Simulation of Silicon Detector Response for β-delayed Proton Emission

JINA Frontiers
Lake Geneva, WI
October 22, 2010

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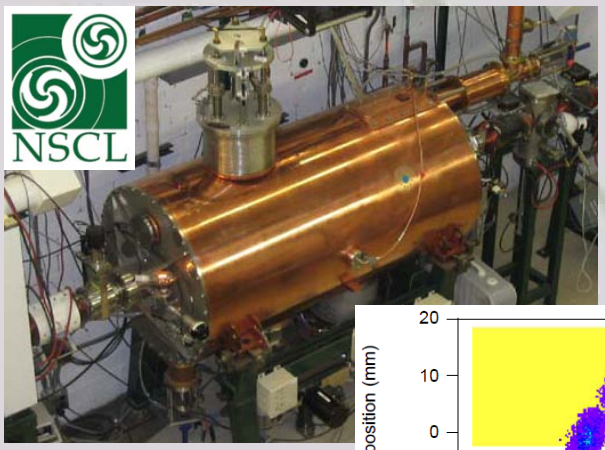
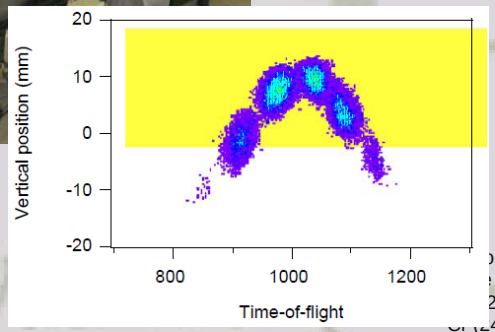
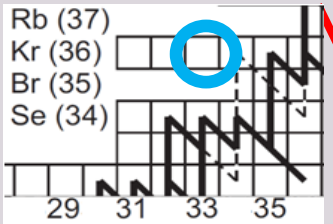
Recent βp-Measurements

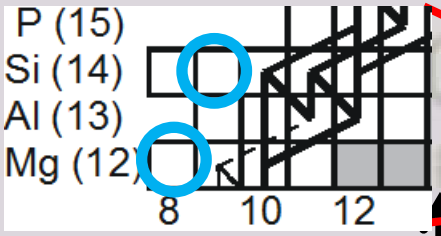


Bazin et. al. 2009, NIM A

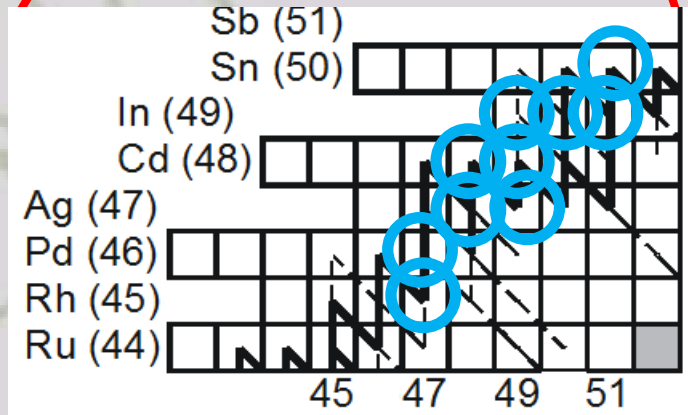




Expt. 07025



Expt. 08008
Expt. 09024



Expt. 07037

Z

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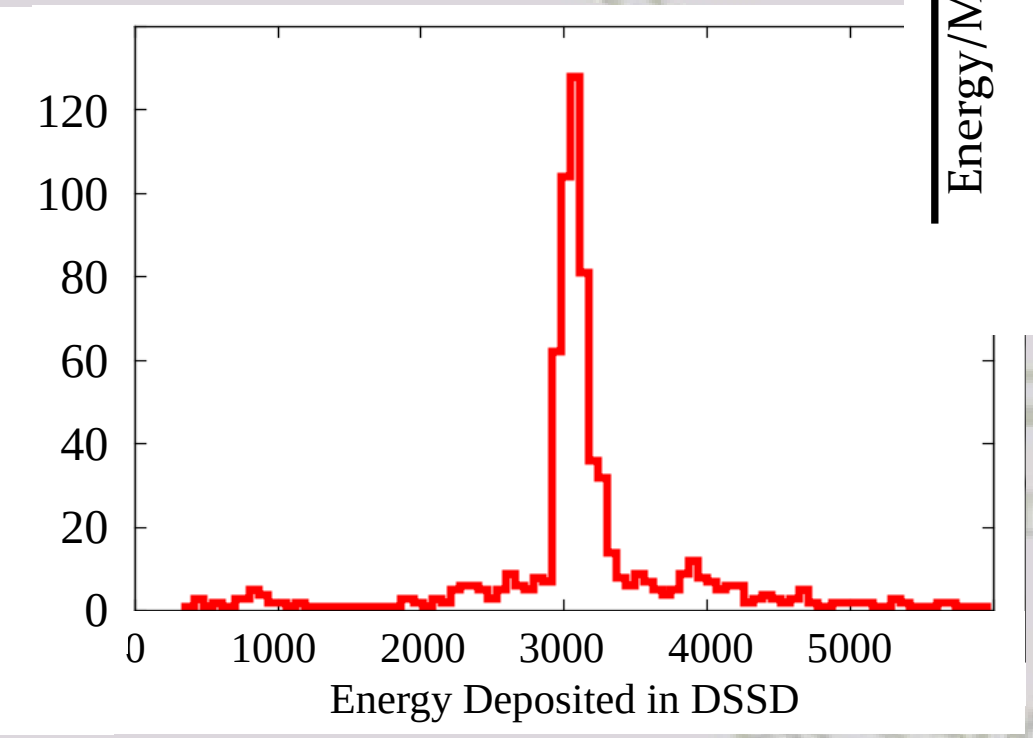
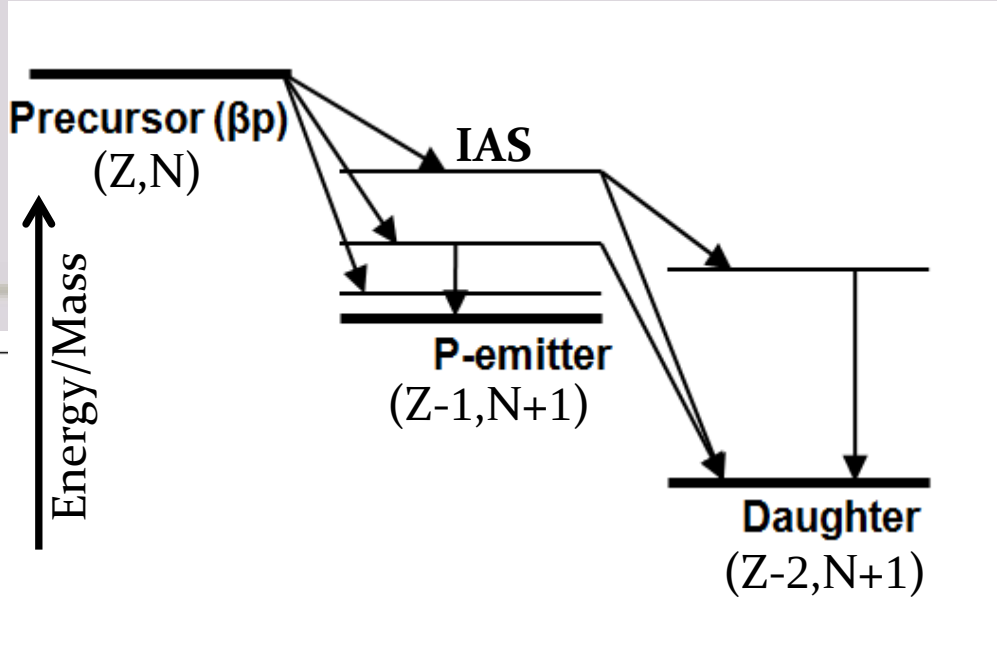
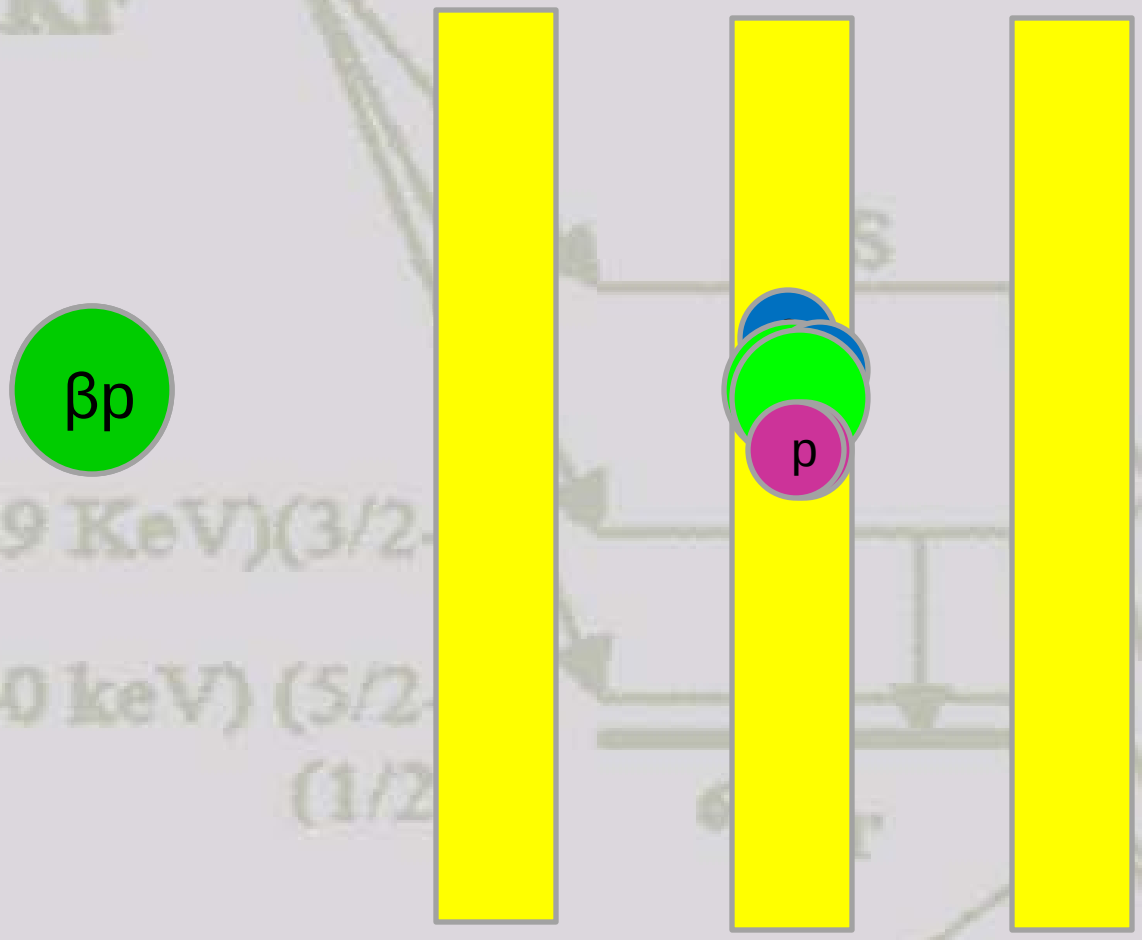
Purpose of Simulations

- βp-isotope implanted within DSSD
  - proton spectroscopy

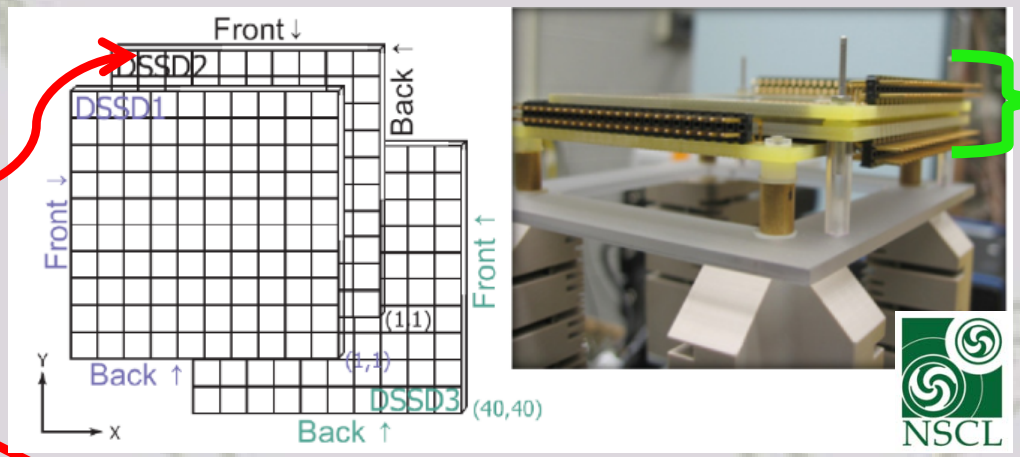




Implantation into DSSD

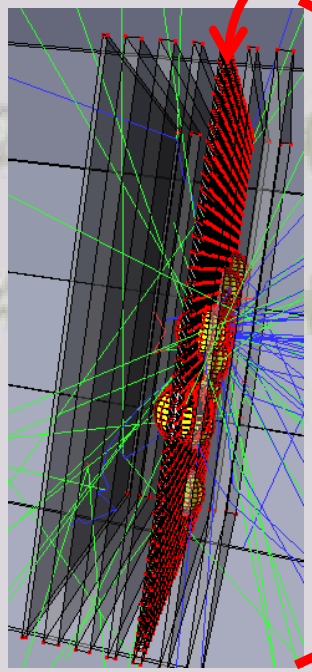


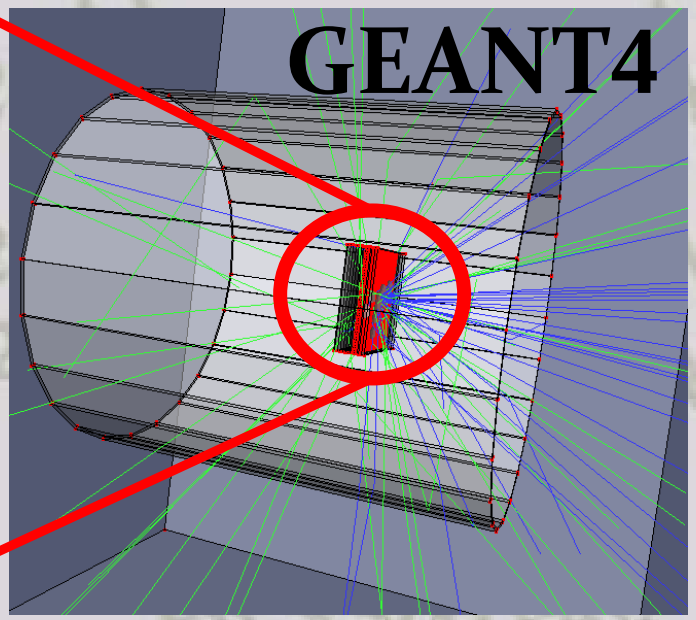
Experimental Set-Up



3 ~500μm DSSDs stacked in the BCS

Implantation Detector

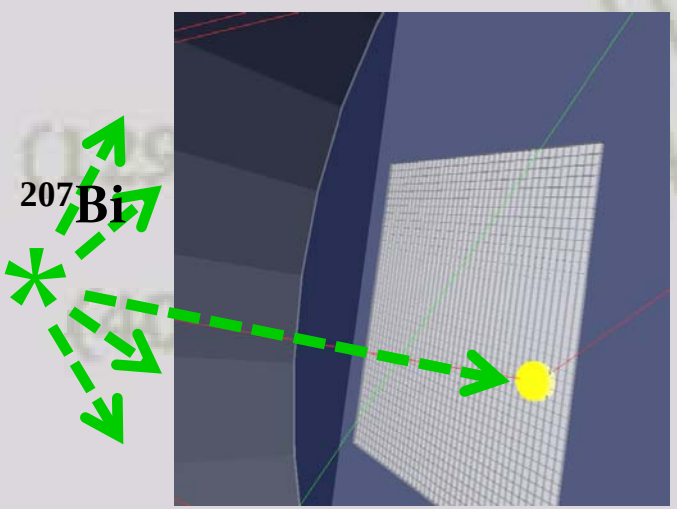


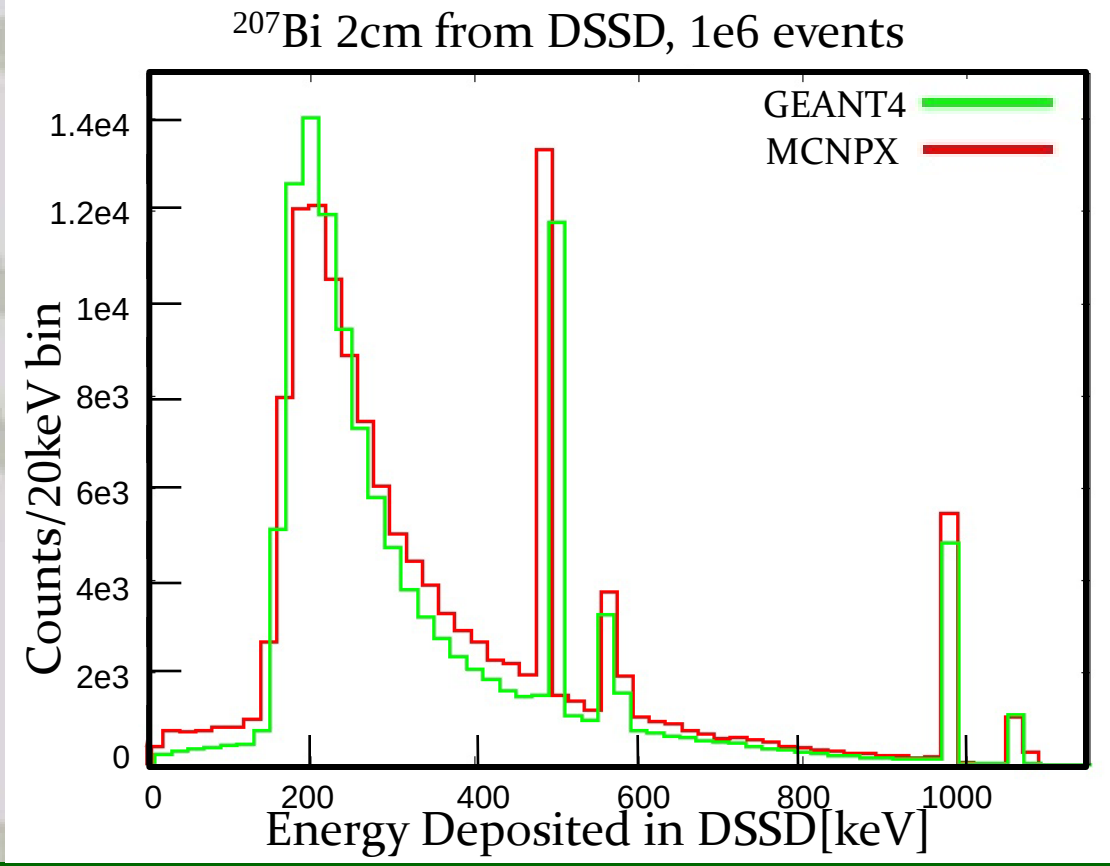


- Isotropic decay
- Implantation Distribution:
  - X-Y: 2D Gaussian fit to data
  - Depth: LISE++

Benchmarking of Simulation

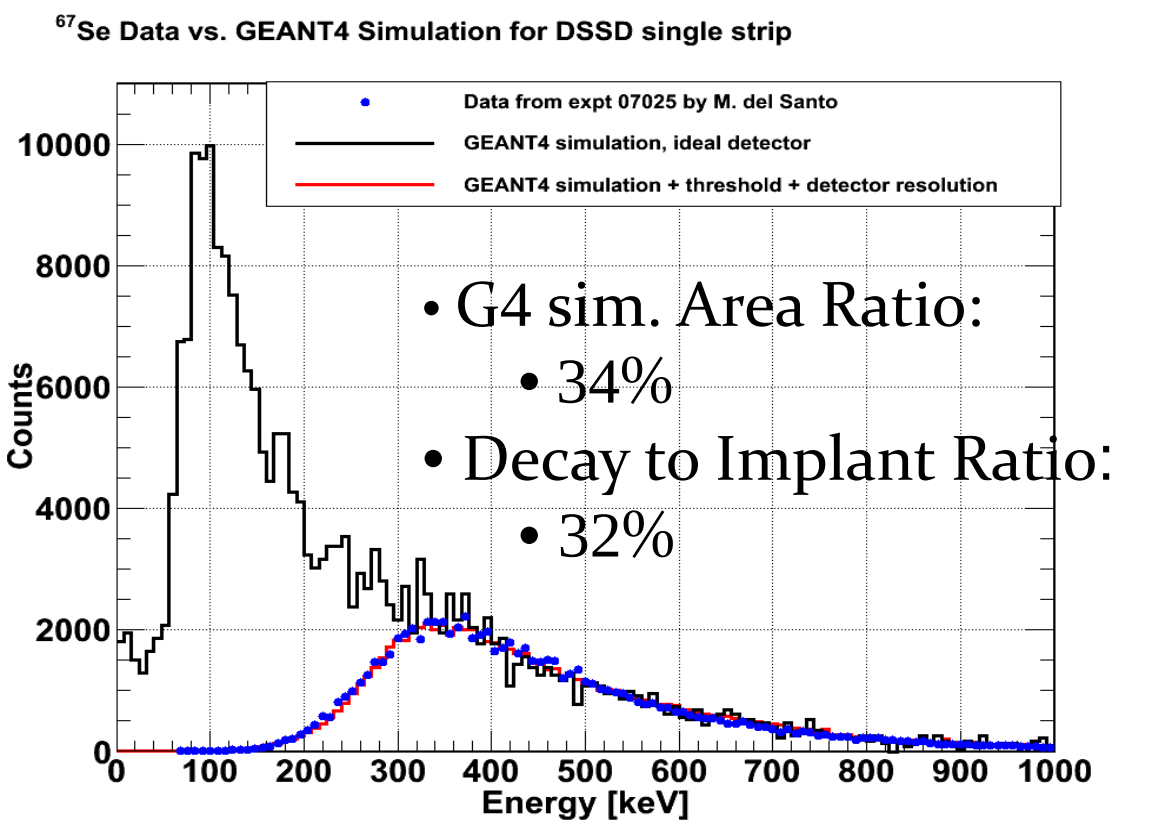
- benchmarked GEANT4 with MCNPX
  - Ex: ^{207}Bi e^- emitter





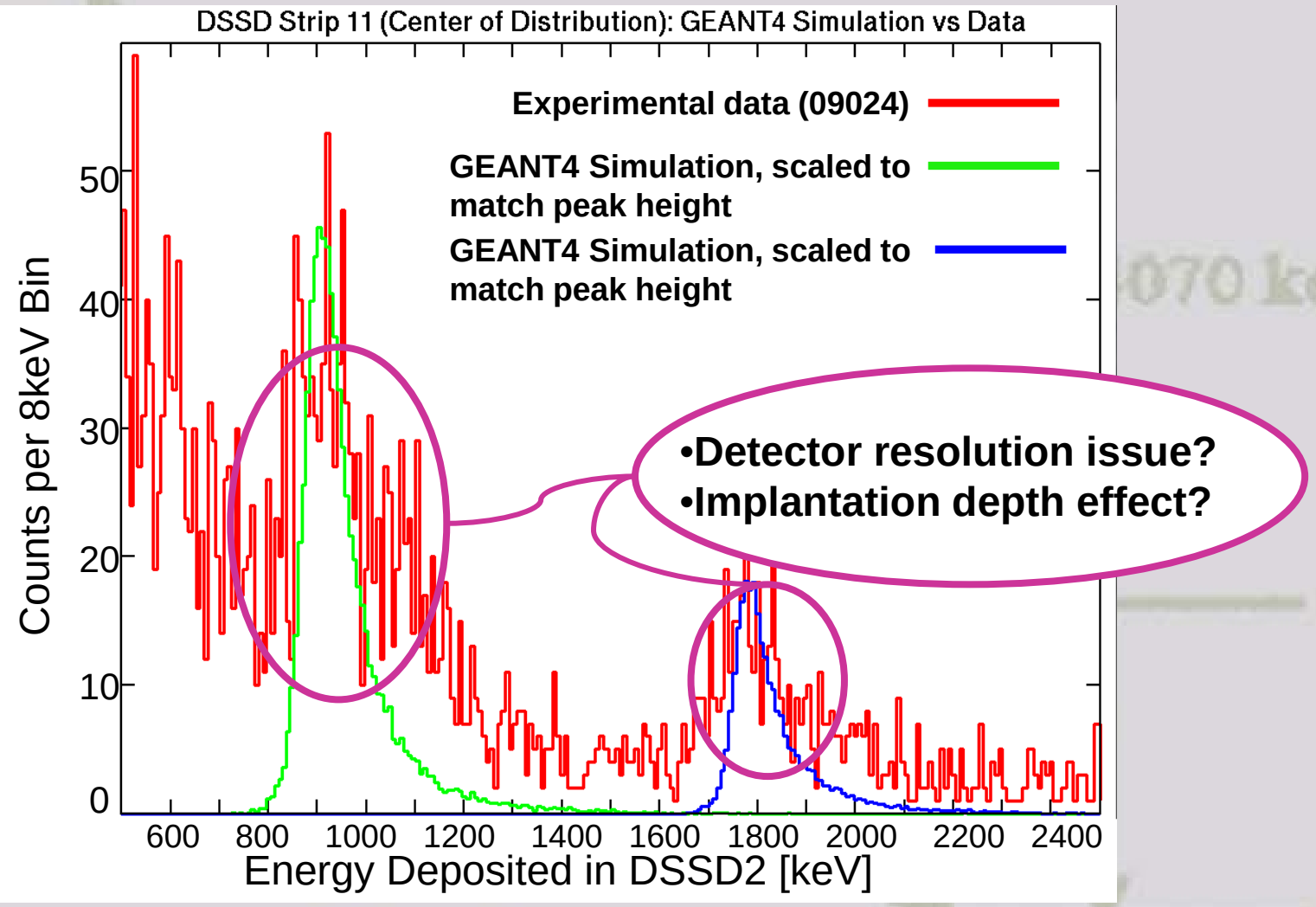
Comparison with β^+-decay data

- Detector Resolution
  - Gaussian Dist.
  - σ[MeV] = $0.022/\sqrt{(E)} + 0.034$
- Threshold
  - tanh function
  - Center = 280 keV
  - Width = 60 keV



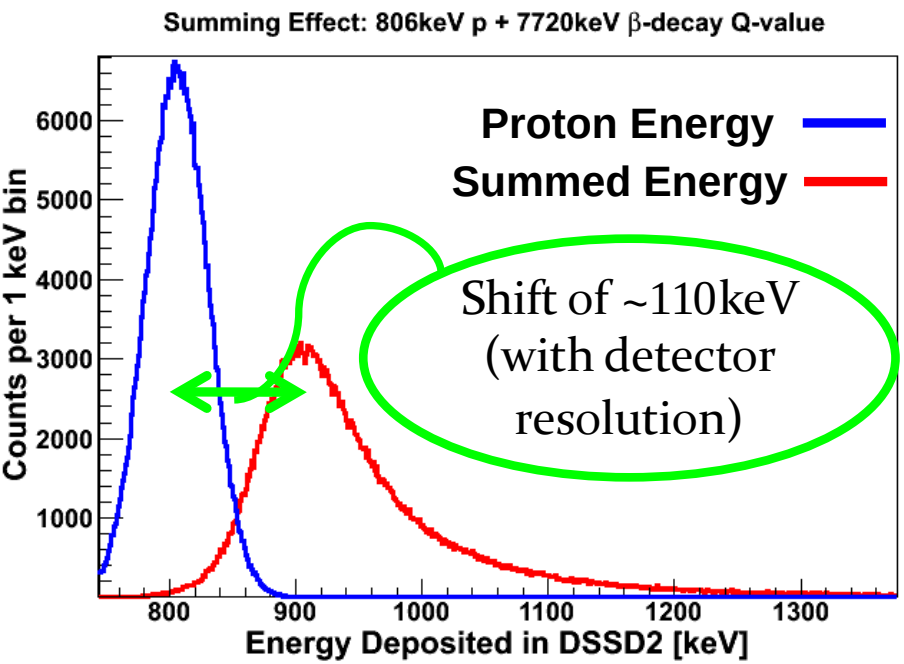
**Channel to Energy calibrations for data from DSSD supplied by M. del Santo*

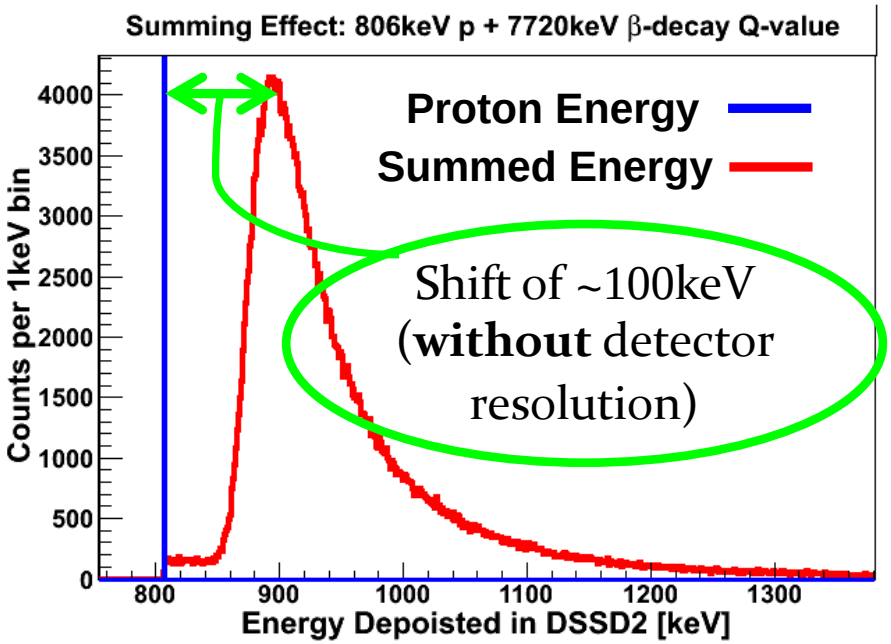
Comparison to βp Data*



Channel to Energy calibrations for data from DSSD supplied by M. del Santo

Impact of Summing Effect*





- Detector Resolution:
  - Gaussian Distribution
  - $\sigma[\mathrm{MeV}] = 0.022/\sqrt{(E)} + 0.034$

- Extract E_p from data via shift

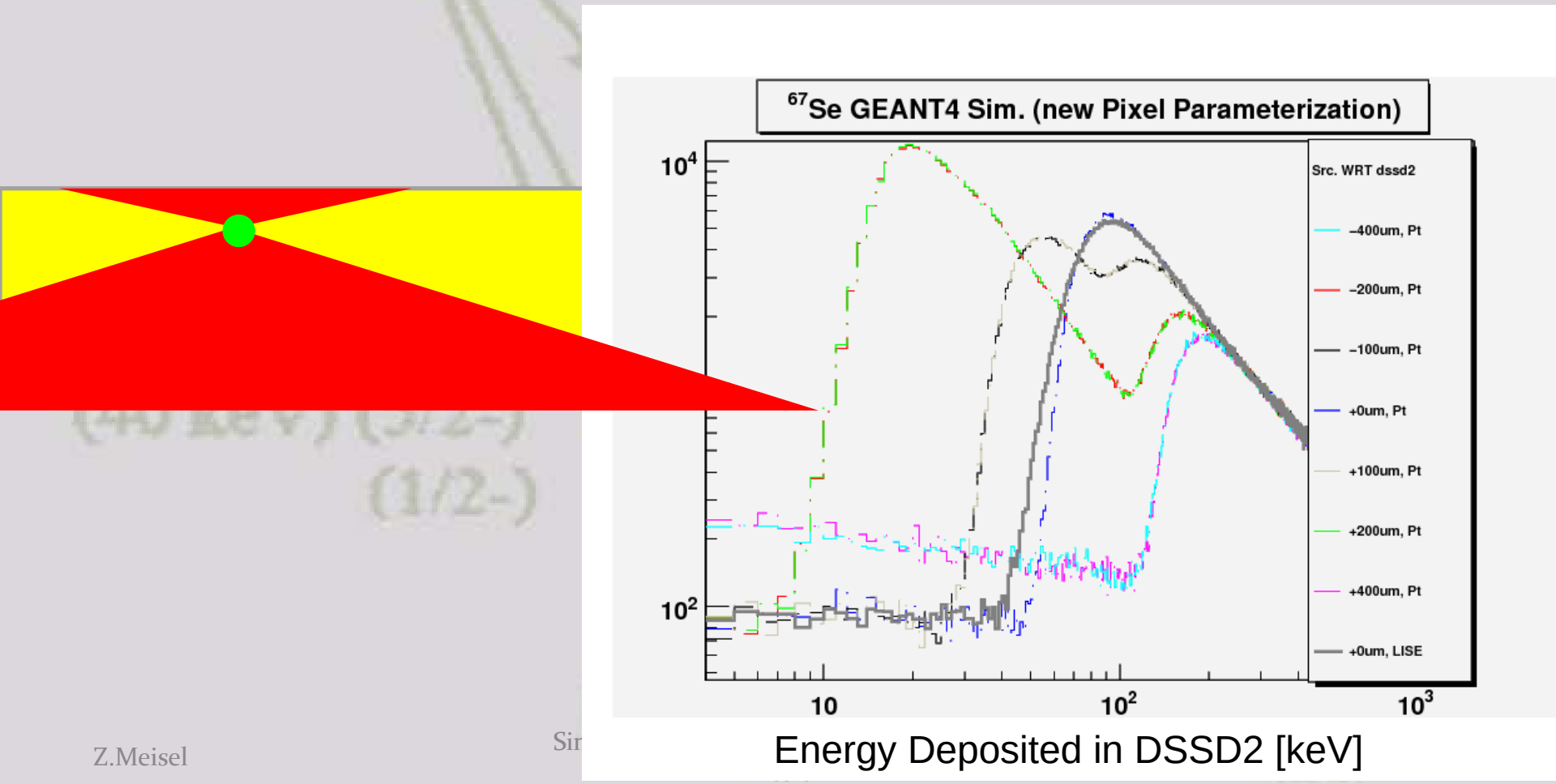
*Preliminary Result

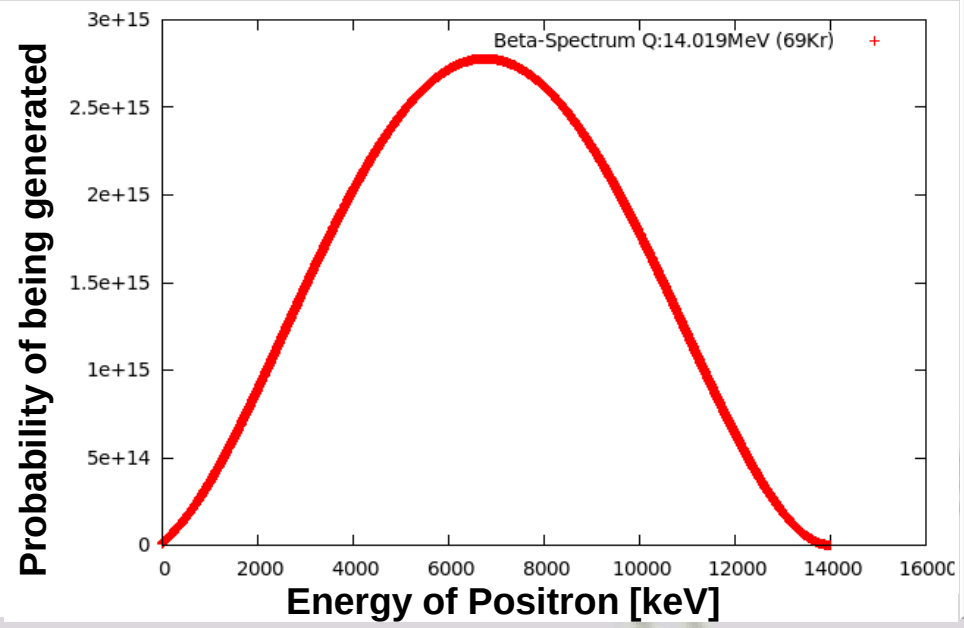
Acknowledgements

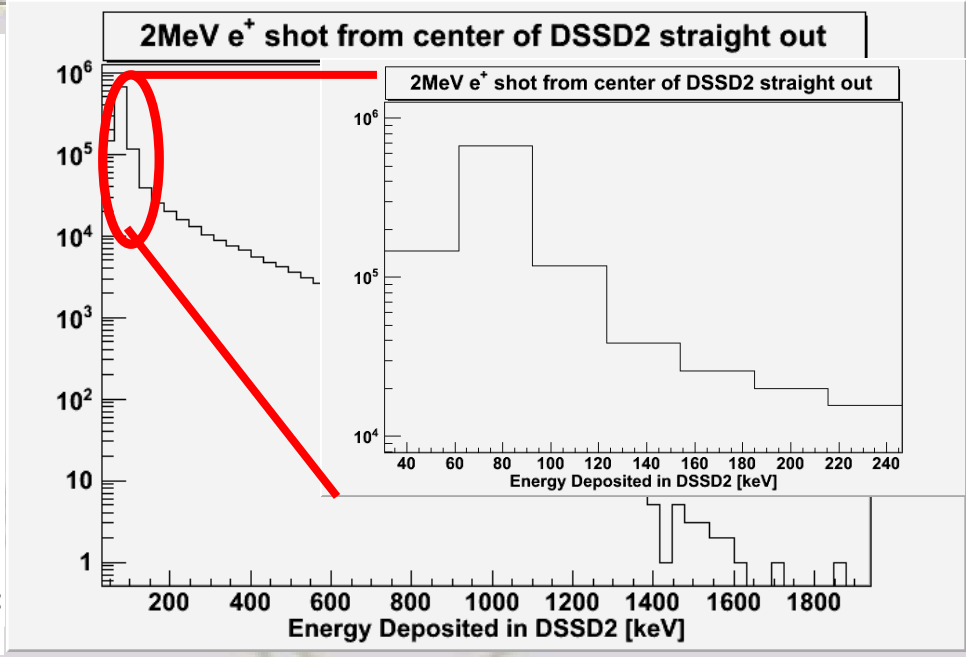
- *Thanks to:*
  - Ana Becerril, Heather Crawford, Richard Cyburt, Sebastian George, Giuseppe Lorusso, Paul Mantica, Marcelo del Santo, Hendrik Schatz, Karl Smith

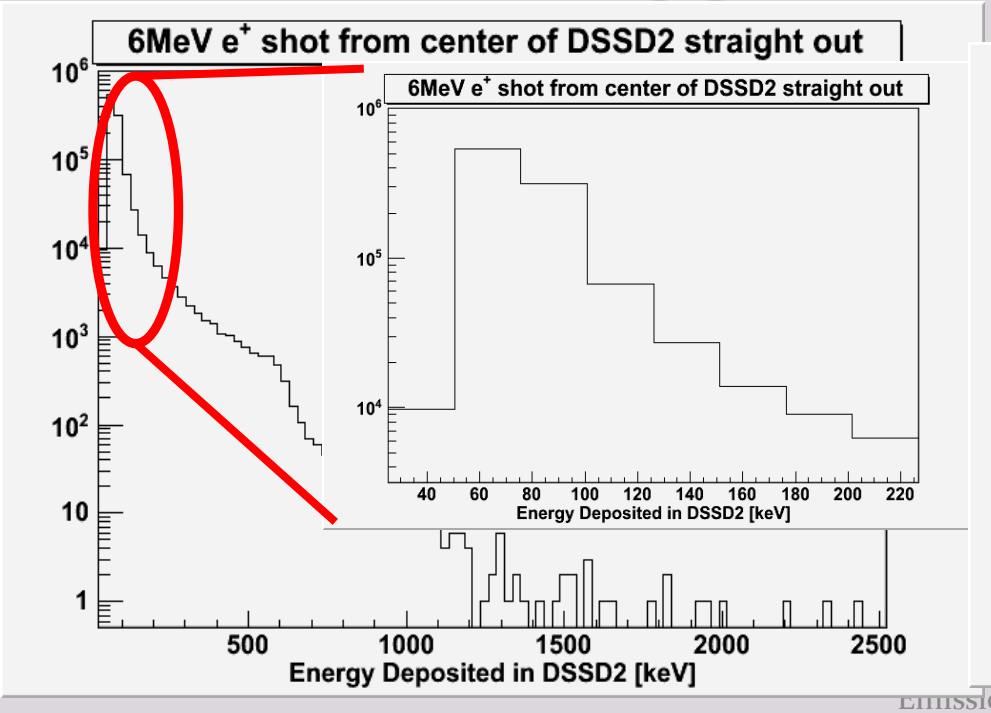
Supplementary slides

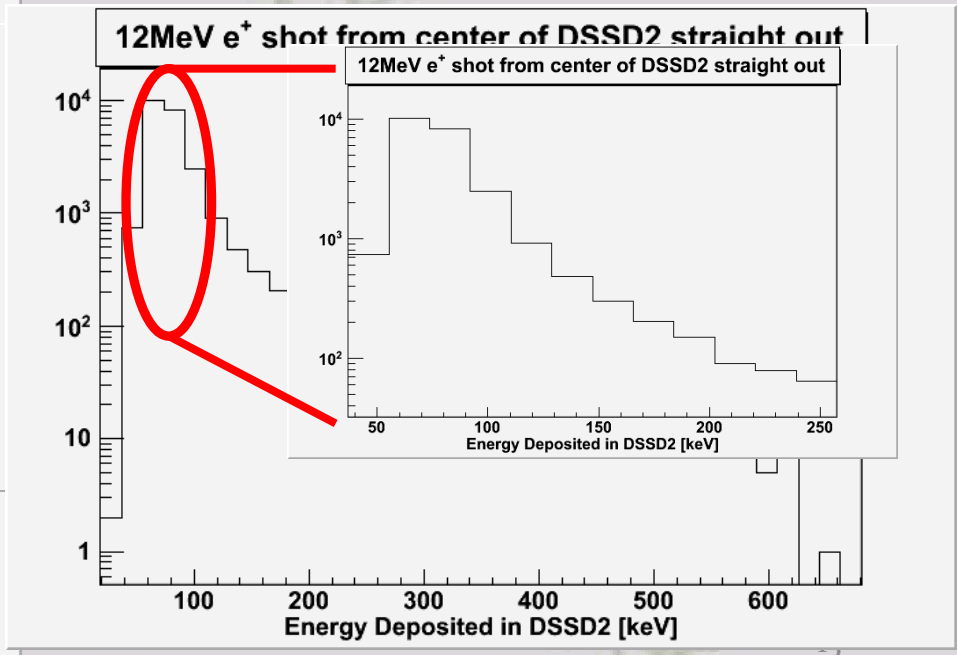
DSSD, correct length:height = 80/1

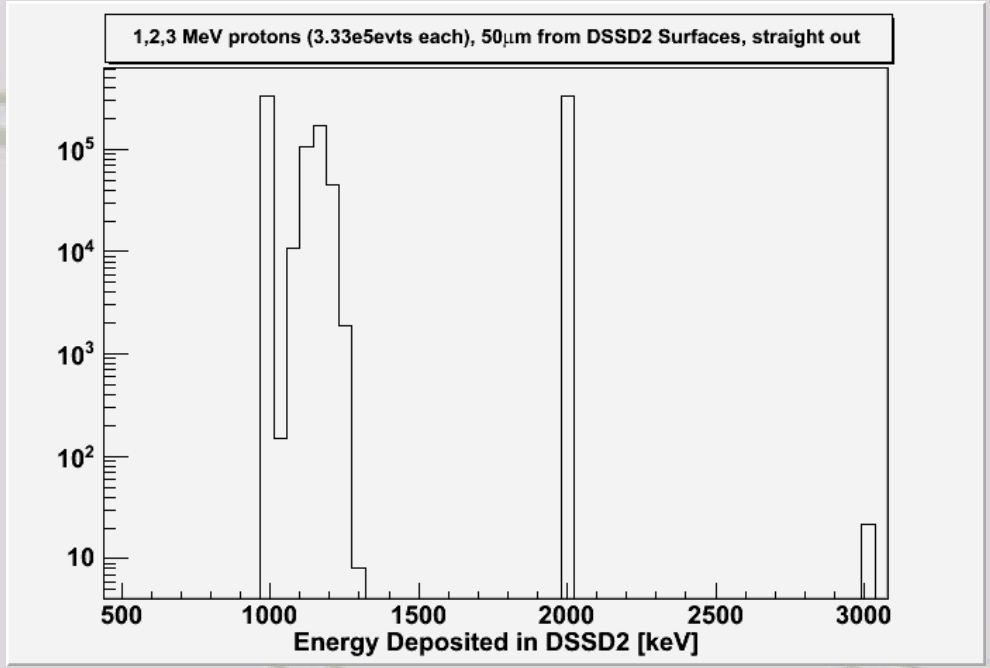


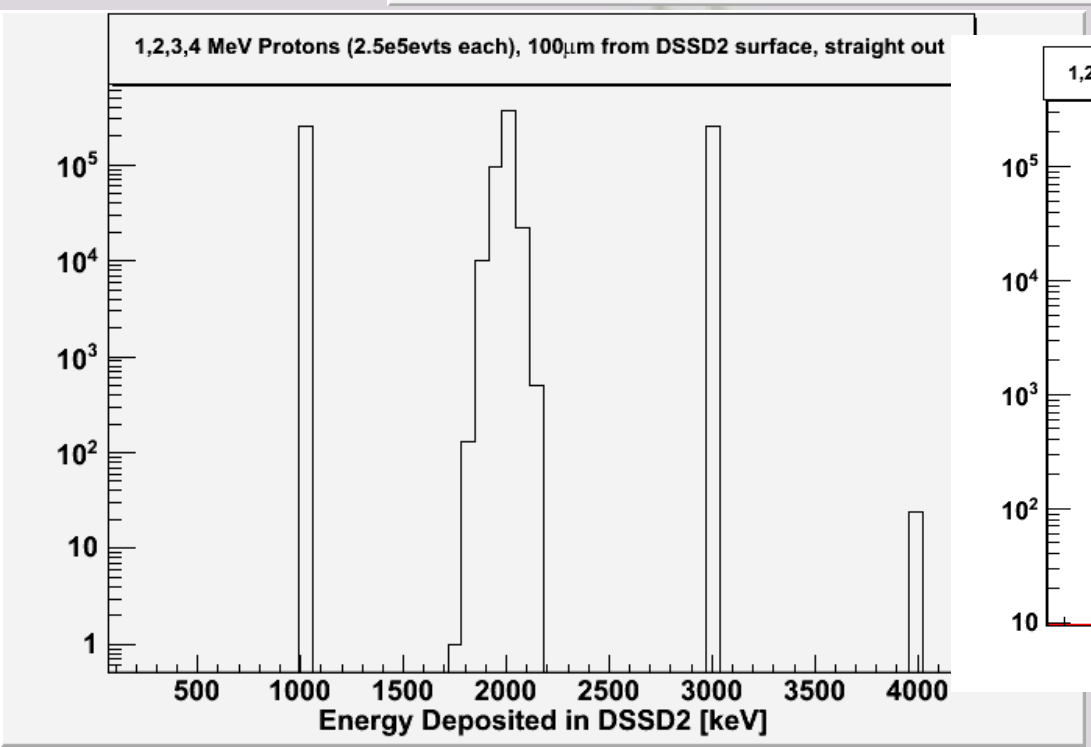

Beta-Spectrum Q:14.019MeV (69Kr)
Probability of being generated
Energy of Positron [keV]

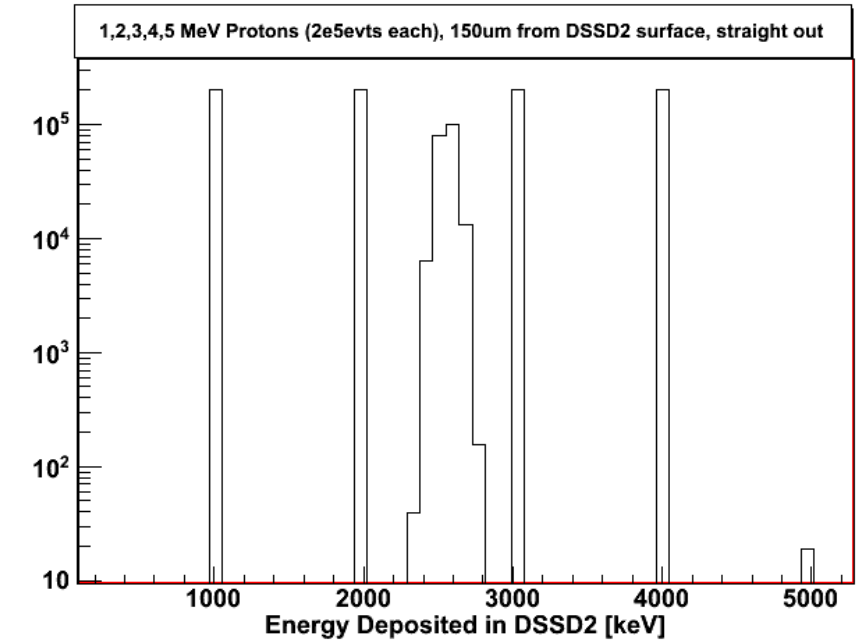

2MeV e+ shot from center of DSSD2 straight out
2MeV e+ shot from center of DSSD2 straight out
Energy Deposited in DSSD2 [keV]
Energy Deposited in DSSD2 [keV]

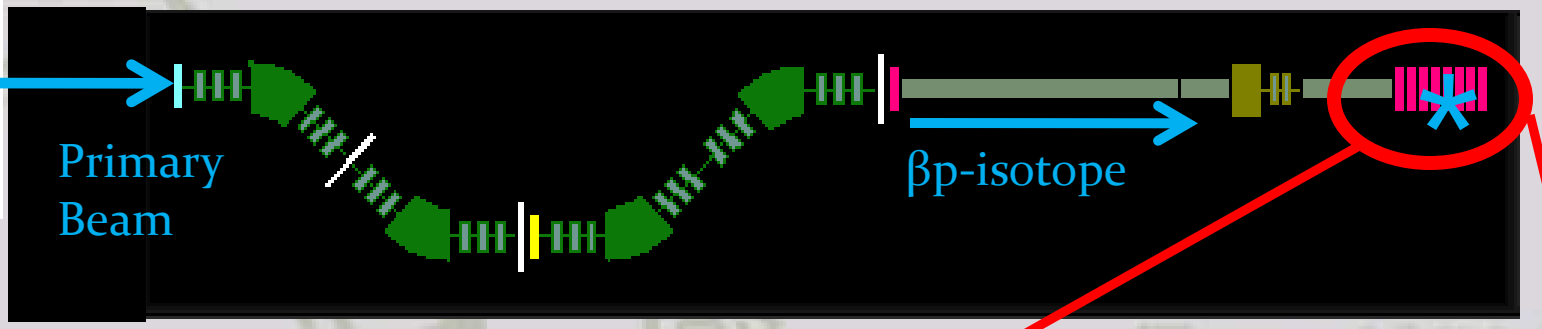

6MeV e+ shot from center of DSSD2 straight out
6MeV e+ shot from center of DSSD2 straight out
Energy Deposited in DSSD2 [keV]
Energy Deposited in DSSD2 [keV]

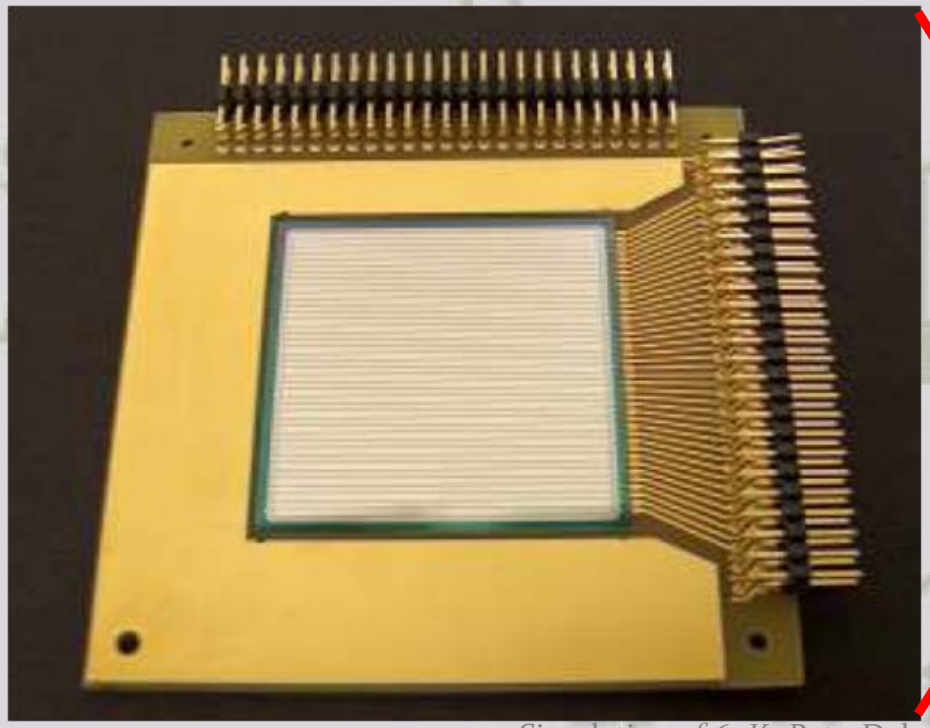

12MeV e+ shot from center of DSSD2 straight out
12MeV e+ shot from center of DSSD2 straight out
Energy Deposited in DSSD2 [keV]
Energy Deposited in DSSD2 [keV]

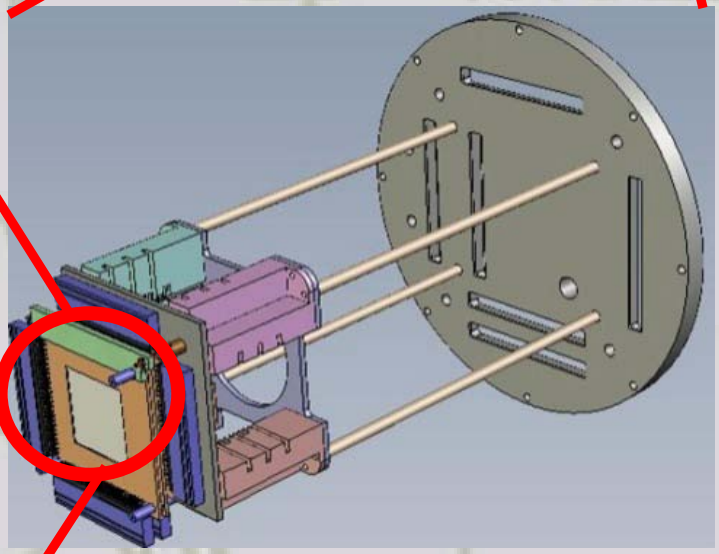

1,2,3 MeV protons (3.33e5evts each), 50μm from DSSD2 Surfaces, straight out
10^5
10^4
10^3
10^2
10
500
1000
1500
2000
2500
3000
Energy Deposited in DSSD2 [keV]


1,2,3,4 MeV Protons (2.5e5evts each), 100μm from DSSD2 surface, straight out
10^5
10^4
10^3
10^2
10
1
500
1000
1500
2000
2500
3000
3500
4000
Energy Deposited in DSSD2 [keV]

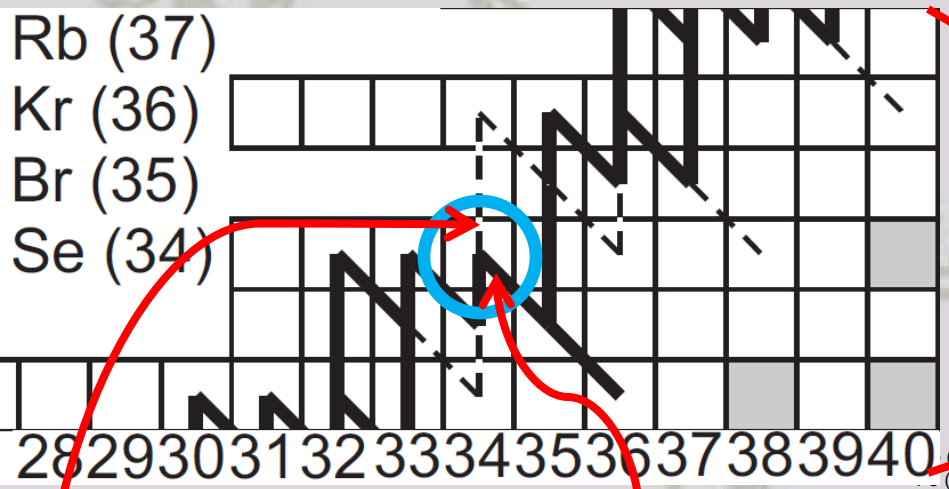

1,2,3,4,5 MeV Protons (2e5evts each), 150um from DSSD2 surface, straight out
10^5
10^4
10^3
10^2
10
1000
2000
3000
4000
5000
Energy Deposited in DSSD2 [keV]

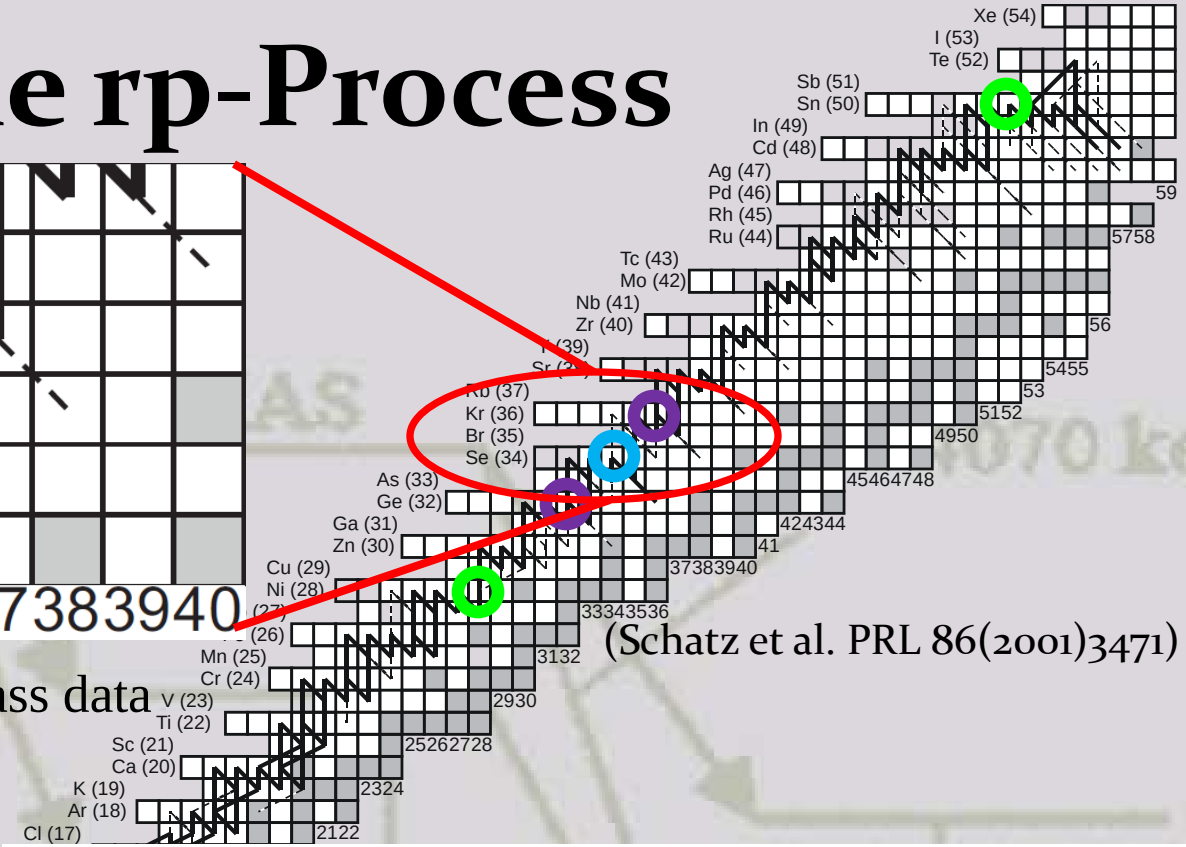

Primary
Beam
βp-isotope





The rp-Process

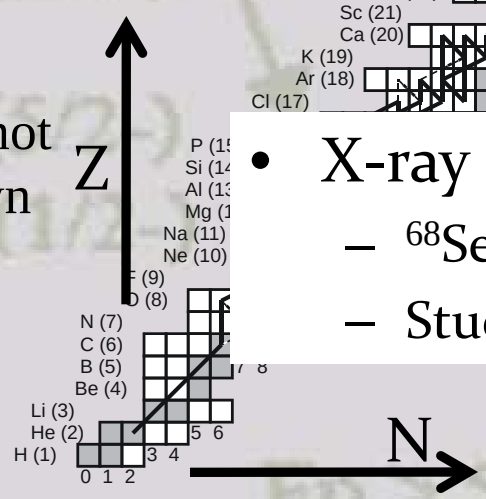




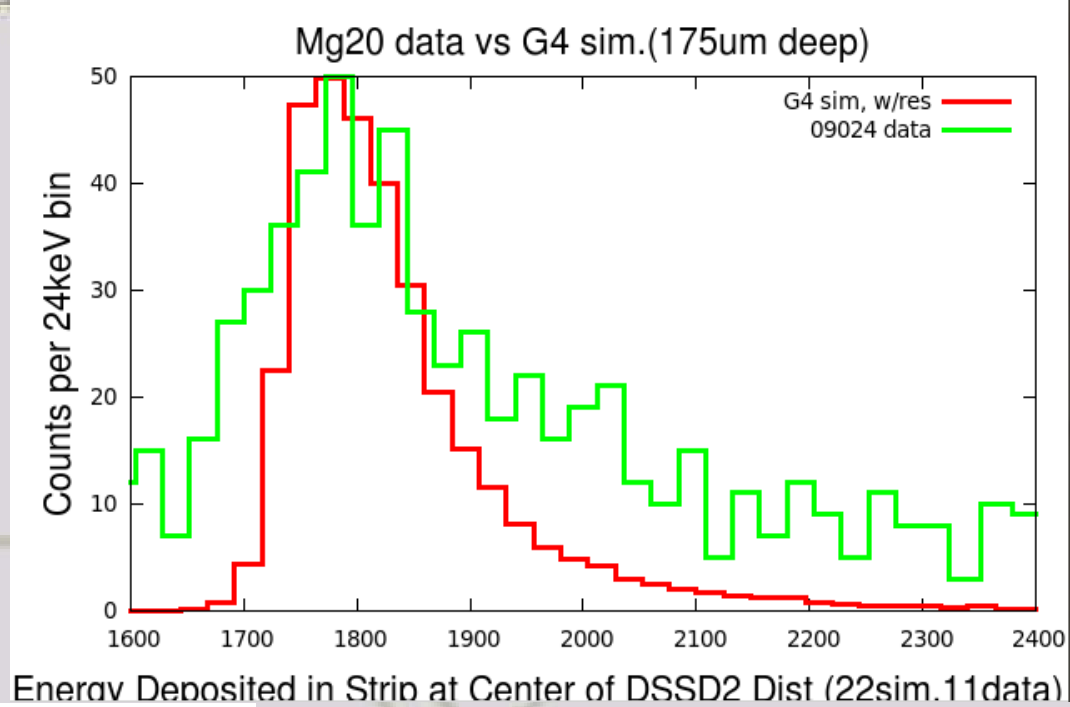
(Schatz et al. PRL 86(2001)3471)

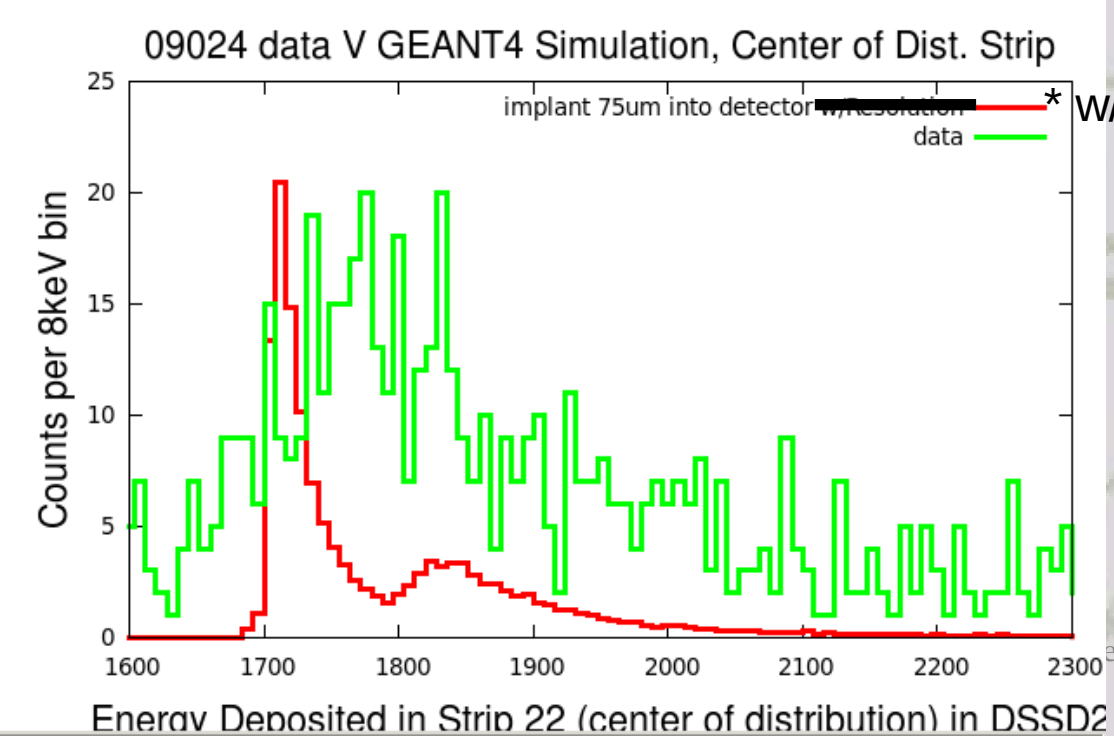
β^+-decay rate known from mass data

Proton Capture rate not experimentally known



- X-ray Burst Waiting Point:
  - $^{68}Se + p + p \rightarrow {}^{69}Br^* + p \rightarrow {}^{70}Kr + \gamma$
  - Study via: $^{69}Kr \rightarrow e^+ + \nu_e + {}^{69}Br^* \rightarrow {}^{68}Se + p$





* w/out resolution