

Dante 1 Data Recording Upgrade

NIF Target Diagnostics

CEA-NNSA Joint Diagnostic Meeting

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June 29-30, 2016



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

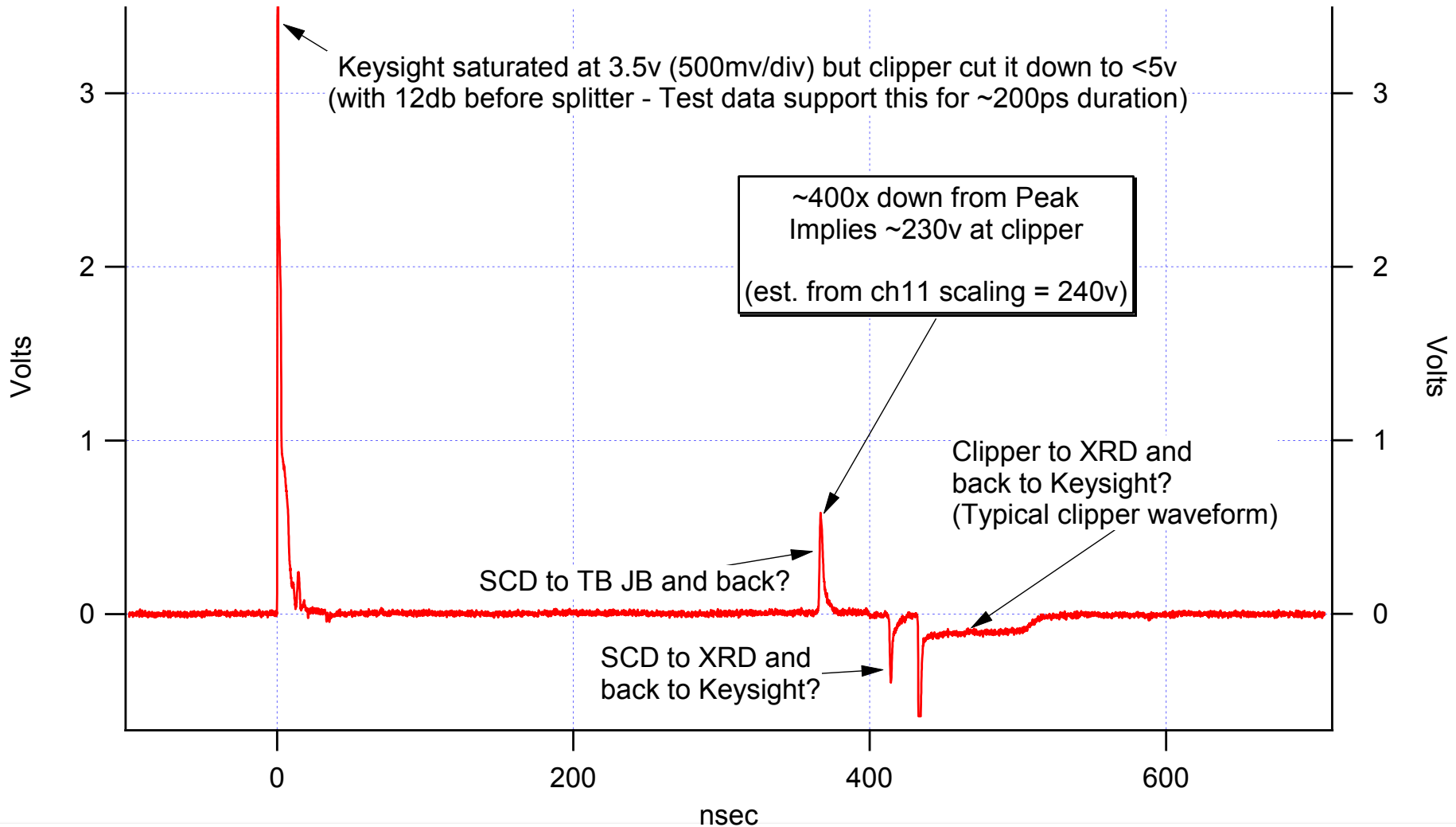
— Reduced Tr uncertainty

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)



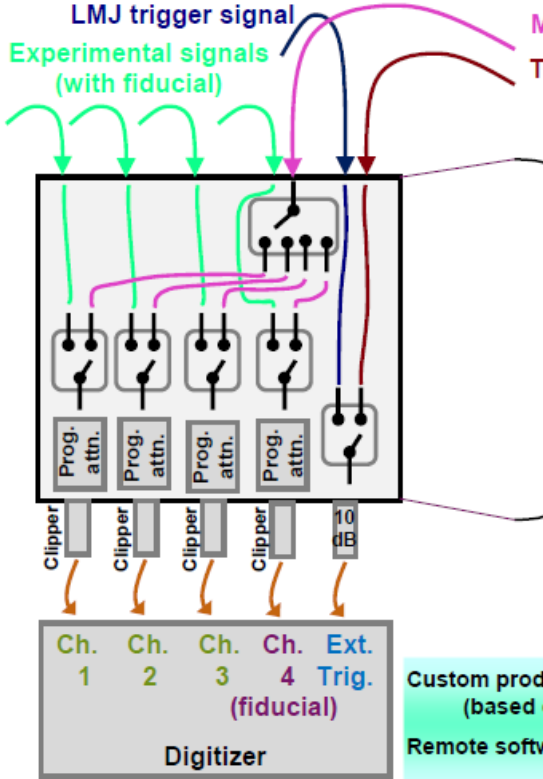
The SOURIS Signal Chassis will provide insitu Calibration Verification – Another CEA contribution



Automated *in situ* metrology for electrical acquisition chains, 1st chassis for attenuation and distribution

LMJ trigger signal

Experimental signals
(with fiducial)



Ch. 1 Ch. 2 Ch. 3 Ch. 4 Ext. Trig. (fiducial)


Digitizer

Metrology stimuli

Trigger signal for metrology

MACAQUE chassis

Module d'Atténuation, de Contrôle
Automatisé
et de Qualification Électrique



Requirements

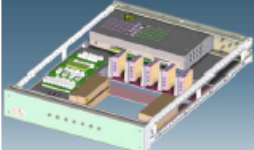
- Programmable attenuator (0 to 60 dB by 20 dB step)
- Transient overvoltage resistant
- Switching exp. vs metro. signals
- Remote control by LAN
- Small size
- HF & timing specifications

Product's specifications

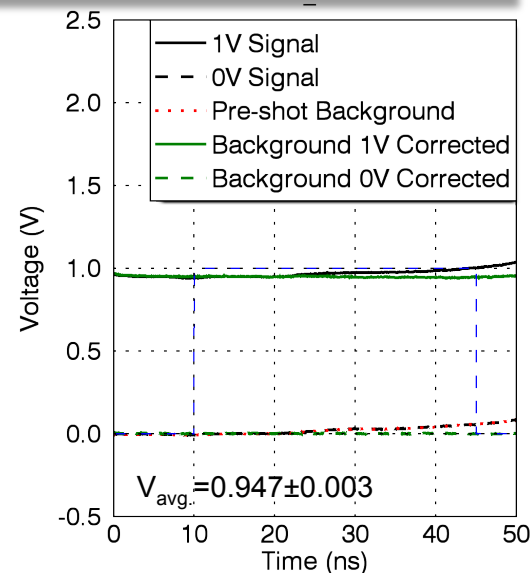
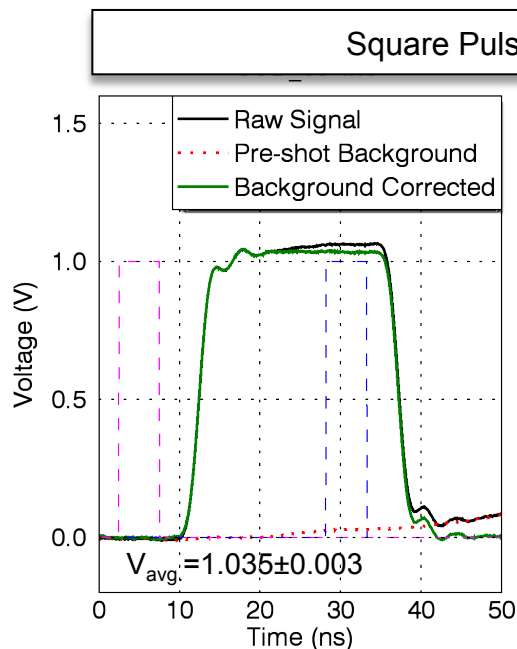
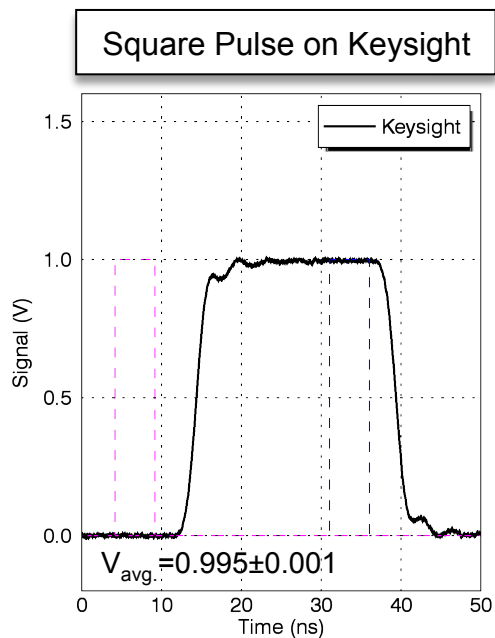
- COTS
- (0 to 70 dB by 10 dB step)
- OK (unitary components tested by CEA)
- OK (switch HF)
- OK
- 2U (19-inch chassis)
- Analog bandwidth > 10 GHz
- Low insertion loss
- SWR < 1.2:1 [DC – 10 GHz]
- Ch-to-Ch skew < 2 ps (typical skew 4.35 ns)

Custom product made by Keysight Technologies in 2014 (based on L4490A RF switch matrix platform + COTS)

Remote software developed in Python/Tango by Thales/Nexeya



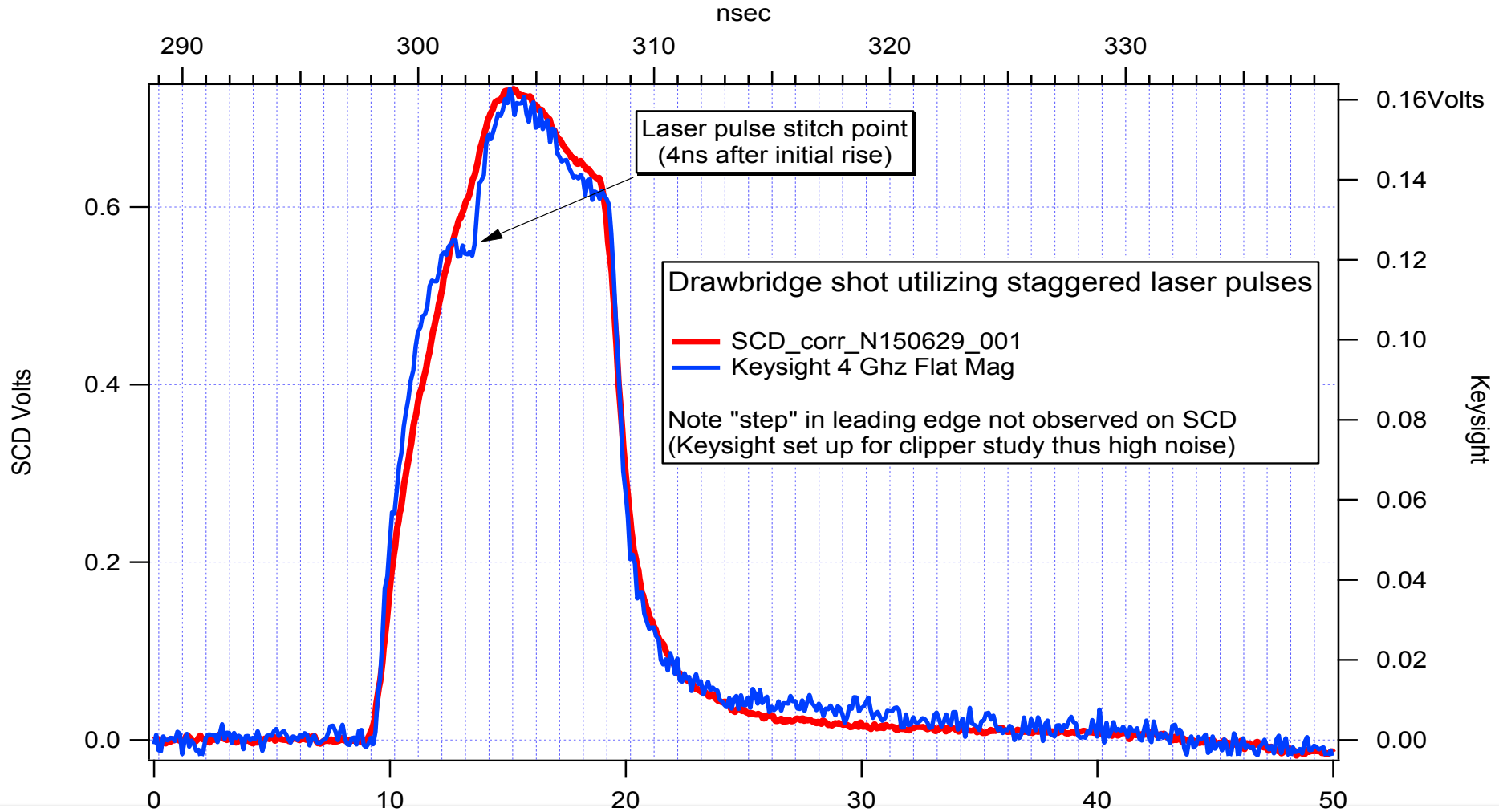
Vertical sensitivity tests of SCD5000 and Keysight shows a systematic offset



- Dynamic calibrations (pulsed square-wave) show there is on average a systematic $5.8 \pm 1.6\%$ 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 $6.5 \pm 3.1\%$ 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.

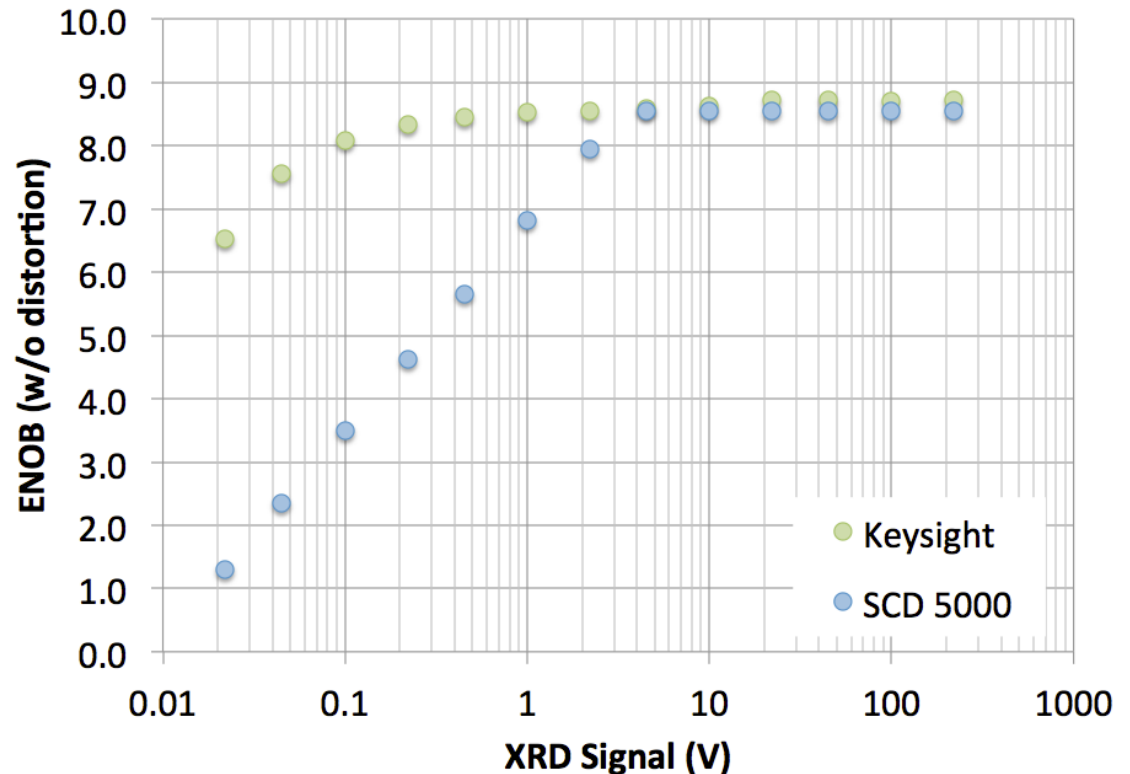
Increased Bandwidth (4Ghz – Flat Magnitude DSP) Reveals Missed Features

SCD 18 vs Keysight - N1506029-001-999



Adjustable V/div on Keysight allows the ENOB to meet or exceed SCD ENOB

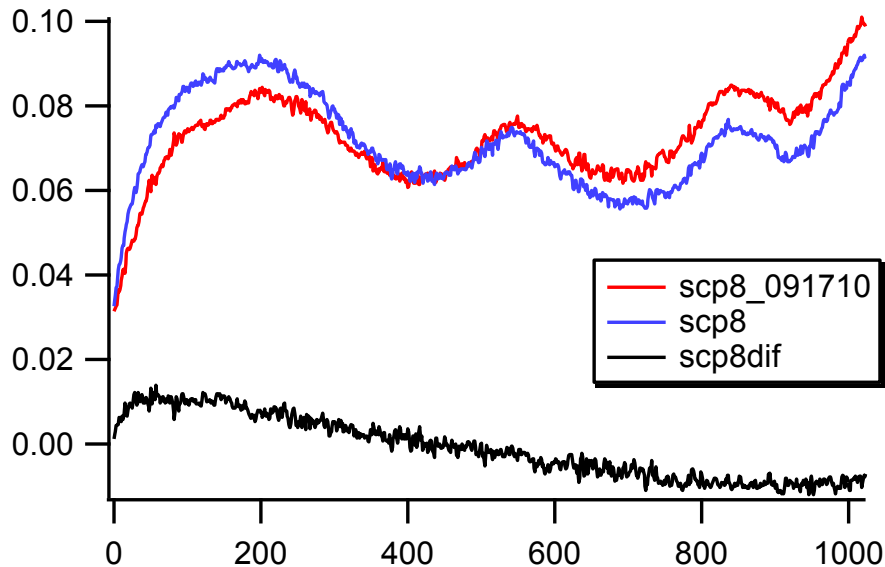
- Dynamic range advantage is significant for hard x-ray data where signals tend to be lower
- Higher dynamic range is important for resolving trough and peak on the same shot – important for low adiabat implosions



Timebase Improved with Keysights

From Keysight S-Series manual

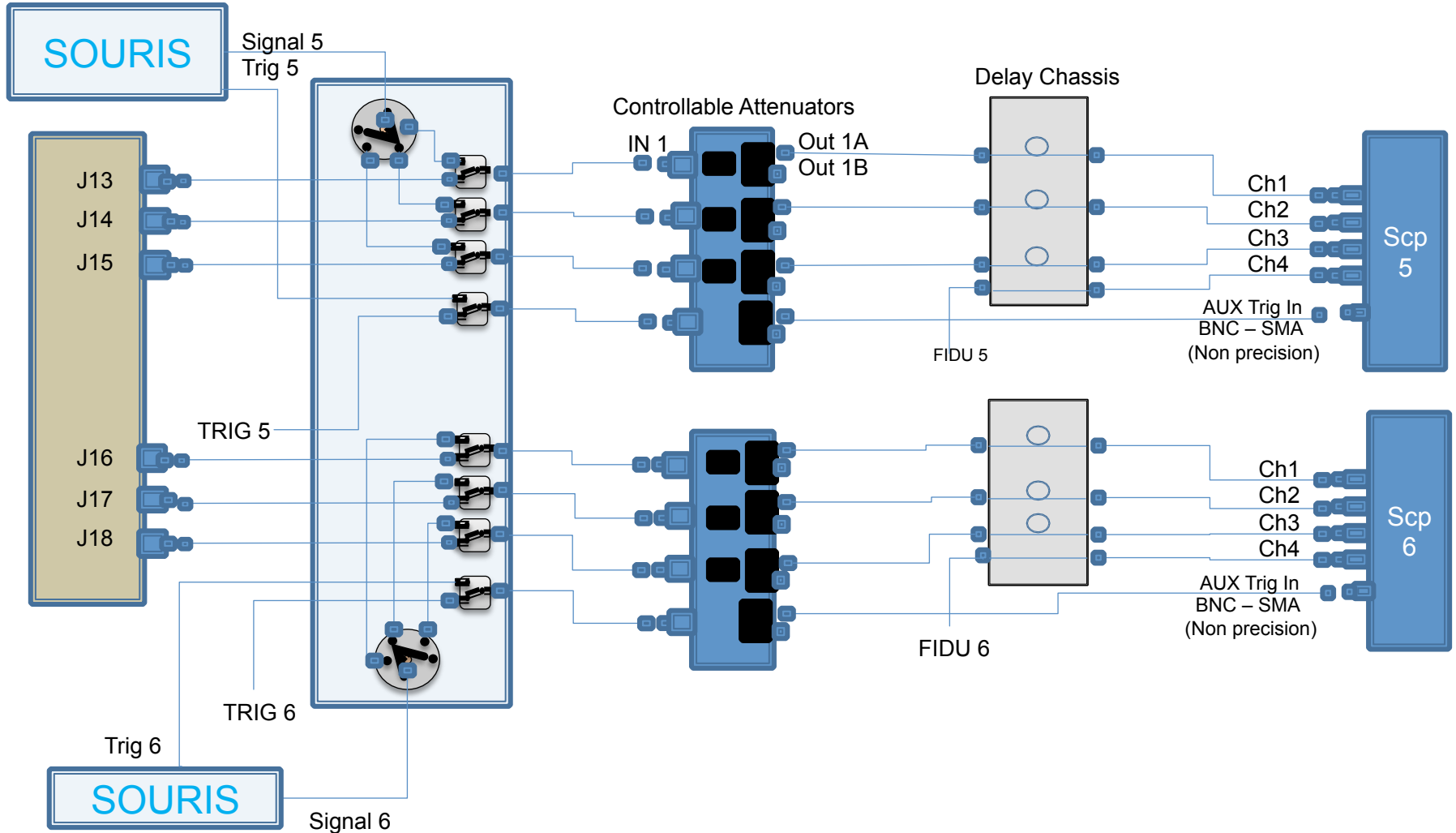
- Best-in-industry time scale accuracy of **12 parts per billion** after calibration for accurate deep-memory measurements
- Low jitter measurement floor with 100 fs (typical) of intrinsic jitter



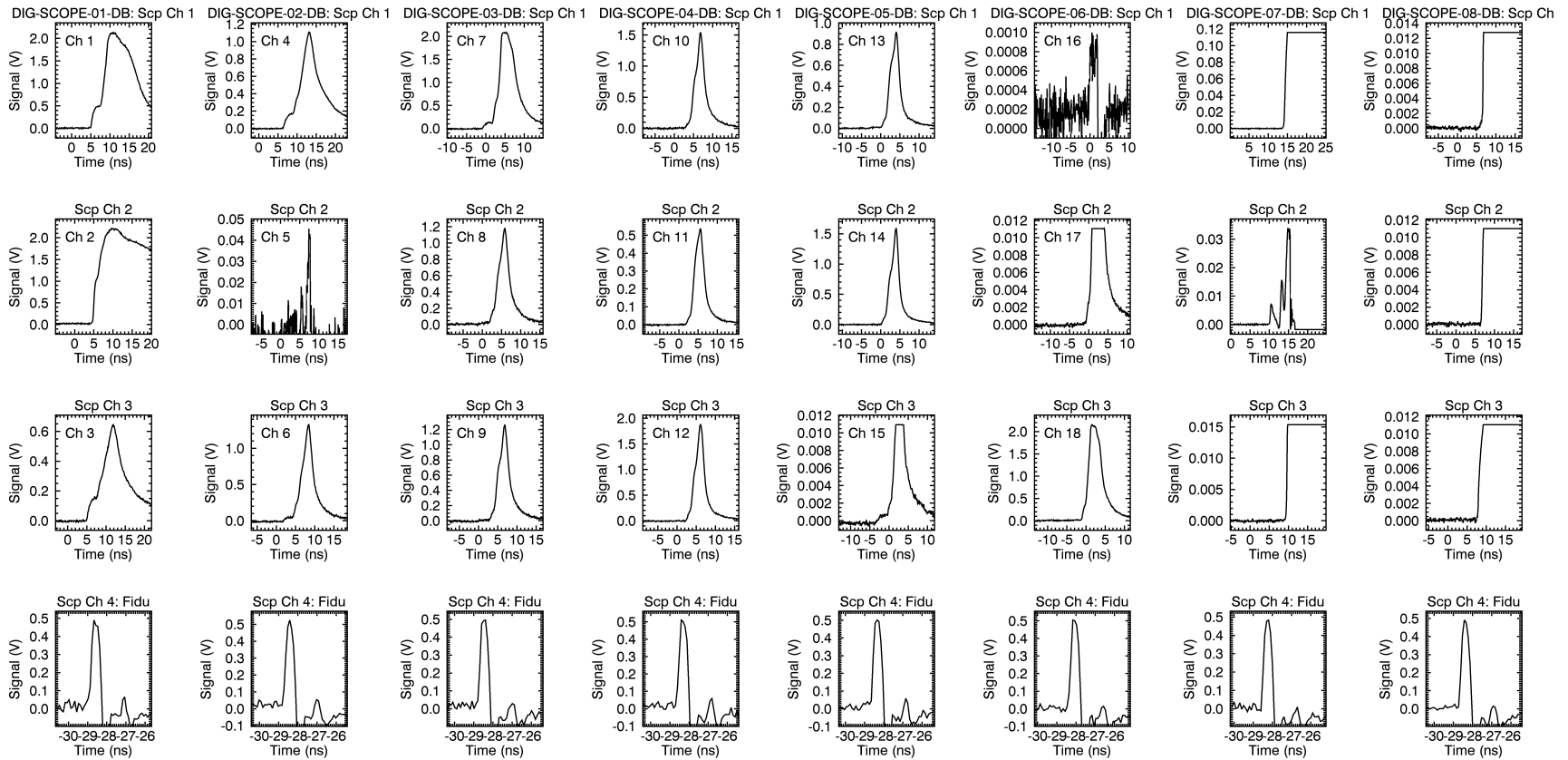
SCD5000 timebase is not stable with time nor temperature

FTD10000 has same issue to lesser extent

System Interconnect Block Diagram (Phase 2)



First Shot data! Sunday 6/27/2016



Summary

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



