

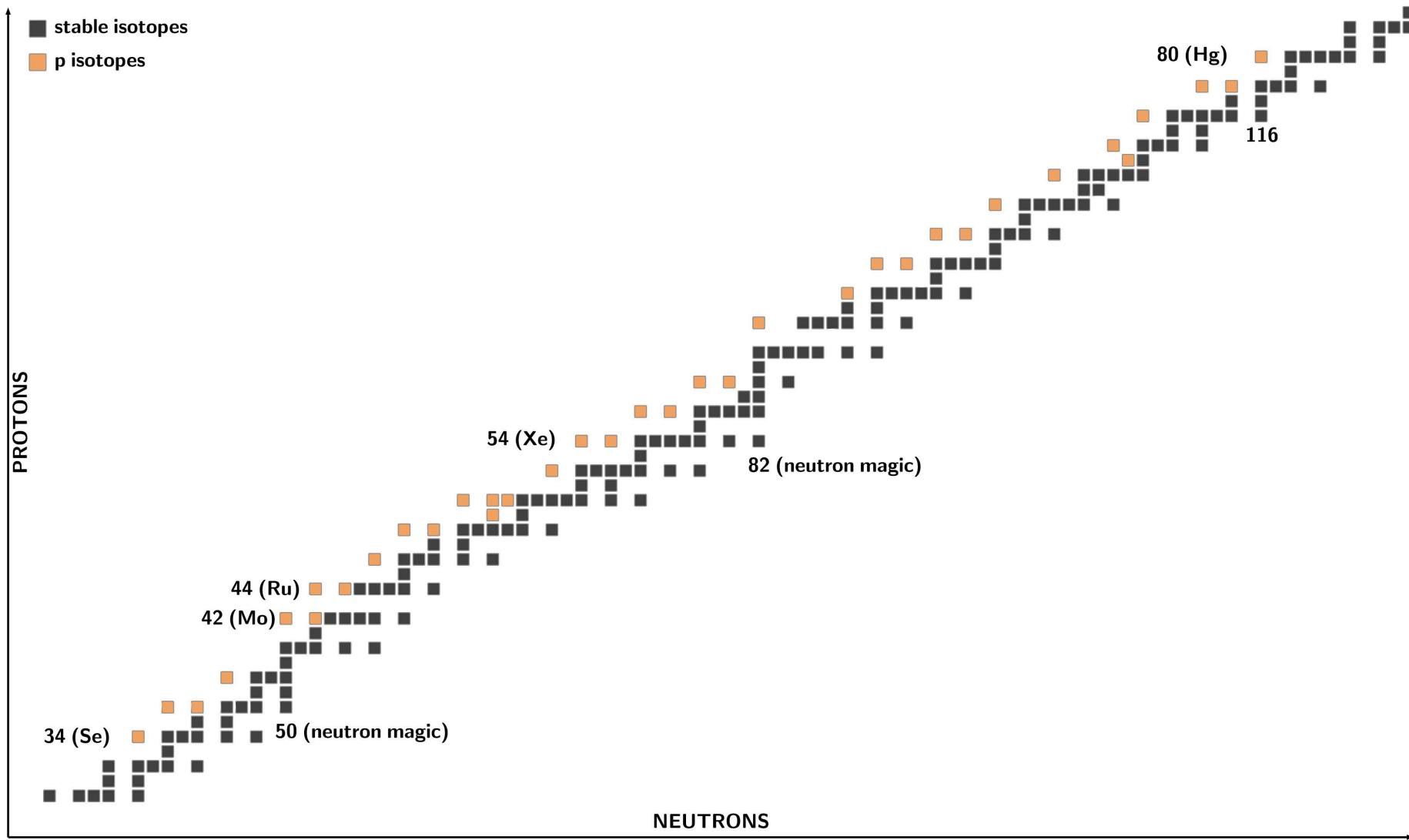
Nuclear astrophysics with storage rings

René Reifarth

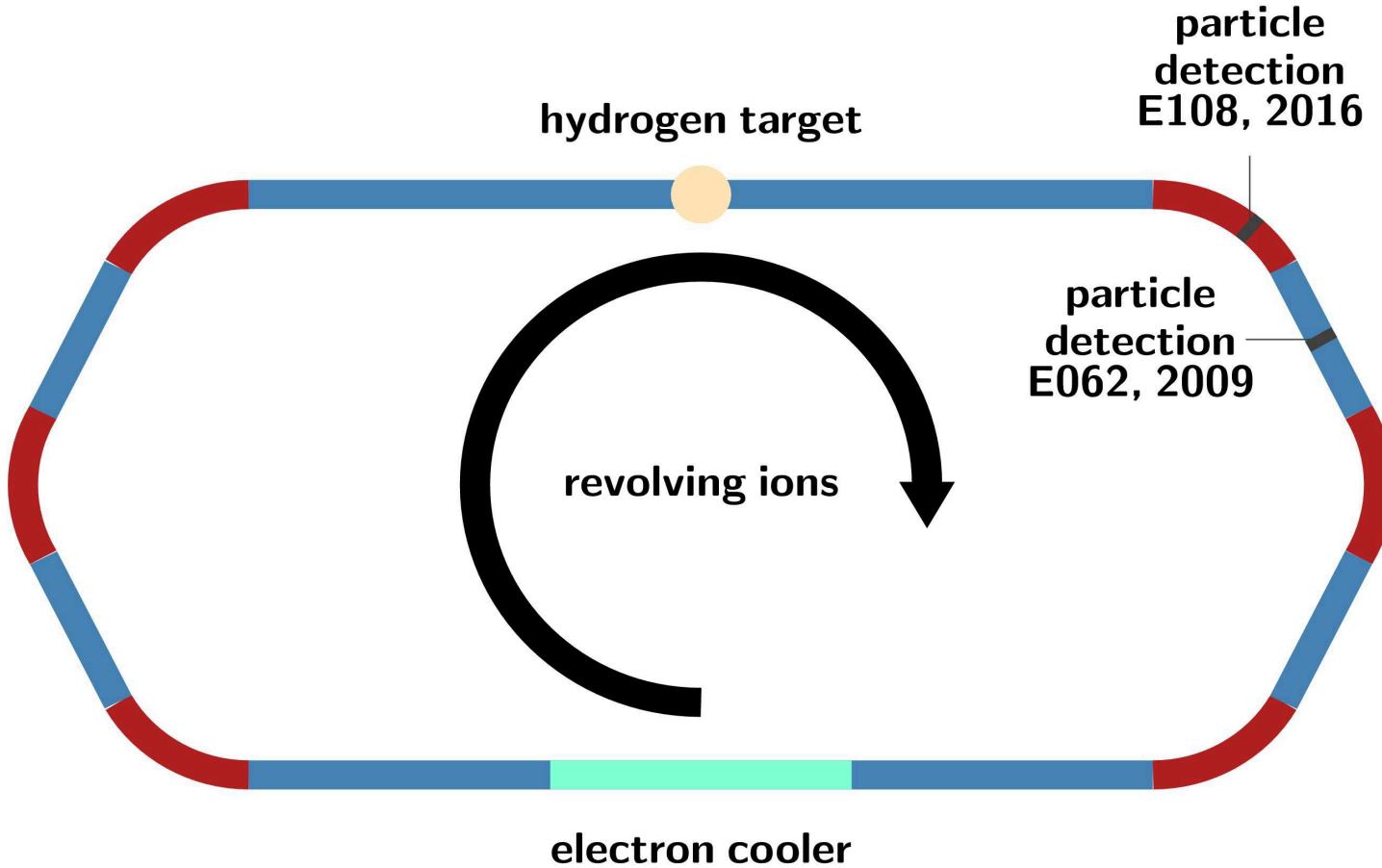
Goethe-Universität Frankfurt

ARIS
5. June 2023, Avignon, France

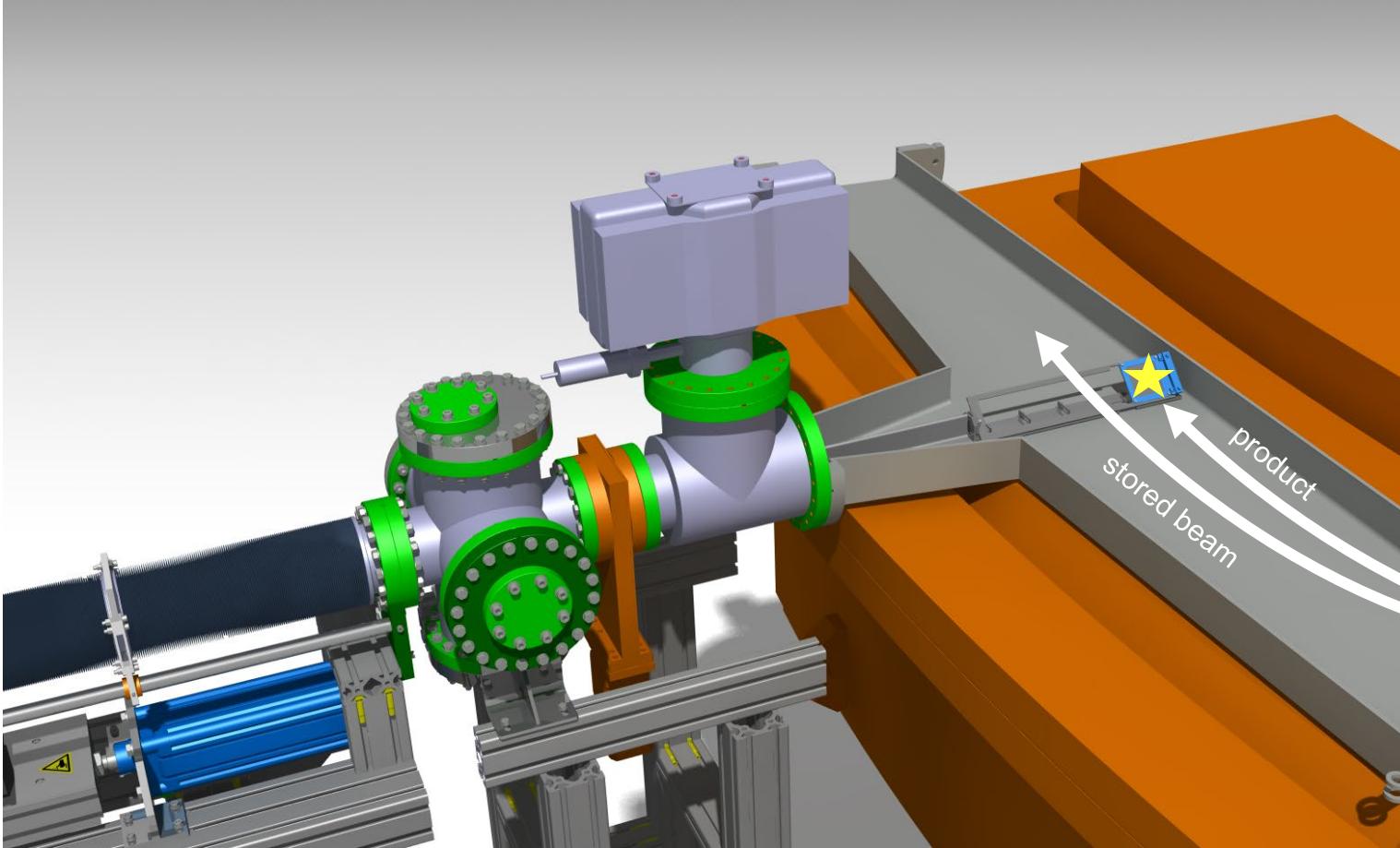
p-isotopes



ESR @ GSI – inverse kinematics

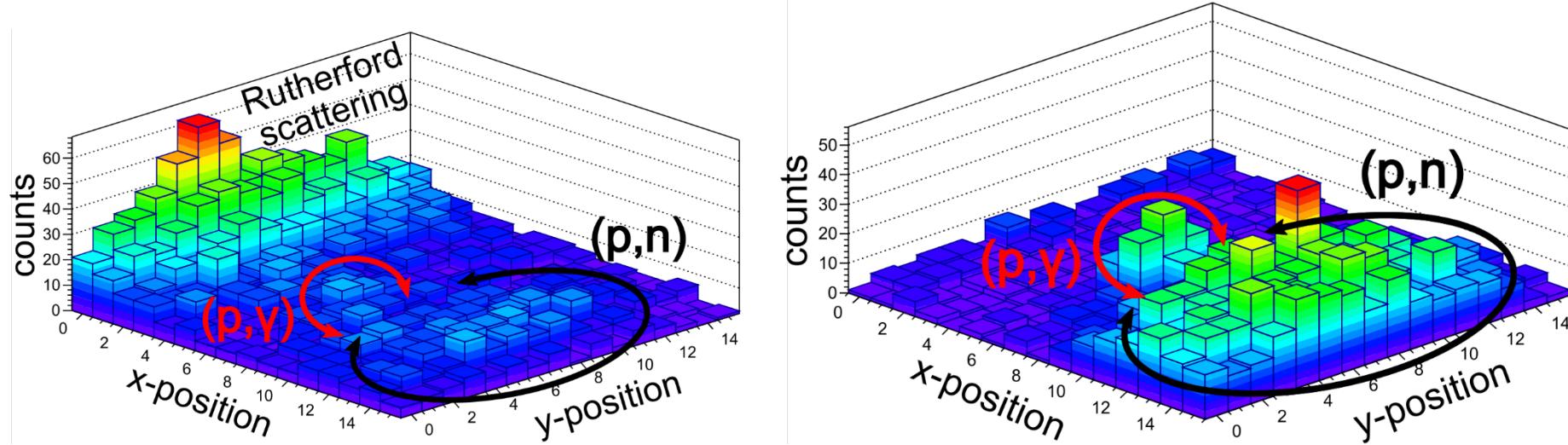


Detection of reaction products



FAIR-Phase-0, 2020

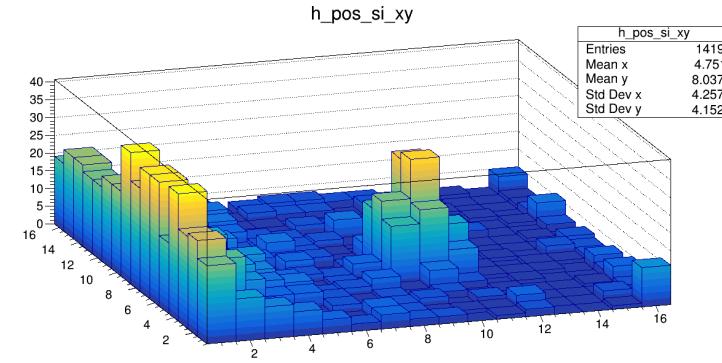
Testing scrapers
 $^{124}\text{Xe}(\text{p},\gamma)^{125}\text{Cs}$ – with hydrogen



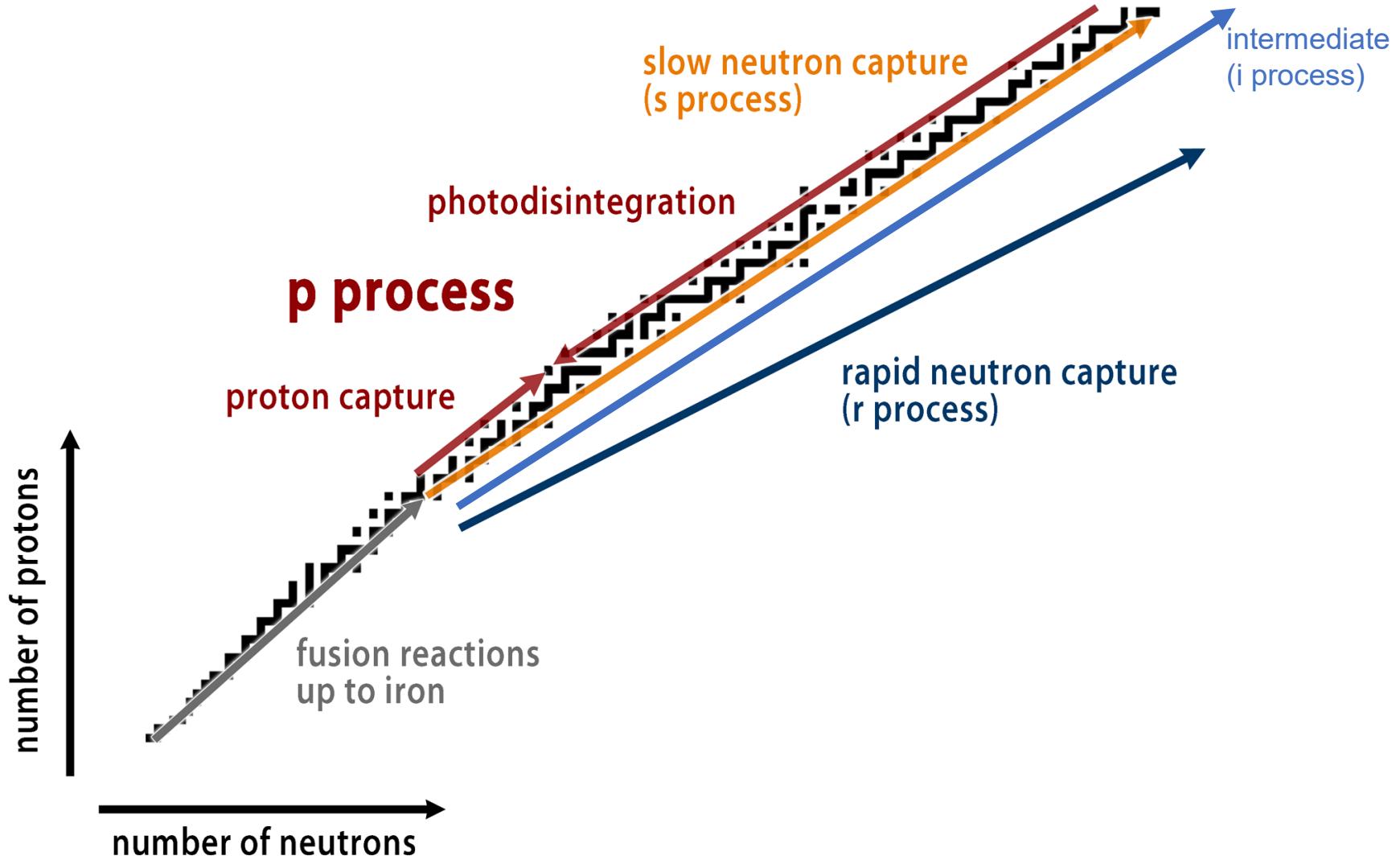
J. Glorius et al, Phys. Rev. Lett. 122, 92701-92706 (2019)
L. Varga et al, in preparation (2023)

FAIR-Phase-0 2021

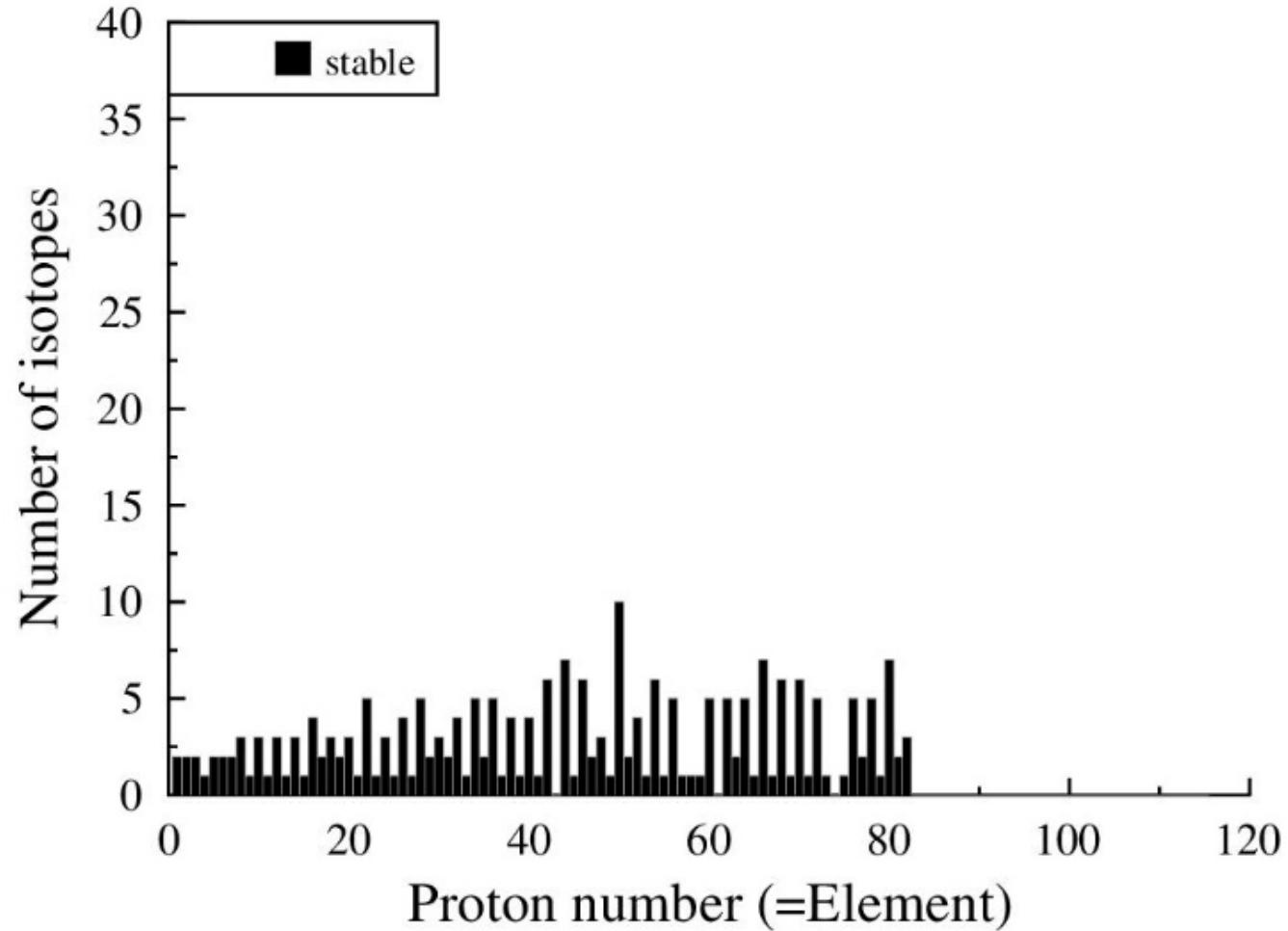
$^{118}\text{Te}(\text{p},\gamma)$ @ 7 AMeV



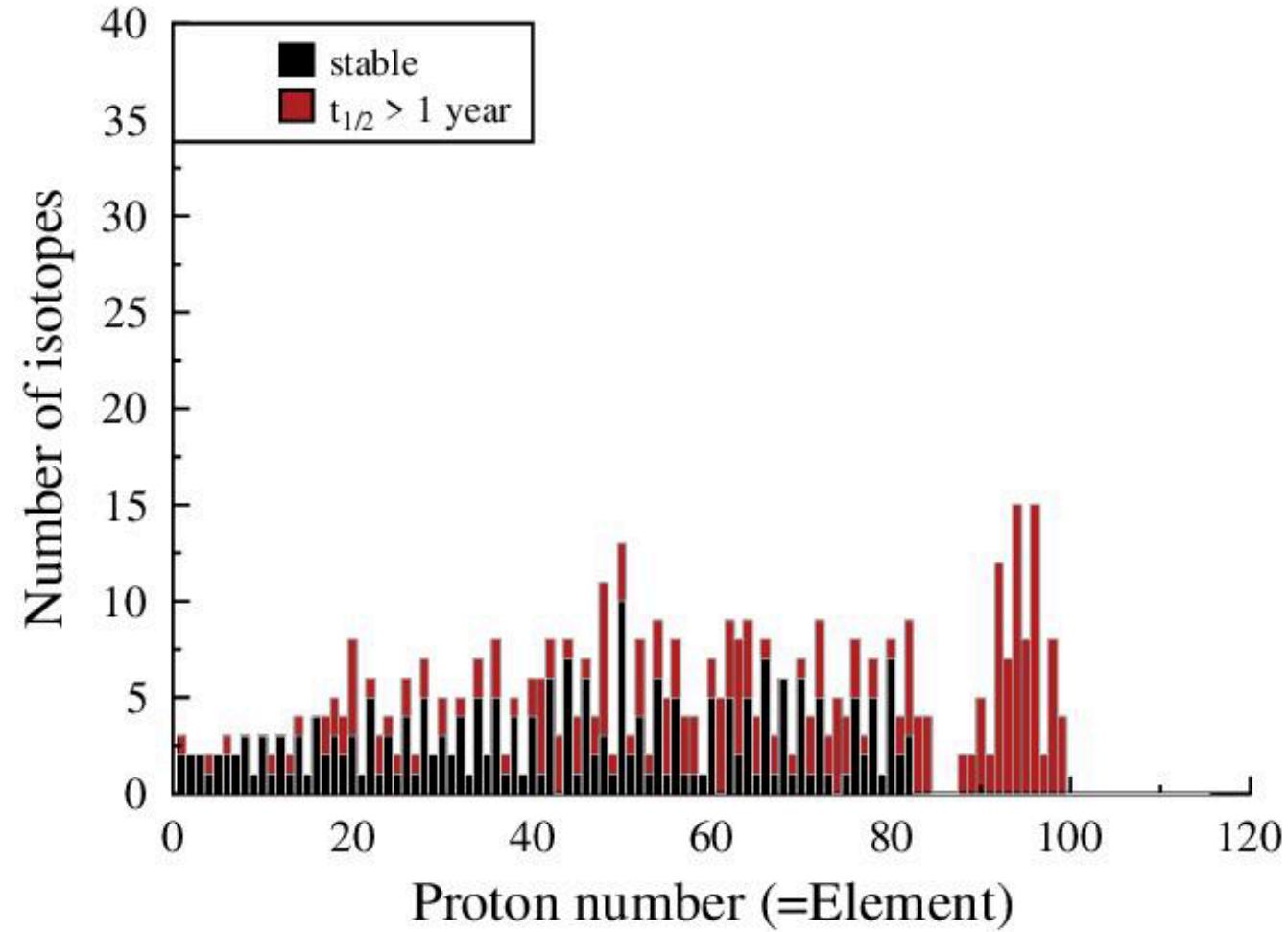
S. Dellmann, Tuesday, 12:15, tresorier



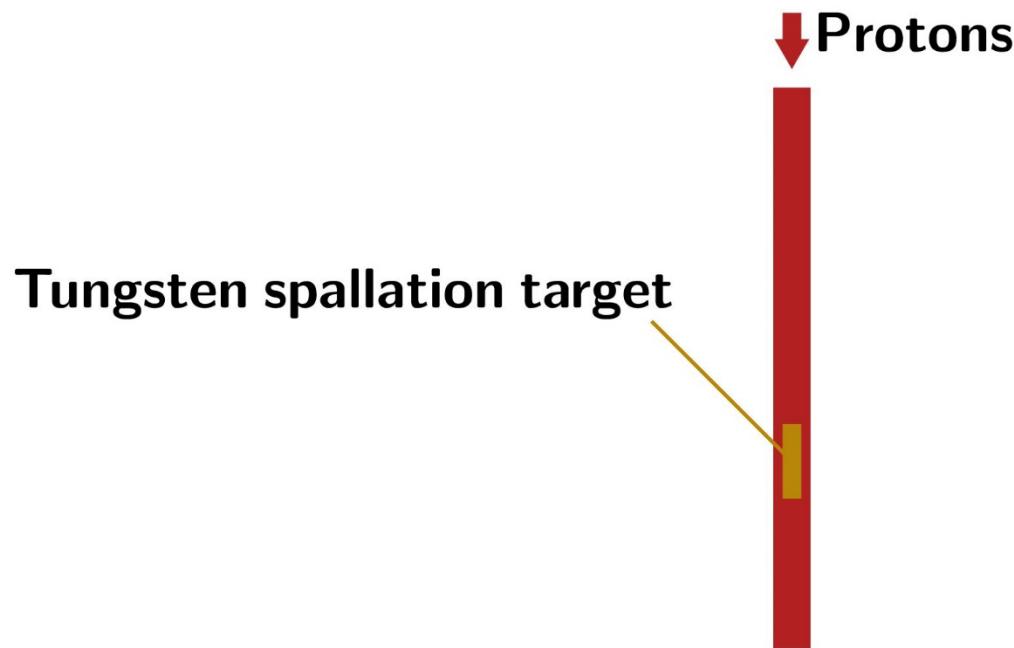
State of the art 1990



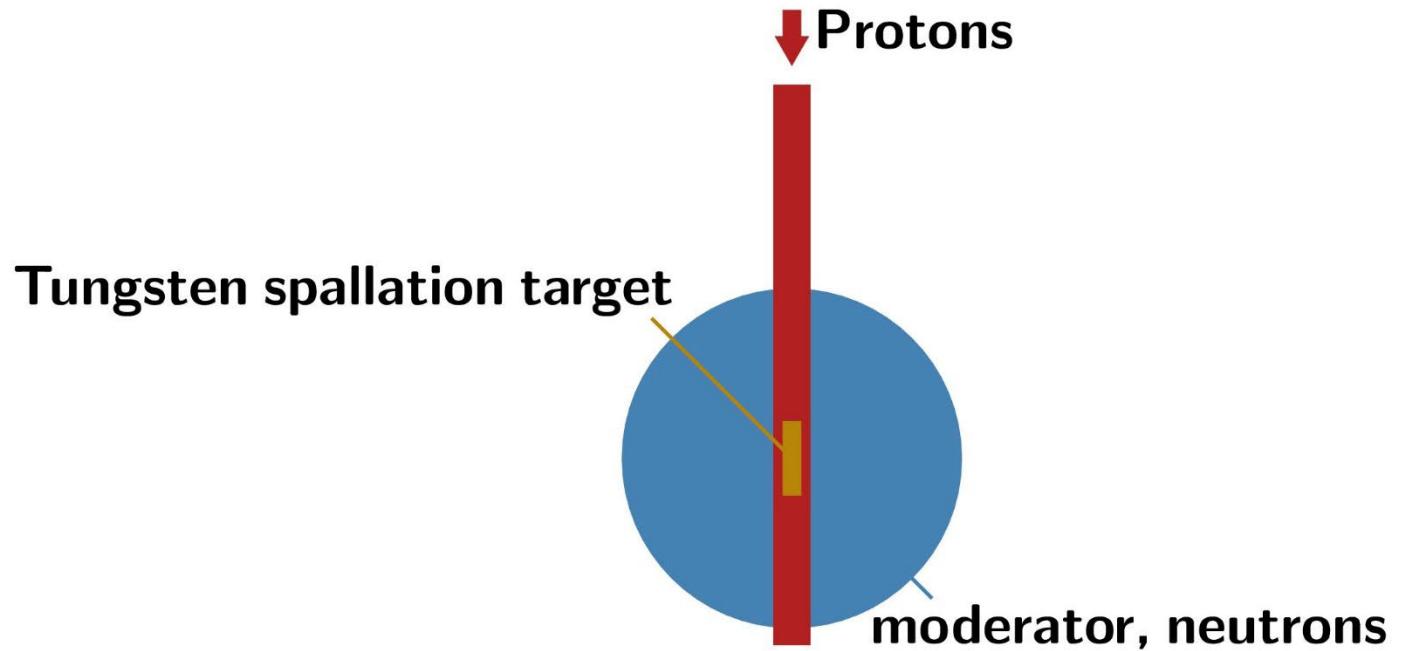
State of the art 2020 (e.g. DANCE)



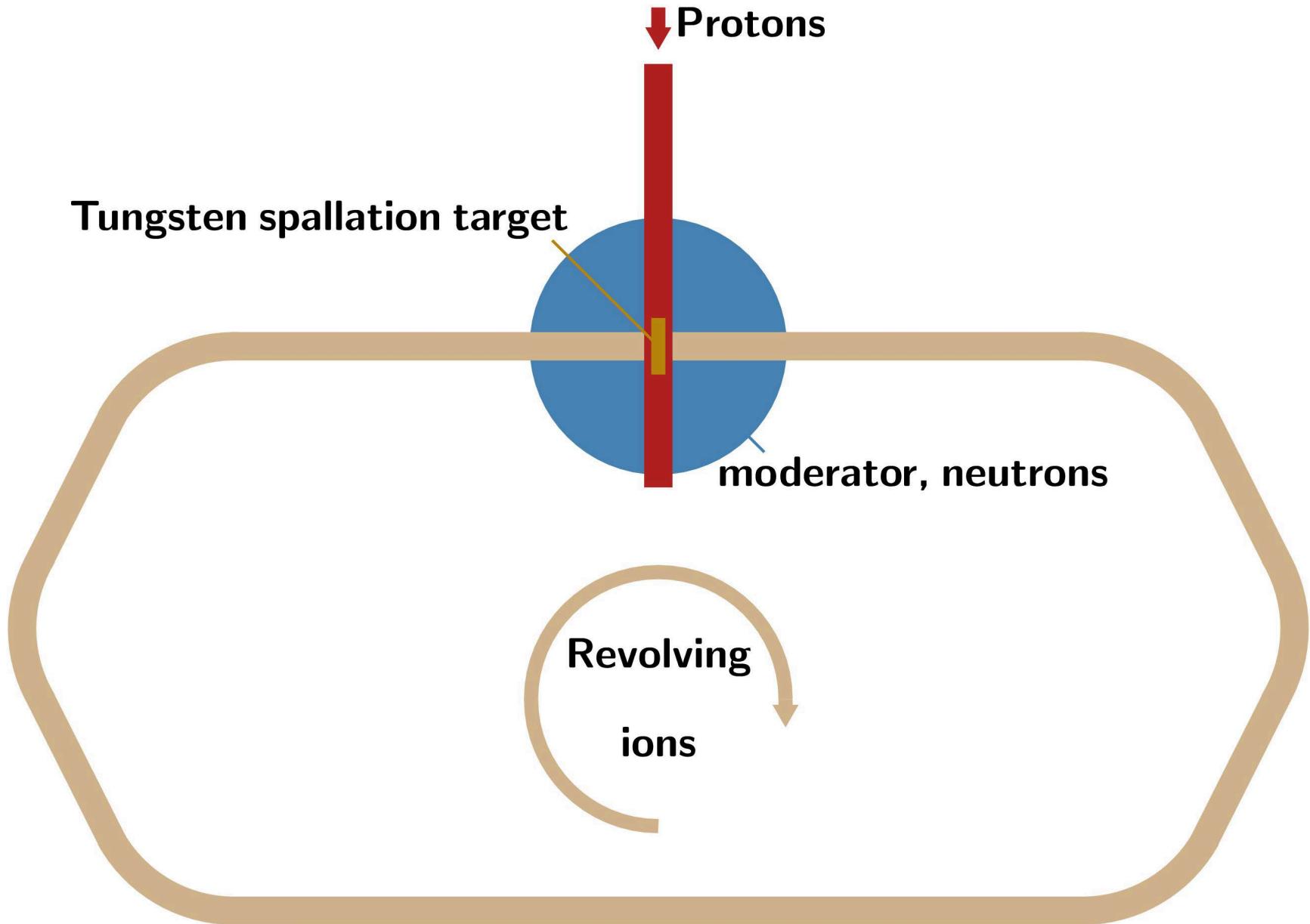
Spallat



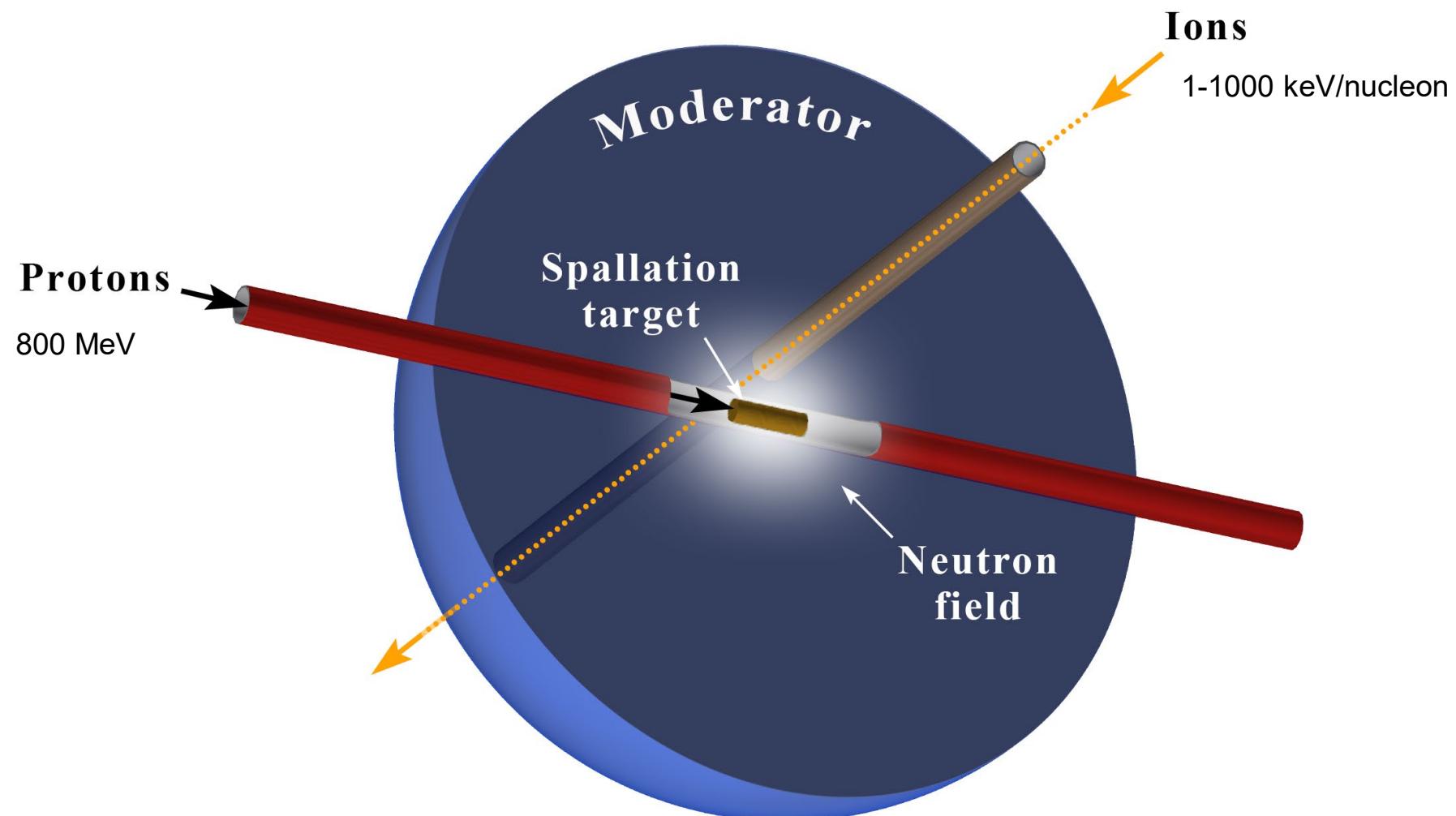
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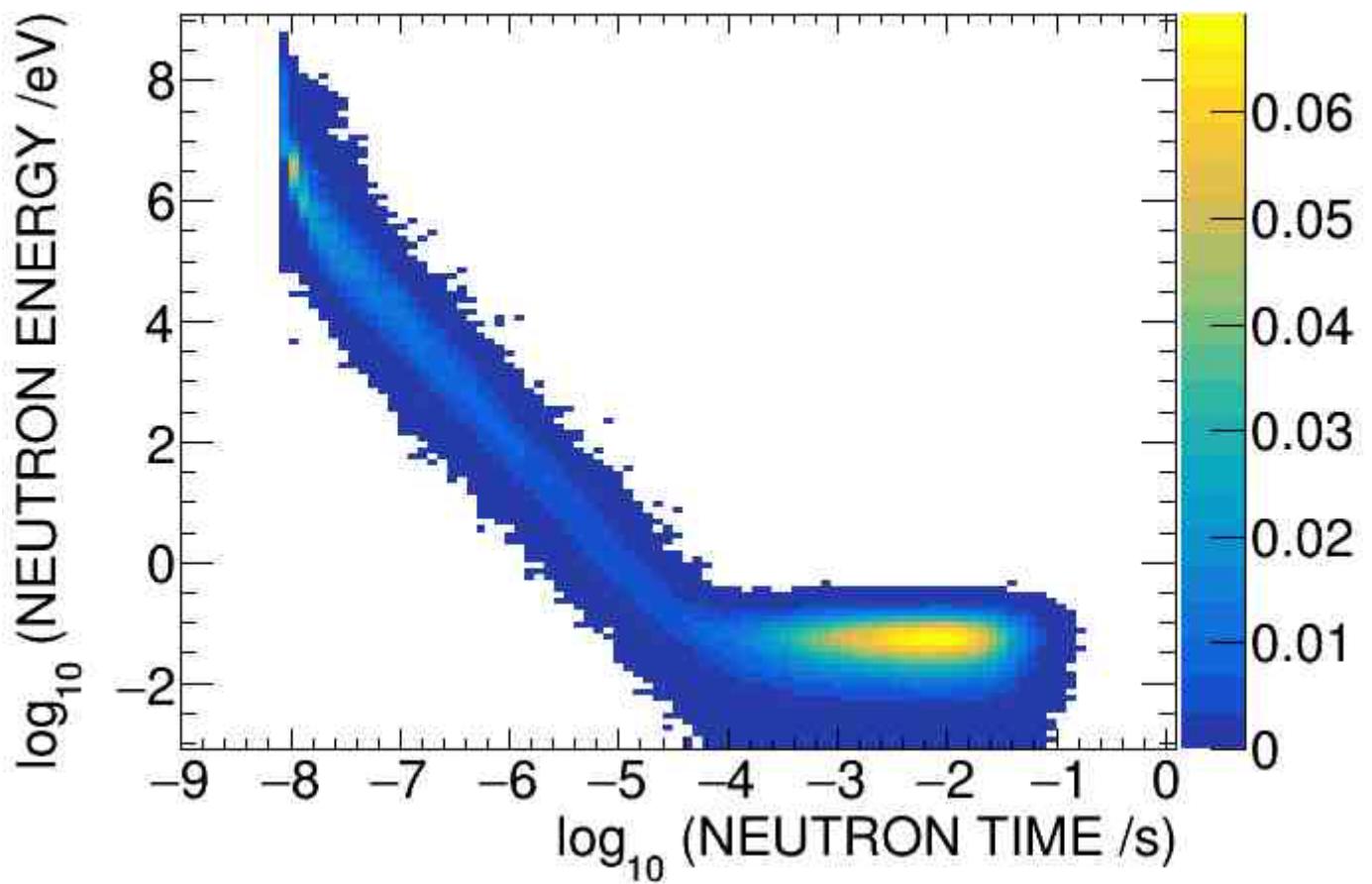
Spallat



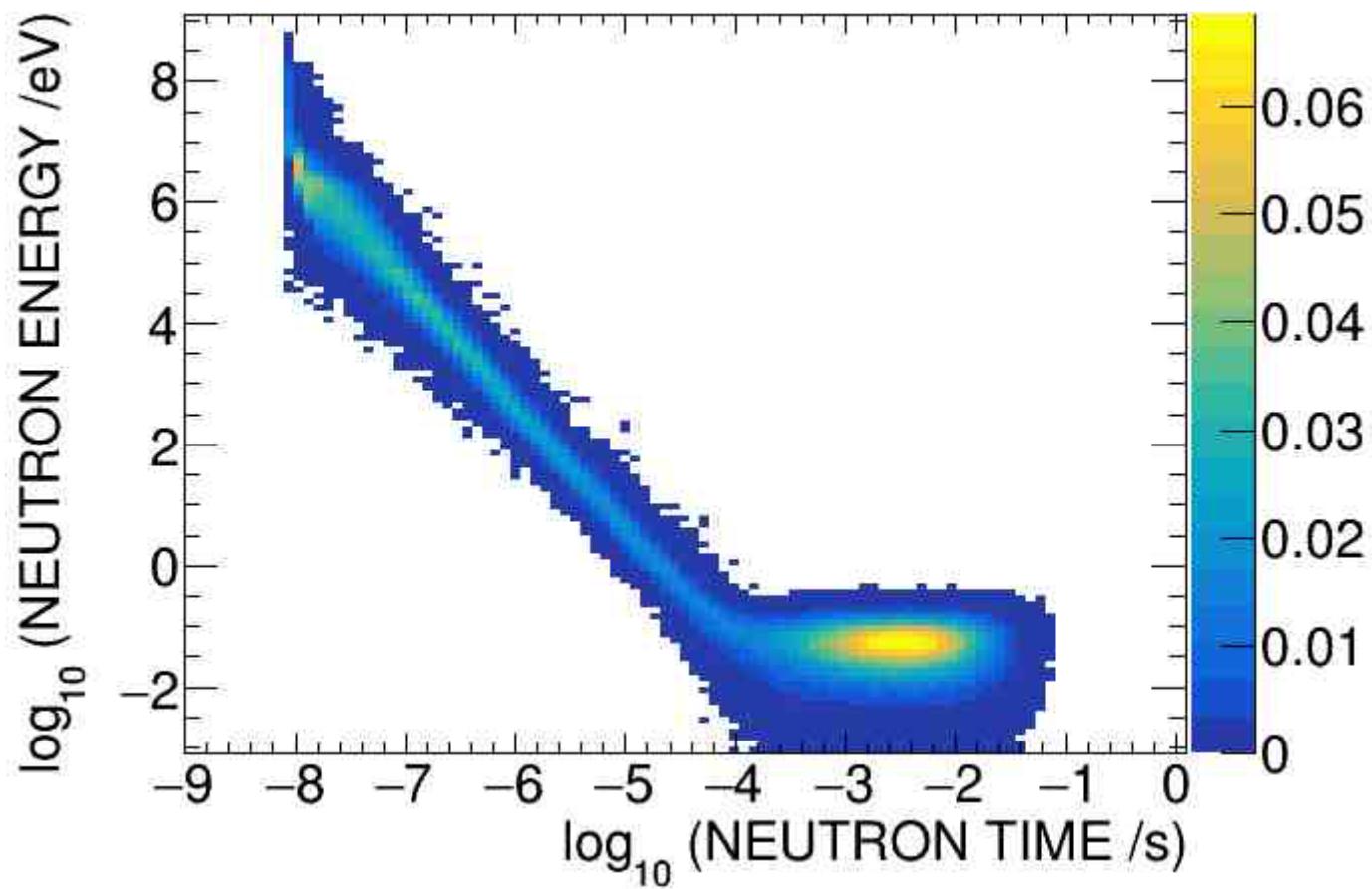
Proposed setup



$D_2O - 230 \mu s$



$^{nat}C - 190 \mu s$



Neutron capture in inverse kinematics

Magnetic dipole: $B\rho = \frac{mv}{q} = \frac{p}{q} = const$

$$\frac{r_{(n,\gamma)}}{r_{primary}} = 1$$

- Schottky spectroscopy
- Separation via E-field
- Wien filter (velocity filters)
- Particle detection

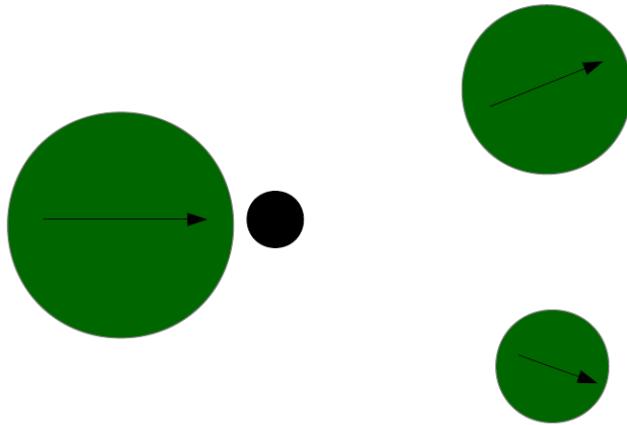
(n,Z) and (n,2n) in inverse kinematics

- Detection of heavy particles
 - Without recoil:
 - With recoil: spread of beam
- Detection of light particles – probably not possible

$$\frac{r_D}{r_P} = \frac{Z_P}{Z_D} \frac{A_D}{A_P + 1}$$

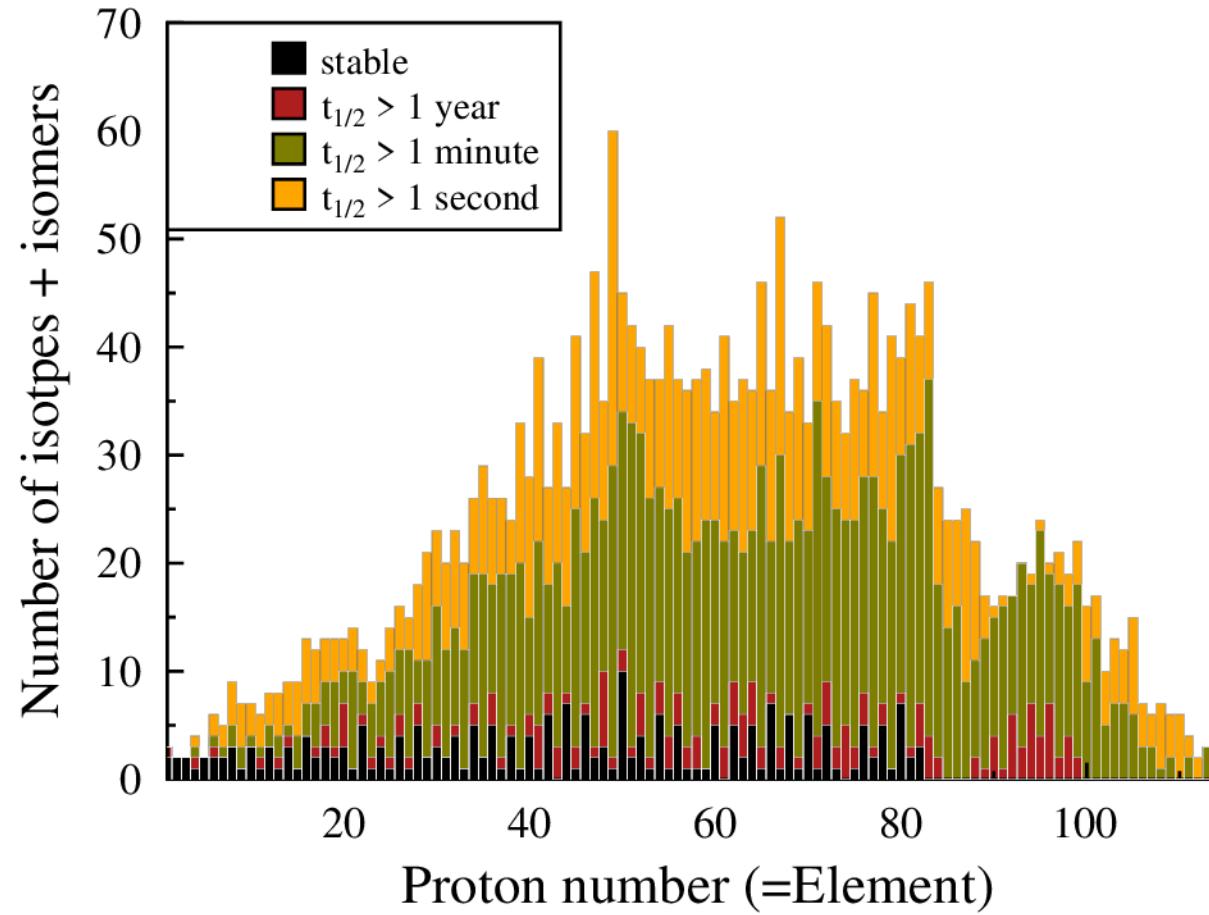
(n,f) in inverse kinematics

- Detection of fission fragments outside neutron target

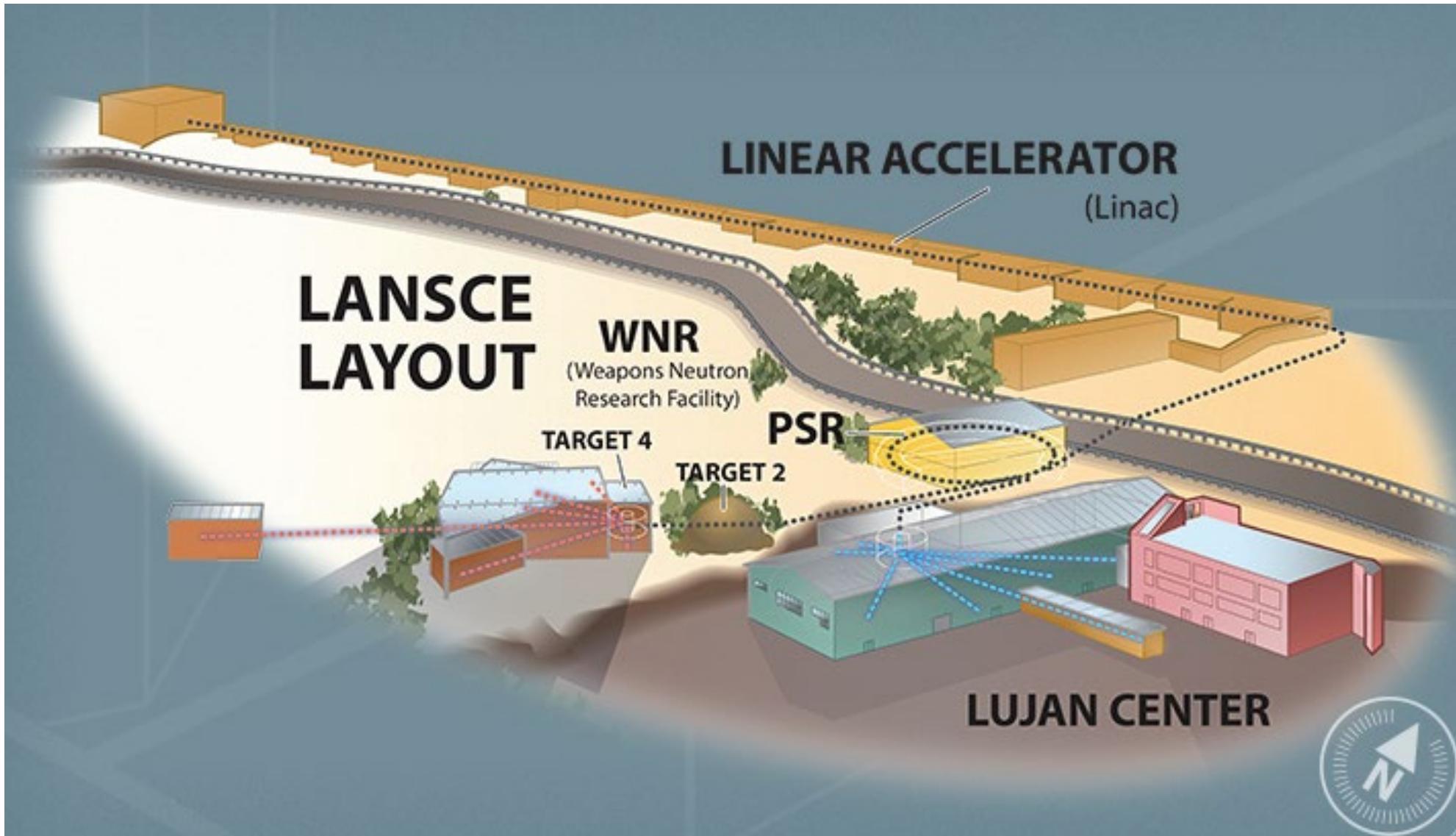


- $E_{cm} > \approx 10 \text{ MeV}$

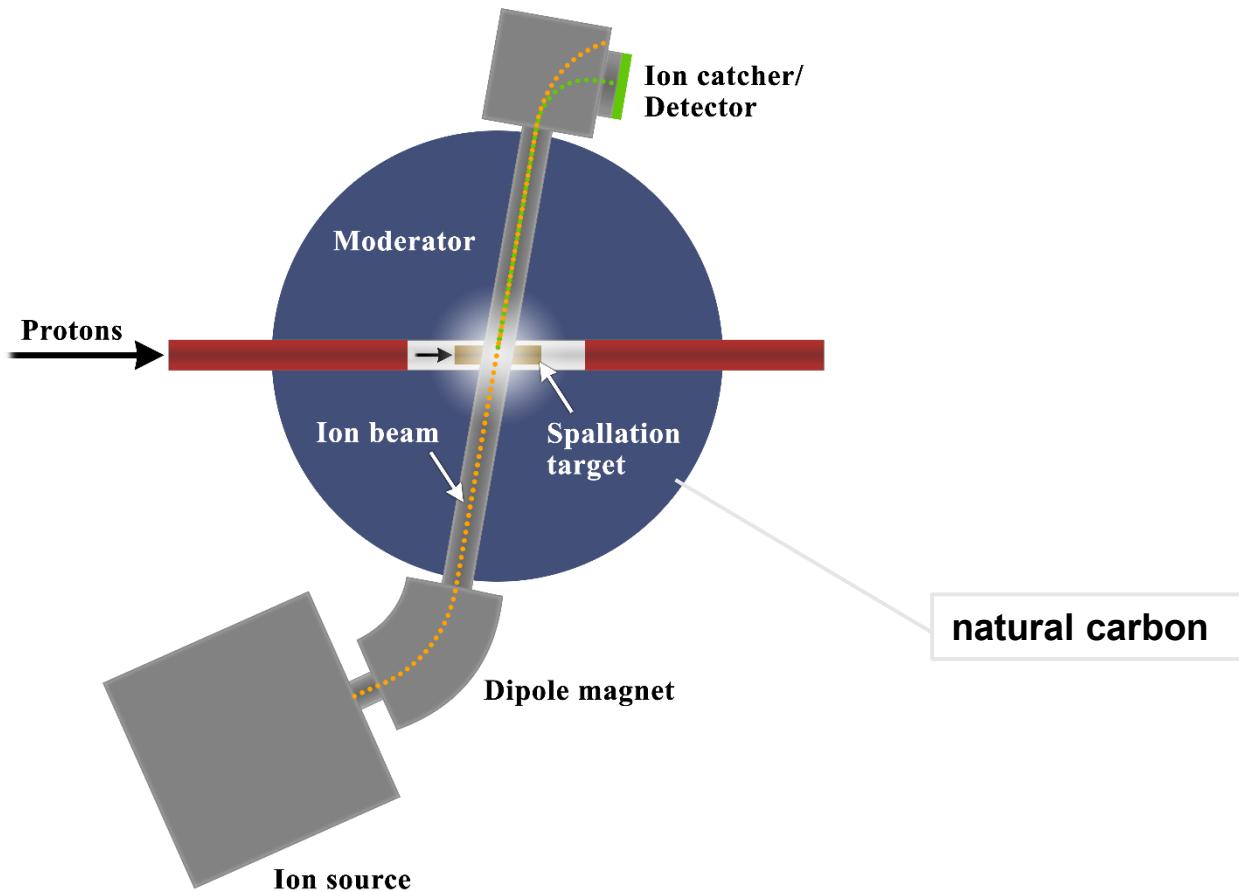
State of the art 2035? (N-TARGET)



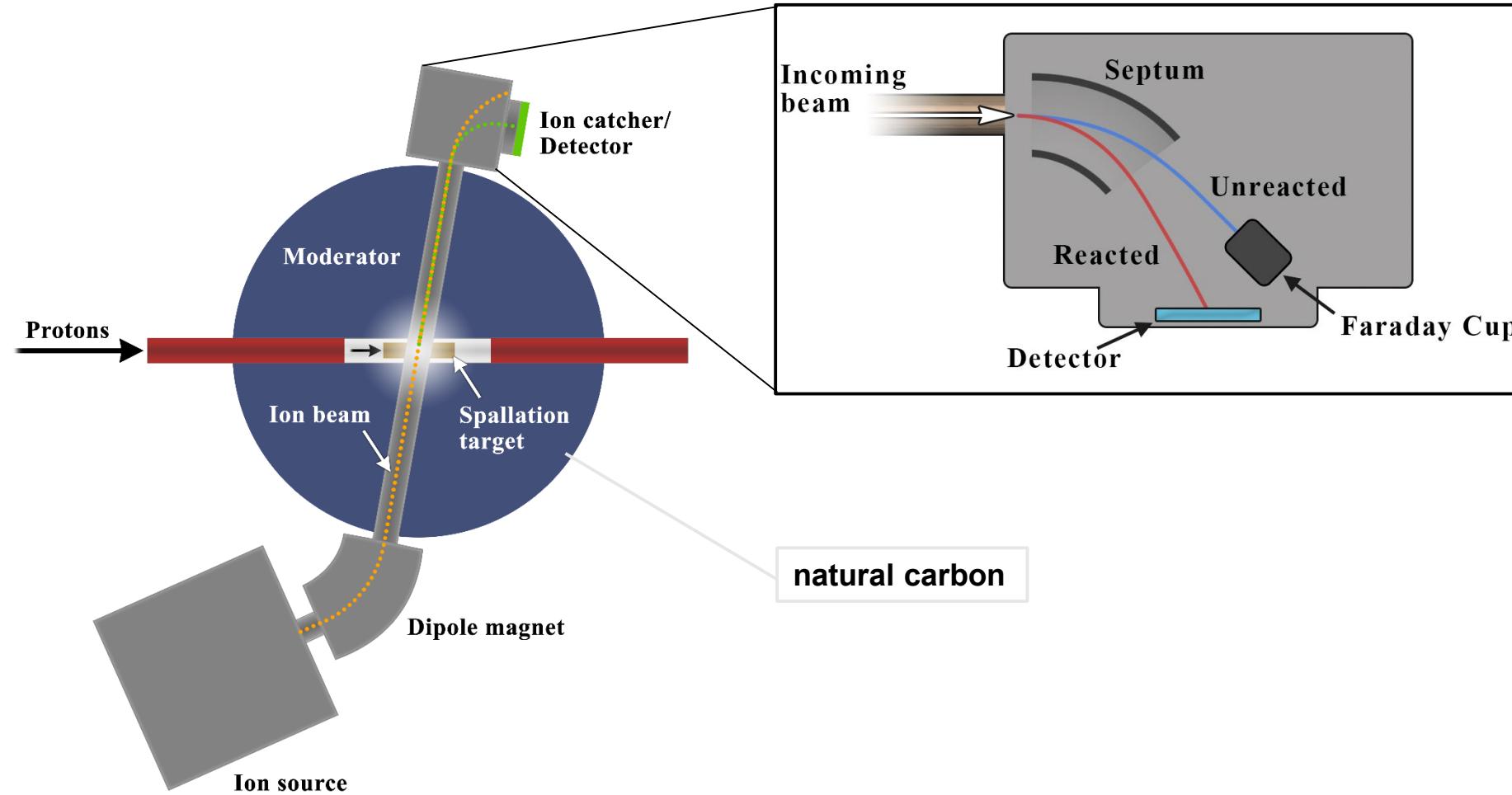
LANSCE@LANL



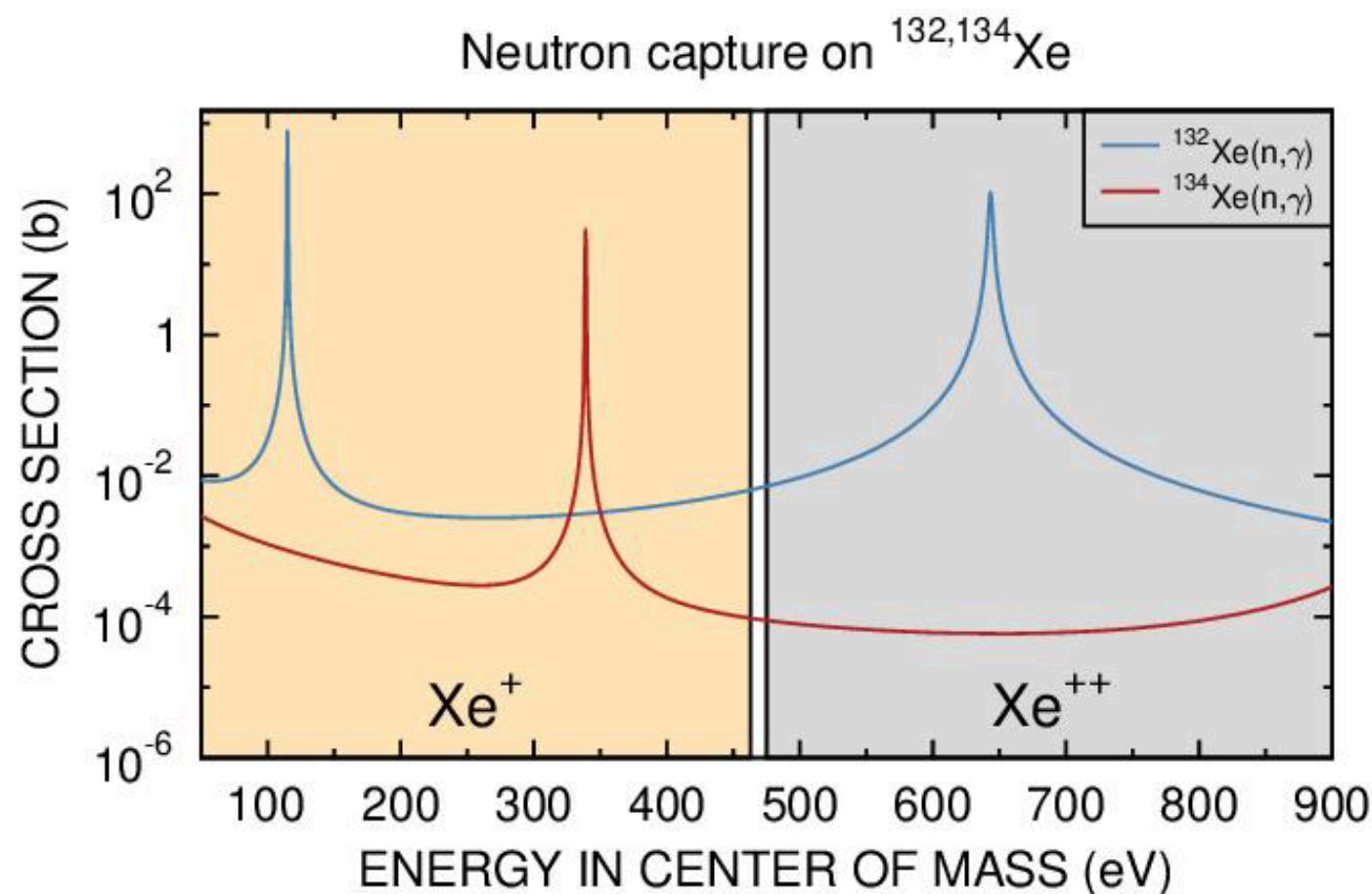
First steps



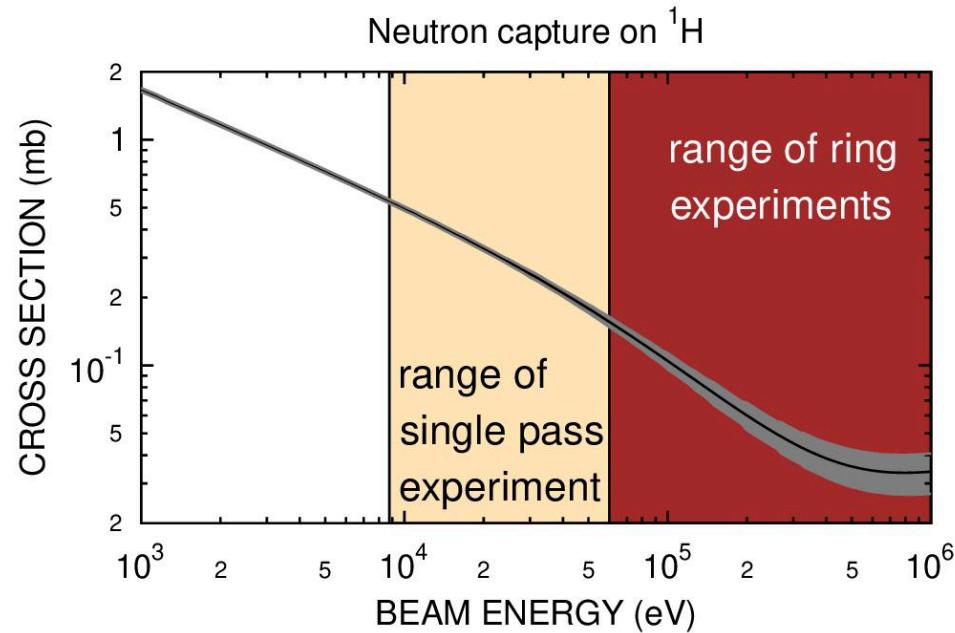
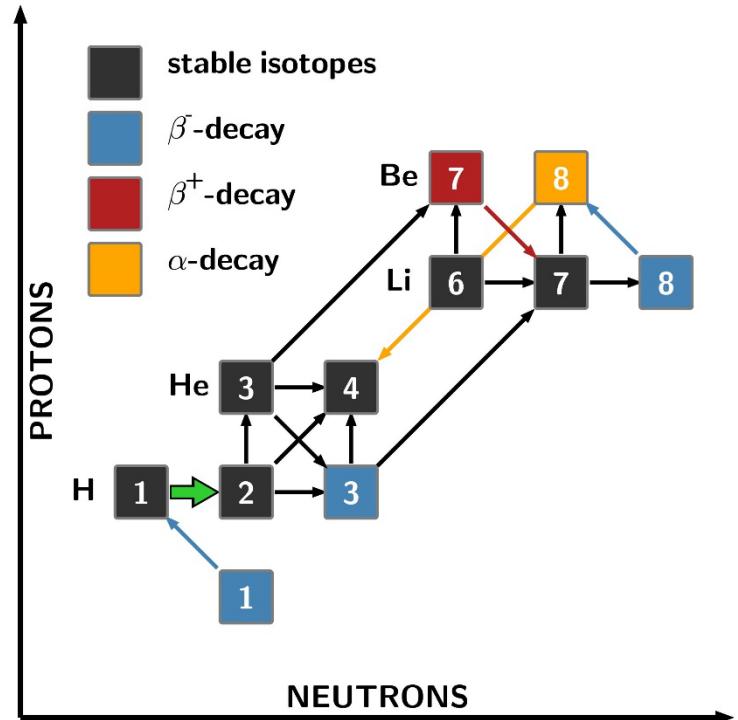
First steps - without heavy ion accelerator



Proof of principle with 60 kV ion source

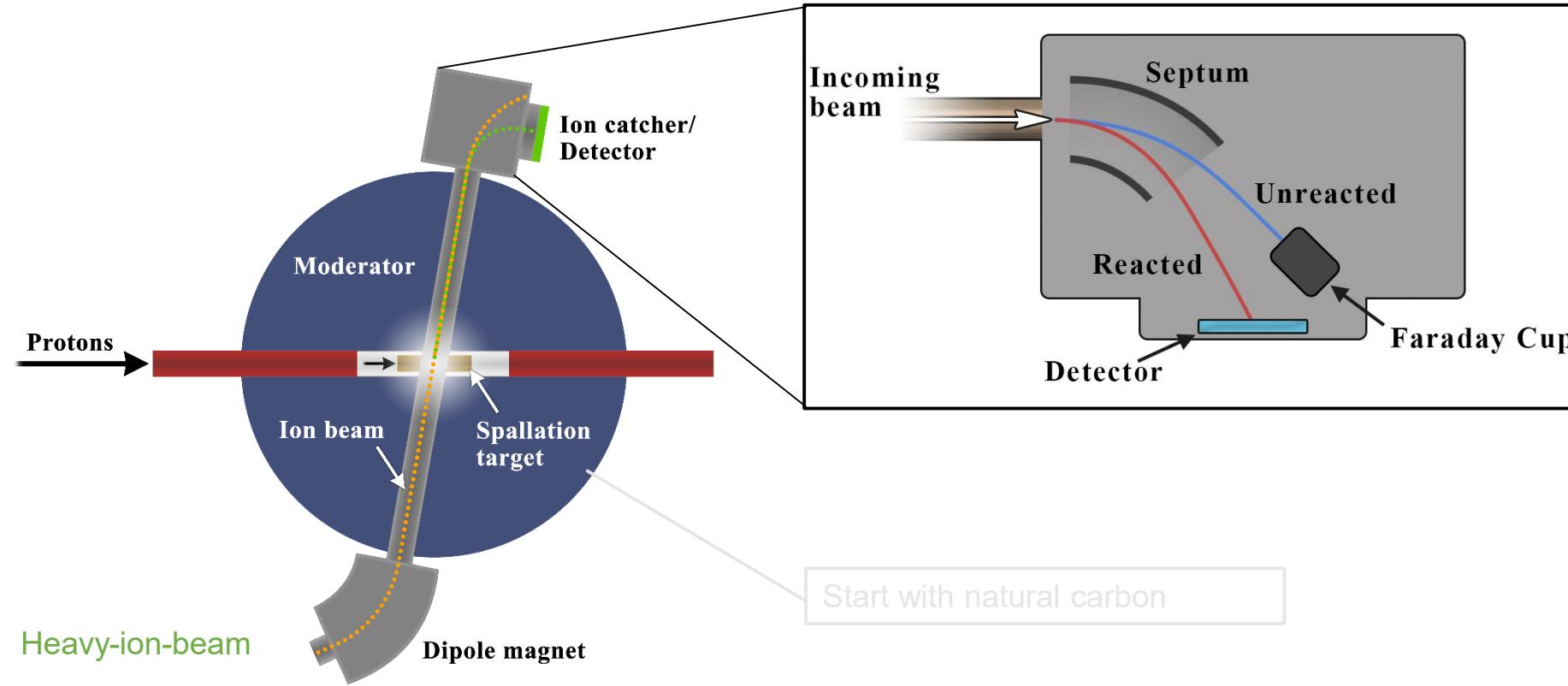


New data on n+p for BBT

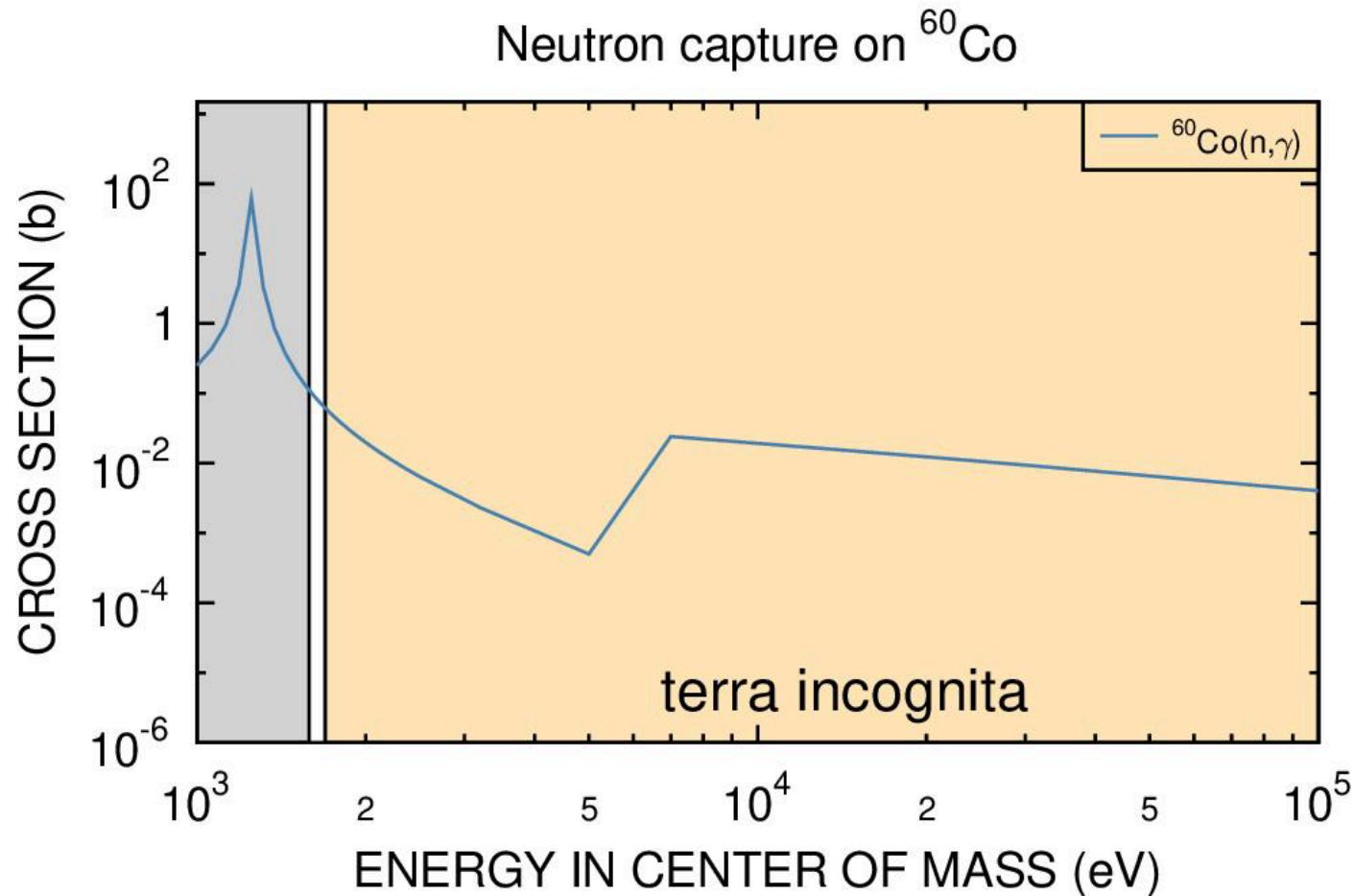


Cyburt et al. New Astronomy, 2001:
“We urge further investigation of this reaction.”

First steps - with heavy ion accelerator



Proof of principle with ^{60}Co



Summary

- proton capture
- neutron capture

