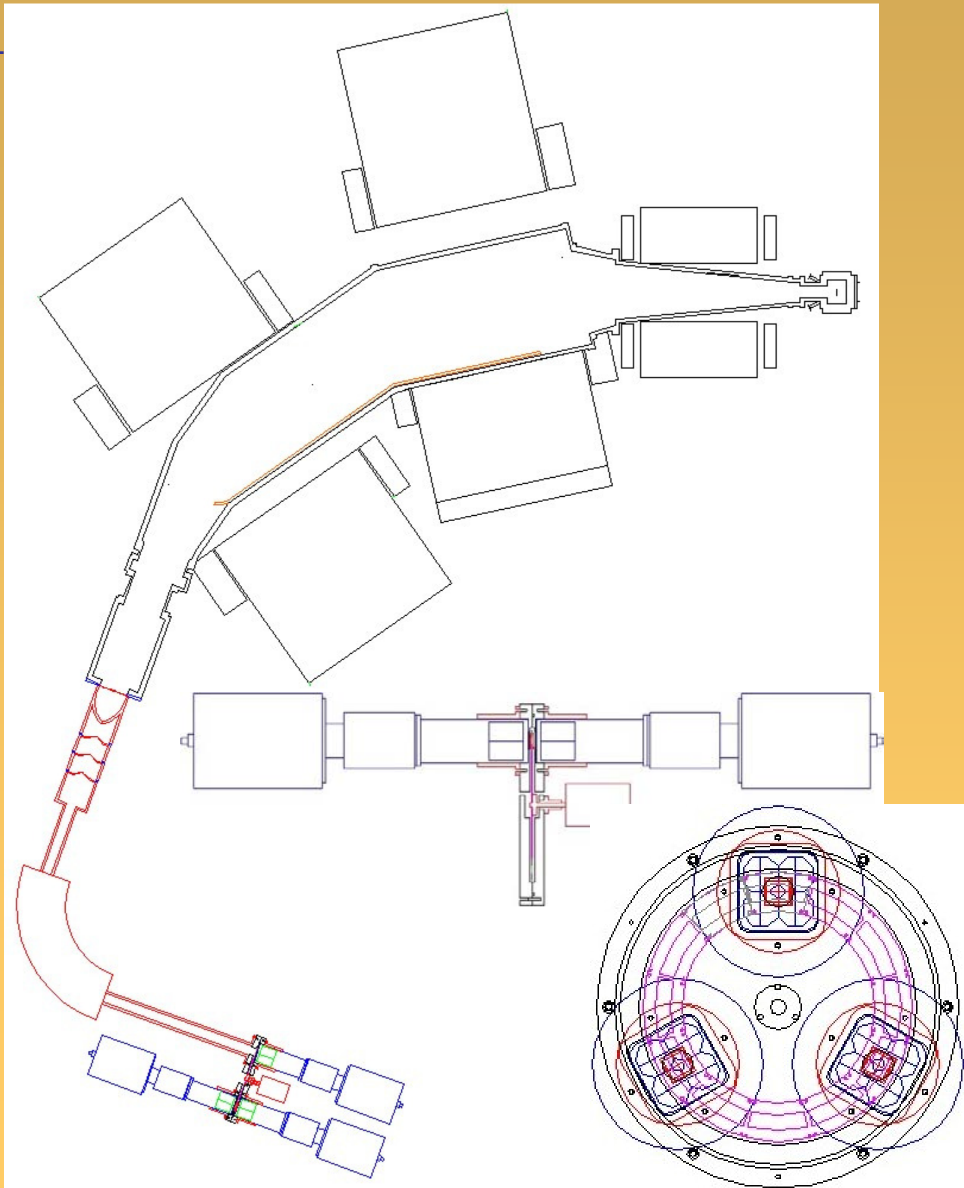
Gas skimming and differential pumping results in "beam" of 1+ ions

1+ ion is sent through mass analysis magnet for determination of A

1+ ion is stopped on rotating wheel system for measurement of α-γ coincidences

α-decay of odd-N SHE populates analog state in daughter. Internal conversion of analog state γ-decay produces k X-ray

k X-ray of daughter is detected in coincidence with α-decay, providing Z identification



Mass Analysis and Detector Facility

Scientific program *in addition to* Z and A identification of SHE

Determination of single-particle states in heavy and superheavy element isotopes will refine models of nuclear structure (Macroscopic-Microscopic, Hartree-Fock-Bogoliubov, Relativistic-Mean-Field).

Identification of spontaneous fission (SF) activities in the actinides and transactinides will clean up many of the questionable Z and A assignments, providing a more solid foundation for understanding SF systematics.

Identification of fission fragments can provide information on neutron multiplicity, fission fragment nuclear structure, and spin distribution in SF.

α-γ coincidence measurements can be used to measure nuclear structure and nuclear shapes in the region between the N=152 and N=162 deformed nuclear shells.

X-ray – γ coincidence measurements can be used to study electron-capture decay, providing low-lying nuclear structure information in neutron-deficient nuclides throughout the upper half of the nuclear chart.

Electron-capture-delayed fission and electron-capture to states above the fission barrier can provide information on fission barriers, fission isomers, and continuum states.

Thank You