Los Alamos NATIONAL LABORATORY

Measuring impossible reaction rates: turning the tables on neutron-induced reactions

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WANDA

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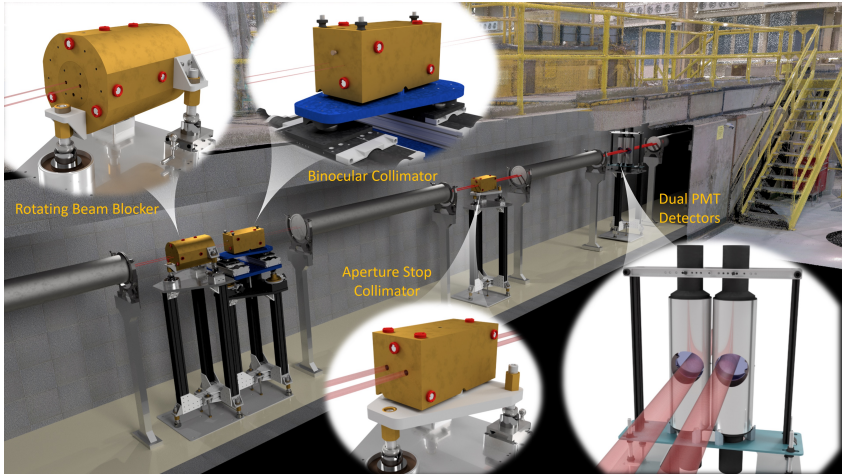
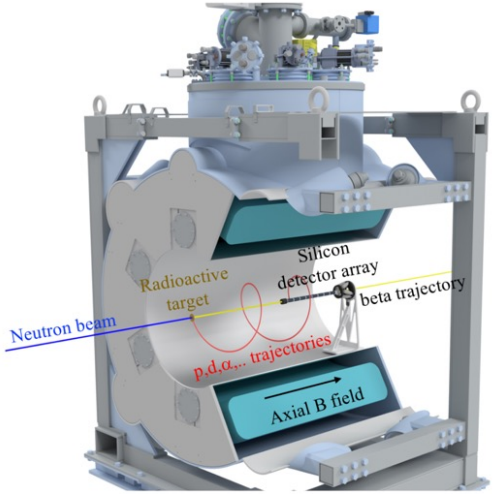
Boundary condition: direct neutron reaction measurements on radionuclides are desired *where feasible*

- LANL OES-NP experience has been that carefully constructed and documented direct measurements have the largest impact.
- The ultimate question is always “what is your systematic uncertainty?”



P. Koehler

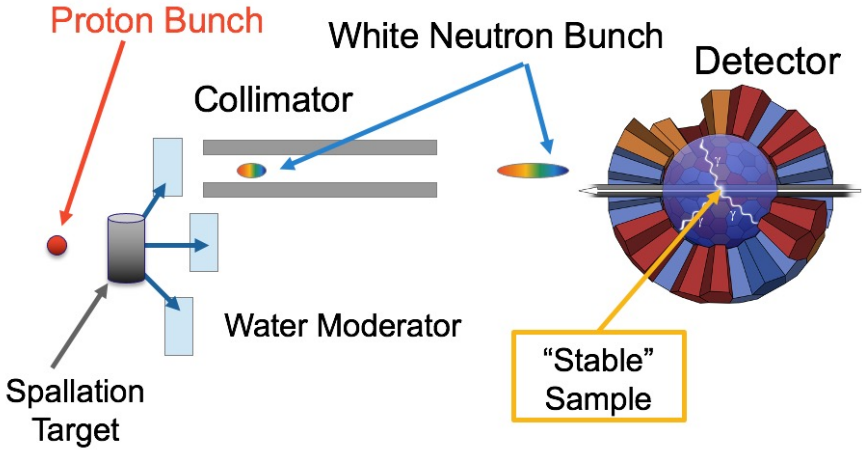


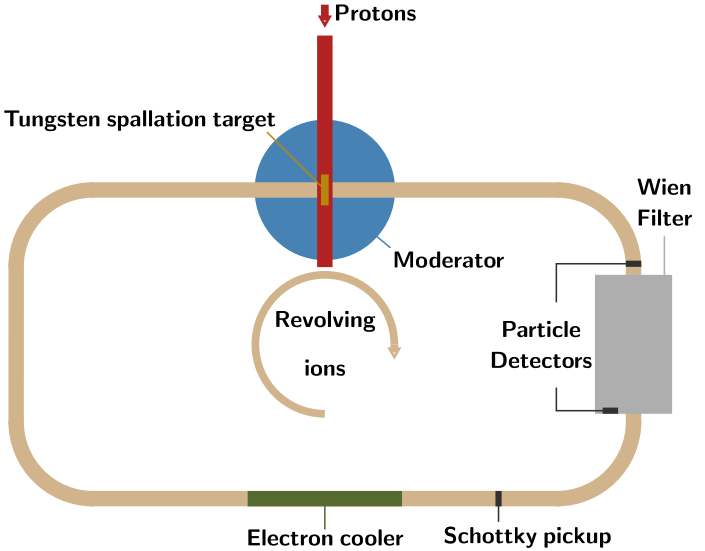
Schematic rendering of DICER for neutron transmission (right) and proposed solenoidal spectrometer for (n,p) and (n,a) measurements (left)

H. Y. Lee

- Modern facilities with intense neutron beams and specialized instruments will enable some key direct measurements.
  - Not necessarily every interesting reaction channel on every interesting nucleus.
- Indirect techniques will always reach farther (synergy!)
- What if we could dramatically expand the reach of direct measurements?

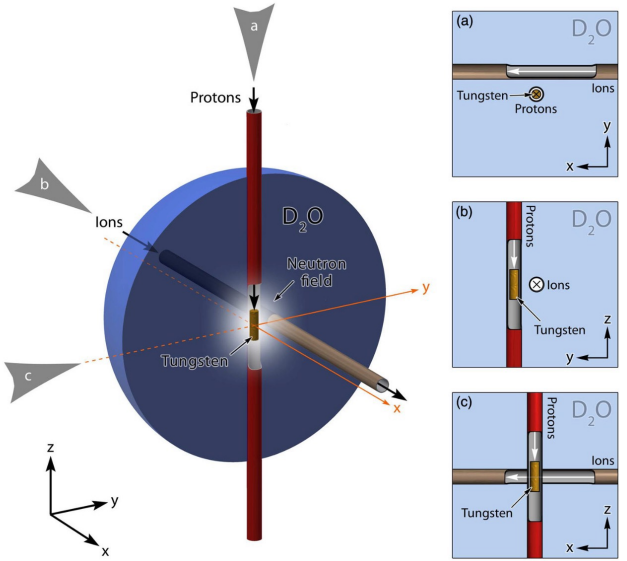
A neutron target could dramatically expand the reach of direct measurements.

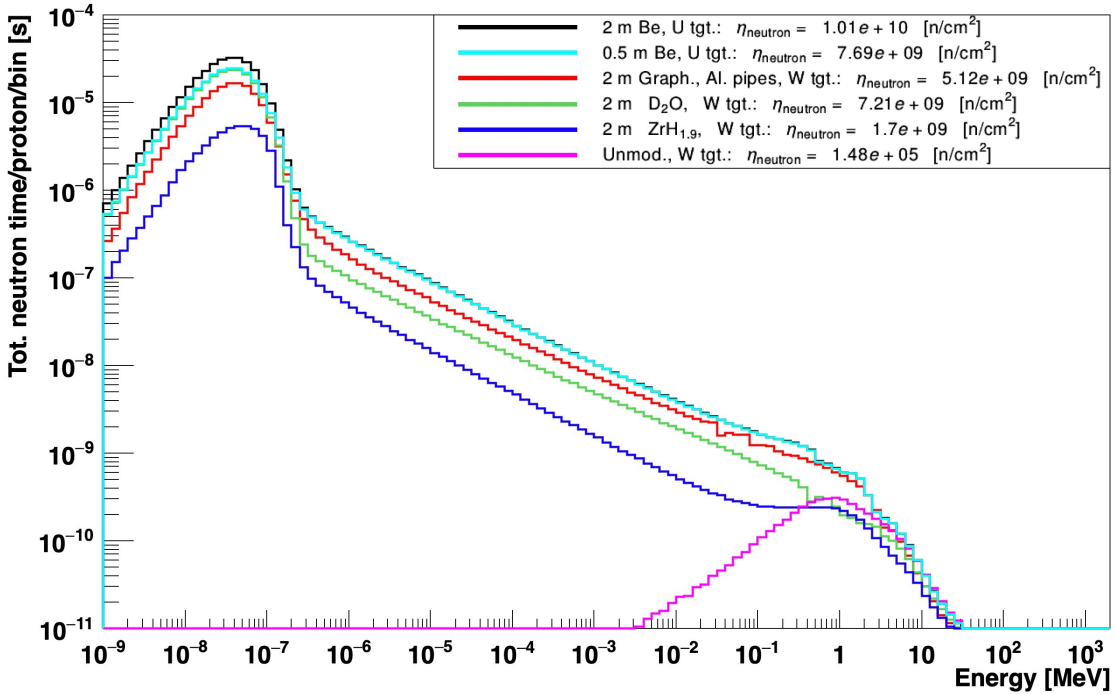




- The traditional approach (left) ultimately fails due to either the sample decaying too quickly or the intrinsic radiation field destroying detector response.
  - For charged particle reactions this has led to radioactive ion beams and inverse kinematics methods to reach farther off stability.
- Bringing an ion beam and spallation neutron source together (right) looks like it would enable inverse kinematics measurements by creating a "neutron target".
  - Concepts under development at LANL and TRIUMF – I'll only speak to LANL concept

The LANL neutron target concept requires neutrons “at rest”

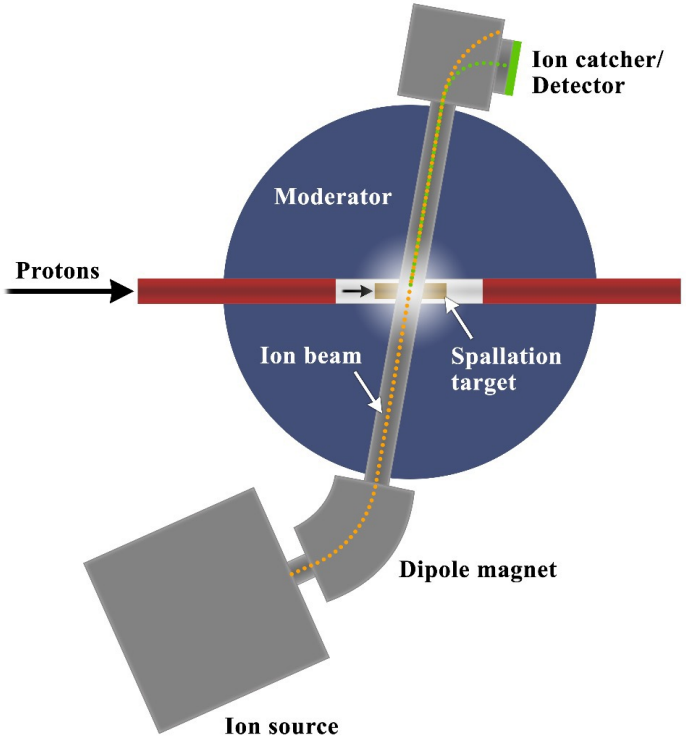




- Spallation creates neutrons, moderator slows down and traps them long enough for reactions to occur.
- Geometry and material choice matters – figure of merit is effective target thickness.

R. Reifarth and A. Cooper

We need to test the concept and believe we know how



Schematic of single-pass neutron target setup for proof of principle at LANSCE

- Basic idea: conduct activation experiment in inverse kinematics for a known reaction.
- Several conditions necessary to keep test “simple”:
  - No storage ring
  - No significant acceleration (low beam energy)
  - Low spallation source beam power
  - No recoil separator
- These conditions make resonant neutron capture attractive:
  - Large cross sections (>100 barns)
  - Low beam energy requirements (10 – 20 keV, though this creates new challenges)
  - Use e.g. stable noble gas beam where heavy ion beam currents can be high
- Direct access to proton beams in LANSCE’s Blue Room make the experiment appear feasible.

Where we go from here: pursuing resources to assemble the proof-of-principle measurement

- Proposing to internal LANL funding calls for now.
- Key questions to answer:
  - Are there neutrons in the neutron target?
  - Can we reliably control / monitor the neutron field?
  - Does the radiation field create vacuum issues through (n,p) and (n,a) reactions?
- Beyond LANSCE Blue Room operations, renewed interest in restoring proton beam delivery to LANSCE's Area A could provide additional opportunities.
  - Blue Room operations turn off LANSCE/WNR due to beamline layout, so the cost of operating there is high.
  - LANSCE's Area A is an independent experimental area where further development could occur.
- Punch line: we have a concept that would enable direct measurements of neutron-induced reactions on short-lived nuclei, and are now pursuing resources to conduct the first proof-of-principle measurement.