Dante 1 Data Recording Upgrade

NIF Target Diagnostics

CEA-NNSA Joint Diagnostic Meeting

June 29-30, 2016

Bart Beeman
Absolutely calibrated soft x-ray power diagnostics are essential for understanding ICF/HED Hohlraum Physics

- Multi-Channel X-ray Diode Arrays
  - NIF (LLNL): Dante 1 & 2
  - LMJ (CEA): DMX
  - Omega (LLE): Dante & DMX

- Transmission Grating Systems
  - Z (SNL)
  - NIKE (NRL)

- Often these are costly to run/maintain
  - Filter damage/replacement, Spectral calibrations, Oscilloscope calibration

- We have upgraded the NIF Lower Dante-1 (143-274) recording system with modern digitizers to reduce the cost of maintaining calibrations

- Modern digitizers also offer improved diagnostic performance:
  - More accurate and stable calibration
  - Reduced Tr uncertainty
SCD5000 Analog Scopes have been replaced with Keysight 10bit Digital Scopes

The system will also incorporate Dry Run test Signals as well as Calibration Verification test signals all Remotely Controllable
An enabling technology: CEA developed “Clipper” protects the Keysight inputs (240v shot data shown)

Keysight saturated at 3.5v (500mv/div) but clipper cut it down to <5v (with 12db before splitter - Test data support this for ~200ps duration)

~400x down from Peak
Implies ~230v at clipper
(est. from ch11 scaling = 240v)

Clipper to XRD and back to Keysight?
(Typical clipper waveform)
The SOURIS Signal Chassis will provide in-situ Calibration Verification – Another CEA contribution.
Vertical sensitivity tests of SCD5000 and Keysight shows a systematic offset

- Dynamic calibrations (pulsed square-wave) show there is on average a systematic 5.8±1.6% over-measurement.

- Re-analysis of N150528-002-999 (H_CVal_DT_Sym_S05) shows this corresponds to about 5.5% reduction in peak flux or about 5eV in peak Tr.

- Dynamic calibrations are 6.5±3.1% higher than the DC calibrations, if these effects are coupled then this offset may have always existed. Scopes move around from channel-to-channel, so this will effect the way the flux is unfolded in a more random way.
Increased Bandwidth (4Ghz – Flat Magnitude DSP) Reveals Missed Features

SCD 18 vs Keysight - N1506029-001-999

Laser pulse stitch point (4ns after initial rise)

Drawbridge shot utilizing staggered laser pulses

SCD_corr_N150629_001
Keysight 4 Ghz Flat Mag

Note "step" in leading edge not observed on SCD (Keysight set up for clipper study thus high noise)
Adjustable V/div on Keysight allows the ENOB to meet or exceed SCD ENOB

- Dynamic range advantage is significant for hard x-ray data where signals tend to be lower

- Higher dynamic range is important for resolving trough and peak on the same shot – important for low adiabat implosions
Timebase Improved with Keysights

From Keysight S-Series manual
- Best-in-industry time scale accuracy of 12 parts per billion after calibration for accurate deep-memory measurements
- Low jitter measurement floor with 100 fs (typical) of intrinsic jitter

SCD5000 timebase is not stable with time nor temperature
FTD10000 has same issue to lesser extent
System Interconnect Block Diagram (Phase 2)

Controllable Attenuators

Delay Chassis

IN 1
Out 1A
Out 1B

Ch1
Ch2
Ch3
Ch4

AUX Trig In
BNC – SMA
(Non precision)

Ch1
Ch2
Ch3
Ch4

AUX Trig In
BNC – SMA
(Non precision)
First Shot data!
Sunday 6/27/2016
Summary

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- Other systems:
  - NIF (LLNL): Dante-2 (64-350) – upgrade planned in 2017
  - LMJ (CEA): DMX – already uses modern digitizers
  - Omega (LLE): Dante – is there user demand to upgrade recording system?
Thank you very much for your contributions to this project!