DiPOLE: Overview and Status

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on behalf of the DiPOLE team

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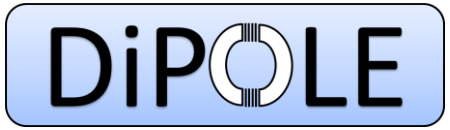

Diode **P**umped **O**ptical **L**aser **E**xperiment

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Diode **P**umped **O**ptical **L**aser for **E**xperiments

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Outline

- Prototype and headline results
- What we've learned
- 100J upgrade
- Outlook

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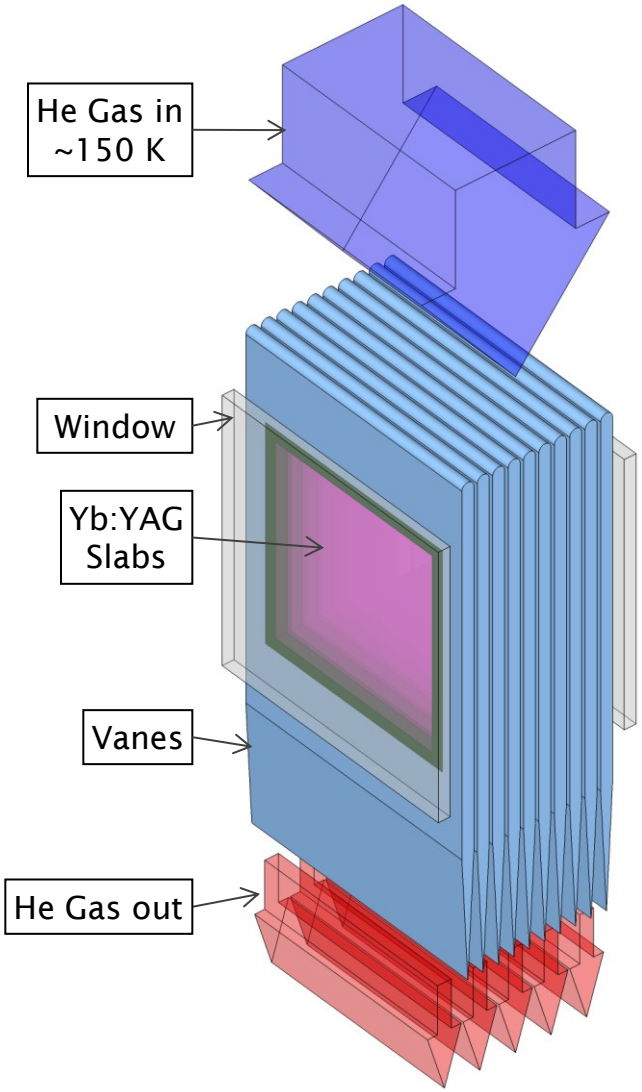
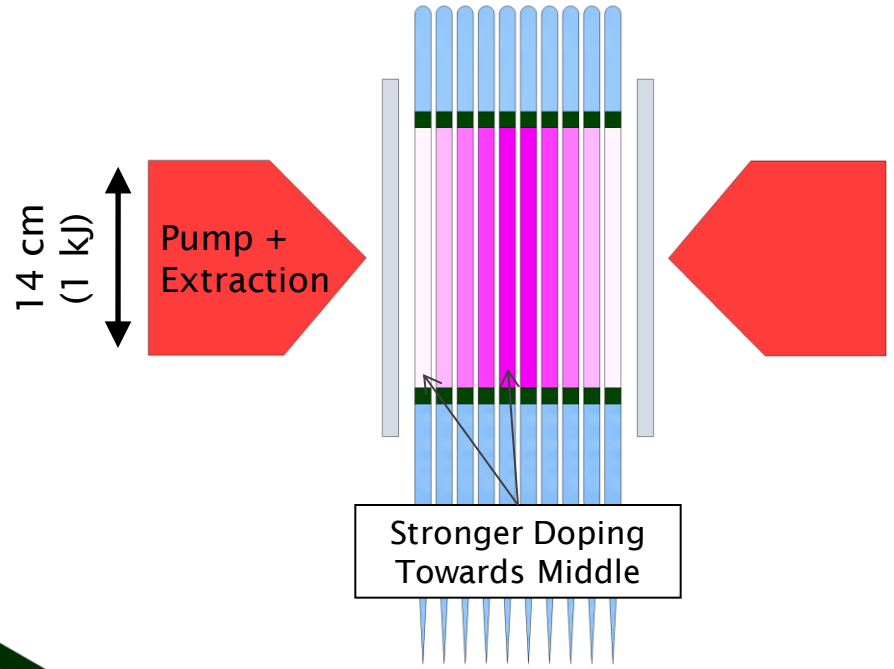
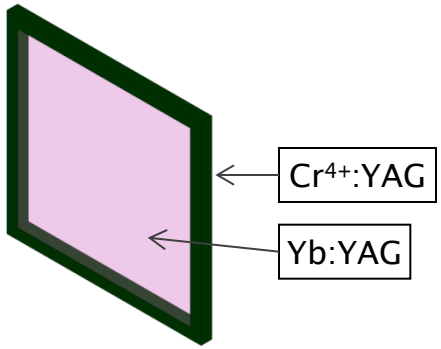
DiPOLE Amplifier Concept

End-pumped slab-stack cooled by **cold** He gas flow







Co-sintered ceramics
Absorber cladding
for ASE management

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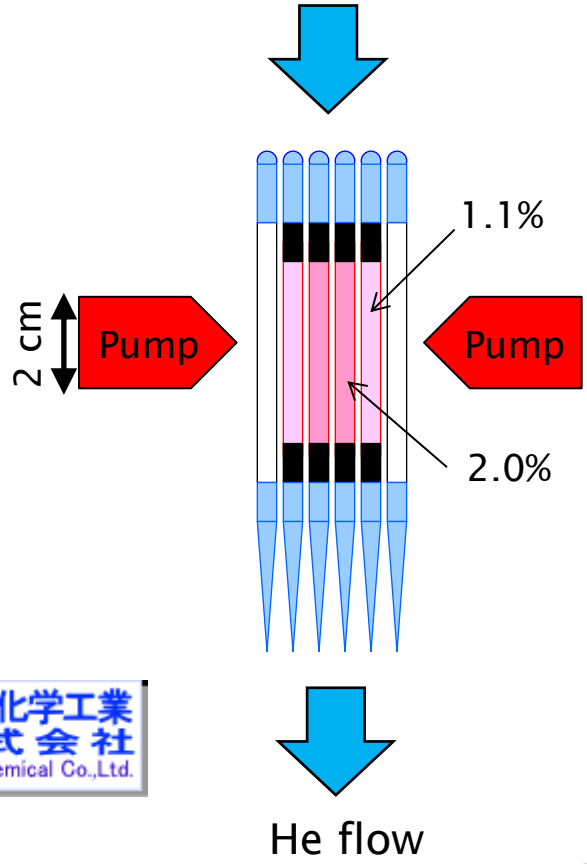
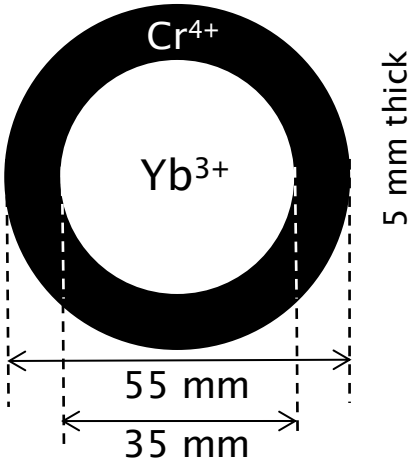
The Prototype: DiPOLE 10J

- Dimensioned for 10 J output at 10 Hz
- Exploit scalability
- Compared to kJ concept
  - Same fluence (damage limited)
  - Same aspect ratio (ASE limited)
  - Same pump absorption
  - Lower thickness
  - Higher doping



YAG compound ceramics



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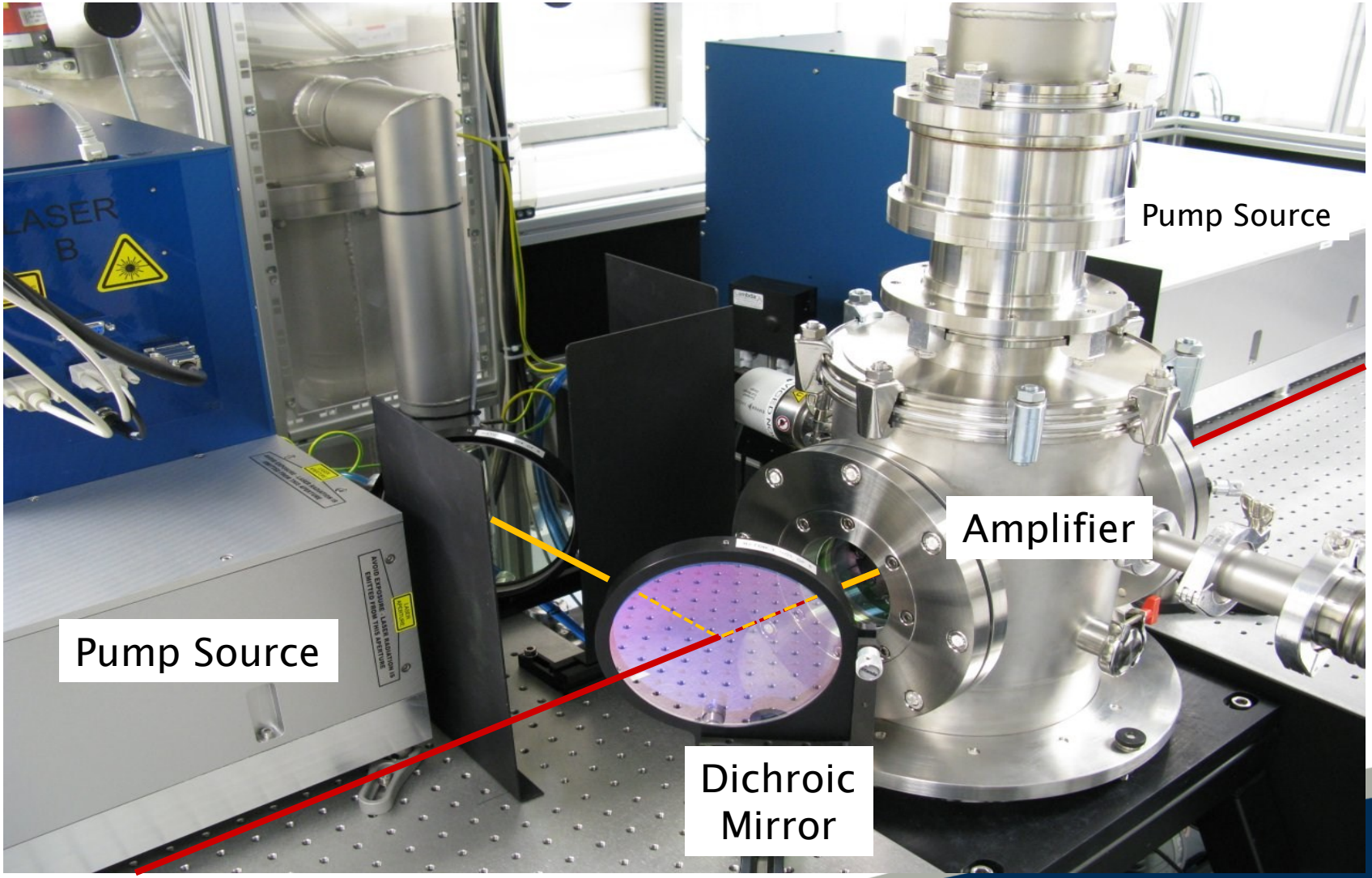
Setup Amplifier



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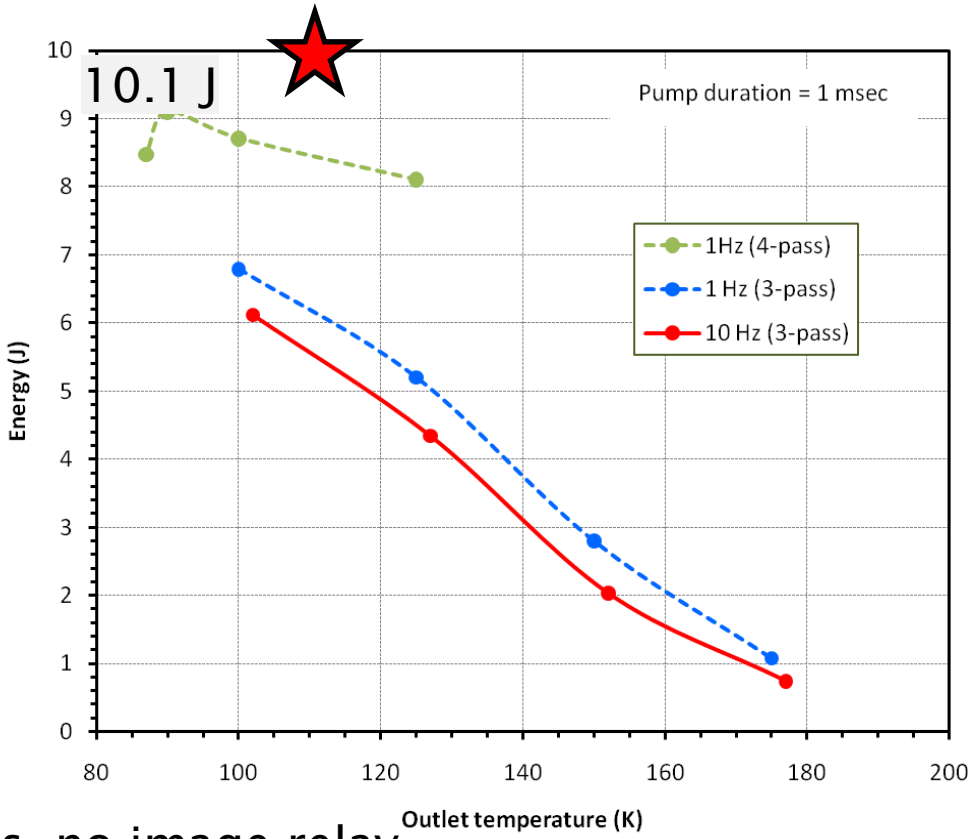
Previous Results



- 3 or 4 passes, no image relay

☺ No major pitfall with gas-cooled cryo approach

☺ Enough stored energy, ASE under control

☹ Needed very low temperatures

Optics Letters, Vol. 37, p. 2175

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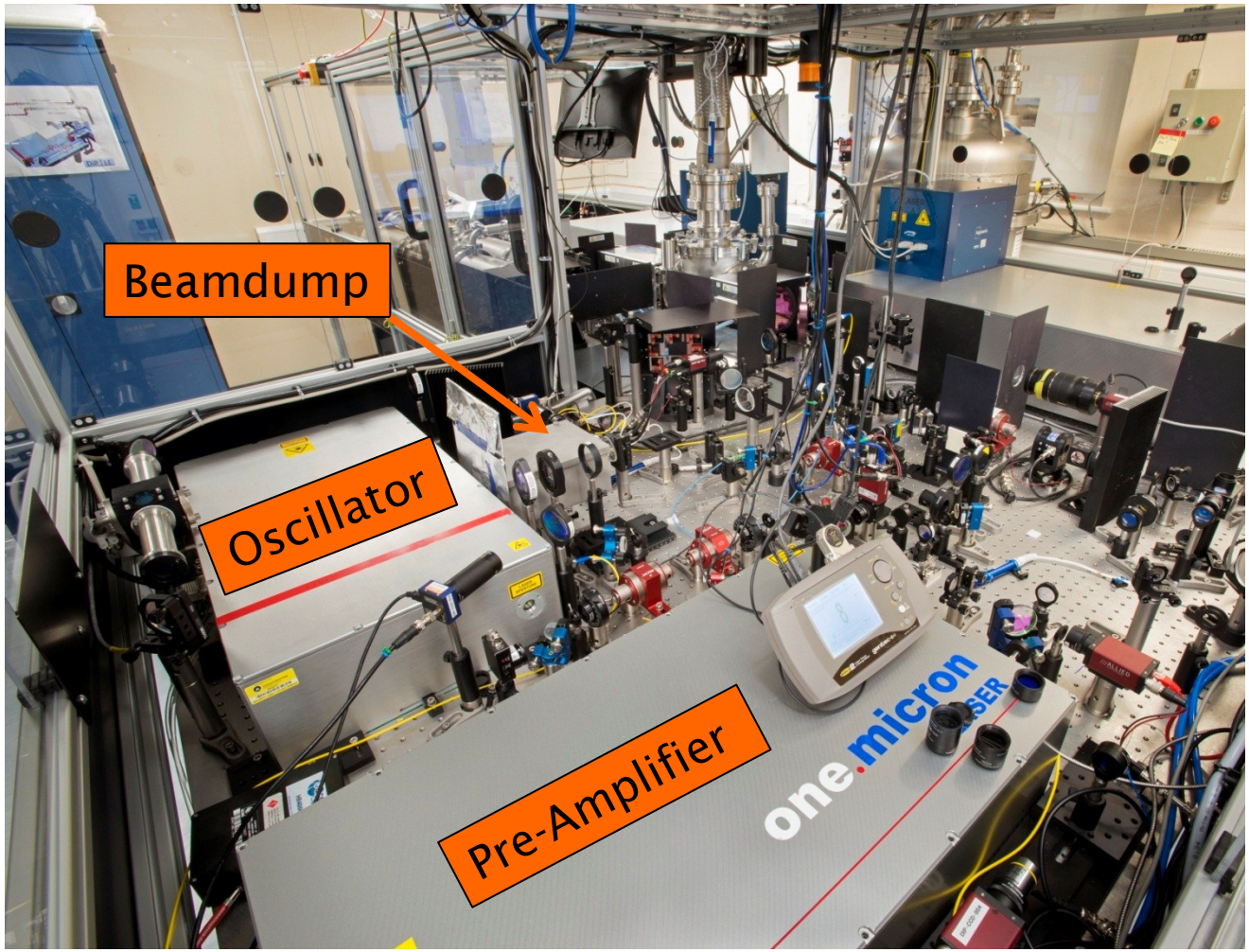
Setup : Frontend + Diagnostics



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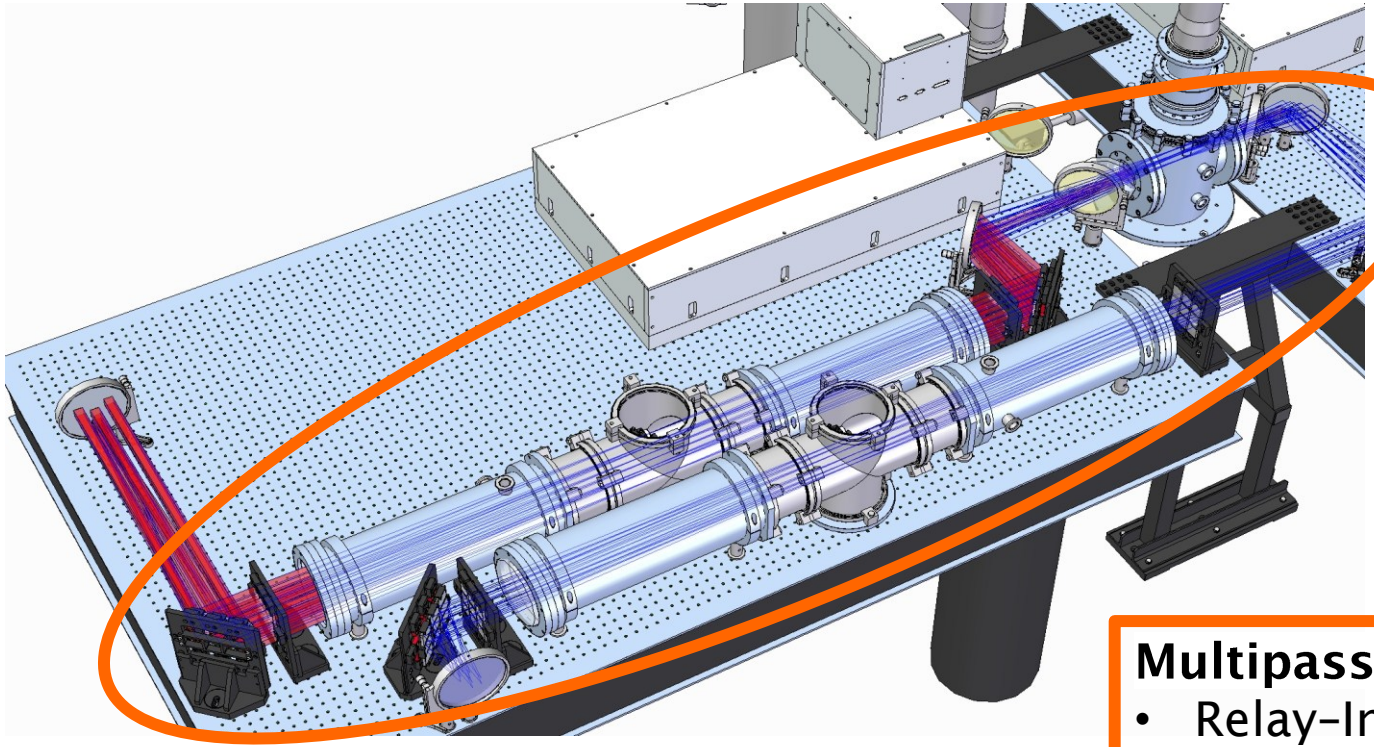
Setup : Multipass



Multipass Architecture

- Relay-Imaged
- Up to 8 passes
- Spatial filtering

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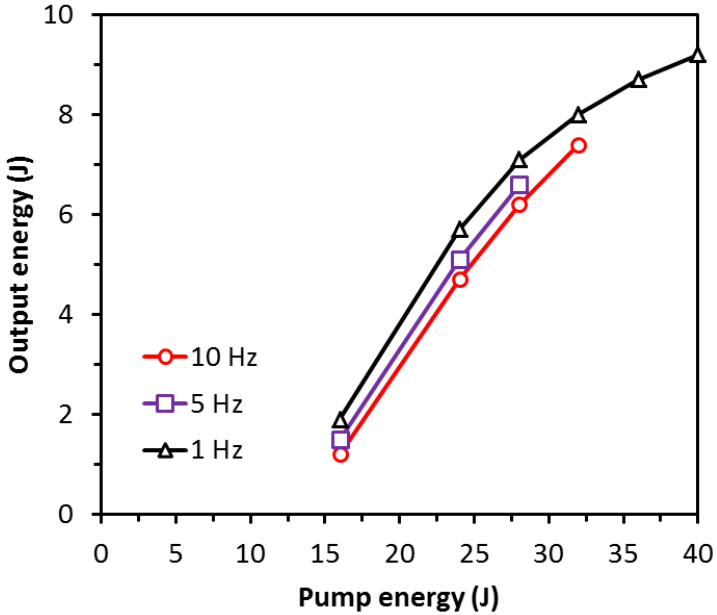
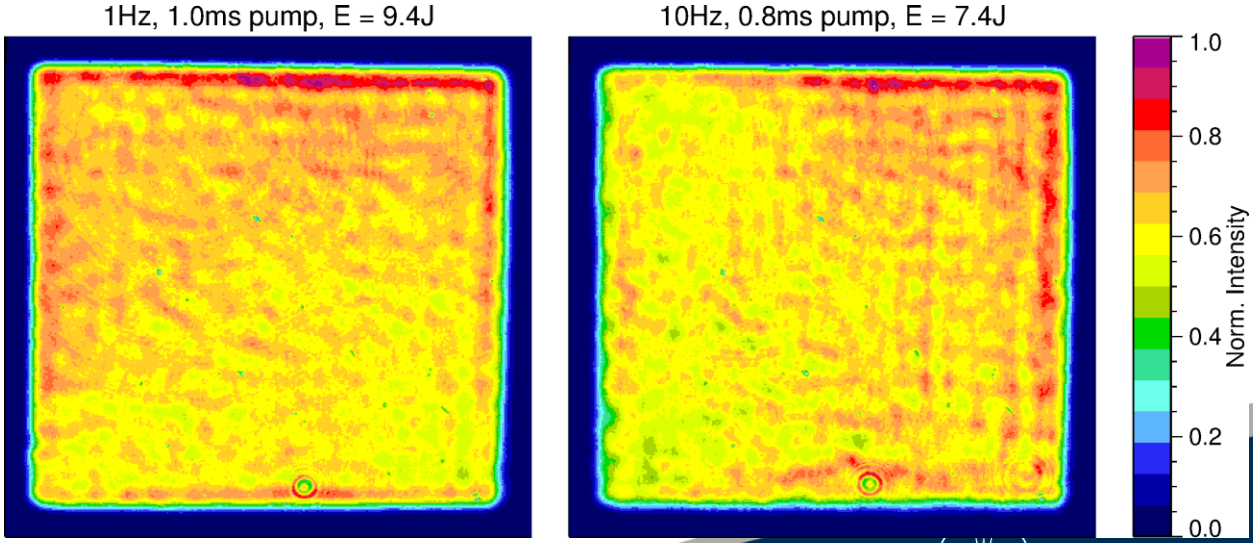
More Recent Results



- 6 passes
- 125K
- Higher temperature
- Higher efficiency
- Much better near-field



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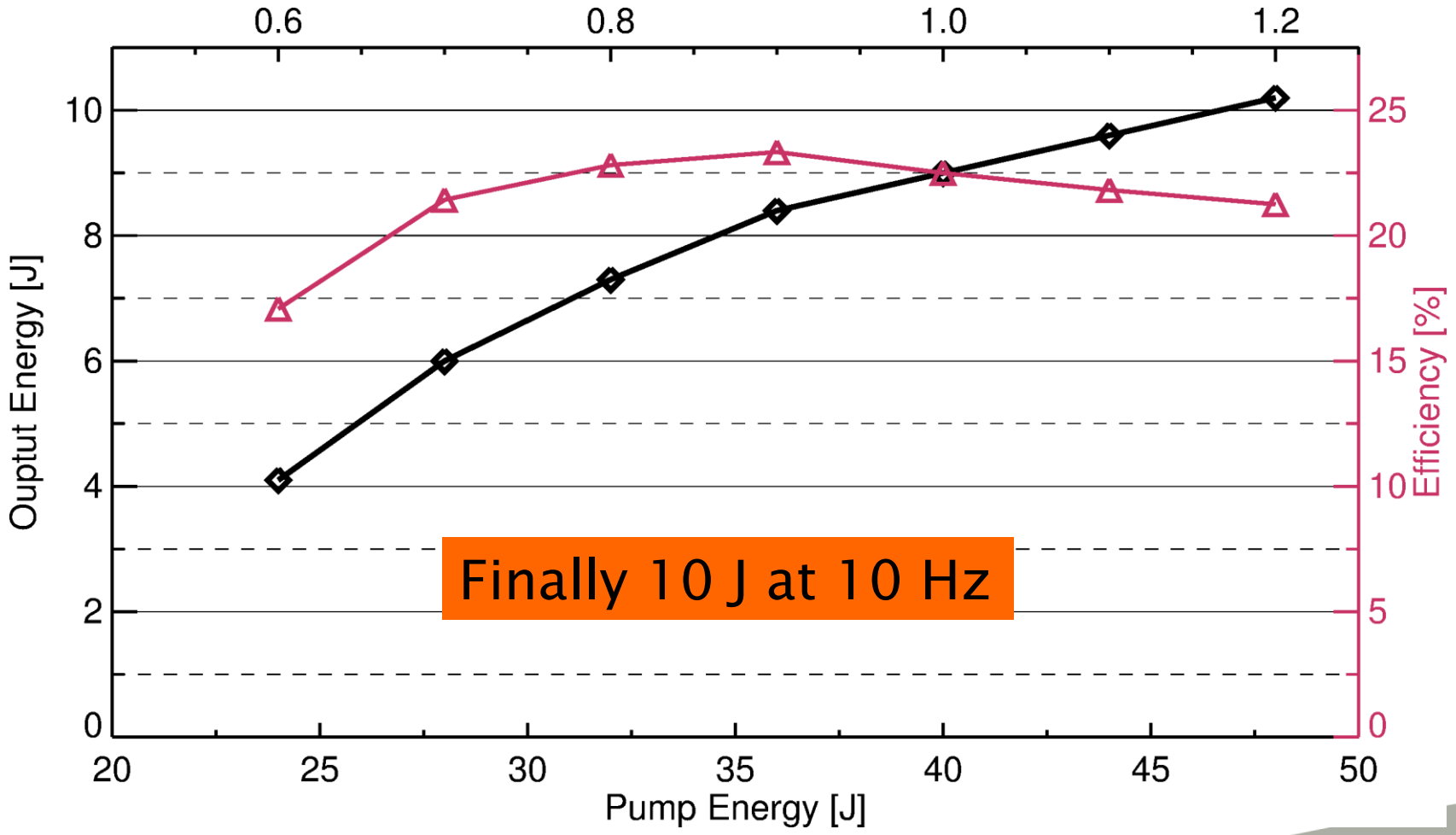
Most Recent Results



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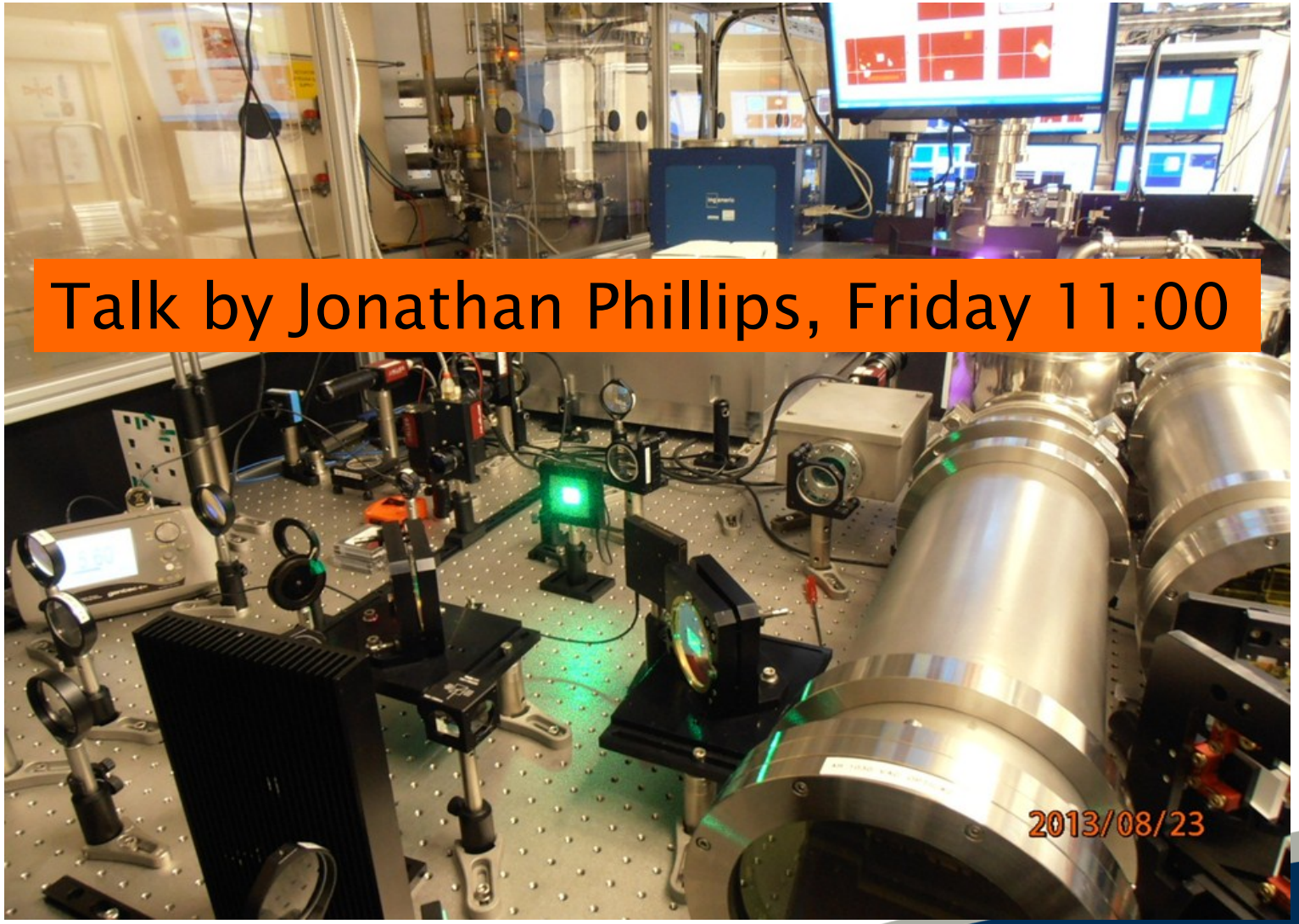
Also Recently: Green



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What we've learned (examples)

- Control of pulse shape
- Control of thermal aberrations
- Dealing with high average power

What we're still learning

- Exotic optics and coatings in exotic conditions
  - Yb:YAG, Sapphire
  - IBS and IAD coatings
  - Vacuum, cryo, high-pressure He

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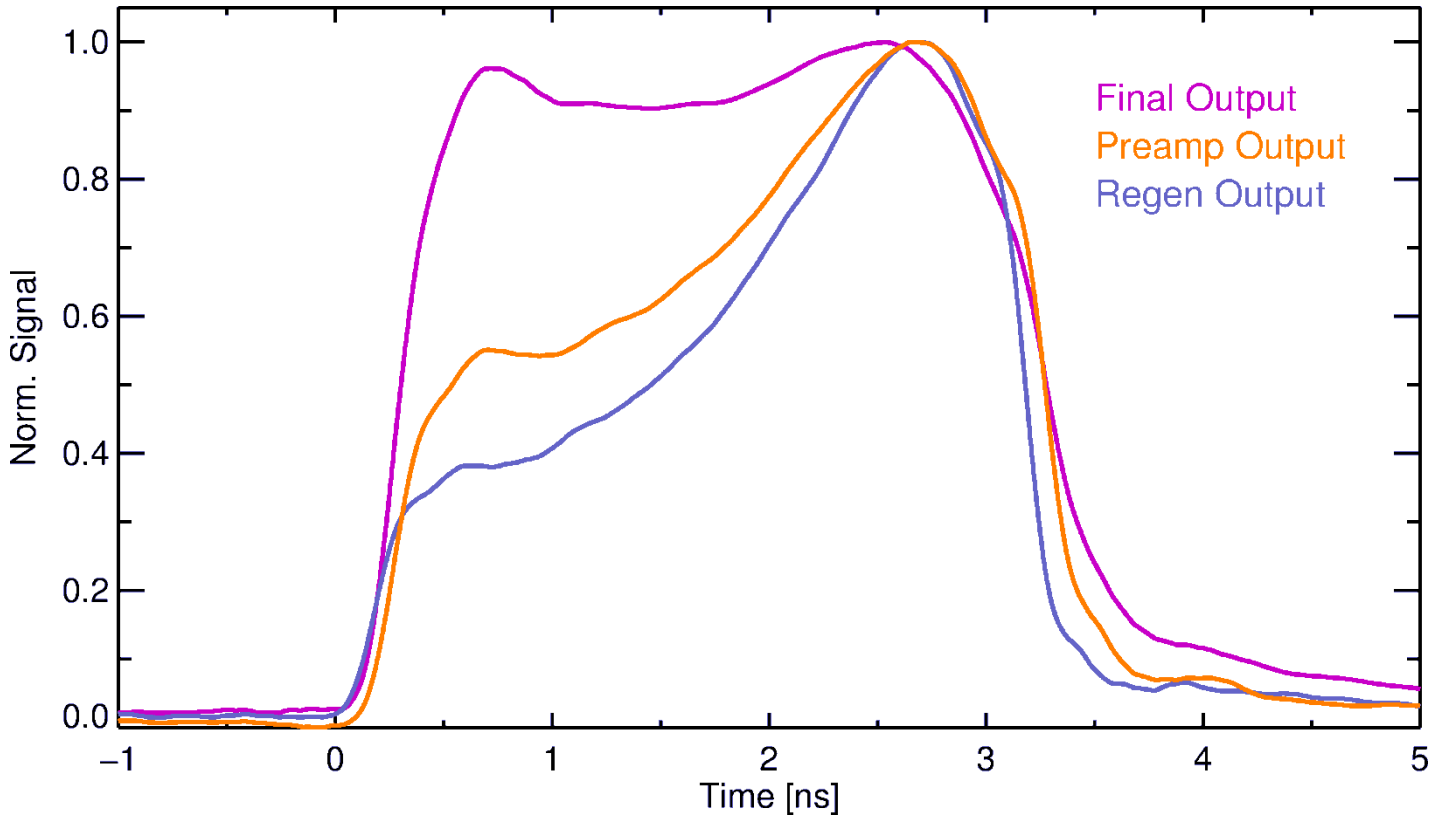
Example: Compensating Gain Saturation



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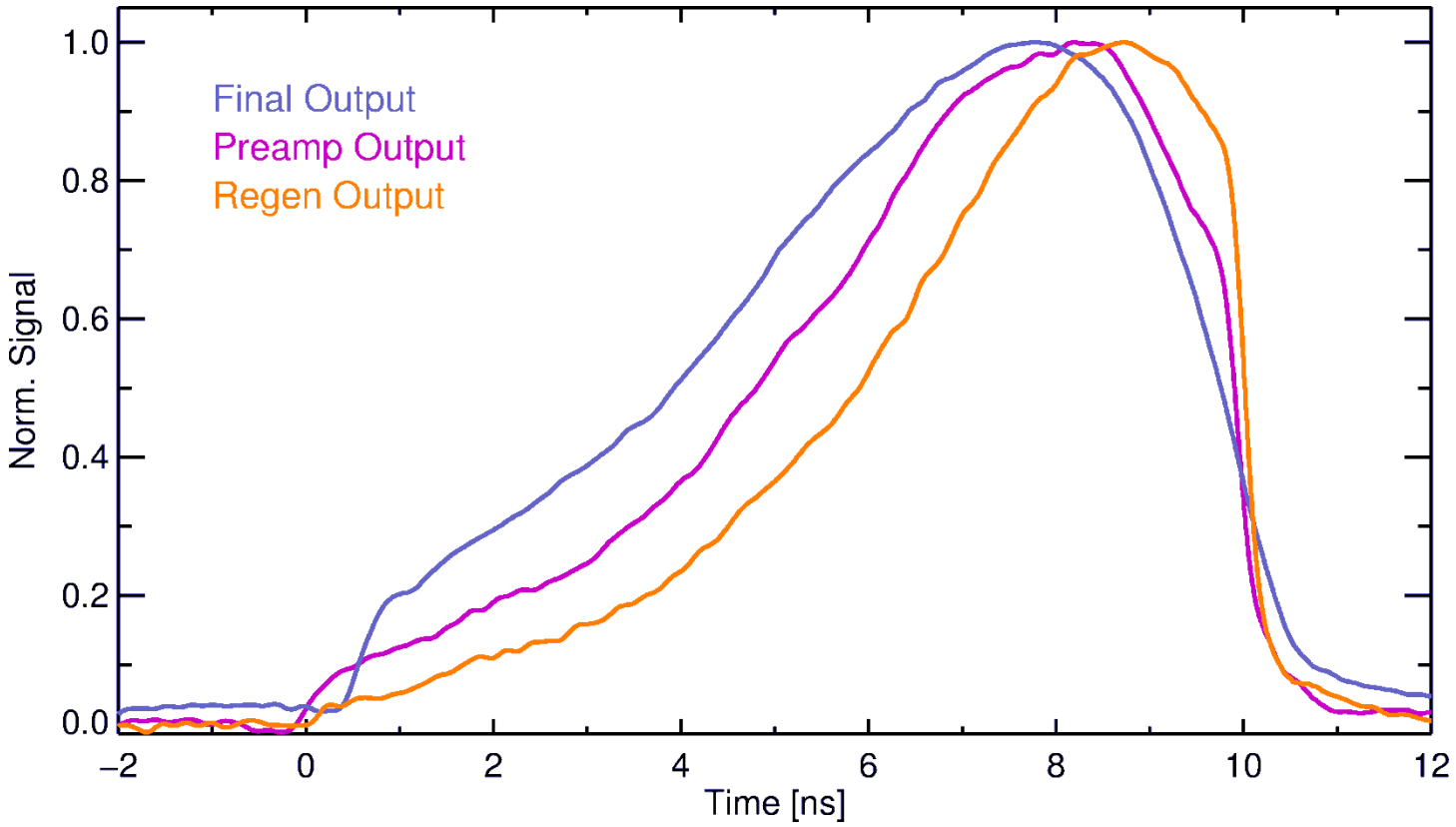
Example: Rising Ramp Profile



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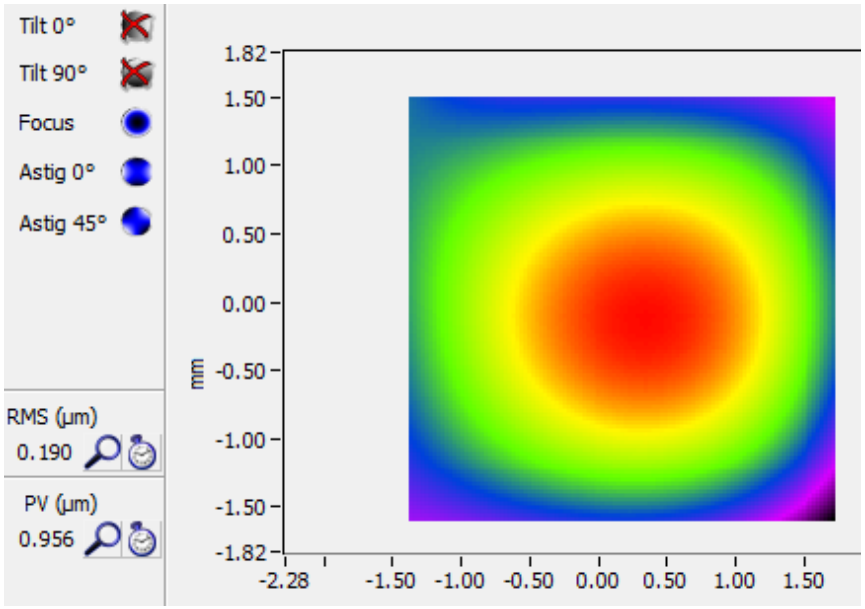
Thermal Aberrations

Measured single pass wave front distortion (thermal contribution only)

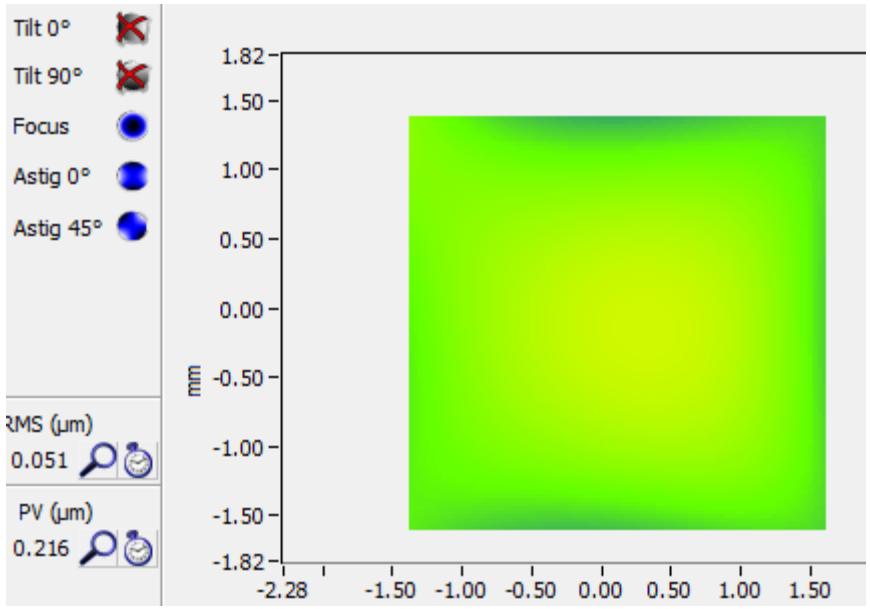
Old Windows (UV-Grade)



P-V 0.96 µm

RMS 0.19 µm

New Windows (Suprasil 3002)



P-V 0.22 µm

RMS 0.05 µm

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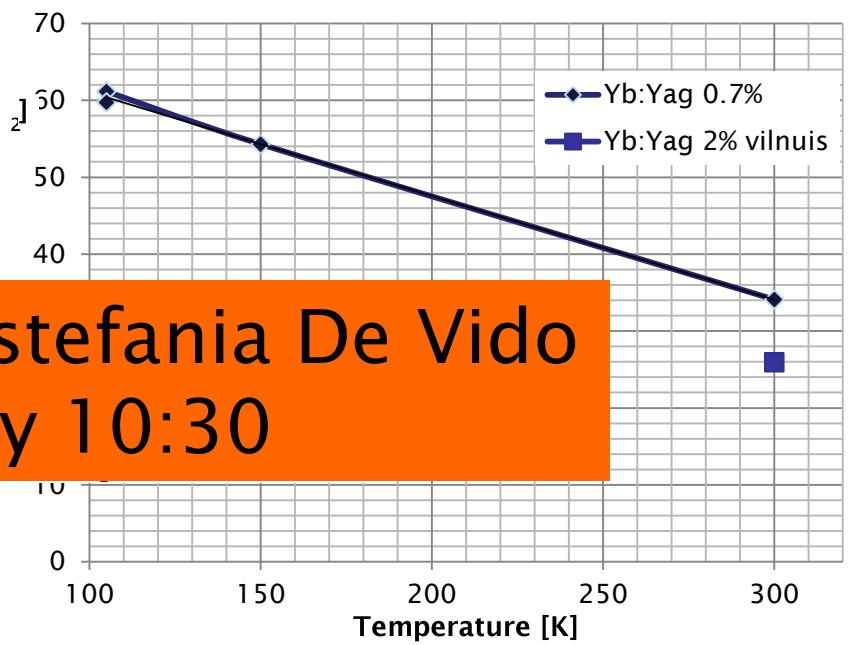
Exotic Optics in Exotic Conditions: Yb:YAG Laser Damage

In-situ behaviour

Offline LIDT testing



Talk by Mariastefania De Vido
Friday 10:30

- Recurring damage at ~2.5 J/cm^2
- In high-pressure cold He flow
- Localised, not growing fast
- Only Yb:YAG affected, not windows

- Measured with small spot
- Ambient and cryo/vacuum
- Much higher LIDTs
- Alternative polishing and coating brings no significant improvement

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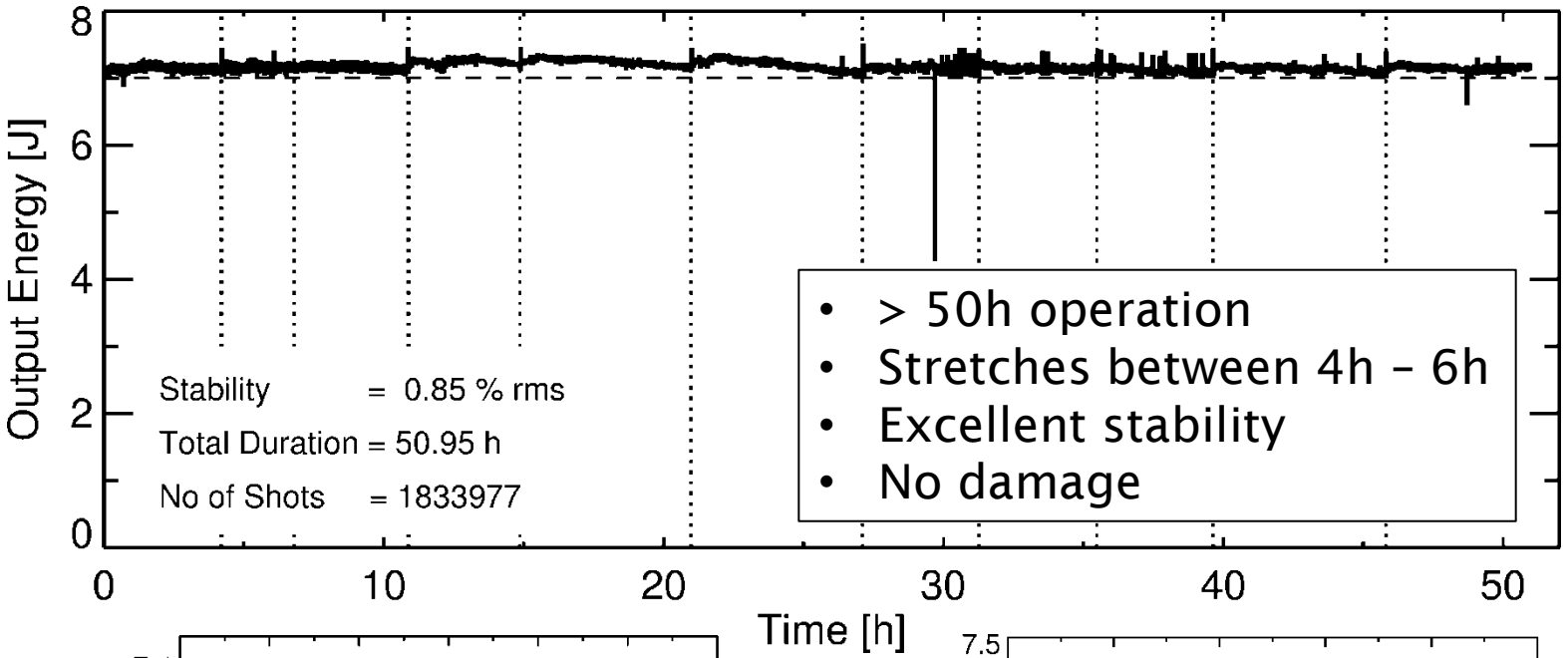
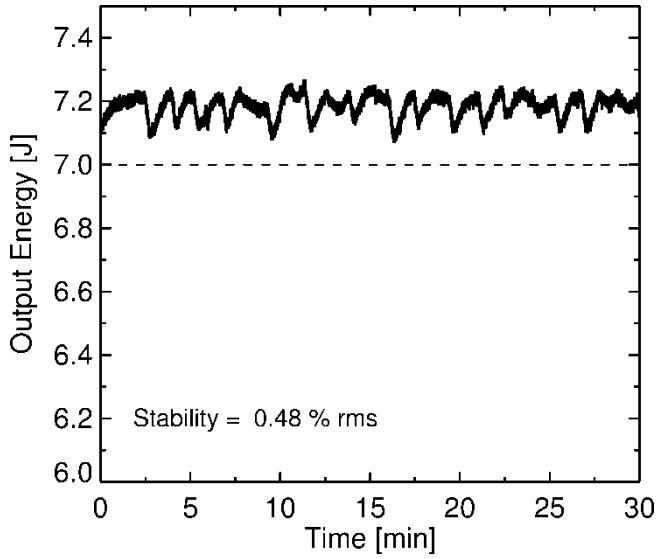
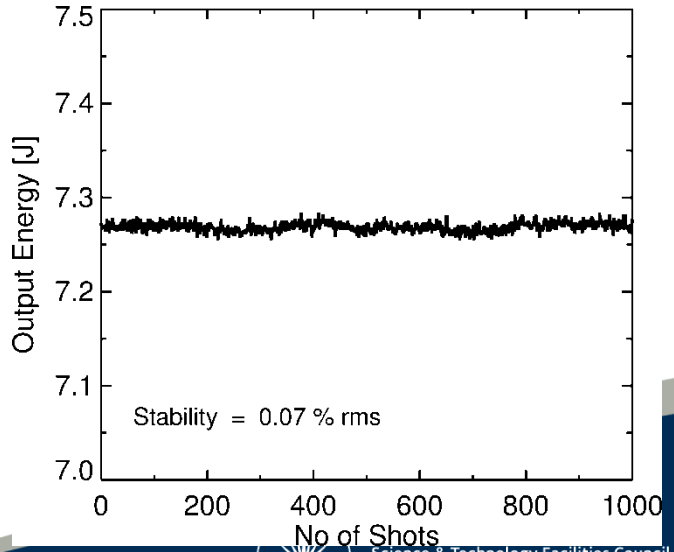
More on Stability







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Upgrade: 100J system for HiLASE

Front-end
Multi-stage
Room temp

~30 mJ

10J stage
6 passes
150 K

10J

100 J stage
4 passes
150 K

100 J

SHG ?

http://www.hilase.cz/en/

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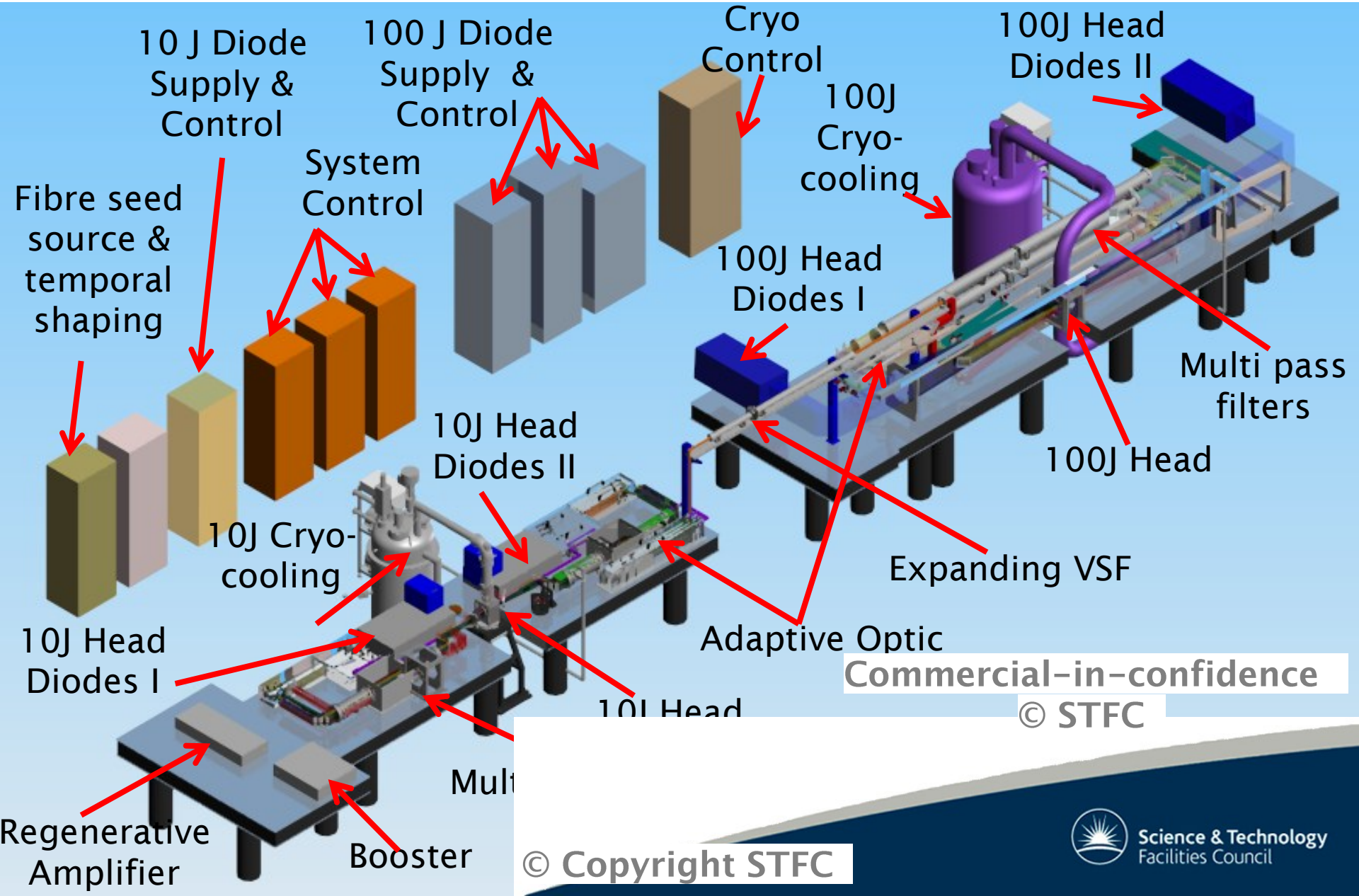
100J layout HiLASE



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100J Features

- **Planned added capabilities**
  - Active (spatial) beam shaping using SLM
  - Pulse shape closed-loop control
  - Active control of wave front using AO
  - Active stabilisation of beam alignment/pointing
  - Advanced diagnostics and central control system
- **Planned delivery May 2015**

- Talk Paul Mason on 100J amplifier Thu 09:30
- Talk Tom Butcher on front-end Thu 17:30
- Talk Jodie Smith on Diagnostics Fri 11:30

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Conclusion + Outlook

- **10 J Prototype:**
  - Record level efficiency, average power, pulse energy
  - Reached 10 J, 10 Hz target
  - Programme to solve outstanding issues + to test new components
- **100 J system status**
  - Team assembled
  - Design nearly finished
  - Lab nearly ready
  - All large contracts placed, goods starting to arrive
- **100 J system plan**
  - Build + commission system on site, then
  - Deliver to HiLASE in May 2015
- **After that**
  - 100 J DiPOLE for European XFEL-HED beamline
  - 10 Hz PW lasers based on DiPOLE-pumped Ti:S or OPCPA

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Thanks for Listening!

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