TITAN-EC test run for E1066

Proof of principle experiment for the first in-trap gamma spectroscopy

This novel in-trap concept will be used for 2v2β decay BR measurements with E1066 at ISAC

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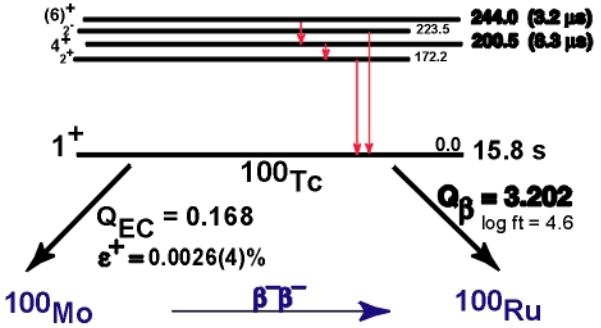
BR measurement EC to β



EC-signature: X-ray after electron capture

β-signature: electrons

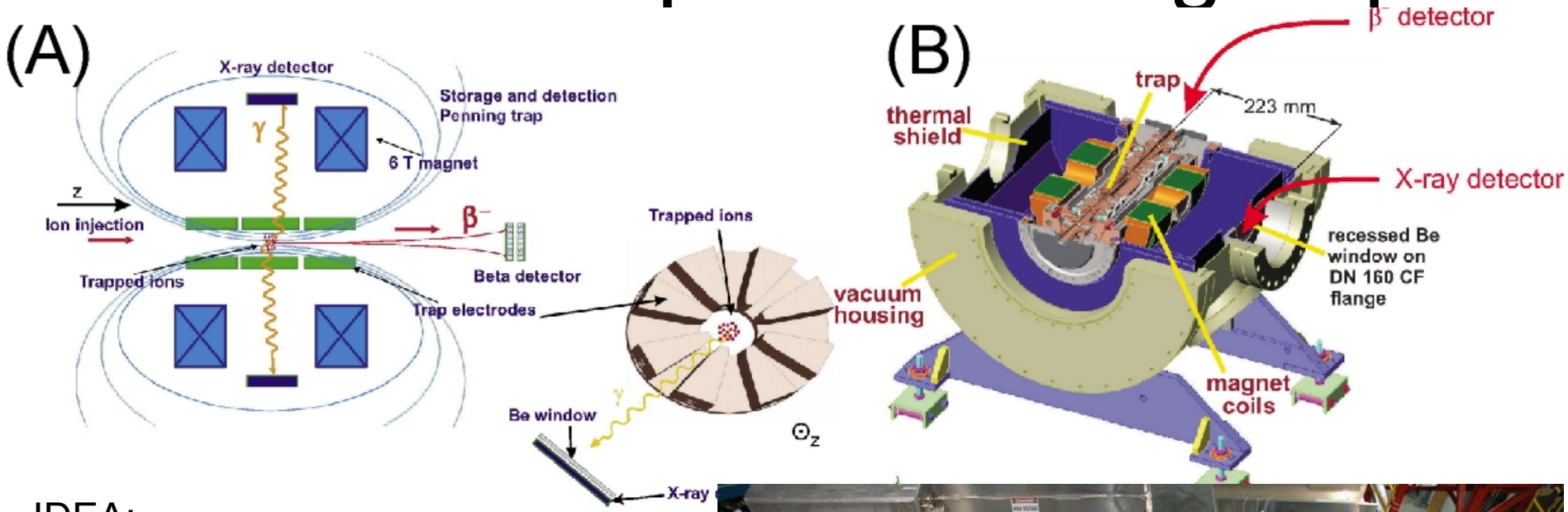
BUT:

small BR and difficult signature of low-energy X-ray in gamma background

possible bremsstrahlung background

isobar and decay daughter contamination

Novel concept in Penning trap



IDEA:

Load ions in trap (maybe after isobar cleaning)

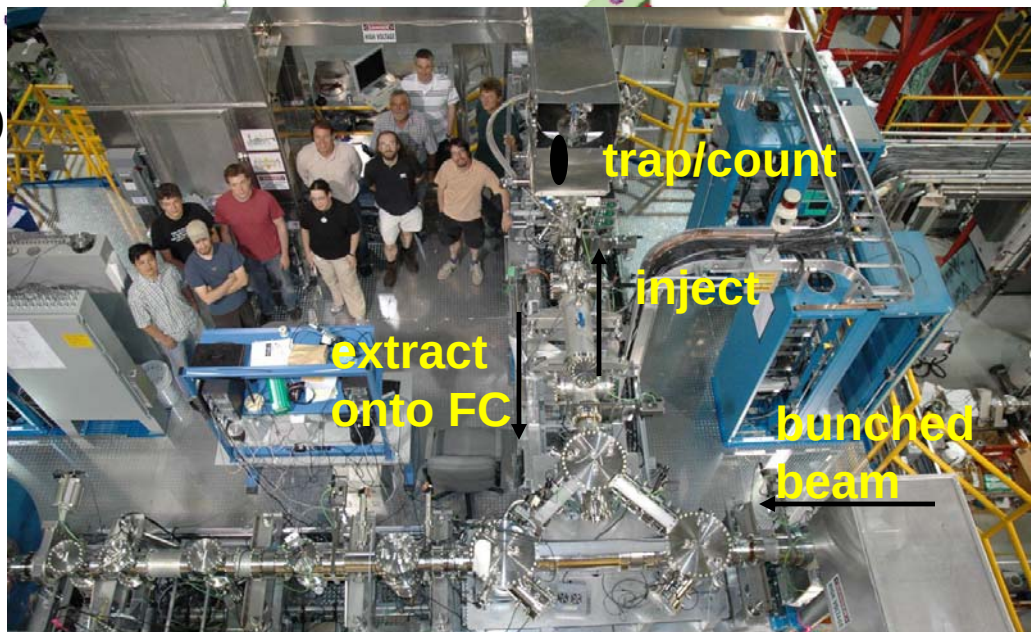
Store for long time, wait for decay

X-ray isotrop, BUT electrons follow B-field

(separation of decay branches)

After counting, remove daughter isotopes

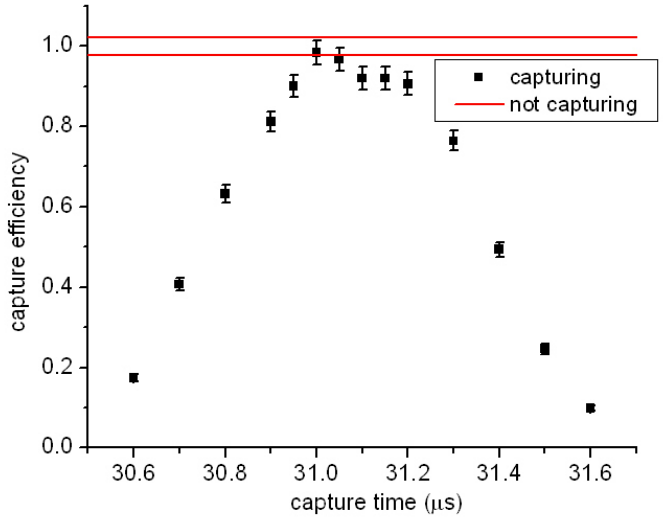
from counting environment



Proof of principal experiment

- Can we load ions in trap and store efficiently for long time?
- How many ions can we load?
- Can we put X-ray detectors near the trap (hence into the B-field)?
- Can we use beta Si(Li) detector in the B-field?
- Can we suppress background nuclei by extracting trap content backwards?

Capture/storage in the trap



Comparing same detector (MCP behind trap) by locking at trapping and shooting through.

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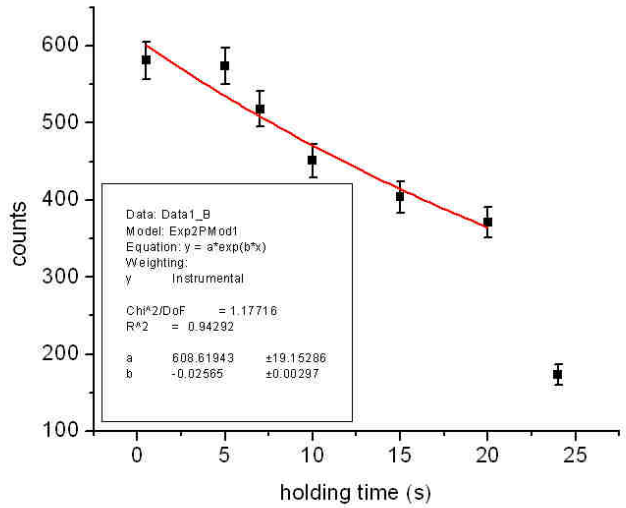

Look at trap content after some time, we found τ = 39±4 s, later even ~ 90 s (better vacuum).

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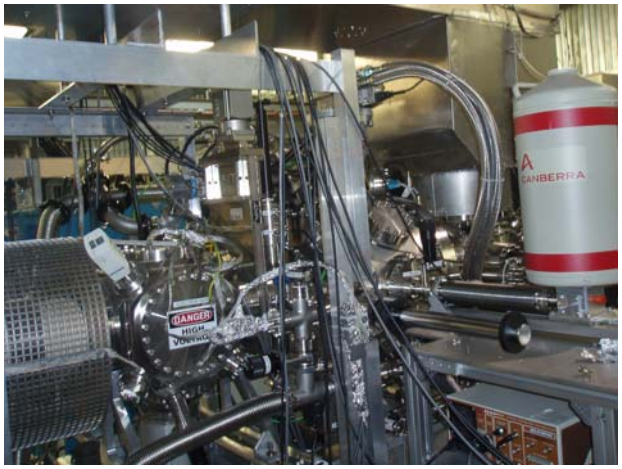
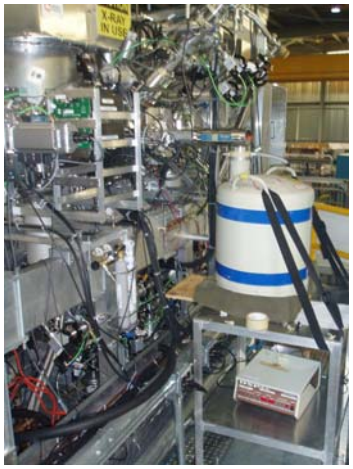
X-ray/gamma spectra





we used 2 Ge detectors
One 20 % Ge external
One LEGe in vacuum

Total solid angle: 0.7%

Ground and isomeric state information for $^{107}_{49}In$

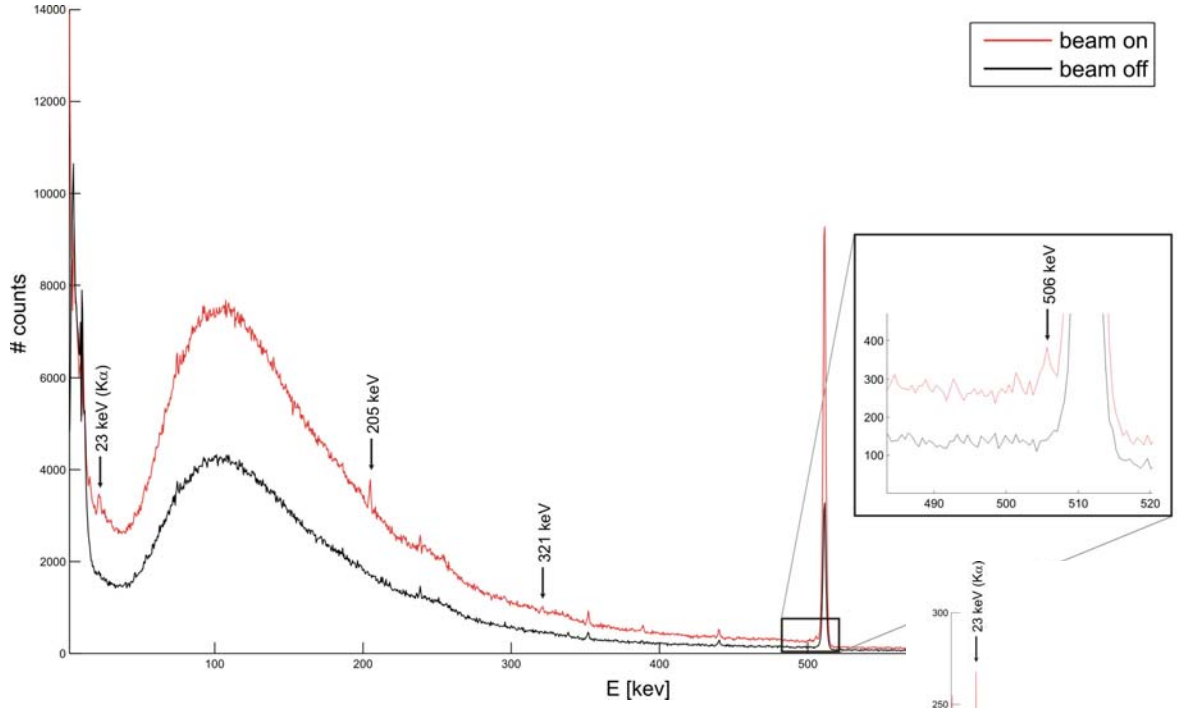
E(level) (MeV)	Jπ	Δ(MeV)	$T_{1/2}$	Decay Modes
0.0	9/2+	-83.5590	32.4 m *3*	ε : 100.00 %
0.6785	1/2-	-82.8805	50.4 s *6*	IT : 100.00 %

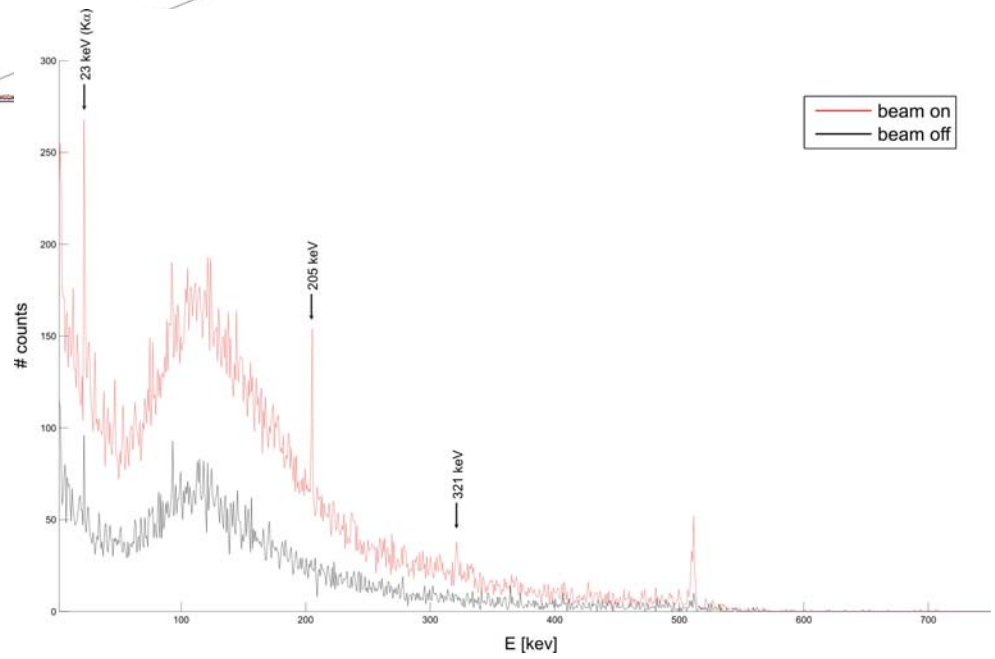
In-107g 1.1e5/s @ 65 uA & 240 A on ionizer
In-107m 1.1e3/s @ 65 uA & 240 A on ionize

Ground state decay X-rays from EC (64%):

	Energy (keV)	Intensity (%)
XR l	3.13	3.92 % *17*
XR kα2	22.984	14.1 % 7
XR kα1	23.174	26.4 % *13*
XR kβ3	26.06	2.29 % *11*
XR kβ1	26.095	4.41 % *21*
XR kβ2	26.644	1.14 % *6*

X-ray / gamma spectra





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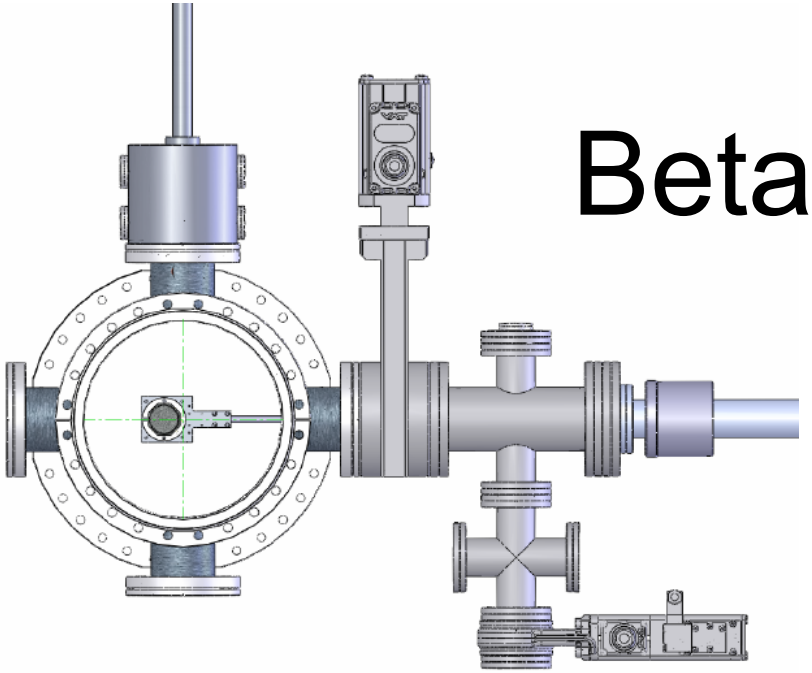
Low energy spectra possible

- Need to fully understand spectra
- Need to check resolution (B-field)
- Could apply anti-coincidence with β

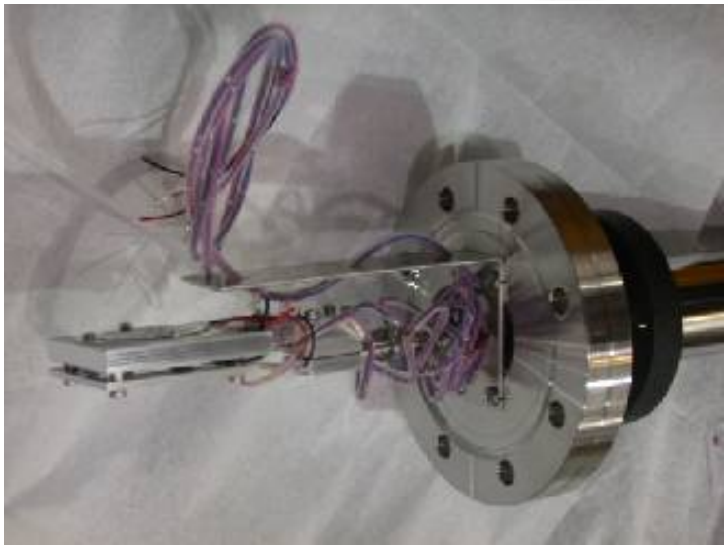
Beta spectroscopy

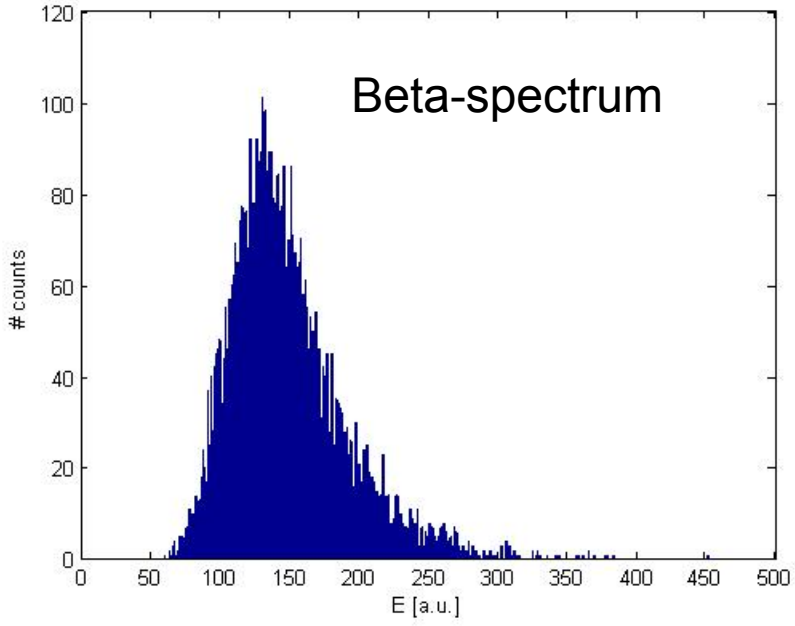


2 PIPS (Passive Implanted Planar Silicon)

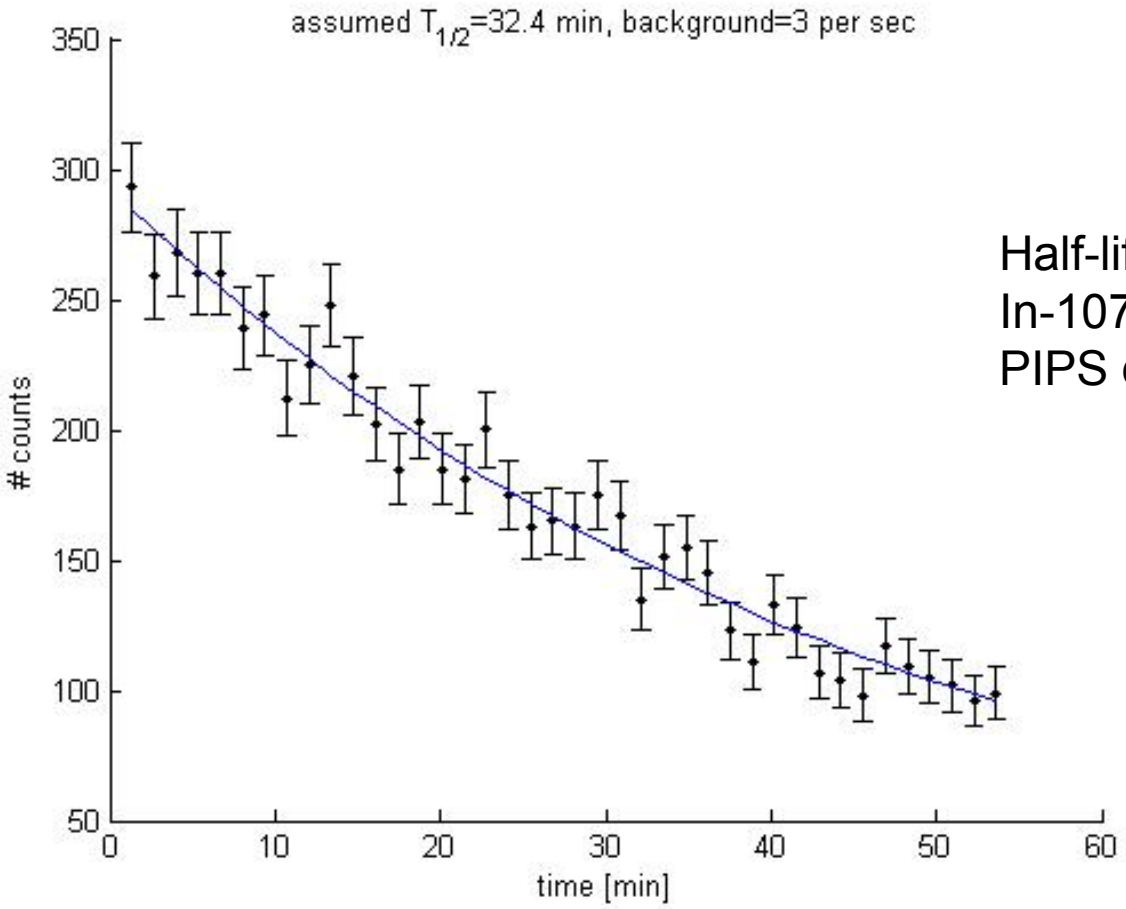
Back-to-back with 6mm Al in between

One detector with Al in front
Active Area: 300 mm²
Active Thickness: 500 μm ☑





Beta measurements



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Half-life measurement of implanted In-107g ions on Al-foil
PIPS detector worked well.

Summary

- Can we load ions in trap and store efficiently for long time? ☑
- How many ions can we load? Need to do more off-line work
- Can we put X-ray detectors near the trap (hence into the B-field)? ☑
  need to check resolution.
- Can we use beta Si(Li) detector in the B-field? ☑
  looks go, we did use the TIG-10 units and have the complete waveforms for off-line analysis and coincidences.
- Can we suppress background nuclei be extracting trap content backwards? ☑
  we extracted the beam backwards and could not see significant contribution from the daughter isotopes Cd.

- Overall very successful run, good proof of principle experiment for first in-trap gamma spectroscopy.
- The real experiment will use 7 Si(Li) detectors, hence more angle coverage

- Thanks to the TITAN people, and ISAC delivery and operation.