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Omega Neutron Bang Time Diagnostic Calibrations July, 2007

Presented by Gordon Chandler

Liner Workshop
Livermore, California 1/25/07

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Critical Support for these Experiments were provided by

- Jose Torres, Christine Coverdale, Dave Beutler, Martin Crawford, Jason Serrano, Roque Gallegos, SNL
- Ian Mckenna, NESTek
- Chuck Source, LLNL
- Vladimir Glebov, Craig Sangster,Jack Armstrong, Greg Pien, the whole Omega support team, LLE

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The Omega July, 2007 NBT Calibrations Primary Motivations

- Calibrate the SNL NPCD's to DT neutrons
- Calibrate the SNL/Bechtel PIN Detectors to DT neutron
- Calibrate the Standard SNL PCD detectors to DT neutrons
- Look at Voltage Scaling for the NPCD Sensitivity
  - ~20% increase in response going between -1000 and -1250 DC bias
  - More sensitivity is possible!

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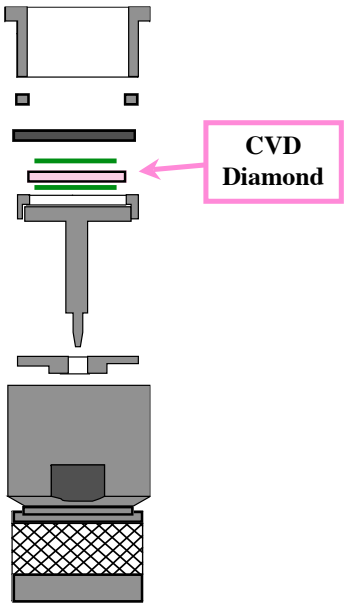
The NPCD Detectors used had the following Characteristics



- CVD Size: 10 mm Ø; 1 mm thick
- CVD Type: Polycrystalline Diamond
- Purchased From: Harris International
- Grade: Electronic
- Response Time: ~2.2 ns

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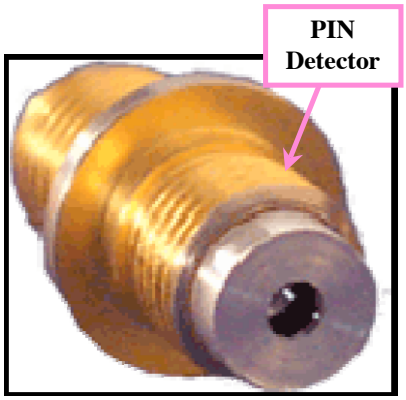
The PIN Detectors used had the following Characteristics



- PIN Element Size: 2 mm Ø; Active element thickness: 250 µm; Dead layer thickness: 0.7 µm; Exit Window: 30 µm
- PIN Model #: 003-PIN-250-SMA
- Purchased From: Emerge Semiconductor (Formally Quantrad)
- Response Time: ~2 ns

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The PCD Detector used had the following Characteristics

- PCD Size: 3 mm Long; 1 mm wide; 0.5 mm thick
- PCD Type: Single Crystal: type IIa
- Purchased From: Alameda Applied Sciences Corporation
- Model #: DRD301005-SMA-HBFF
- Response Time: ~0.1 - 0.5 ns

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The Omega Neutron Calibration Sources used were Gas and Cryo DT Filled Capsules

- 13 - Gas filled DT capsules: ~850 μm Diam.; 14.5 μm thk CH walls; 15 atm DT
  - Yields ranged from 2.9E12 - 2.3E13
  - Burn Times ranged from 125 - 150 ps
  - Ion Temperatures ranged from 5.2 - 6.2 keV
- 2 - Cryo-DT capsules: ~850 μm Diam.; 3.7 μm thk strong CD walls; 91 μm solid DT wall;
  - Yields of 1.27E12 and 2.4E12
  - Ion Temperatures of 1.7 and 2.0 keV
- Noise background shots to measure the noise level and compare with Vladimir's detectors

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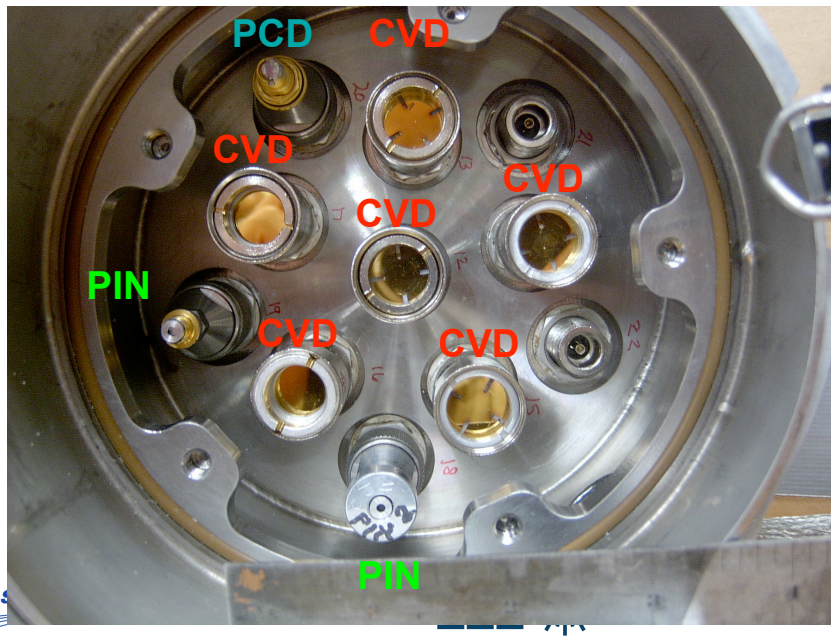
The 9 channel detector head with the 6 CVD; 2 PIN and 1 PCD detector



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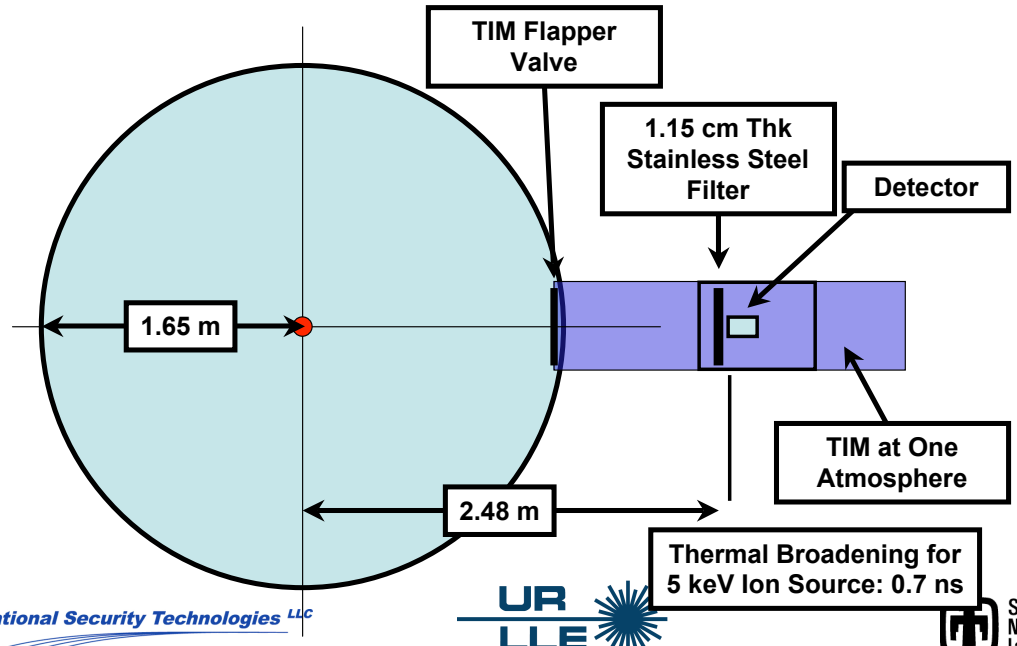
The Nine Channel Detector Head was fielded in an Omega TIM but Isolated from the Target Chamber



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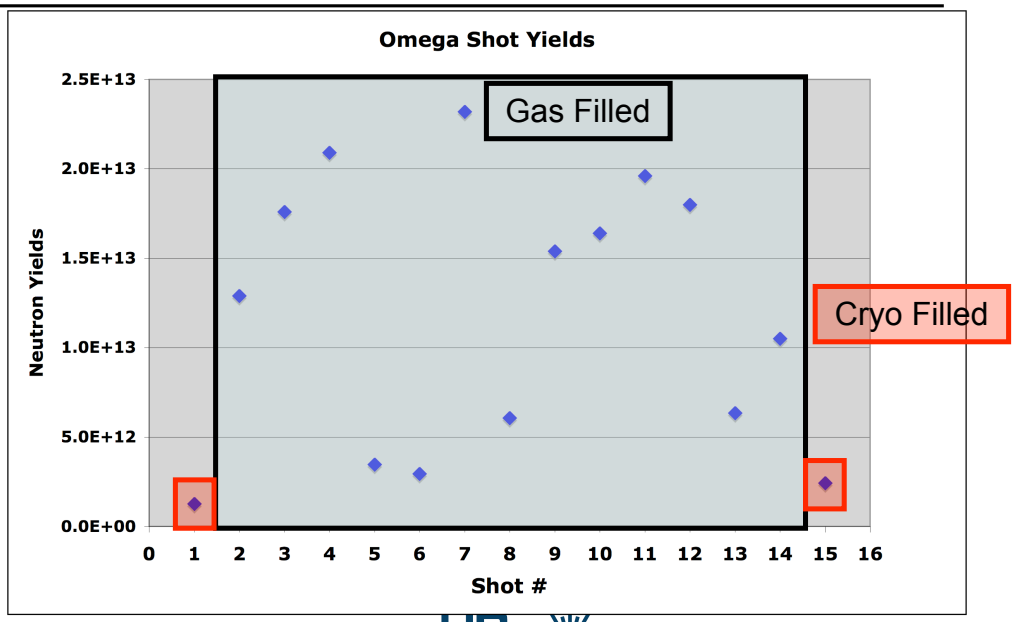
The Neutron Yields from the Capsule Implosions varied by a Factor of 10



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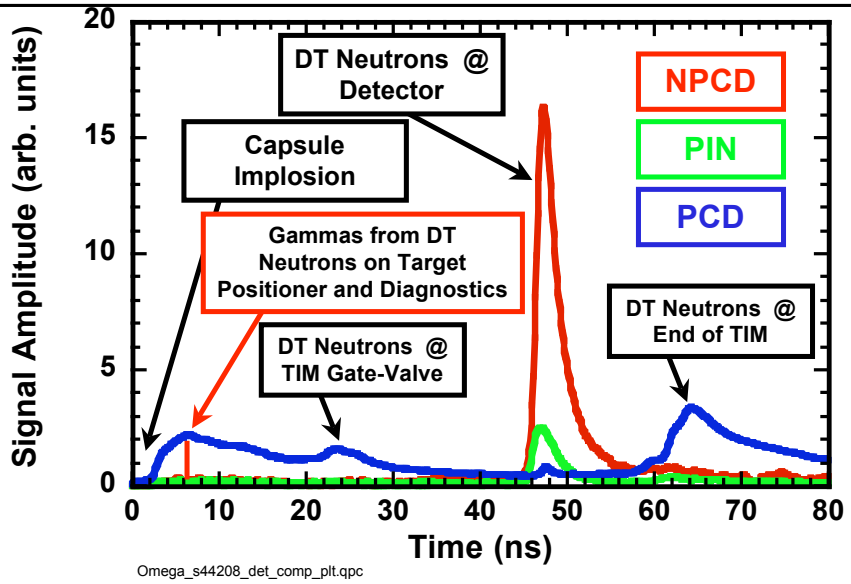
Typical Signals Obtained from the NPCD, PIN, and PCD detectors



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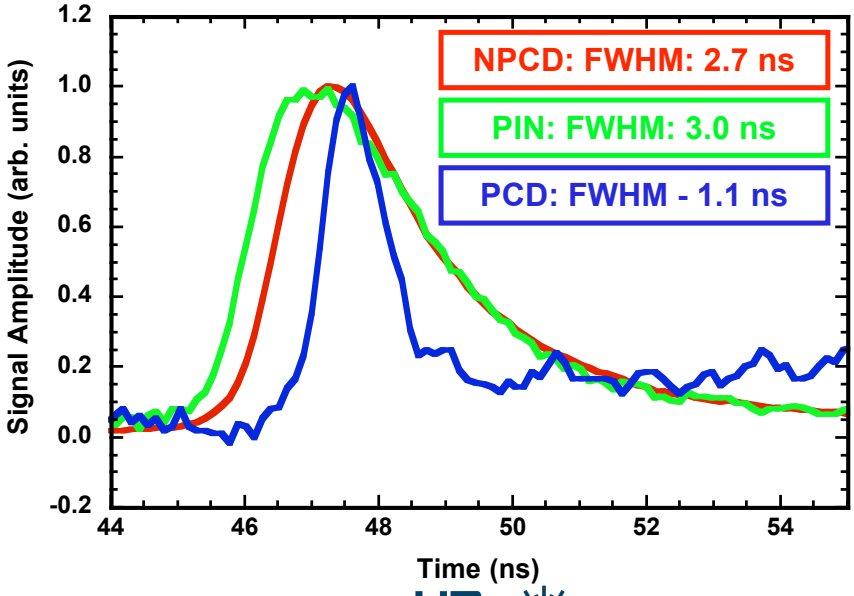
The Diagnostic Response Times are Indicated in the Normalized Neutron Induced Signals



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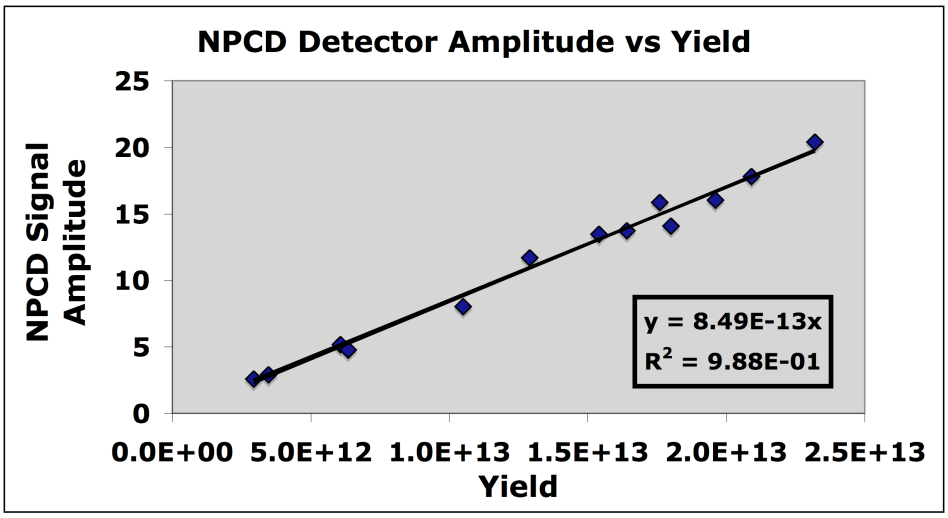
The NPCD detectors displayed a linear Amplitude over 1 Decade in Yield



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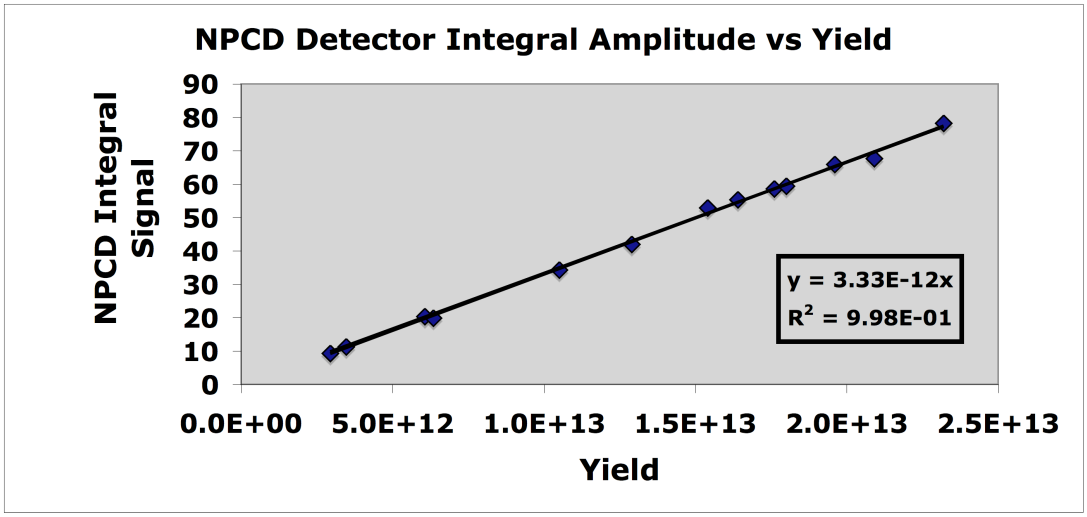
The Integral Responses Observed from the Detectors was also Linear



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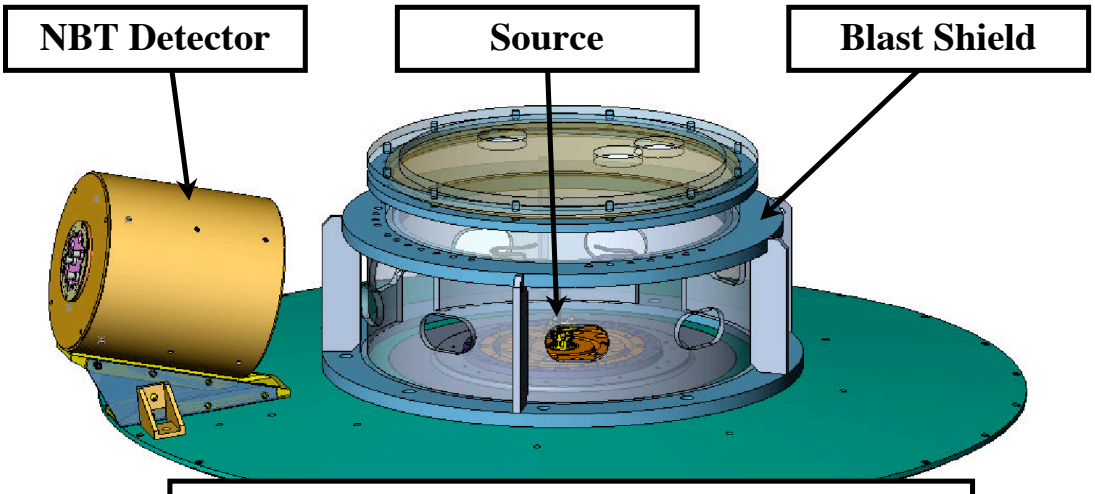
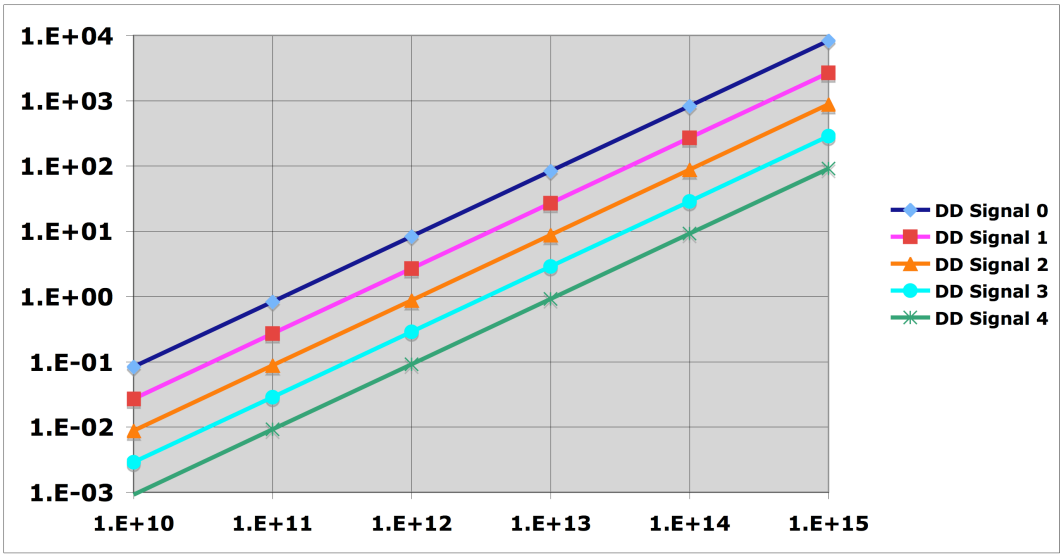
The prototype detector head is shown as an assembly into the Z vacuum chamber

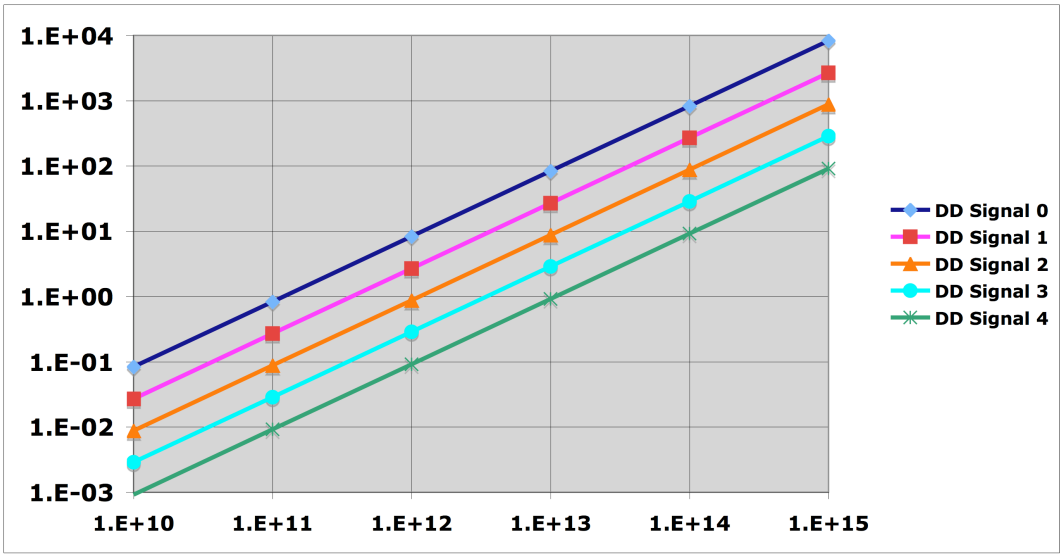


The detector is fielded close to the source to limit temporal dispersion of the neutrons

The Calibration at Omega Allows for a Signal Estimate



The Calibration at Omega Allows for a Signal Estimate for the Integral Amplitude verse Yield



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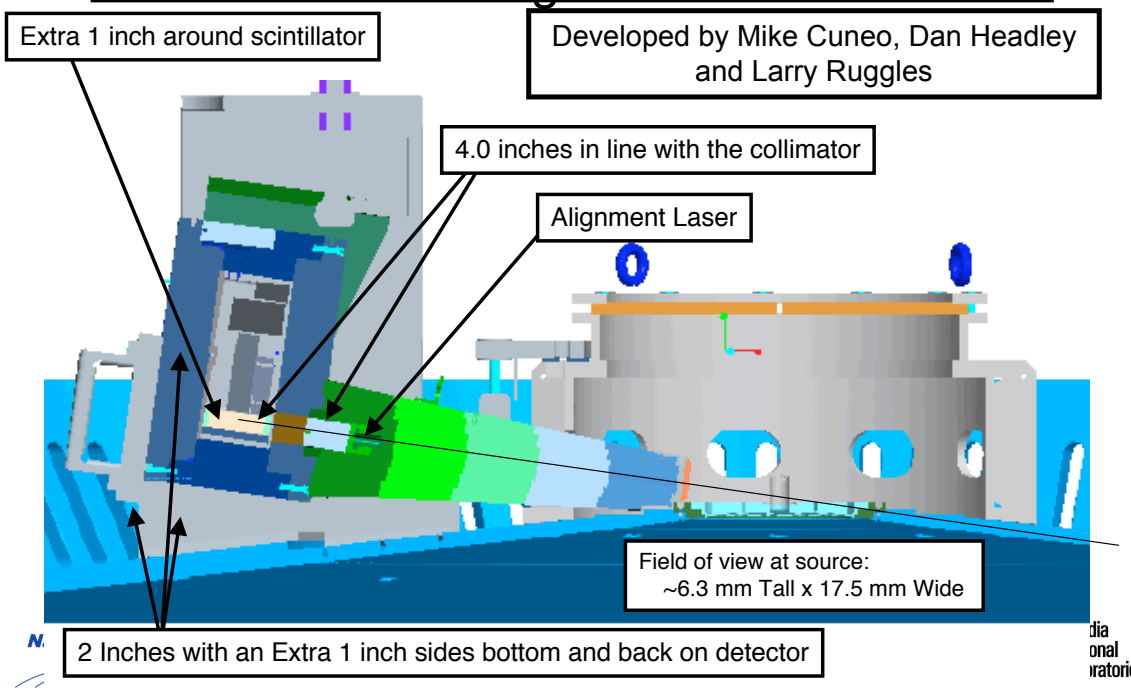
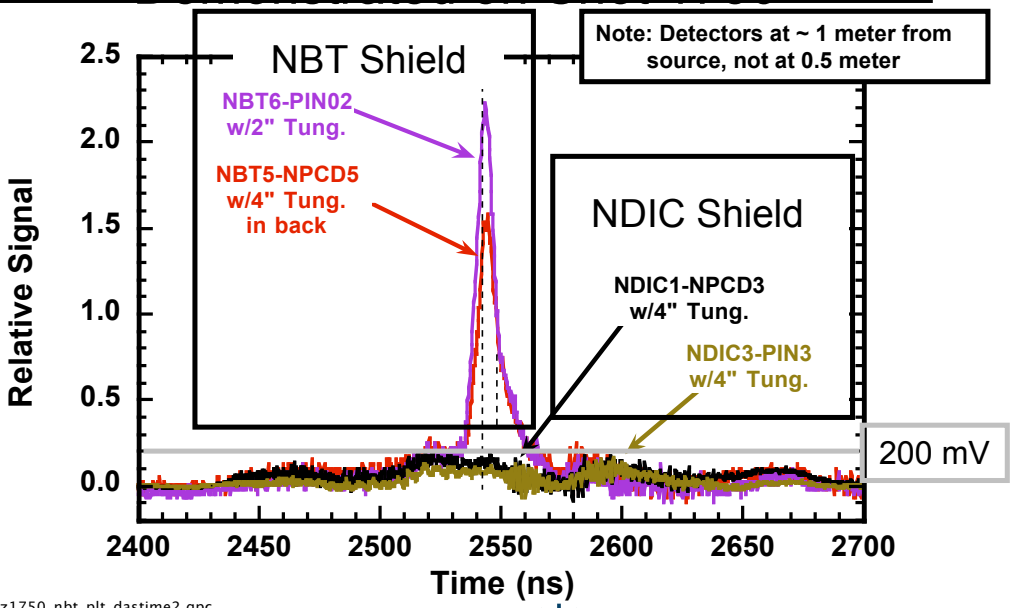
The Neutron Detector In Chamber (NDIC) was used to explore enhanced Shielding Configurations



The Improved Brems Shielding Performance of the NDIC Shielding was Demonstrated on Shot 1750



z1750_nbt_plt_dastime2.qpc

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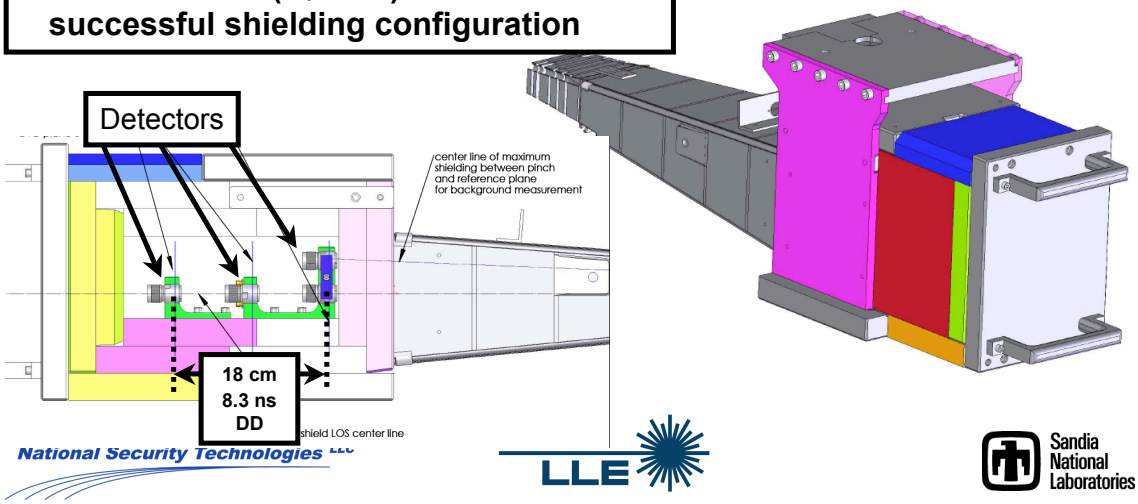
A a Modified Neutron Detector In Chamber (NDIC) Shield is Proposed to allow TOF Separation For DD Neutrons

- **Allows for 8 ns Temporal Separation for DD neutrons at the Detectors**
- **Utilizes original components to minimize cost (~$100k) and maintain successful shielding configuration**



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Work to be done

- Calibrations
  - Two more shots to look at for signal levels and a few others for noise levels
  - Need to incorporate a number of corrections to the data:
    - Signal Cable Compensations
    - Attenuation due to Stainless Gate-valve and Shield
  - Look at complete data set on voltage scaling
  - Compare with other detector responses: PIN and PCD
  - Look at absolute timing of the neutron signals to see at what point on the signal corresponds to the neutron birth time
  - Look at TLD Brems measurements for the relative shield attenuation
  - Writeup
  - Look for opportunities to do DD calibrations on Omega with present detectors and DD/DT calibrations on new CVD diamond detectors
    - For PIN detectors not sure how to scale to DD sensitivity

Work to be done (cont)

- Detectors
  - New detectors are being fabricated by NSTec
    - Different CVD detector Sizes and Element Types
    - Two different detector housings
    - Compare response-time, sensitivity and noise characteristics with present detectors
- Shielding Design
  - Look at MCNP modeling of designs
- How to implement on ZR
  - Develop Proposal for Diagnostic Development
  - Think about Costing for different implementations