United States Department of Energy Critical, Subcritical, and Fundamental Physics Measurements Perspective and Status

OECD-NEA Workshop on Future Criticality Safety Research Needs,

September 21-22, 2009

Pocatello, Idaho, USA

Integral Experiments Mission

- The United States Department of Energy (DOE) Nuclear Criticality Safety Program (NCSP) is responsible for maintaining the fundamental capability to be able to perform critical, subcritical, and fundamental physics measurements, within the limits of its resources, to address the specific needs of the DOE United States Criticality Safety community.

Integral Experiments Vision

- The IE element will provide a **sustainable** infrastructure and a systematic, interactive process to assess, design, perform, and document integral criticality safety-related benchmark-quality experiments to support **safe**, **efficient** fissionable material **operations**.

History

- In the past, almost all national laboratories had a Critical Experiment Facility
- In recent years, the DOE previously performed the majority of critical, subcritical, and fundamental physics measurements at the Los Alamos National Laboratory in Los Alamos, New Mexico
- Sandia National Laboratory has been a continual operating facility available for experiments

History (cont'd)

- DOE shut down the experiment operations at Los Alamos and safely transport the material and associated equipment to a new, more secure location at the Nevada Test Site
- Additionally, no real process in place to ensure all data from measurements was captured

Current Status

- The new Critical Experiment Facility (CEF) is currently under construction at the Device Assembly Facility
- It has already resumed subcritical and fundamental physics measurements
- The CEF is scheduled for completion in 2010 and once the new experiment facility is fully operational, multiple approved critical measurements are scheduled to commence at this facility

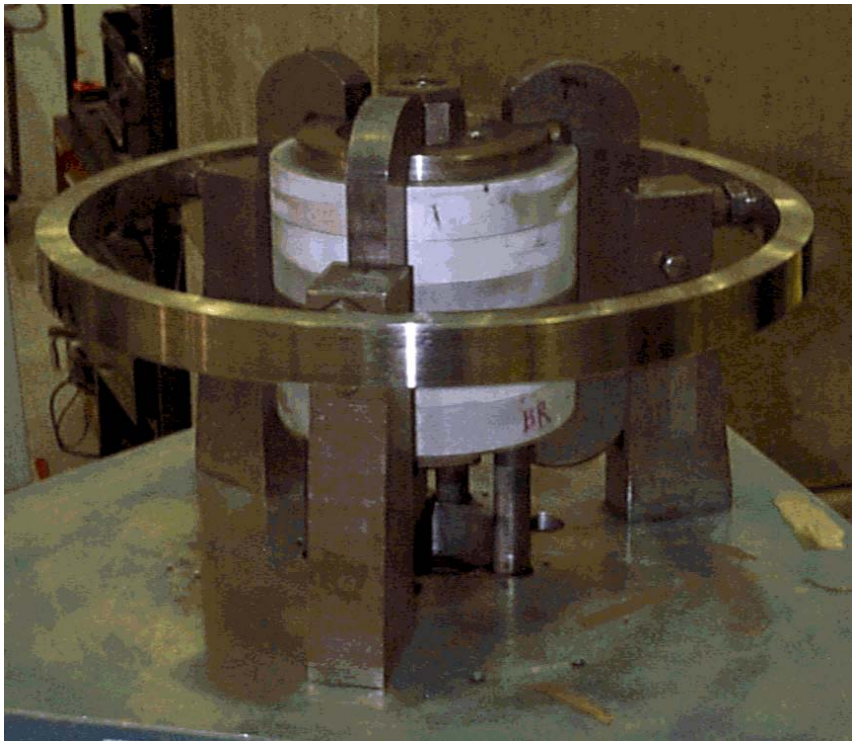
Current Status (cont'd)

- Sandia National Laboratory available and used for performing critical measurements
- Additionally, the US DOE has contracts in place with the French government for joint measurements/data acquisition

Future at the NTS - CEF

- Conduct one subcritical experiment in the DAF during each fiscal year (FY 2011 through FY 2014)
- Design and execute critical experiments following the successful completion of the CEF operational readiness review and successful completion of the CEF startup plan

Fast Burst Assembly

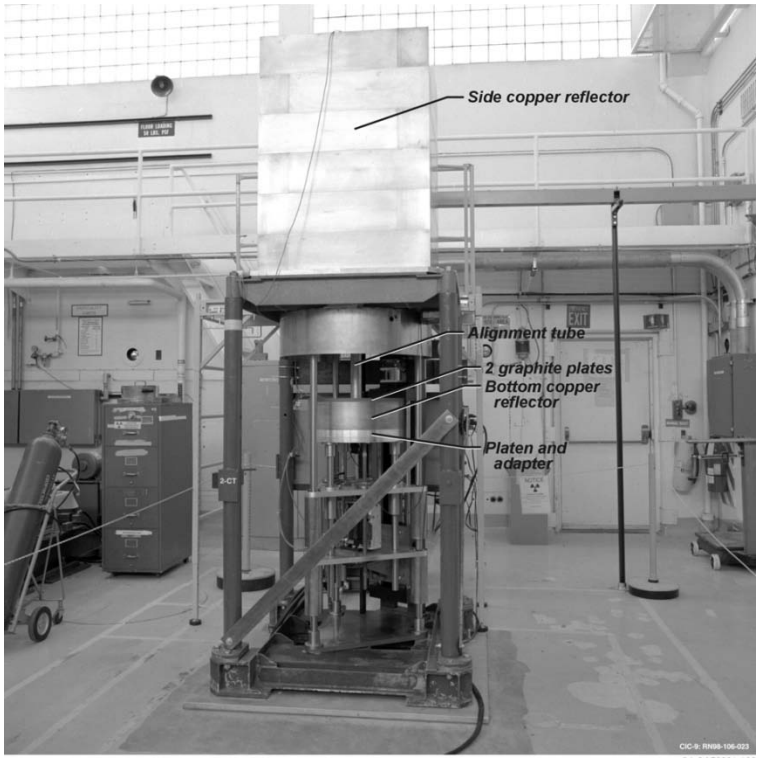


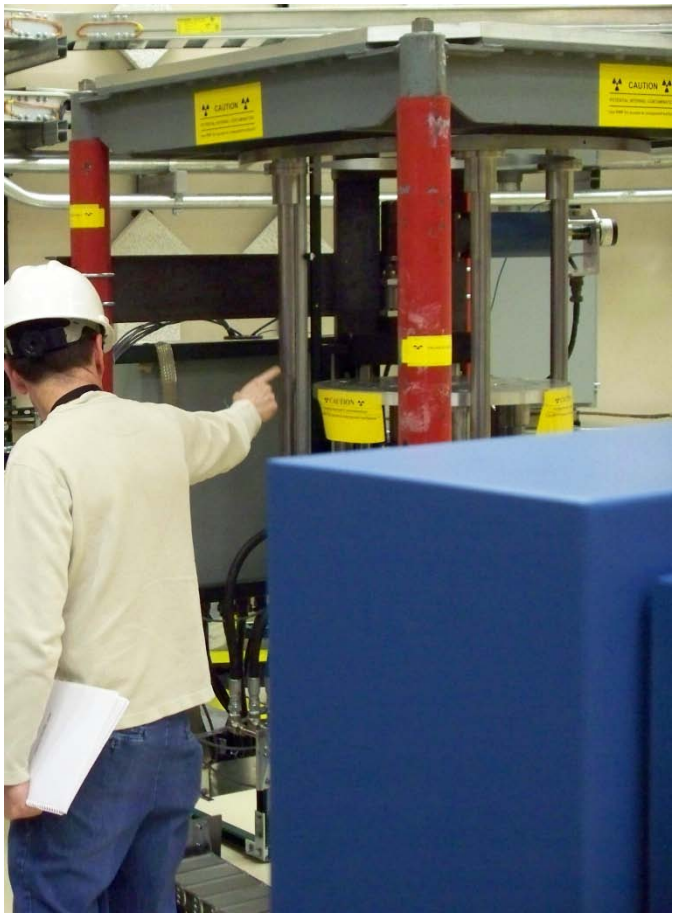
- Godiva-IV delayed-critical and super-prompt-critical burst assembly made from an alloy of highly enriched uranium (HEU) and molybdenum

General-Purpose Lift Machines

- Two general-purpose vertical lift assembly machines
  - Planet
  - Comet

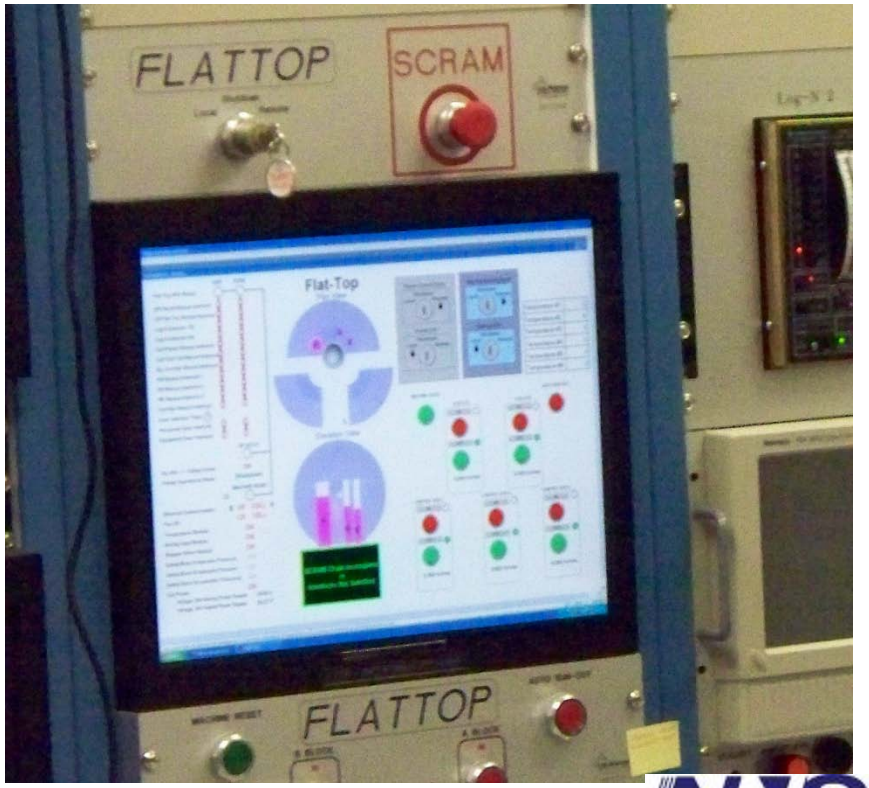
Comet


Side copper reflector
Alignment tube
2 graphite plates
Bottom copper reflector
Platen and adapter
04-GA50001-183


CAUTION

Planet

Fast Benchmark Assembly



RACK 12
RACK 13
RACK 14
RACK 15
RACK 16
EQUIPMENT WILL REMAIN POWERED UP
PLANET
SCRAM
FLATTOP
FLATTOP

CEF Support Features

- Two general-purpose measurement laboratories
- Access to a wide variety of nuclear material and materials required for nuclear experiments (e.g., structural materials, reflector and interstitial materials, test materials)
- Fissionable material storage vaults
- Machine shop
- Counting room
- Rabbit system (rapid sample handling - future)

Sandia National Laboratory

- Maintain the capability to perform water-moderated low-enriched lattice critical experiments in the Sandia Critical Experiments Facility. The initial focus will be on the Seven Percent Critical Experiment (7uPCX)

Sandia (cont'd)

- Design, perform, and analyze benchmark experiments for validating reactor physics methods and models for fuel enrichments greater than 5-wt% 235U
- Measurements of critical boron concentration, burnable absorber worth, relative pin powers, and relative average powers
- Provide additional information for application to the criticality-safety bases for commercial fuel facilities handling greater than 5-wt% 235U fuel

Sandia (cont'd)

- A training mission for non-Q cleared individuals
- Hands-on training for non-cleared individuals another major use of the SNL critical experiments facility

France

- The Institut De Radioprotection et De Sûreté Nucléaire (IRSN) has initiated an experimental program, Matériaux Interaction Réflexion Toutes Epaisseurs (MIRTE), in which integral reactivity characteristics of various structural materials will be tested in critical assemblies on the APPARATUS B facility at the Commissariat à l'Énergie Atomique (CEA) Valduc Centre
- Most configurations will be focused on interaction, but some will be reflected. Only low-enriched UO_2 (4.738% enriched uranium) water-moderated rod arrays with thermal energy spectra will be constructed

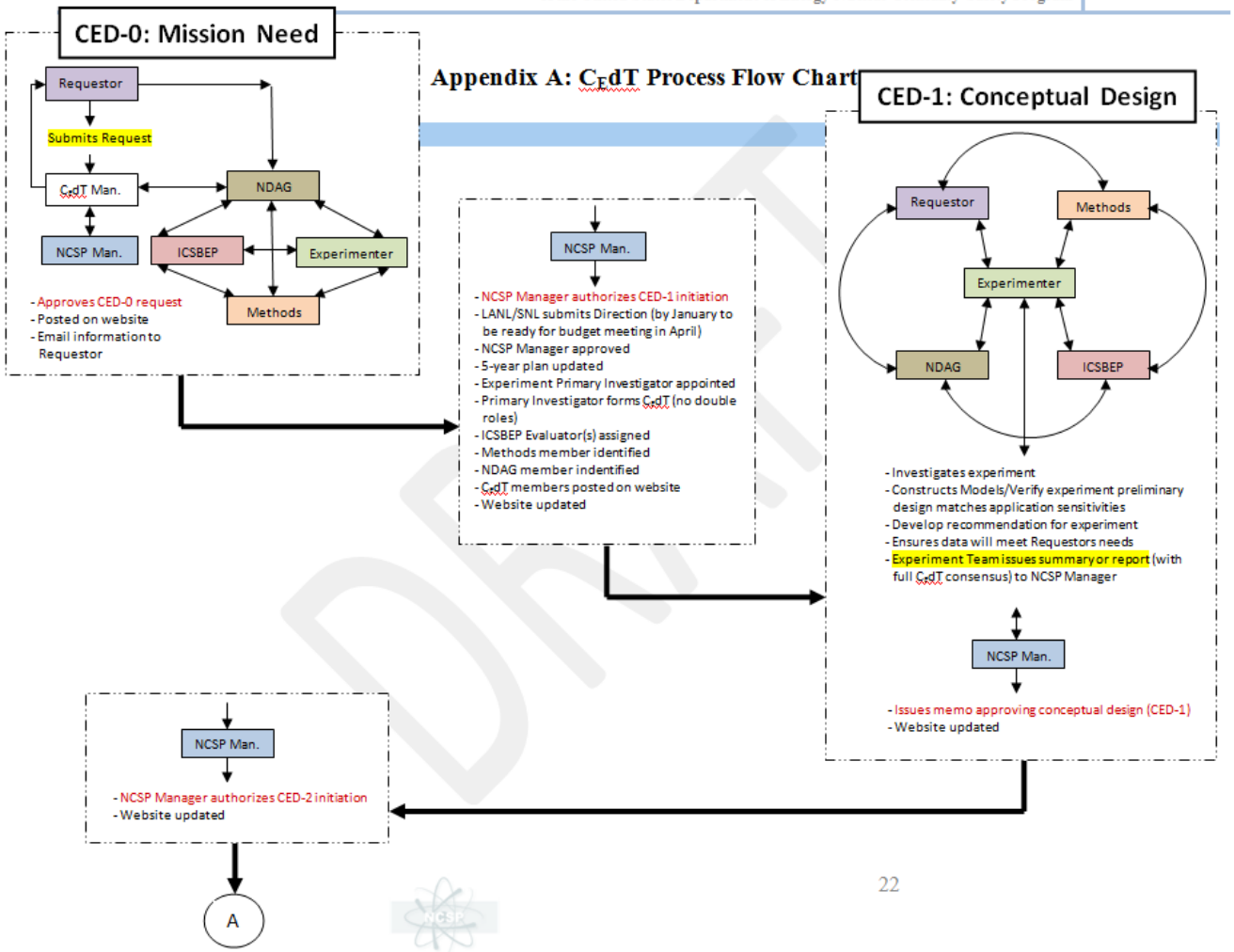
France (cont'd)

- LLNL, LANL, PNNL, SRS, Y-12 criticality and dosimetry specialists participating in a Nuclear Accident Dosimeter (NAD) exercise (SILENE 2010) in Valduc, France
- Actual LLNL-designed NADs (currently installed in the DAF & the Plutonium Facility will be used) Personal NAD will also be tested
- Participants to support the exercise, participate in the exercise, and publish the results

Critical Subcritical Experiment Design Team (C_EdT)

- In order to facilitate integral measurement capabilities with the DOE, a Critical Subcritical Experiment Design Team (C_EdT) process has been developed.
- Ensure requestor's nuclear data needs are well understood and met by integrating all capabilities of the NCSP to design and approve the requested measurements, including deciding which facilities within the DOE is best suited to perform and document the requested measurements.

Appendix A: C_FdT Process Flow Chart



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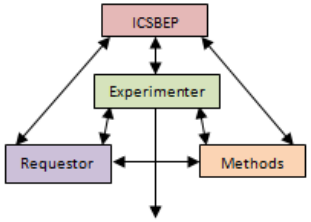
A

CED-2: Final Design



- Detailed experiment plans developed
- Demonstrate expected precision and systematic bias acceptably small
- Evaluator demonstrate experimental bias expected to be acceptably small
- Experiment precision discussed with Requestor to ensure needs met (Area of Applicability verified)
- Resource loaded schedule prepared
- Section 1 and 2 of ICSBEP evaluation drafted (CeDT concurs with draft)
- CeDT issues summary or report to NCSP Manager

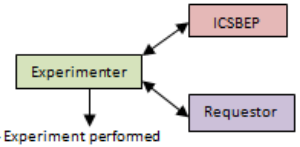
NCSP Man.

- Issues memo approving final design (CED-2)
- Website updated

NCSP Man.

- NCSP Manager authorizes CED-3 initiation
- Should be approved by March to receive funding priority for next FY
- Prioritized and incorporated into funding cycle and 5-Year Plan as appropriate
- Requestor invited to witness experiment (if possible – clearance, funding, etc.)
- Website updated

CED-3: Execution



- Experiment performed
- Data collected
- Section 1 finalized for sending to ICSBEP evaluator
- Experimenter issues summary or report on completion of experiment to NCSP Manager

NCSP Man.

- Approves completion of experiment (CED-3)
- Website updated

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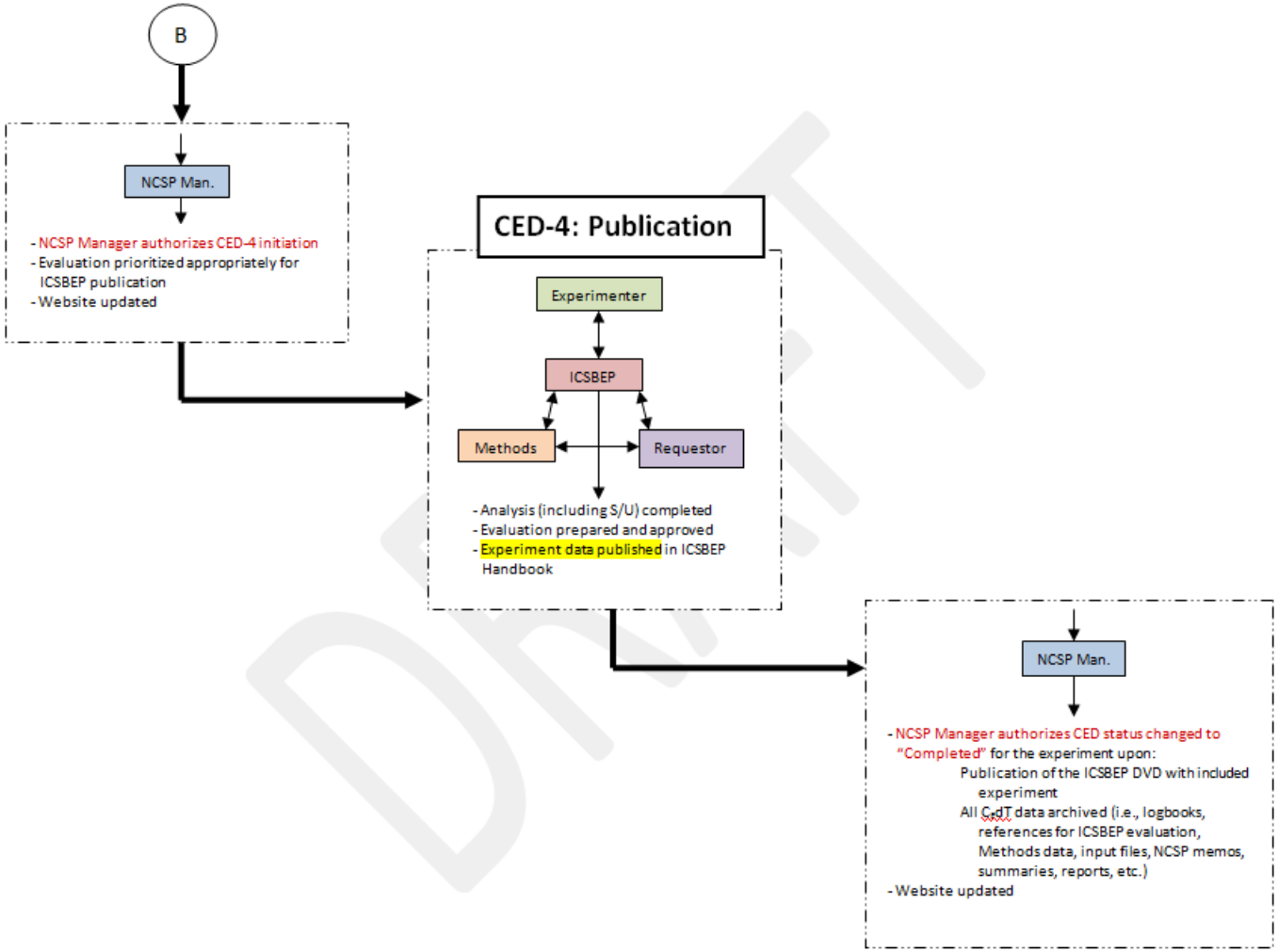
B
NCSP Man.
- NCSP Manager authorizes CED-4 initiation
- Evaluation prioritized appropriately for ICSBEP publication
- Website updated
CED-4: Publication
Experimenter
ICSBEP
Methods
Requestor
- Analysis (including S/U) completed
- Evaluation prepared and approved
- Experiment data published in ICSBEP Handbook
NCSP Man.
- NCSP Manager authorizes CED status changed to "Completed" for the experiment upon:
Publication of the ICSBEP DVD with included experiment
All C&T data archived (i.e., logbooks, references for ICSBEP evaluation, Methods data, input files, NCSP memos, summaries, reports, etc.)
- Website updated

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Approved Experiments

- Plutonium Sphere Reflected with Copper (Cu)
- Plutonium Sphere Reflected with Lead (Pb)
- Plutonium Sphere Reflected with Manganese (Mn)
- Plutonium Sphere Reflected with Nickel (Ni)
- Plutonium Sphere Reflected with Tungsten (W)
- Plutonium Sphere Reflected with Acrylic
- Planet (CEF Start-Up Plan)
- Comet (CEF Start-Up Plan)
- Flattop (CEF Start-Up Plan)
- Godiva (CEF Start-Up Plan)
- Vanadium as a Reflector, Diluent or Absorber
- Use of Borabond4™ as a Fixed Neutron Absorber
- Spherical Lattice of Alternating HEU & Polyethylene/Lucite Shells
- Poly-Reflected Pu Neutron Multiplicity & Gamma Spectral Data

Questions?