

# Optical Systems for the JLab FEL

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Thomas Jefferson National Accelerator Facility

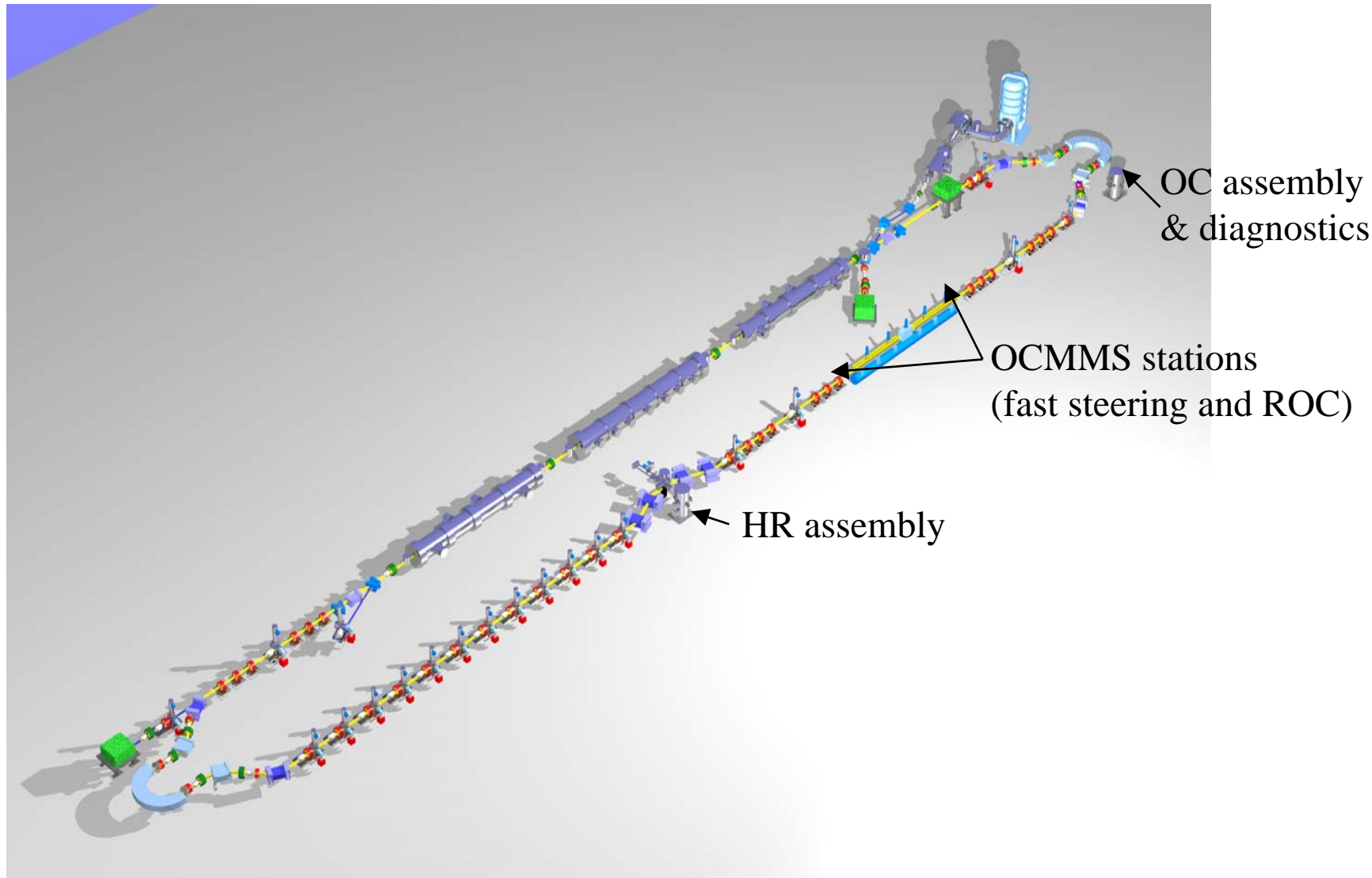


# OUTLINE

- Present status of the IR Upgrade FEL Optical Subsystems
  - Optical cavity
  - Optical transport
  - Optical diagnostics
- Near-term upgrades
  - Extended power-handling
- Conclusions



# IR UPGRADE OPTICAL CAVITY SYSTEMS



# OPTICAL CAVITY STATUS

- We currently have optics for broadband and 1.06 micron operation installed.
  - Broadband optics are silver-coated silicon substrates, hole-outcoupled.
- We have optics on the shelf for high power output at 2.8 & 6 microns.
  - Will reconfigure optical cavity to take advantage of accelerator gradient.
- OCMMS (optical cavity mirror metrology system) installation complete week of March 7. Will then begin working to feedback on mirror position.



# OPTICAL TRANSPORT SYSTEM (OTS)

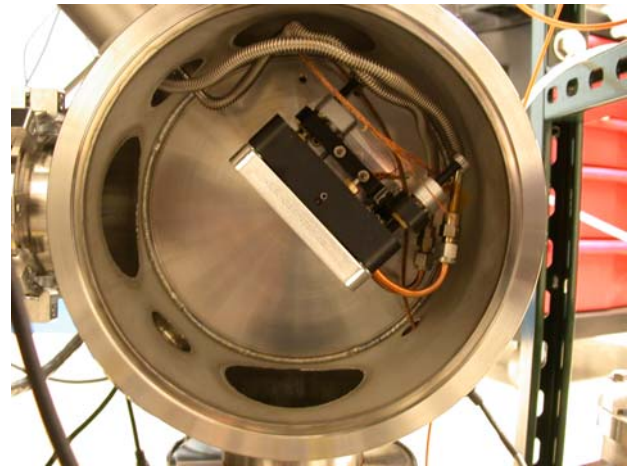
- IR Demo OTS used uncooled, silver-coated copper mirrors to transport beam.
  - Had to compensate for drift as absorbed power warmed the mirror mounts
  - We lost ~ 20% of the FEL output to absorption.
- We are commissioning OTS Lite
  - Collimate beam close to optical cavity.
  - All mirrors are water-cooled, to minimize drift.
  - Mirrors are silver-coated silicon, to improve beam quality.
  - Hole in Optics Control Room mirror transmits  $\sim 5 \times 10^{-4}$  onto diagnostics table.
- We are building the components for OTS Standard
  - Collimator and mirror cassette style turning mirrors downstairs, to be optimized for different wavelength regimes.
  - Three dielectrically-coated, 1 silver-coated.
    - Backplane cooled Si turning mirrors.



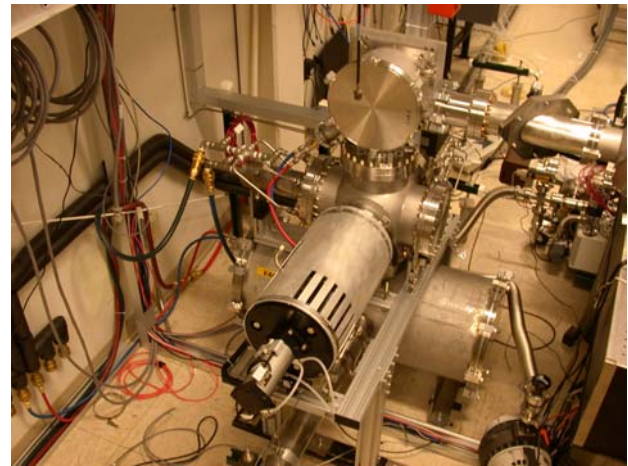
# FEL OPTICAL TRANSPORT COMPONENTS



Collimator and transport in vault



Water-cooled, actuated mirror can



UL 1 mirror cassette assembly



# OTS STATUS

- We've received the turning mirror cassette hardware, and collimator can 1 assembly.
- Collimator can 2 is in fabrication, we're beginning to assemble other hardware.



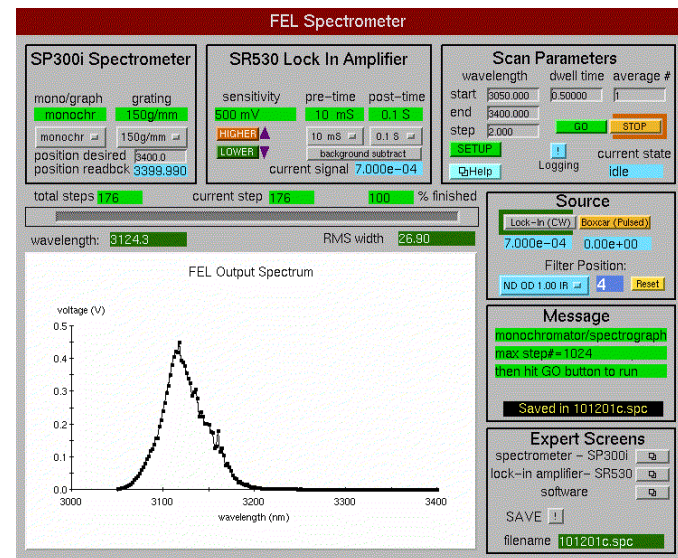
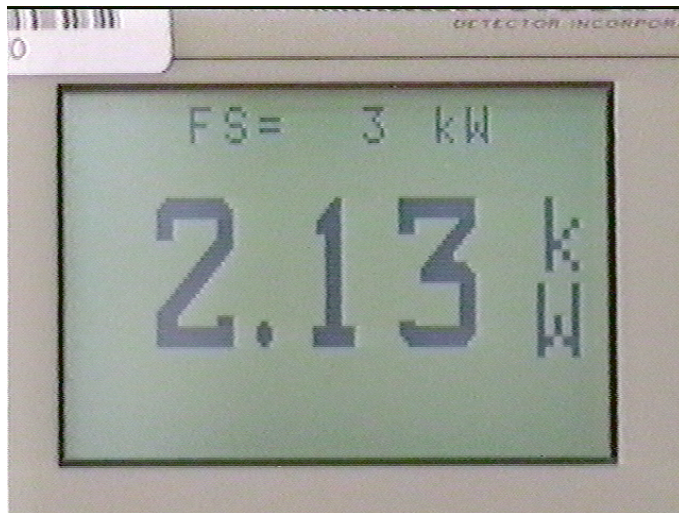
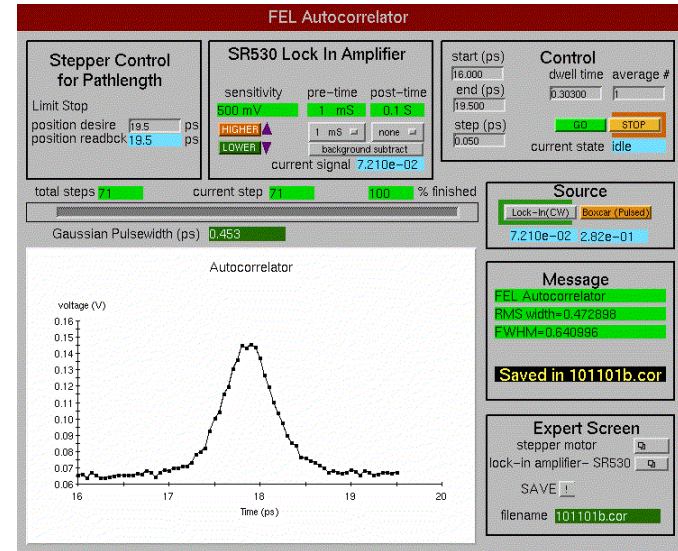
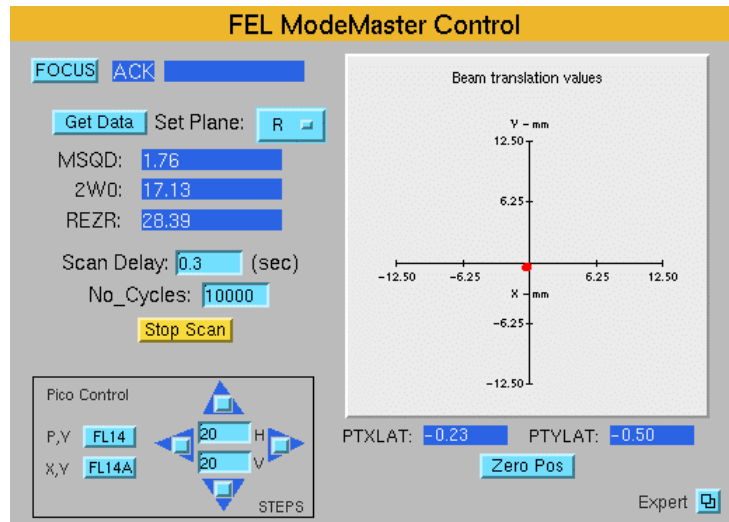
# OPTICAL DIAGNOSTICS CAPABILITIES

- Performs continuous diagnostics on CW or pulsed laser output
  - Lasing spectrum ( $\lambda^{\text{peak}}$ , FWHM)
  - Output power
  - Pulsewidth (via autocorrelation)
  - Beam Profile, Beam Quality, Pointing Stability (performed in user labs)
- Provide optical beam dump if beam is not required by users
- Diagnostics
  - Power: JLab-designed power meter, Molectron PM3 - PM10K
  - Energy: Molectron J-25 pyroelectric detector
  - Pulsewidth of micropulse: Two-photon absorption or Type I autocorrelation
  - Pulseshape: Frequency Resolved Optical Gating
  - Beam Profile: Spiricon Pyrocam Type I & III, Coherent Modemaster
  - Spectrum: Acton SP300I (0.3 m fl)
    - EG&G Judson InSb and MCT
    - Sensors Unlimited InGaAs array, CalSensors PbSe array
    - Hamamatsu PMT

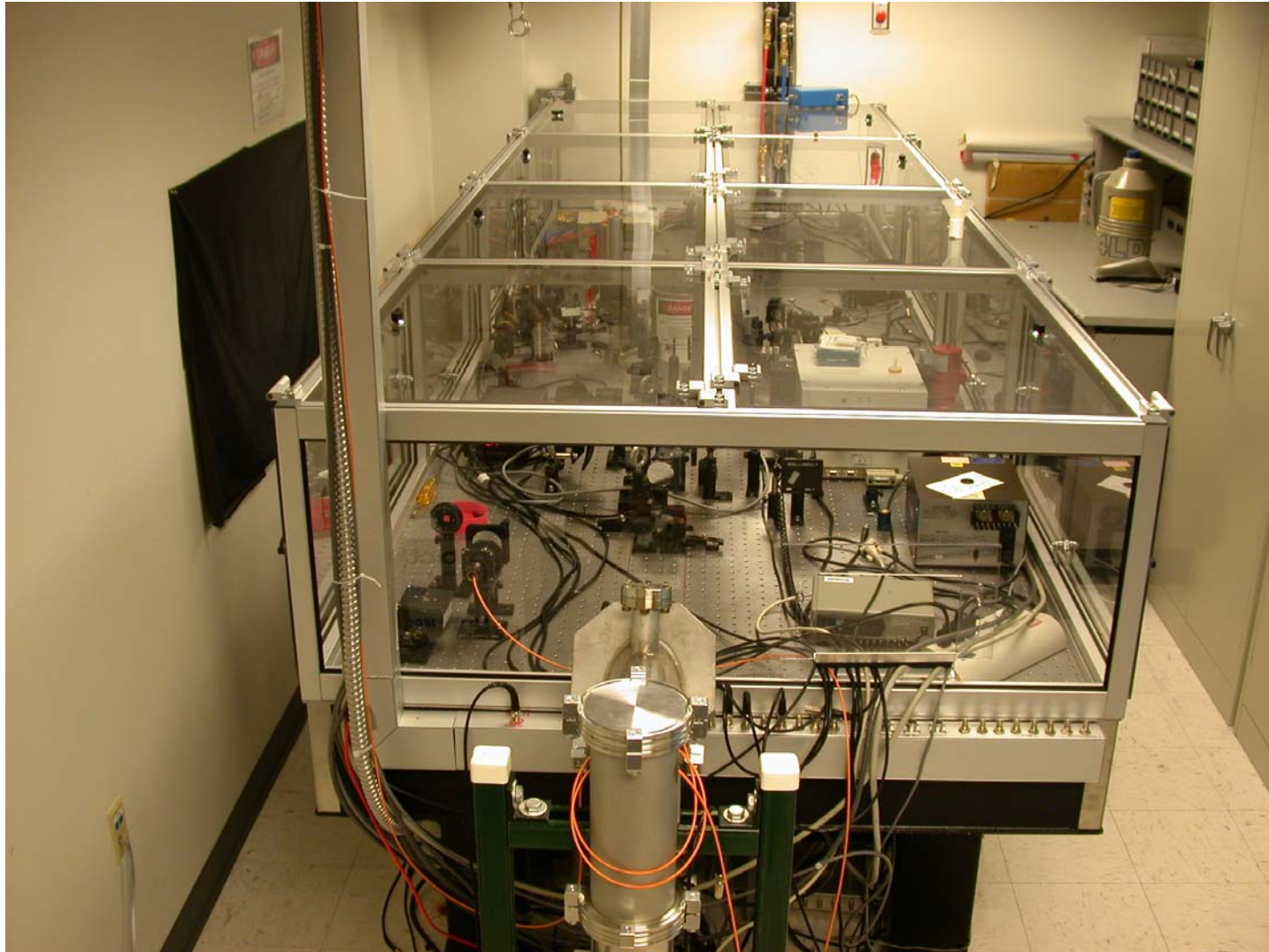




# EXAMPLES OF DIAGNOSTIC OUTPUTS



# OPTICS CONTROL ROOM



# CONCLUSIONS

- We've gained valuable experience on the optical cavity during commissioning.
- We are ready to commission the OTS
- We have a complete set of optical diagnostics for the IR Upgrade FEL
  - Macropulse energy
  - Average power
  - Spectrum
  - Pulsewidth and pulshape
  - Beam profile
  - Beam quality

