Experiment S323:
β-Decay of very neutron-rich Rh, Pd, Ag nuclei including the r-process waiting point ^{128}Pd

K. Smith

Spokesperson: F. Montes

GSI-Contact Person: C. Nociforo, I. Dillmann

Approved April 2006

Presented in FRS Users' meeting 2007, 2008, 2009, 2010

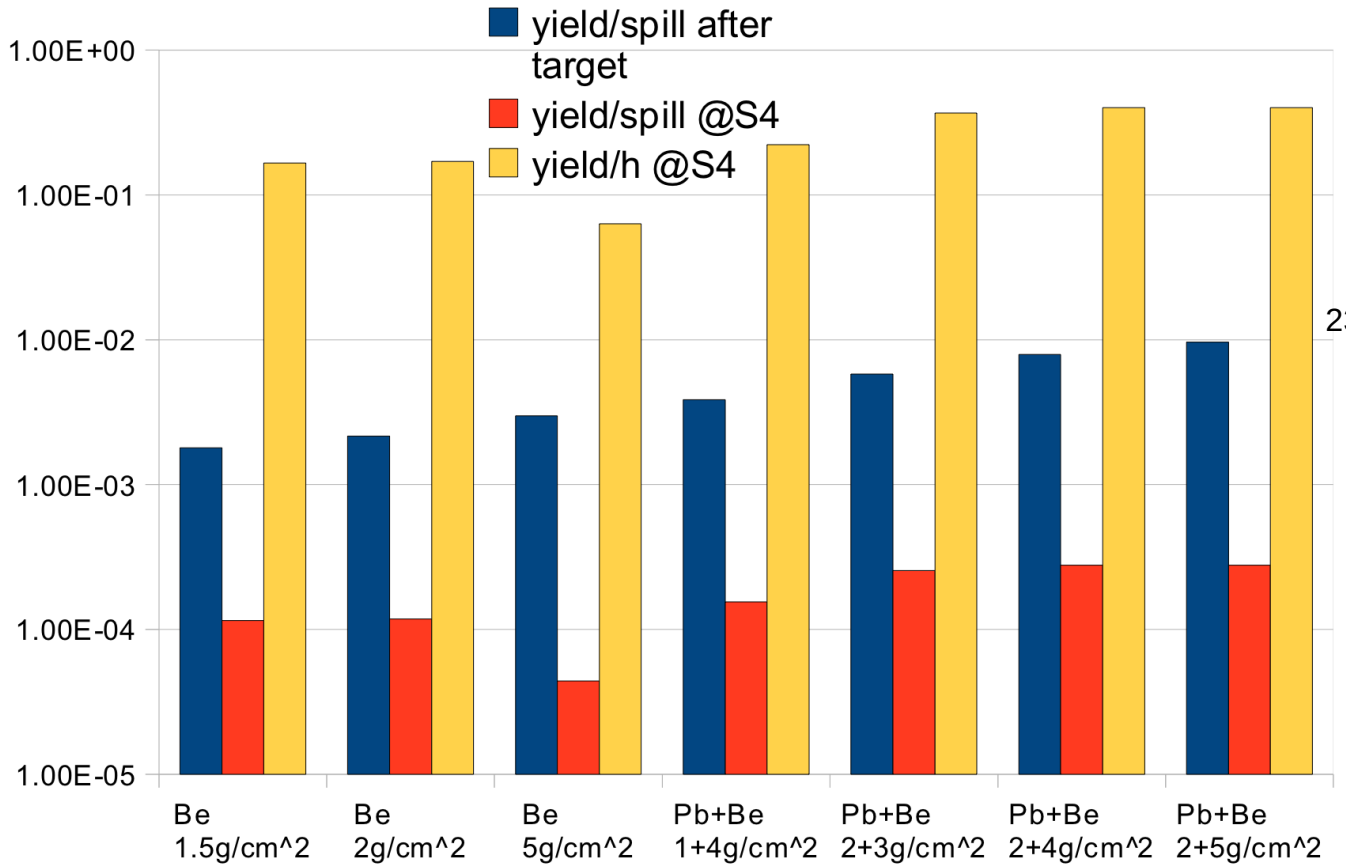
http://groups.nscl.msu.edu/nero/Web/S323/index.html

Motivation

- **^{128}Pd is first bottleneck isotope of the N=82 abundance peak (sets timescale for following nucleosynthesis)**
- **^{128}Pd half-life affects predictions of Th, U cosmochronometers in ultra-metal poor stars**
- **β-delayed neutron emission probabilities (P_n) are direct inputs in r-process calculations: set abundances in the important A=115-125 region**
- **Both half-lives and P_n values are rough indicators of nuclear structure (reliable extrapolations to more exotic nuclei)**

^{128}Pd production

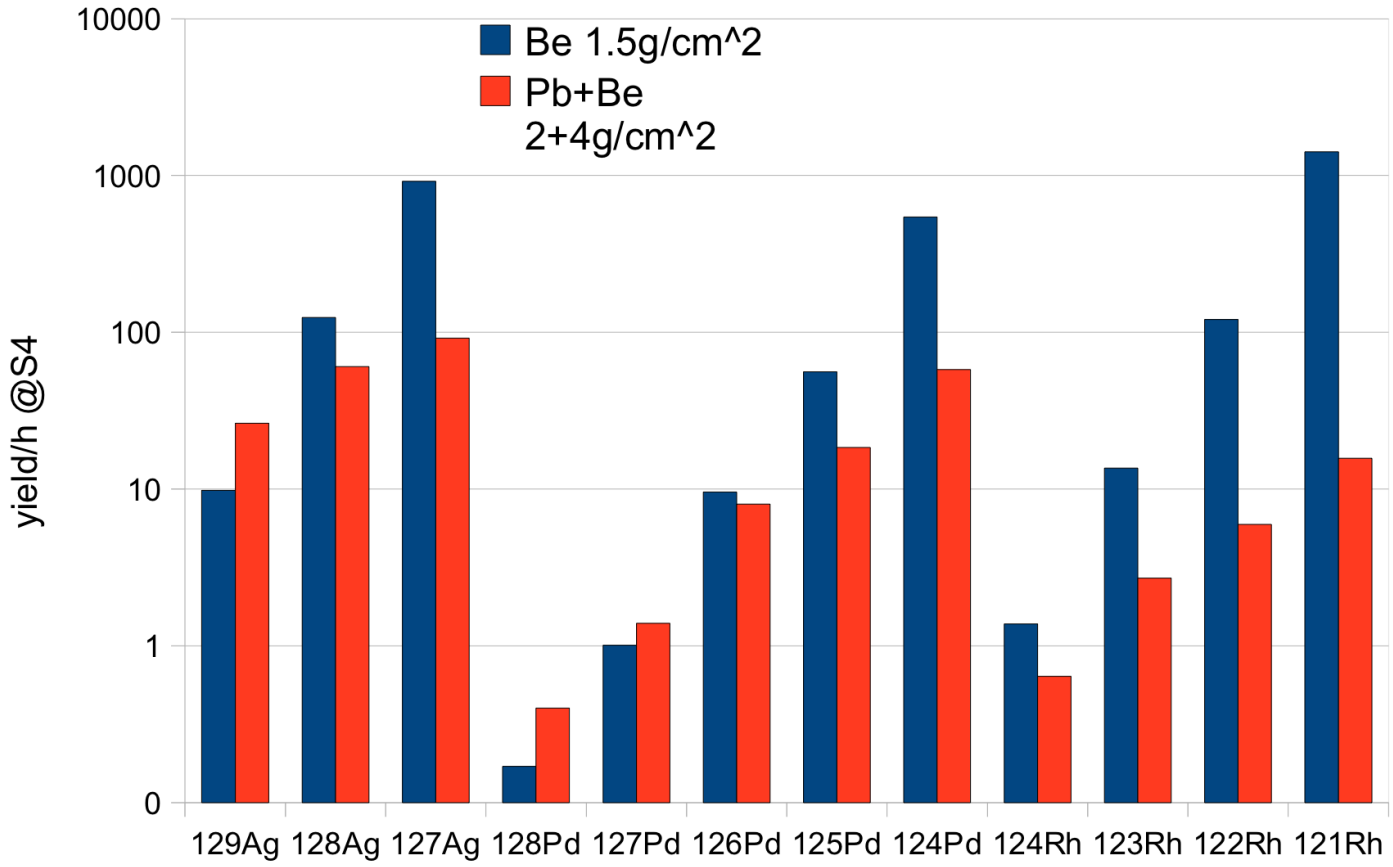
- Recently measured ^{127,128}Pd, ^{123,124}Rh fission rates from Be (RIKEN)
- Experimental ^{238}U on Pb fission rates used for fission step ^{238}U➔^{129}Ag, $^{130\text{-}131}$Cd,$^{131\text{-}132}$In, $^{132\text{-}134}$Sn, $^{133\text{-}136}$Sb, ^{134}Te
- COFRA rates used for fragmentation to ^{128}Pd



^{238}U primary beam
2x10^{9}/spill

2.5s cycle time

Production setting



^{238}U primary beam
2x10^{9}/spill

2.5s cycle time

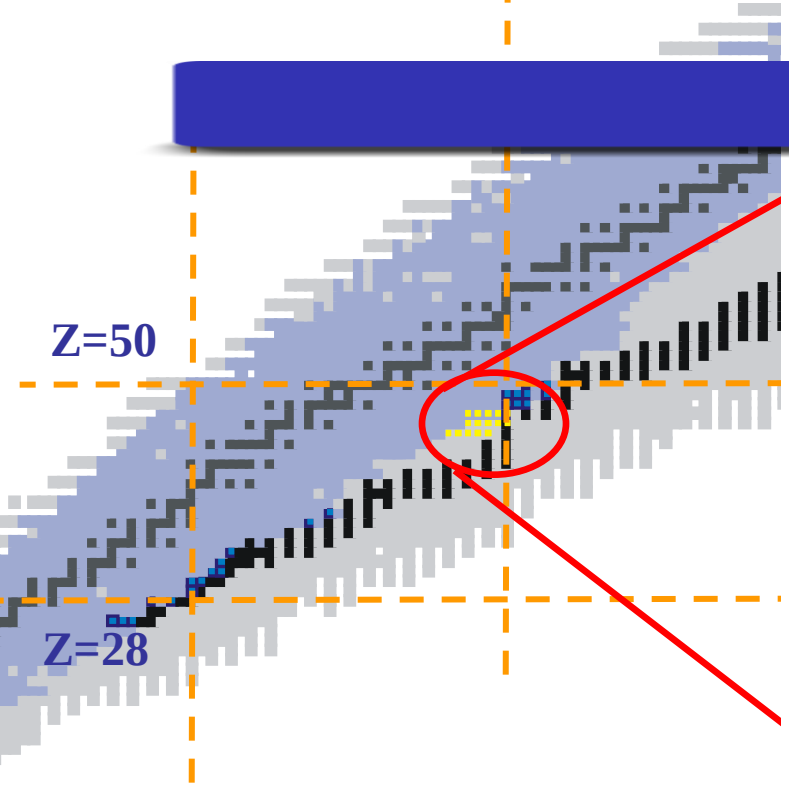
No wedge

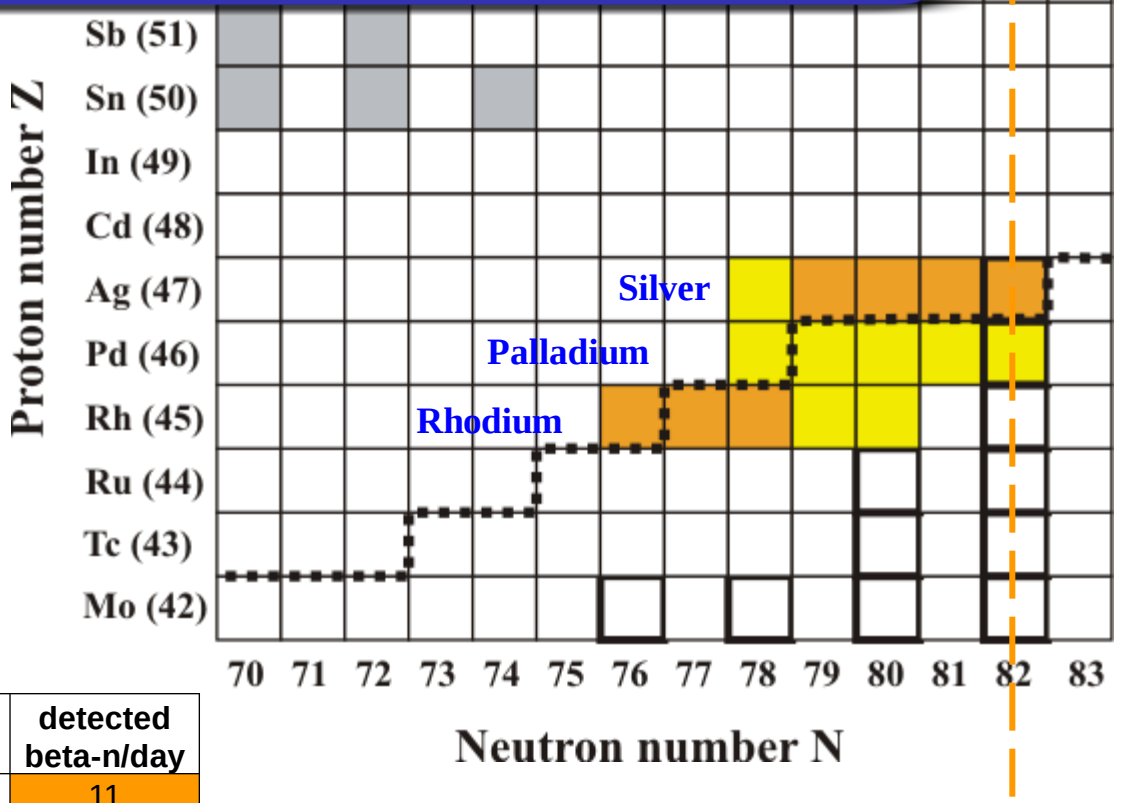
S4 slits -
detector size

Be 1.5g/cm^2 production setting has a larger acceptance for all isotopes of interest

6 particles per spill total implantation rate

Statistics

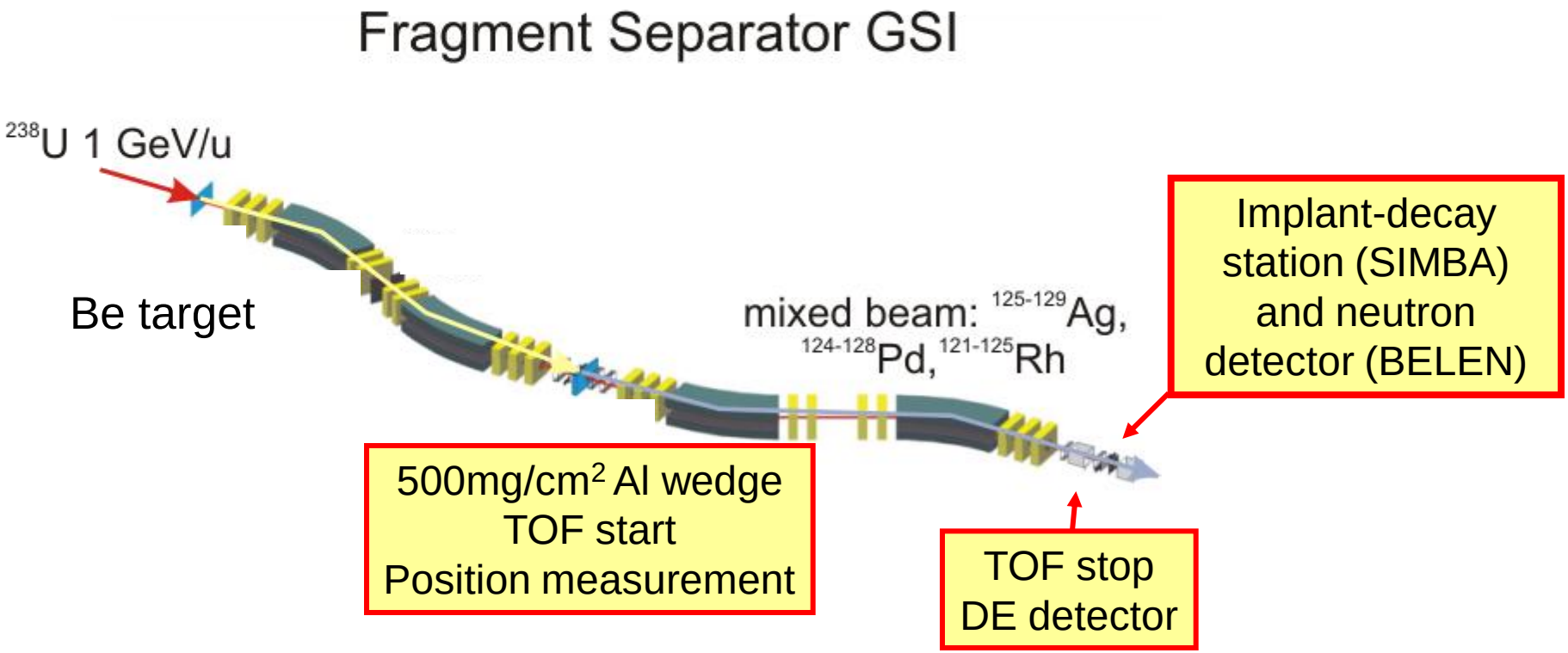




	implants/ day	detected beta/day	theoretical Pn[%]	detected beta-n/day
129Ag	223	201	13.1	11
128Ag	2889	2600	4.9	51
127Ag	21393	19253	4.6	354
128Pd	4	3	7.6	0
127Pd	23	21	3.9	0
126Pd	222	200	2.9	2
125Pd	1286	1157	1.5	7
124Pd	12234	11011	0.4	18
124Rh	21	19	11.2	1
123Rh	157	141	12.5	7
122Rh	912	821	10.5	34
121Rh	5944	5350	6.6	141

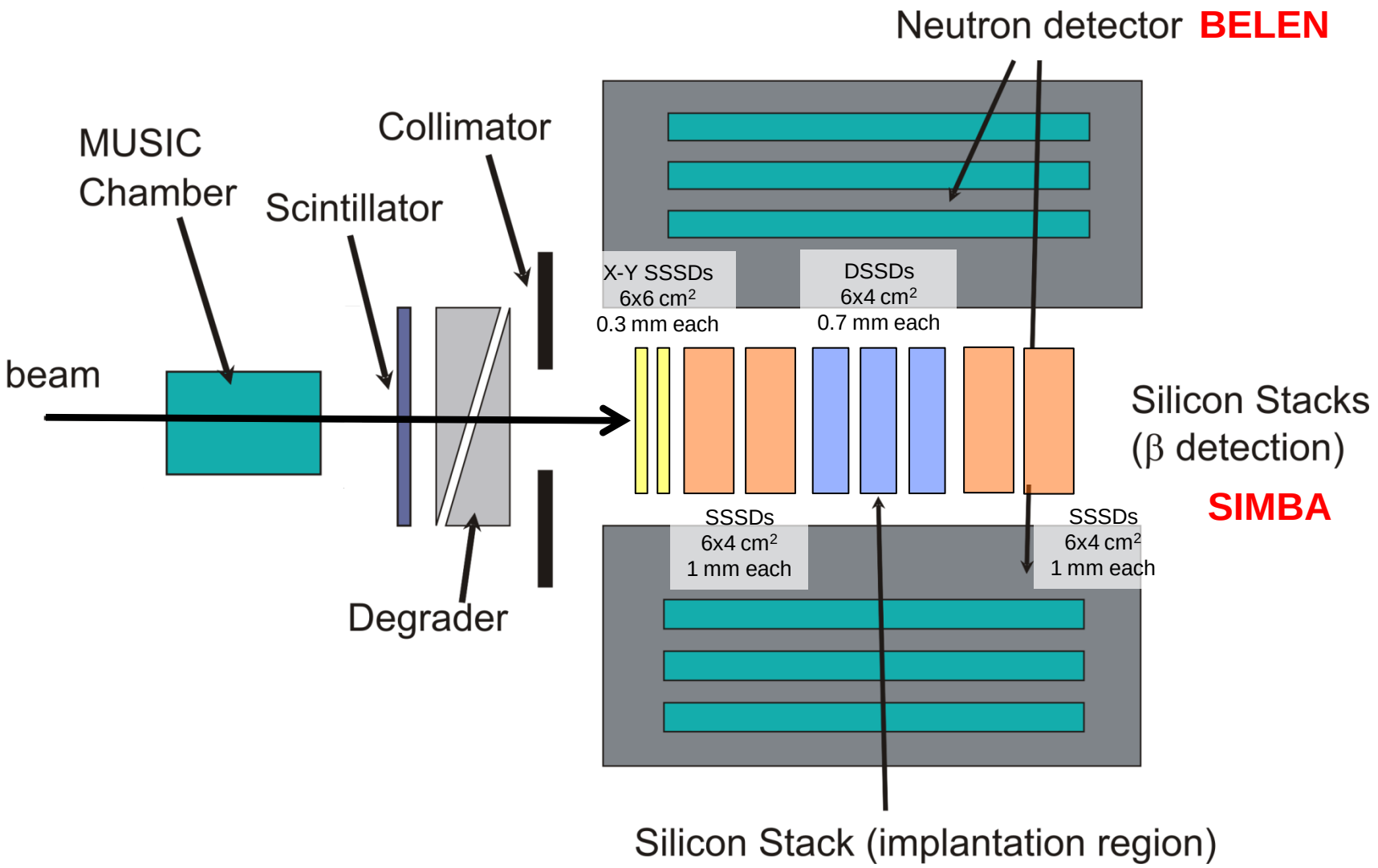
- Be target 1500 mg/cm^2
- Al wedge 500 mg/cm^2
- Beta efficiency 90%
- Neutron detector efficiency 40%

Experimental setup



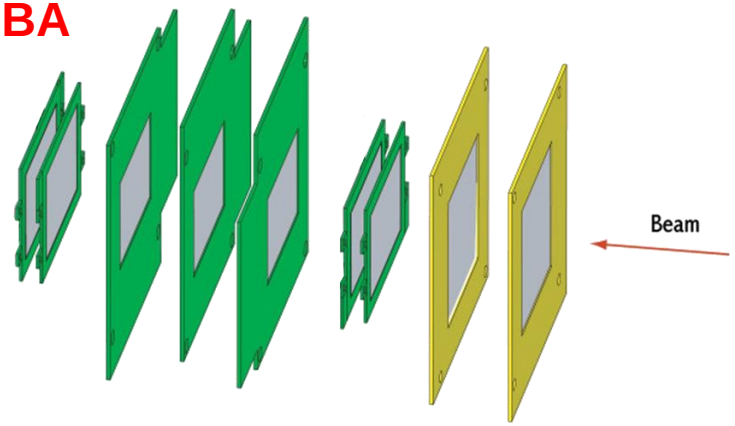
Detectors at S2:
TPC1 + TPC2 + Scintillator

Implant-decay station and neutron detector



Detectors / DAQ

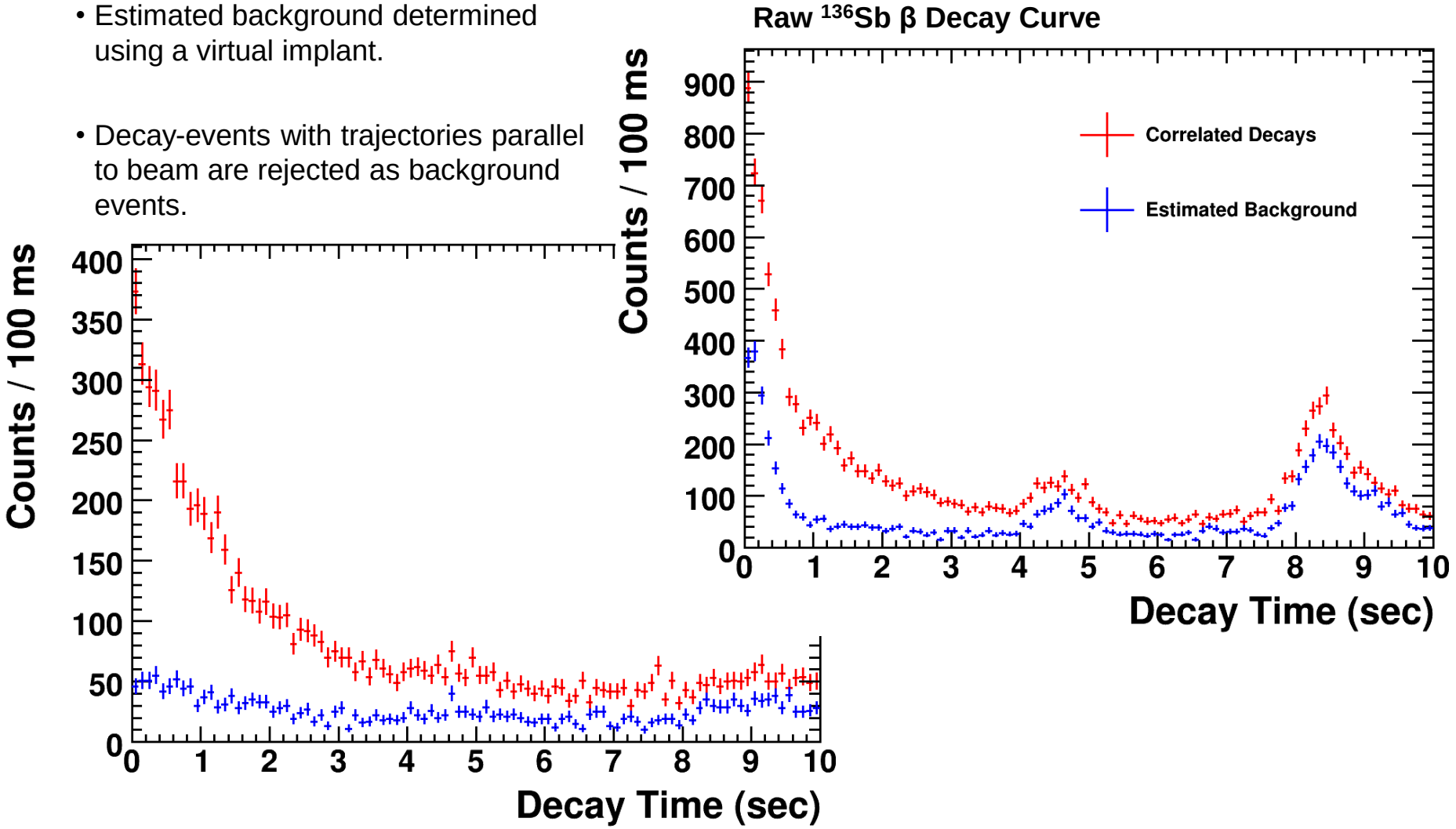
SIMBA



- Implantation/decay system SIMBA has been mounted in a cylindrical container such that it can be surrounded by the BELEN detector (**SIMBA detector ready to be installed**)
- Polyethelene matrix is ready to be milled to hold the BELEN and SIMBA detectors. Additional shielding will be used to block beam-related neutrons.
- 10 additional ^{3}He tubes for BELEN have been ordered in addition to the current 20 increasing efficiency to ~46% (**BELEN will be ready beginning 2011**)
- Data Acquisition system was written during the BELEN neutron detector test and with the addition of SIMBA is ready to be tested with the full-setup (**DAQ ready**)
- Analysis software developed and tested

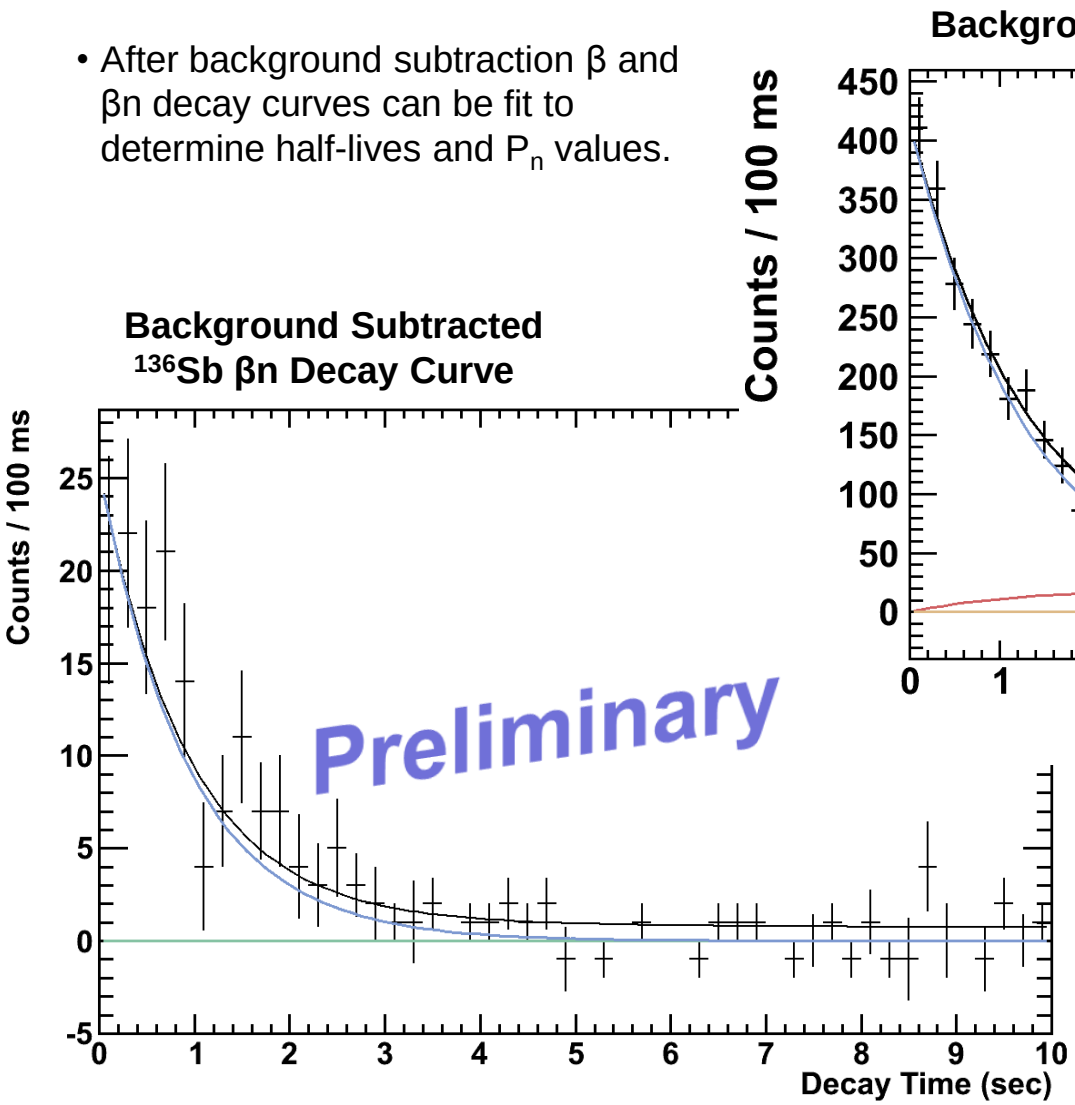
E040 Analysis: ^{136}Sb Case

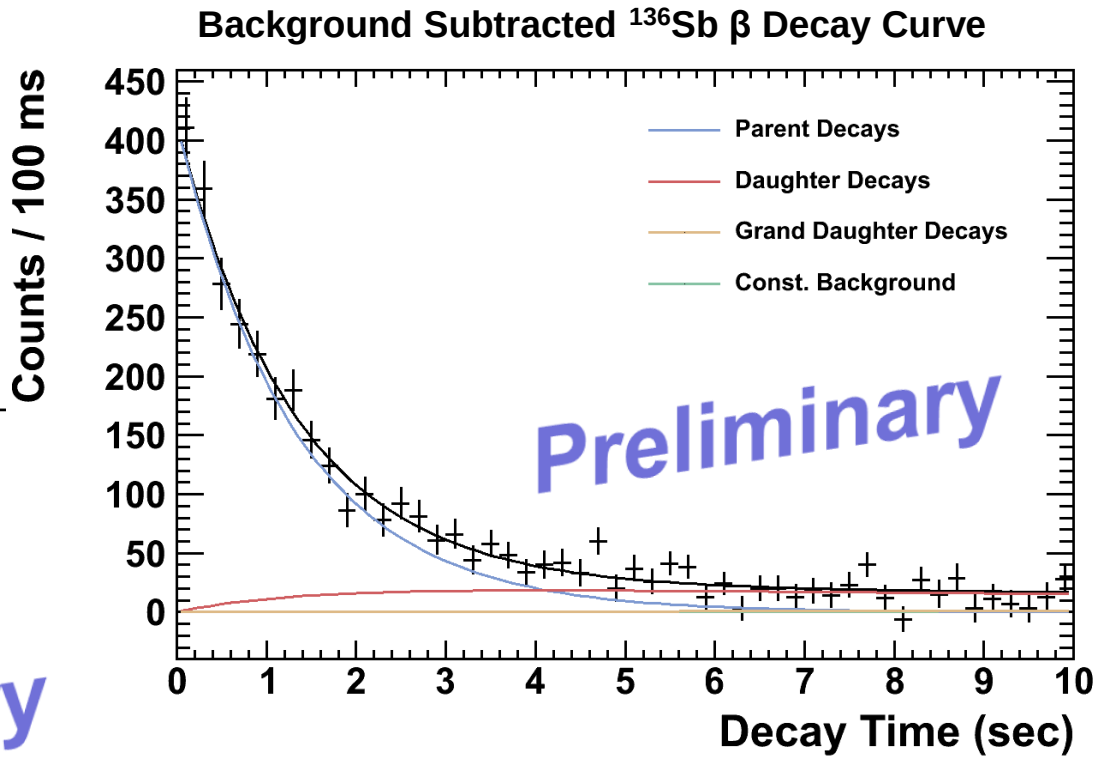
- Previous experiment E040 was performed with a similar setup.
- Estimated background determined using a virtual implant.
- Decay-events with trajectories parallel to beam are rejected as background events.



^{136}Sb Case

- After background subtraction β and βn decay curves can be fit to determine half-lives and P_n values.

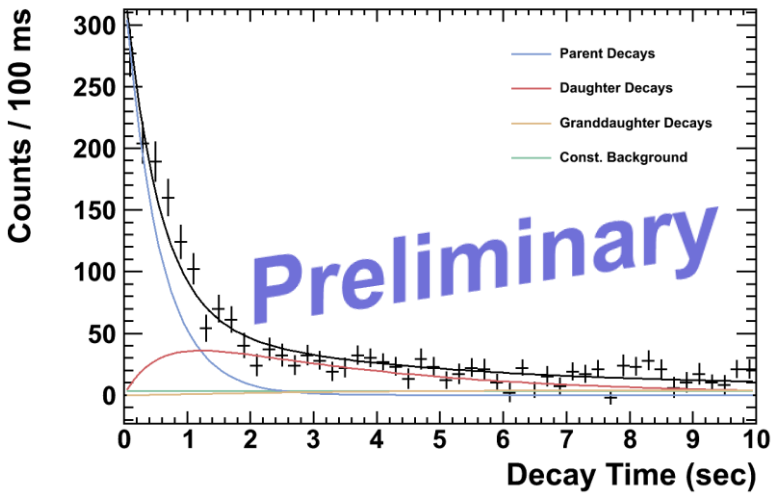




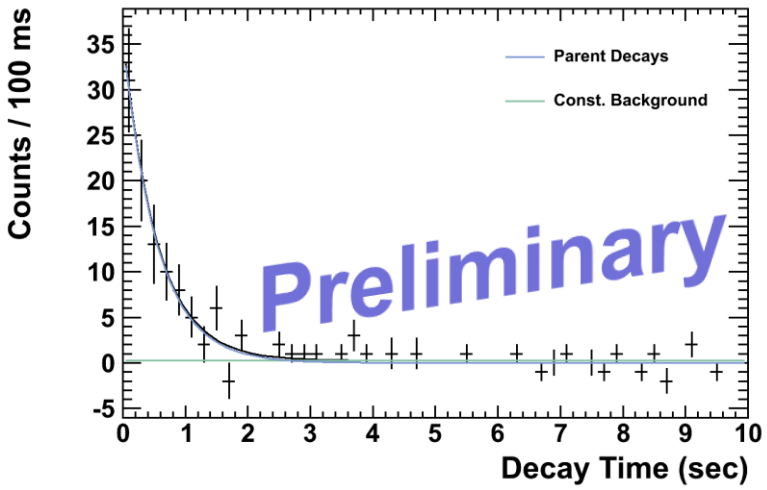
E040 Analysis

- Method can also be applied to other species.

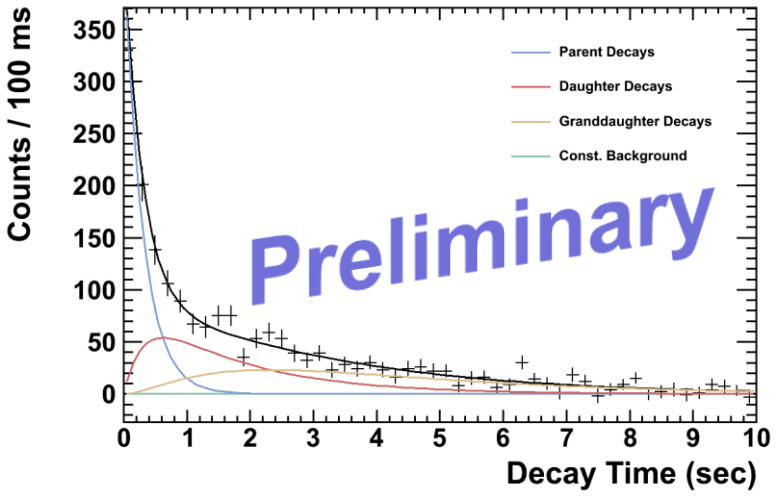
^{137}Sb β Decay Curve



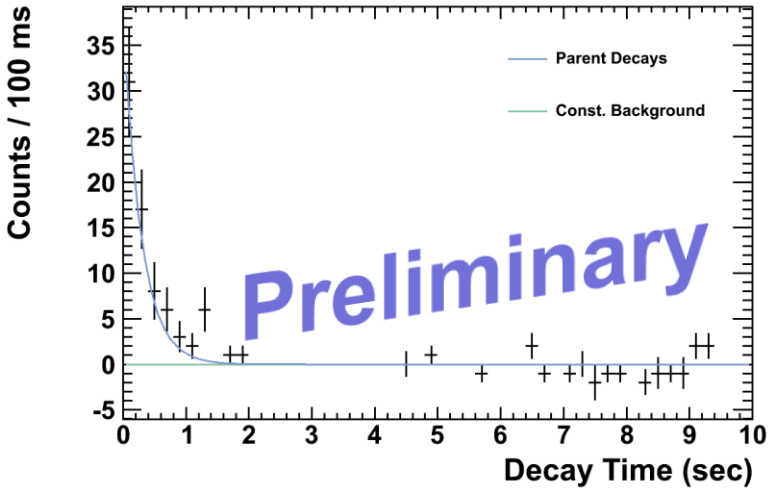
^{137}Sb βn Decay Curve



^{142}I β Decay Curve



^{142}I βn Decay Curve



Approved beam time

Parasitic beam time	
projectile	beam time
^{136}Xe (1 A GeV)	2 days

Main beam time		
projectile	setting	beam time
^{238}U (1 A GeV)	FRS calibrations	1 day
^{238}U (1 A GeV)	^{128}Pd	5 days

Total approved beam time	
main beam time ^{238}U	6 days
parasitic beam time ^{136}Xe	2 days

We request beamtime any time 2011