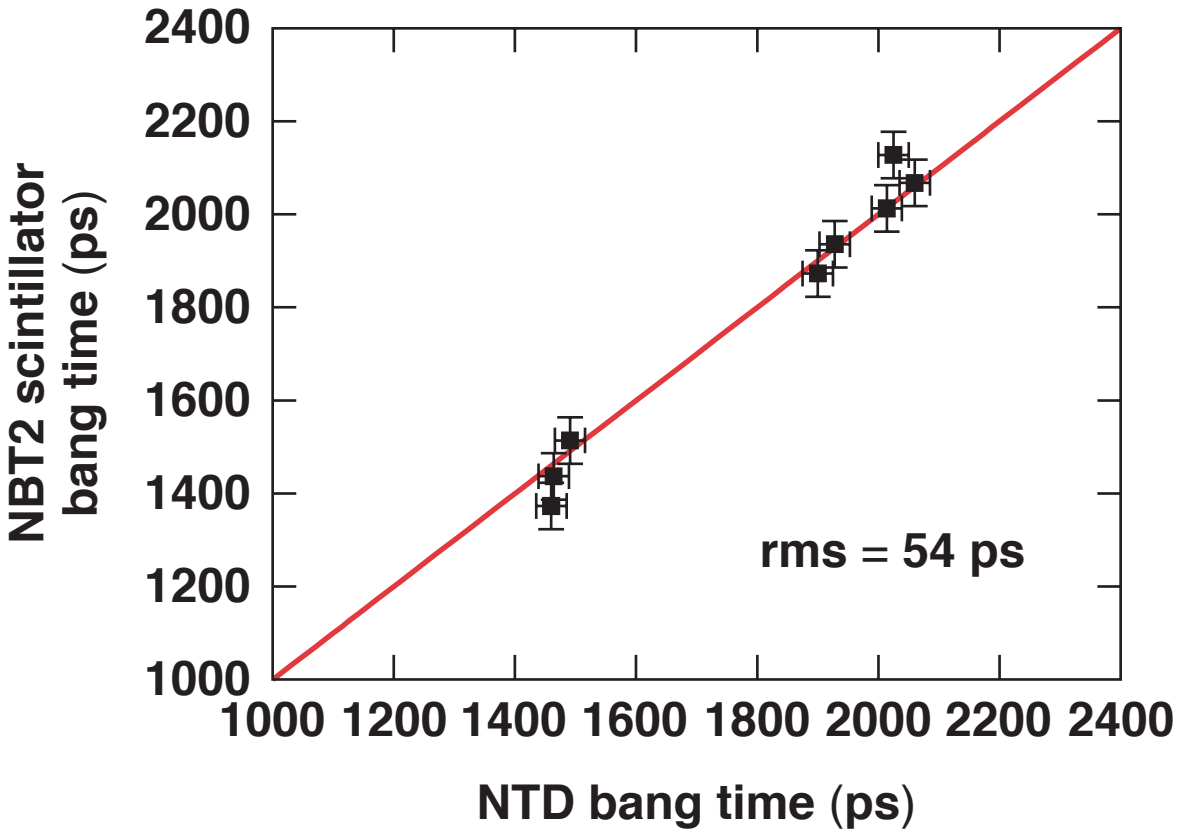
NIF Neutron Bang Time Detector Development on OMEGA



V. Yu. Glebov
University of Rochester
Laboratory for Laser Energetics

46th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Savannah, GA
15–19 November 2004

Contributors

C. Stoeckl, T. C. Sangster, C. Mileham, and S. Roberts

Laboratory for Laser Energetics
University of Rochester

R. A. Lerche

Lawrence Livermore National Laboratory

Summary

NIF neutron bang time detector prototypes have been developed and tested on OMEGA

UR LLE

- 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

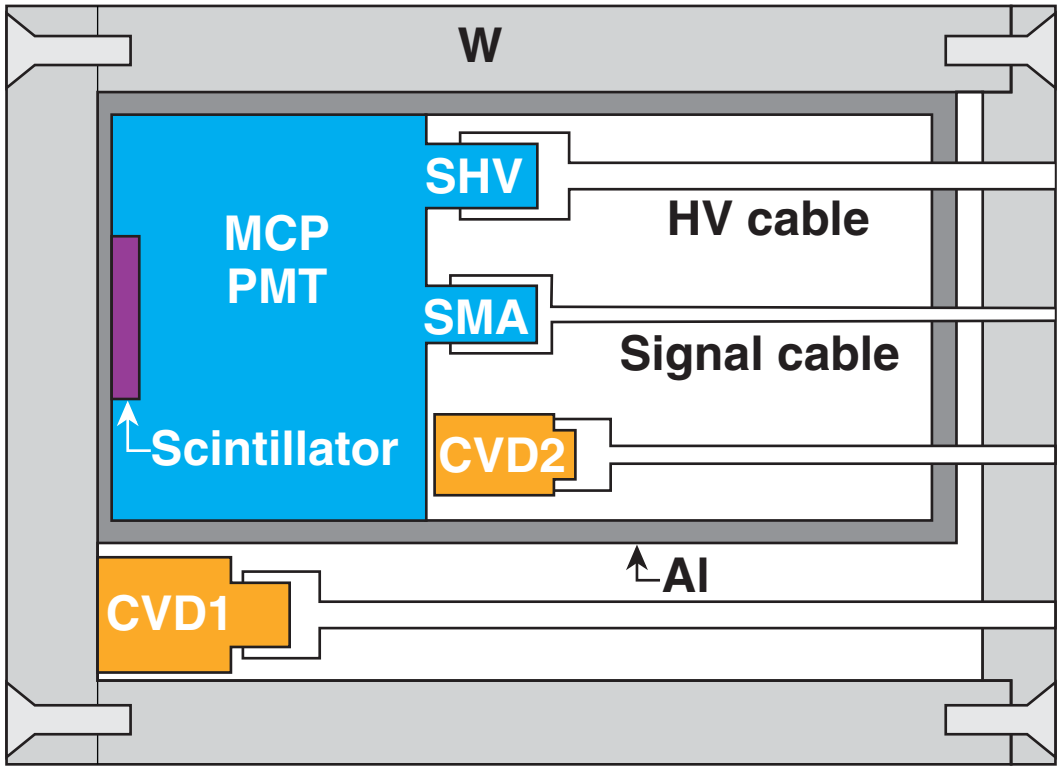
UR LLE

- 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 (1×10^9),
  - bang time accuracy ($\leqslant$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



E13412

Two scintillator and three CVD-diamond prototypes were tested in re-entrant tubes in the OMEGA target chamber

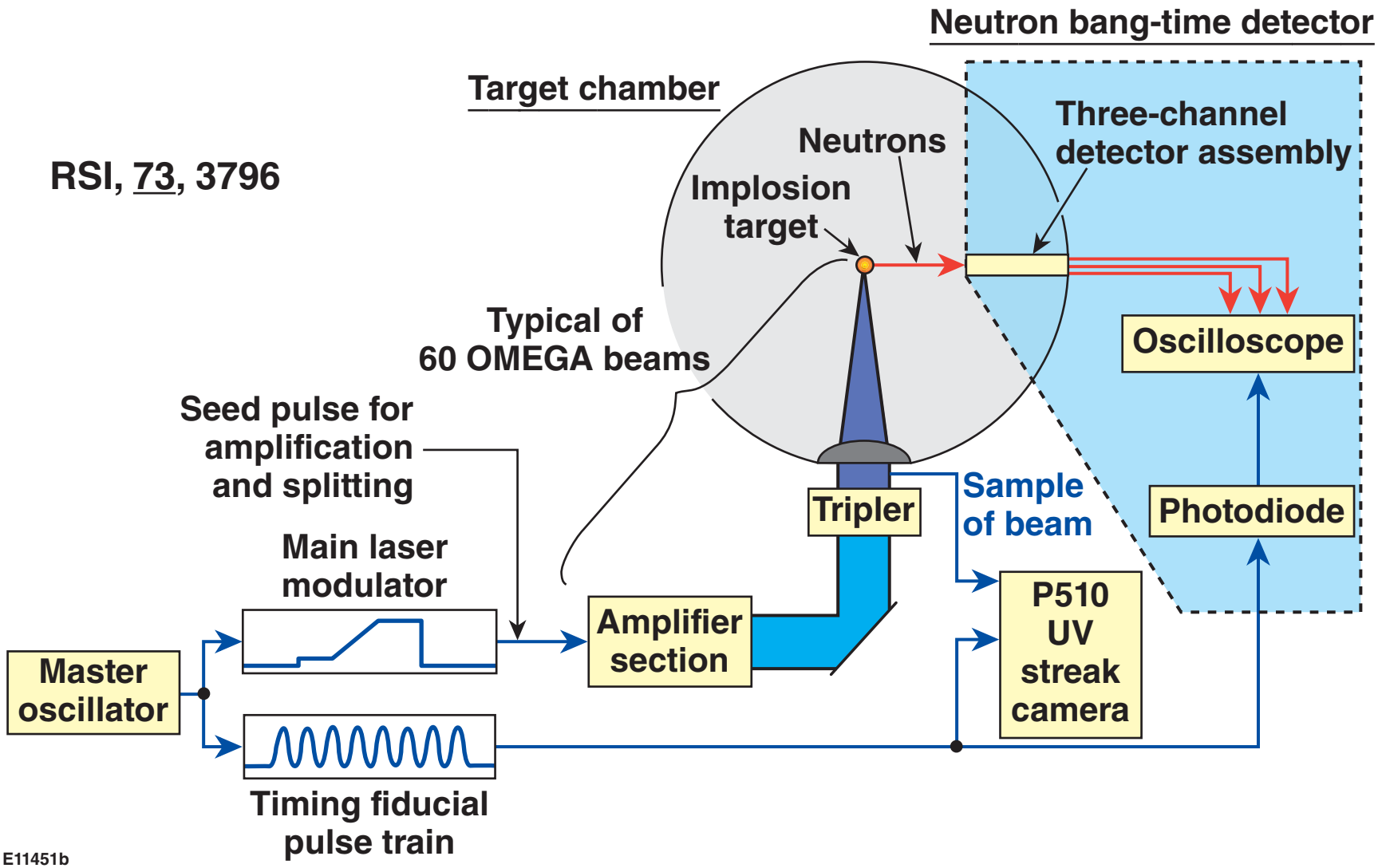
UR LLE

- 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.

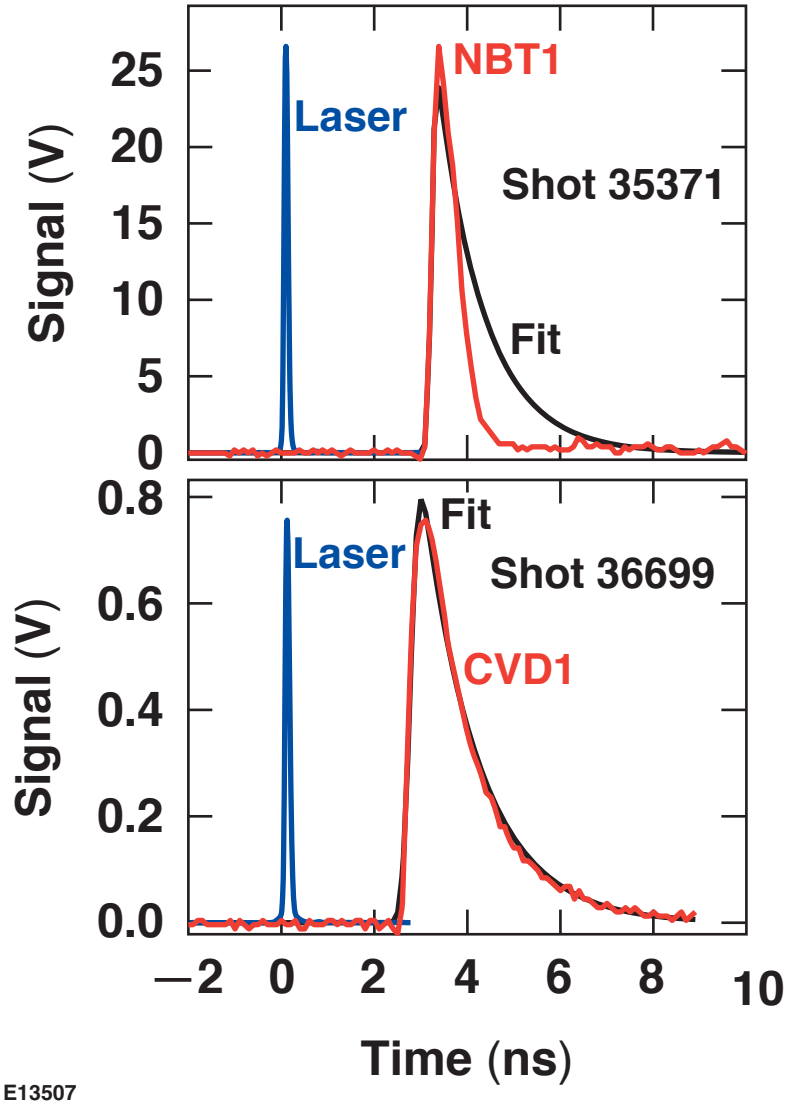
Several different detector housings were tested in the reentrant tube on OMEGA for the NIF NBT prototype

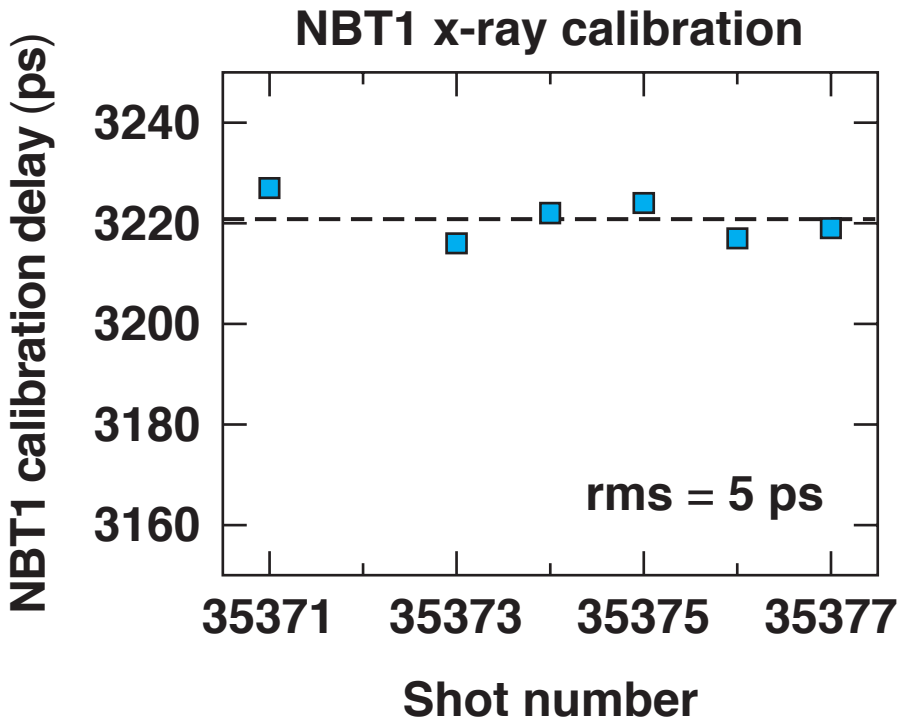
UR
LLE

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



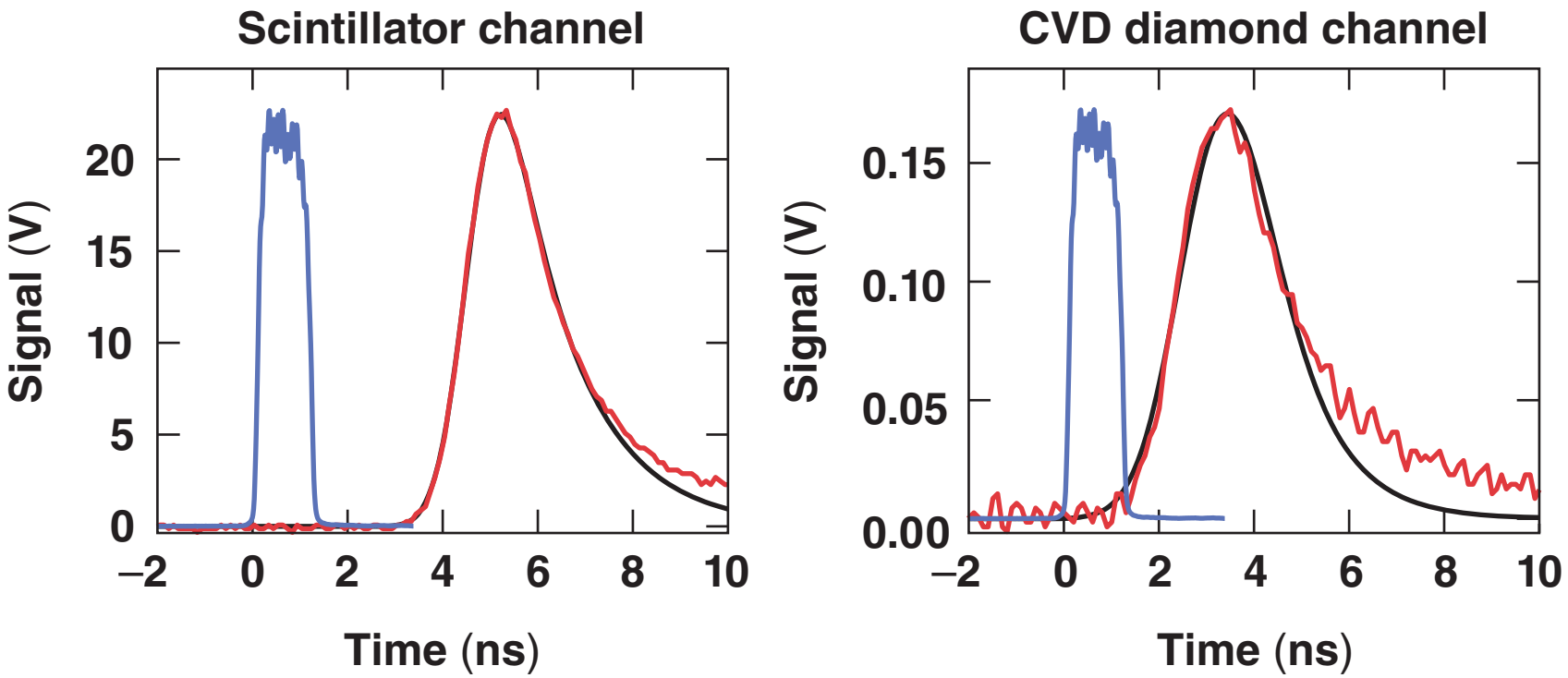


E13507

The results from the single-stage MCP PMT prototype demonstrate its feasibility for the NIF

UR LLE

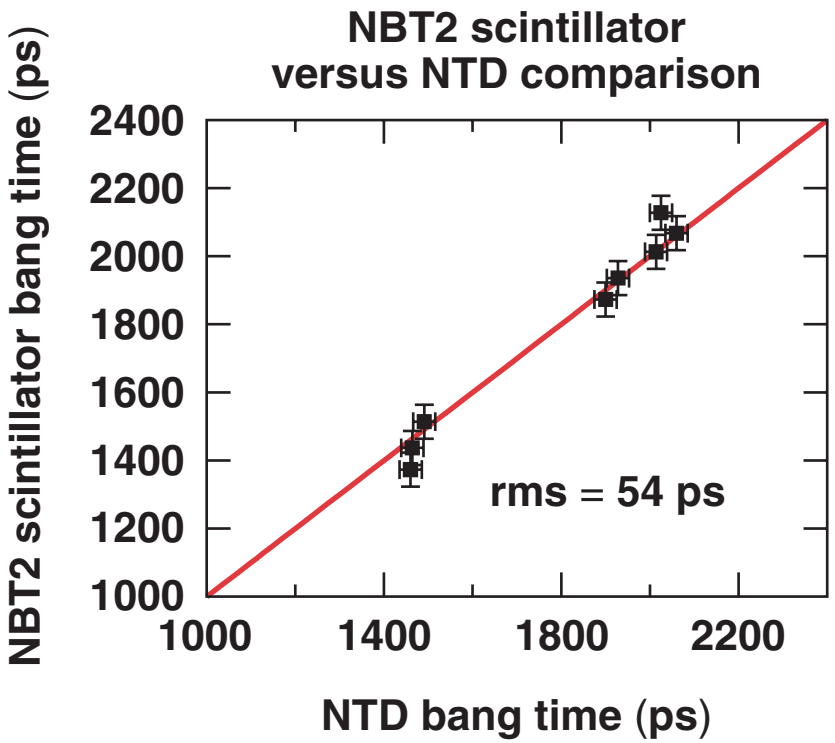
Shot 36100, DD, $Y_n = 3.9 \times 10^{11}$

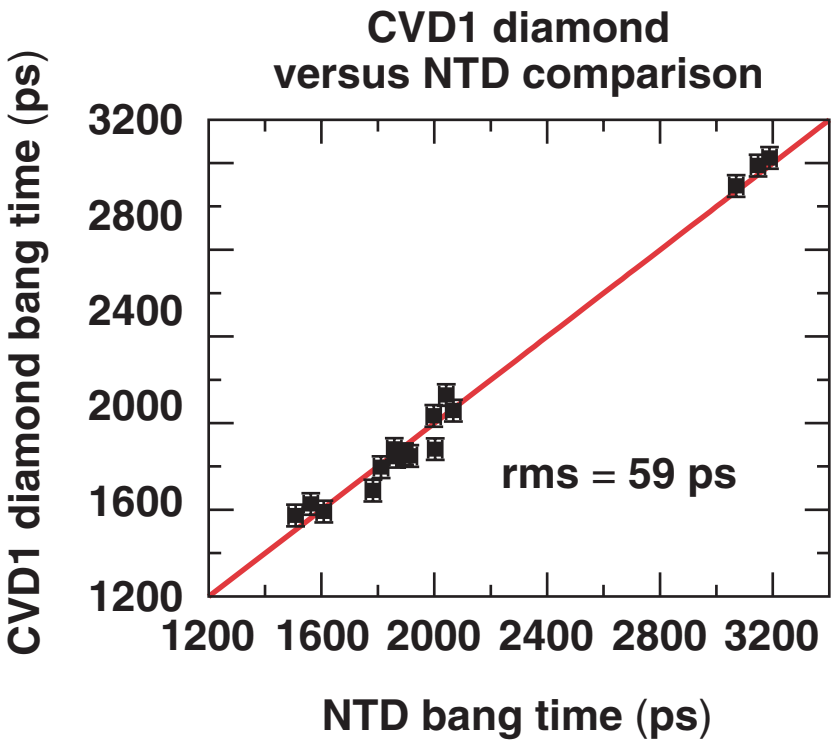


- When scaled to 50 cm from TCC and with a DD neutron yield of 1.0×10^9, the scintillator channel of the NIF NBT2 will give a 260 mV signal.

E13145

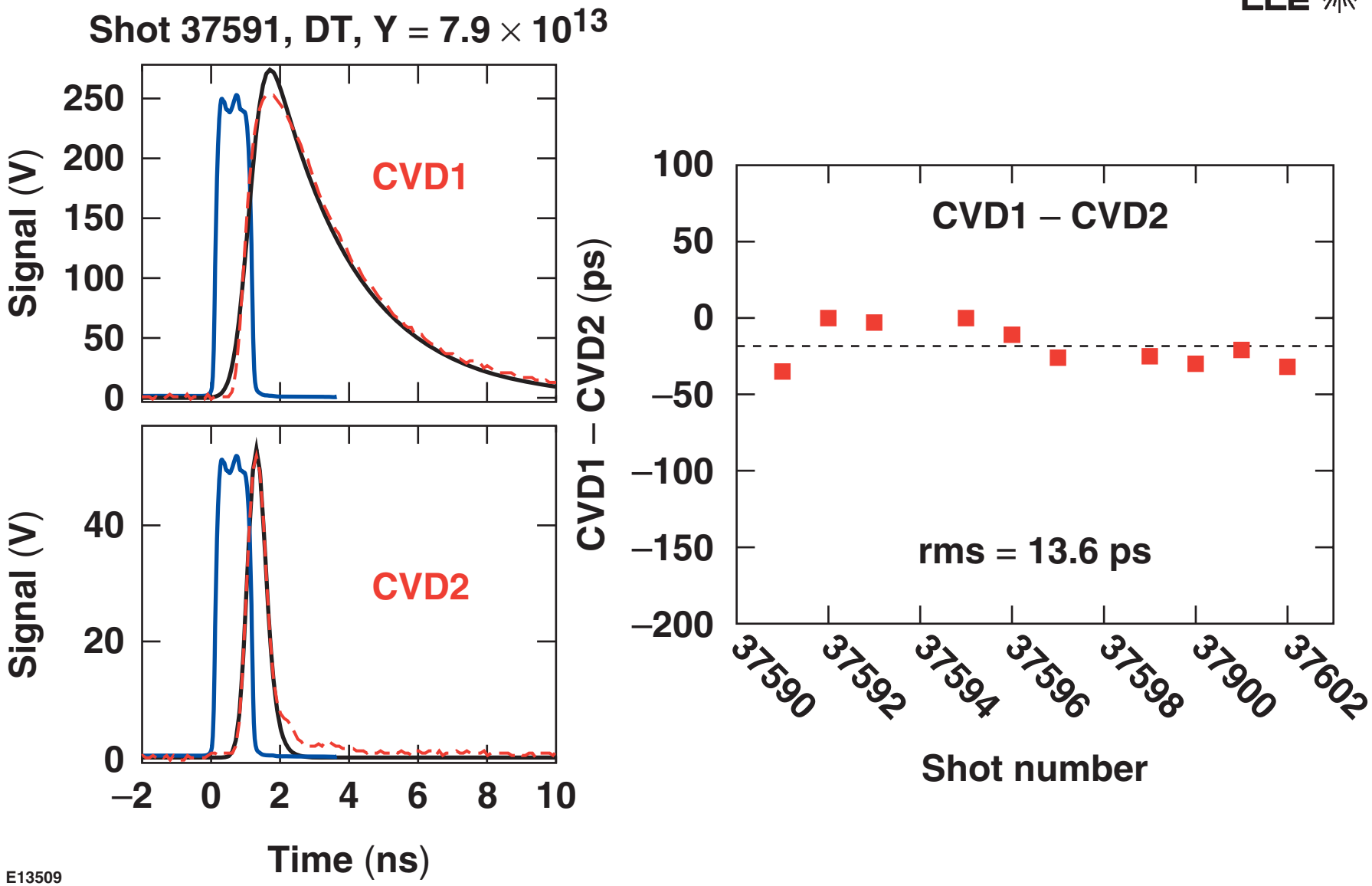
Both scintillator and CVD diamond channels have a bang time accuracy better than 100 ps





E13508

The internal bang time precision of the NIF NBT prototype CVD diamond channels is about 15 ps

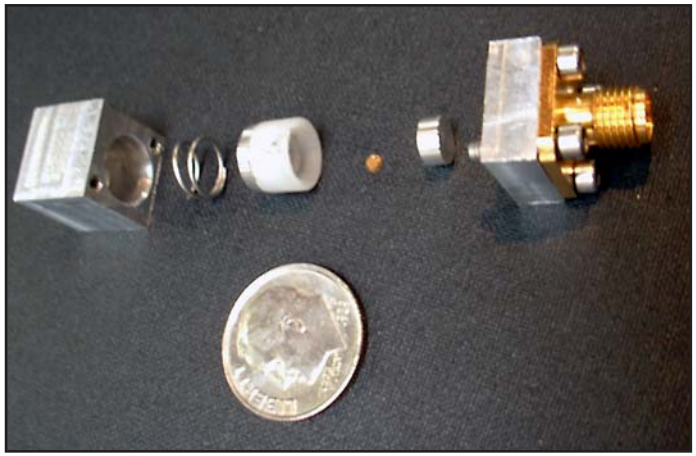


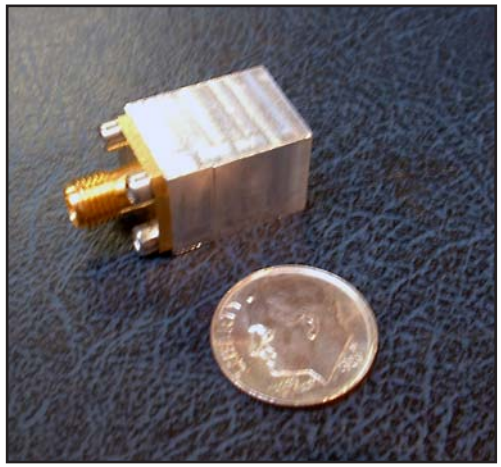
E13509

A very small CVD diamond detector will extend the NIF NBT yield range up to 1×10^{16}

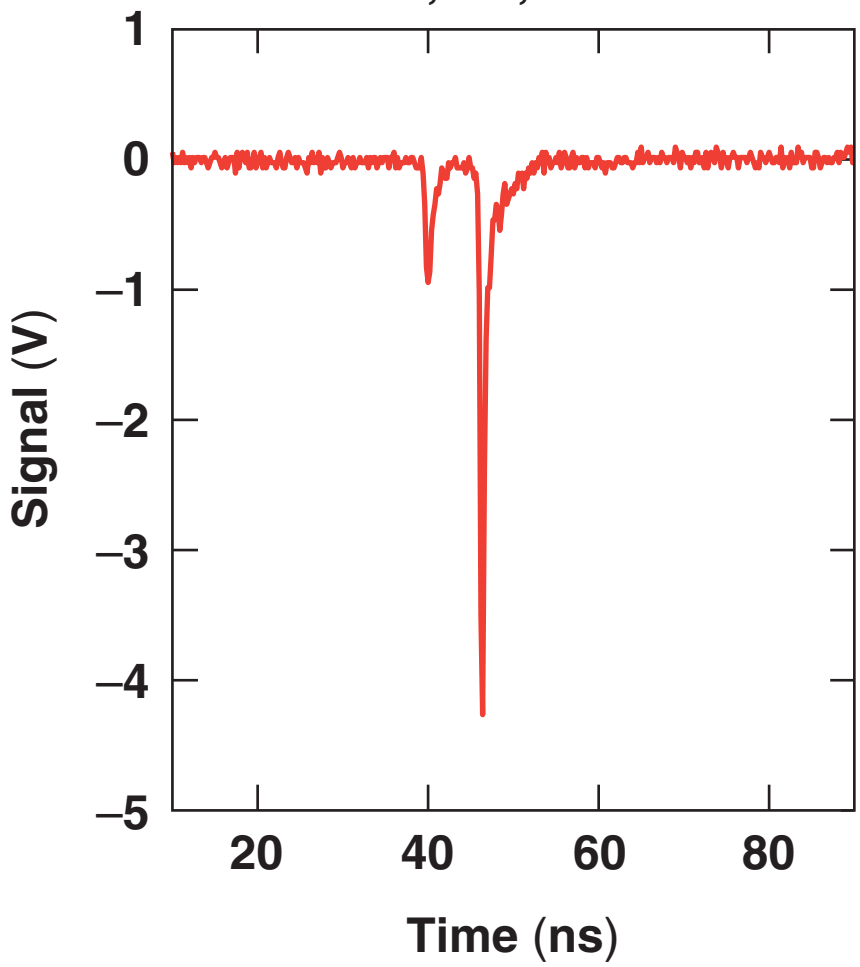
UR LLE

CVD3, 2-mm-diam, 0.5-mm-thick





Shot 37600, DT, Y = 7.7×10^{13}



E13510

Summary/Conclusions

NIF neutron bang time detector prototypes have been developed and tested on OMEGA

UR LLE

- 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.