LLNL Pulsed Spheres Evaluation Effort

Presentation for
Working Party on Evaluation Collaboration (WPEC) Subgroup 47
June 24, 2019

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LLNL-PRES-778823

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

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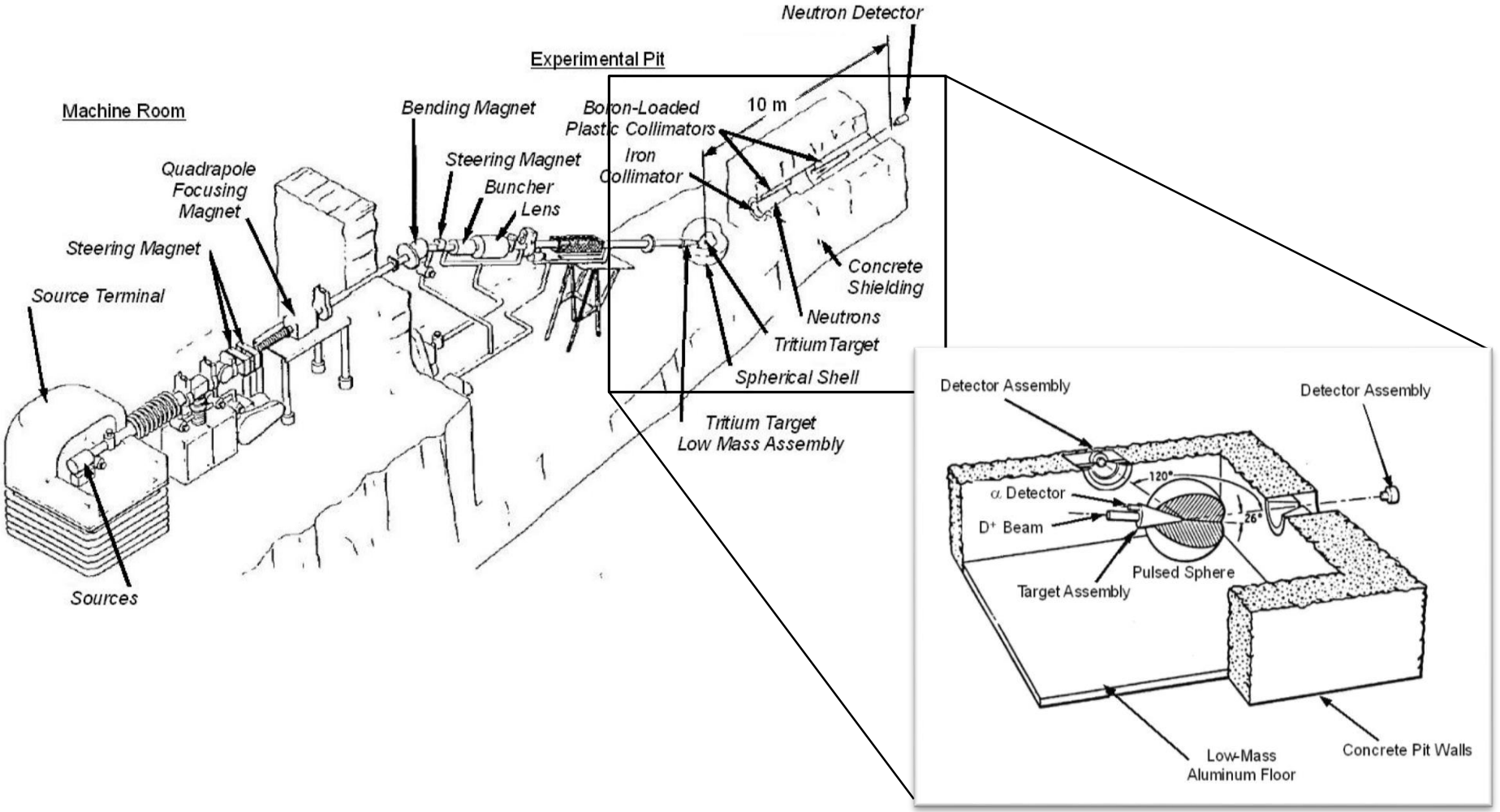
LLNL Pulsed Sphere Experiments

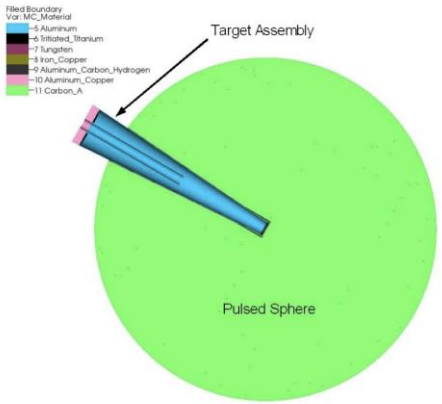
- Major experimental campaign conducted at Lawrence Livermore National Laboratory (California, USA) from 1968-1985
- Insulated Core Transformer (ICT) accelerated pulsed beam of deuterons to 400 keV to hit a tritiated titanium disk, generating 14 MeV neutrons
- Spheres of various materials and radii were placed around the target assembly
- Uncollided and collided leakage neutrons were measured as a function of time using well-collimated neutron detectors, generating a time of flight spectrum for each experiment

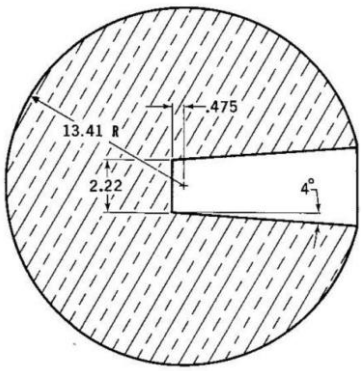
Schematic of the Pulsed Spheres Set-up

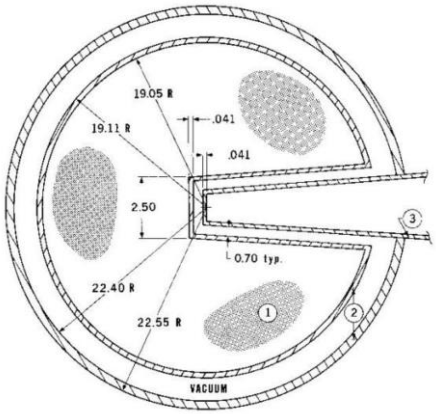


Many Different Test Materials

- Radius of spheres designed to be integral number of mean free paths for 14 MeV neutrons
- Multiple size spheres measured for each material
- Test materials included:
  - ^{6}Li, ^{7}Li, Be, C, N, O, Al, ^{235}U (93%), ^{238}U, ^{239}Pu(94%), Fe, Cu, Mo, Pb, W, Teflon, polyethylene, light water, heavy water, air, concrete, Fiberglass

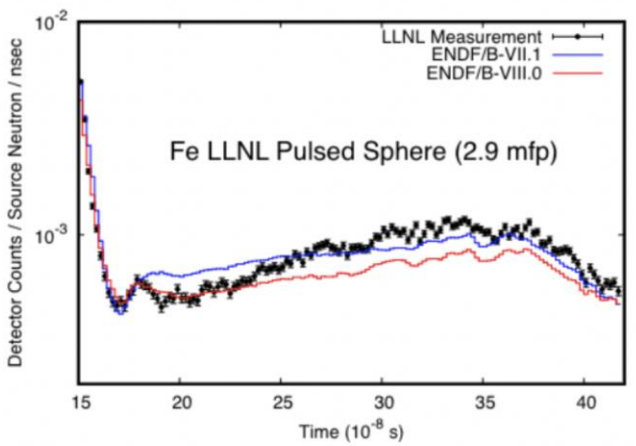




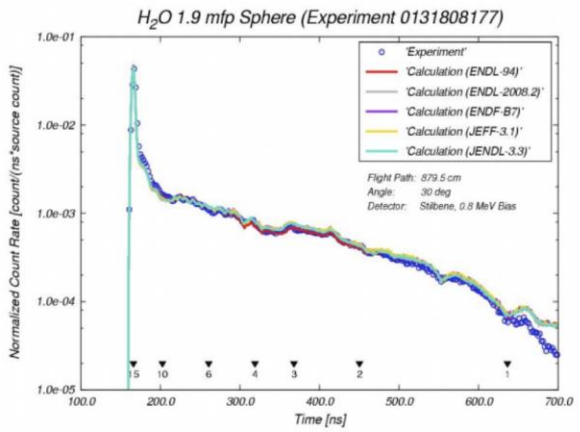


Current LLNL Effort

- Pulsed Spheres have been used for multiple nuclear data efforts because they are sensitive to elastic and inelastic scattering cross sections
  - Originally designed to be easily modeled to aid code development and nuclear data evaluation



Example (MCNP) showing nuclear data for Iron continues to need improvement or need for improved simulation



Example (MERCURY) showing excellent agreement above 1 MeV for Water

Current LLNL Effort

- Our goal is to analyze the pulsed sphere experiments in an ICSBEP-style evaluation, with full sensitivity and uncertainty analysis for sources of experimental uncertainty, including:
  - Deuteron beam size and intensity
  - Deuteron impurities in the tritiated target
  - Tolerances of experimental equipment
  - Uncertainties in experimental equipment compositions
  - Room return effects
- Currently working on ”blank” measurement- case with no test sphere surrounding the target assembly, first two test sphere cases will be Fe and polyethylene
- Due to recent improvements in the LLNL code, COG, we will start by modeling the deuteron beam in a one-step calculation

Initial COG Model of the Experiment