

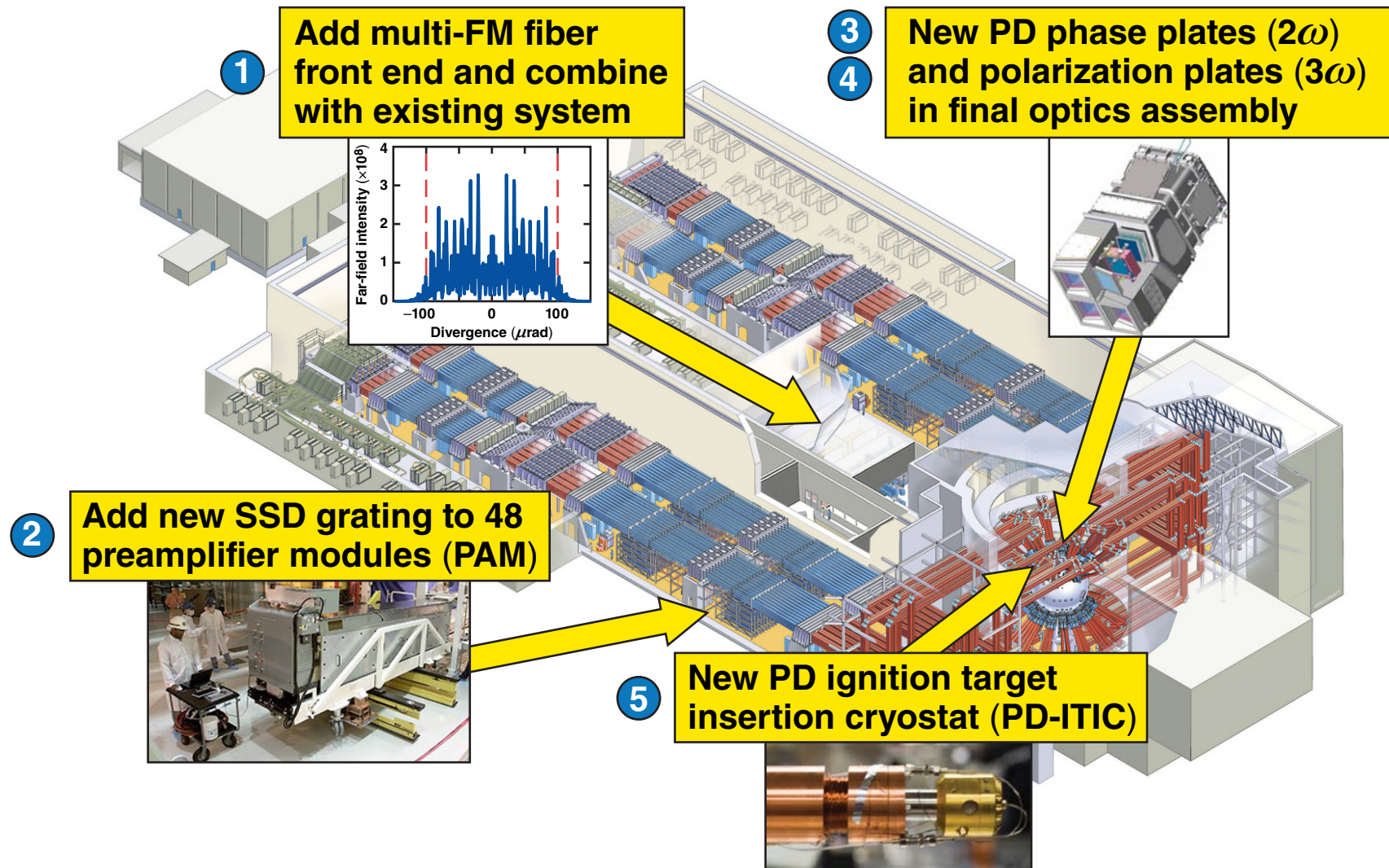


# Polar-drive ignition could be tested on the NIF with a few modest modifications to the facility



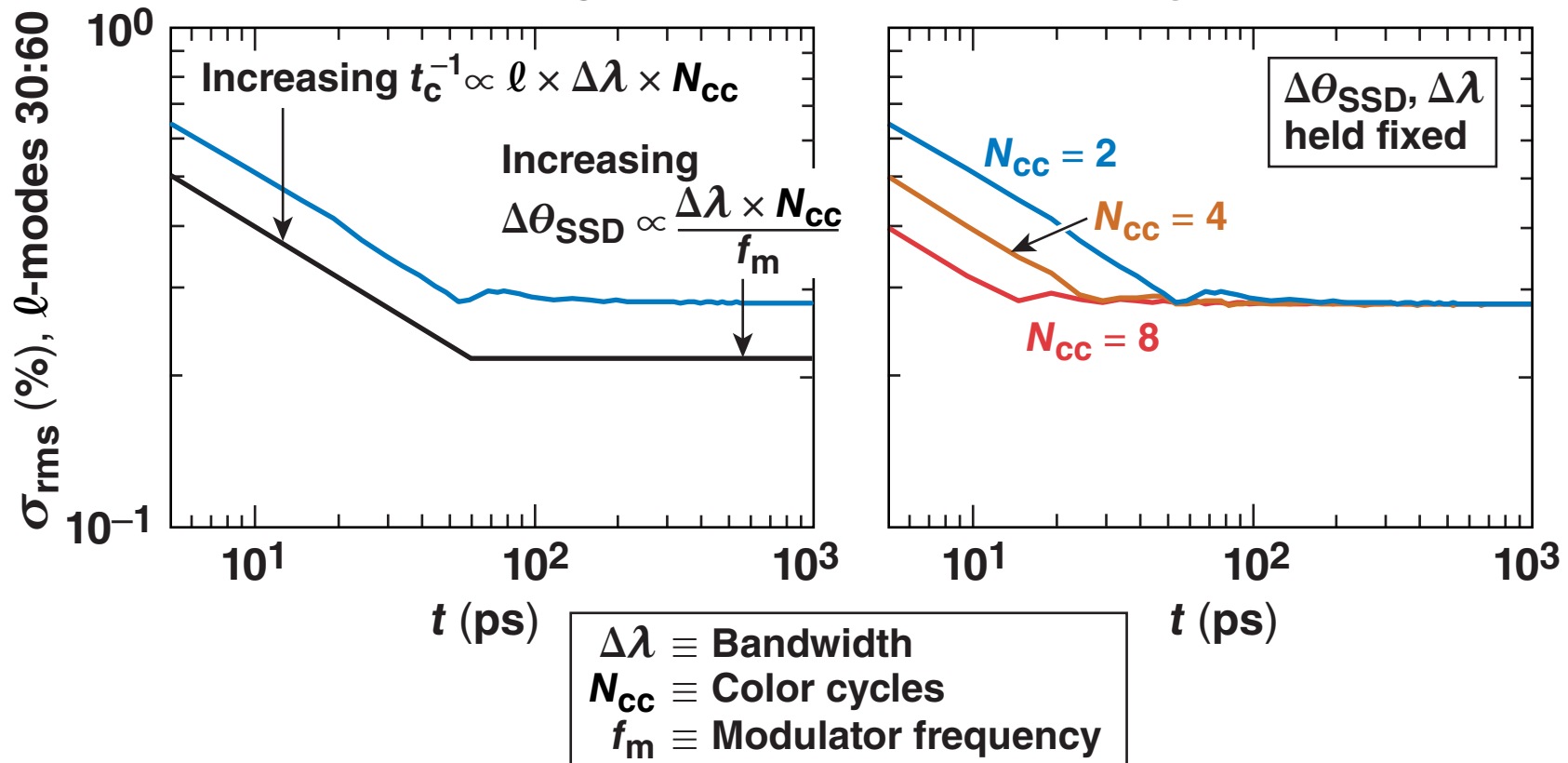
- **Beam-smoothing improvements:**
  - Multi-FM 1-D smoothing for spectral dispersion (SSD) provides the required beam smoothing with simple modifications to the NIF facility
  - Beam smoothing is only required at the beginning of the laser pulse, which minimizes stress on the laser
  - Polar-drive phase plate and polarization-smoothing designs are underway
  - A NIF PD beam-smoothing demonstration on OMEGA EP is planned in FY12
- **Direct-drive target technology:**
  - NIF-scale fill-tube targets have been demonstrated and are being optimized
  - Concepts for a polar-drive ignition target insertion cryostat (PD-ITIC) are being developed

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



# Laser nonuniformity imprint is minimized by optimizing smoothing by spectral dispersion (SSD)

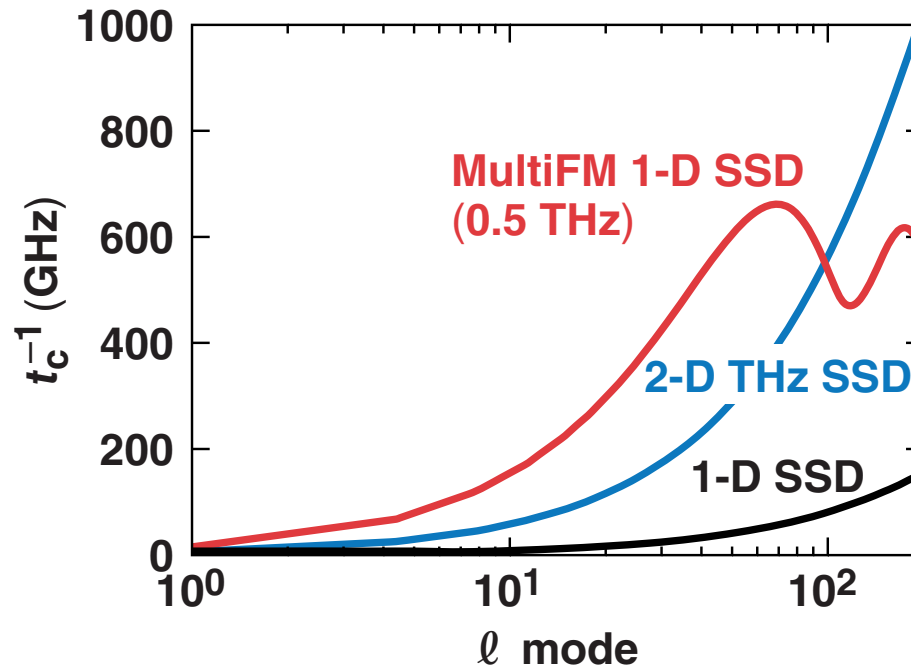
## Single-beam laser nonuniformity



- SSD divergence ( $\Delta\theta_{SSD}$ ) determines the asymptotic uniformity
- Increasing the inverse coherence time ( $t_c^{-1}$ ) allows the target to experience a smoother spot for a longer period

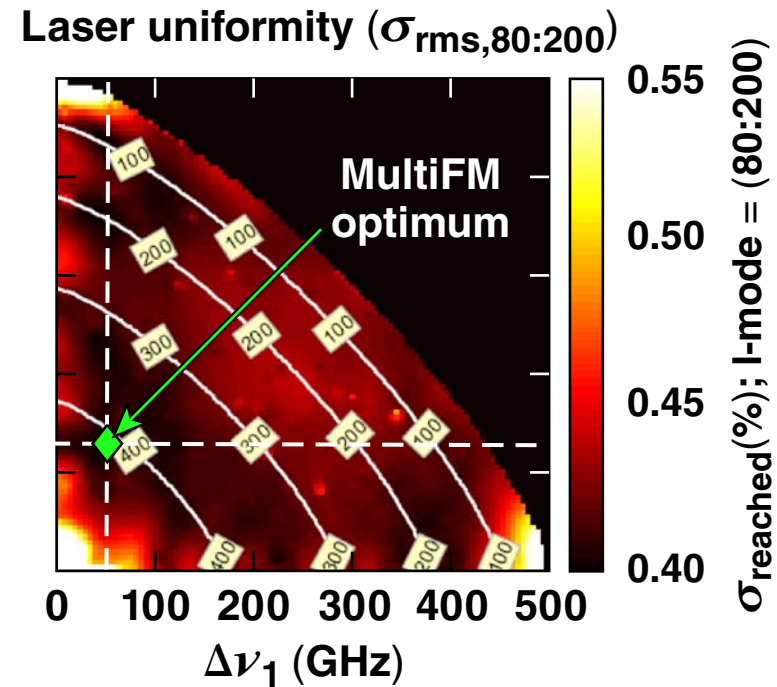
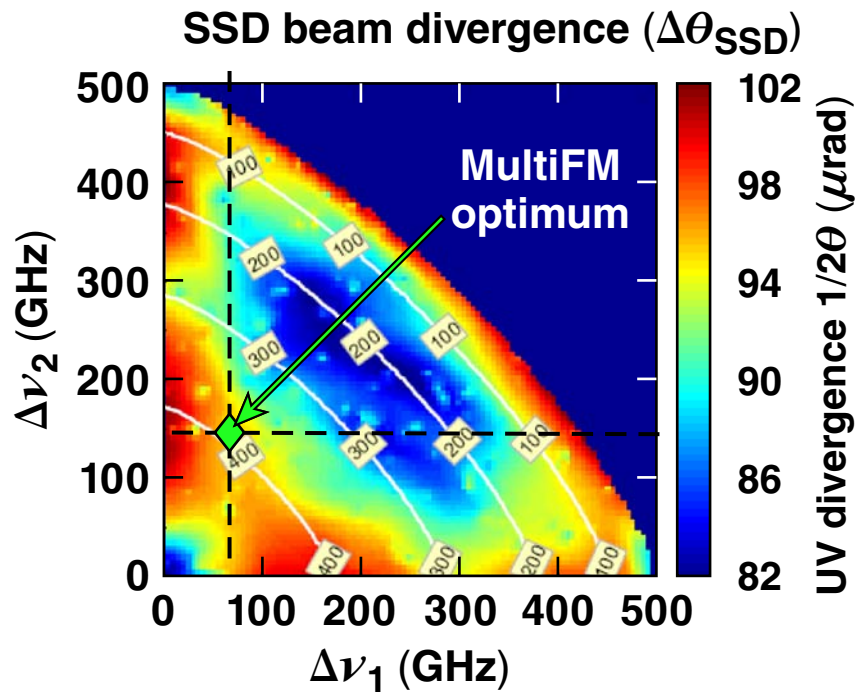
# MultiFM 1-D SSD provides required beam smoothing performance with minimal impact on the facility

Inverse coherence time versus far-field spatial frequency



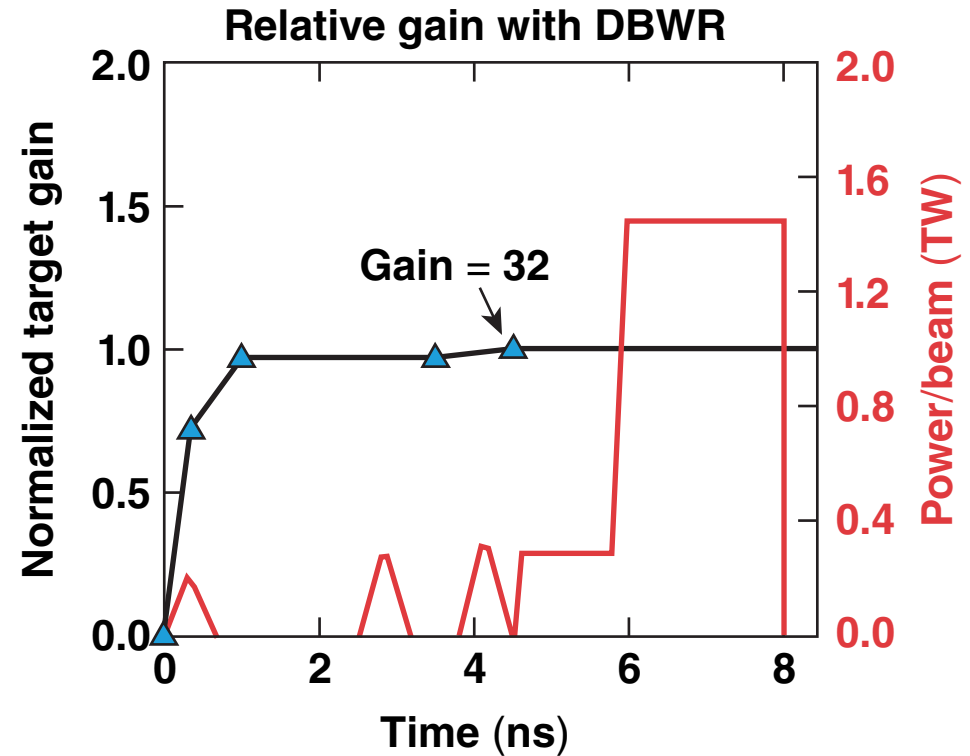
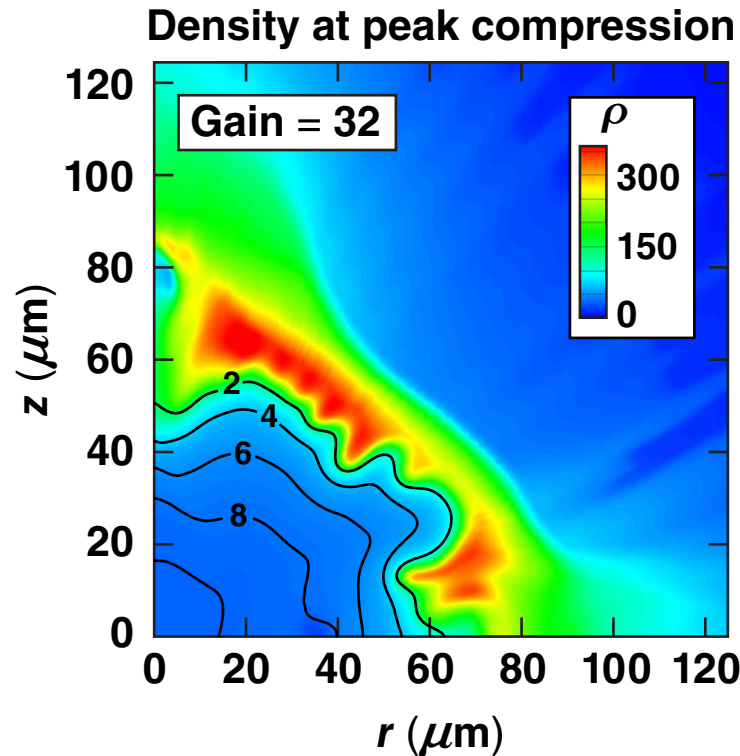
- Traditional SSD systems using single-frequency phase modulation have low smoothing rates for many important spatial modes ( $\ell < 150$ )
- MultiFM 1-D SSD is a new approach that
  - provides better smoothing rates with lower total bandwidth (esp. for PD pulse shapes with picket prepulses)
  - can be implemented on NIF with simple modifications

# An optimized MultiFM configuration that achieves high gain in polar drive simulations has been identified



- MultiFM 1-D SSD employs technology developed for the telecommunications industry
  - 40-GHz phase modulators and drive electronics
  - UV bandwidth:  $\Delta f_{\text{total}} = 500$  GHz (effective bandwidth)
  - SSD divergence:  $\Delta\theta_{\text{SSD}} = 100 \mu\text{rad}$  (half angle at full beam)
- DRACO 2-D simulations with all nonuniformity sources: Gain = 32

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



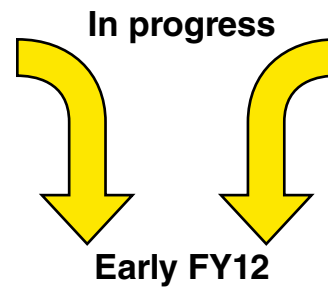
MultiFM 1-D SSD beam smoothing only needs to be applied to pickets in the polar-drive point design pulse shape.



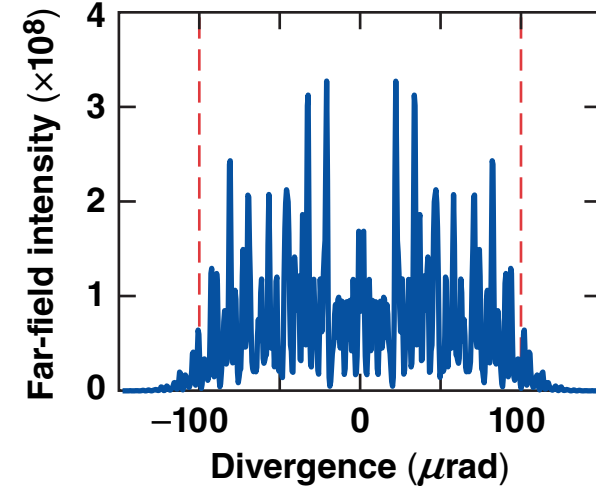
# A MultiFM 1-D SSD beam-smoothing demonstration on OMEGA EP will validate laser imprint performance



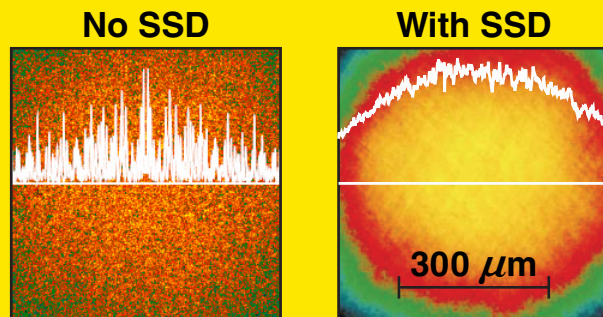
Integrate NIF PAM into OMEGA EP



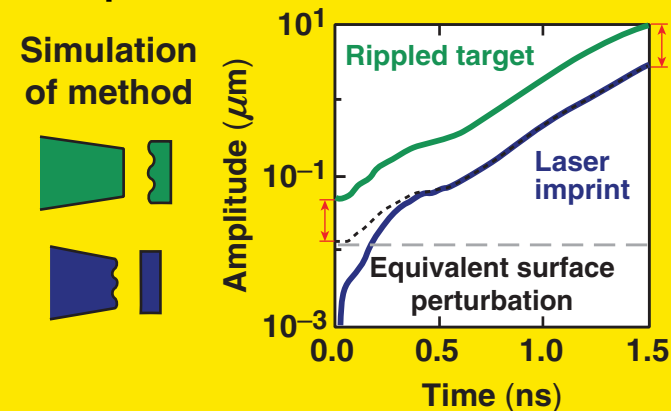
Demonstrate MultiFM Seed Source



Verify smoothing with equivalent target plane measurements\*



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

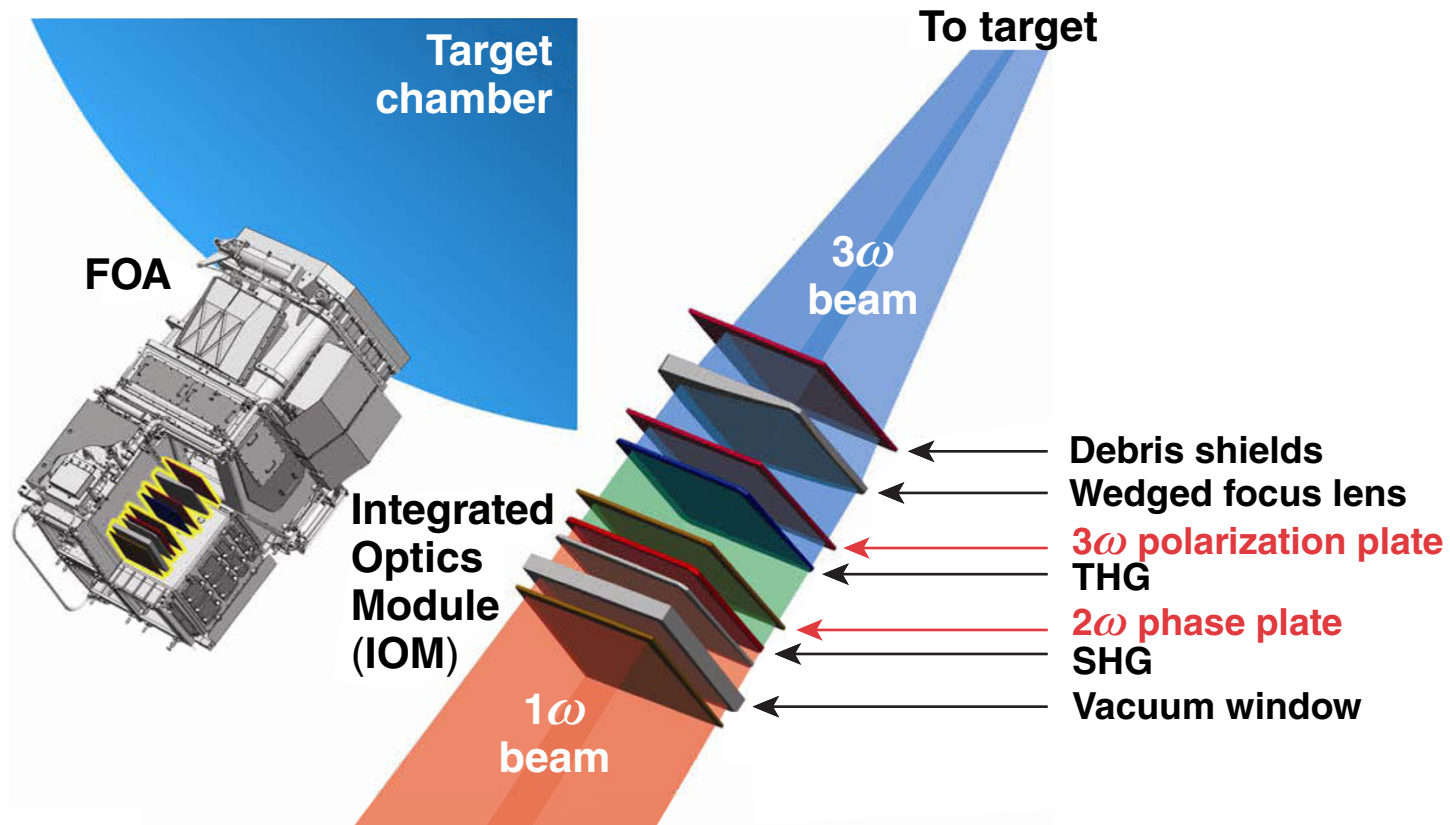


\*S. P. Regan *et al.*, J. Opt. Soc. Am. B **17**, 1483 (2000).

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



# The focal-spot conditioning strategy for polar-drive ignition includes phase and polarization plates



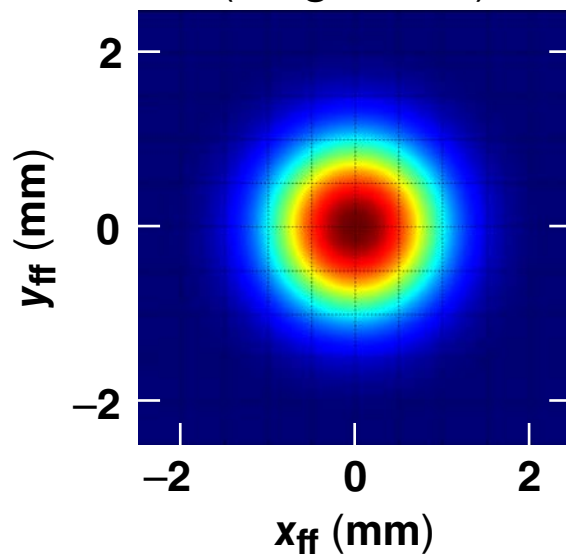
The NIF final optics assembly (FOA) will include:

- Phase plate between the frequency conversion crystals ( $2\omega$ )
- Polarization plate ( $3\omega$ )

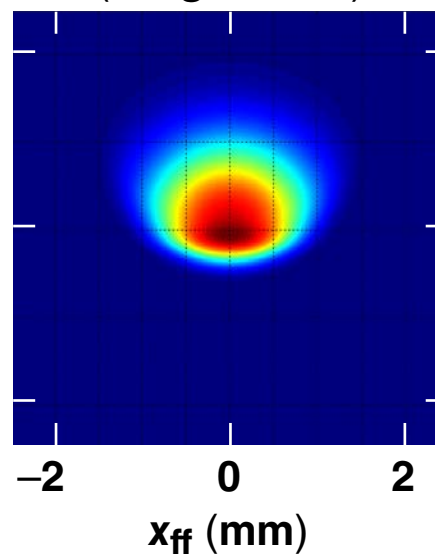
# Phase plates and polarization smoothing are being designed to efficiently and uniformly couple energy to polar-drive targets

## Focal spots for polar-drive beams

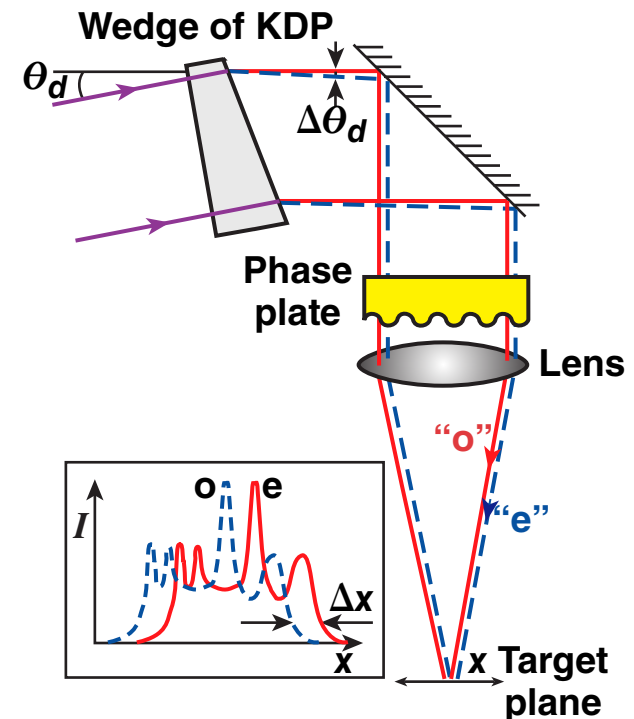
Polar and mid-latitude  
(Rings 1 to 3)



Equatorial  
(Rings 4 to 5)

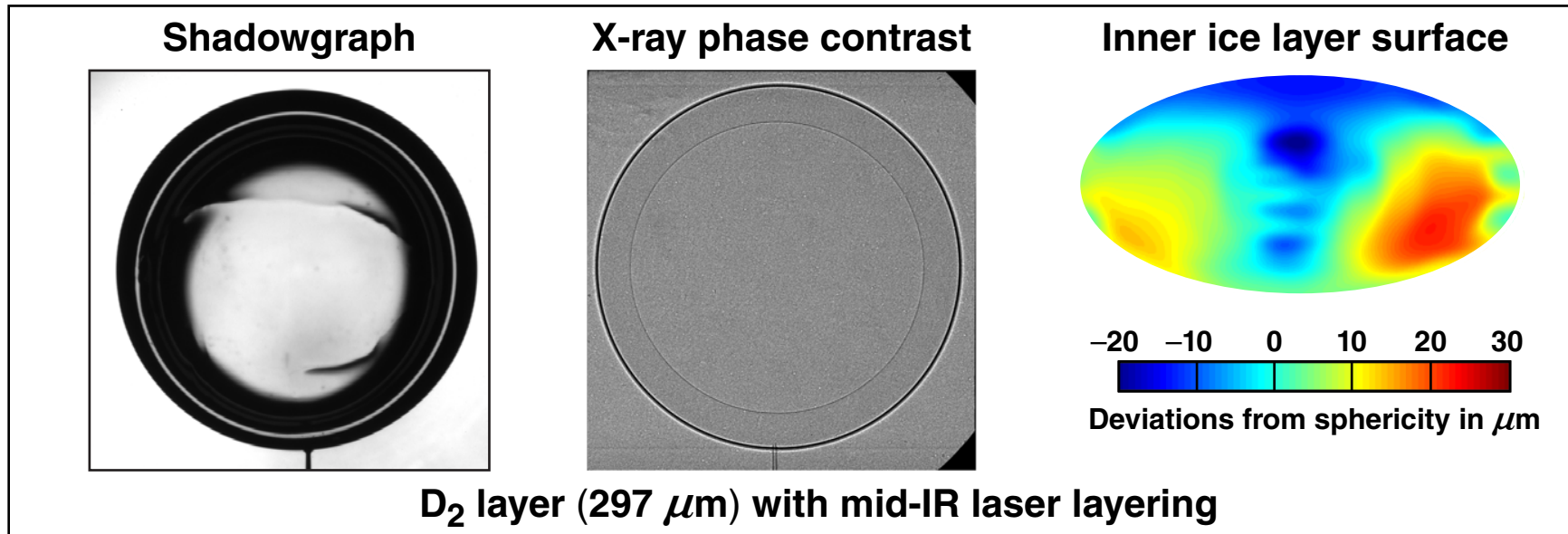


## Polarization smoothing

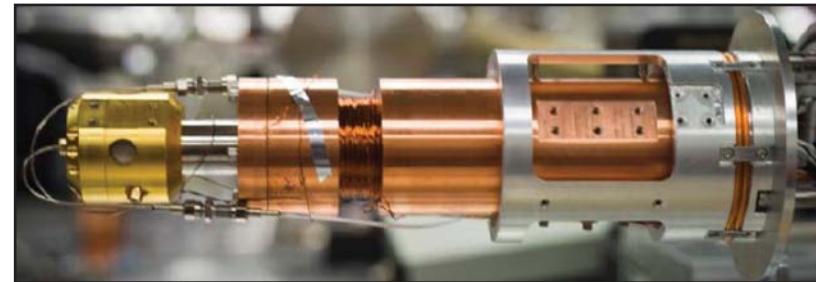


- Phase plates efficiently deliver laser energy with a desired focal pattern to achieve required irradiation uniformity.
- Polarization smoothing instantaneously improves targeted modes of focal-spot irradiance modulation.

# A NIF fill-tube target has been demonstrated that will be optimized to meet polar-drive ice layer specifications



**Target: 2.95-mm OD, 20-μm wall**  
**Fill tube: 30-μm OD at shell wall**



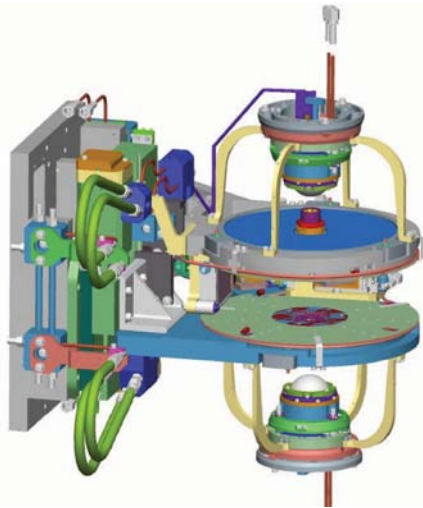
**Cryogenic layering sphere**

**Facility renovations and equipment upgrades are underway at LLE to demonstrate NIF PD cryogenic layering with DT targets.**

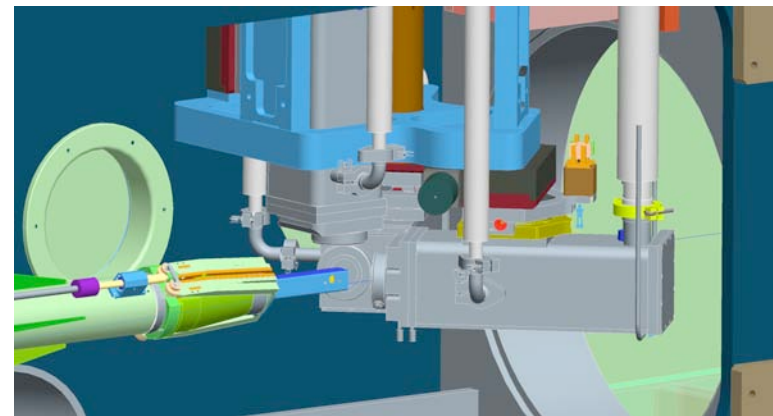
# A polar-drive ignition target insertion cryostat (PD-ITIC) will minimize the impact on the NIF facility



Target Alignment System (TAS)



Load, Layer, and Characterization Station (LLCS)



- A polar-drive target that survives  $>3$ -s exposure to the target chamber is required to use existing “clam-shell” shroud design
- Use existing NIF space envelope and cryogenic support systems (TAS, LLCS, TARPOS)

**Existing TAS and LLCS place challenging constraints on a PD-ITIC design that will limit size of the cryogenic shroud.**

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