Isotope Production Activities Update

10 December 2018

Berkeley
UNIVERSITY OF CALIFORNIA

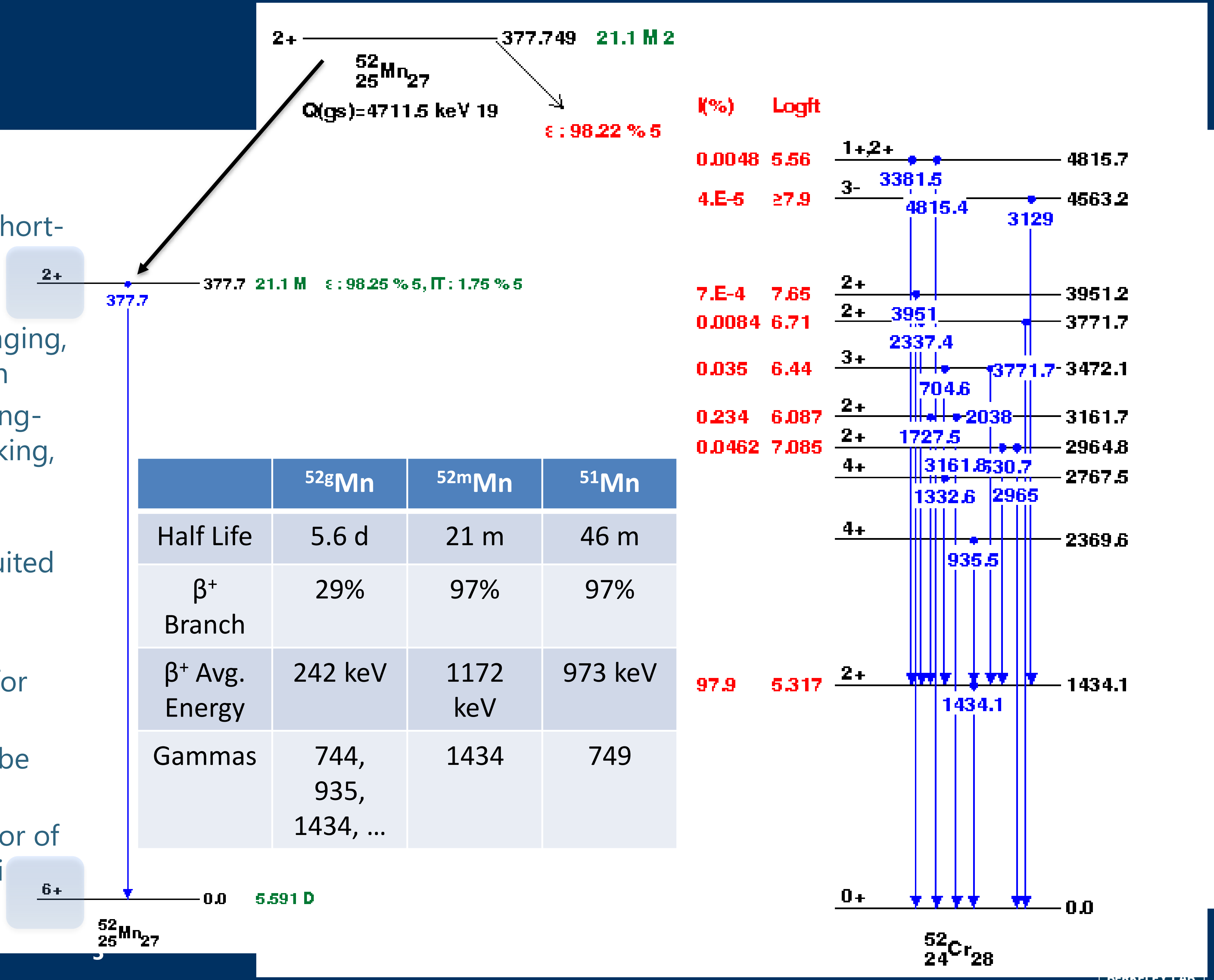
BERKELEY LAB

Stacked-target Charged Particle Excitation Functions

Low(er) Energy – LBNL

- Emerging medical radionuclides
  - ^{51}Mn ($t_{1/2}$ = 46 min, 97% β^+) – short-lived PET tracer for metabolic studies
    - Best option for clinical imaging, needs in-house production
  - ^{52g}Mn ($t_{1/2}$ = 5.6 d, 29% β^+) – long-lived PET tracer for neuron tracking, immune studies
    - Long half-life, unfavorable gammas make this best-suited to pre-clinical imaging
    - Easy distribution
  - ^{52m}Mn – short-lived PET tracer for metabolic studies
    - Difficult to produce, must be done in-house
  - Interesting lens to study behavior of excited states in $p_{3/2}$ / $f_{7/2}$ nuclei

	^{52g}Mn	^{52m}Mn	^{51}Mn
Half Life	5.6 d	21 m	46 m
β^+ Branch	29%	97%	97%
β^+ Avg. Energy	242 keV	1172 keV	973 keV
Gammas	744, 935, 1434, …	1434	749



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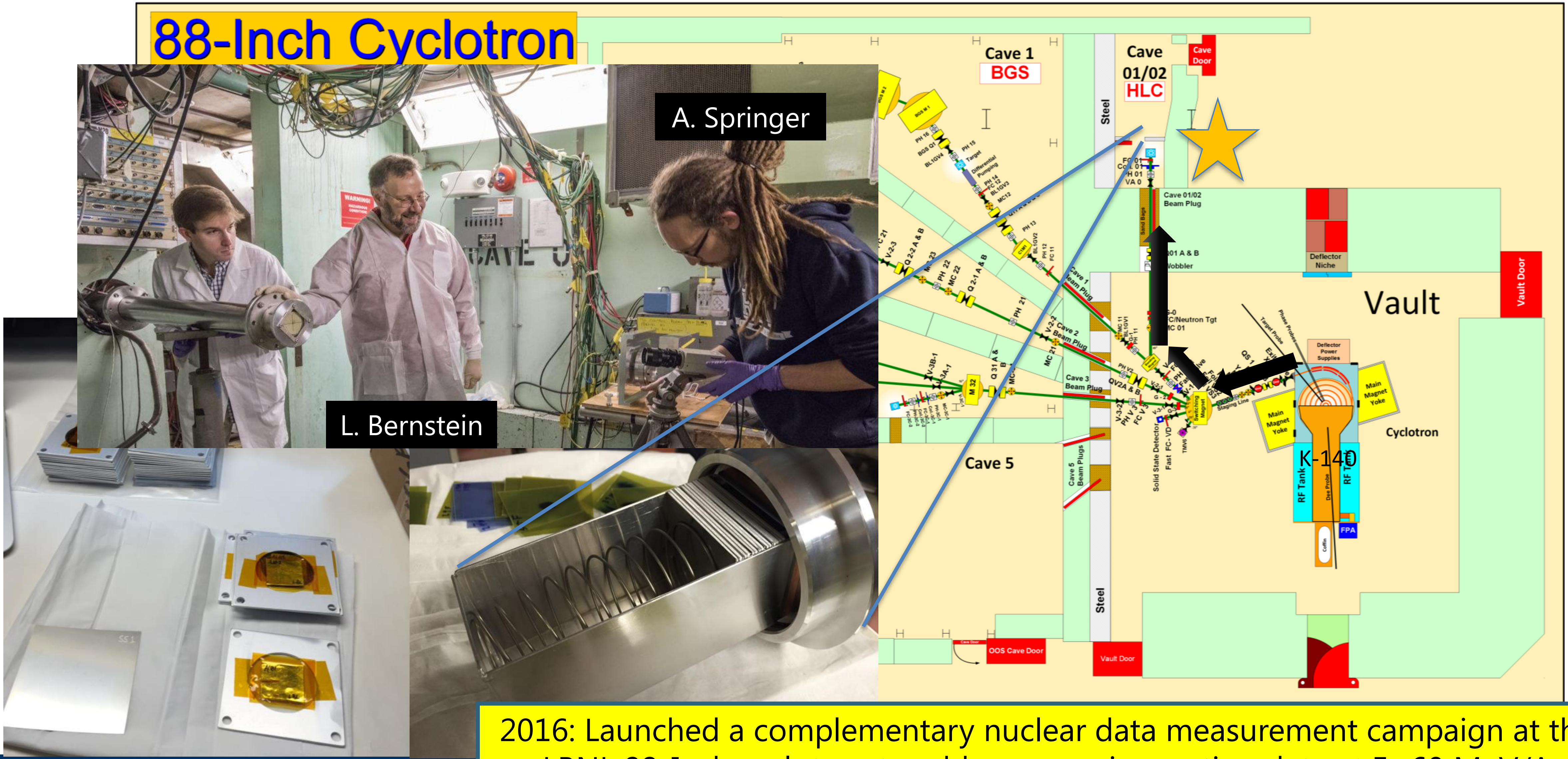
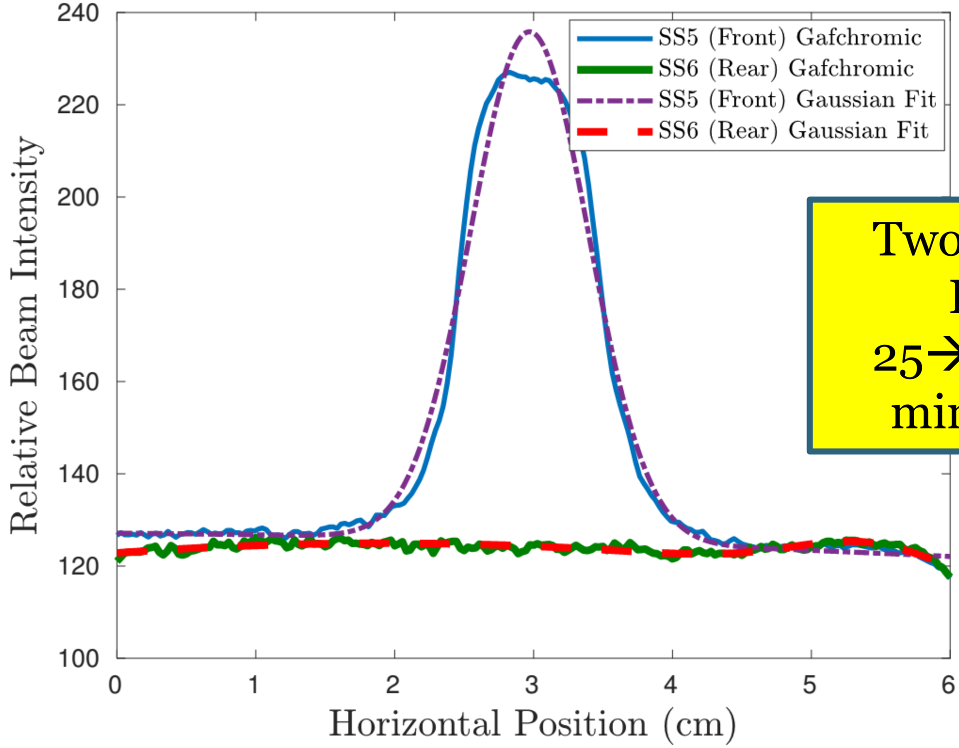
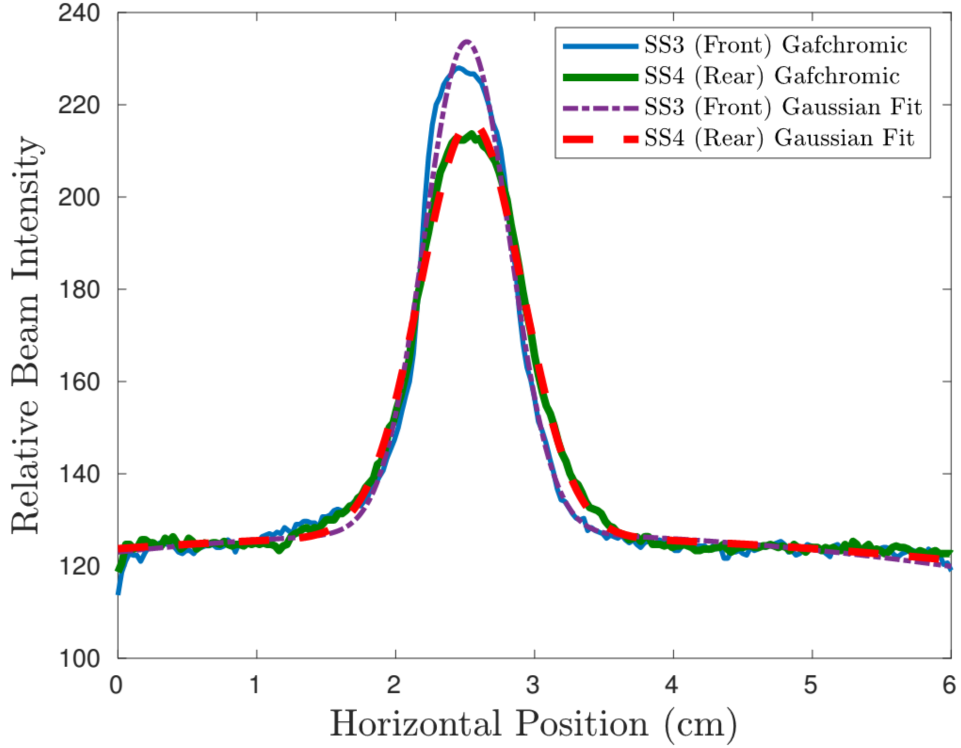


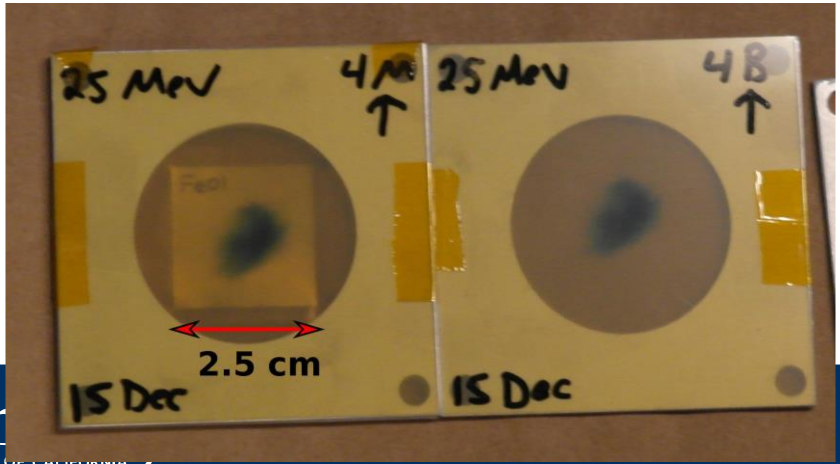
2016: Launched a complementary nuclear data measurement campaign at the LBNL 88-Inch cyclotron to address gaps in reaction data at E<60 MeV/A

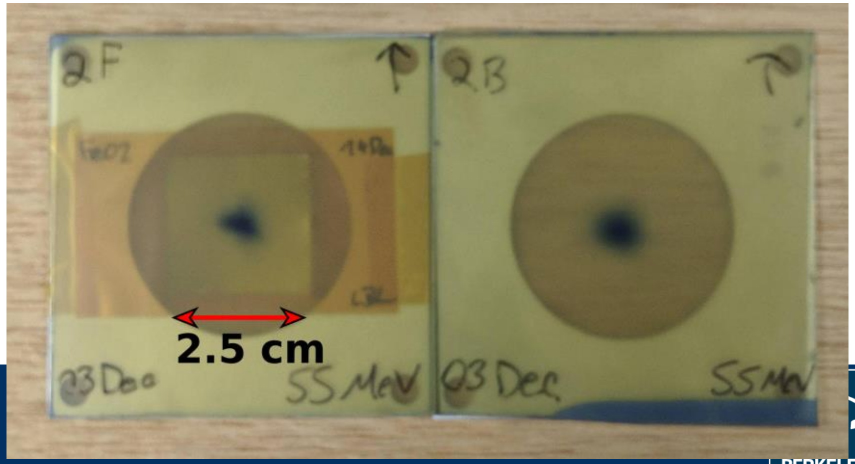
$^{nat}Fe(p,x)^{51,52}Mn$ – Novel PET imaging



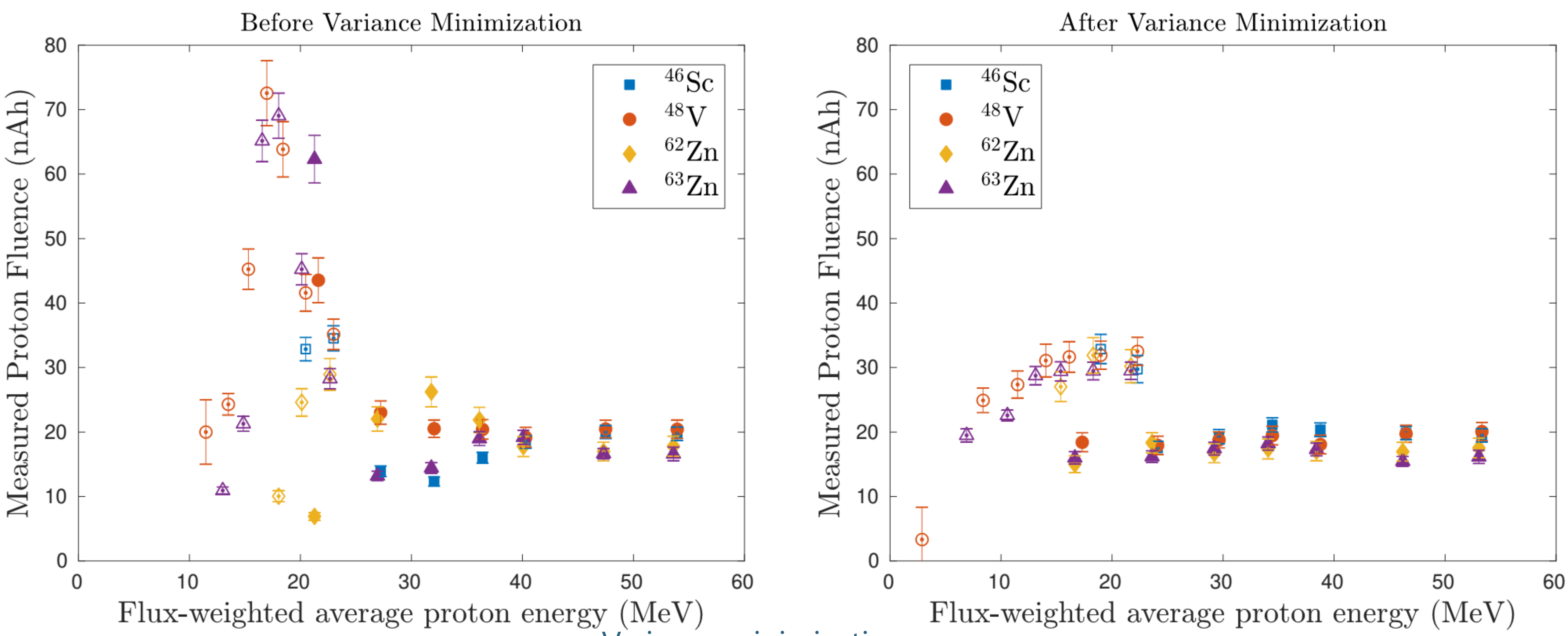
Two overlapping stacks:
E_p= 55→15 MeV,
25→0 MeV (120 nA@10 min, 100 nA@20 min)







$^{nat}Fe(p,x)^{51,52}Mn$ – Novel PET imaging



Variance minimization:
- 55 MeV: +5.25% Al density
- 25 MeV: +6.69% silicone density

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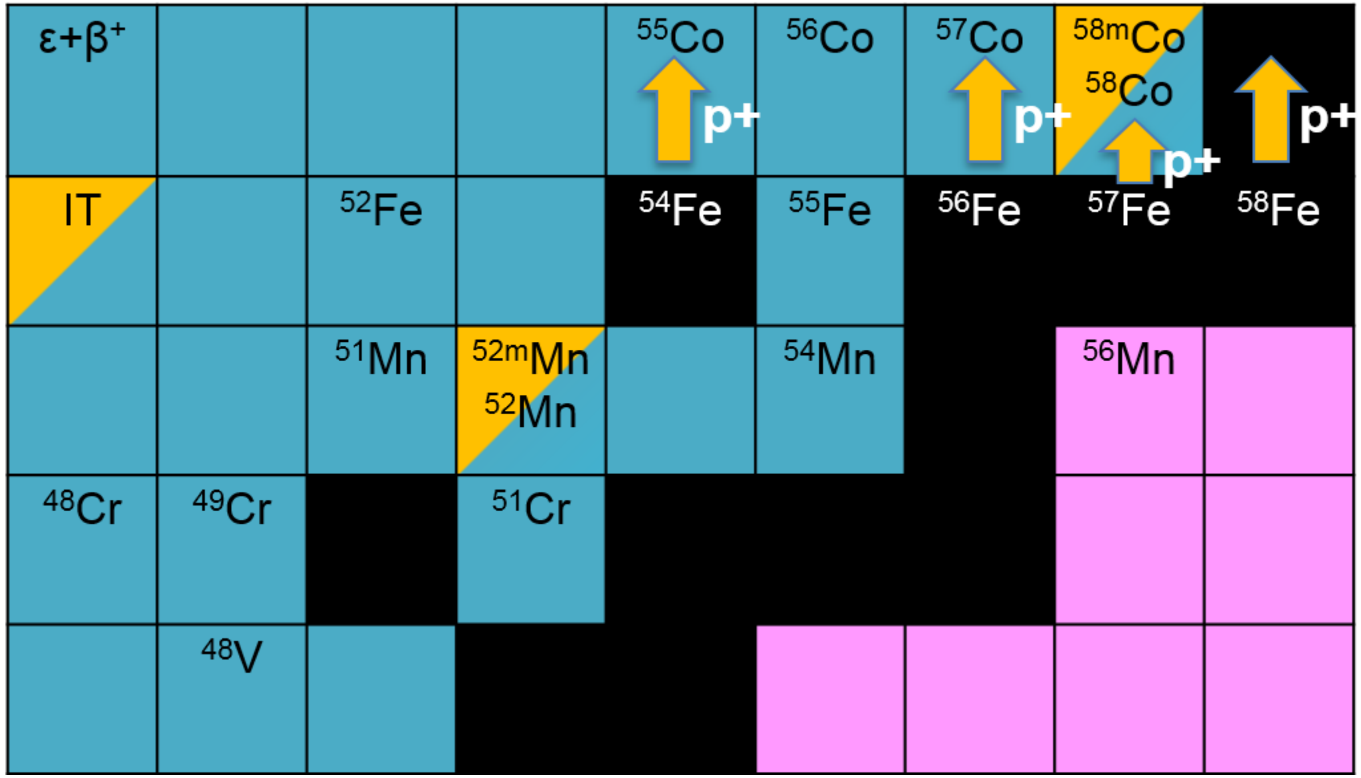
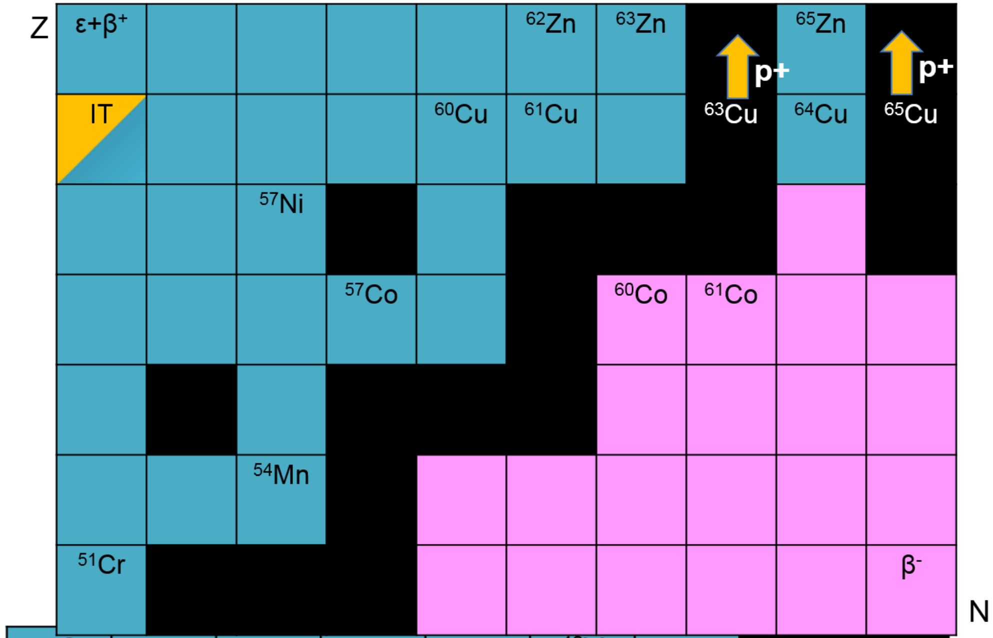
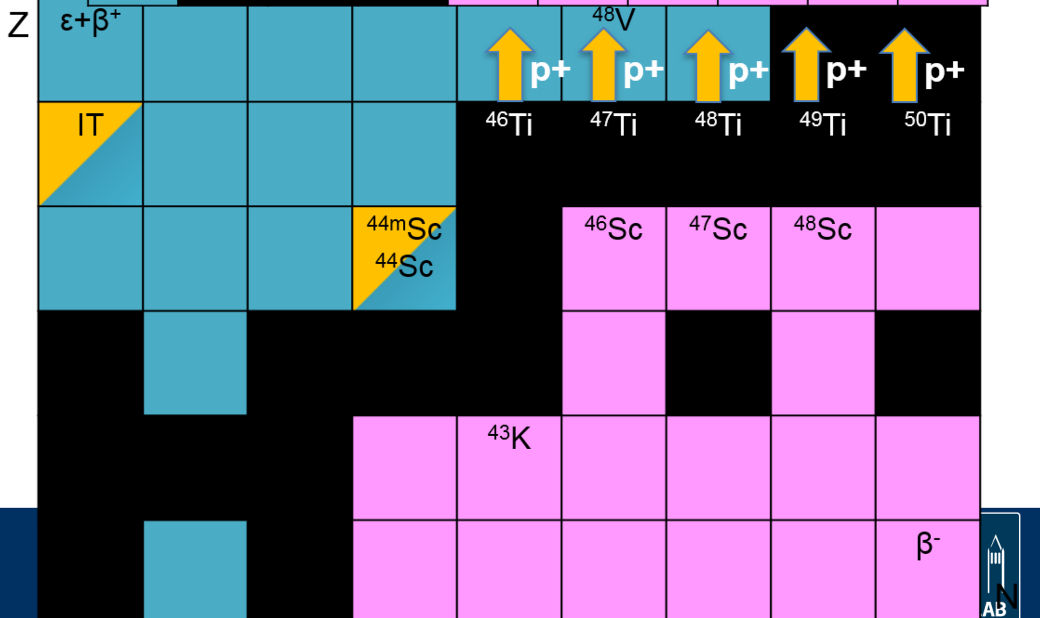
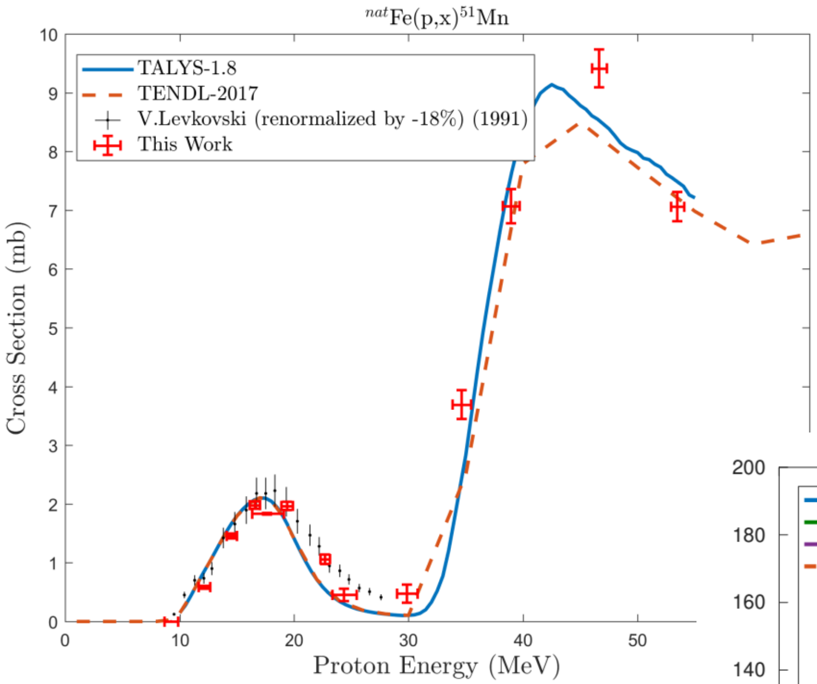






Measurements of 34 cross-sections for $^{nat}Fe(p,x)$, $^{nat}Cu(p,x)$, and $^{nat}Cu(p,x)$

$^{nat}Fe(p,x)^{51,52}Mn$ – Novel PET imaging



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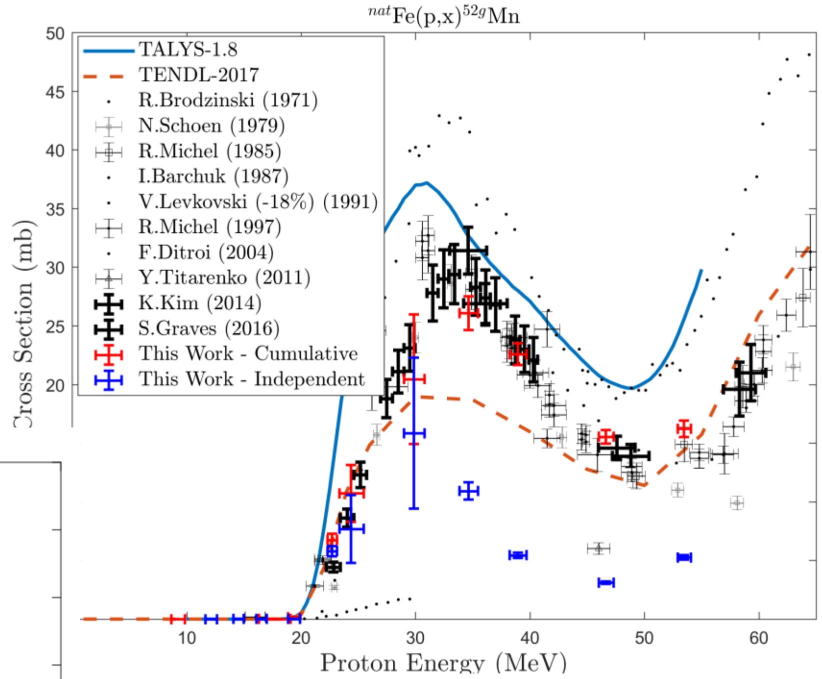
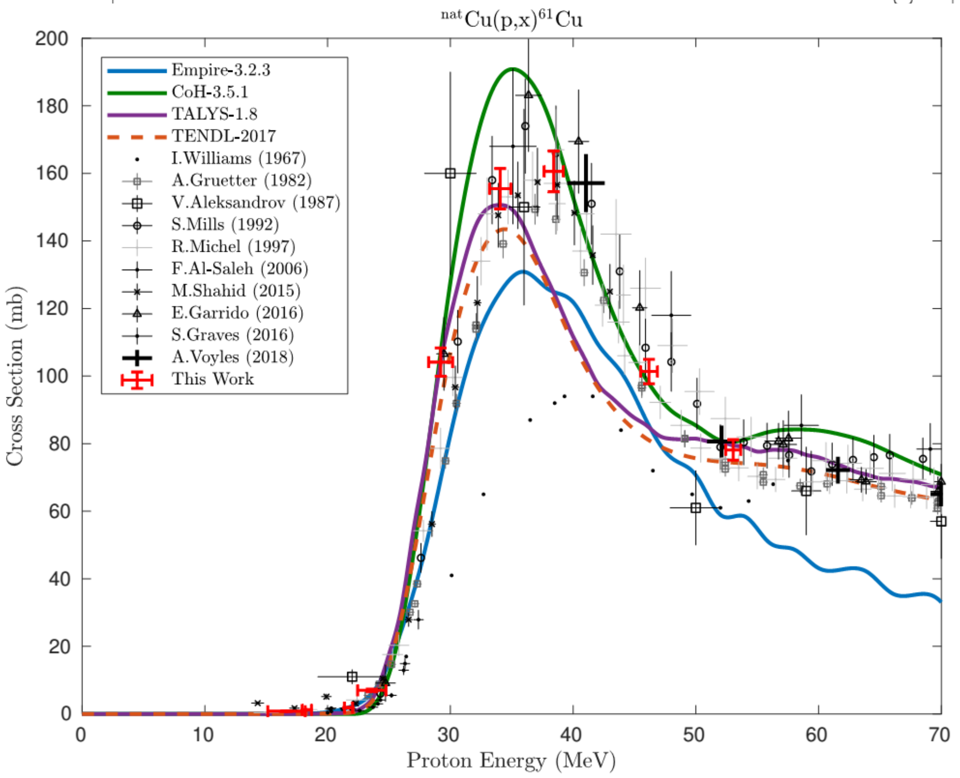


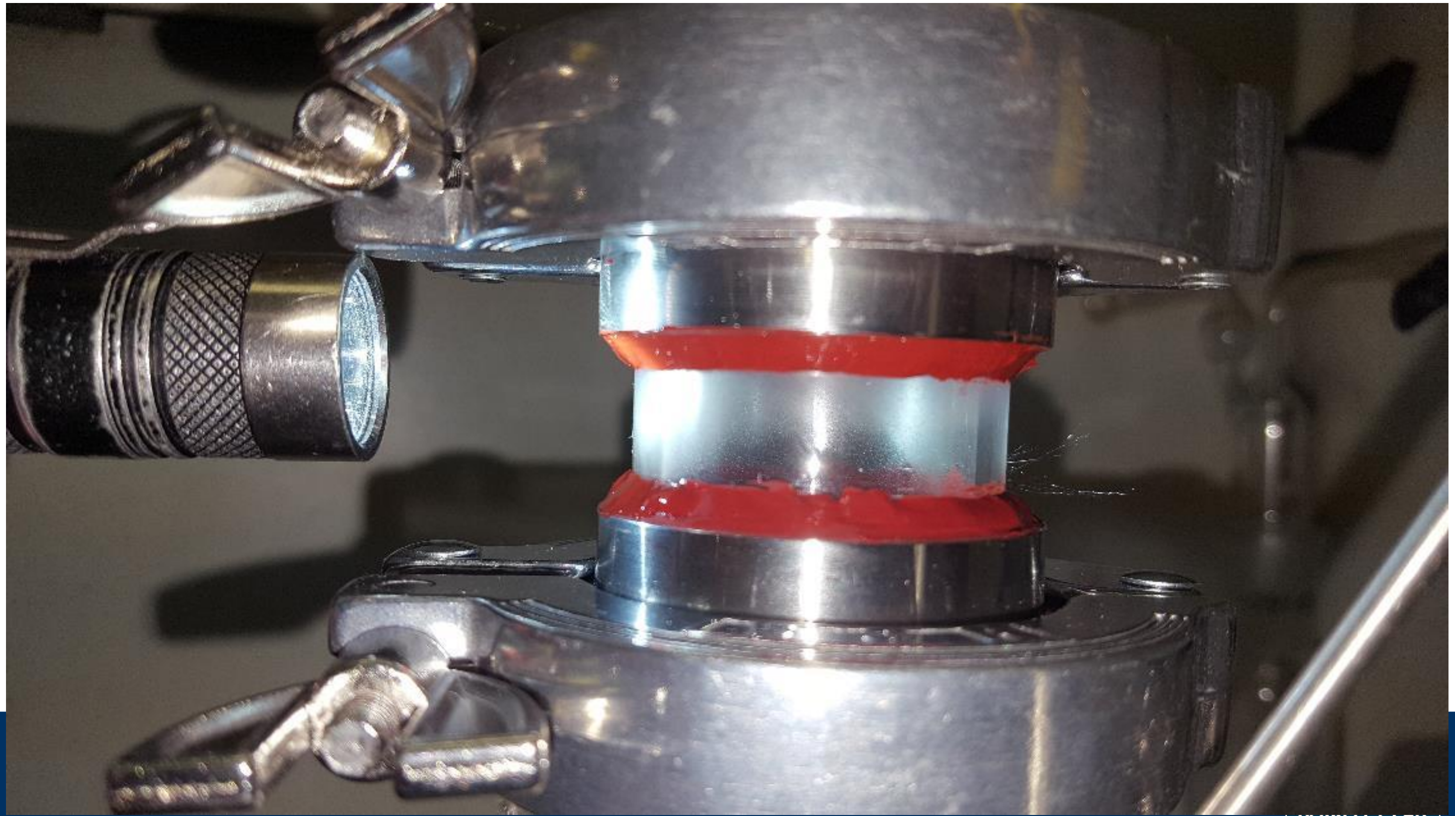


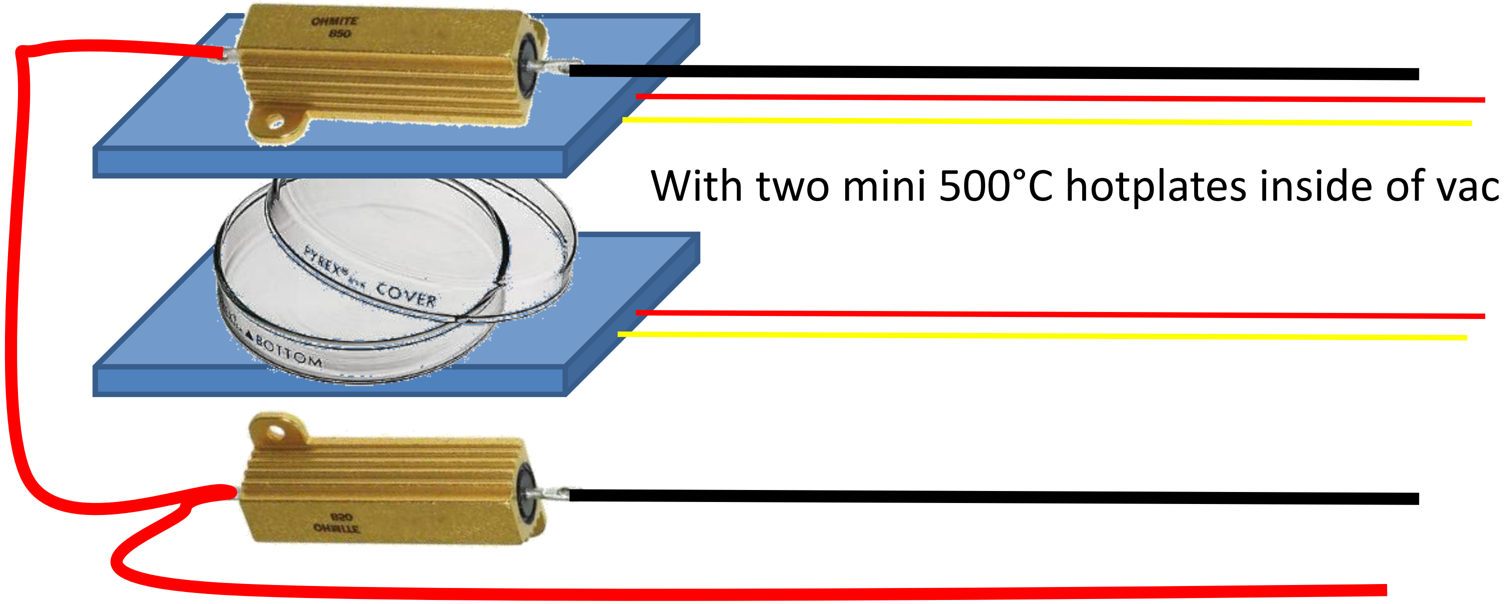
As Targetry Fabrication

Attempt 1 = Fail

Too much distance
Too much As_2O_3 in old stock
Adhesive breaks down above 400°C

Result was films of As_2O_3 on receiver and intermediate on sight glass. However near source was nice film of pure As

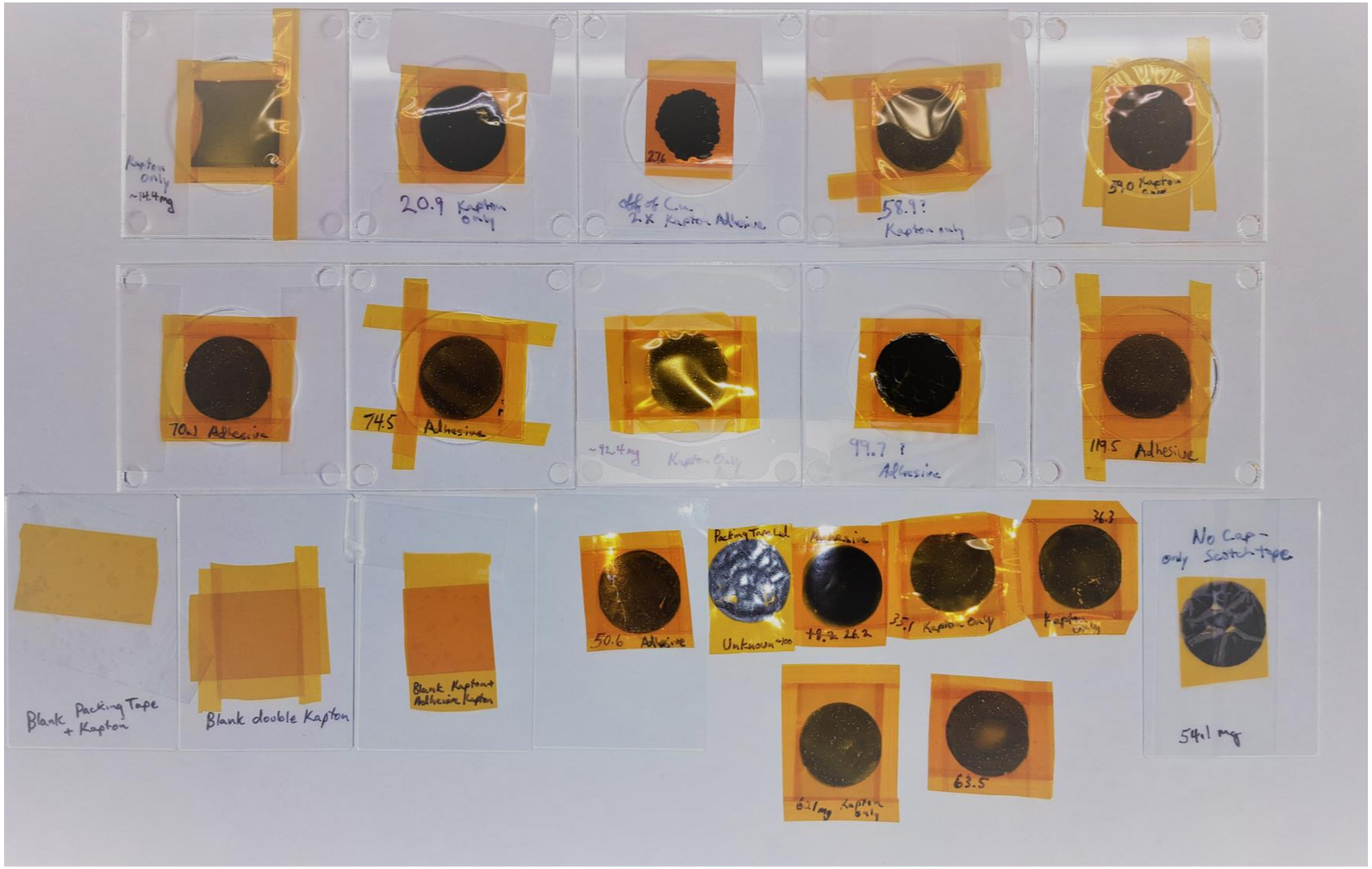


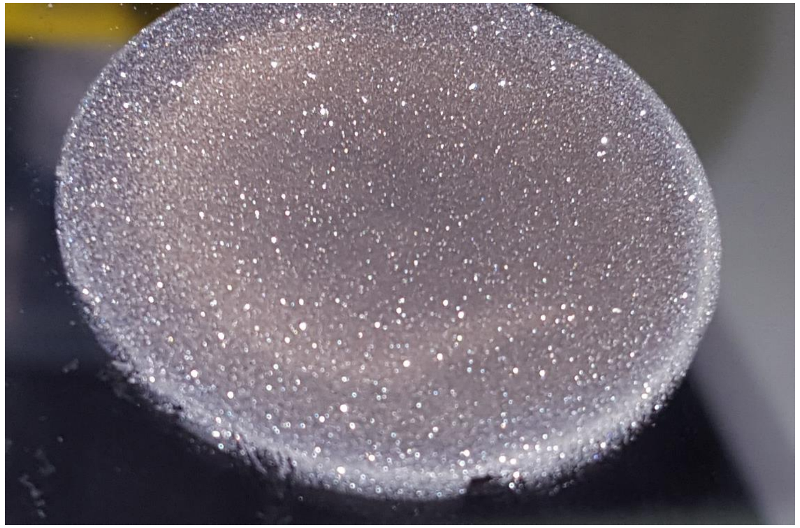


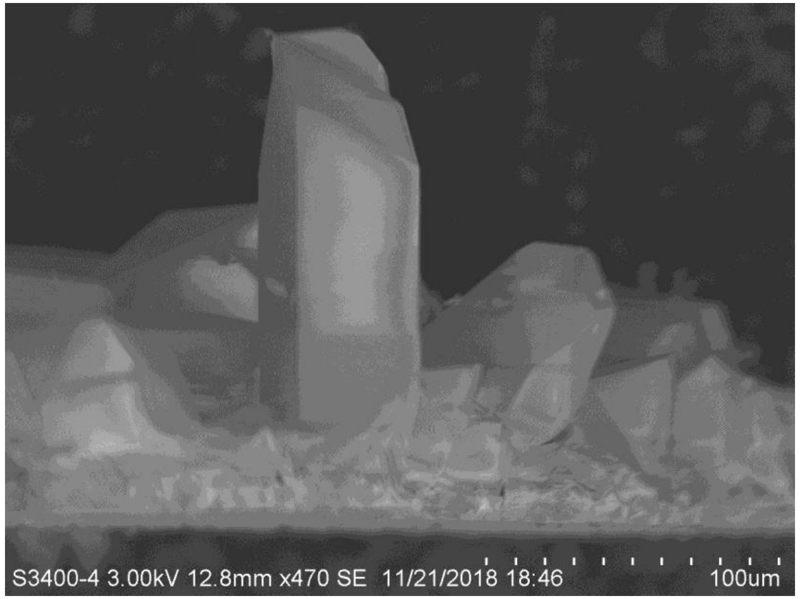
With two mini 500°C hotplates inside of vac chamber



Success!!! (as of 4:54 AM…)

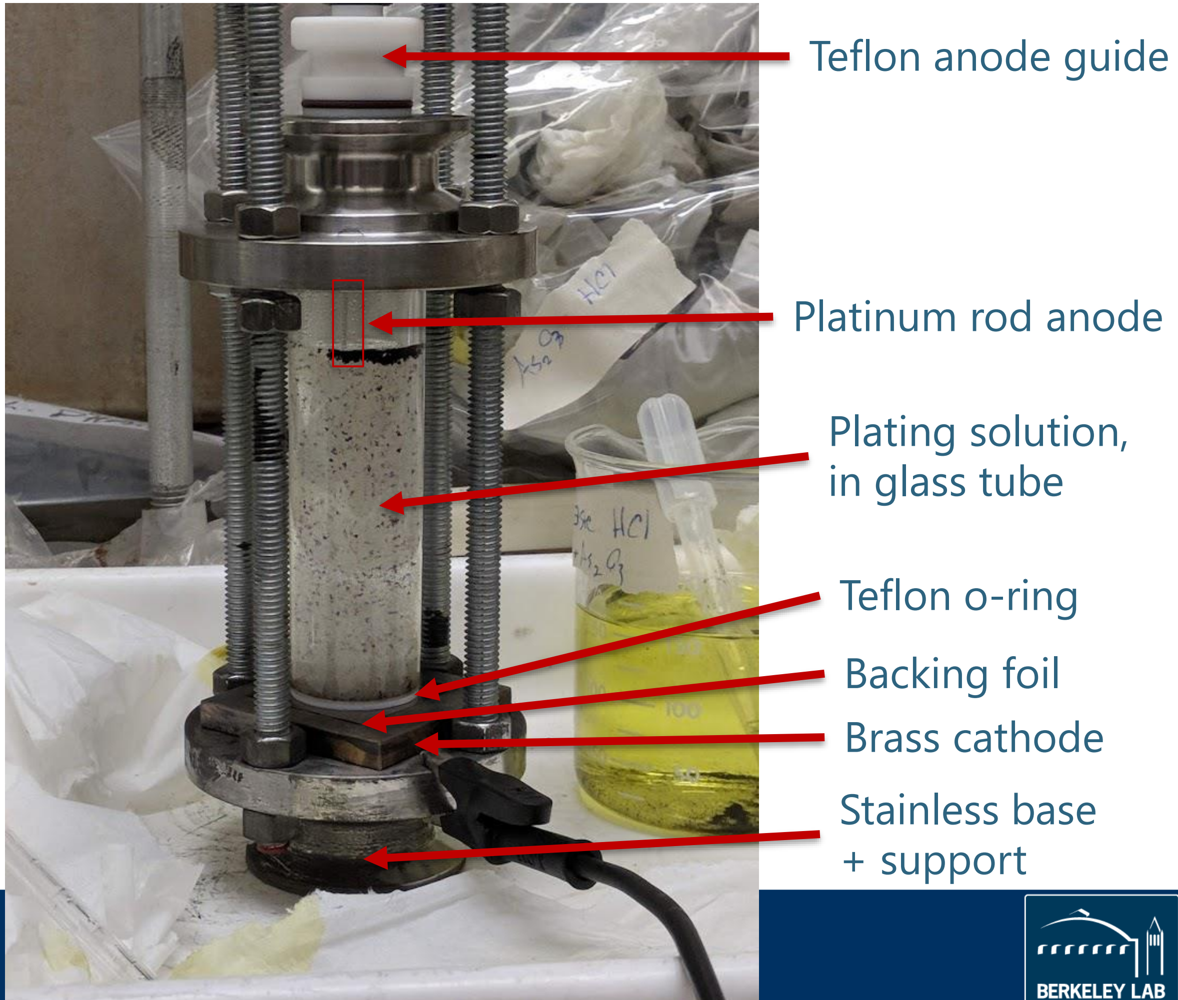




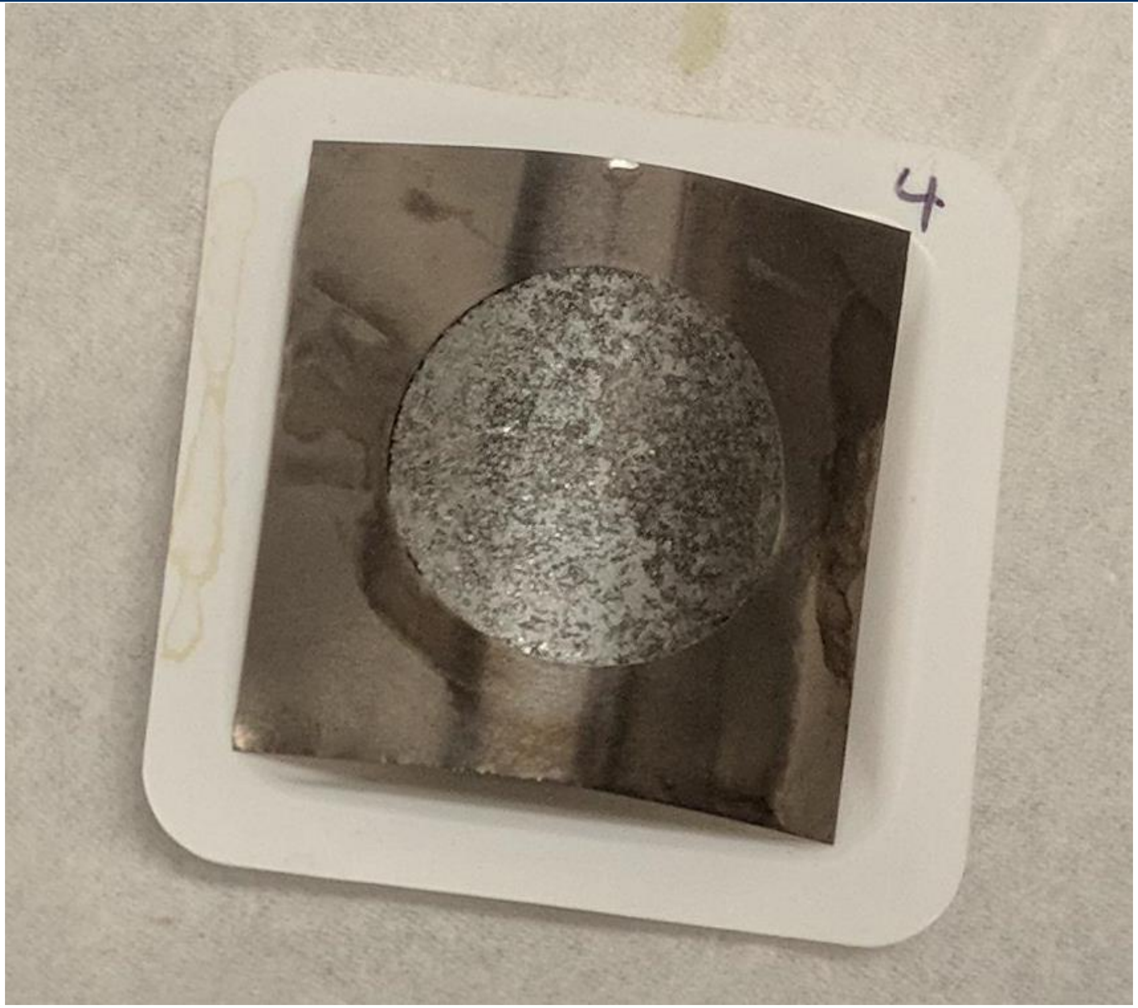


Back to Berkeley…

- Two deposition methods on 10um titanium foil:
  - As_2O_3 (12.5 g/L) in 7M HCl, @ 130 mA
  - As_2O_3 (0.2M) in 1:2 molar choline chloride : ethylene glycol deep eutectic solvent, @ 46 mA



t_0 t=0.5 h t=1 h t=1.5 h t=2 h t=2.5 h



~6 mg/cm^2
2.5 h @ 130 mA

~0.5 mg/cm^2
15 m @ 30 mA

Next steps

- Characterization of all As targets
- Continue fabricating electroplated As targets
  - Pending new WPC approval
  - Need relevant group members to take some more training
- Start development of pressed-powder As targets
  - As, As_2O_3, Cu_3As, FeAs, Zn_3As_2…