



The Role of Data Driven Models in Optimizing the Operation of the National Ignition Facility

**Presentation to
14th International Conference on Accelerator & Large
Experimental Physics Control Systems (ICALEPCS)
October 6-11, 2013**

Kathleen McCandless

NIF Laser performance modeling is a team effort, led by Brian MacGowan

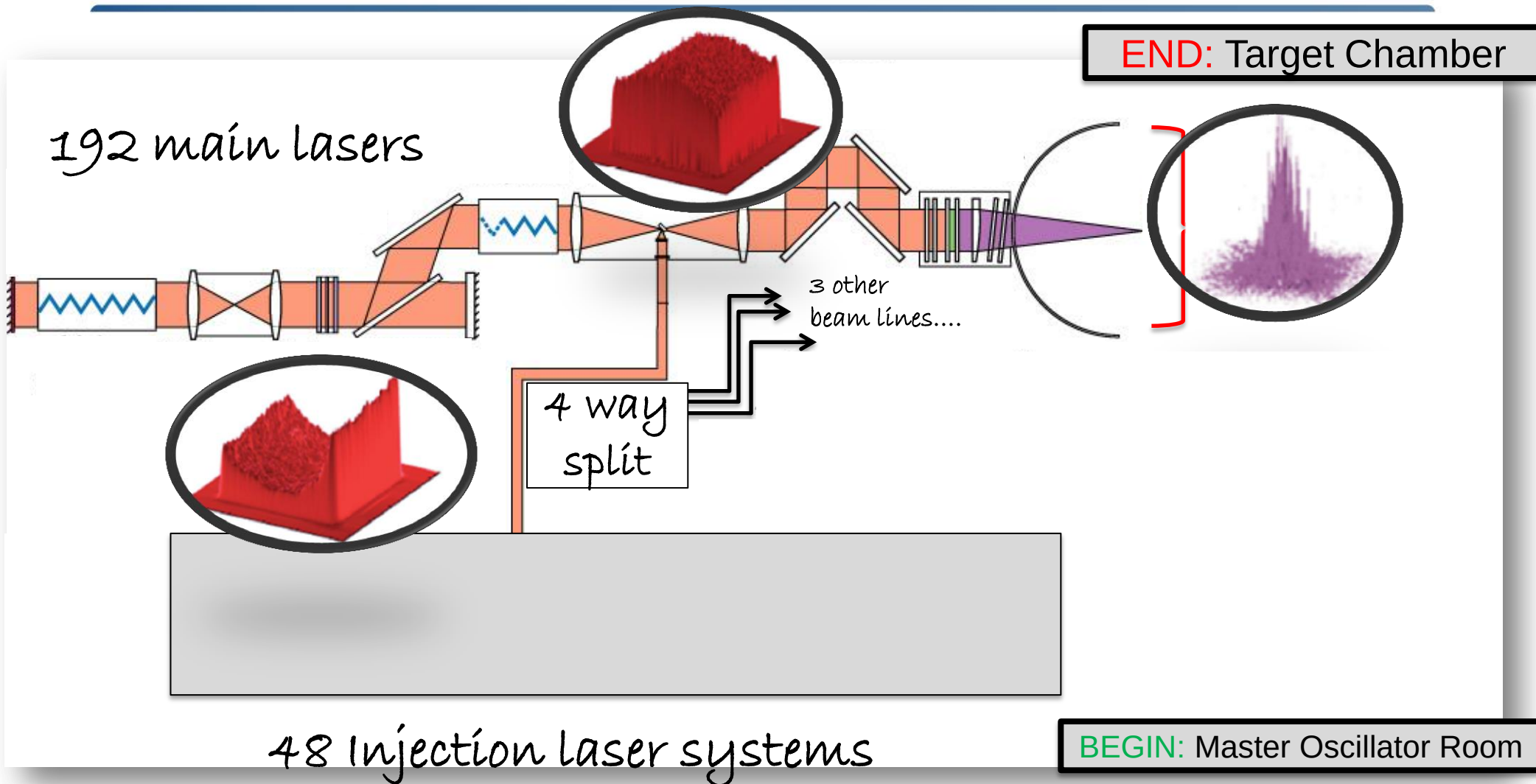
Brian MacGowan 	Jean-Michel Di Nicola 	Sham Dixit 	Eyal Feigenbaum 	Ron House 
	Ken Jancaitis 	Kai La Fortune 	Kathleen McCandless 	Charles Orth 
Program Leader	Rick Sacks 	Mike Shaw 	Clay Widmayer 	Steven Yang 

The National Ignition Facility

August 13th, 2013, 1.7MJ shot, we achieved the highest DT neutron yield, estimated at nearly 3×10^{15} (three quadrillion!)



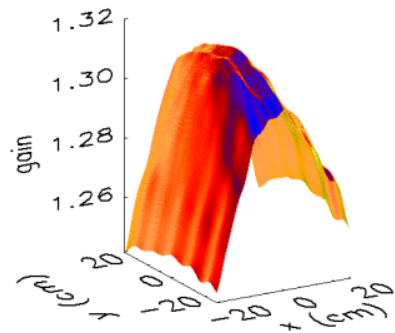
To deliver an accurate energy and pulse shape, we require a physics based simulation engine



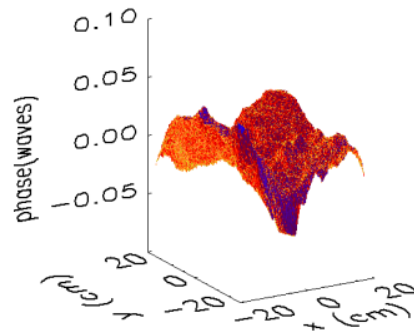
To achieve the desired pulse shape at the target chamber center **A**, we use a laser performance operations model (**LPOM**) to derive the input pulse shape **B**

LPOM provides the Virtual Beam Line (VBL) code with quantitative measurements from laser components

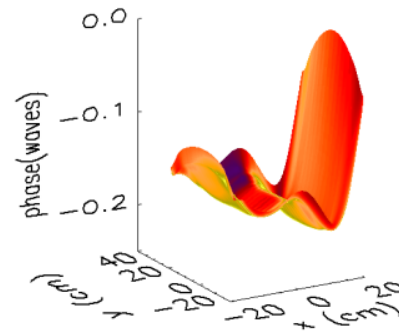
Gain Profiles



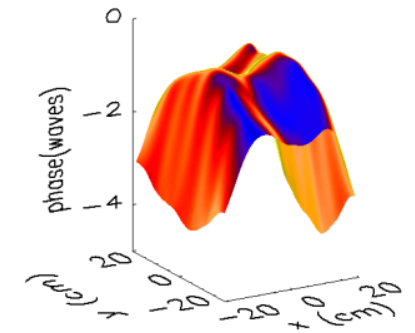
Optical Aberrations



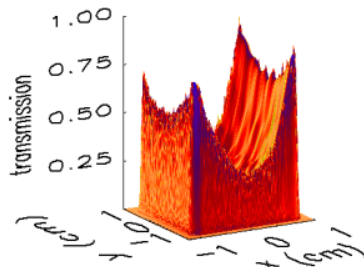
Thermal Distortions



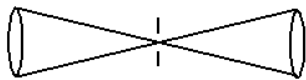
Wavefront Control



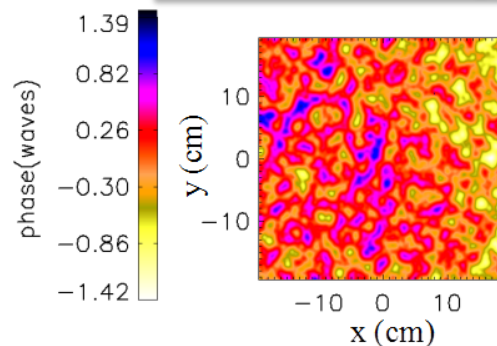
Beam-shaping Masks



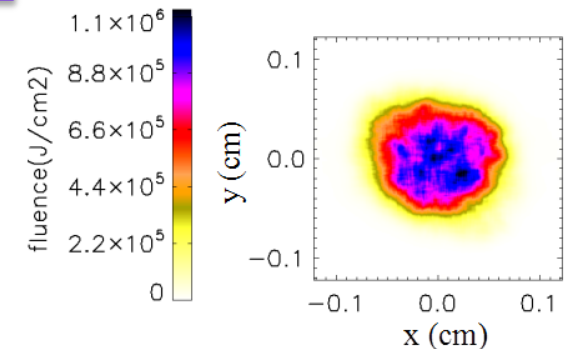
Spatial Filtering



Focal-spot Conditioning



Final Focus

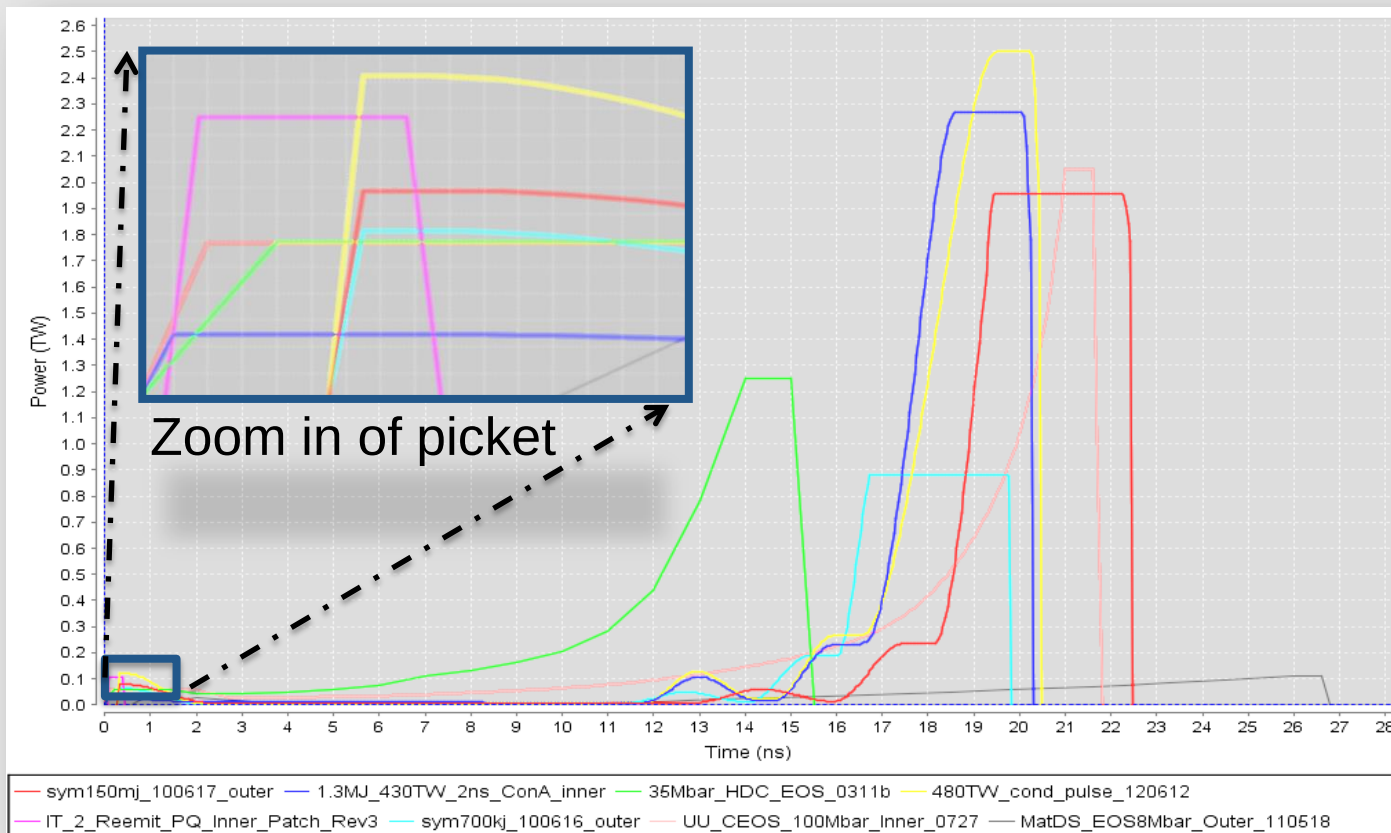


The **Virtual Beam Line** code simulates laser physics including: Frantz-Nodvik gain amplification, diffraction, nonlinear effects such as self focusing, and frequency conversion



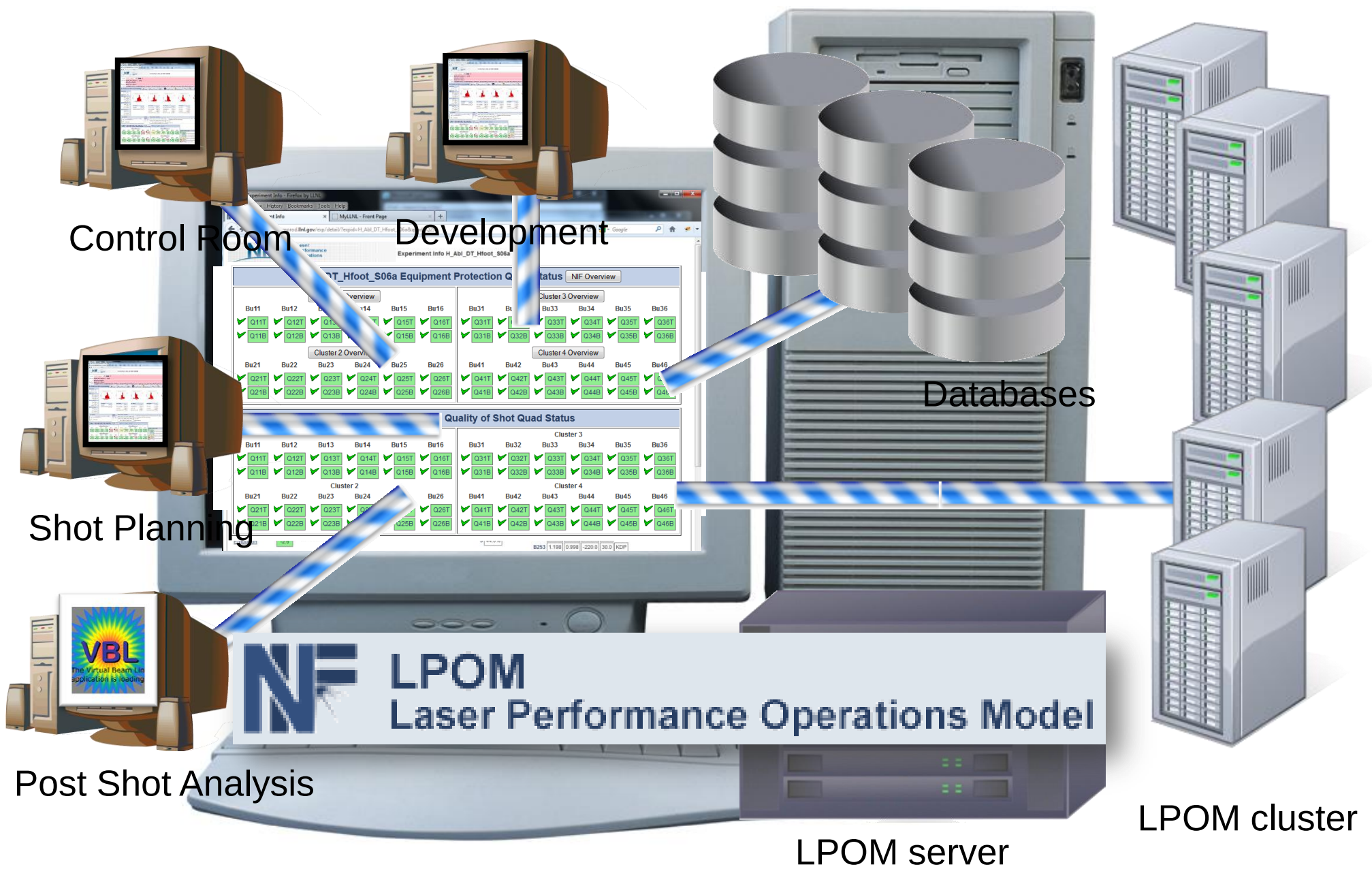
Delivering the pulse shape requires a detailed laser energetics model which is provided by LPOM

NIF operations require precisely specified energy waveforms from 192 beams for a variety of pulse lengths and temporal shapes



We need to be operate at very high energy and power, but with low risk of optical damage

The Laser Performance Operations Model is used for planning, executing and interpreting each experiment

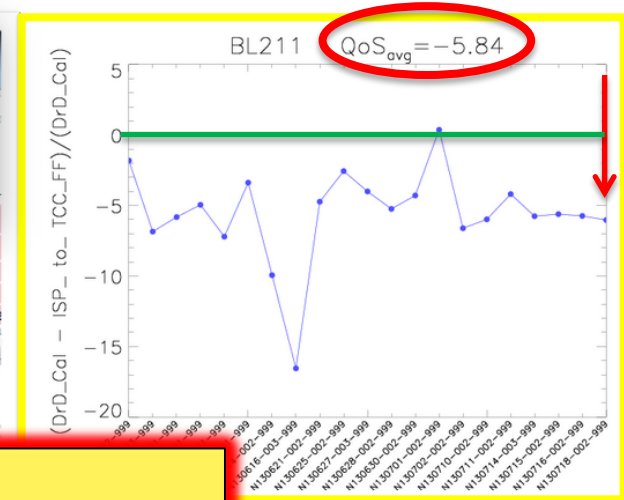




Shot performance is tracked with a dashboard web interface and the ability to drill into beamlines and quads.

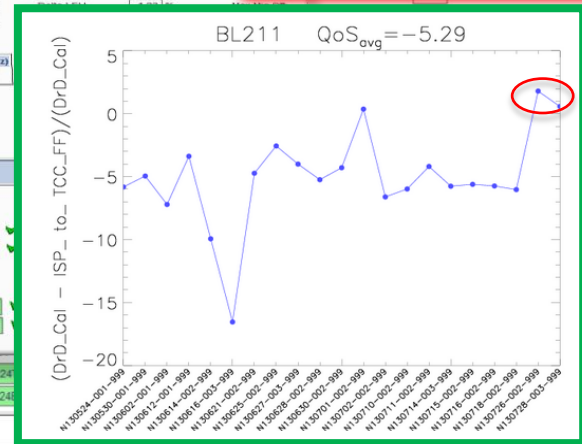
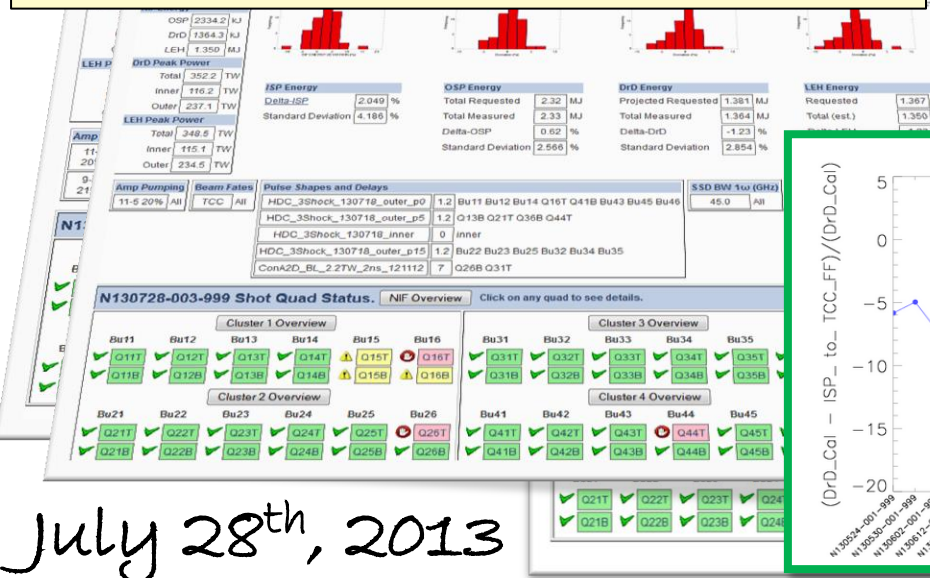
July 18th, 2013

BEAM	OSP (%)	TCC (%)	DDS (%)	Trend
B211	-1.75	-5.61	99.50	



Metric: measured – requested energy
OSP: Output Sensor Package
TCC: Target Chamber Center

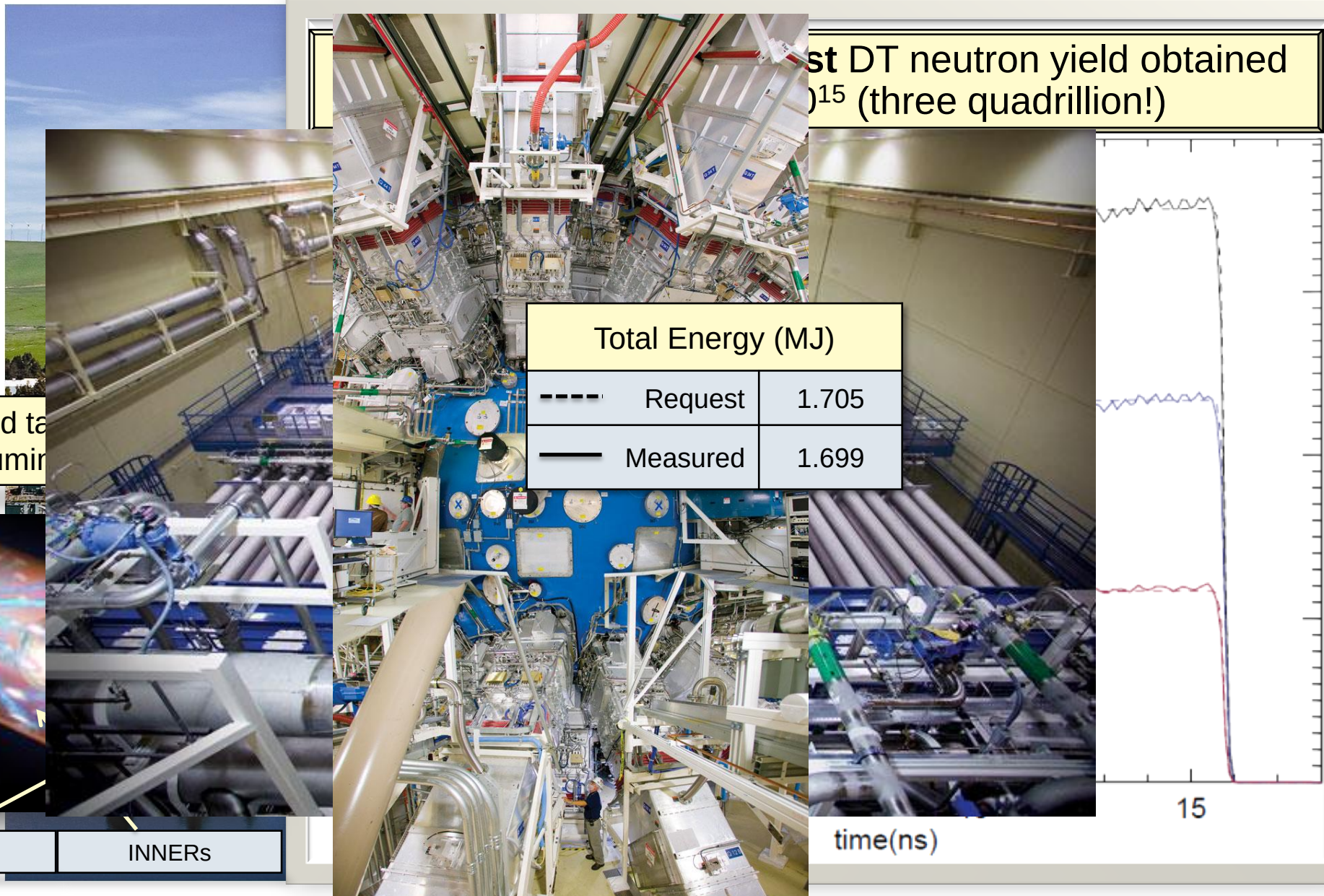
July 19th 2013:
 BL211 3w model adjusted



July 28th, 2013

Quality of shot **trending over time** by beamline is critical to adjusting dynamic laser performance to accurately deliver all 192 pulses

Our live physics model of the laser (LPOM/VBL) is key to our ability to deliver continued success!



NIF

