# The APS PC Gun Drive Laser

## Future LEA Experiments Workshop

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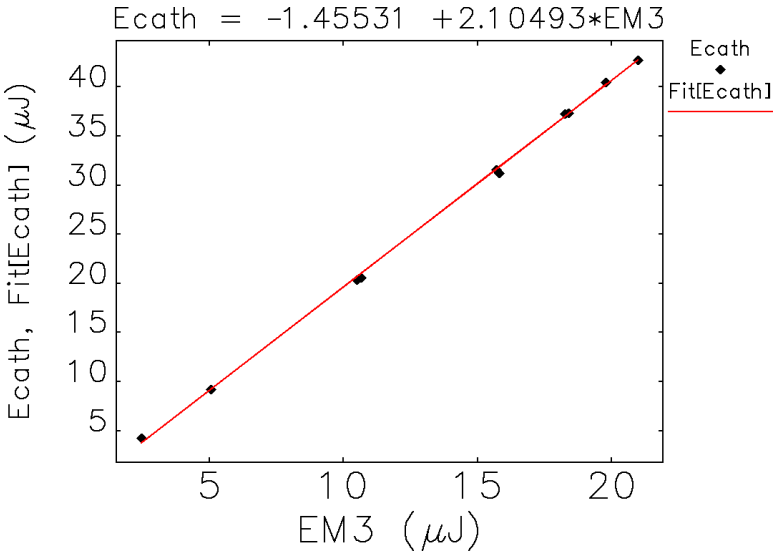
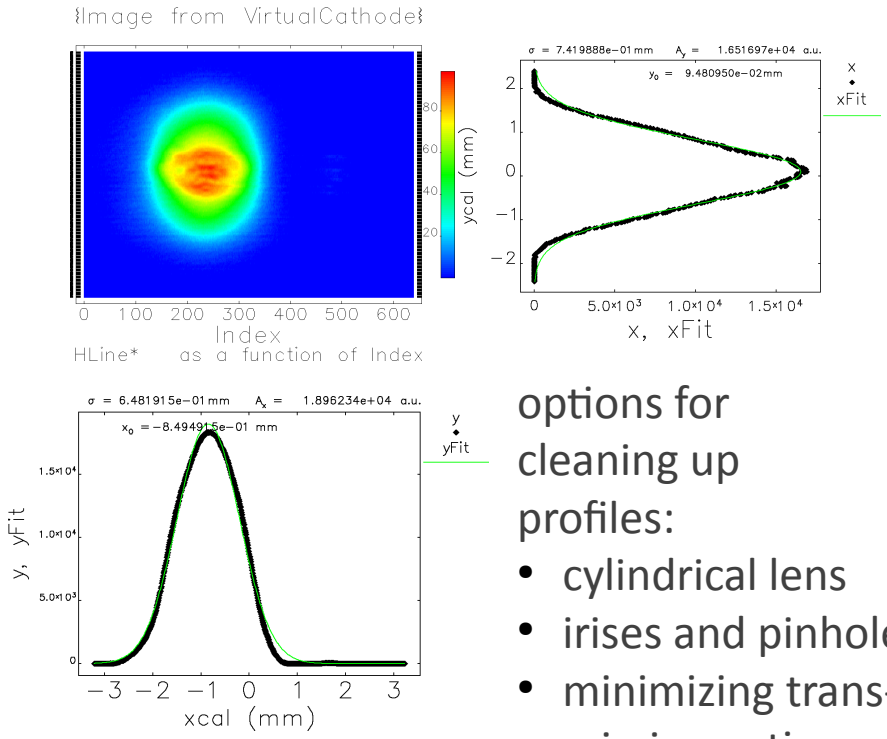
# APS PC Gun Drive Laser—Chirped Pulsed Amplifier (CPA)

- Nd:Glass system, fundamental wavelength: 1053 nm
- Time Bandwidth Oscillator—seed, operates at 119 MHz, 24$^{th}$ subharmonic of 2856 MHz
- Stretcher increases the seed pulse duration from 200 fs to 0.5 ns
- Positive Light Amplifier—Dual-head, Brewster-cut rods, laser-diode pumped, 5 mJ output, 2-30 Hz rep rate
- Compressor—reduces amplifier output bunch duration down to 0.5 ps, rms (typically operate at 2.0-3.0 ps); transmission eff. : 0.5
- Doubling Crystals—1-mm thick BBO (527 nm and 263 nm), maximum overall efficiency (1054 nm→263 nm): 12%
- Transport and Diagnostics—harmonic separation, steering, focusing, energy control, cavity build-up, beam purity, IR profiles

# Typically deliver 2-50 µJ of 263 nm light to the copper photo cathode



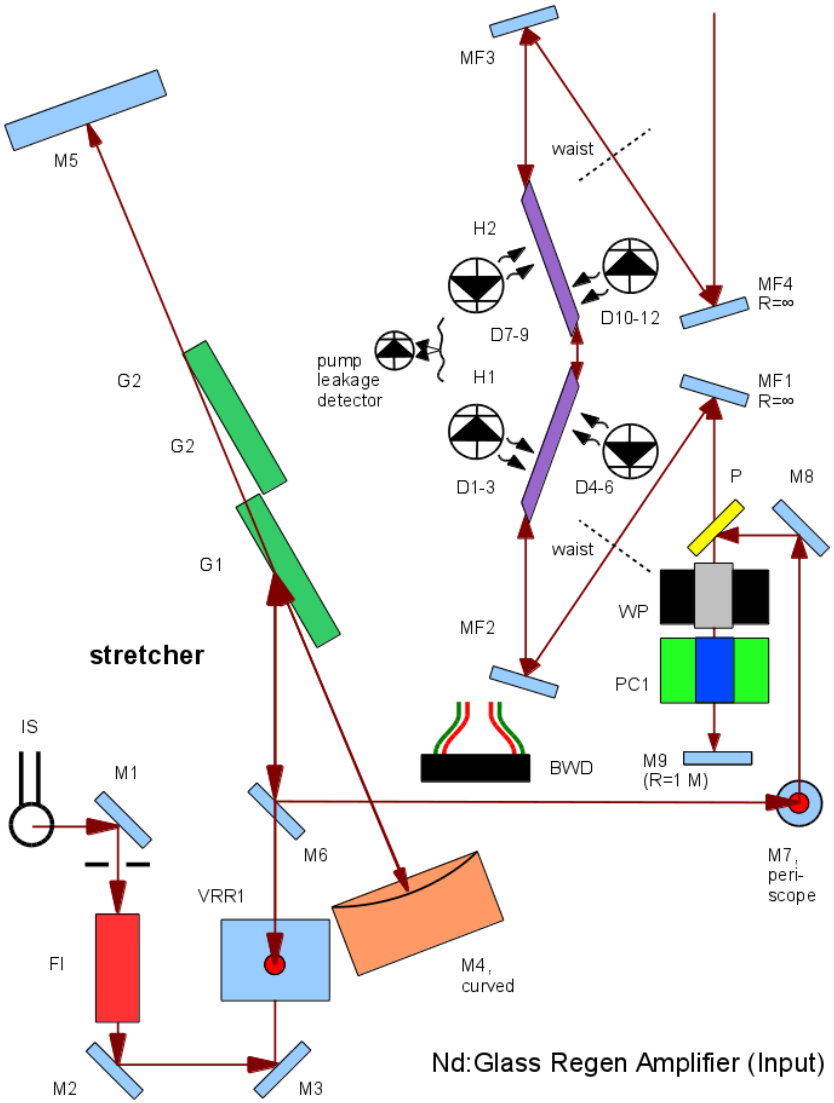

Coherent J-10MB-LE calibrated detector



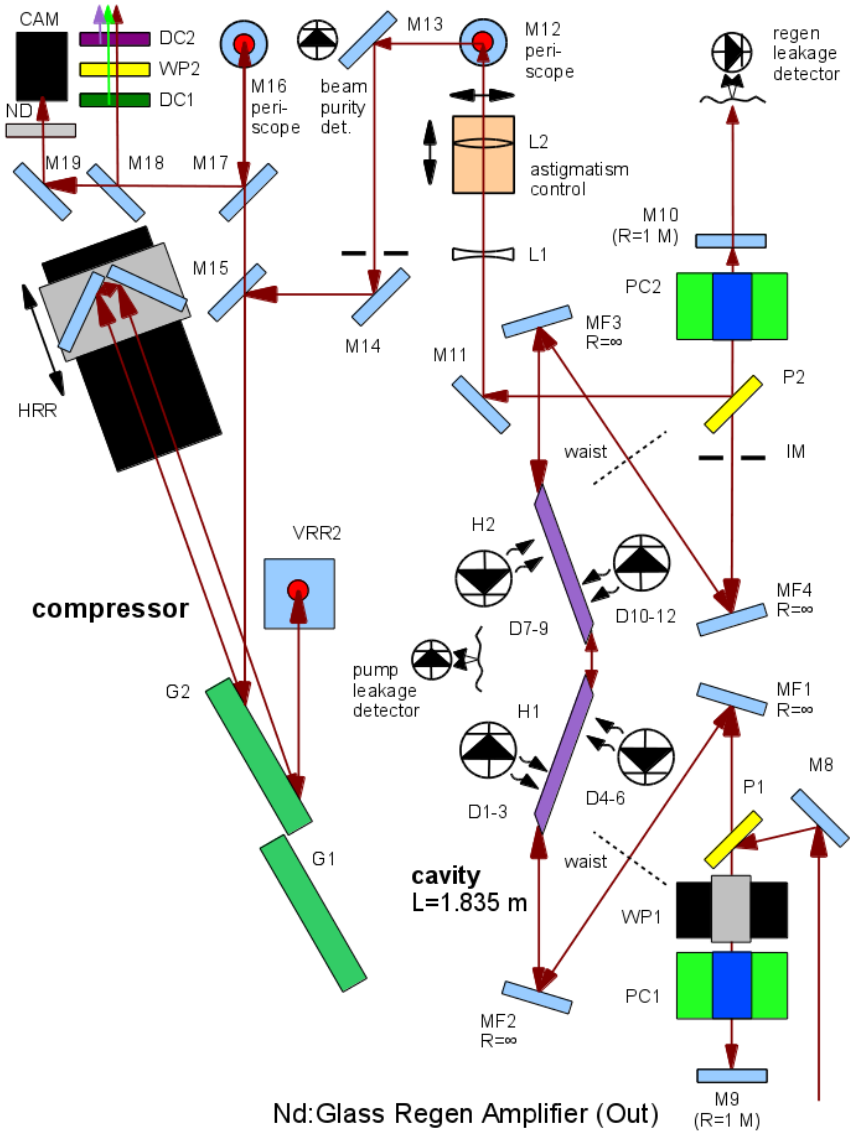

options for cleaning up profiles:

- cylindrical lens
- irises and pinholes
- minimizing trans-missive optics
- microlenses

# Stretcher, Amplifier, Compressor, SHG

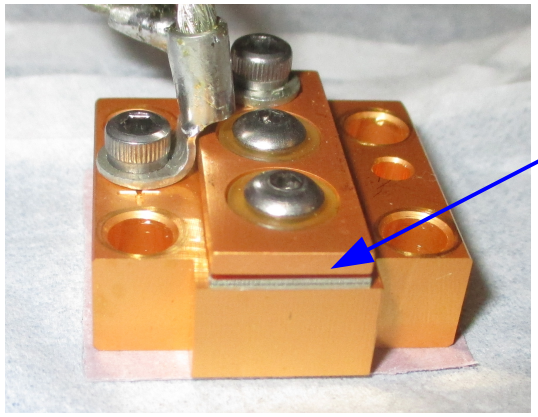


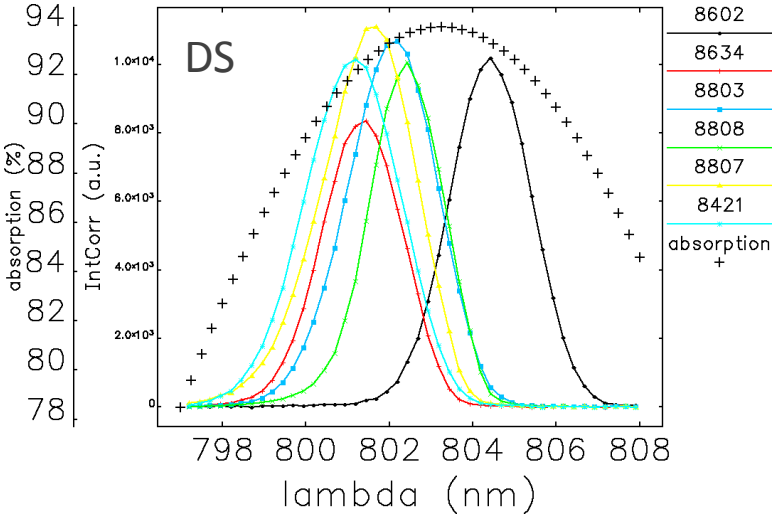

Nd:Glass Regen Amplifier (Input)

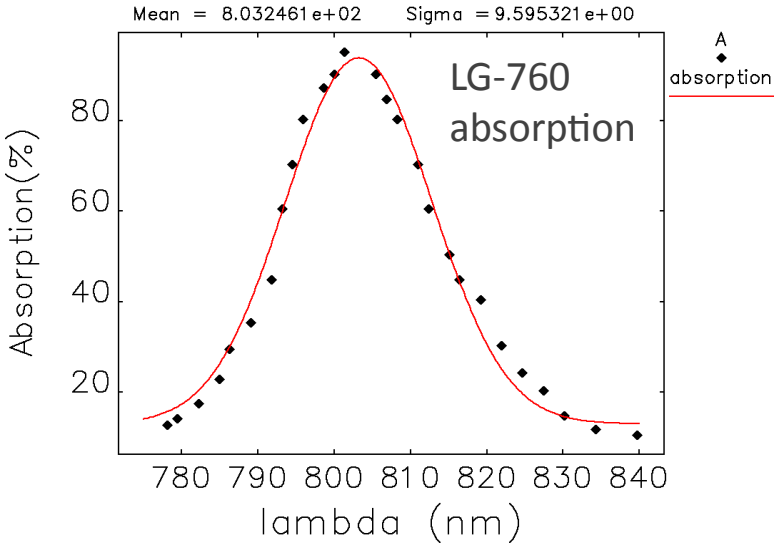


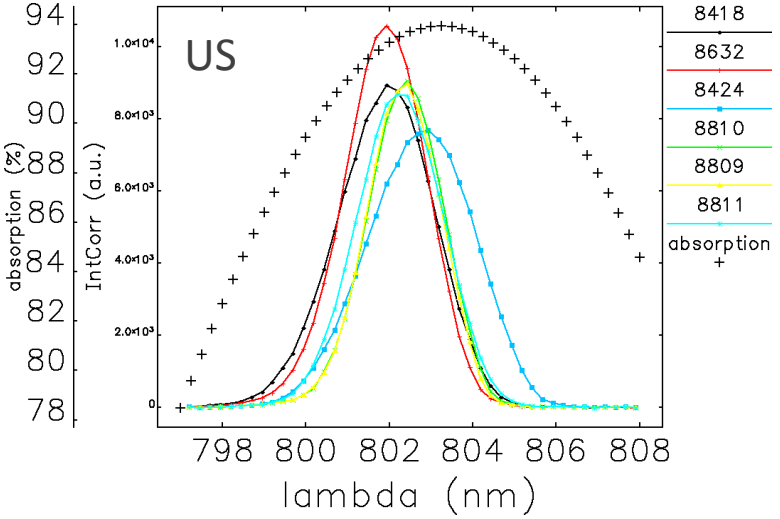

Nd:Glass Regen Amplifier (Out)

# Pump Laser Diodes—Six diodes per head, two heads

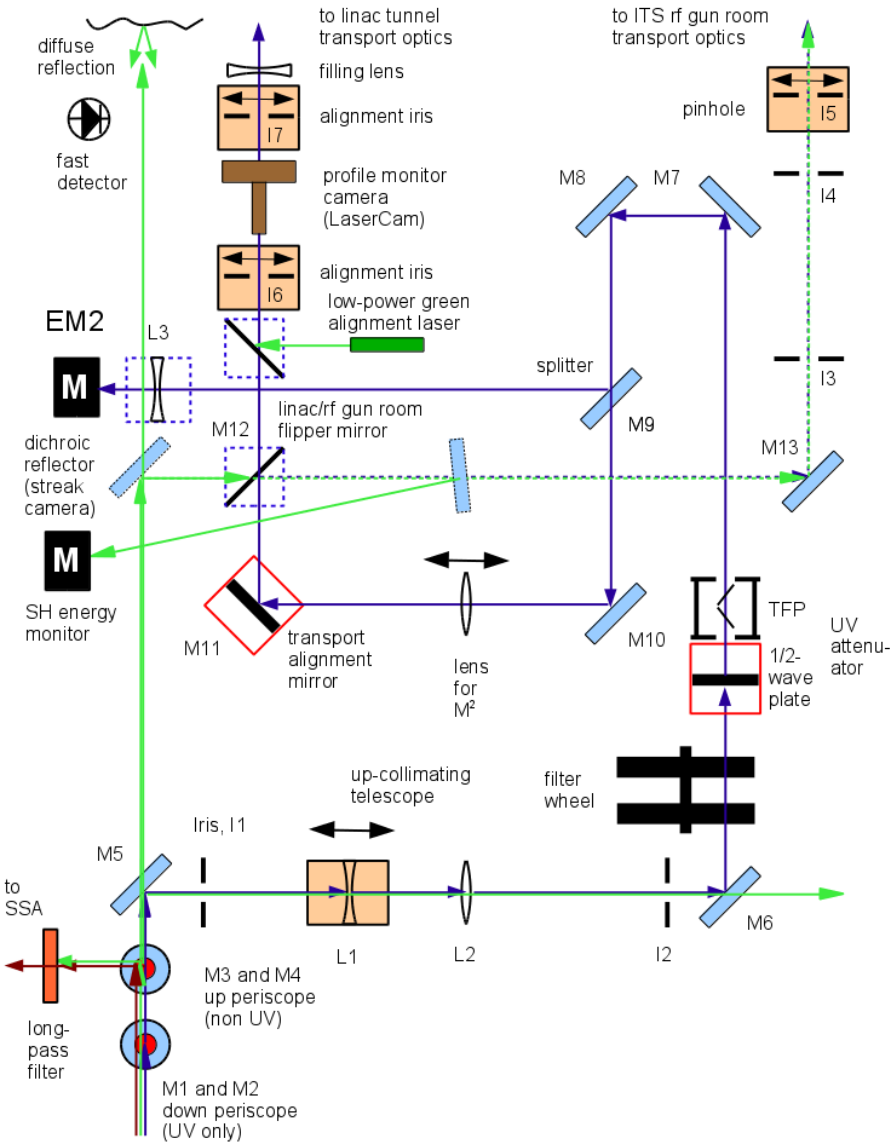


# Tranport Enclosure and Transport Line

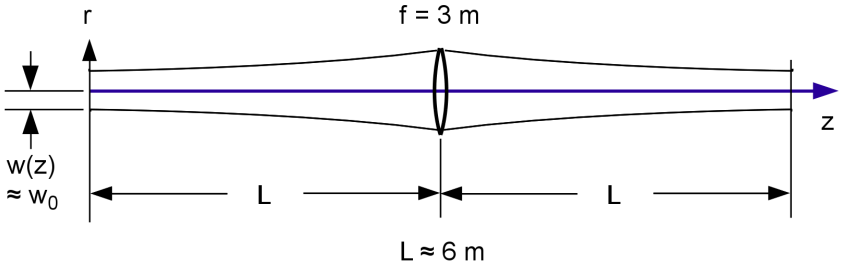



## Transport line—1:1 imager

Rule of thumb: 3W < $d_{lens}$ (50 mm)

let 3W=15 mm, W=5 mm

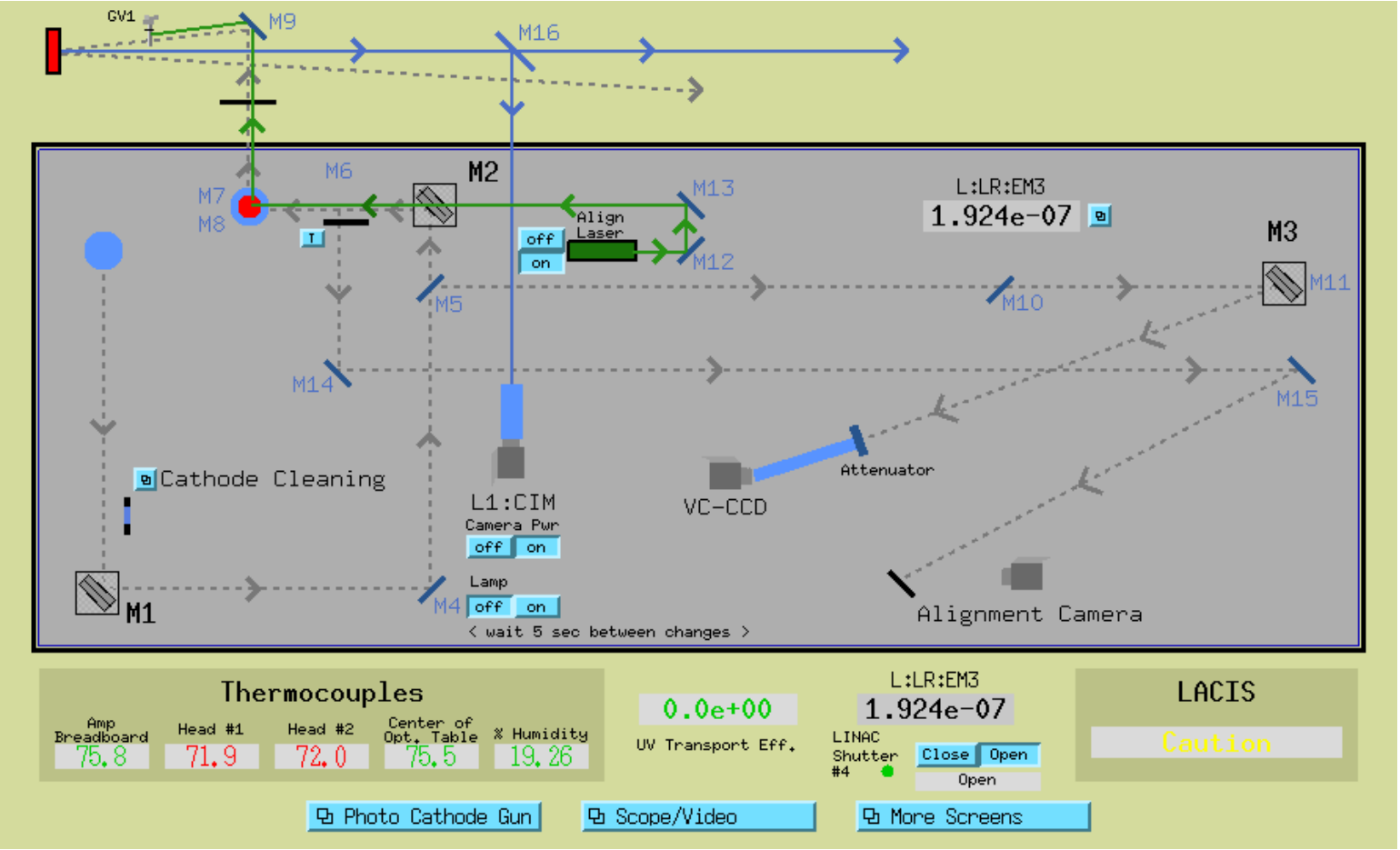
$$\theta = \frac{W}{L} = \frac{0.005}{6} = 0.83\ mrad$$



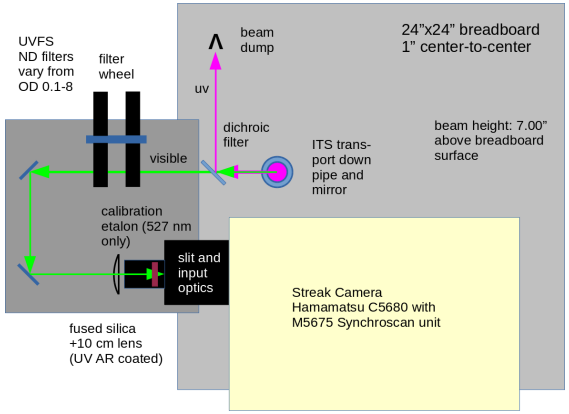

$$W_0 = \frac{M^2\lambda}{\pi\theta} = \frac{(1.5)(263\times10^{-9})}{\pi(0.83\times10^{-3})} = 1.51\times10^{-4}\,m$$

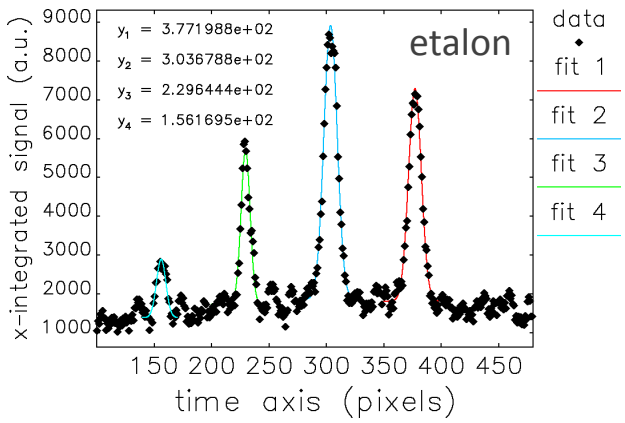
$$z_R = \frac{\pi W_0^2}{\lambda} = \frac{\pi(1.51\times10^{-4})^2}{263\times10^{-9}} = 0.273\,m$$

# Linac Optics Table



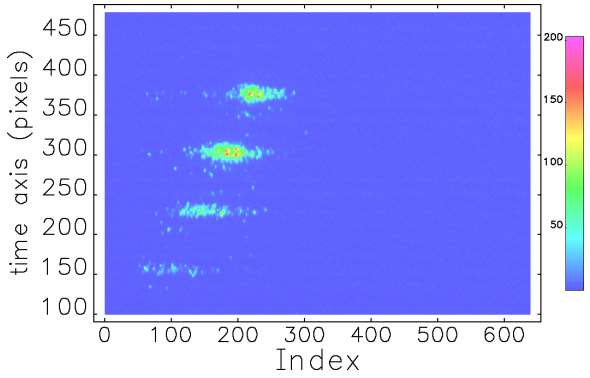
# Pulse duration—streak camera and auto-correlator (IR only)



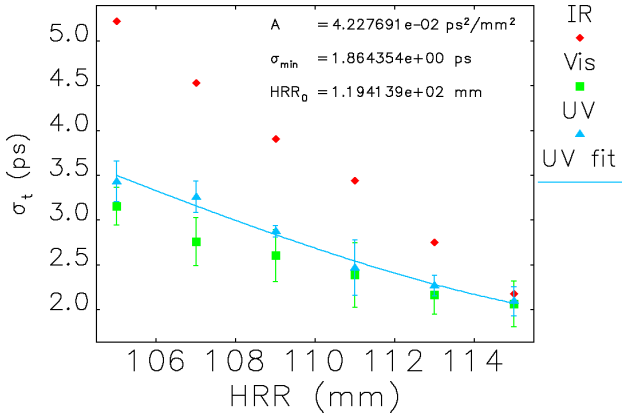




36.4 ps spacings

- Calibration of SH with calibrated etalon
- Calibration of UV with Colby Delay generator
- Both methods yielded a calibration of 0.5 ps/pixel
- Employ the compressor HRR to pulse duration

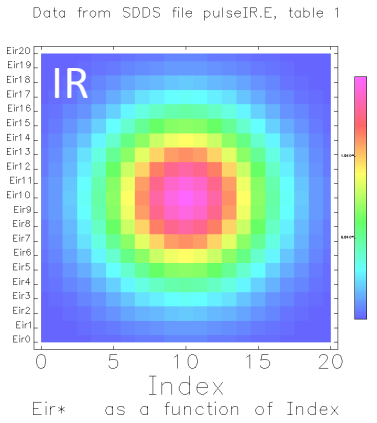


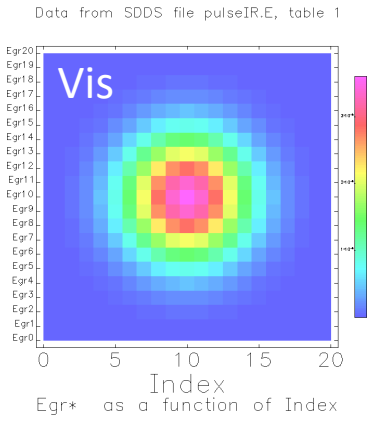

etalon

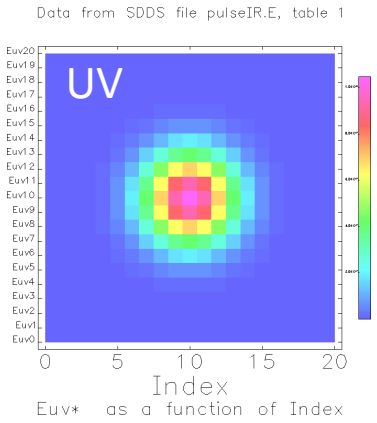



3-wavelength comparison

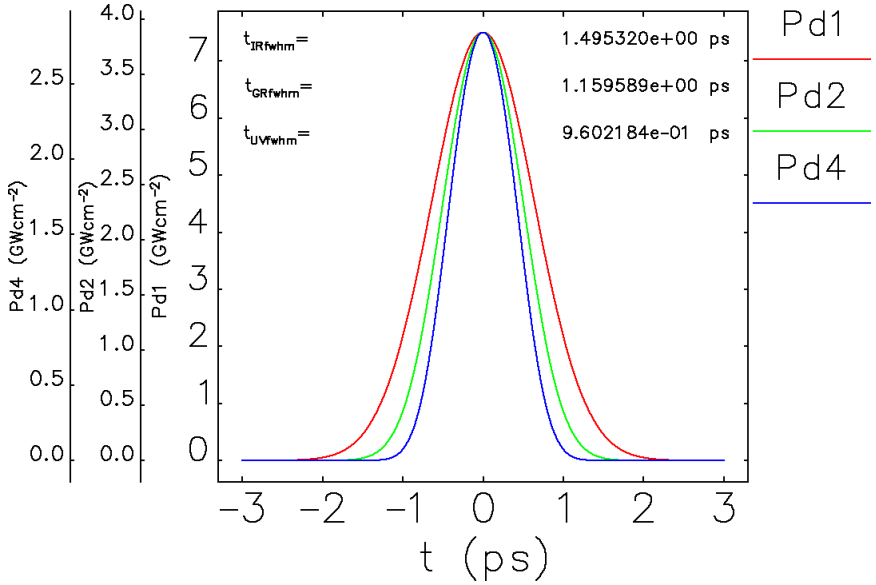
# Modeling second harmonic generation —using a pair of 1-mm thick BBO crystals



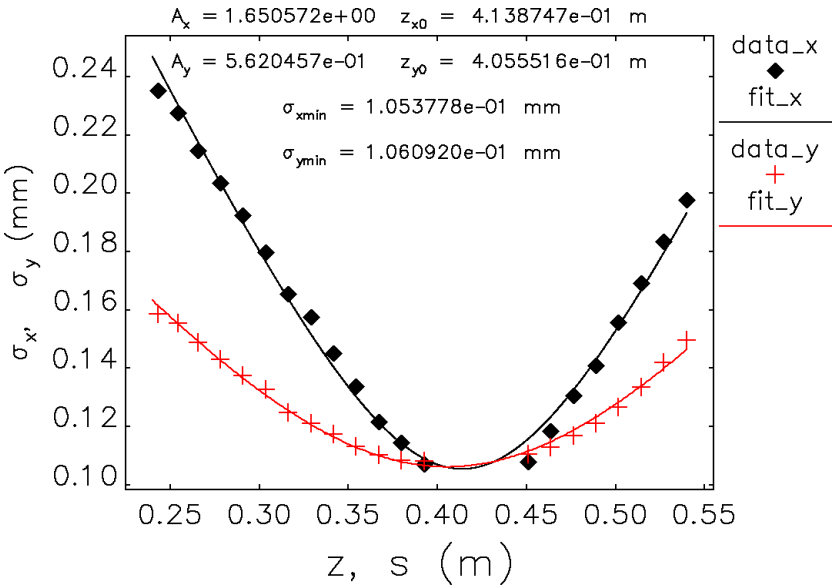



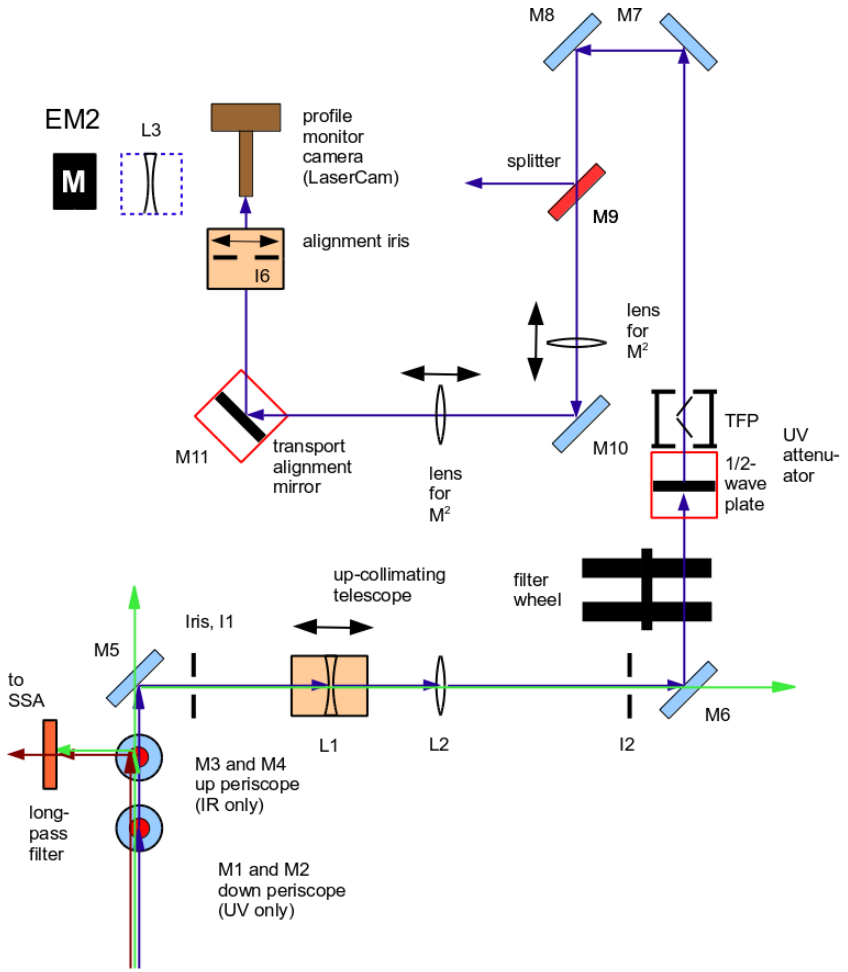




- $E_{ir}$=1.5 mJ, $w_x$=$w_y$=2 mm, $\sigma_t$=0.64 ps
- SHG beams shrink both transversely and long.
- Ignoring group velocity mismatch (GVM)
- In BBO, GVM=100 fs/mm at 1000 nm
- 600 fs/mm at 527 nm



# $M^2$ beam quality observations

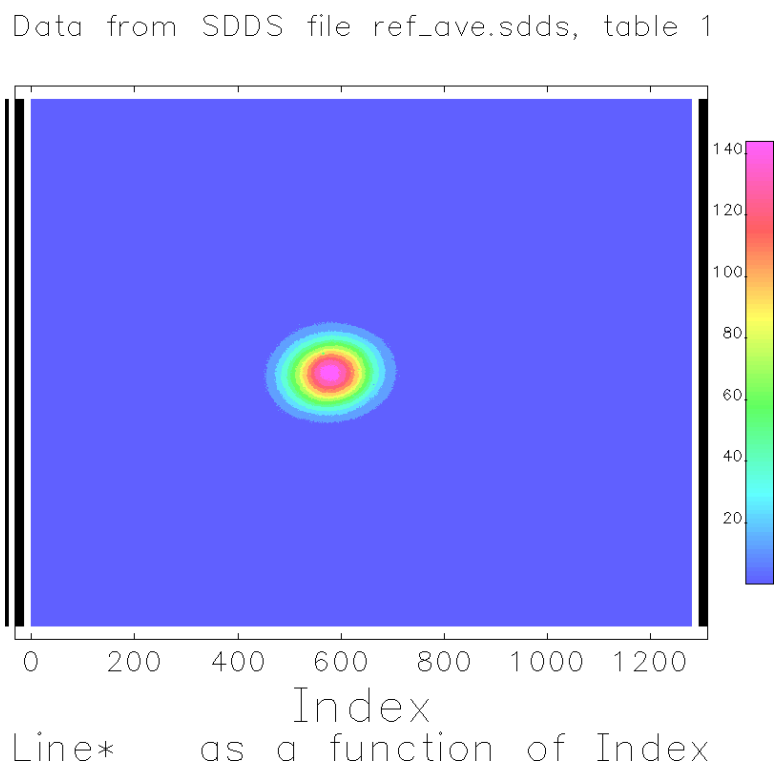


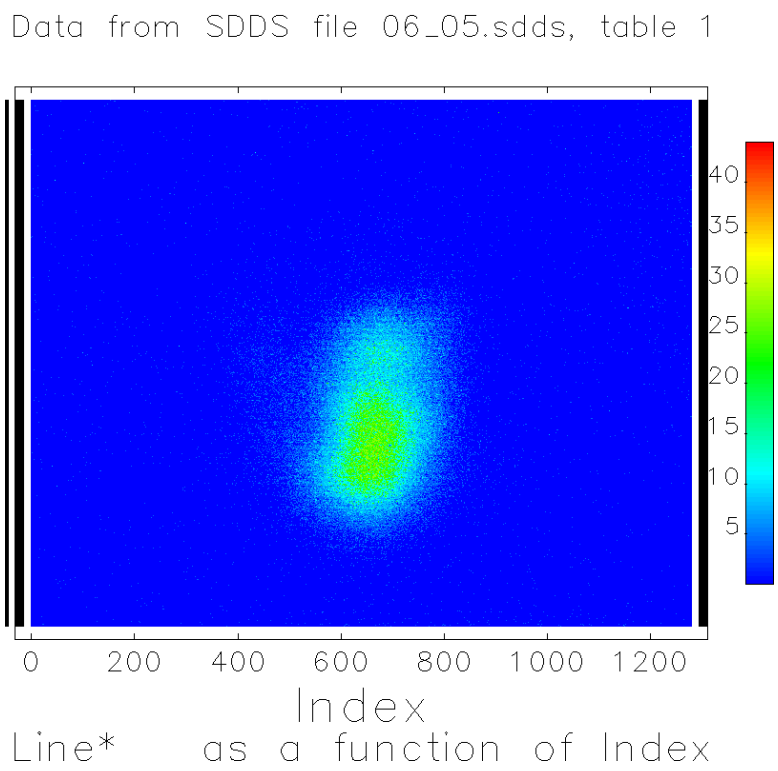

- $M_x$=2.54
- $M_y$=1.95
- pixels saturated during maximum focusing
- will increase minimum spots size and repeat measurement
- still some work to do on beam quality

# UV images

## Laser Room

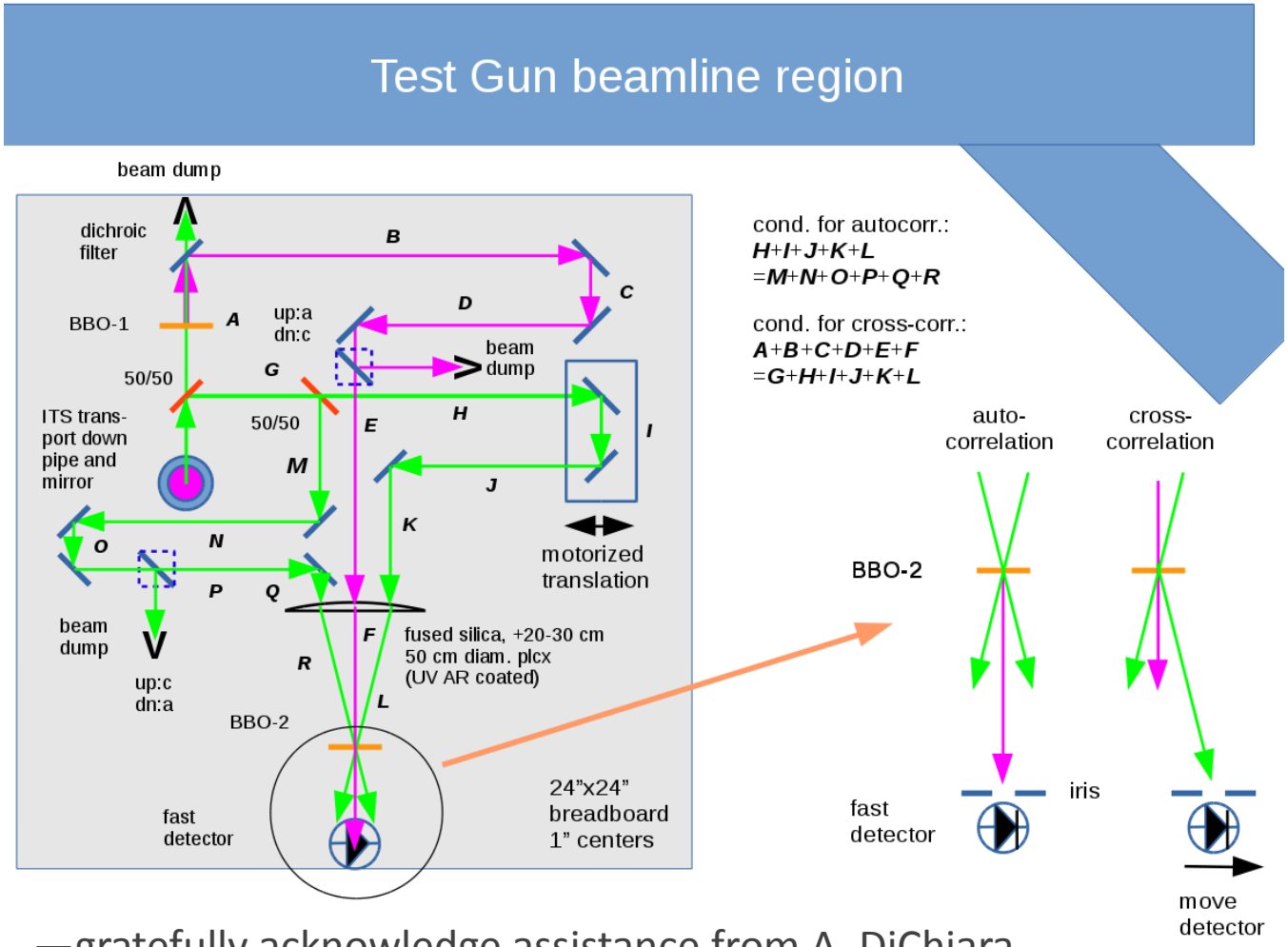



## Linac Tunnel




Both images recorded using a Coherent LaserCam HR digital camera with BIP-12

# On-going work: Auto/Cross-Correlator for pulse duration measurements




—gratefully acknowledge assistance from A. DiChiara