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Purpose-Built Cyclotron

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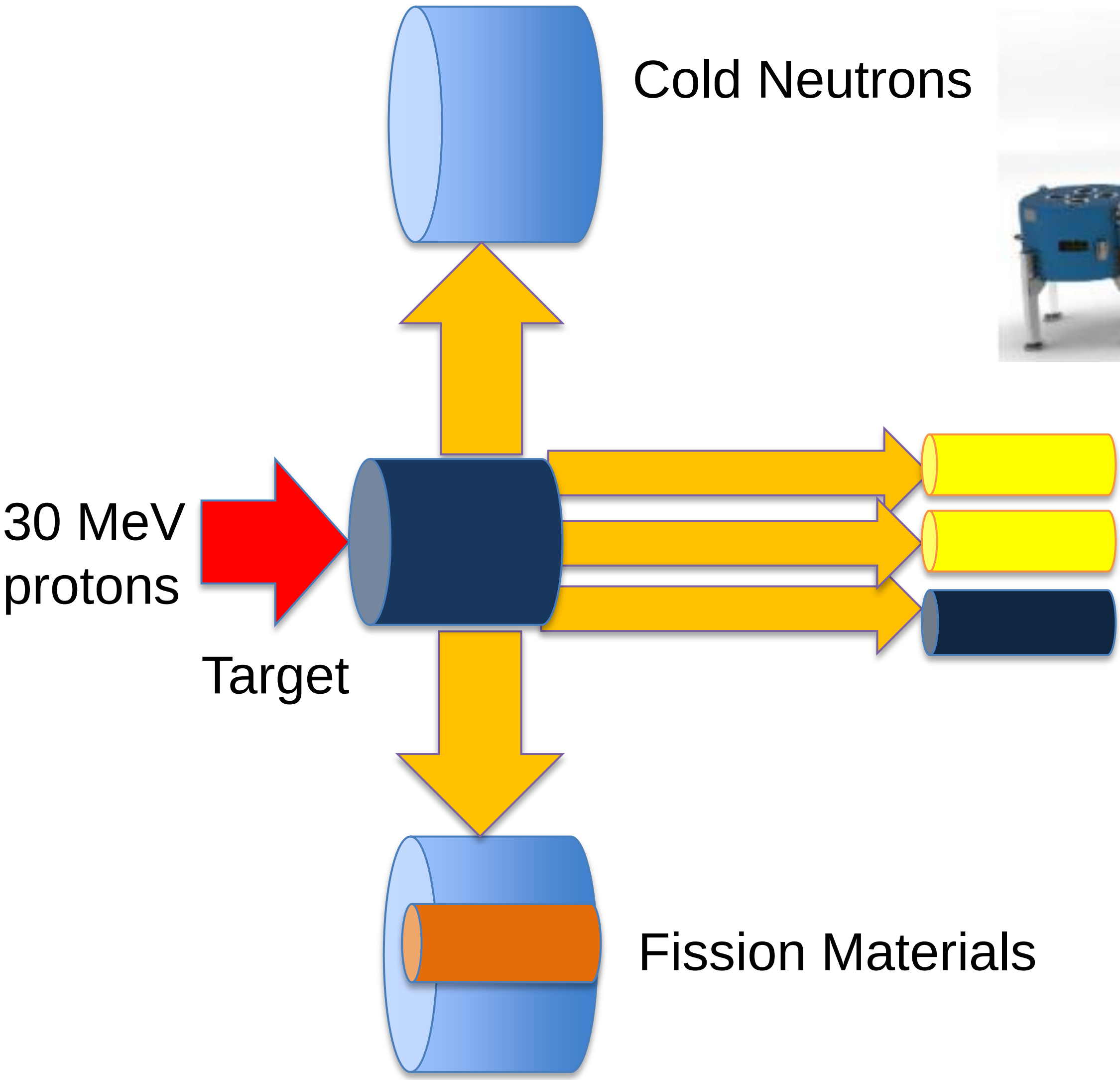
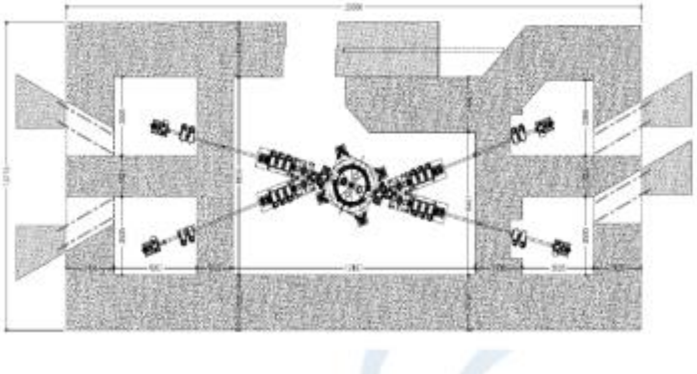
Medical Cyclotron

- Could provide 15-35 MeV at >1 mA , ~30 kW of proton beam for direct proton irradiation for high energy physics and/or produce a neutron source for nuclear materials research, fuels research, physics research
- Off-the-shelf cyclotron technology used by many hospitals and isotope suppliers – high reliability, low cost, multiple beam lines, variable energy
- Shielded vault cyclotron room with separate beam lines to target rooms
- 30 MeV protons penetrate ~1mm in tungsten, ~2mm in Zr
- 1mA proton current on 3 cm diameter target generates ~0.4 dpa/day
- ~10^{14} neutrons/sec

Purpose-Built Cyclotron Applications





Purpose-built Cyclotron has the potential to benefit several areas beyond HEP

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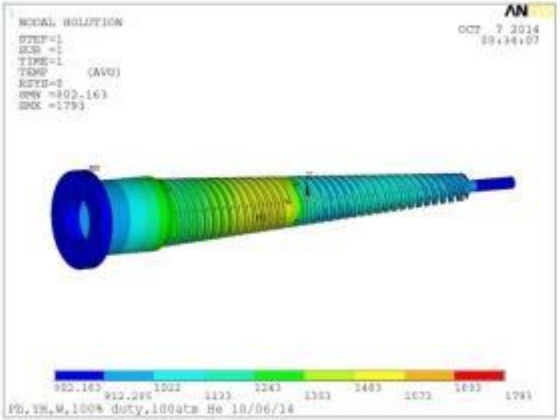
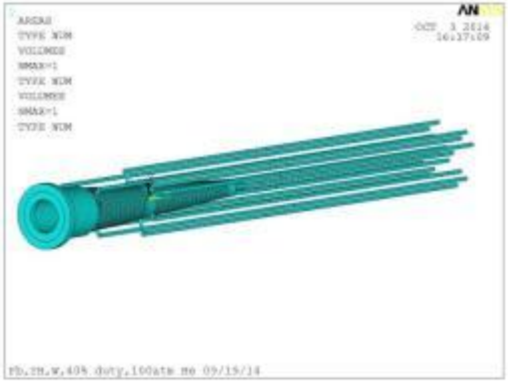
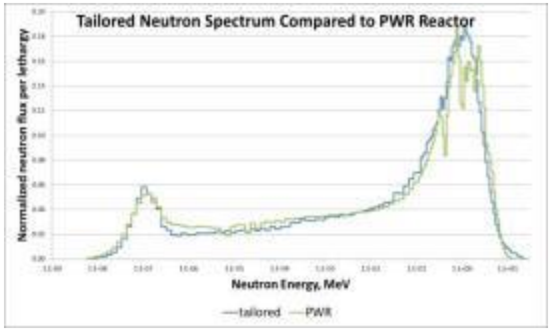
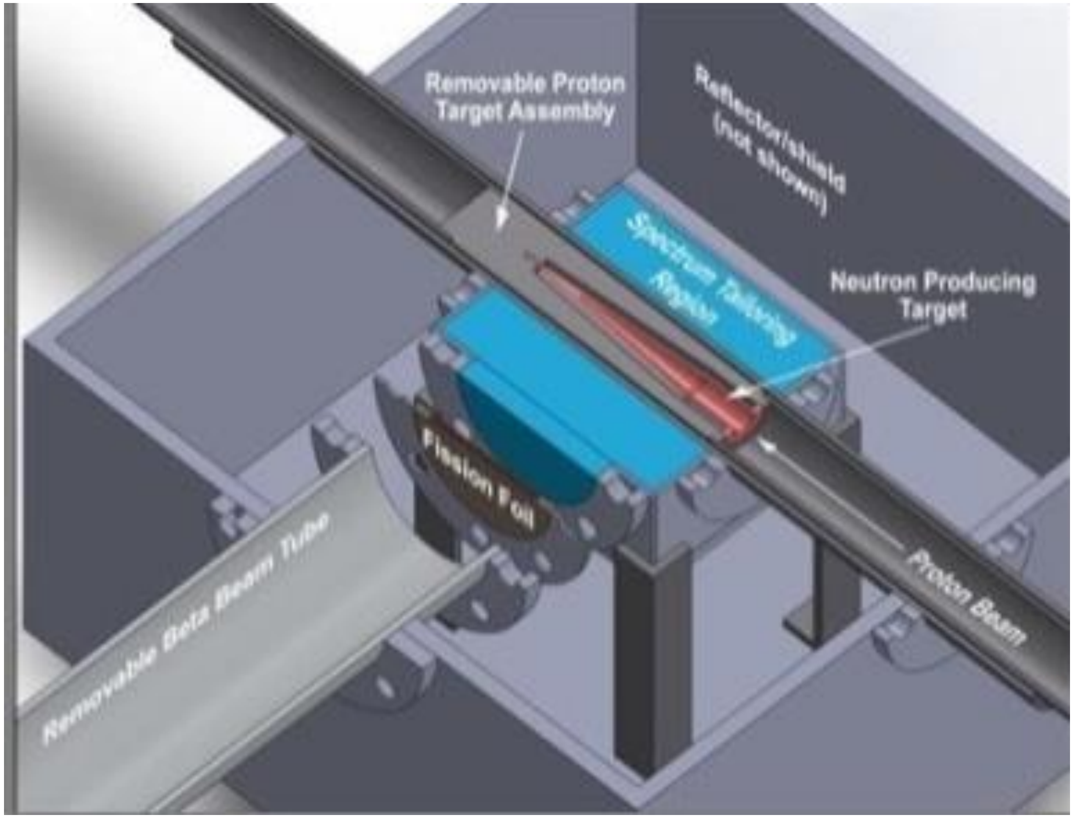
- Highest priority opportunities within the US Nuclear and Fusion energy programs are irradiation of fusion and fast reactor structural materials, where no suitable irradiation environments exist
- Enable the in-situ real-time measurements of various separate-effects phenomena in fuels or materials, which would be very valuable to the modeling and simulation technical community. Such capabilities are more feasible in an accelerator-based system than a reactor
- Integral effects testing of fast reactor fuels, including driver fuel, minor actinide burning fuel, and transmutation of spent fuel
- Enable research supporting current LWR reactor technologies such as pressure vessel embrittlement, ex-reactor components
- Support DOE Office of Nuclear Energy plus Office of Science programs
    - Materials Program - Fusion Energy Sciences (FES)
    - Isotope Production Program – Nuclear Physics (NP)
    - Ultra Cold Neutrons – Nuclear Physics (NP)

Reactor Neutrino Anomaly Neutron Generating Target Configuration





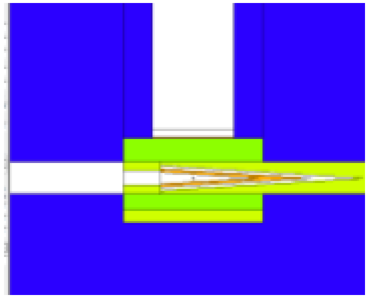
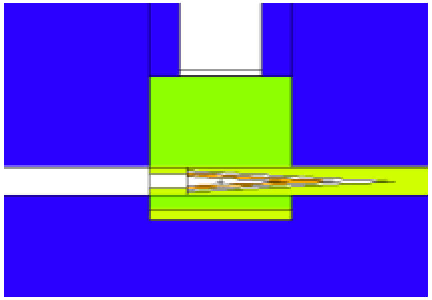
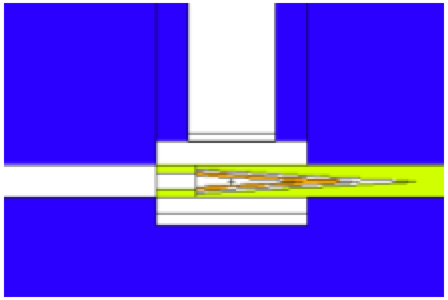
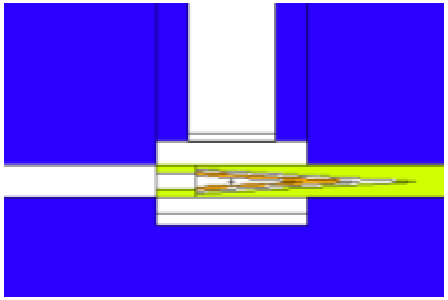


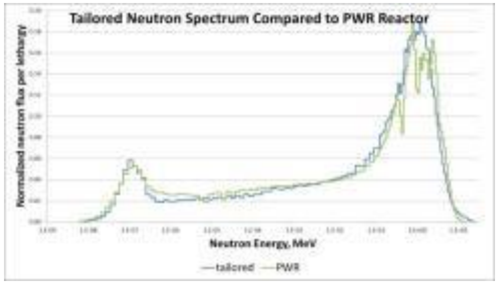


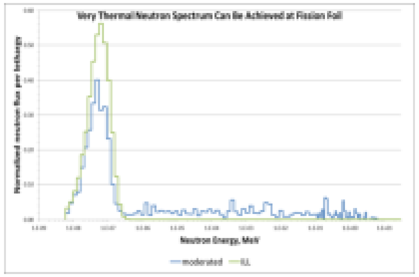
- Target generates 10^{14} n/s
- Withstands 30 kW deposited energy
- Simulates PWR neutron spectrum at fission foil

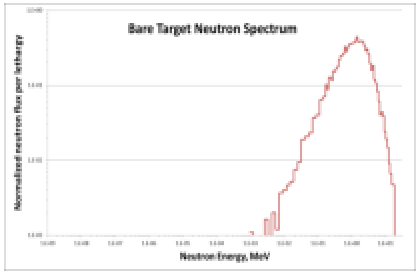
Creating Different Neutron Spectra by Changing Moderator and Target

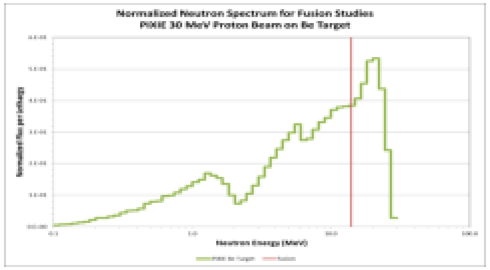
Pressurized Water Reactor	Thermal Test Reactor	Fast Reactor	Fusion









Purpose-Built Cyclotron Capabilities

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- Flexible design allows support to multiple missions for DOE-SC-HEP, FES, NP, DOE-NE,
- Benefits of test reactor neutron fluxes without reactor issues – licensing, fuel supply, safety, waste
- Robust technology allows it to be designed and constructed with today's technology in order to fill gaps in tomorrow's technology
- Continuous wave, high availability, high beam current provides potential for irradiation tests to high fluence
- Energy distribution of neutrons similar to fast reactor fission spectrum but with high energy tail up to proton energy
- Ability to tailor neutron spectrum from fast to thermal as well as the gamma to neutron flux ratio
- H and He generation in materials allow accelerated aging testing
- Potential for beneficial isotope production and/or neutrons simultaneous with proton irradiation testing