NIF Neutron Bang Time Detector Development on OMEGA

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NBT2 scintillator bang time (ps)

NTD bang time (ps)

rms = 54 ps
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NIF neutron bang time detector prototypes have been developed and tested on OMEGA.

- The neutron bang time detector (NBT) diagnostic requirement for the NIF is better than 100-ps accuracy over a yield range from $10^9$ to $10^{16}$ DD and DT neutron yield.
- The proposed solution is a three channel system based on a fast scintillator and CVD diamond detectors.
- Prototypes tested in DD and DT implosions on OMEGA show better than 100-ps timing accuracy, satisfying the NIF specification.
A neutron bang time (NBT) detector is a core/facility diagnostic for the NIF

• The most important requirements developed by the expert group for the NBT on the NIF are
  – the distance from TCC (~ 50 cm),
  – the minimum neutron yield ($1 \times 10^9$),
  – bang time accuracy ($\leq 100$ ps for DD and DT), and
  – dynamic range ($10^9$ to $10^{16}$).

The NIF NBT prototype has been developed and tested on OMEGA, satisfying NIF specifications.
The conceptual design of the NIF NBT prototype housing is simple; it should be able to work at TIM/DIM

- Light-tight thin aluminum cylinder for the scintillator + PMT
- Tungsten alloy shielding with removable front plate
- Two CVD diamonds inside the tungsten shielding
Two scintillator and three CVD-diamond prototypes were tested in re-entrant tubes in the OMEGA target chamber.

- **NBT1 scintillator channel**
  - 11-mm-diam, 3-mm-thick BC-422Q (1%) scintillator
  - Hamamatsu R3809U-52, PMT with two MCP’s, 140-ps rise time
  - PMT gain of $10^5$ and neutral density filter $ND = 1$ (attenuation 10)

- **NBT2 scintillator channel**
  - 17-mm-diam, 3-mm-thick BC-422 scintillator
  - Photek 113, PMT with one MCP, 150-ps rise time, gain 1000

- **CVD diamond channels**
  - CVD1: 10-mm-diam, 1.0-mm-thick wafer
  - CVD2: 5-mm-diam, 0.3-mm-thick wafer
  - CVD3: 2-mm-diam, 0.5-mm-thick wafer

- Scintillators and CVD diamonds were at 75 cm from TCC.
Several different detector housings were tested in the reentrant tube on OMEGA for the NIF NBT prototype.
The infrastructure of the existing LLE NBT detector was used for the NIF NBT prototype tests.
It is possible to calibrate scintillator and CVD diamond channels using a 100-ps laser pulse on a gold target.
The results from the single-stage MCP PMT prototype demonstrate its feasibility for the NIF.

Shot 36100, DD, $Y_n = 3.9 \times 10^{11}$

- When scaled to 50 cm from TCC and with a DD neutron yield of $1.0 \times 10^9$, the scintillator channel of the NIF NBT2 will give a 260 mV signal.
Both scintillator and CVD diamond channels have a bang time accuracy better than 100 ps.

- NBT2 scintillator versus NTD comparison: rms = 54 ps
- CVD1 diamond versus NTD comparison: rms = 59 ps
The internal bang time precision of the NIF NBT prototype CVD diamond channels is about 15 ps.

Shot 37591, DT, $Y = 7.9 \times 10^{13}$

CVD1

CVD2

Signal (V)

Time (ns)

CVD1 – CVD2

Signal (V)

Shot 37590, 37591, 37592, 37594, 37596, 37598, 37900, 37602

rms = 13.6 ps
A very small CVD diamond detector will extend the NIF NBT yield range up to $1 \times 10^{16}$
NIF neutron bang time detector prototypes have been developed and tested on OMEGA

- The neutron bang time detector (NBT) diagnostic requirement for the NIF is better than 100-ps accuracy over a yield range from $10^9$ to $10^{16}$ DD and DT neutron yield.

- The proposed solution is a three channel system based on a fast scintillator and CVD diamond detectors.

- Prototypes tested in DD and DT implosions on OMEGA show better than 100-ps timing accuracy, satisfying the NIF specification.