n-capture in inverse kinematics

René Reifarth
Los Alamos National Laboratory, USA
Goethe-University Frankfurt, Germany

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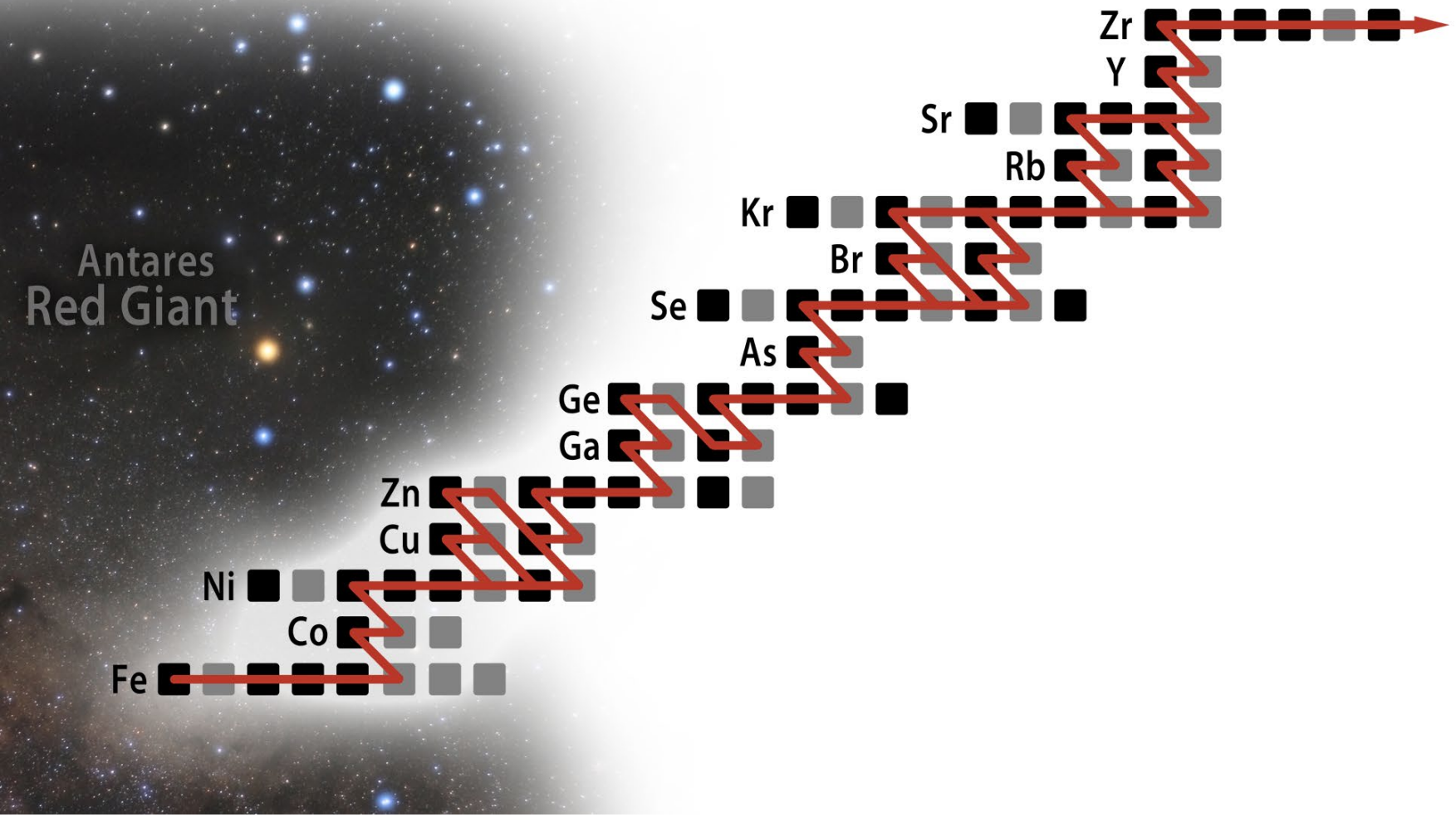
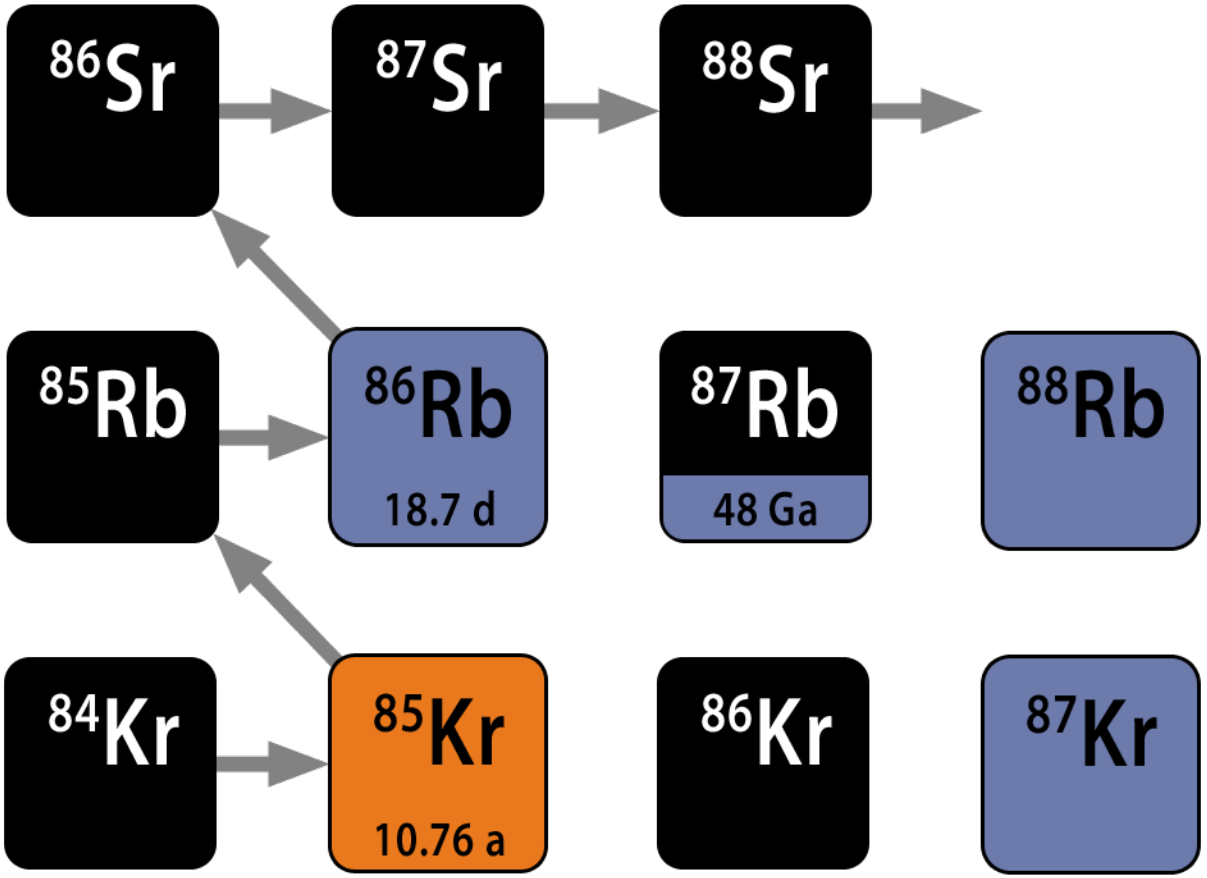
LA-UR-24-22929

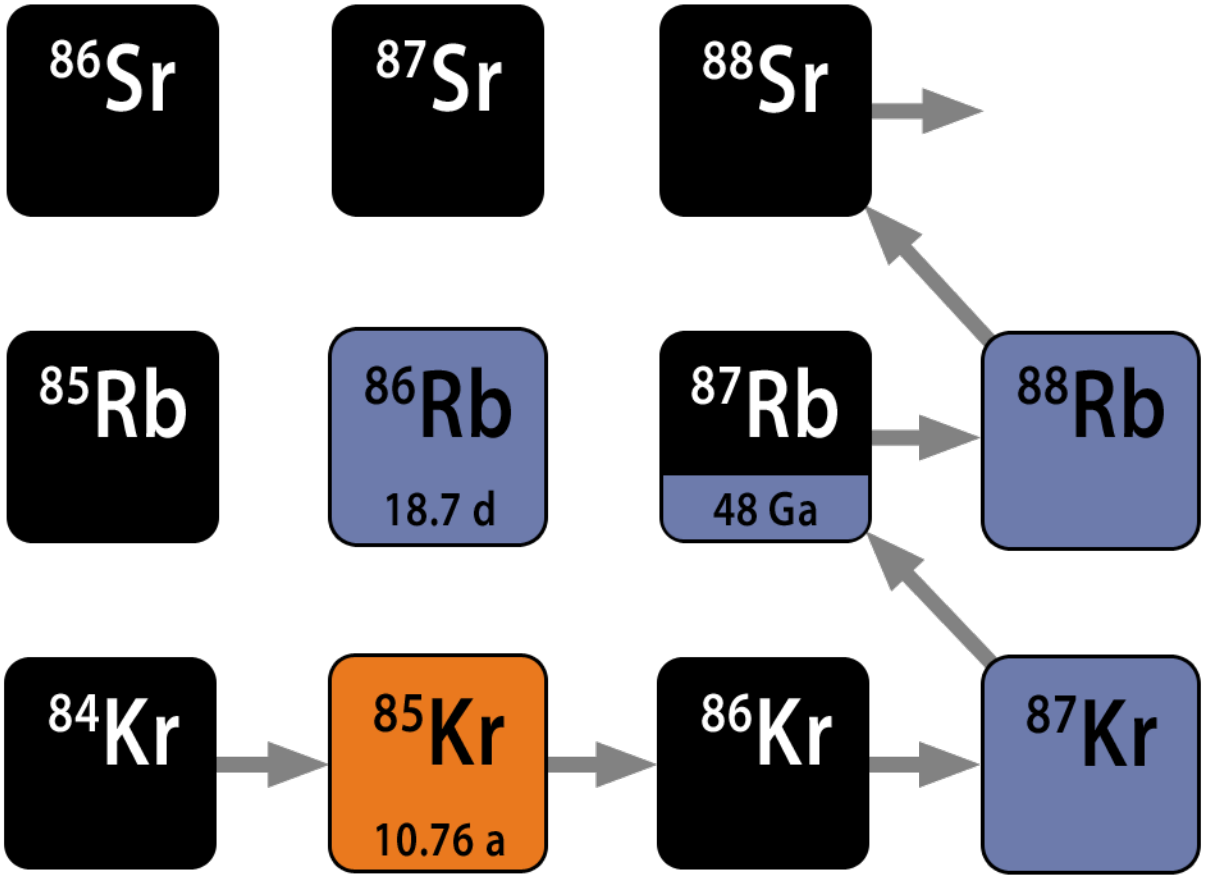
Neutron-induced nucleosynthesis



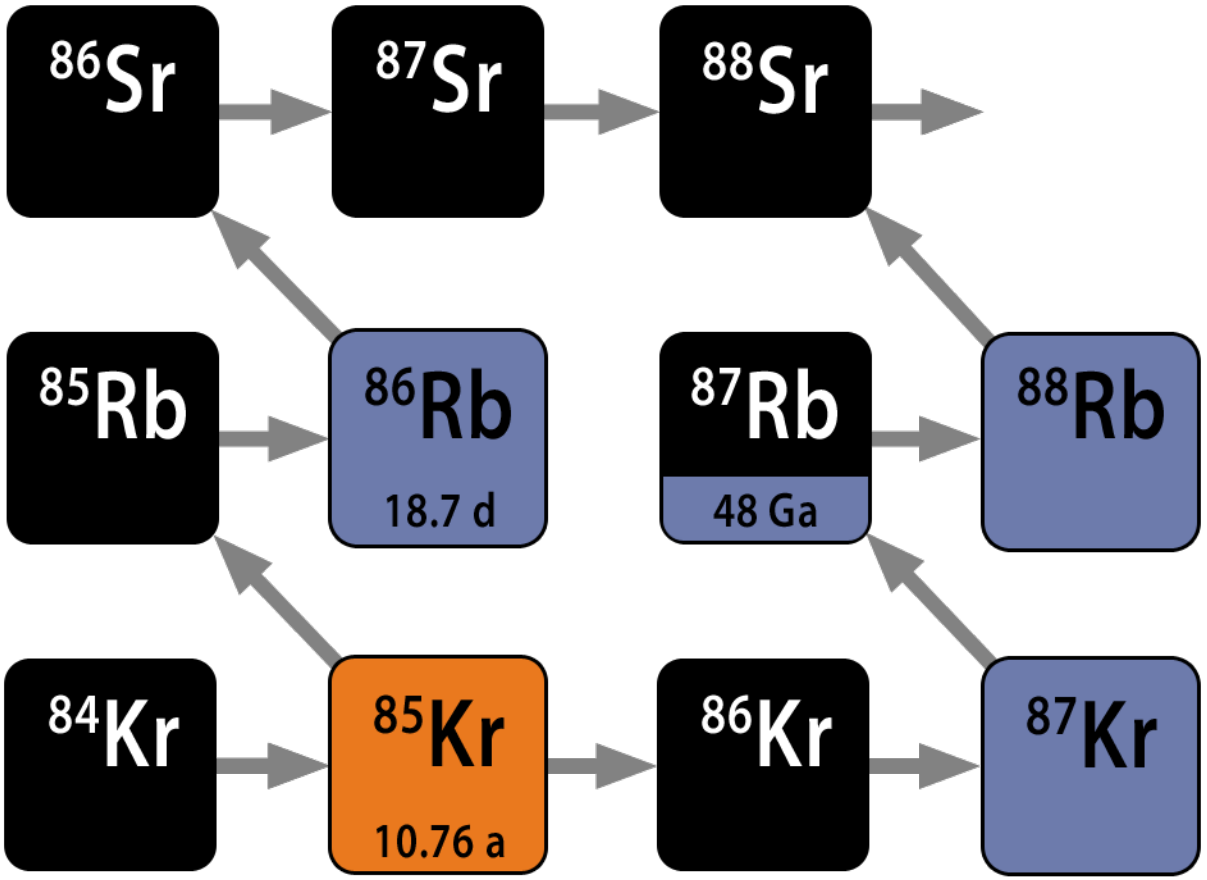
Branches in the synthesis paths



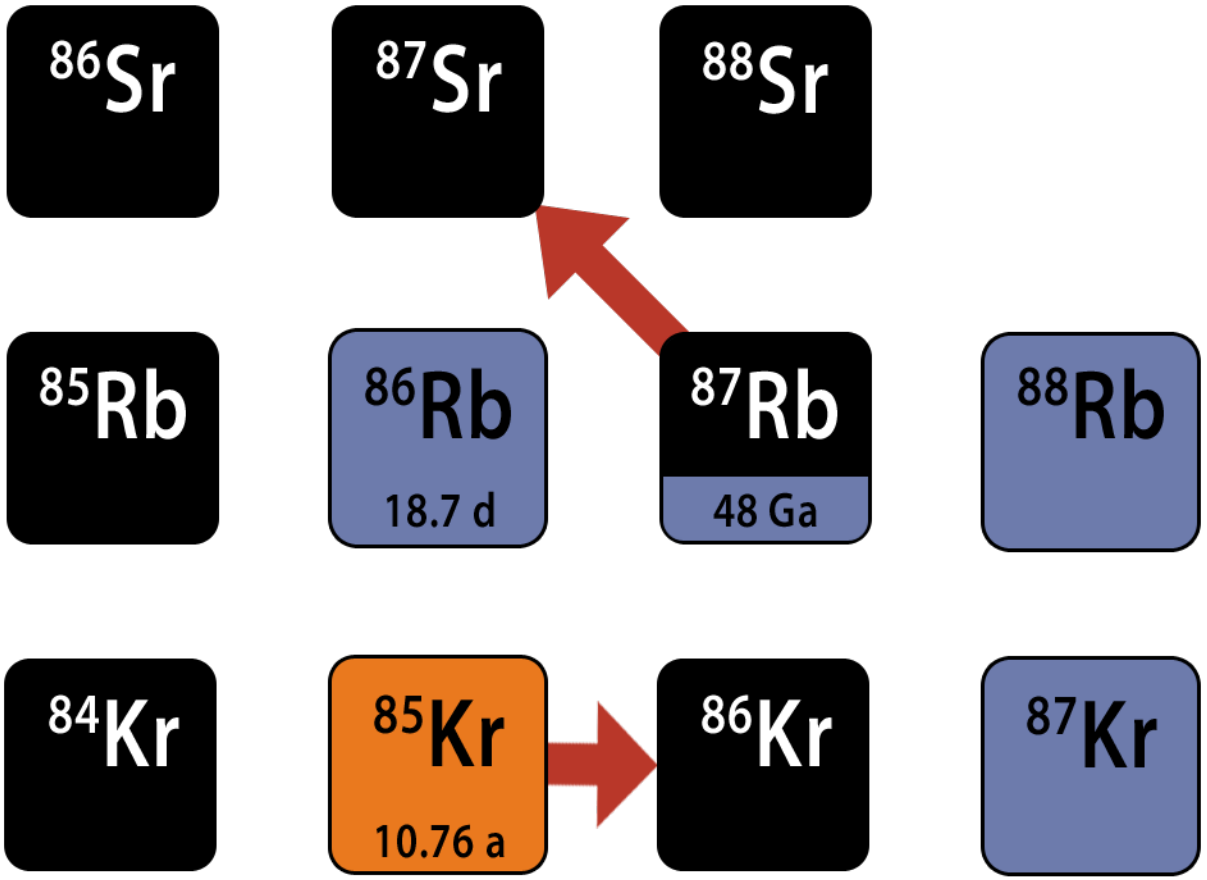
Branches in the synthesis paths



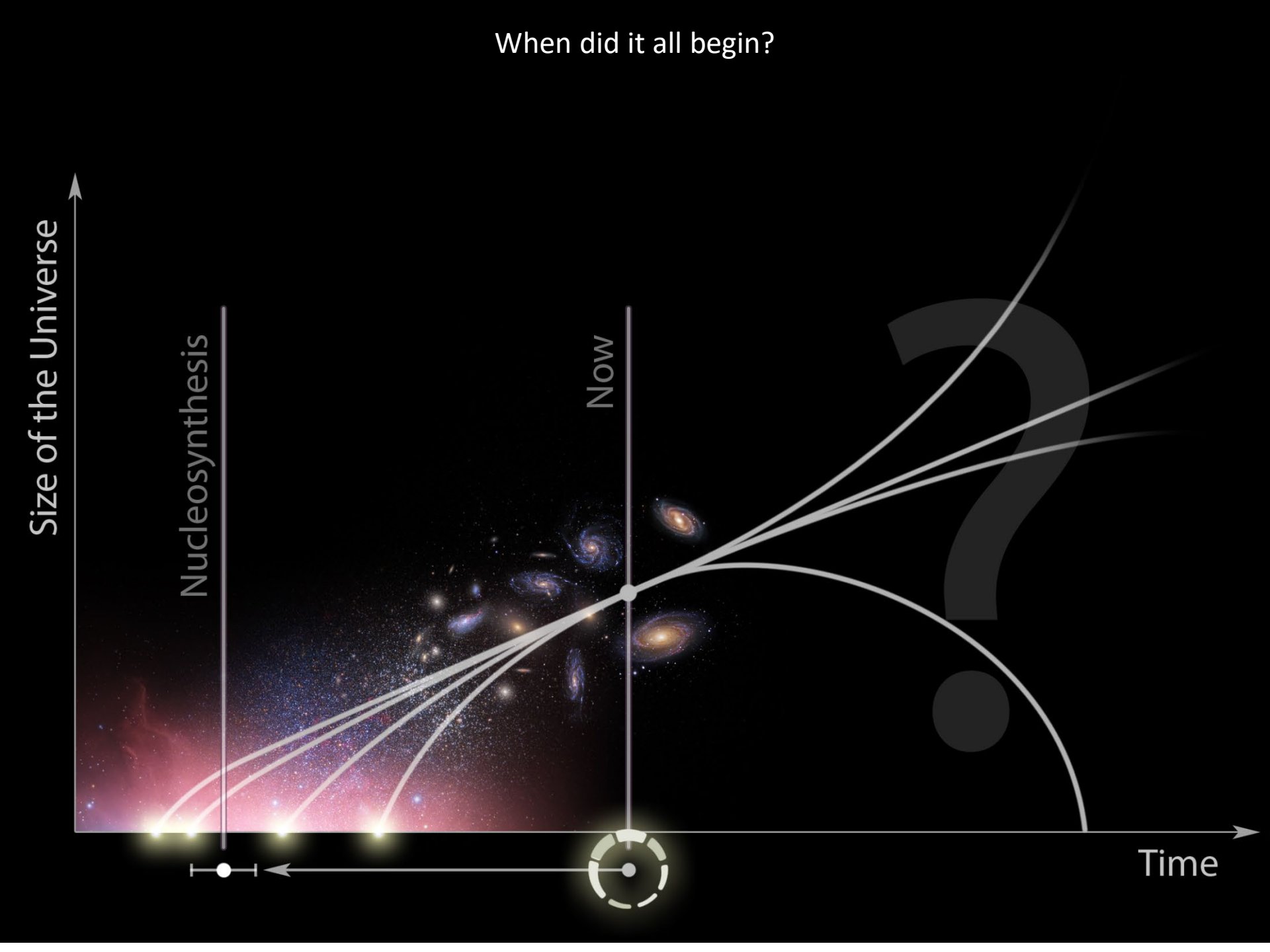
Branches in the synthesis paths



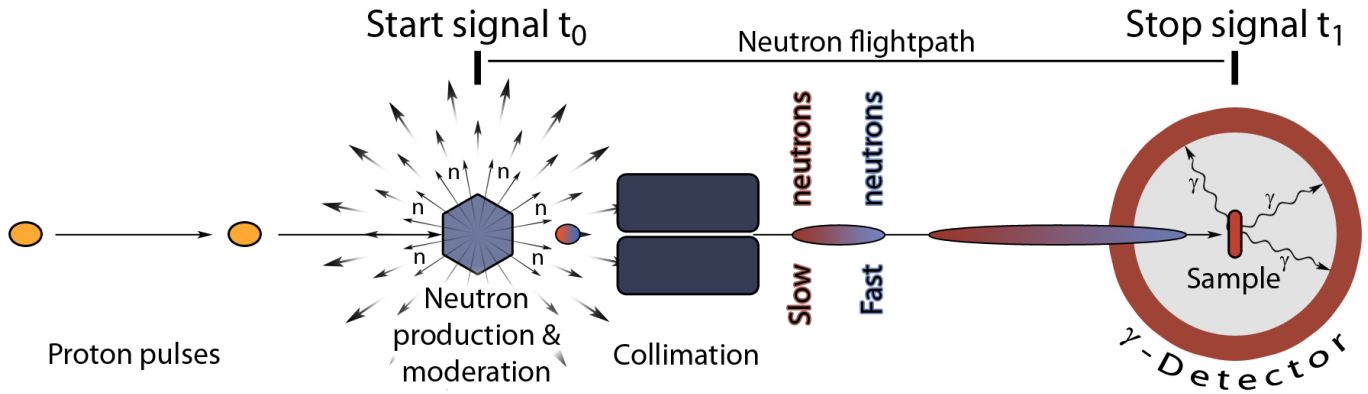
Branches in the synthesis paths



When did it all begin?

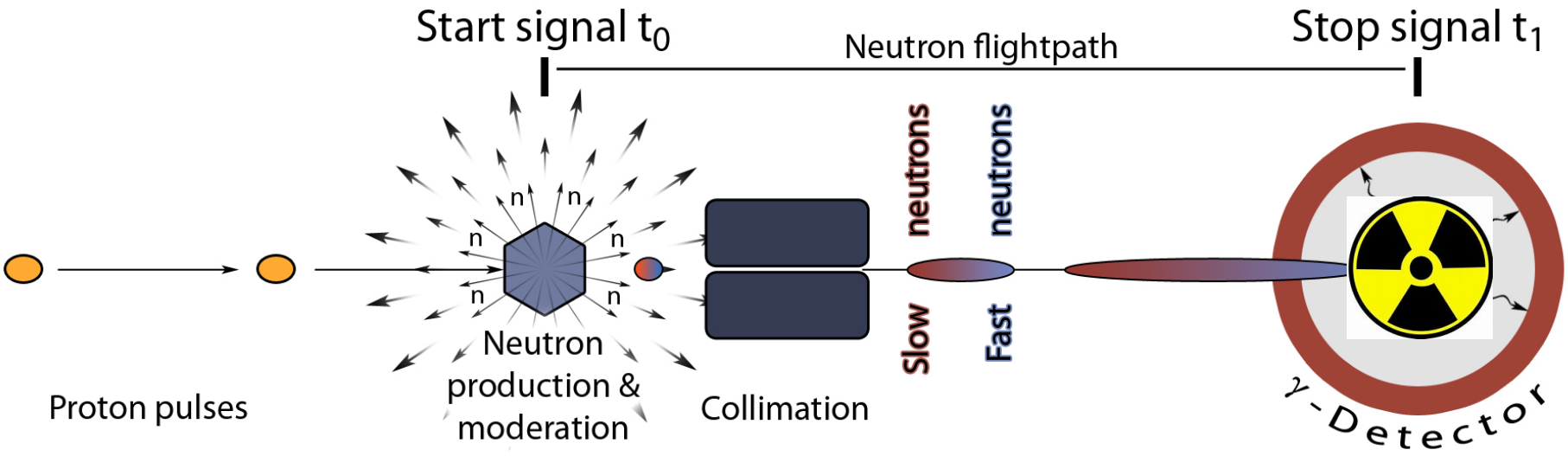


Neutron Captures time-of-flight technique



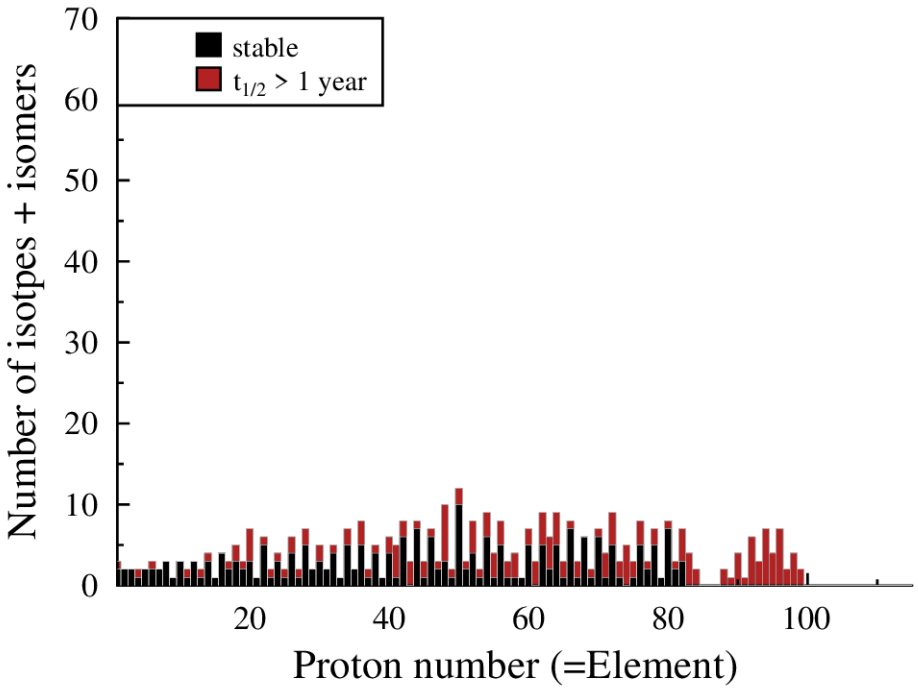
Reifarth et al., Journal of Physics G 41 (2014) 53101

Neutron Captures time-of-flight technique



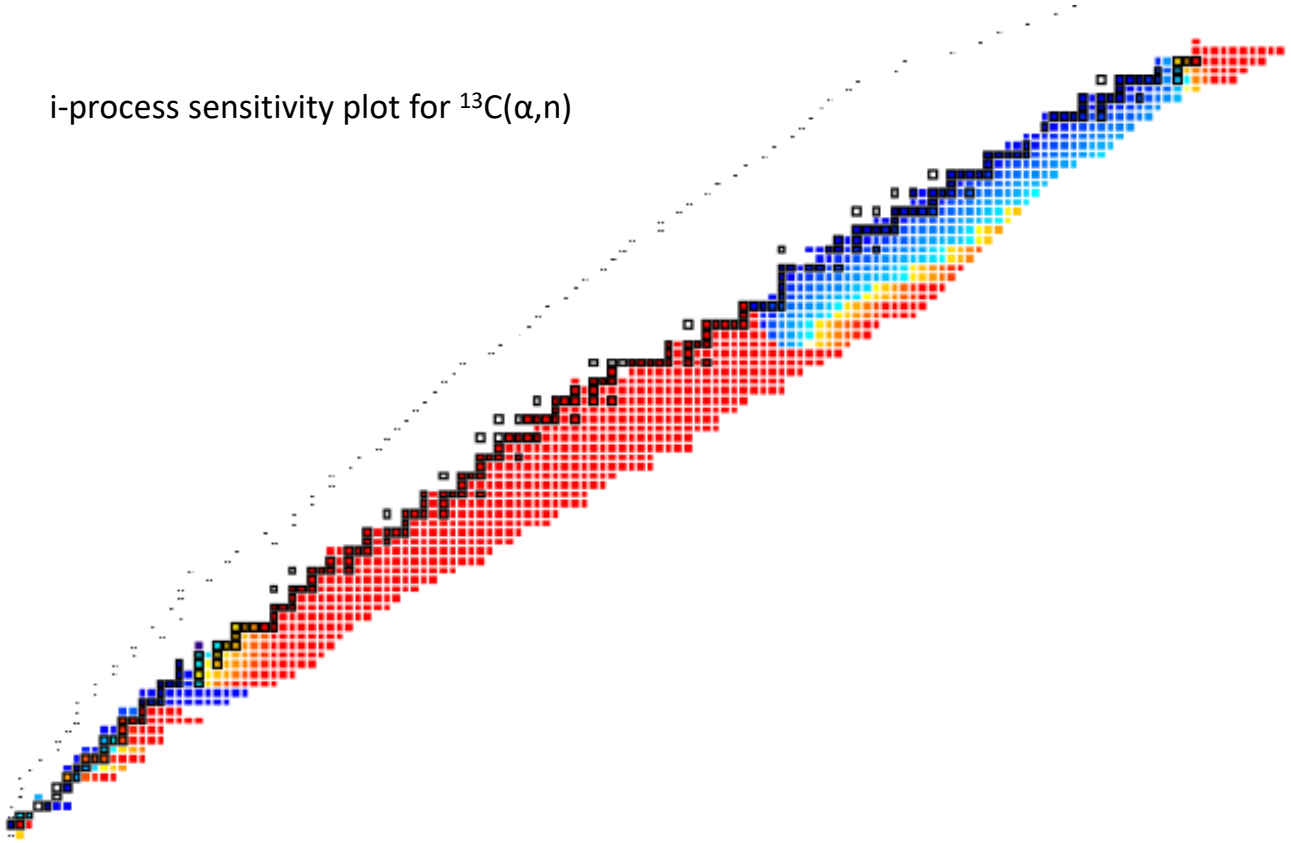
Reifarth et al., Journal of Physics G 41 (2014) 53101

State of the art 2020 (e.g. **DANCE, nTOF**)



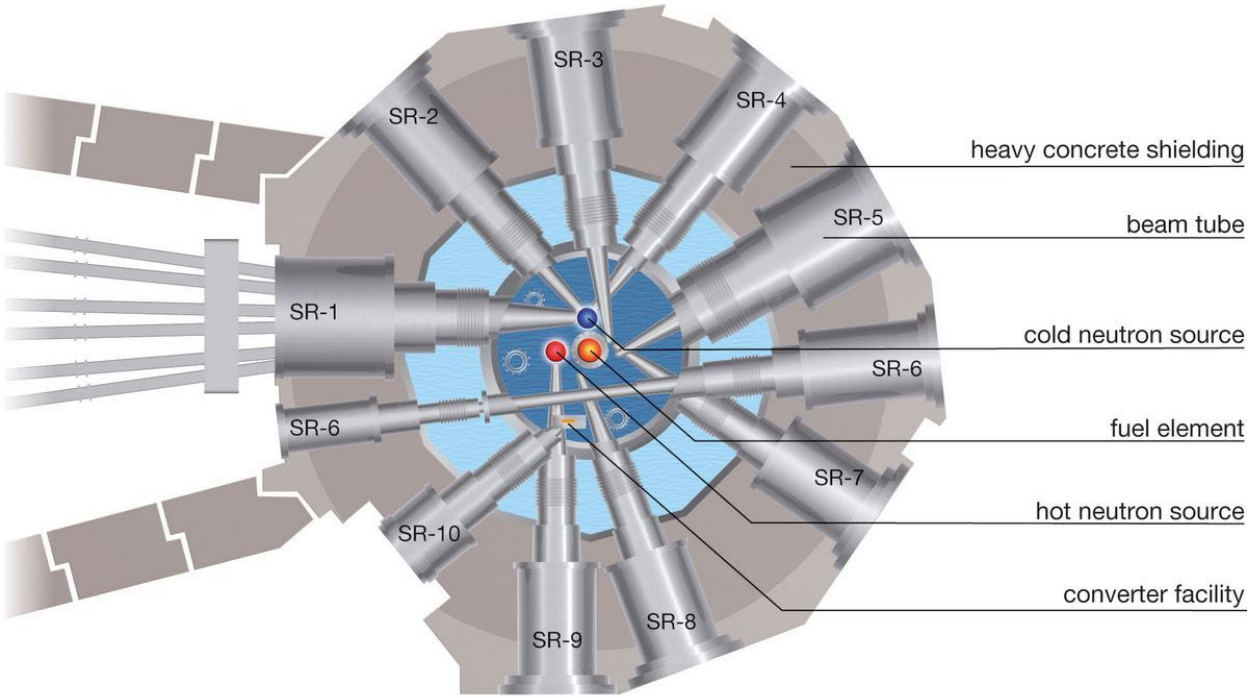
Other n-induced processes …

i-process sensitivity plot for $^{13}C(\alpha,n)$



https://exp-astro.de/sensitivities/

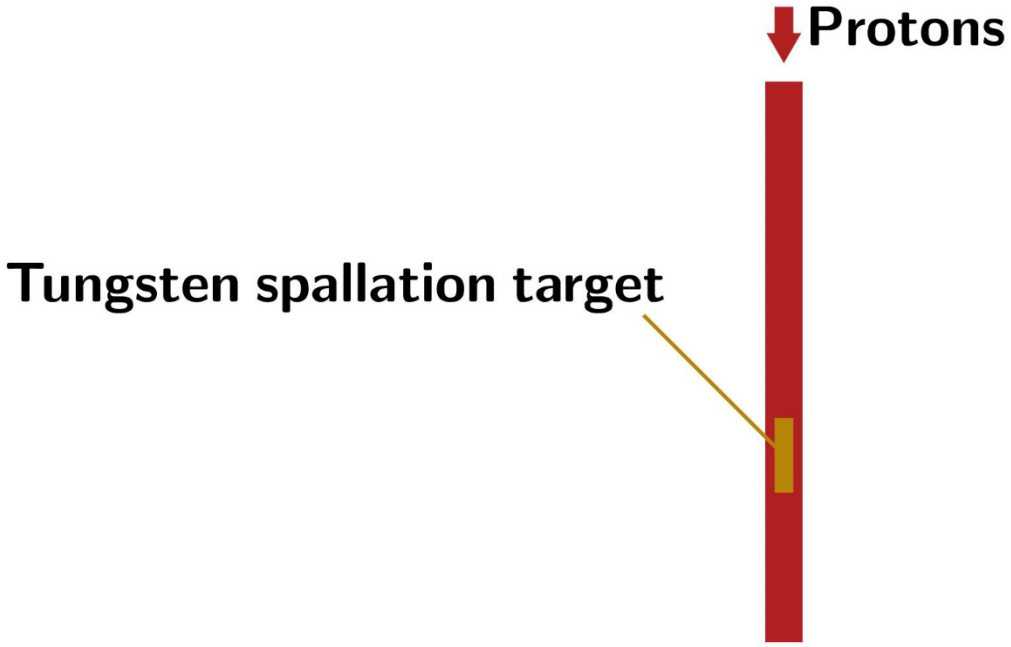
Beam tubes at FRM II, Munich, Germany

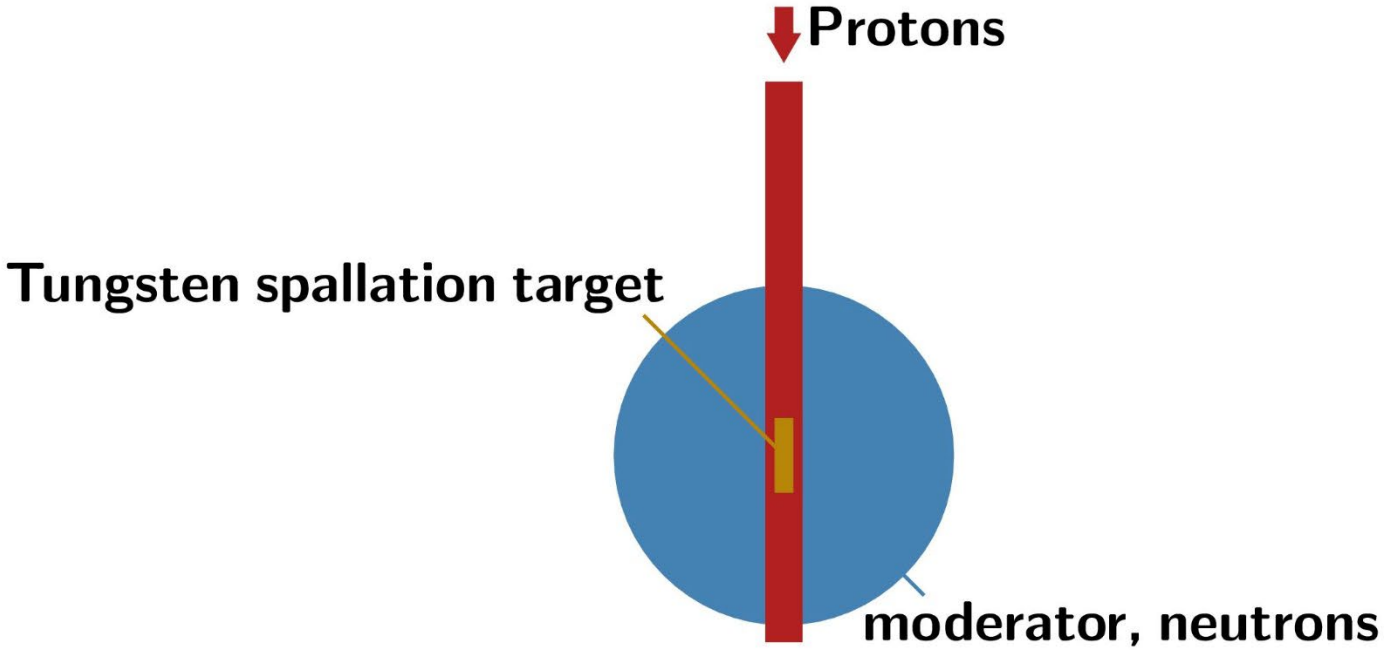


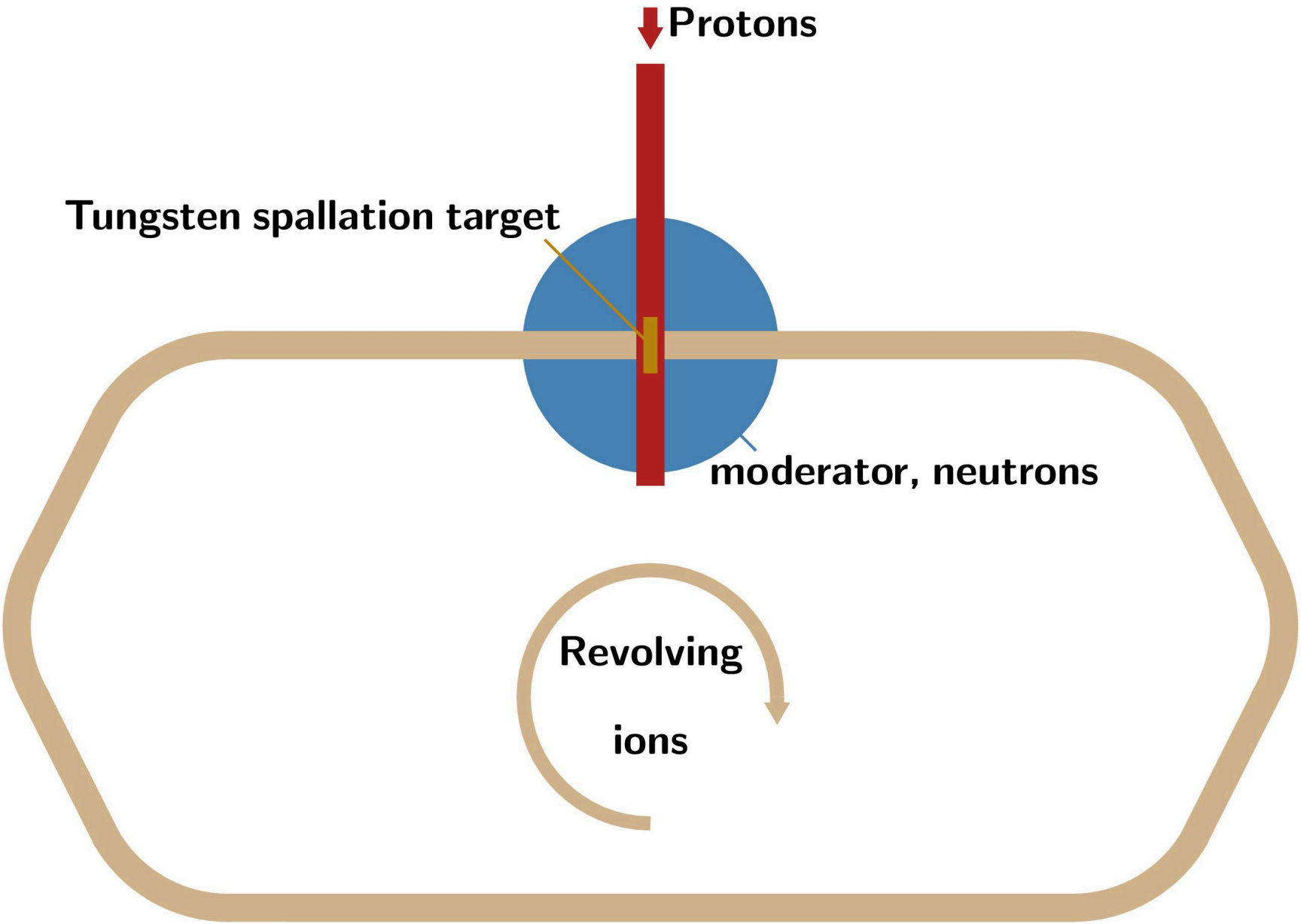
https://www.frm2.tum.de/en/the-neutron-source/reactor/guiding-the-beams/

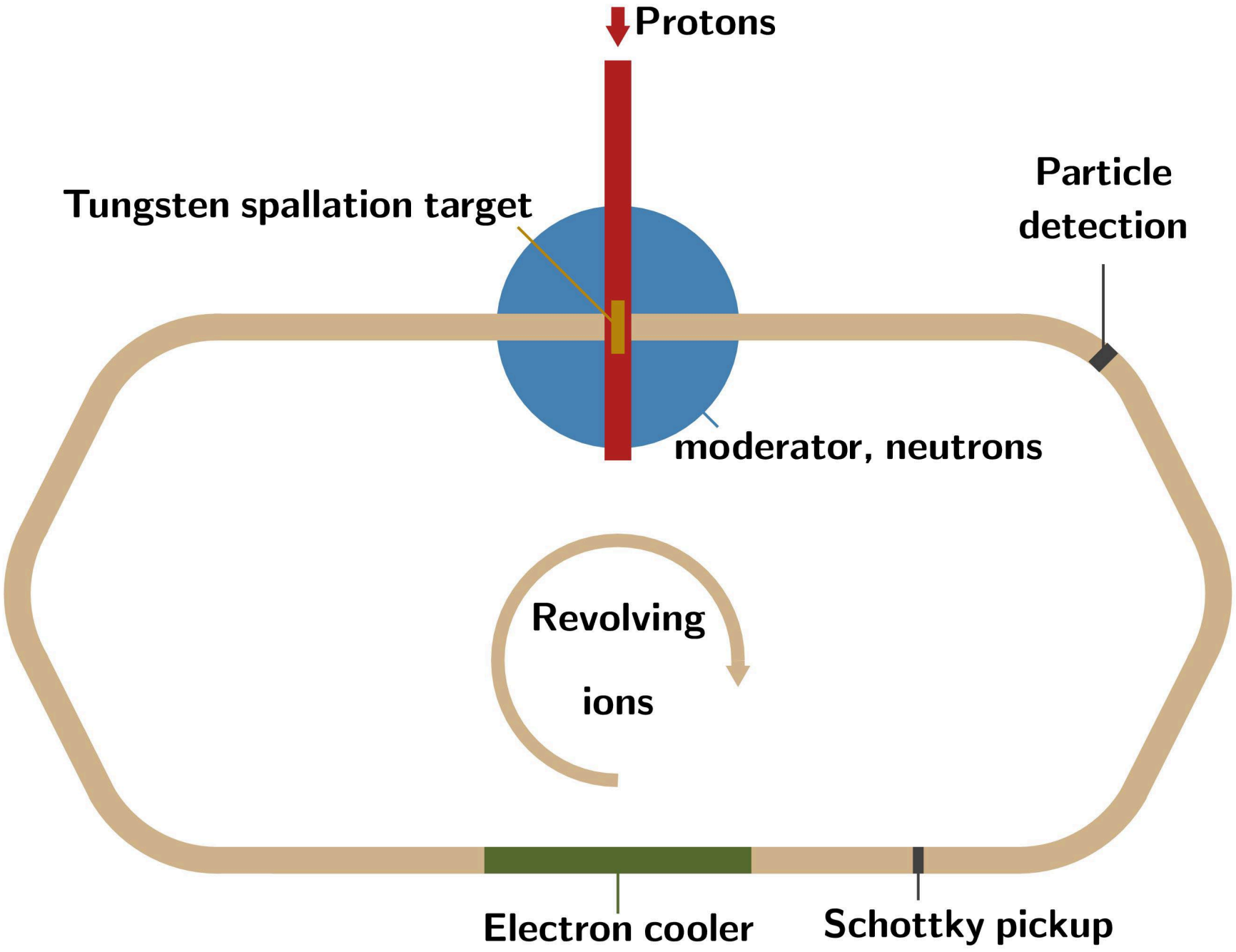

NOT IN MY BACK YARD
Not In My Back Yard
Not In My Back Yard
Not In My Back Yard!
Not in my back yard
NIMBY


WIND POWER
NOT IN MY BACK YARD


Protons
Tungsten spallation target

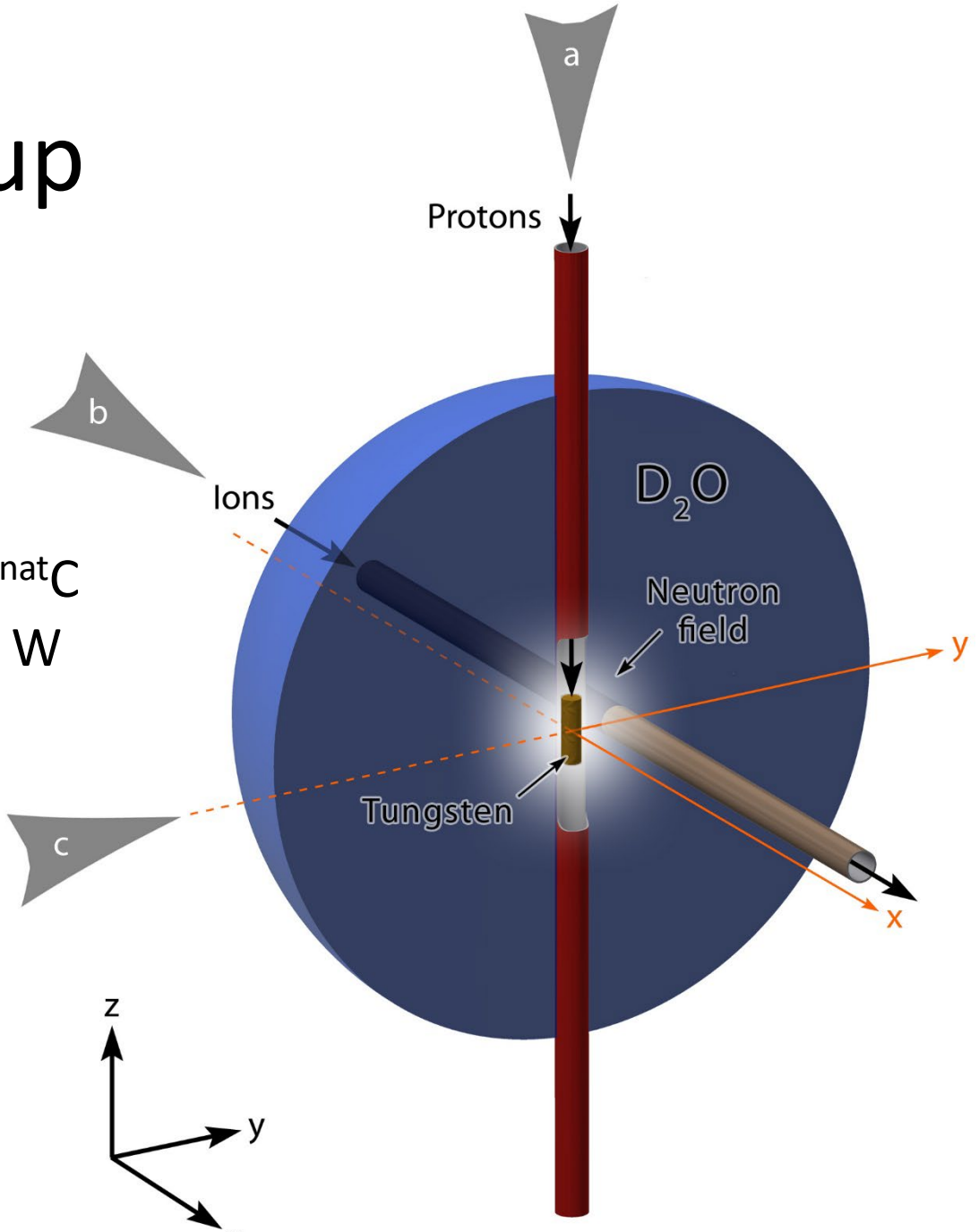

Protons
Tungsten spallation target
moderator, neutrons


Protons
Tungsten spallation target
moderator, neutrons
Revolving
ions


Protons
Tungsten spallation target
Particle
detection
moderator, neutrons
Revolving
ions
Electron cooler
Schottky pickup

Proposed setup

- Moderator: 0.5-2m D_2O or ^{nat}C
- Spallation target: 10-50 cm W
- Protons: 0.5 – 50 GeV



Reifarth et al, Phys. Rev ST Accelerator and Beams, 20, 044701 (2017)

Neutron target density - LANCE

- 800 MeV, 100 μA, 10 cm W, 2 m D_2O

  $8\ 10^9$ n/cm^2

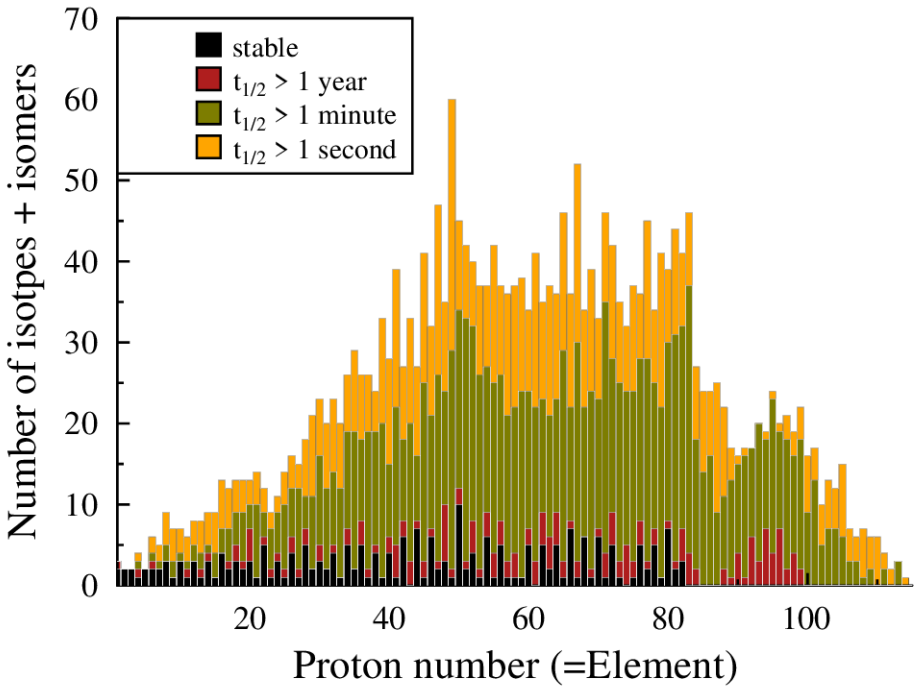
- 800 MeV, 100 μA, 10 cm W, 2 m ^{nat}C

  $6\ 10^9$ n/cm^2

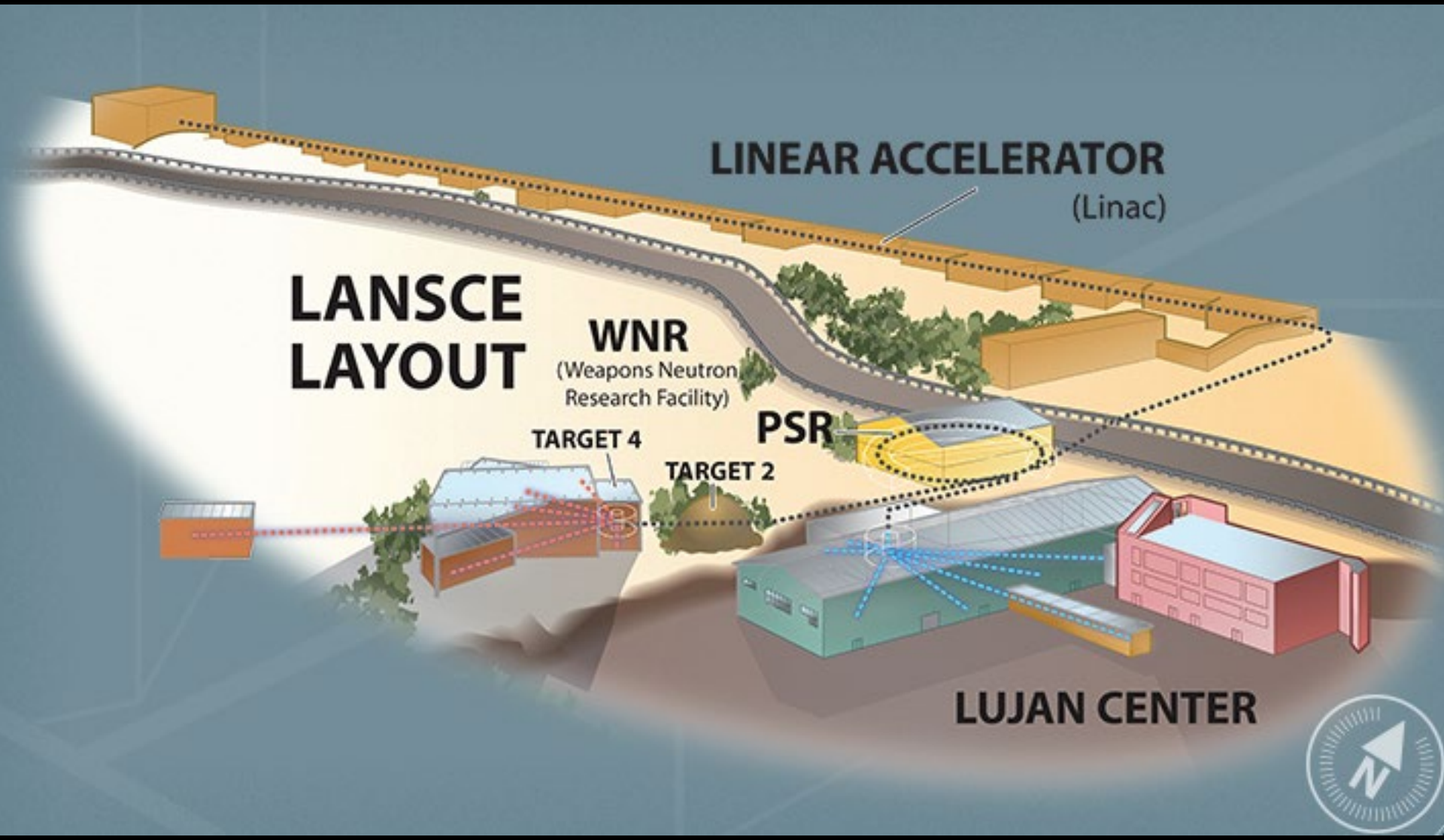
- 800 MeV, 1 mA, 10 cm W, 2 m ^{nat}C

  $6\ 10^{10}$ n/cm^2

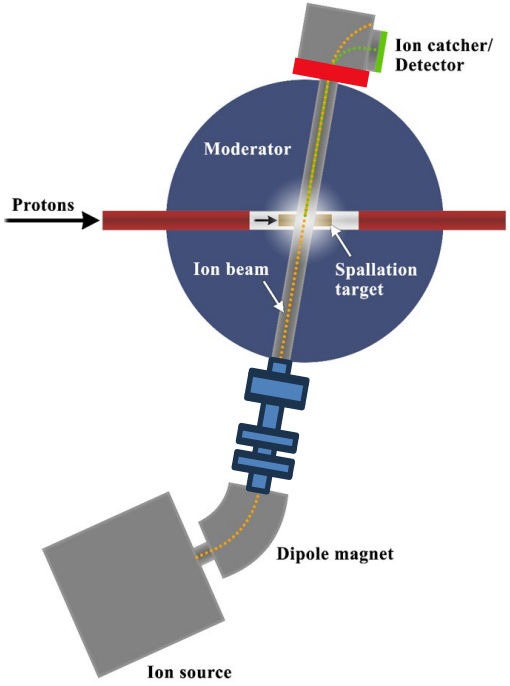
State of the art 2035? (**N-TARGET**)



Possible channels: (n,γ), (n,α), (n,2n), (n,f), …


LINEAR ACCELERATOR
(Linac)
LANSCE
LAYOUT
WNR
(Weapons Neutron
Research Facility)
PSR
TARGET 4
TARGET 2
LUJAN CENTER
N

in-flight activation

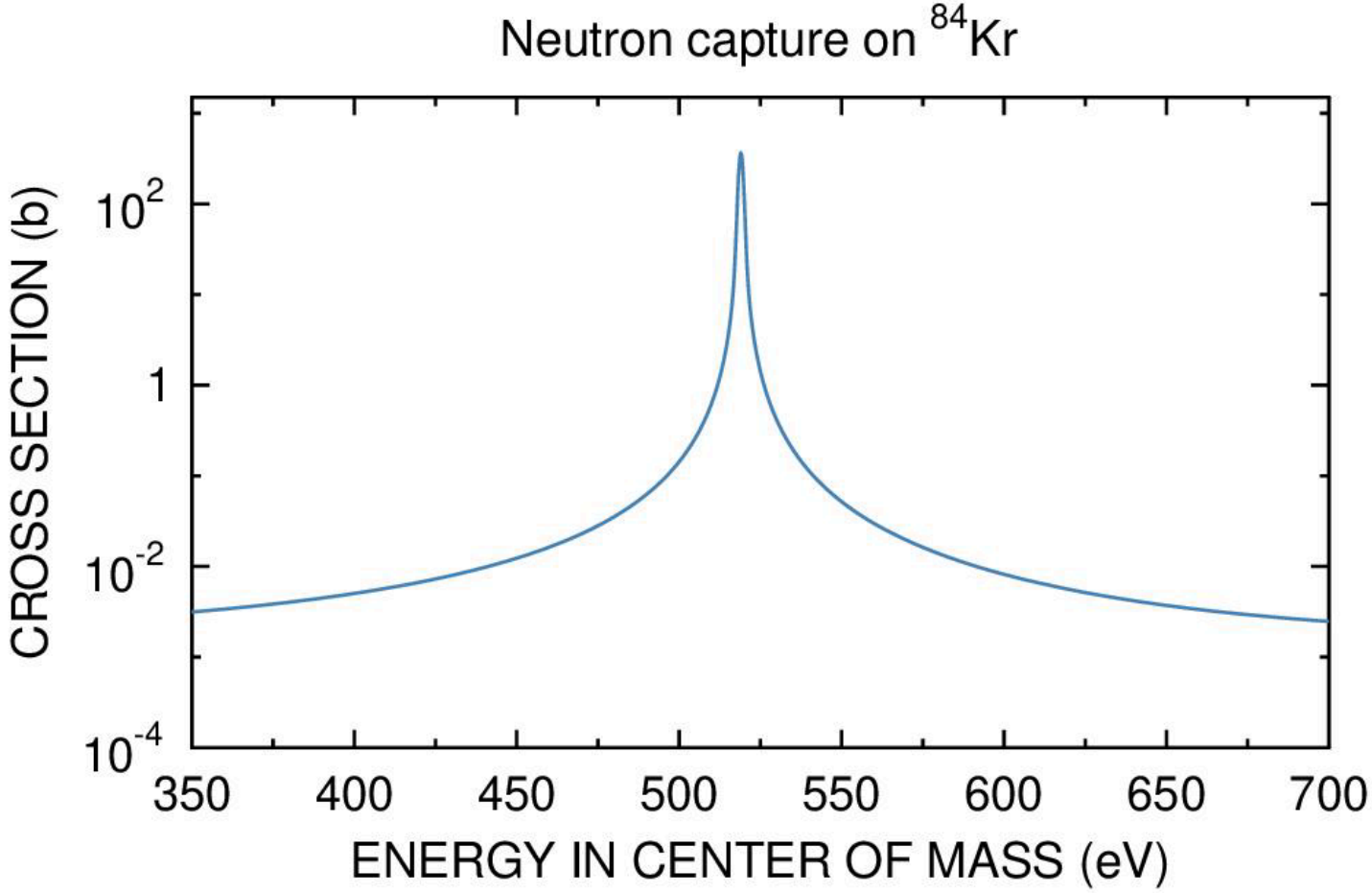


Implantation
(Blue Room)

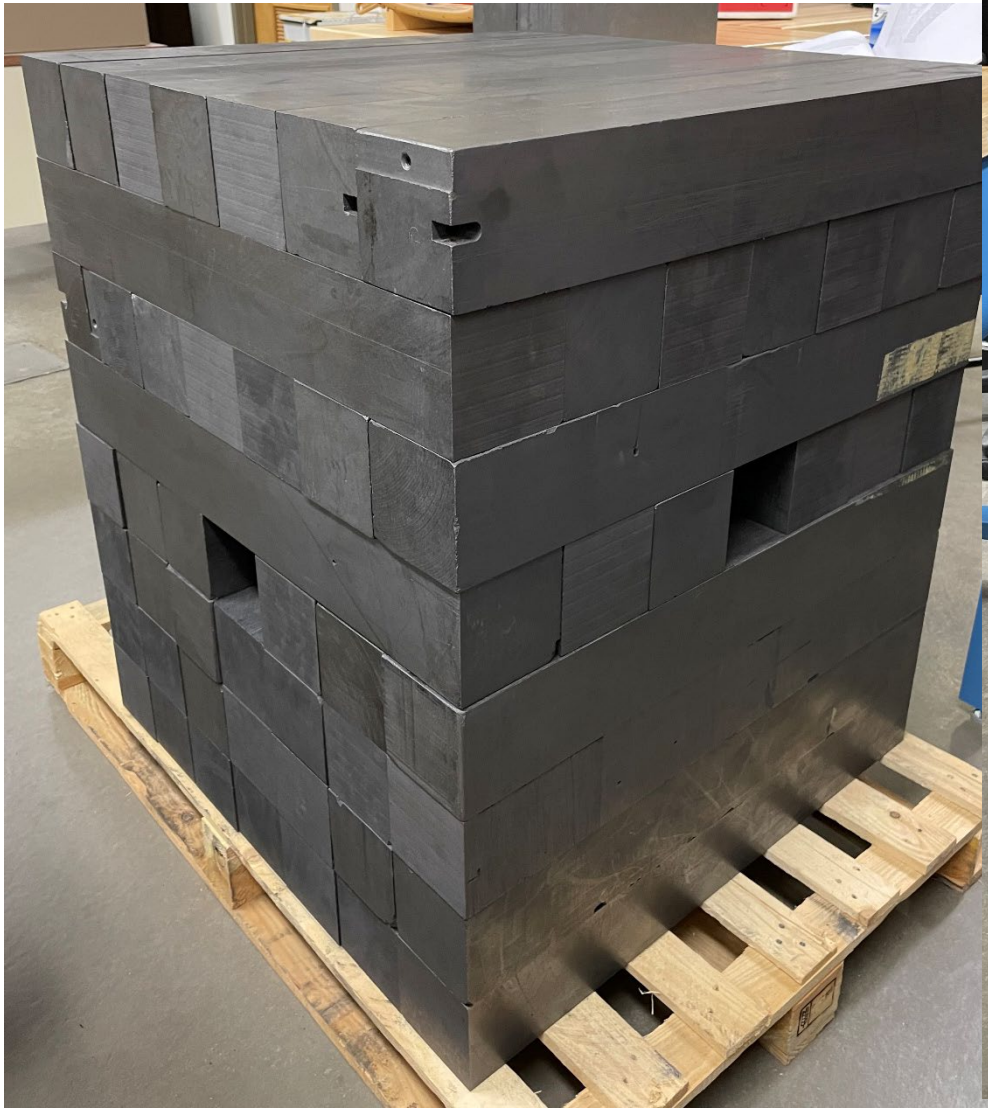
Cool down &
Transport

Activity Counting
(low background)

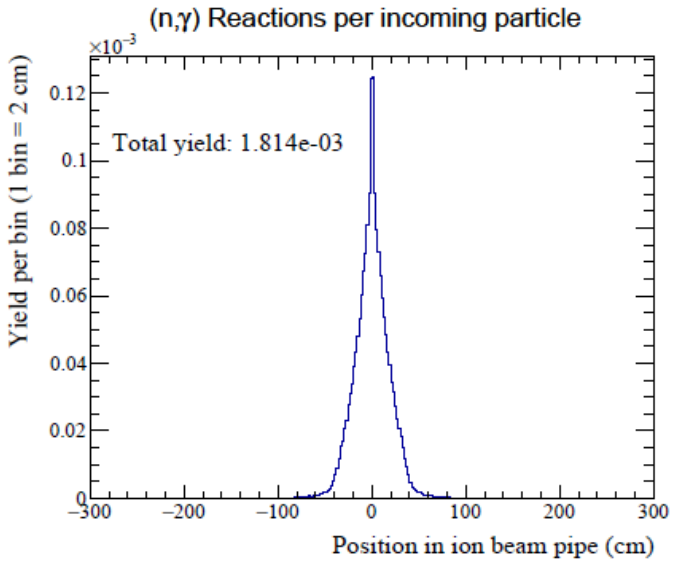
Proof of principle with 60 kV ion source

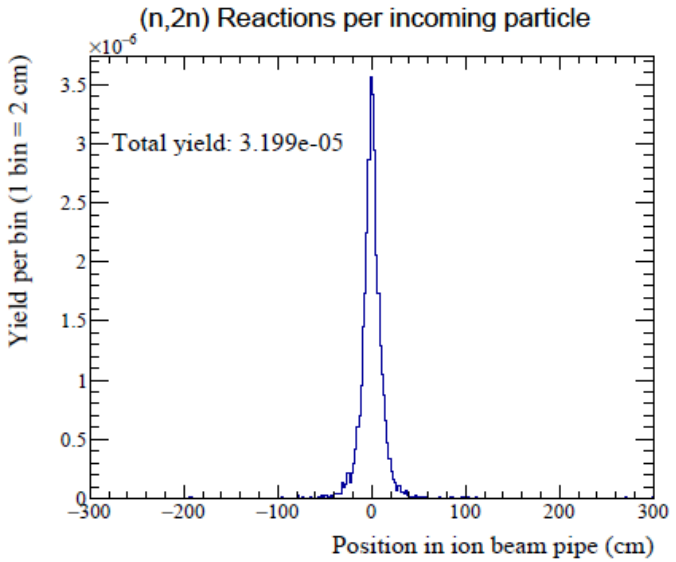


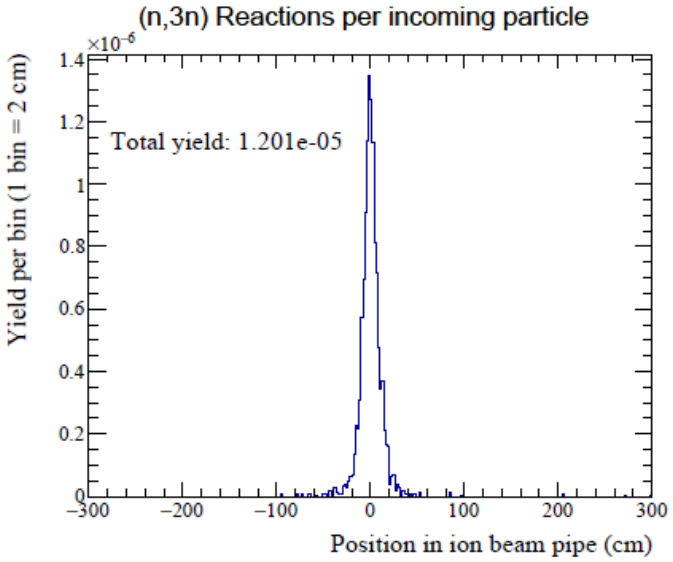
Scheduled for 2025 / 2026

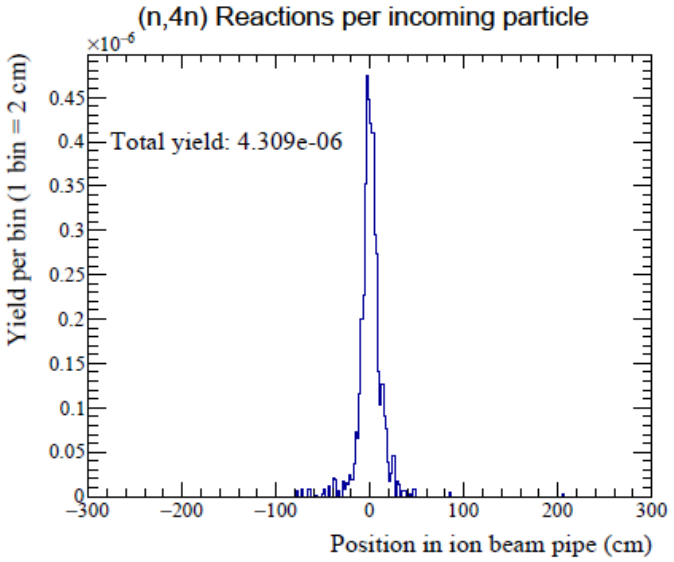


Activation of gold wire



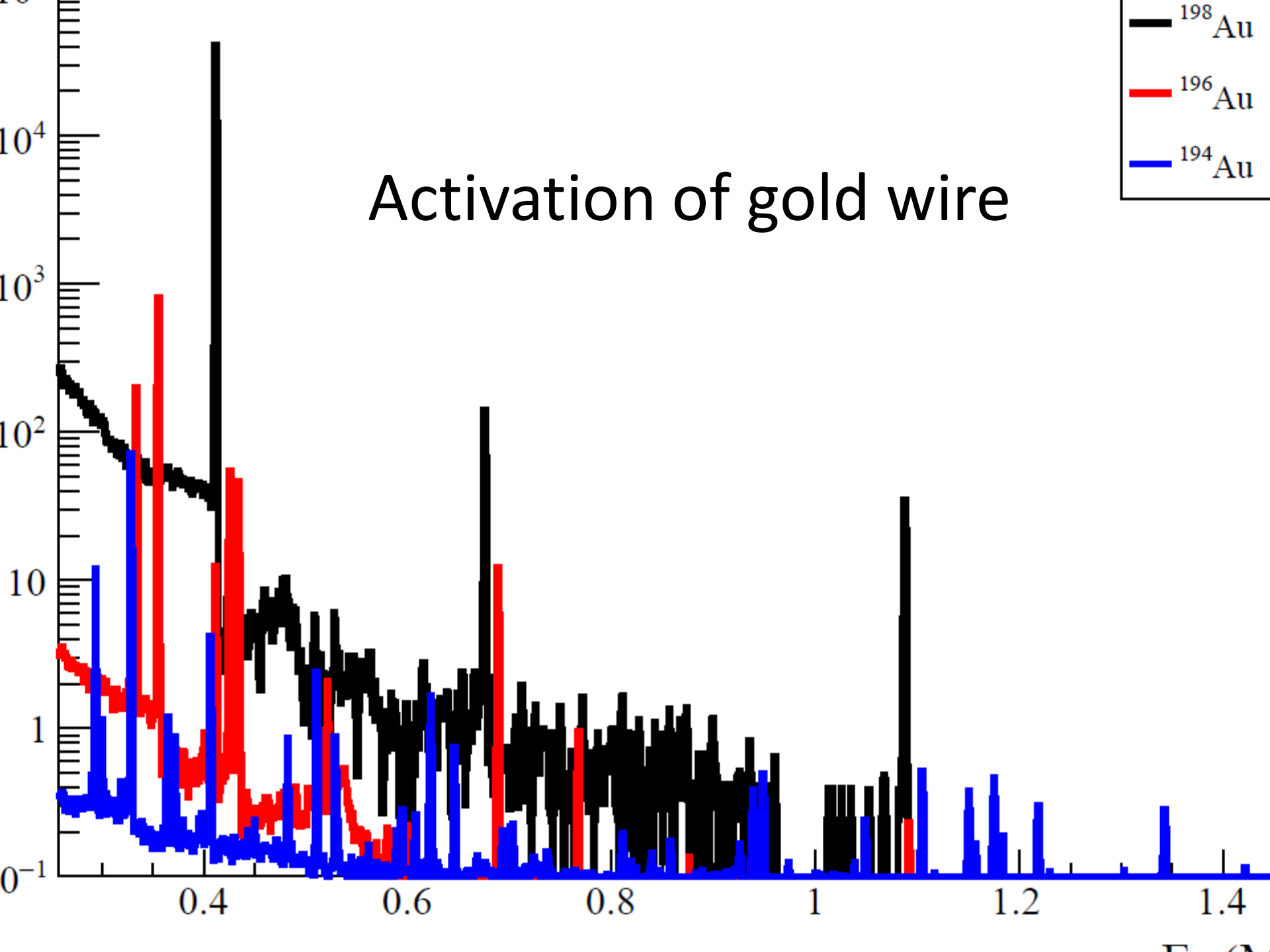


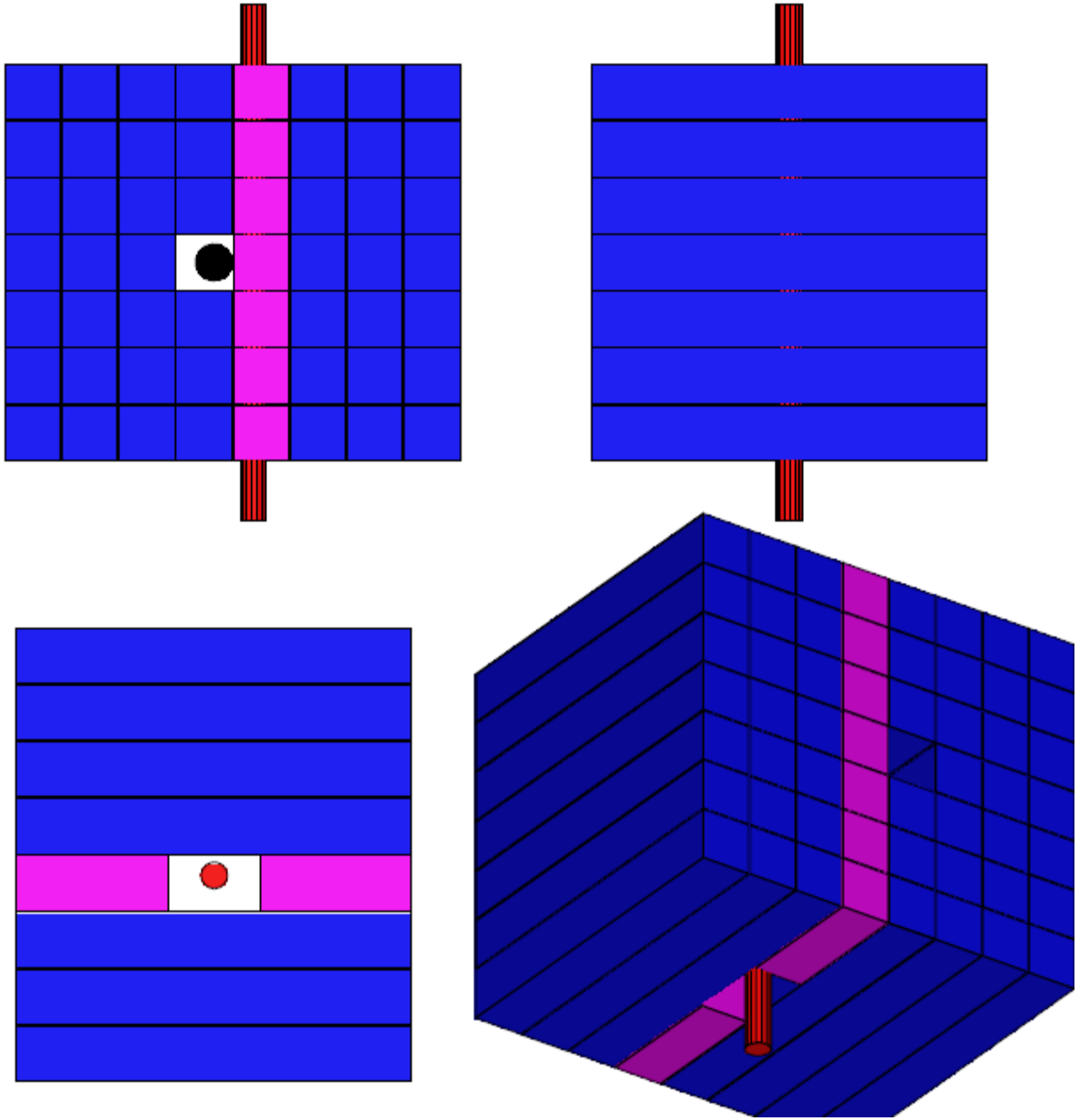




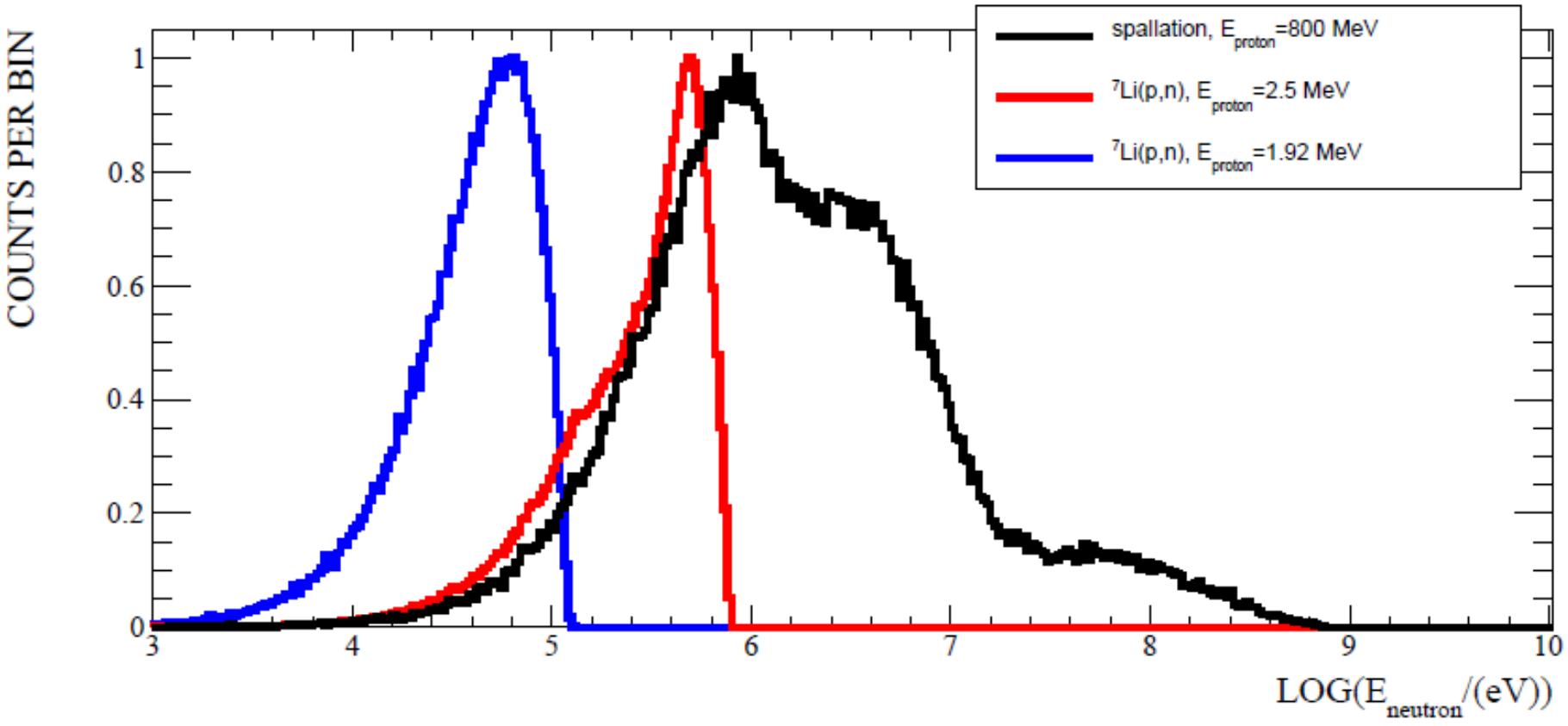
Scheduled for 2024

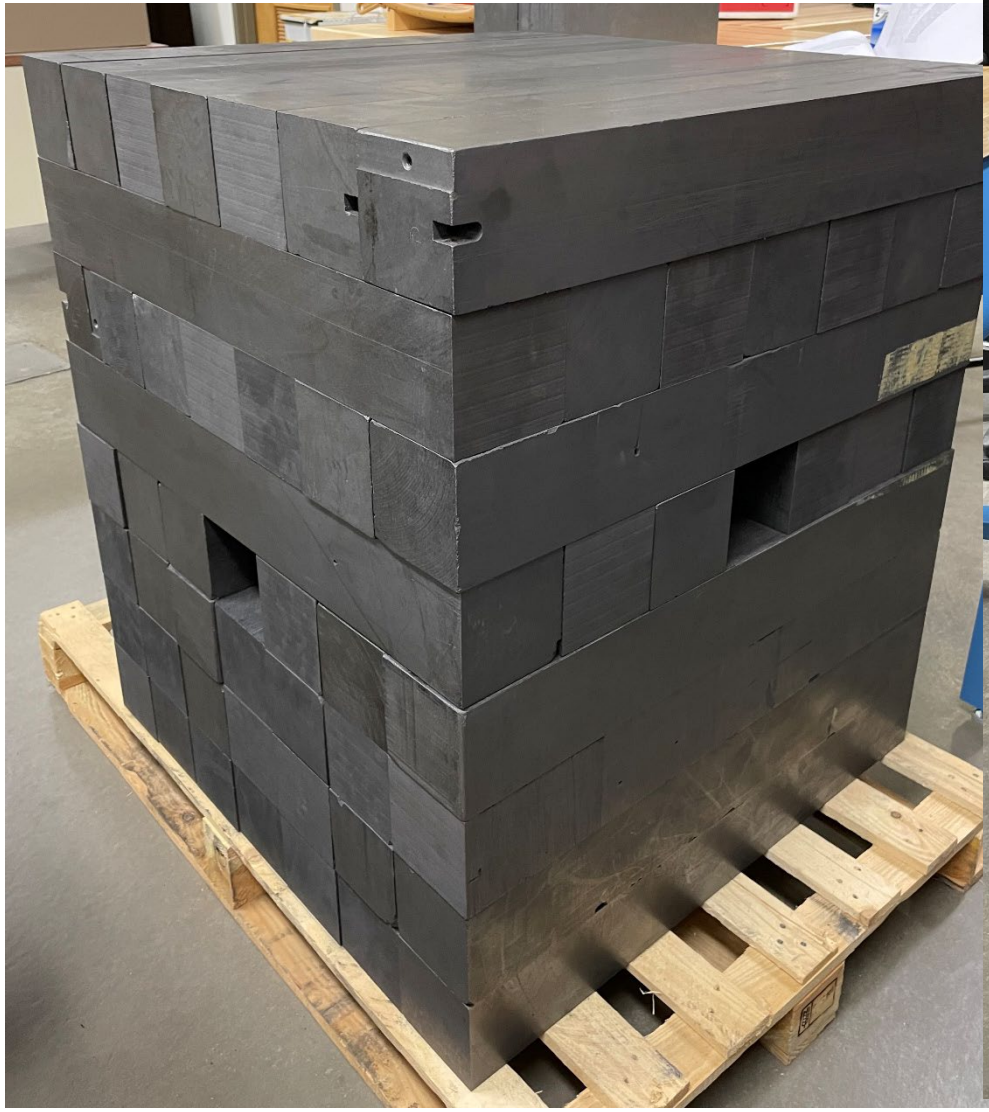
Activation of gold wire





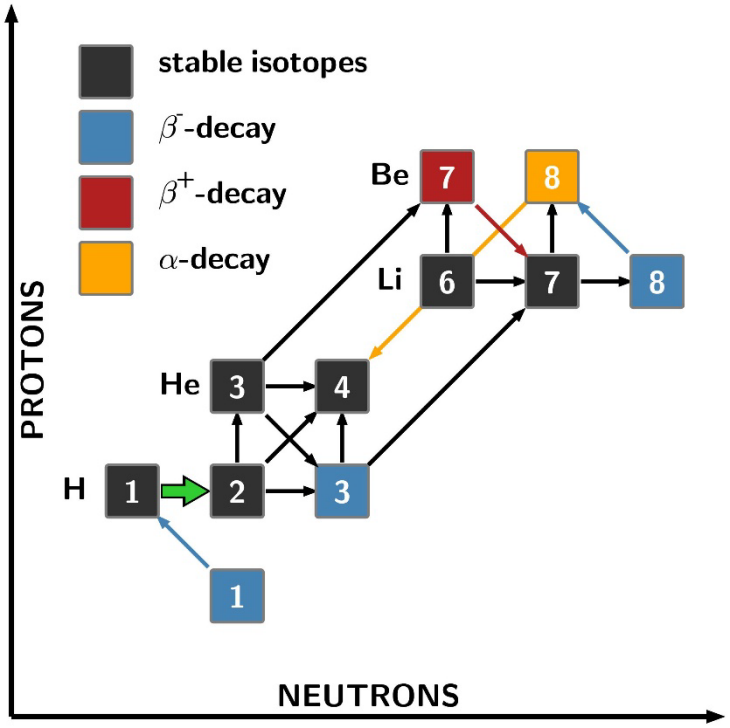
Low- and high-energy neutrons

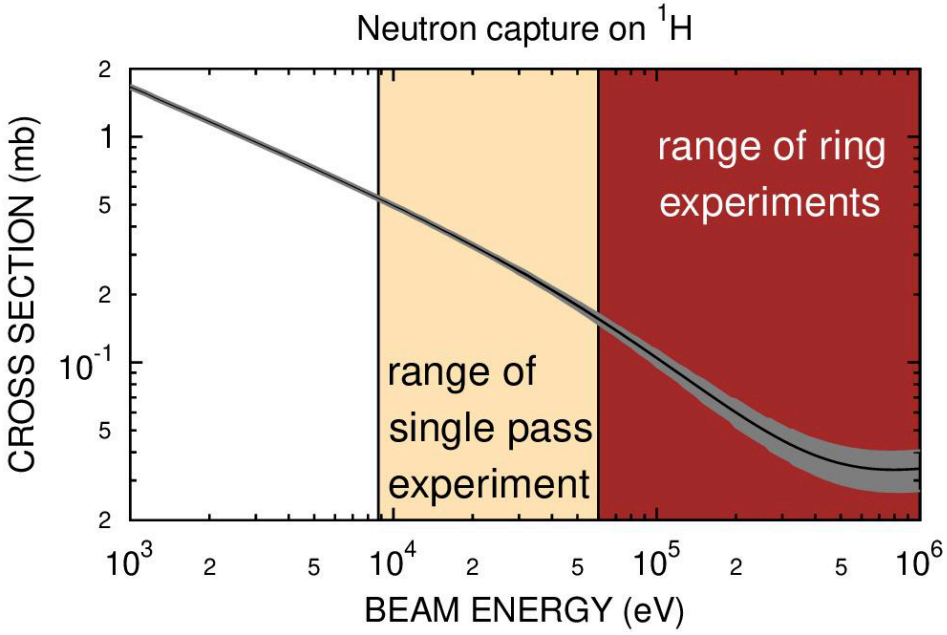




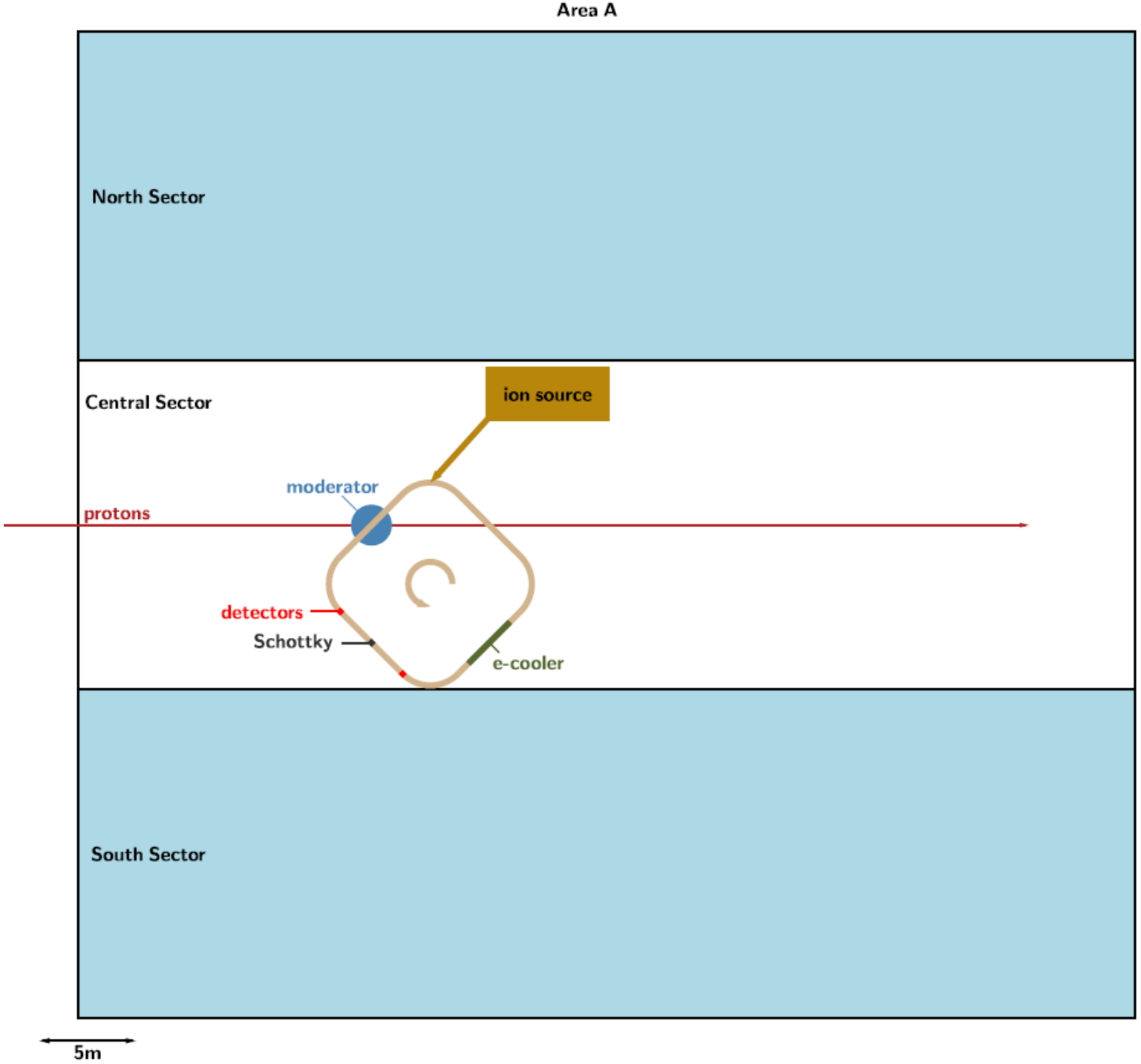
Ready to be shipped to University of Nore Dame, IN, USA for first test experiment

New data on n+p for BBT

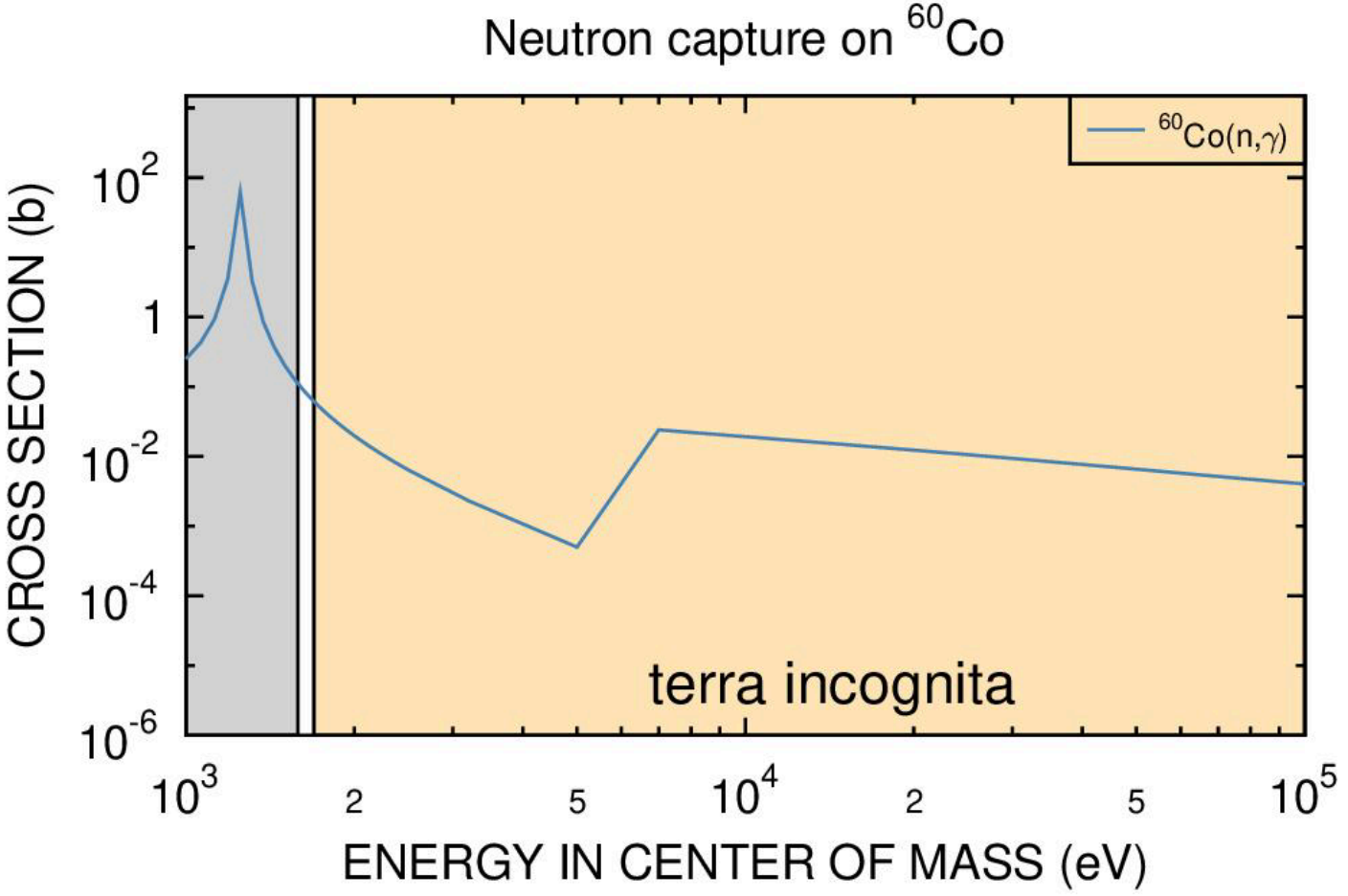




Cyburt et al. New Astronomy, 2001:
"*We urge further investigation of this reaction.*"

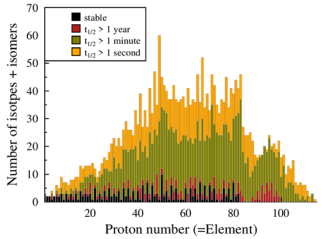

Area A
North Sector
Central Sector
ion source
moderator
protons
detectors
Schottky
e-cooler
South Sector
5m

Proof of principle with ^{60}Co

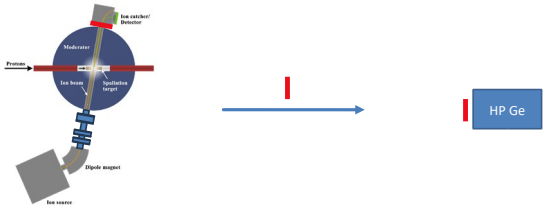


Summary

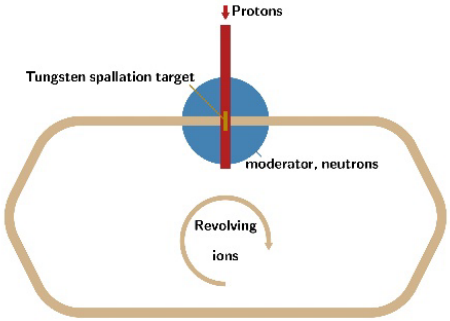
Inverse kinematics experiments allow n-induced reaction measurements on short-lived isotopes



Proof-principle experiment under way



Many part are at or beyond state-of-the-art, joint efforts are extremely valuable



Thanks to: A. Cooper, A. Couture, D. Gorelov, S. Mosby ….