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LLNL Project Analysis

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Neutron image simulations - MCNP6 vs. COG11

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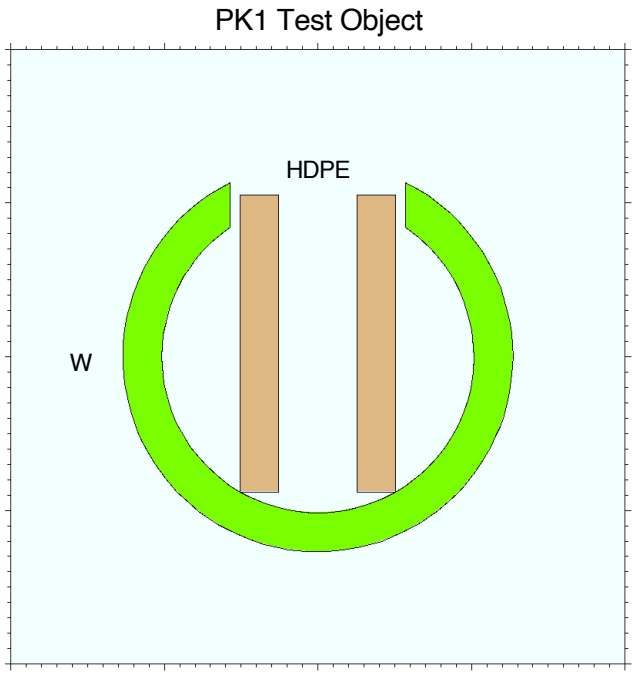
Lawrence Livermore National Laboratory

National Nuclear Security Administration

Problem: Compare MCNP6 and COG11 neutron image simulations

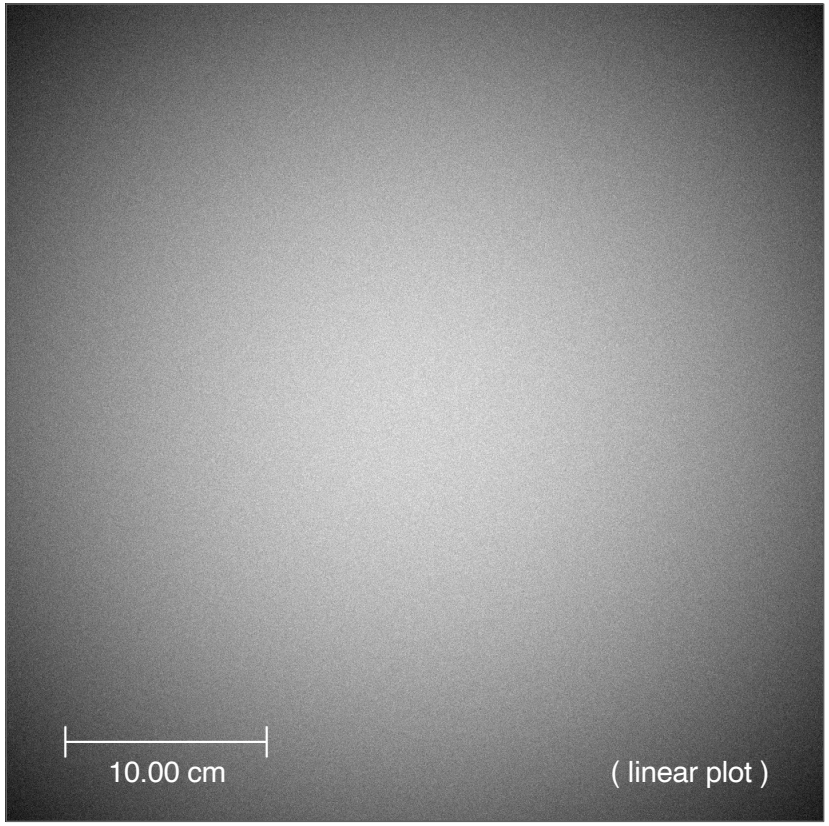
- **Monte Carlo simulations:**
  - **abstract 14.100 MeV neutron source**
    - **7 mm Ø spot viewed @ 45° w.r.t. imaging axis ***
  - **W shell/HDPE sleeve test object ("PK1")**
    - **5.000" Ø, 0.500" wall spherical W shell**
    - **2.000" Ø, 0.500" wall cylindrical HDPE sleeve**
    - **SOD = 30.00 cm, ODD = 31.00 cm (M ~ 2.033:1)**
  - **abstract neutron imaging detector**
    - **1024 x 1024 array w/ 400 μm pixel pitch**
    - **MCNP6 "FMESH01" boundary-crossing tallies**
    - **COG11 "ptcnts" boundary-crossing tallies**
    - **total & scatter images [n/pixel/(src n)]**



* Note: Analogous to Thermo-Fischer P385 DTn source used in recent experiments at LLNL.

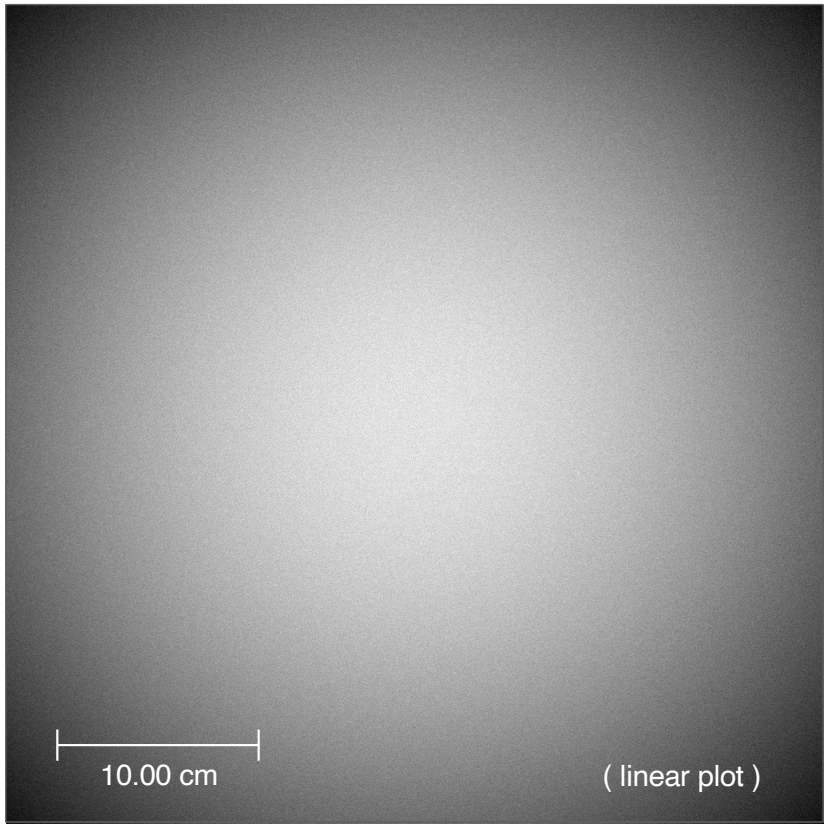
Open field neutron images (I_o) …

MCNP6 Simulated Image *



(1024 x 1024 MCNP6.2 FMESH01 tally w/ 400 μm pixel pitch)

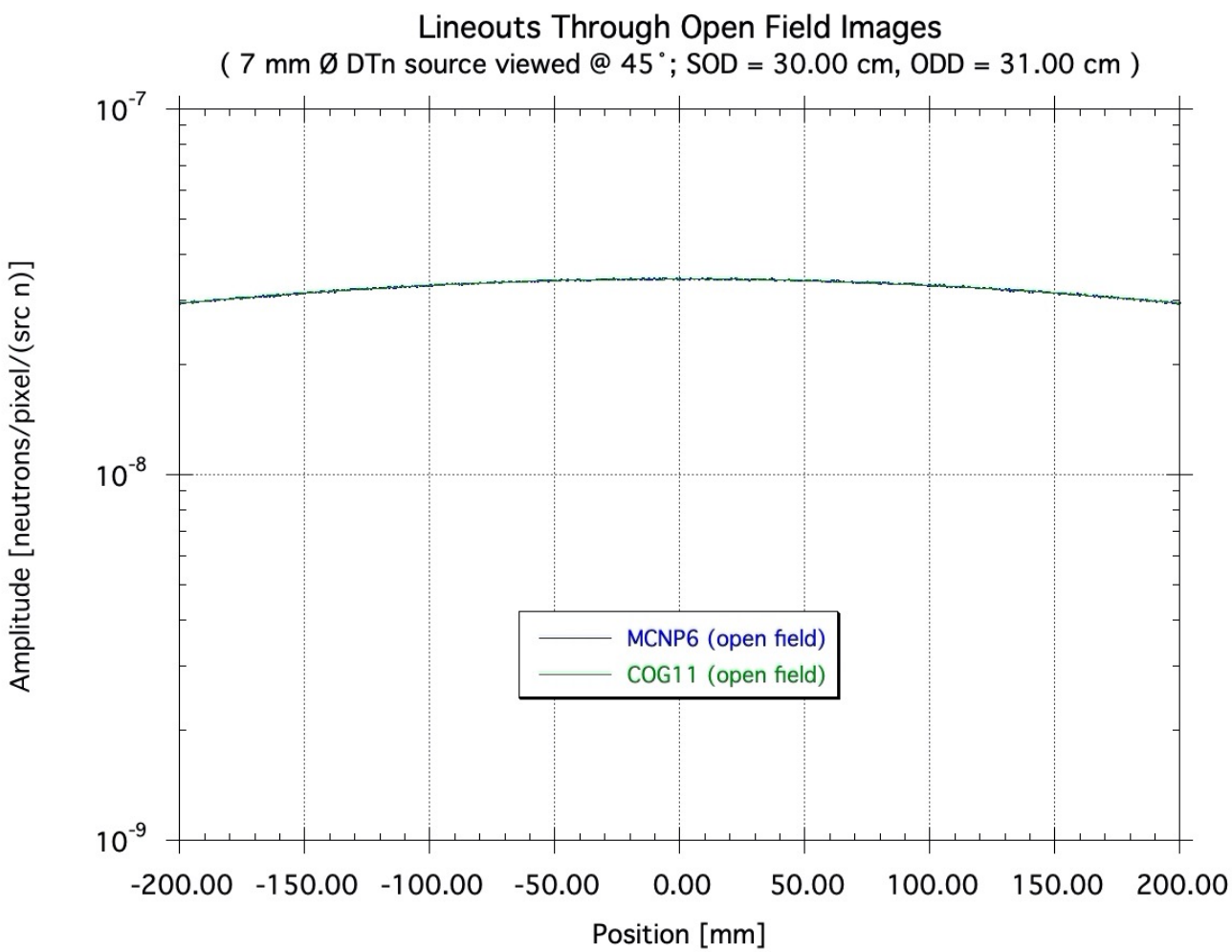
COG11 Simulated Image *



(1024 x 1024 COG11.3 imaging tally w/ 400 μm pixel pitch)

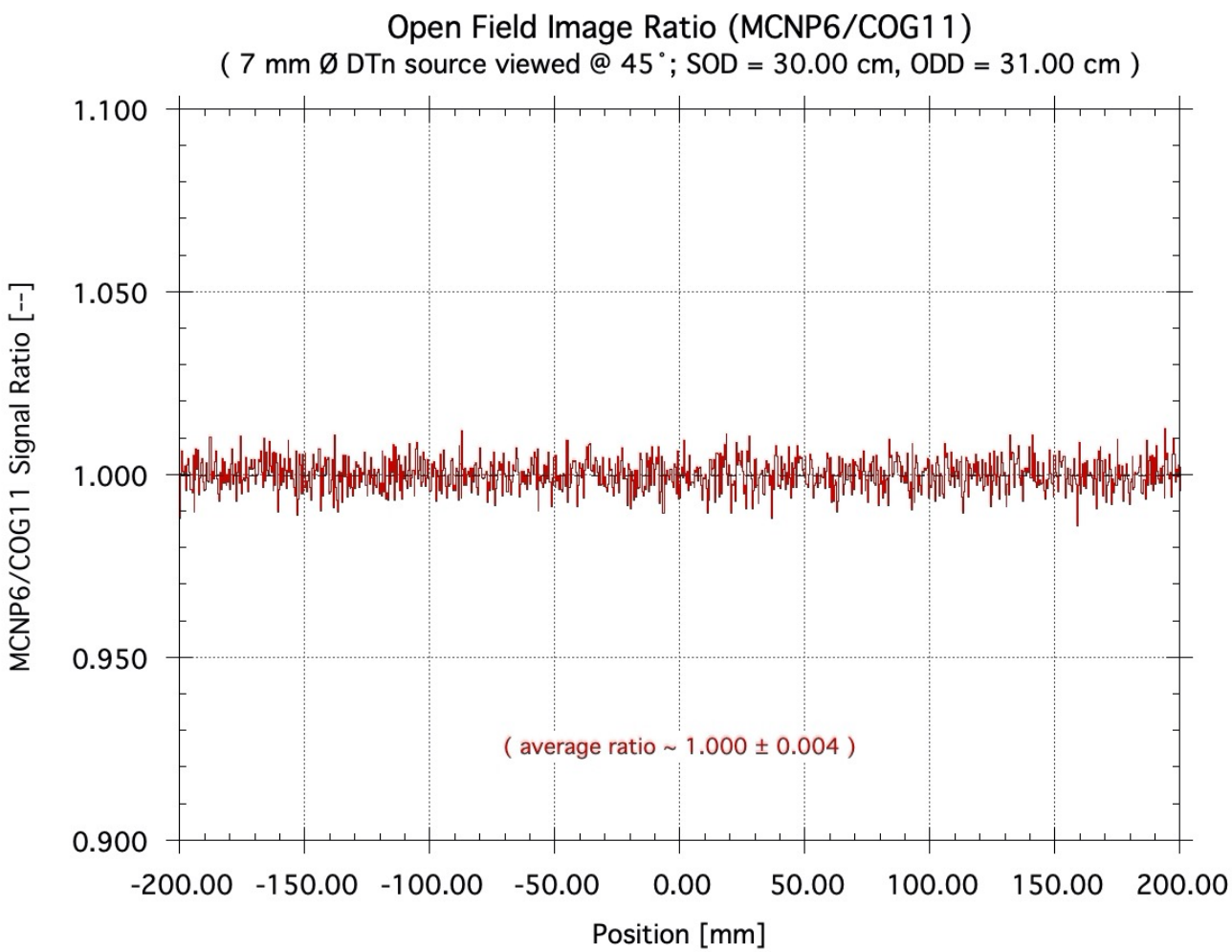
* Note: Images are shown at the same contrast level for comparison.

Open field neutron images (I_o) … *



* Note: Direct comparison of unscaled MCNP6.2 & COG11.3 simulated images.

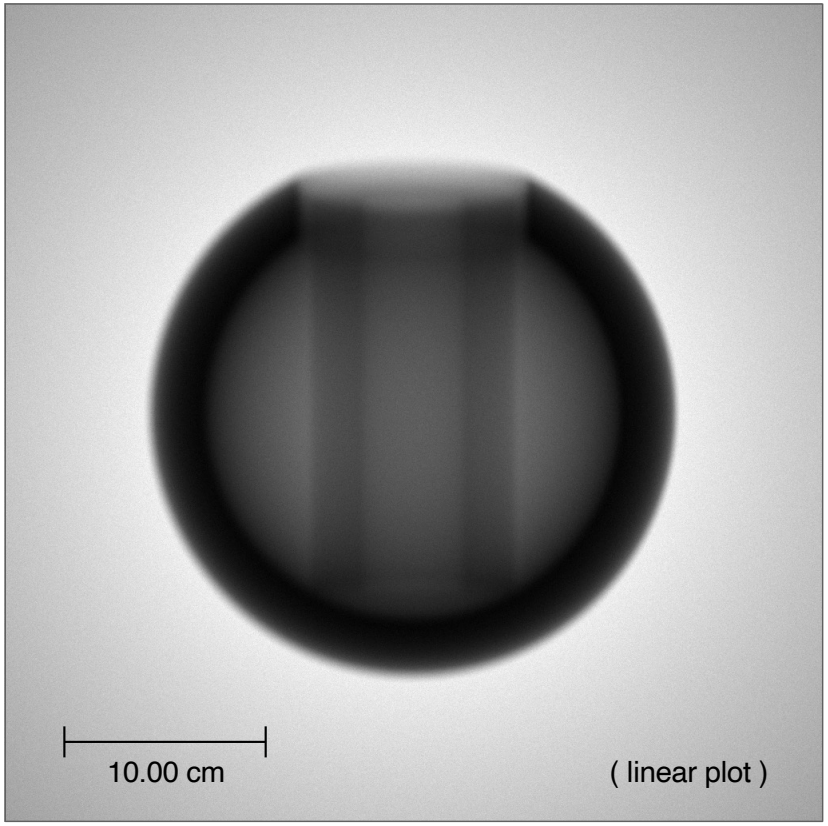
Open field neutron images (MCNP6/COG11 ratio) … *



* Note: No materials are involved in the open field simulations. Differences in response are due primarily to statistical jitter.

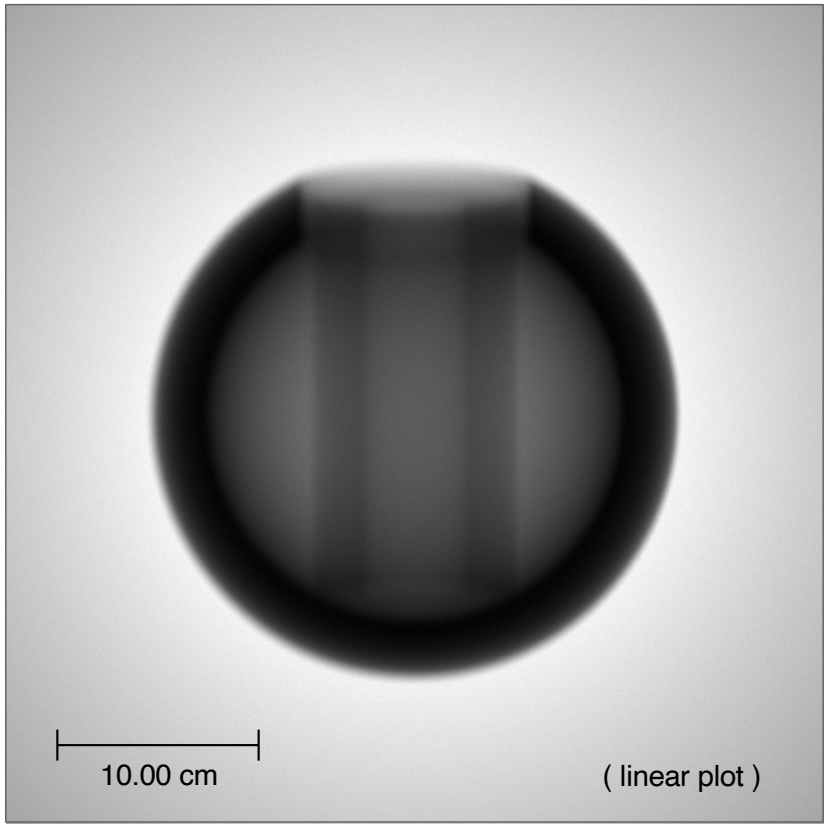
PK1 total neutron images (I) …

MCNP6 Simulated Image *



(1024 x 1024 MCNP6.2 FMESH01 tally w/ 400 μm pixel pitch)

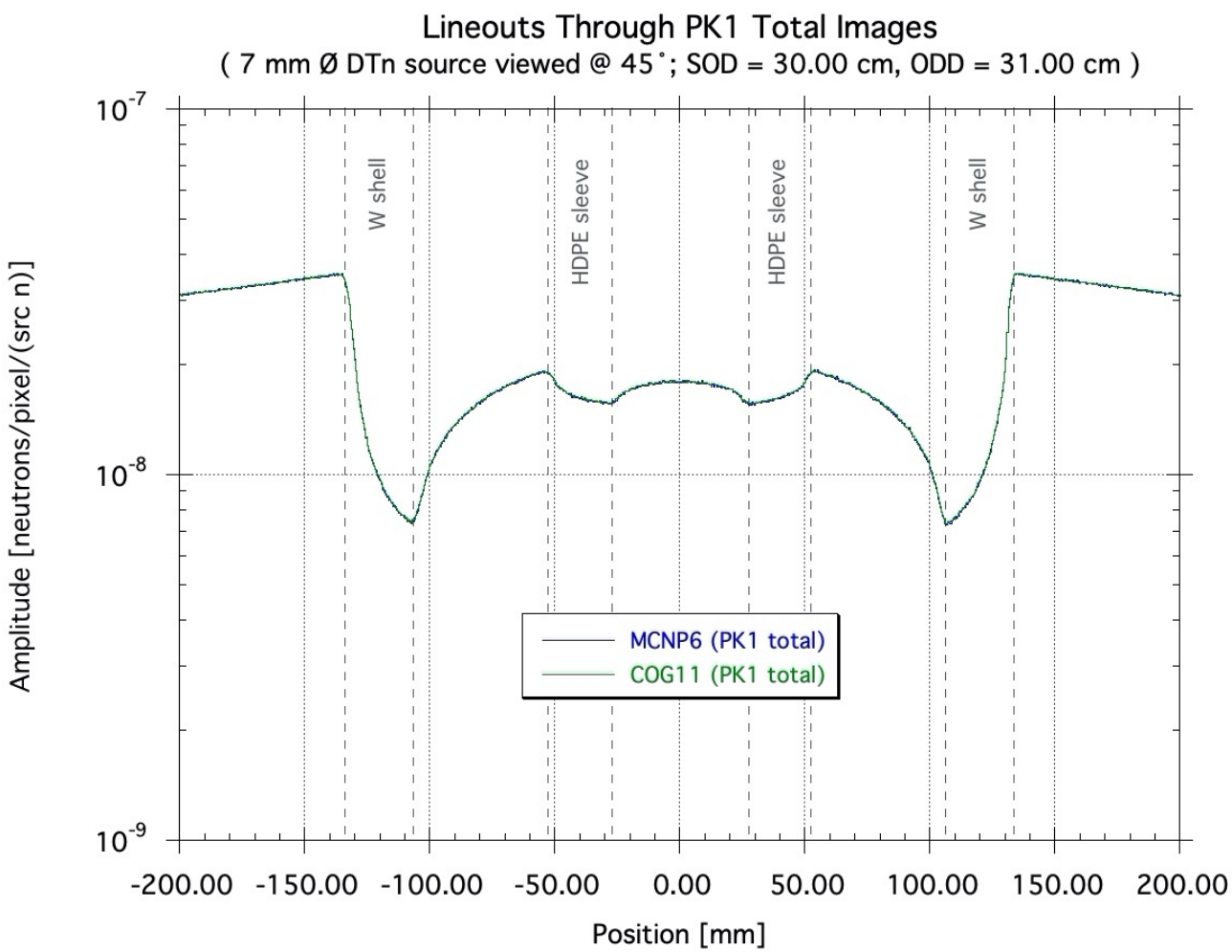
COG11 Simulated Image *



(1024 x 1024 COG11.3 imaging tally w/ 400 μm pixel pitch)

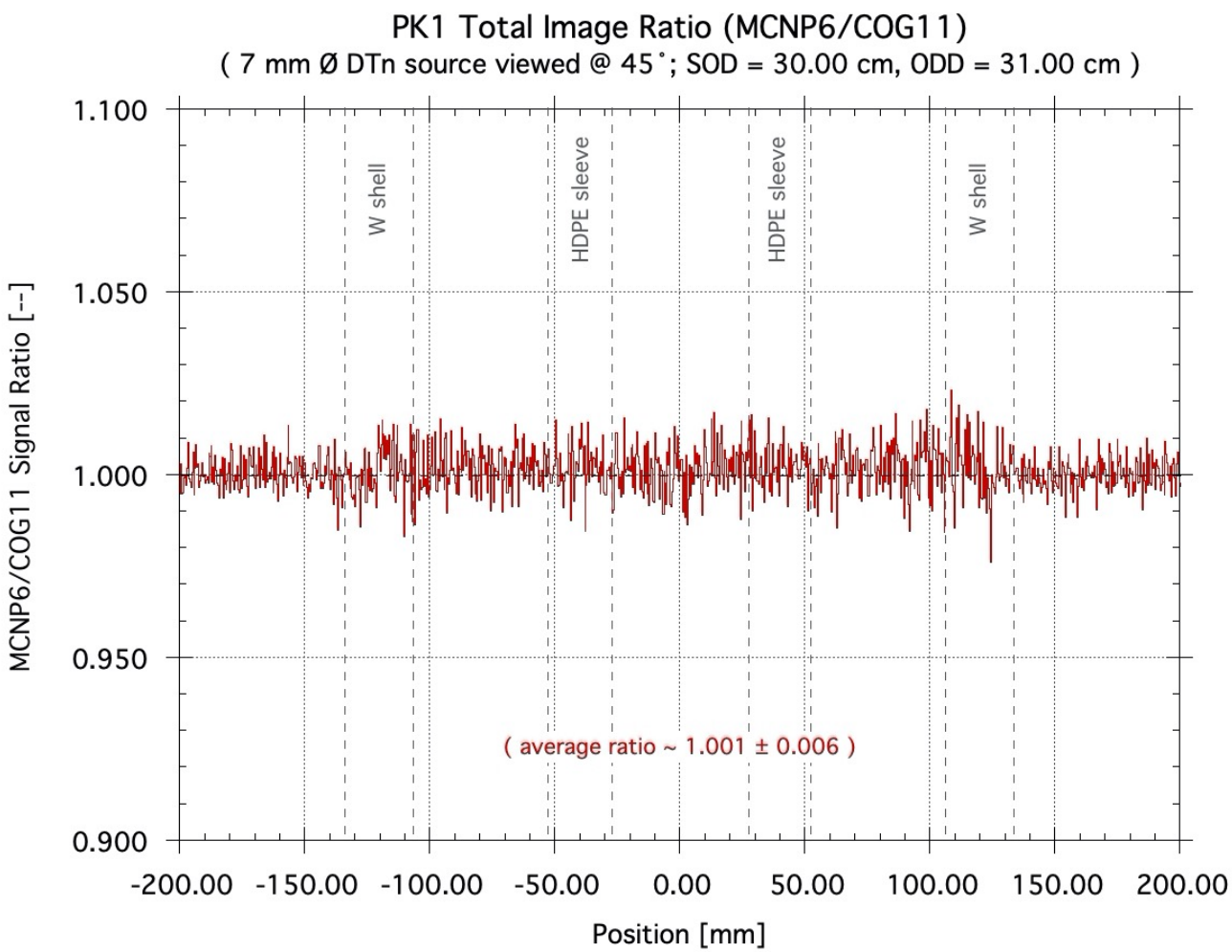
* Note: Images are shown at the same contrast level for comparison.

PK1 total neutron images (I) … *



* Note: Direct comparison of unscaled MCNP6.2 & COG11.3 simulated images.

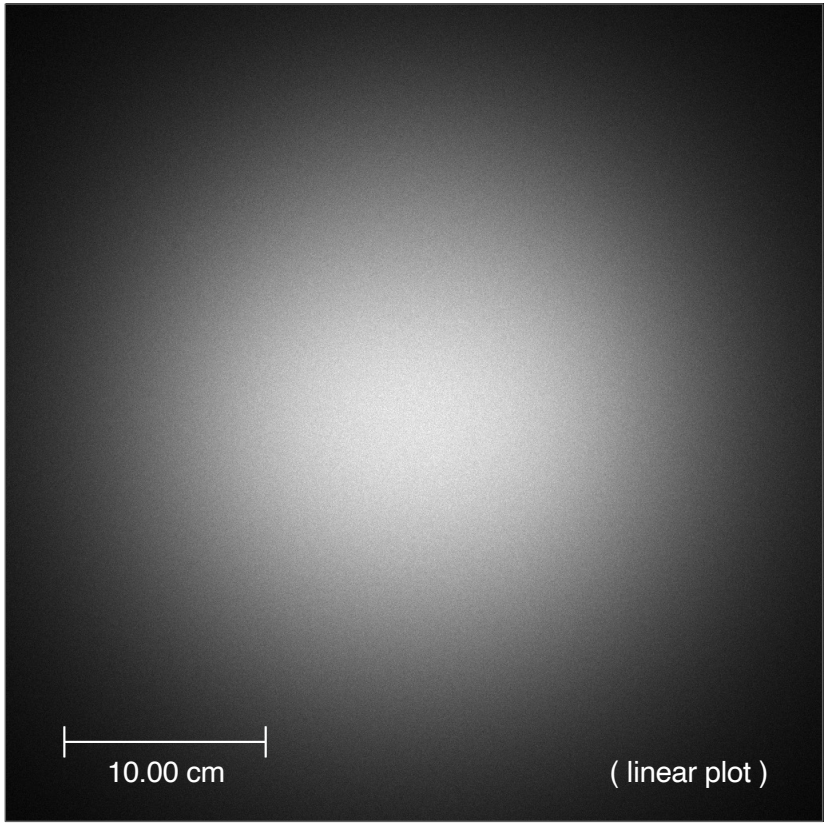
PK1 total neutron images (MCNP6/COG11 ratio) … *



* Note: Differences in response are due primarily to statistical jitter.

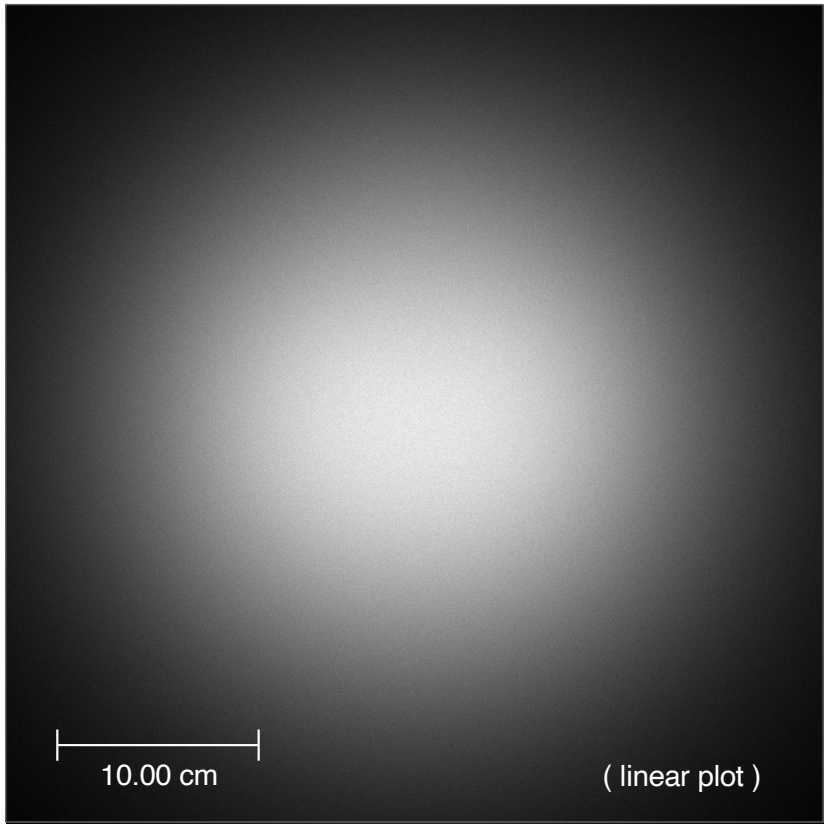
PK1 scattered neutron images …

MCNP6 Simulated Image *



(1024 x 1024 MCNP6.2 FMESH01 tally w/ 400 μm pixel pitch)

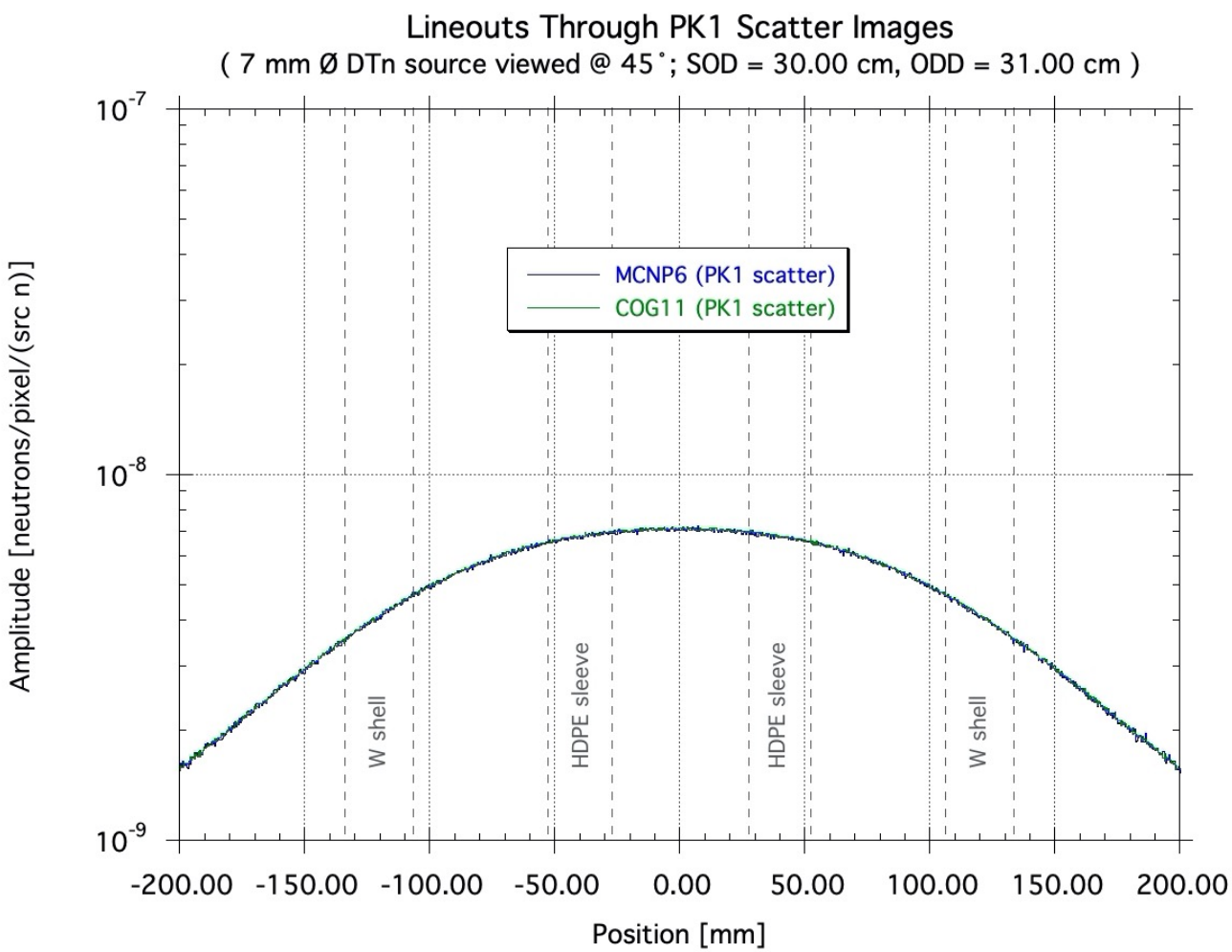
COG11 Simulated Image *



(1024 x 1024 COG11.3 imaging tally w/ 400 μm pixel pitch)

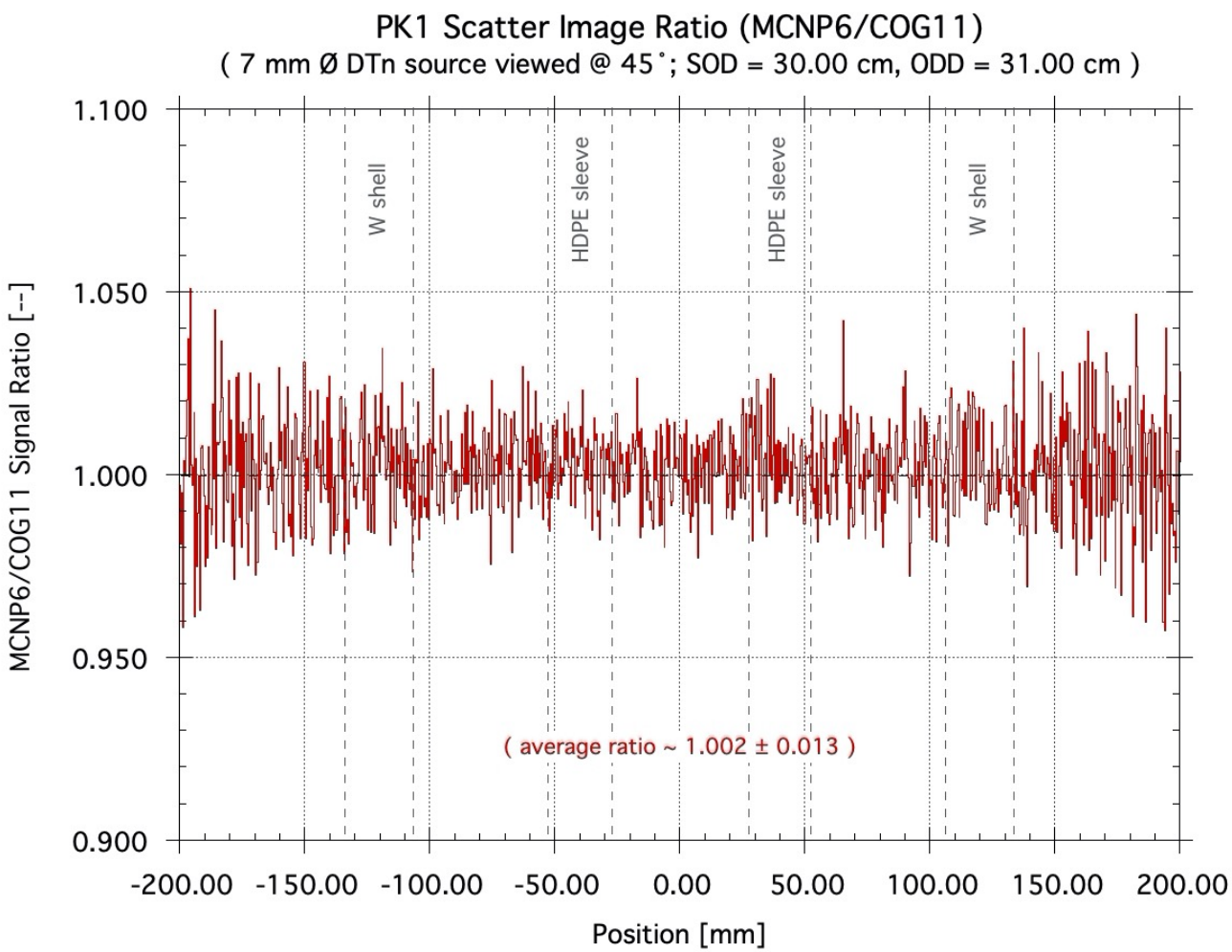
* Note: Images are shown at the same contrast level for comparison.

PK1 scattered neutron images … *



* Note: Direct comparison of unscaled MCNP6.2 & COG11.3 simulated images.

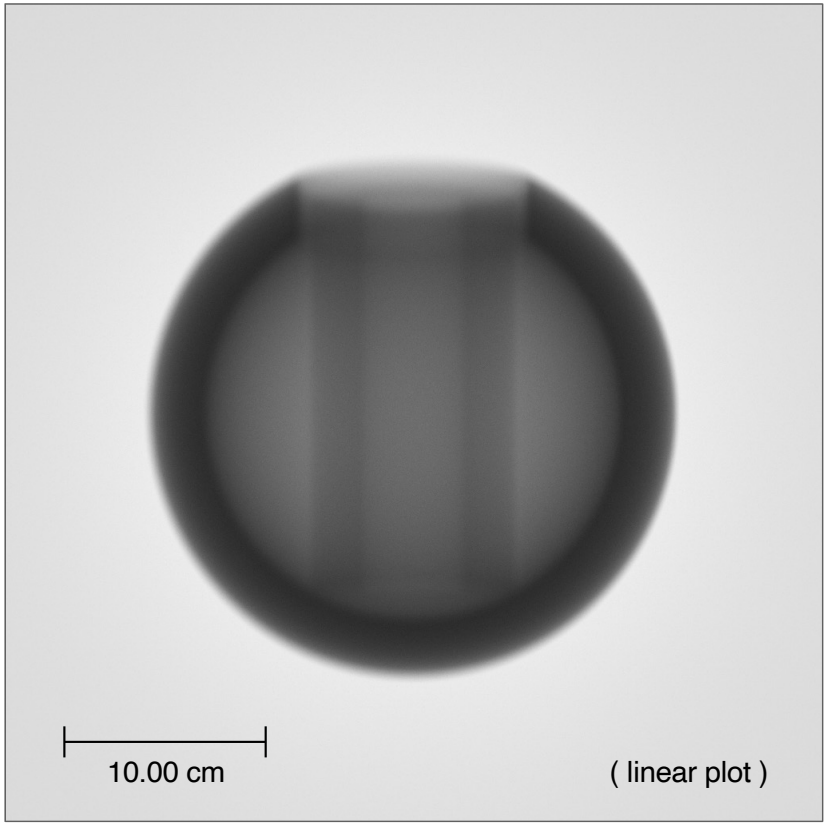
PK1 scattered neutron images (MCNP6/COG11 ratio) … *



* Note: Differences in response are due primarily to statistical jitter.

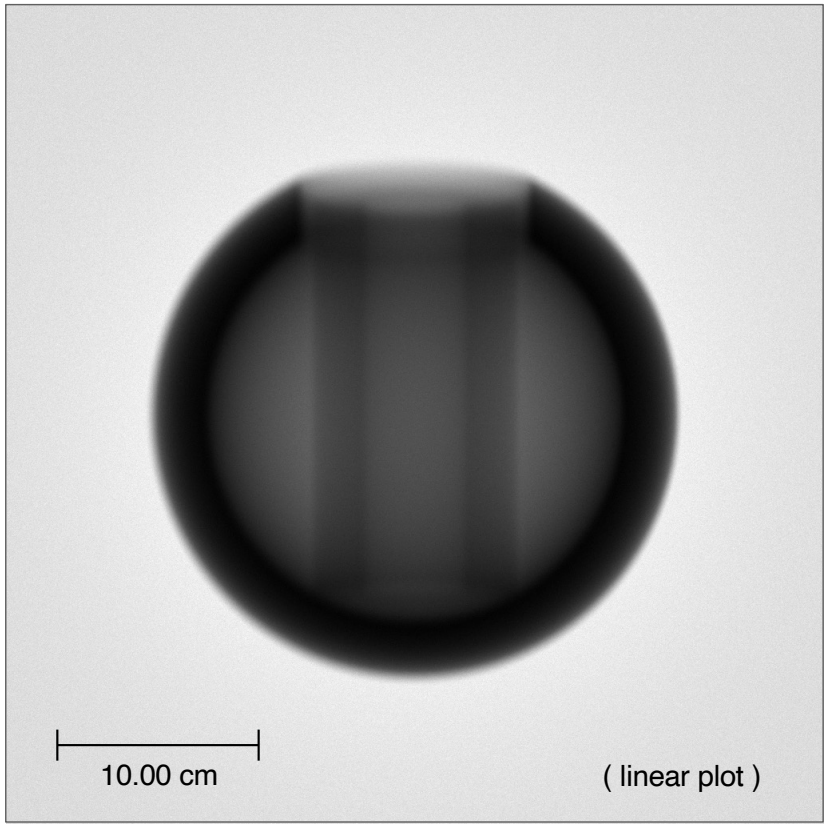
PK1 flat field (I/I_o) neutron images …

MCNP6 Simulated Image *



(1024 x 1024 MCNP6.2 FMESH01 tally w/ 400 μm pixel pitch)

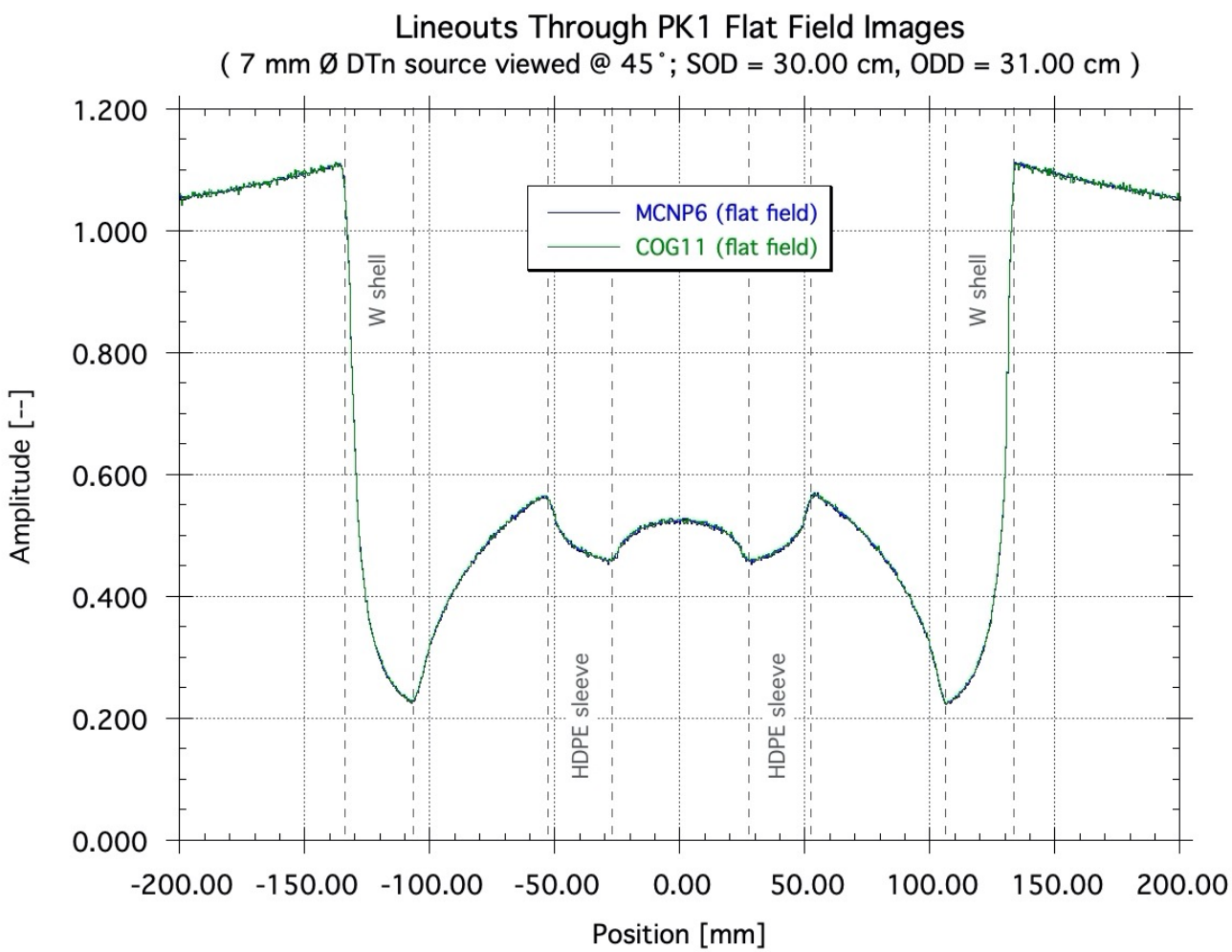
COG11 Simulated Image *



(1024 x 1024 COG11.3 imaging tally w/ 400 μm pixel pitch)

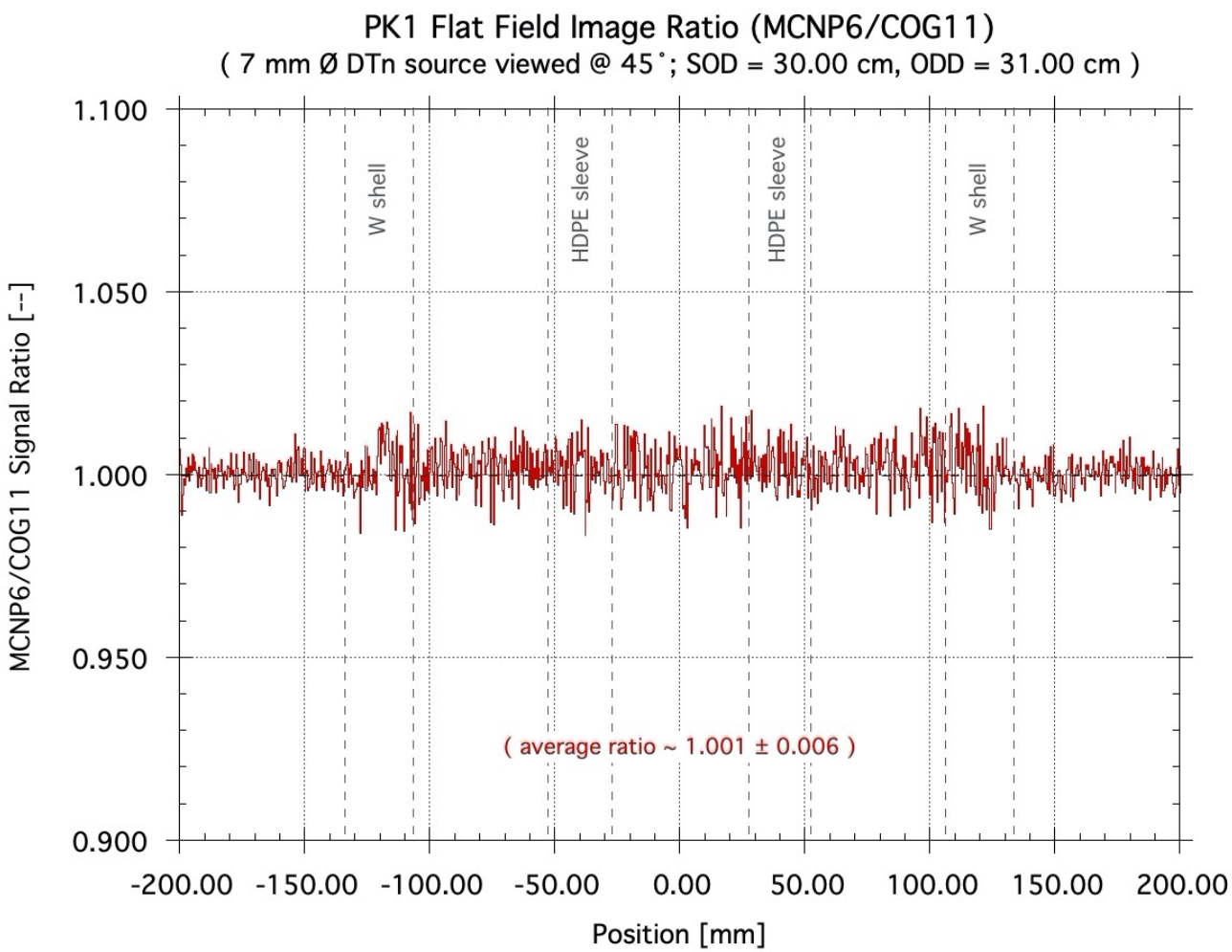
* Note: Images are shown at the same contrast level for comparison.

PK1 flat field (I/I_o) neutron images … *



* Note: Direct comparison of unscaled MCNP6.2 & COG11.3 simulated images.

PK1 flat field neutron images (MCNP6/COG11 ratio) … *



* Note: Differences in response are due primarily to statistical jitter.

Summary comments …

- **MCNP6- and COG11-generated neutron images are essentially identical.**
  - **differences in response are due primarily to statistical jitter**
    - **identical geometry models with mixed-Z test object**
    - **same nuclear data libraries for materials (ENDF/B-VIII.0)**
- **The relative efficiency of the two codes depends strongly on scenario.**
  - **MCNP6 was ~ 60% faster than COG11 in small-scale test runs**
    - **e.g. 1B particle serial mode runs w/ 32 x 32 pixel arrays**
  - **COG11 was > 10X faster than MCNP6 in large-scale production runs ***
    - **e.g. 15B particle parallel mode runs w/ 1024 x 1024 pixel arrays**

* Note: "Your mileage may vary." MCNP6 has a number of inscrutable idiosyncrasies when it comes to running FMESH detector tallies…

Fini...

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