Spin Distribution of Excited Nuclear States in $^{nat}Fe(p,\alpha n)$

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08 May 2017

6th Workshop on Nuclear Level Density and Gamma Strength

Berkeley
UNIVERSITY OF CALIFORNIA

^{51,52}Mn - Motivation

- Emerging medical radionuclides
  - ^{51}Mn ($t_{1/2}$ = 46 min, 97% β^+) – short-lived PET tracer for metabolic studies
  - ^{52g}Mn ($t_{1/2}$ = 5.6 d, 29% β^+) – long-lived PET tracer for neuron tracking, immune studies

Preparation and *in vivo* characterization of $^{51}MnCl_2$ as PET tracer of Ca^{2+} channel-mediated transport

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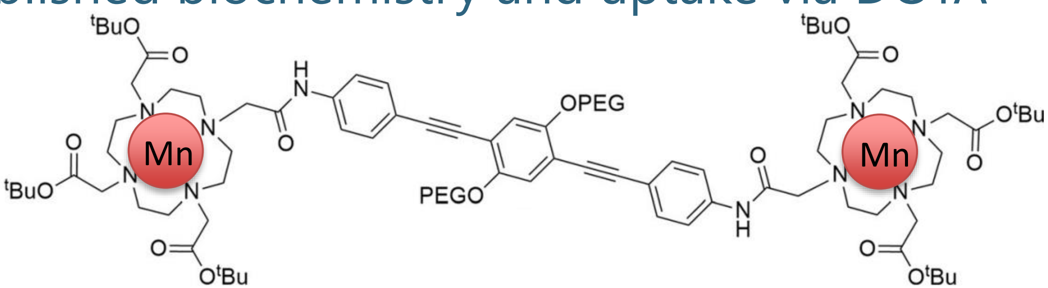
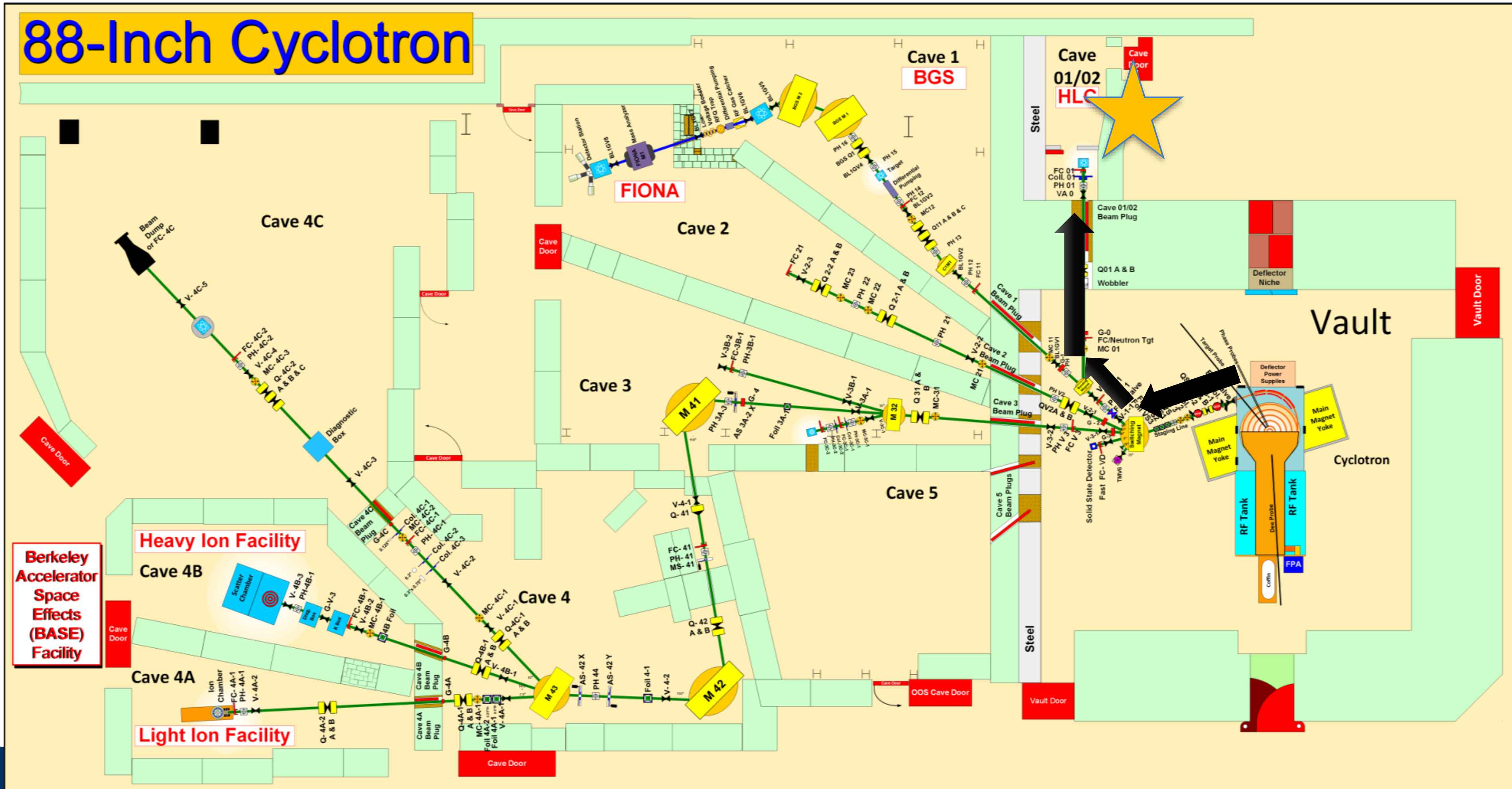
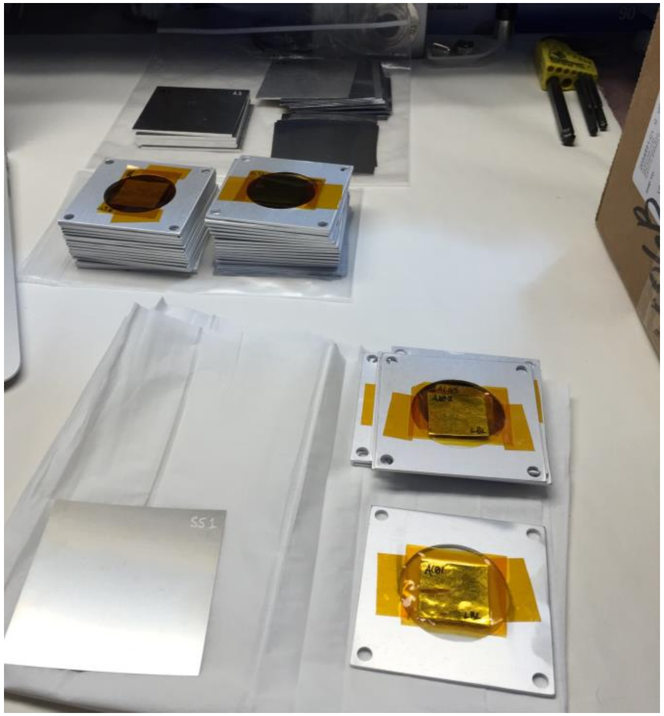
  - Manganese has well-established biochemistry and uptake via DOTA-based chelation

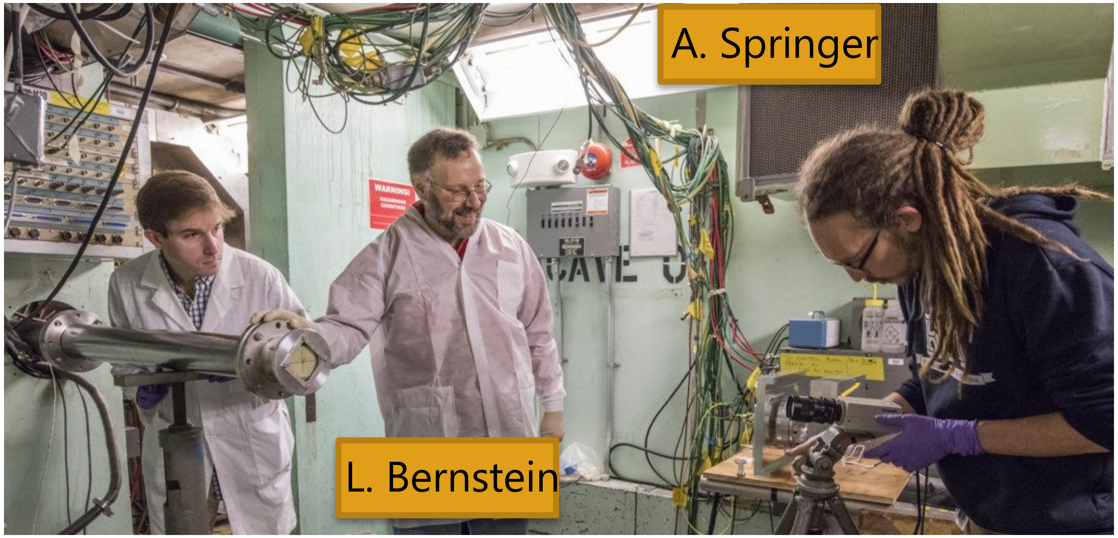


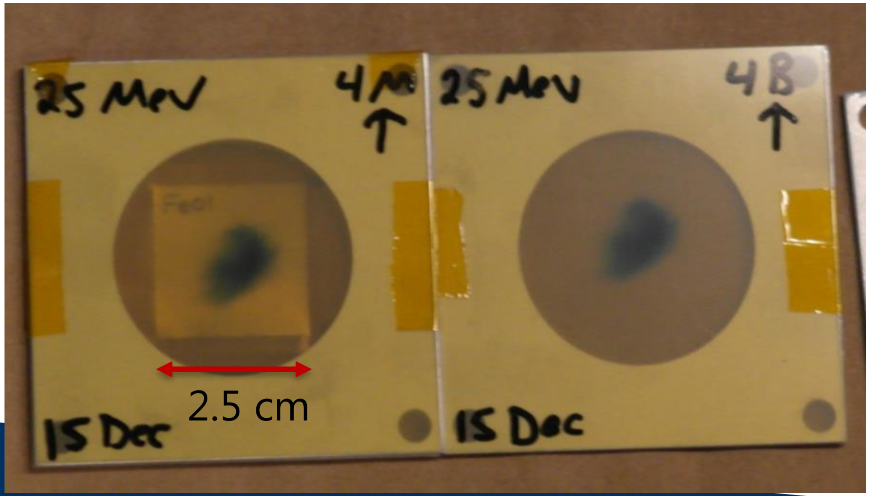
Almost no Fe(p,x) XS measurements exist – can use these to probe spin physics in the A≈50 region

Methodology



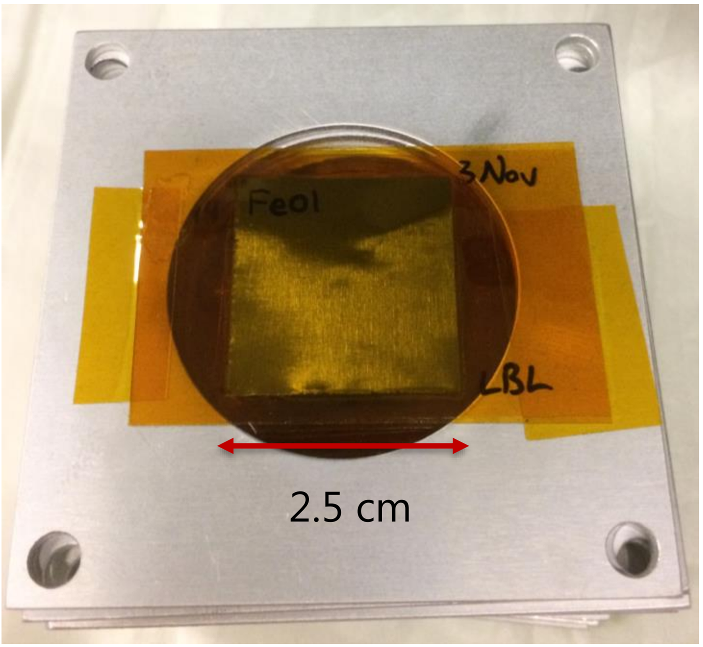


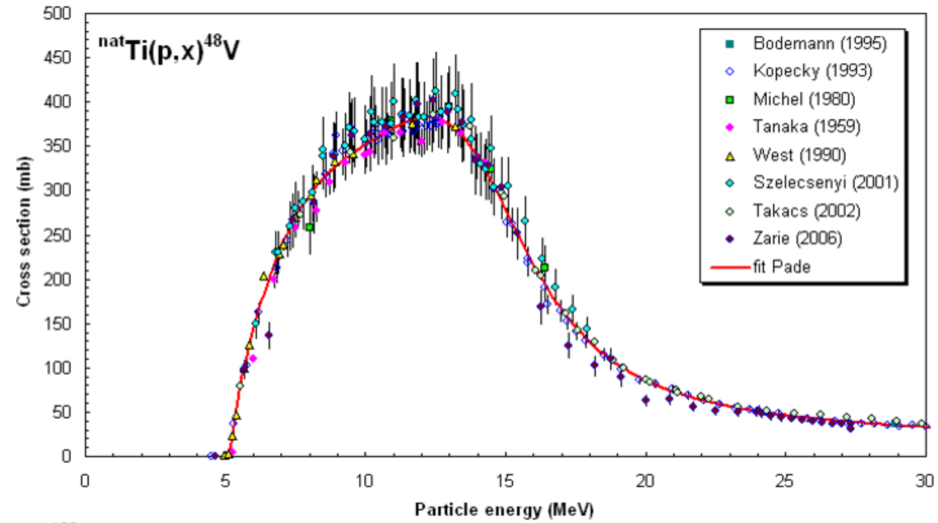


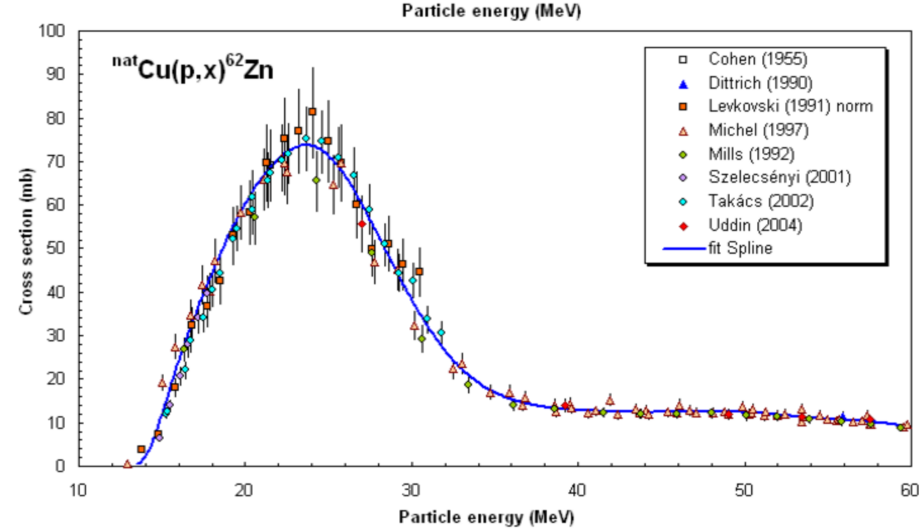


Two overlapping stacks:
E_p= 55→21 MeV, 25→11 MeV

- 25 µm-thin ^{nat}Fe, ^{nat}Cu, ^{nat}Ti foils in 0.1” Al frames

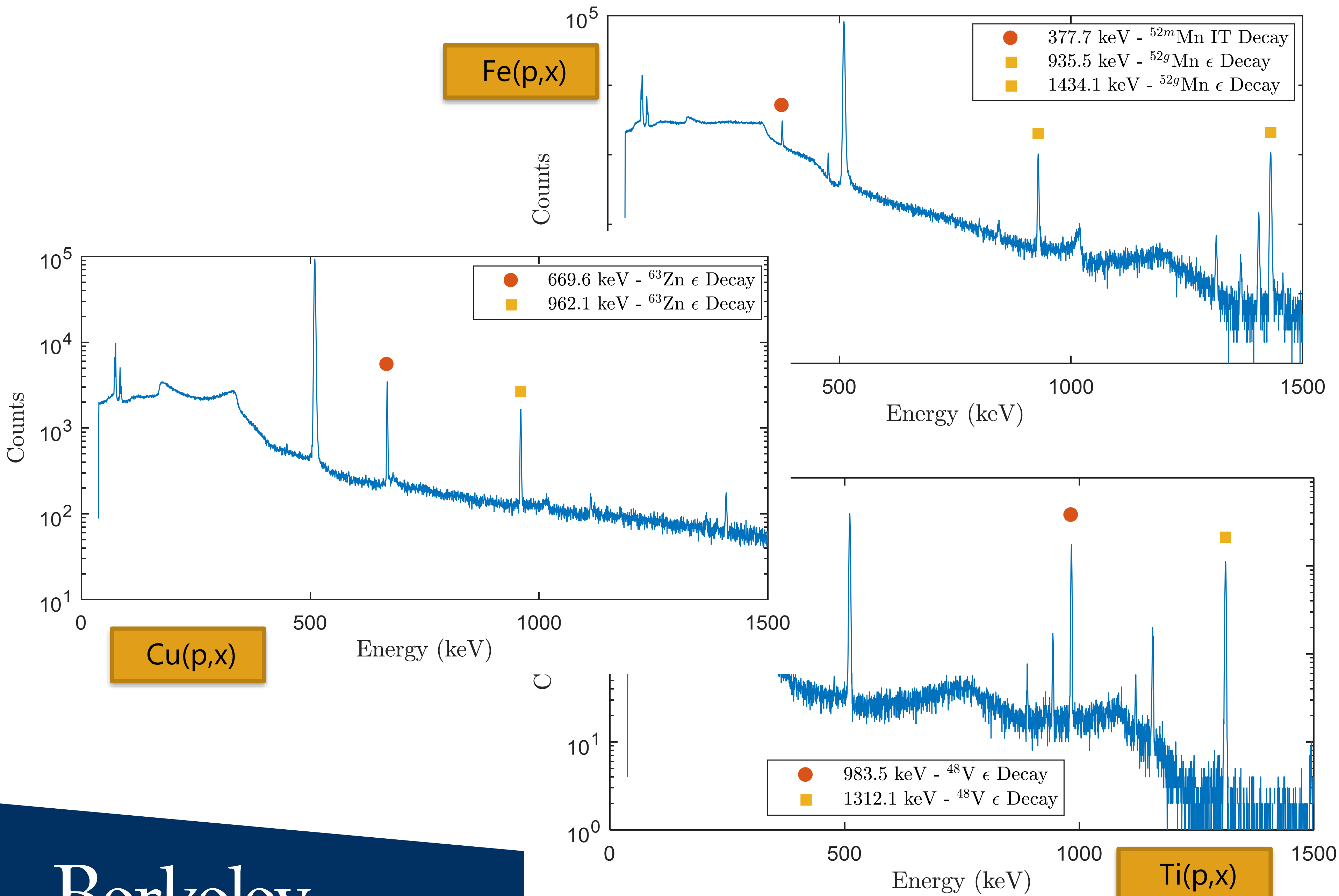


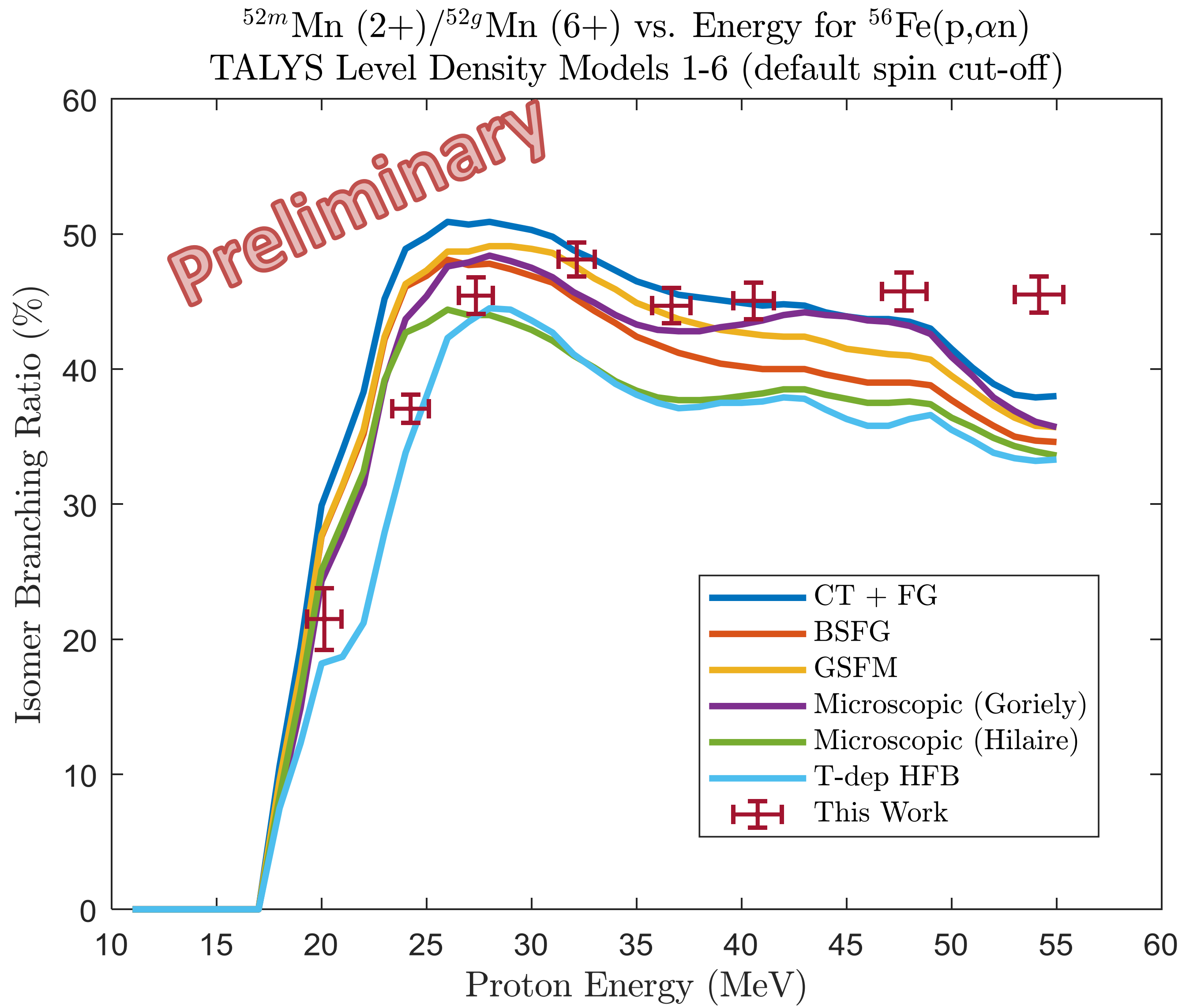


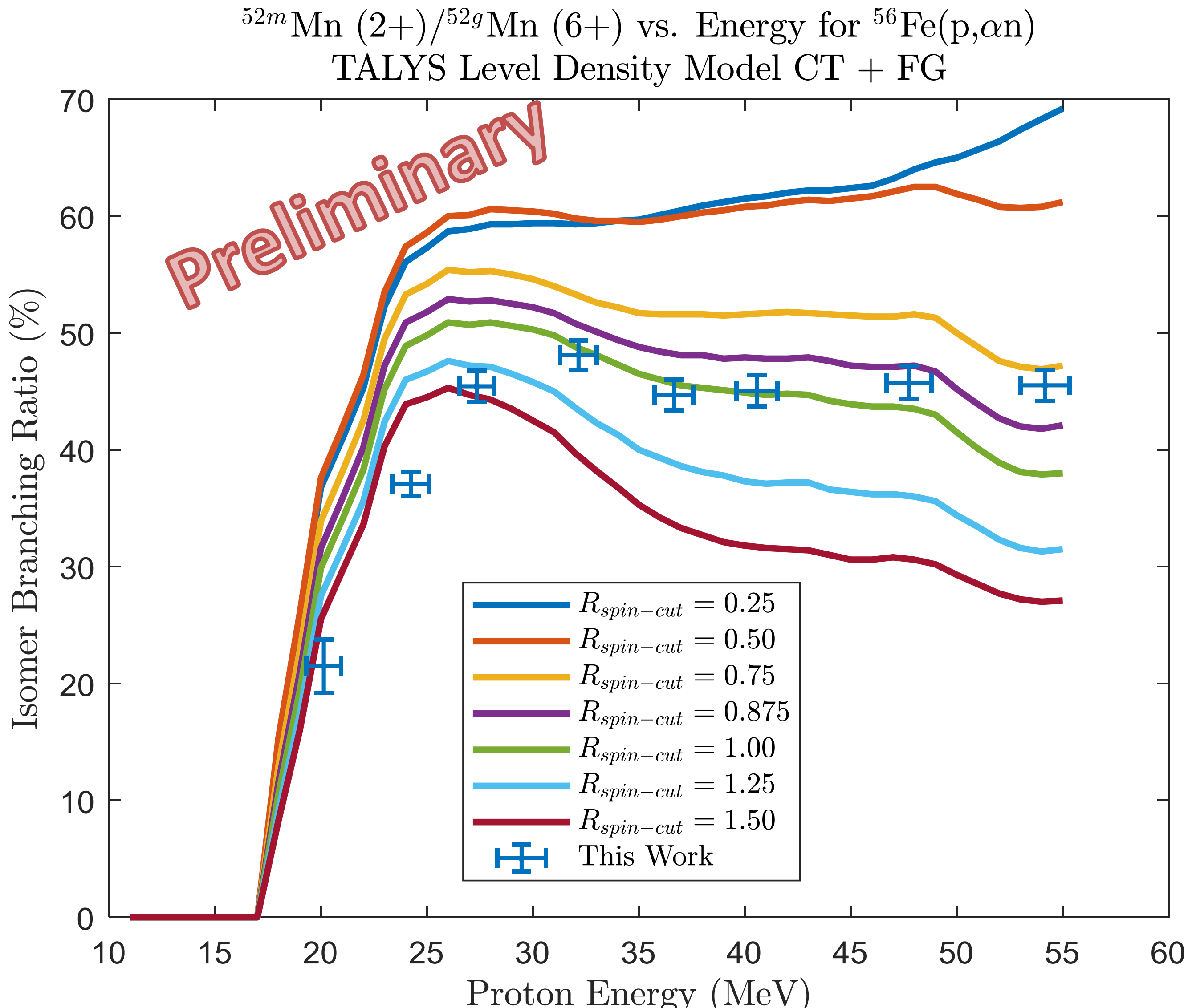


nds.iaea.org/medical/monitor_reactions.html

- Dosimetry: IAEA charged particle beam monitor reactions:
  - $^{nat}Ti(p,x)^{48}V$
  - $^{nat}Cu(p,x)^{62,63,65}Zn$


Fe(p,x)
377.7 keV - 52mMn IT Decay
935.5 keV - 52gMn ϵ Decay
1434.1 keV - 52gMn ϵ Decay
Counts
Energy (keV)
669.6 keV - 63Zn ϵ Decay
962.1 keV - 63Zn ϵ Decay
Cu(p,x)
983.5 keV - 48V ϵ Decay
1312.1 keV - 48V ϵ Decay
Ti(p,x)


^{52m}Mn (2+)/^{52g}Mn (6+) vs. Energy for ^{56}Fe(p,αn)
TALYS Level Density Models 1-6 (default spin cut-off)
Preliminary
Isomer Branching Ratio (%)
Proton Energy (MeV)
0
10
20
30
40
50
60
10
15
20
25
30
35
40
45
50
55
60
CT + FG
BSFG
GSFM
Microscopic (Goriely)
Microscopic (Hilaire)
T-dep HFB
This Work

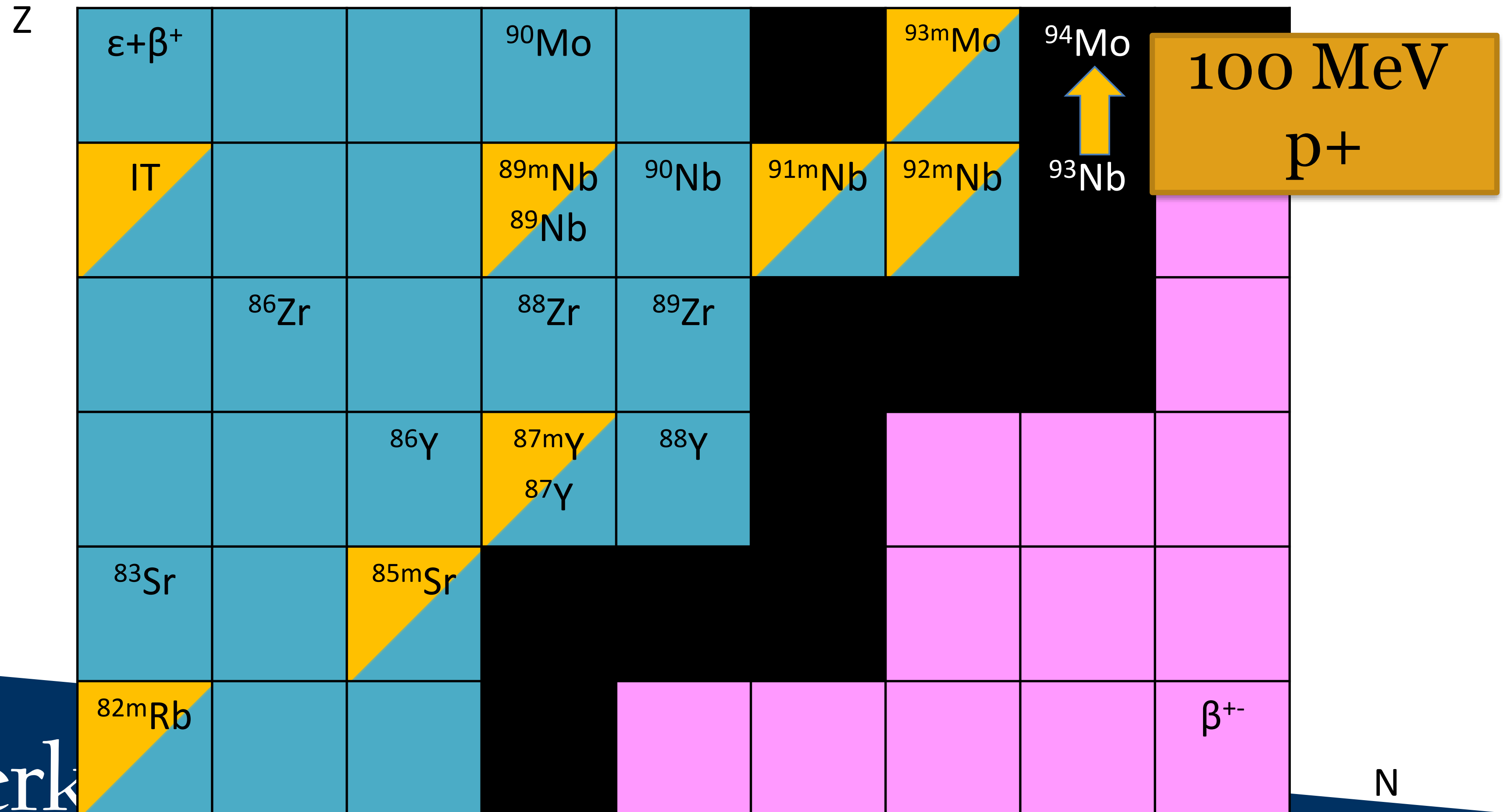


Results consistent with R≈1 at high energy.

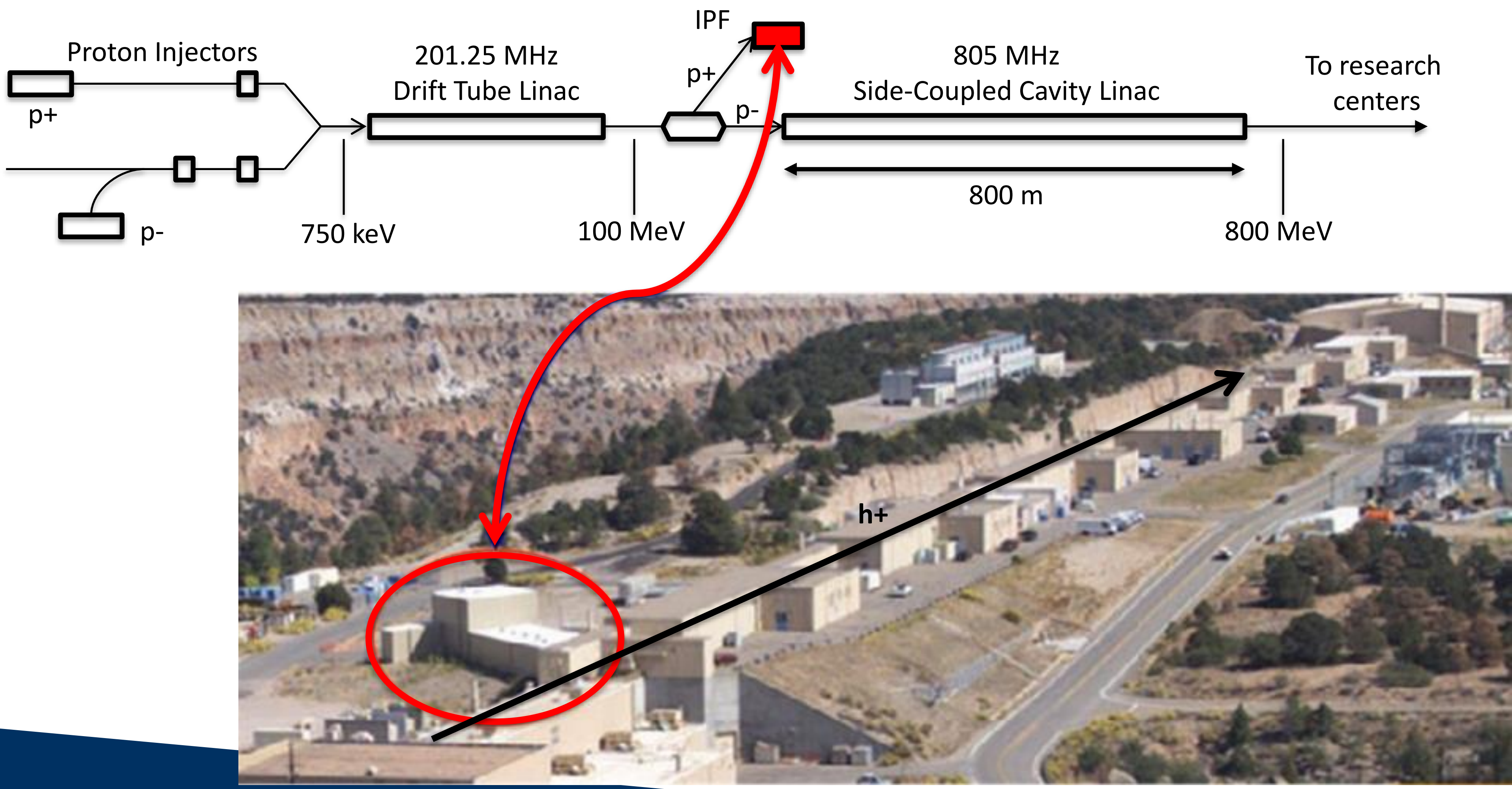
At low energy, results are ambiguous due to energy straggling.

Measurements @ LANL – Nb(p,x)

- $^{nat}Nb(p,4n)^{90}Mo$ is a high-priority objective as a new proton beam dosimetry standard for $E_p \approx 50 - 100$ MeV



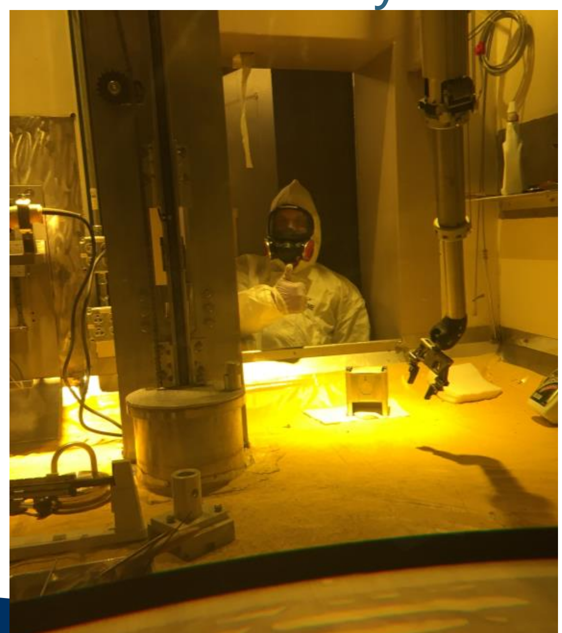
Measurements @ LANL – Nb(p,x)

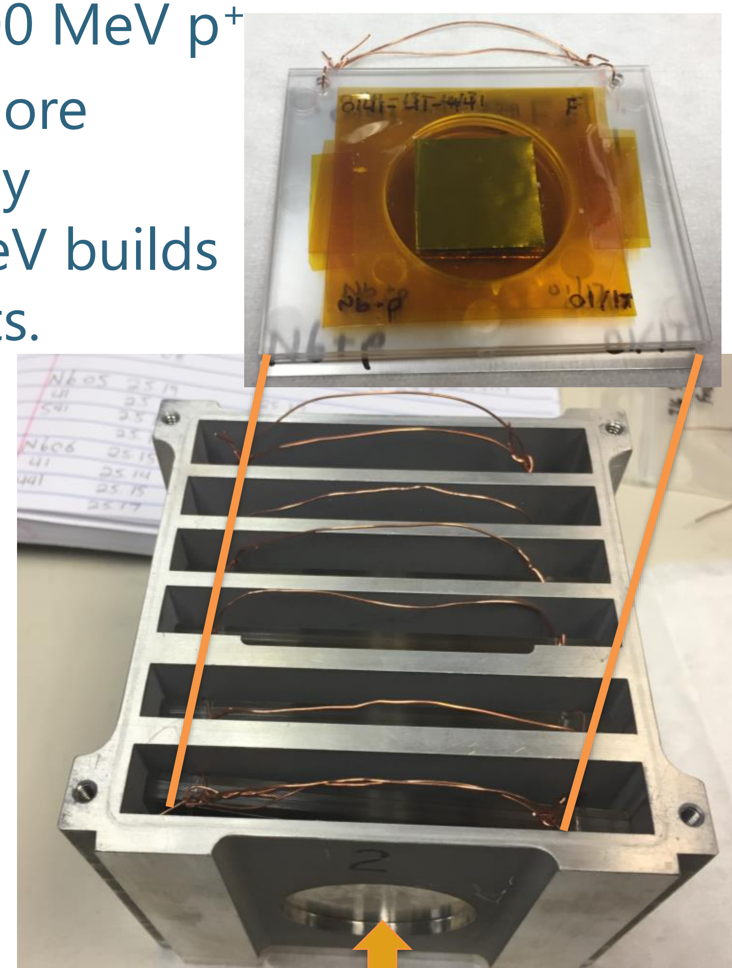


Measurements @ LANL – Nb(p,x)

- LBNL: 5 – 55 MeV / A, LANL: 45 – 100 MeV p^+
- Complementary measurements explore reaction dynamics in different energy regimes, overlap region of 45-55 MeV builds confidence and consistency in results.

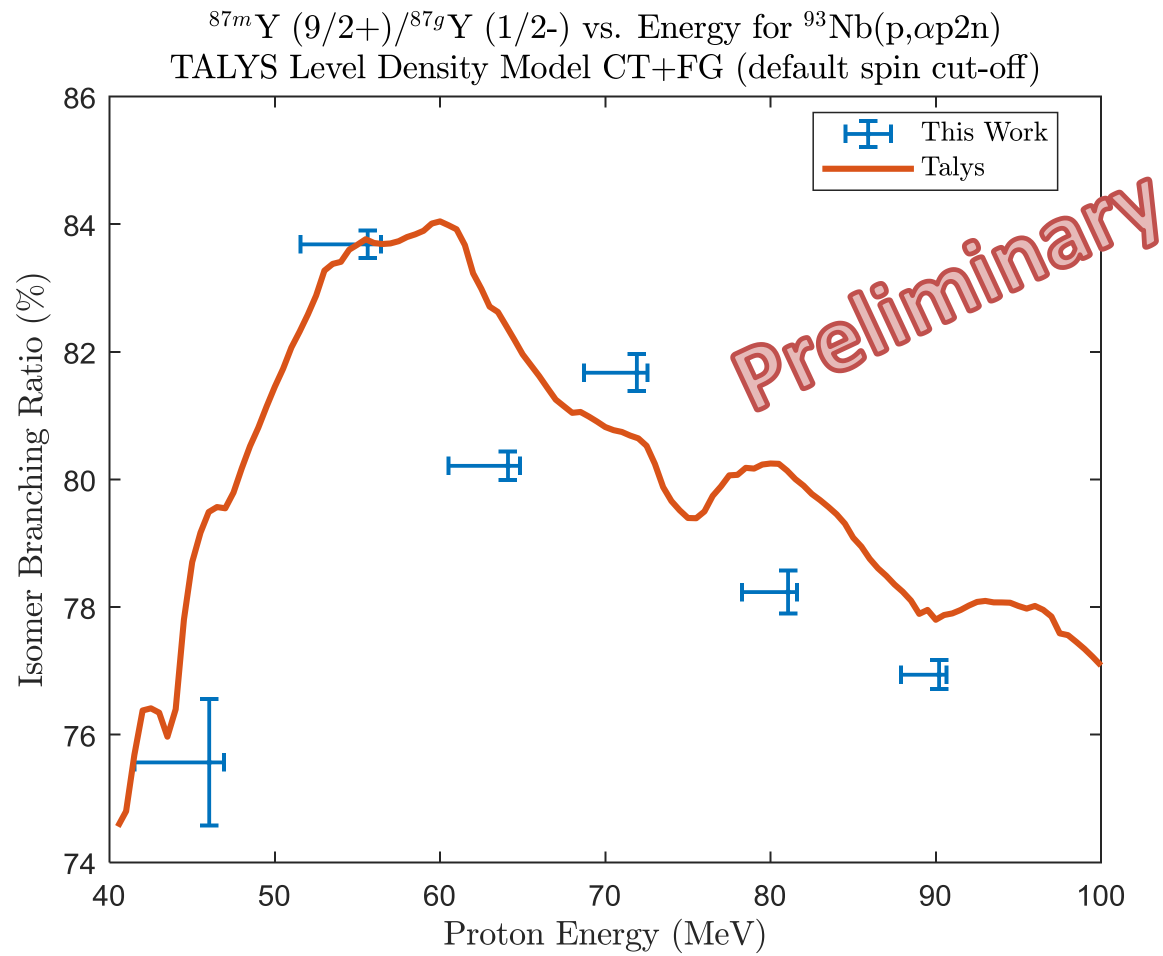

M. Nortier





100 MeV p+

Measurements @ LANL – Nb(p,x)



Summary

Demonstrated ability to measure $R_{spin\text{-}cut}$ in excitation function studies for emerging medical radioisotopes

- Already completed: Fe(p,x), Zr(d,x), Nb(p,x)
- Upcoming targets: ^{86}Sr(p,x)^{86}Y, La(p,x)^{134,135}Ce, ^{177}Hf(n,p)^{177}Lu
  - ^{7}Li(p,n) quasi-monoenergetic neutron source development

- Possible future candidates: Access targets previously fielded by β^+-Oslo in the A≈50,90, rare earth regions via (p,xn), (α,xn)

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