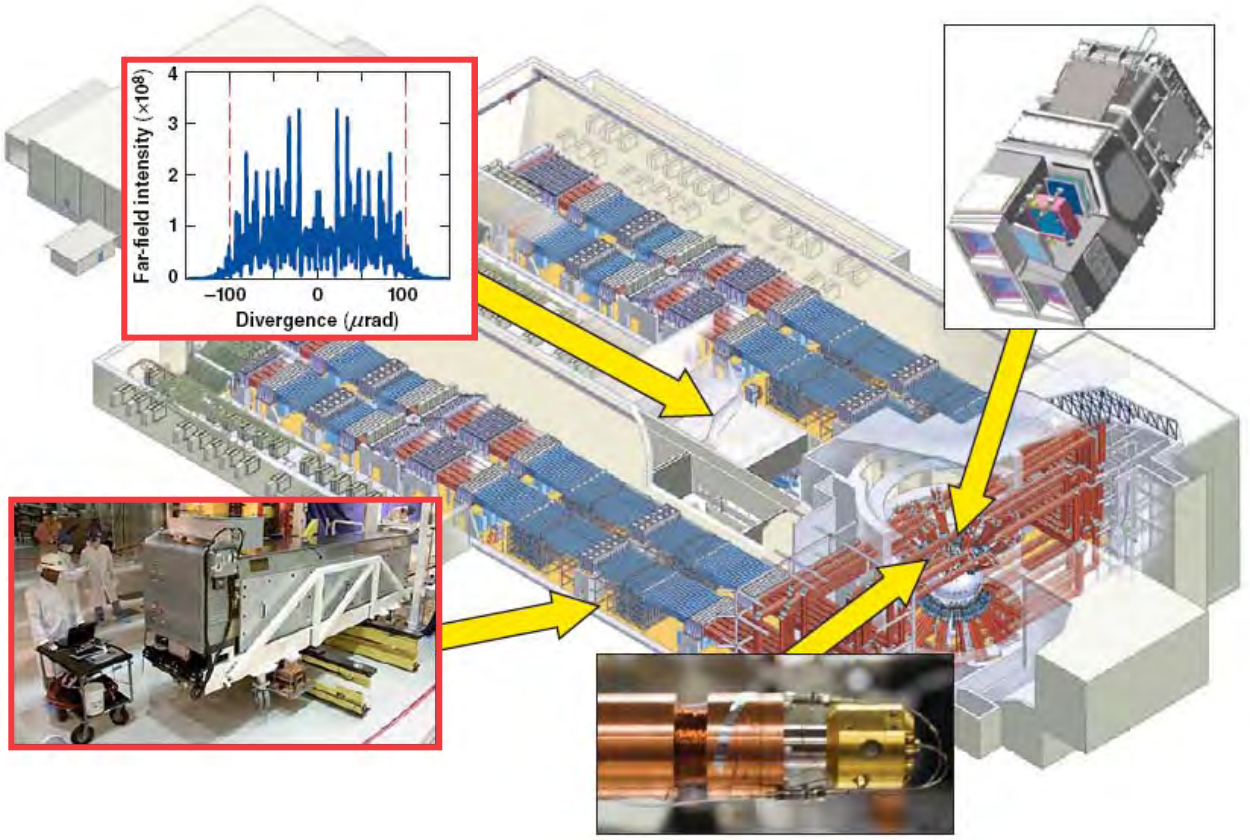
Demonstrating Polar-Drive Beam Smoothing Technology for NIF on OMEGA EP



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International Workshop
on ICF Shock Ignition
Rochester, NY
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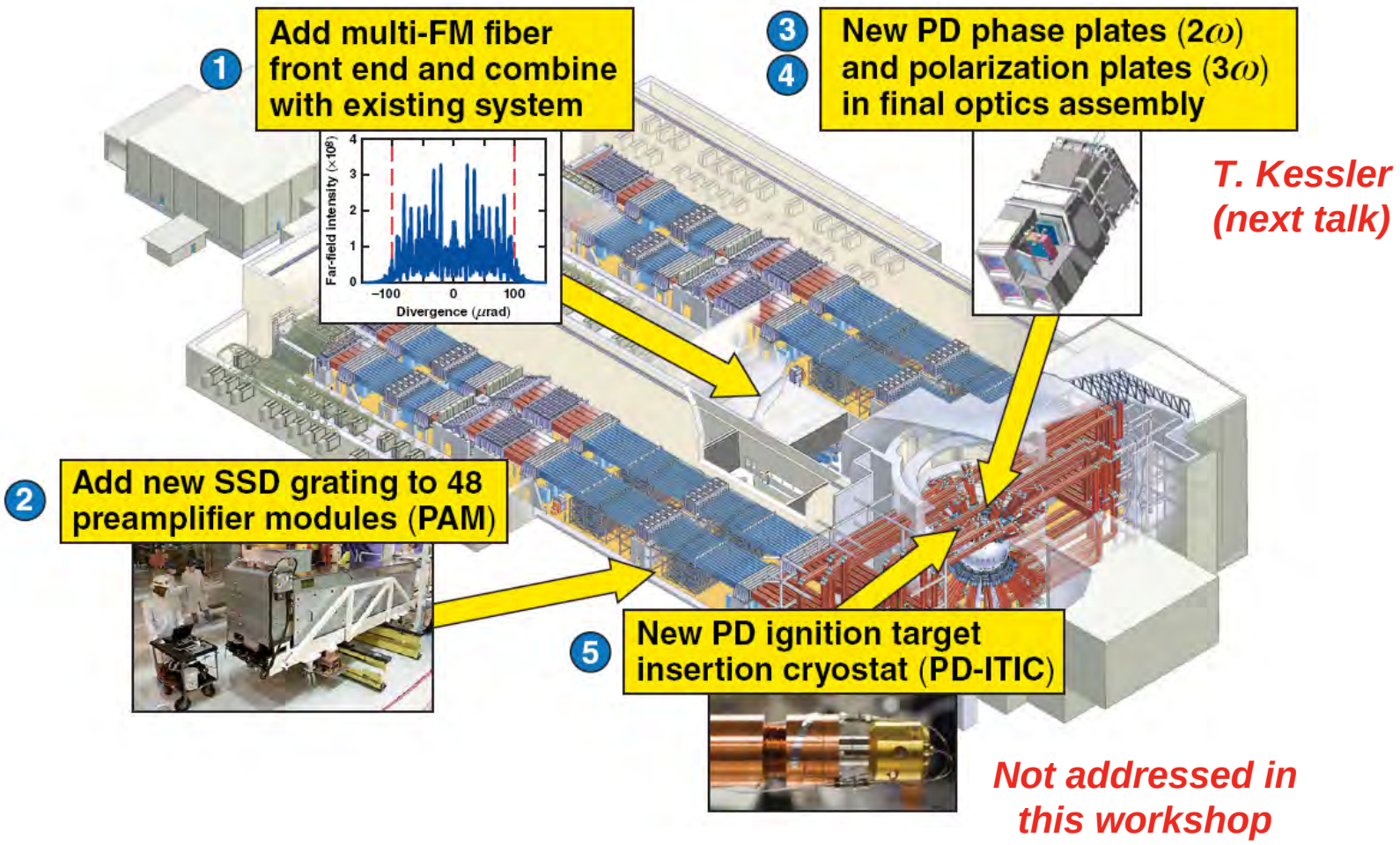
Summary

Polar-drive beam smoothing will be proven on Omega EP to prepare for direct-drive ignition on NIF

- **Shock ignition on NIF will use polar direct drive**
  - **MultiFM 1-D SSD beam smoothing is a viable approach for NIF to provide the required beam smoothing**
- **Dynamic bandwidth reduction minimizes stress on the laser with little affect on target gain**
- **Spatio-temporal distortion from the SSD grating limits pulse shaping**
  - **Pulse shapes must be clearly specified to avoid confusion**
- **MultiFM technology is being developed and proven in an offline testbed**

Efforts to demonstrate MultiFM 1-D SSD beam smoothing on OMEGA EP are well underway

Implementing polar drive (PD) requires five changes on the NIF for an ignition demonstration



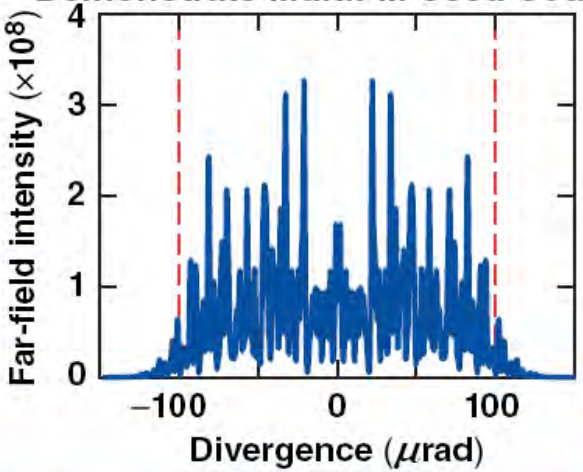
A MultiFM 1-D SSD beam-smoothing demonstration on OMEGA EP will validate laser performance

Integrate NIF PAM into OMEGA EP

In progress

Early FY12

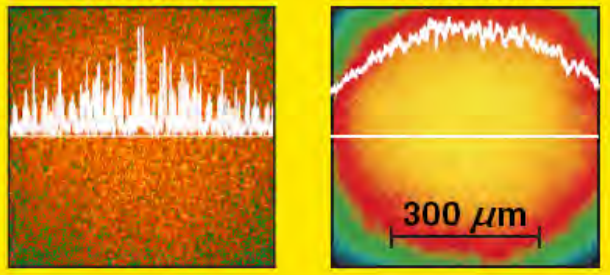
Demonstrate MultiFM Seed Source



Verify smoothing with equivalent target plane measurements*

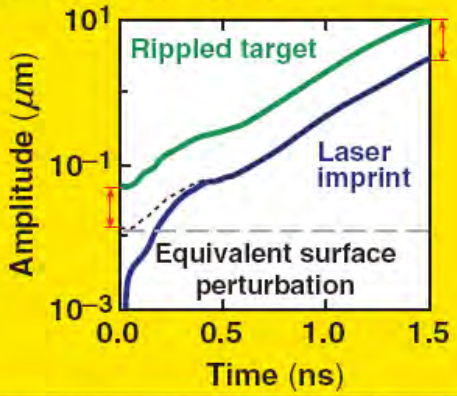
No SSD

With SSD



Verify laser imprint with foil-target experiments on OMEGA EP**

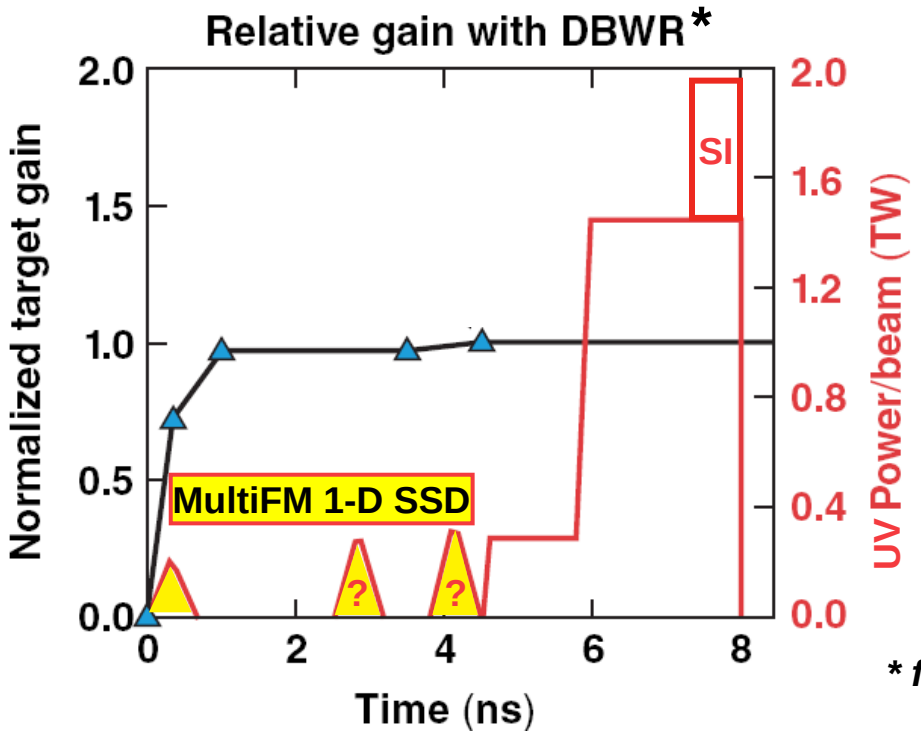
Simulation of method



*S. P. Regan *et al.*, J. Opt. Soc. Am. B 17, 1483 (2000).

**T. R. Boehly *et al.*, Laser Part. Beams 18, 11 (2000).

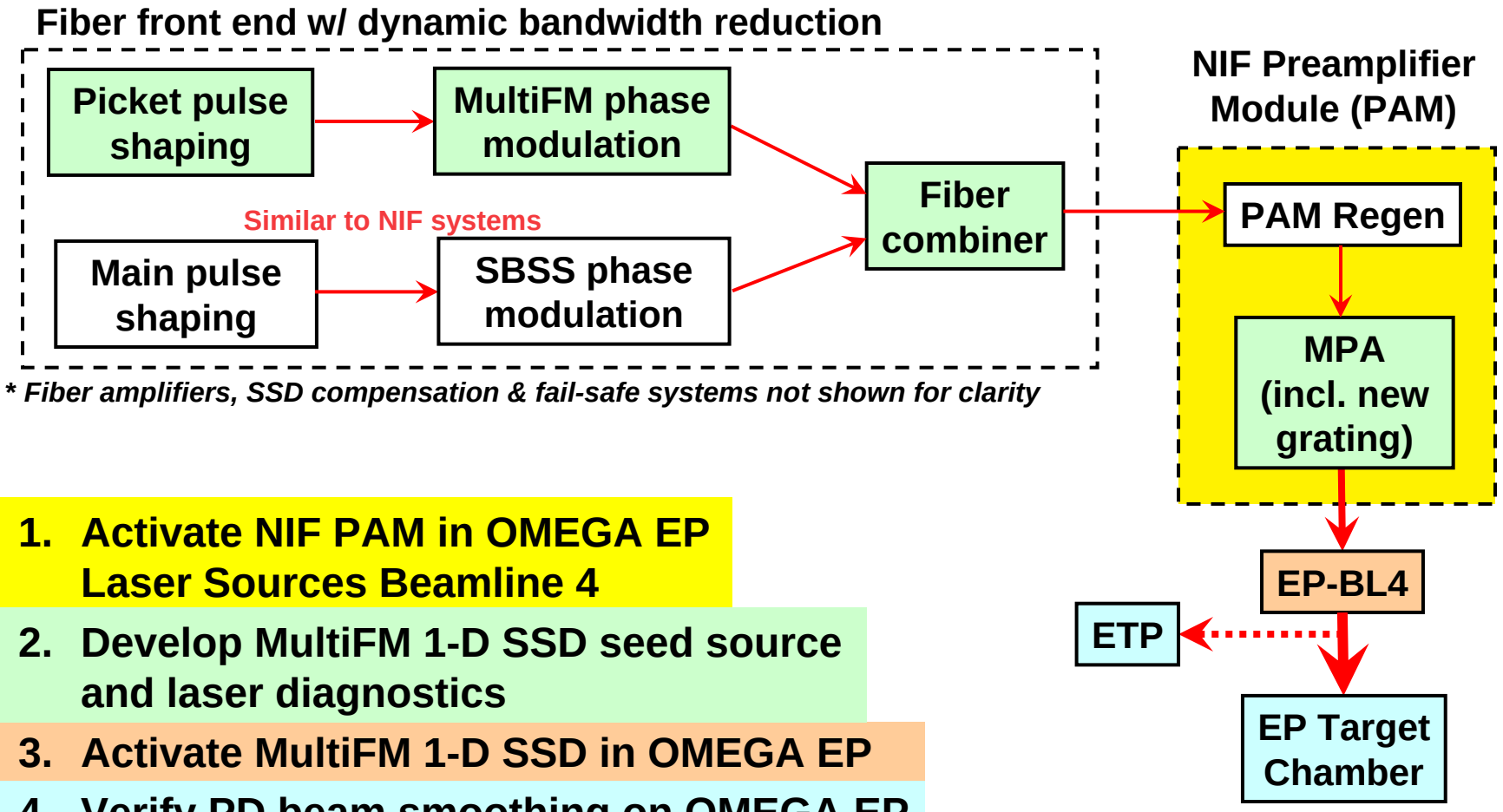
Dynamic Bandwidth Reduction (DBWR) minimizes stress on the laser with little affect on target gain



** from T. Collins*

- **Polar-drive ignition on NIF requires MultiFM 1-D SSD beam smoothing only for pickets in the pulse shape**
- **DBWR will be tested on Omega EP by optically splicing two pulse shapes with and without MultiFM bandwidth**

Demonstrating PD beam smoothing on Omega EP involves four major stages



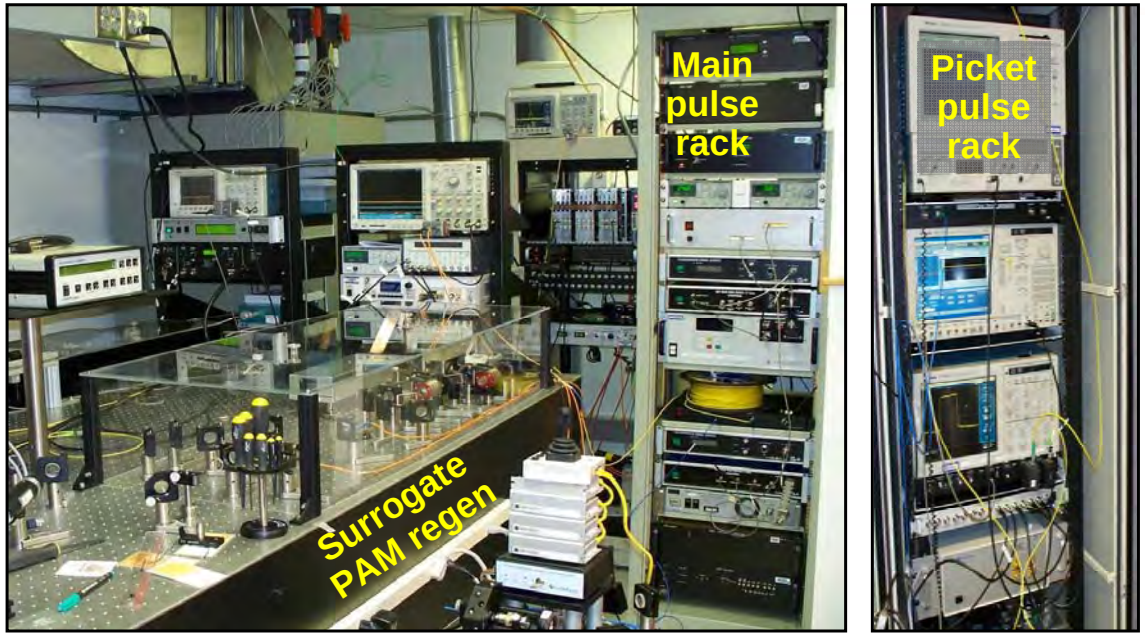
1. Activate NIF PAM in OMEGA EP Laser Sources Beamline 4
2. Develop MultiFM 1-D SSD seed source and laser diagnostics
3. Activate MultiFM 1-D SSD in OMEGA EP
4. Verify PD beam smoothing on OMEGA EP

MPA = Multi-Pass Amplifier
ETP = Equivalent Target Plane

NIF PAM integration in Omega EP is nearly complete and activation will start in Q3FY11

- Temporally shaped pulses have been injected into PAM regenerative amplifier and propagated through PAM to the BL4 injection point
- MPA power conditioning activation and pulse amplification will be accomplished during Q3FY11 maintenance shutdown
- Narrowband BL4 activation should be completed in FY11

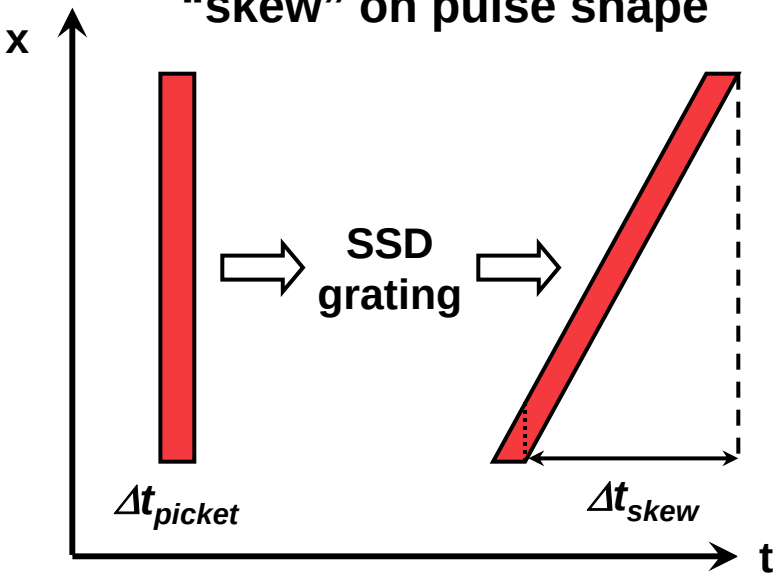
A MultiFM testbed has been built to develop and verify system performance before moving into EP



- **Main pulse rack:**
  - **Arbitrary waveform generator (using AWG comparable to NIF)**
  - **SBS suppression with fail-safe system**
  - **17-GHz phase modulation**
- **Picket pulse rack:**
  - **Multiple picket pulse generation (AWG with ~50-ps resolution)**
  - **MultiFM phase modulation system**
- **Surrogate PAM with regenerative amplifier and SSD grating (not shown)**

Spatio-temporal distortion from the SSD grating in the PAM limits pulse shaping

SSD grating puts "skew" on pulse shape

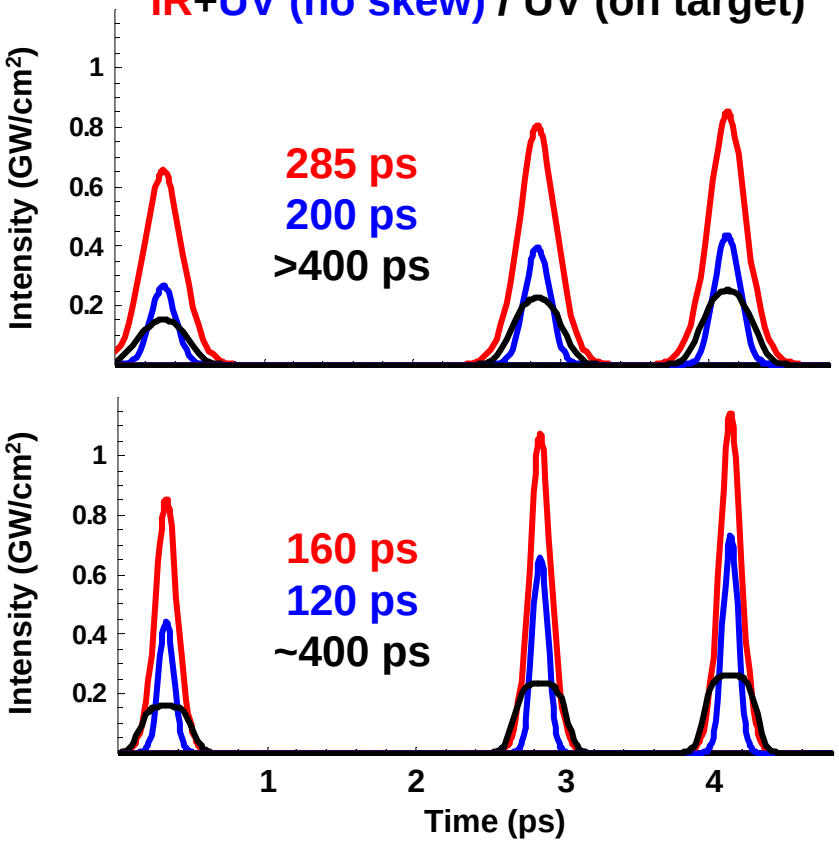


For MultiFM 1-D SSD:

Δt_{skew} = 360 ps

Picket pulse widths (FWHM)*

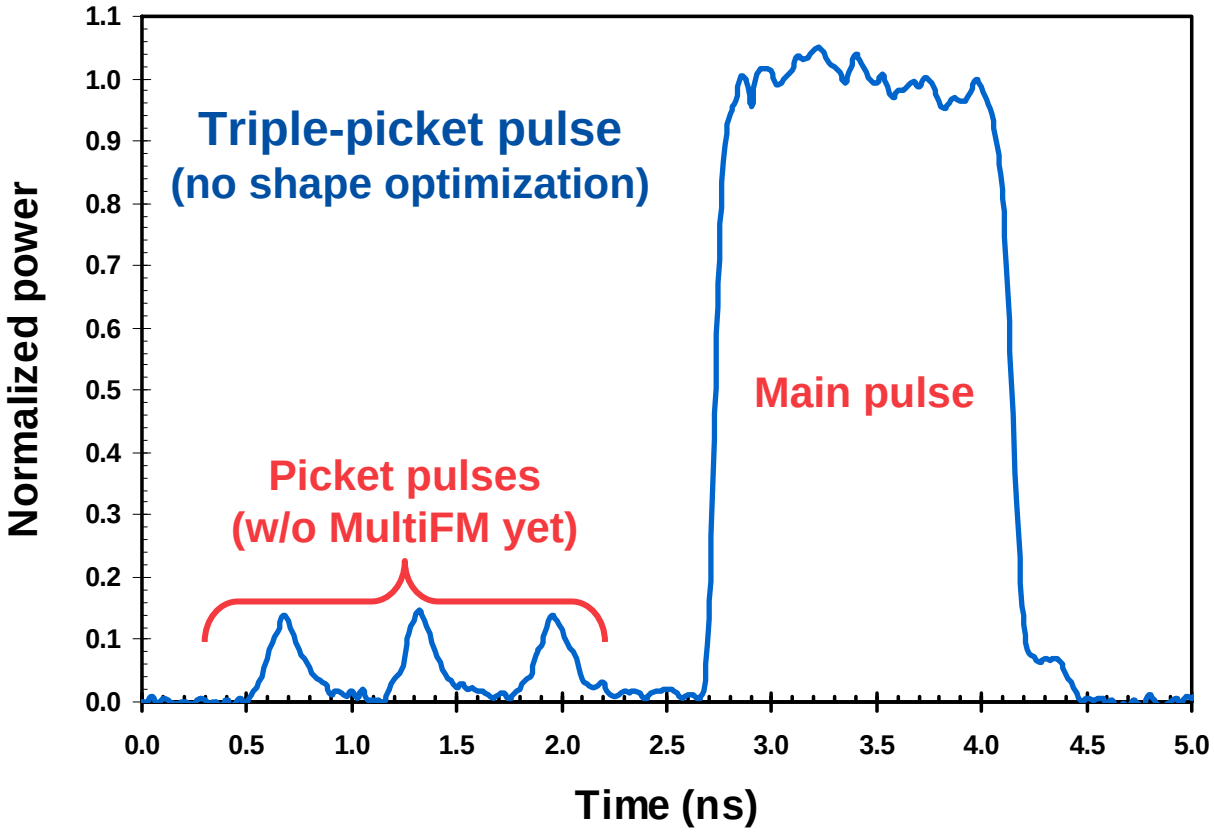
IR+UV (no skew) / UV (on target)



Pulse shapes must be clearly specified to avoid confusion!

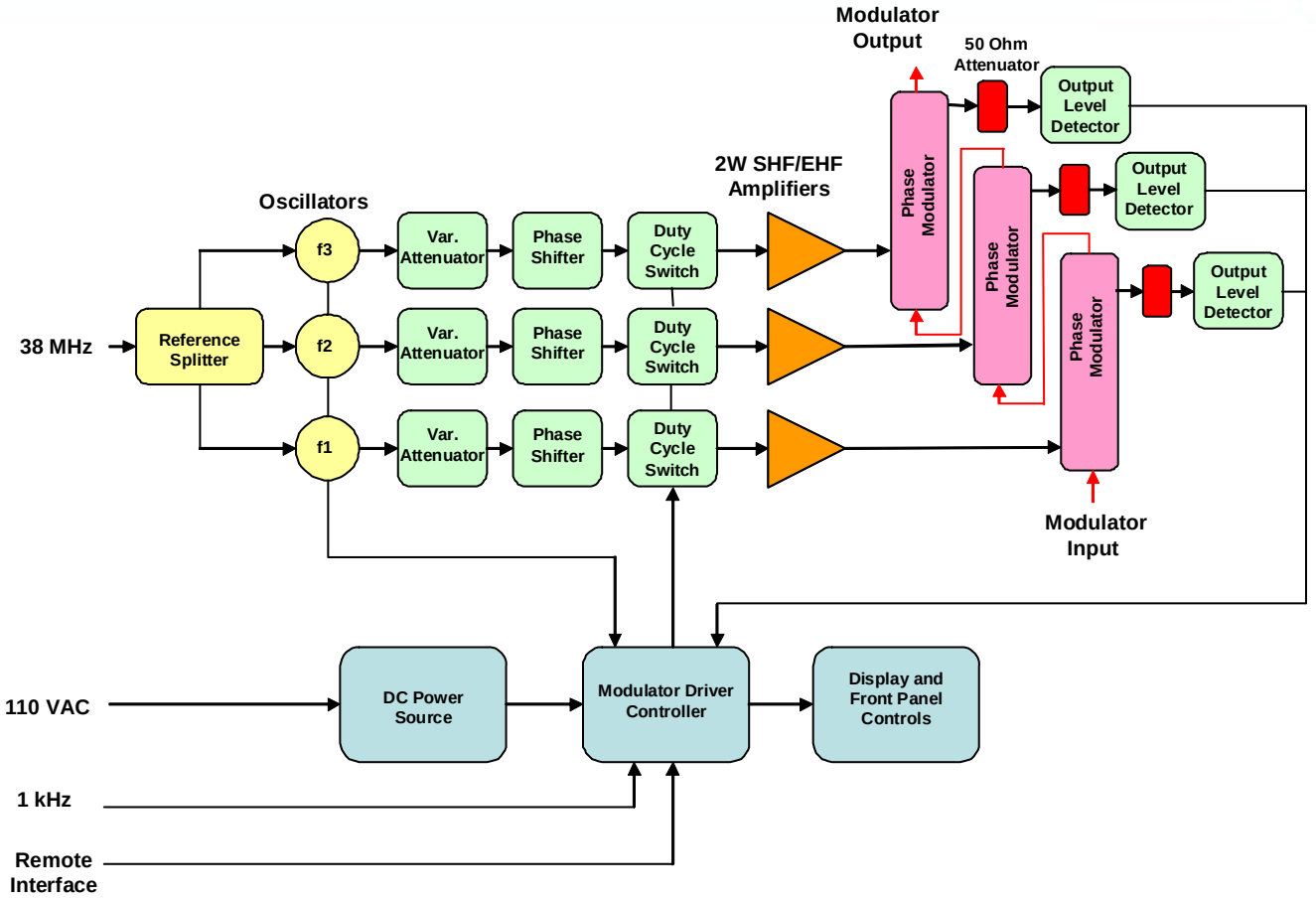
** from A. Shvydky*

Pulse shaping to provide dynamic bandwidth reduction has been demonstrated by optically splicing



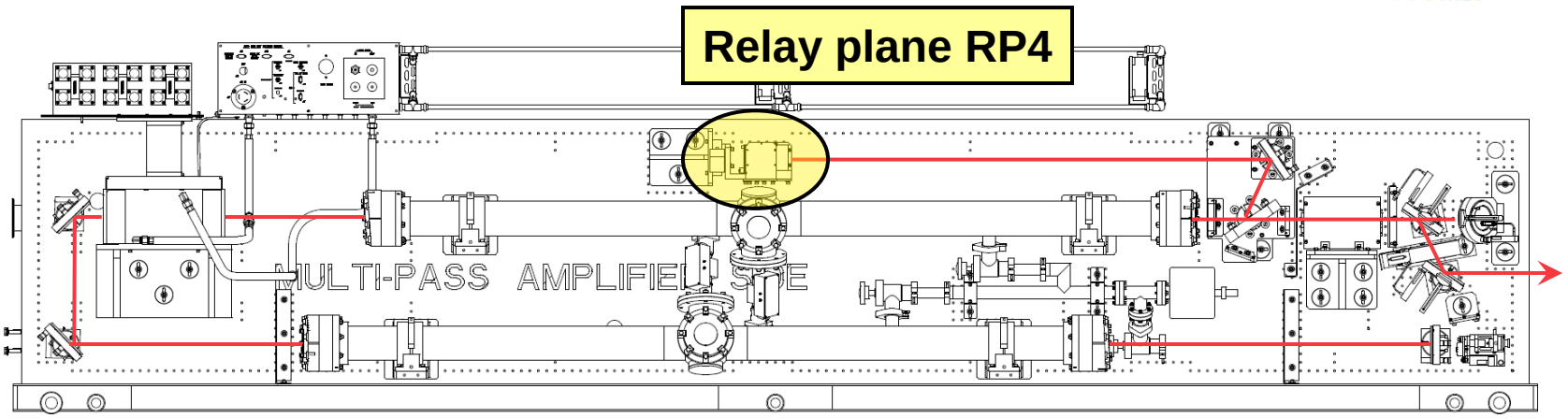
Polar-drive pulse shape performance will be tested to characterize suitability for experiments on Omega EP and NIF

MultiFM 1-D SSD employs technology originally developed for the telecommunications industry



- Custom 40-GHz phase modulators and drive electronics are expected soon
- Phase-locked modulation provides better control of beam smoothing

The only PAM modification required for MultiFM 1-D SSD is a new grating in the multi-pass amplifier



- **For Omega EP, the existing 1-D SSD grating will be replaced**
  - **Minor mechanical design effort**
- **For NIF, the existing 1-D SSD grating is needed for indirect drive. Two options will be explored:**
  - **Engineer new mount that can accommodate all three required optics (mirror, 1-D SSD and MultiFM 1-D SSD gratings)**
  - **install MultiFM grating at an image plane equivalent to RP4**

Efforts to demonstrate MultiFM 1-D SSD beam smoothing on OMEGA EP are well underway

- **Activate NIF PAM in OMEGA EP Laser Sources Beamline 4**
  - **NIF PAM regen and alignment through PAM is complete**
  - **Operational Readiness Review anticipate by May 2011**
- **Develop MultiFM 1-D SSD seed source and diagnostics**
  - **Main pulse shaping with 17-GHz phase modulator activated offline**
  - **Optical splicing demonstrated offline (w/o MultiFM)**
  - **Custom phase modulators & MultiFM driver electronics due by May 2011**
- **Activate MultiFM 1-D SSD in OMEGA EP**
  - **Dedicated EP system time in Q4FY11 (LS4) and Q1FY12 (BL4)**
- **Verify PD beam smoothing on OMEGA EP**
  - **Modifications to UV diagnostic package to facilitate equivalent target plane (ETP) measurements are designed and will be ready early in Q3FY11.**
  - **ETP experiments are planned in Q4FY11 and Q1FY12 (w/ mFM)**
  - **Planar foil imprint/RT experiments will demonstrate PD smoothing by Q2FY12**

Conclusion

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