A Status Report

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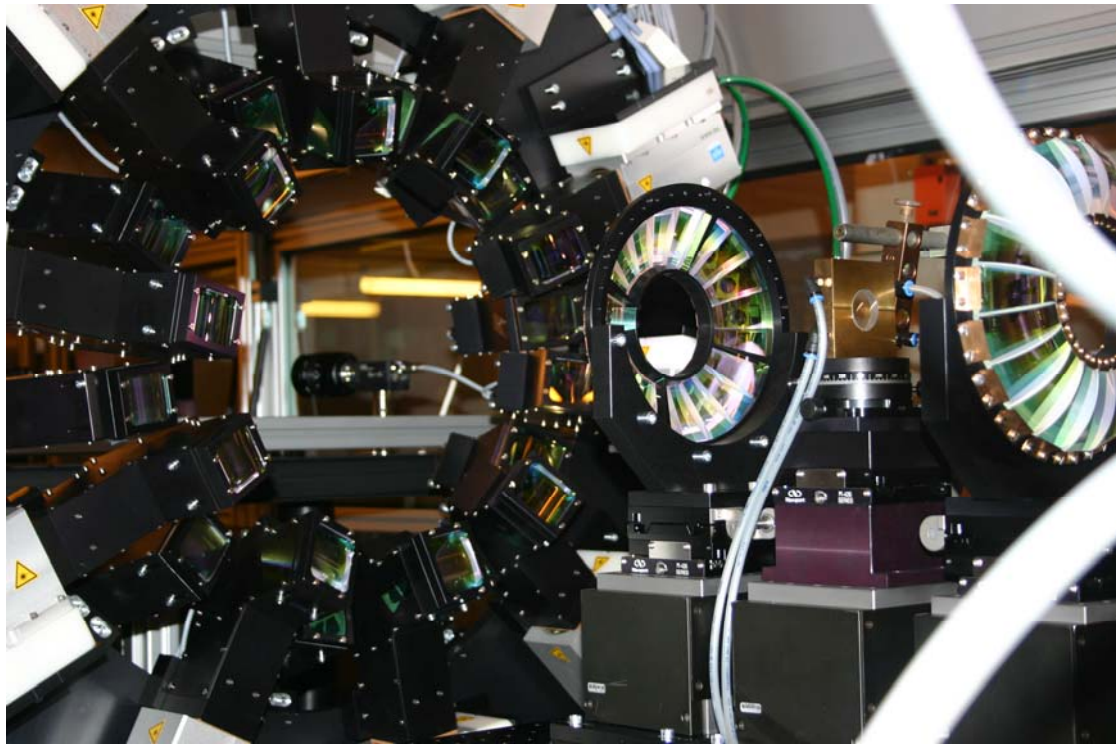
Outline

- Review of Building Blocks, A1-A4
- Construction
  Pump Delivery
  A5
- Achievements and Next Steps



Financial Support

POLARIS **is supported by**

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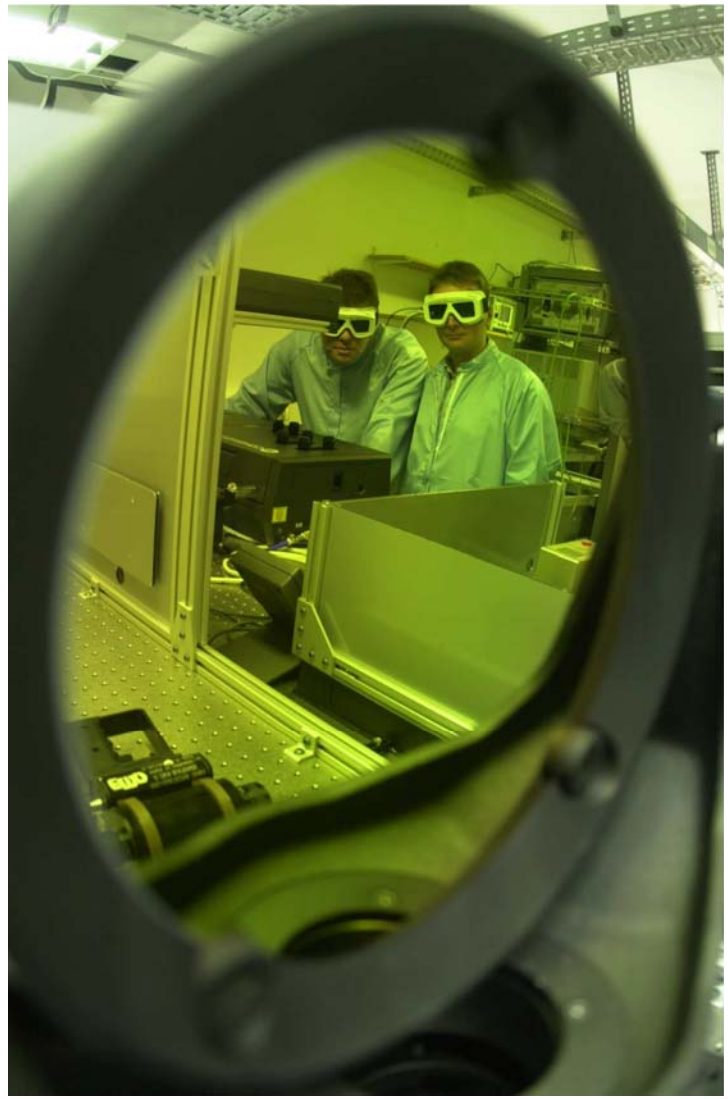
BMBF as part of Zentrum für Innovationskompetenz

„ultra optics"

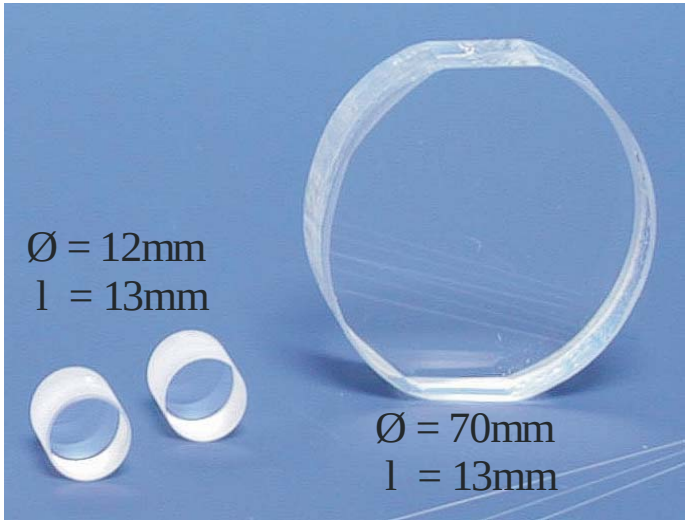
Friedrich-Schiller-Universität Jena

Institut für Optik und Quantenelektronik

20. April 2005



Yb^{3+} Doped Fluoride Phosphate-Glass

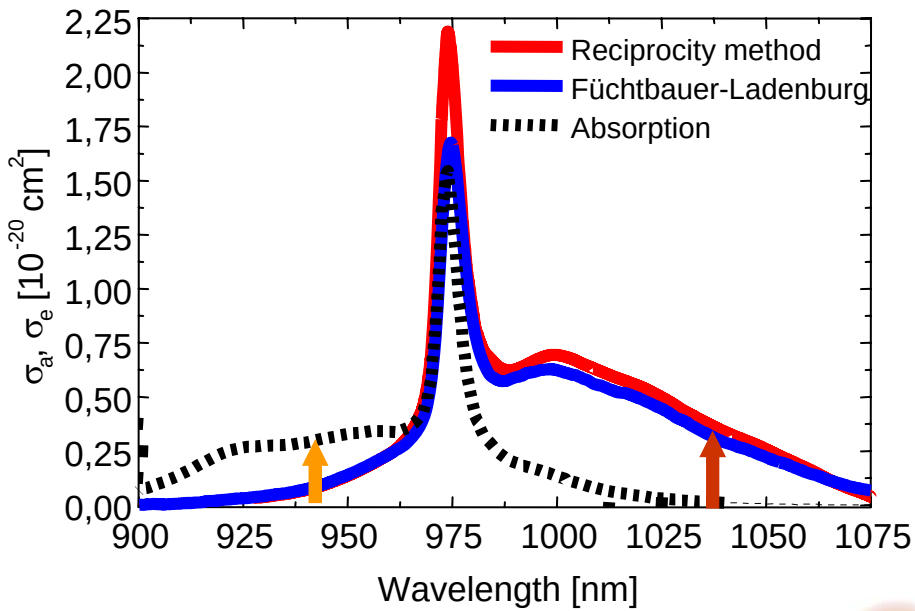


Otto-Schott-Institute
for glass chemistry, Jena, Germany

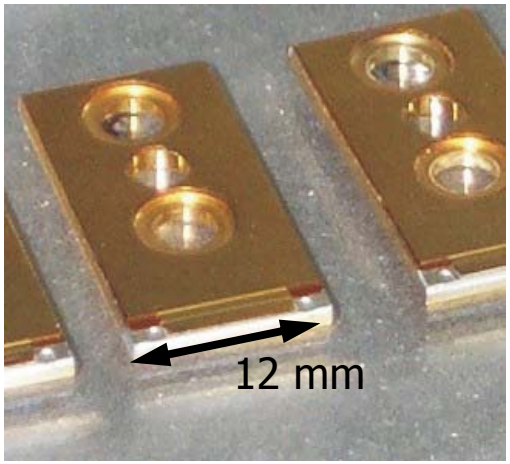
Ytterbium doped fluoride phosphate glass
(Yb^{3+}FP20 glass)

Yb^{3+}: $8*10^{20}$ cm^{-3}
$\Delta n < 10^{-6}$
fluorescence life time 1.4 ms
saturation fluence 44 J/cm^2
damage threshold 5 J/cm^2

small quantum defect
quasi-three-level laser medium



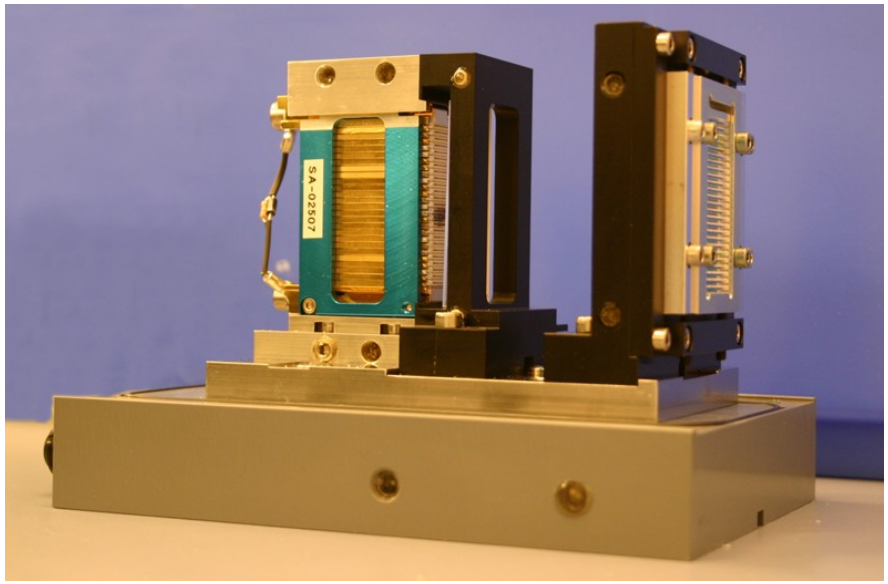
The Pump Source – 940 nm Laser Diodes

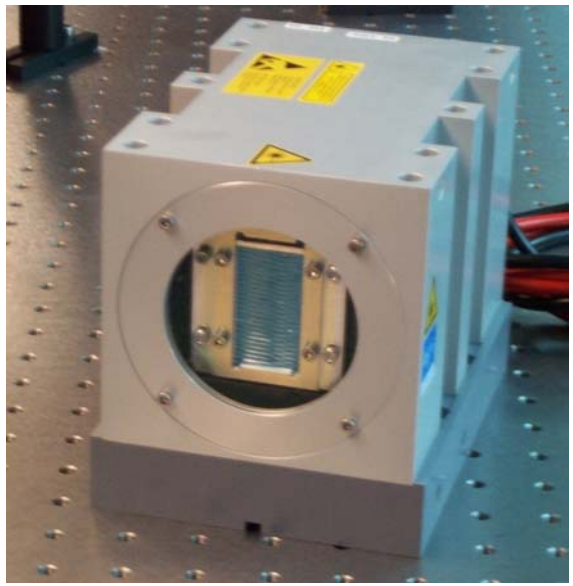


7250 high power laser diodes

290 stacks

stack
fast axis – collimation
beam compaction
beam shaping





Diode Driver and Diode Life Time

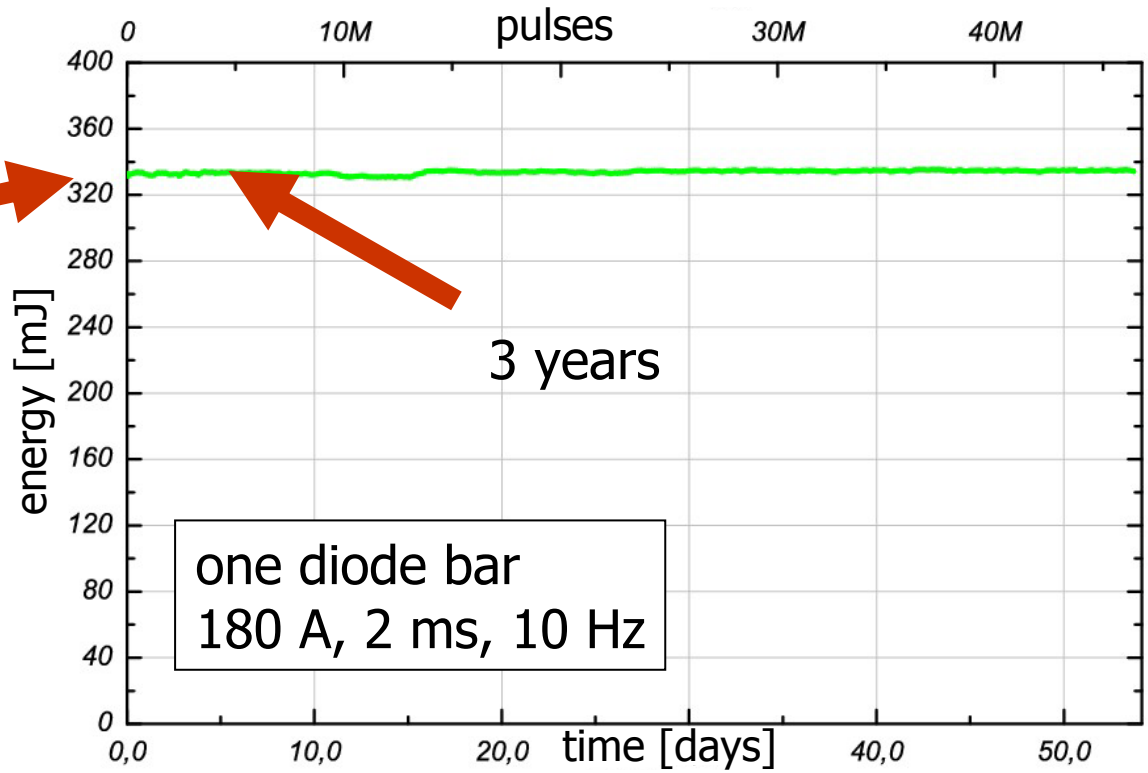
pulsed diode driver:

- stabilized rectangular pulses
- 250 A and 60 V
- 80 µs rise and fall times
- 4 channels
- computer controled via CAN

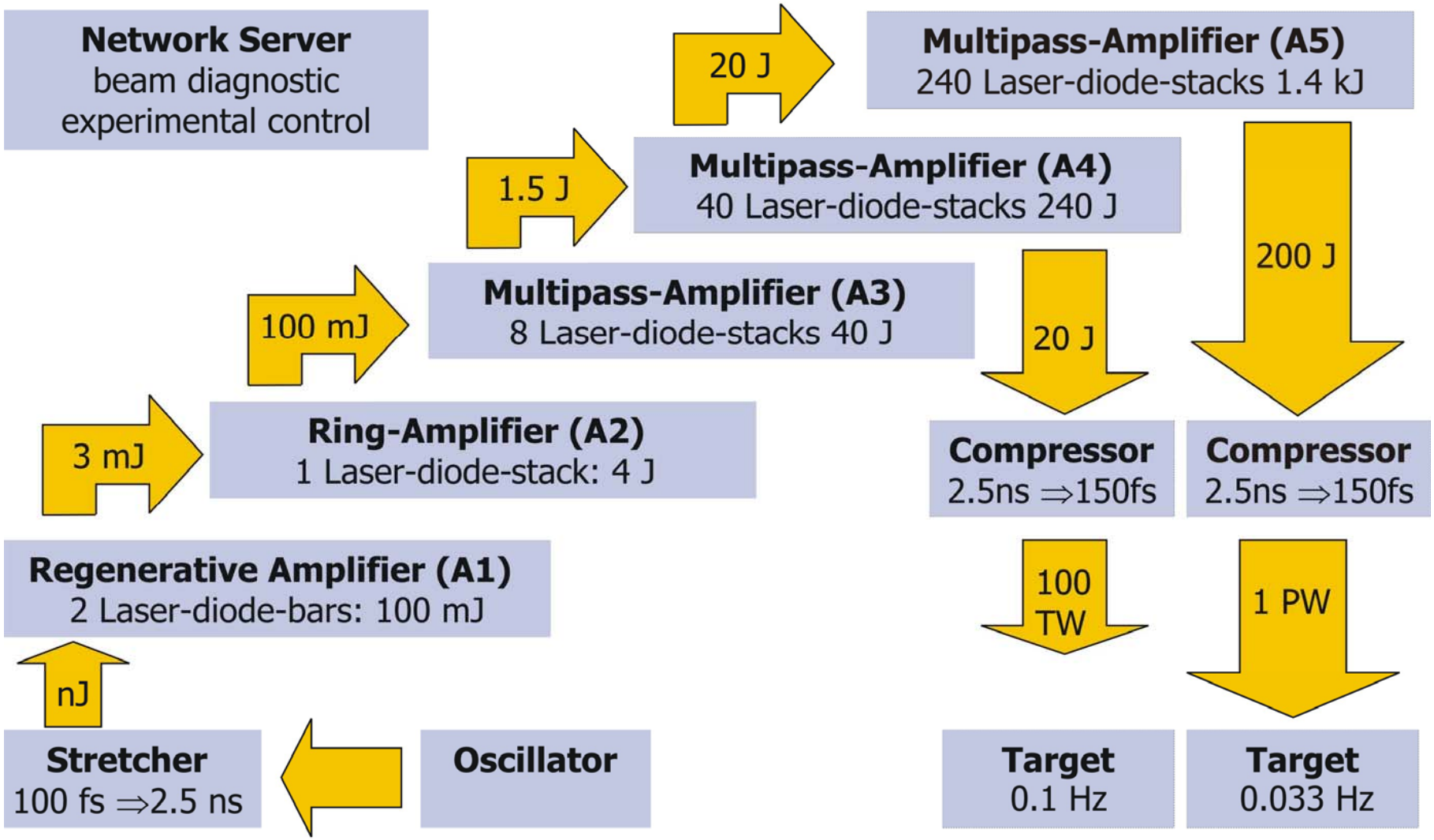
T&H
Jena, Germany

life time test:

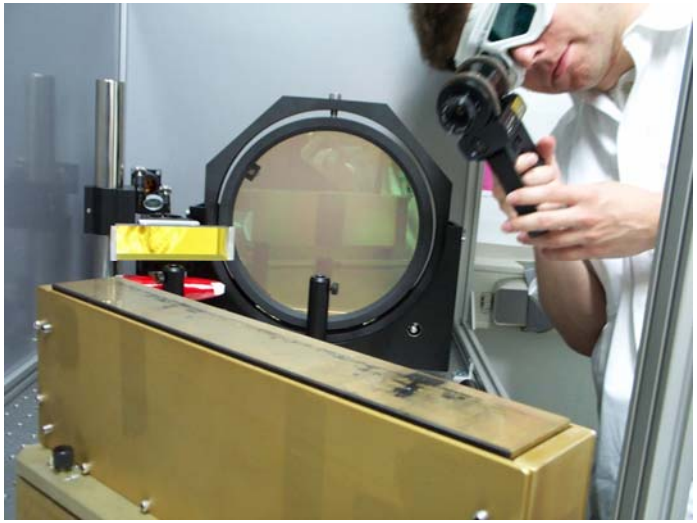
170W



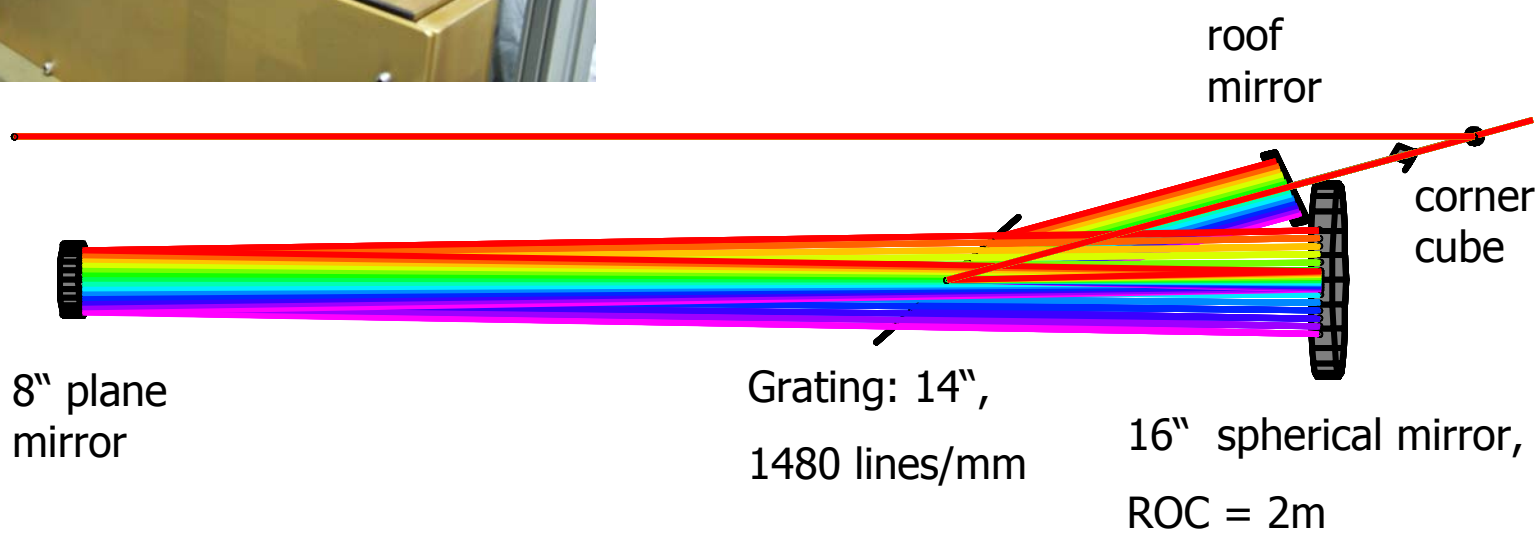
POLARIS Outline



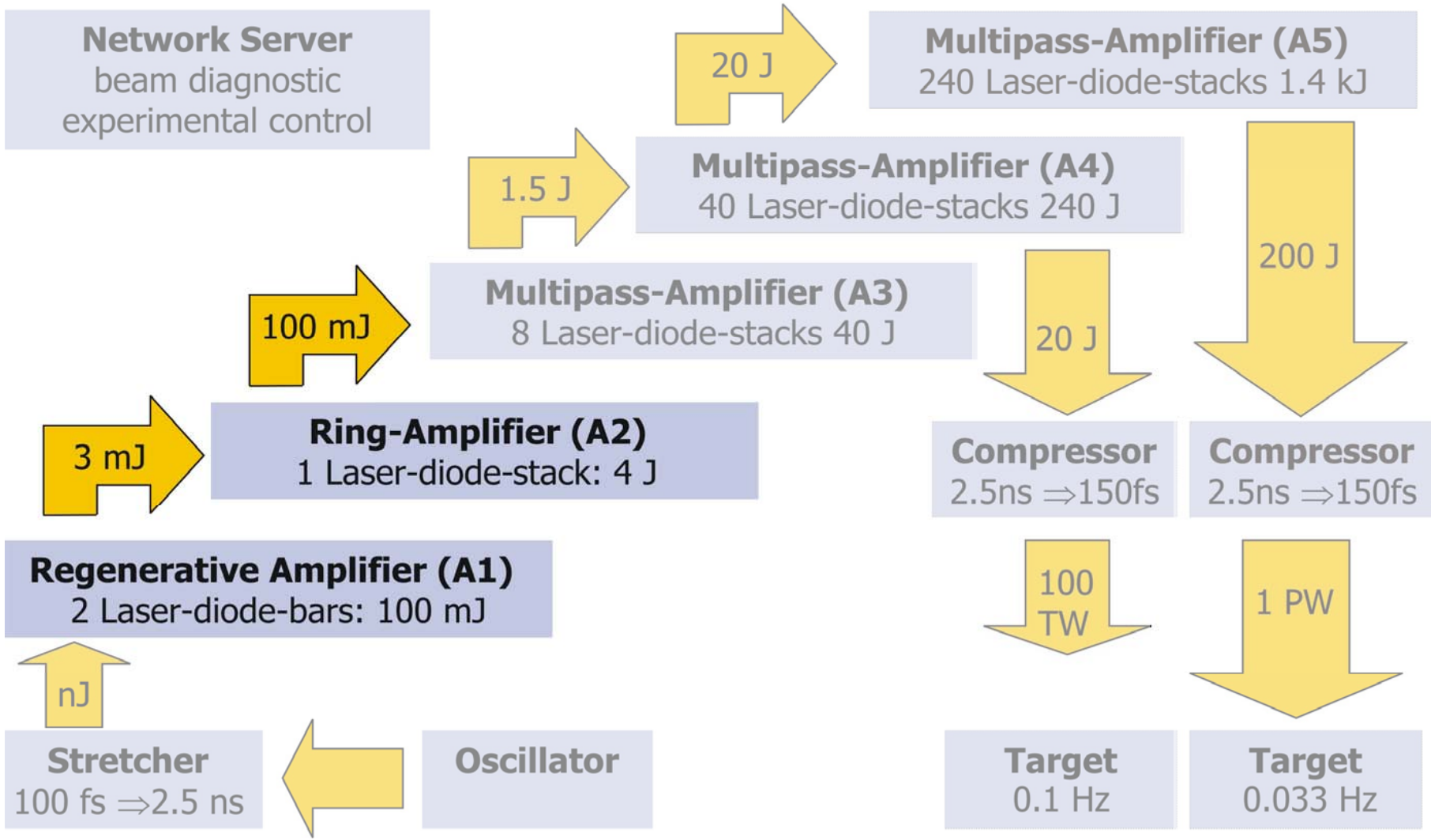
Pulse Stretcher



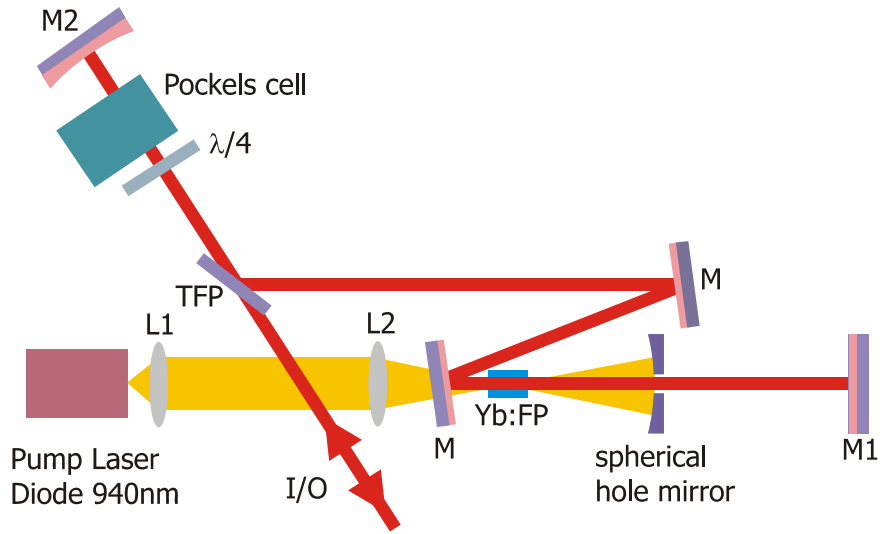
angle of incidence: 60°
number of passes: 4
clipping: 32 nm
stretching: 140 ps/nm
efficiency: 30 %



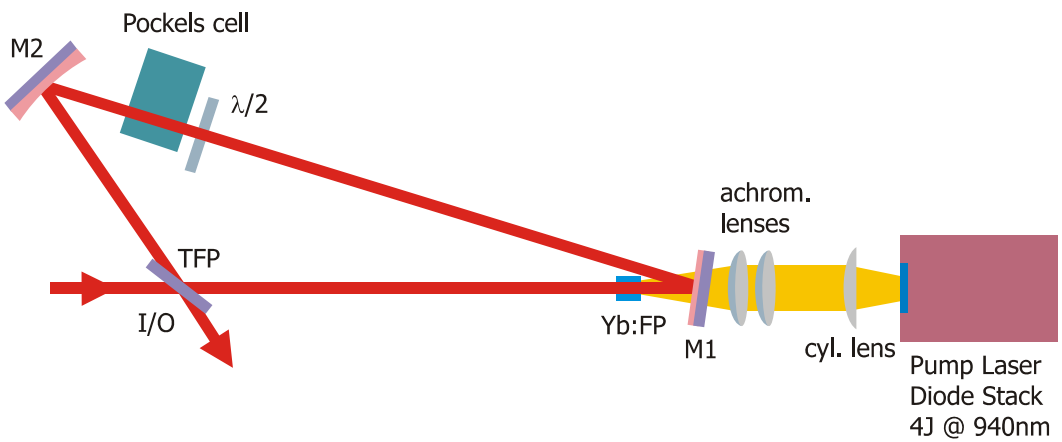
POLARIS A1 and A2



POLARIS Amplifier A1 and A2

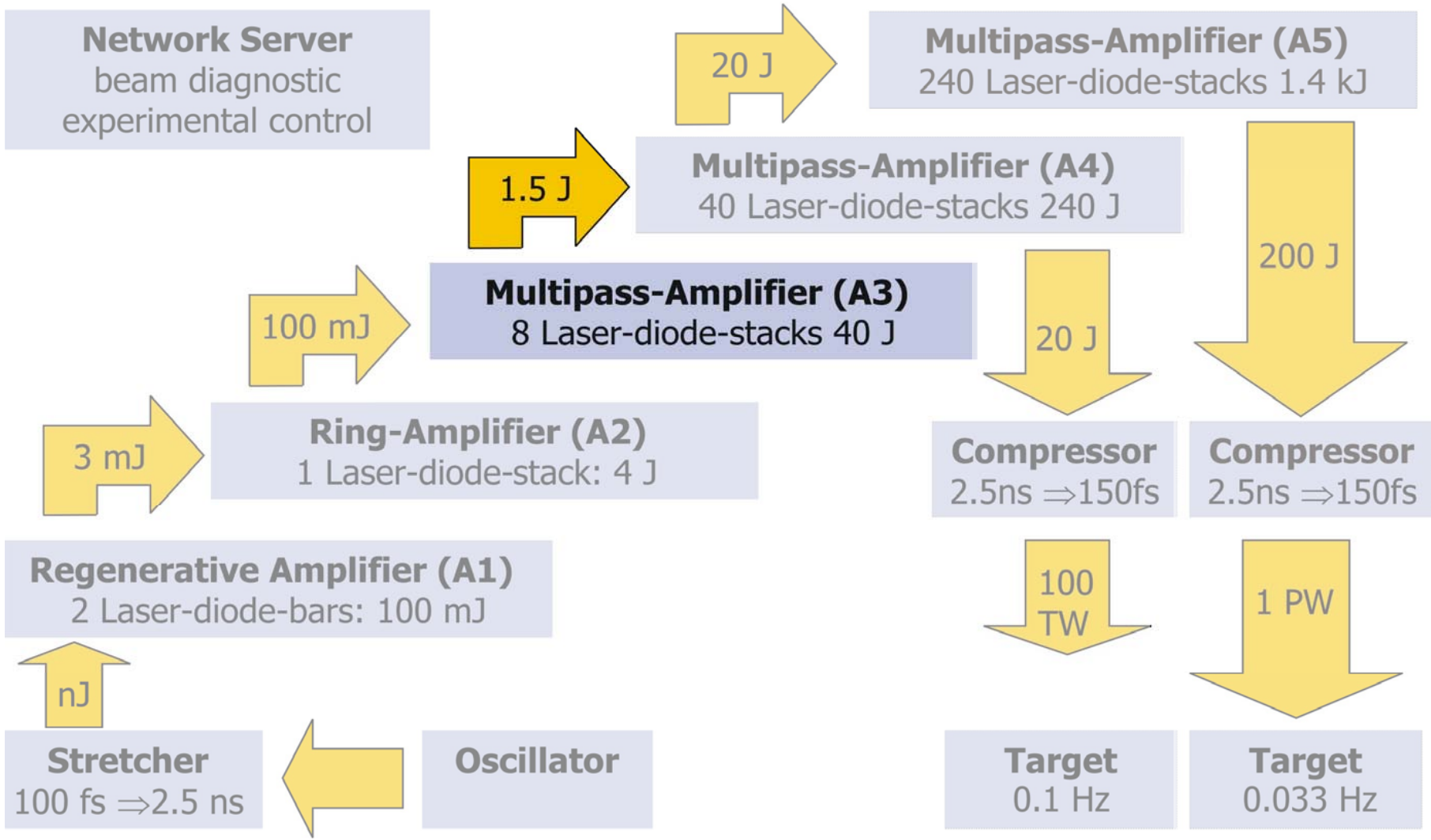


- A1 (regenerative)
  - stable 1790 mm cavity with 400 μm waist
  - 120 mJ pump energy (in 2.6 ms)
  - Gain 10^7 (100 round trips)
  - 13 nm output bandwidth
  - 3 mJ output



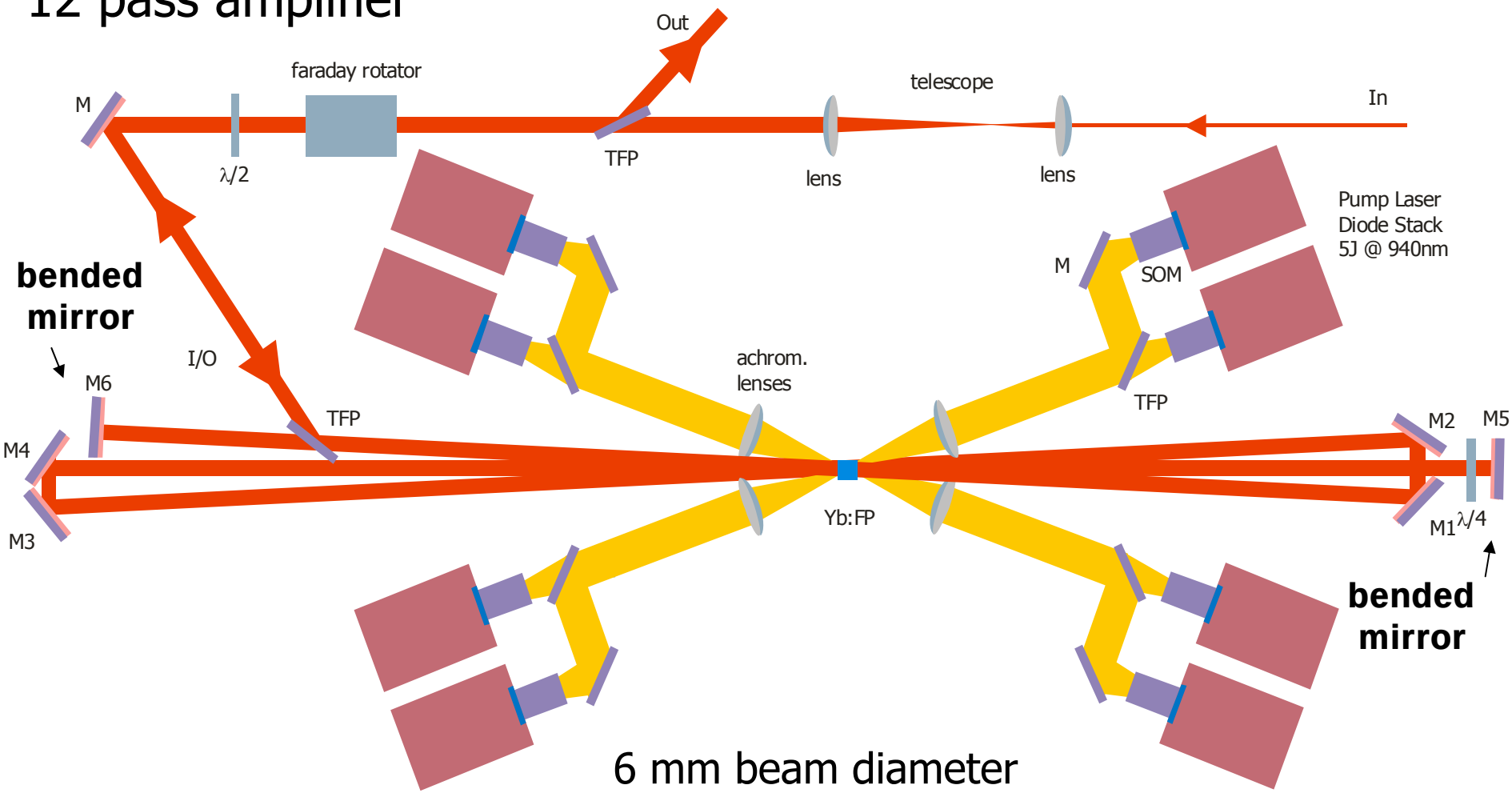
- A2 (regenerative)
  - stable 4 m ring cavity with 1.8 mm waist
  - 4 J absorbed pump energy
  - Gain 35 (30 round trips)
  - 12.5 nm output bandwidth
  - 100 mJ output

POLARIS A3


Network Server
beam diagnostic
experimental control
20 J
Multipass-Amplifier (A5)
240 Laser-diode-stacks 1.4 kJ
1.5 J
Multipass-Amplifier (A4)
40 Laser-diode-stacks 240 J
200 J
100 mJ
Multipass-Amplifier (A3)
8 Laser-diode-stacks 40 J
20 J
3 mJ
Ring-Amplifier (A2)
1 Laser-diode-stack: 4 J
Compressor
2.5ns ⇒150fs
Compressor
2.5ns ⇒150fs
Regenerative Amplifier (A1)
2 Laser-diode-bars: 100 mJ
100
TW
1 PW
nJ
Stretcher
100 fs ⇒2.5 ns
Oscillator
Target
0.1 Hz
Target
0.033 Hz

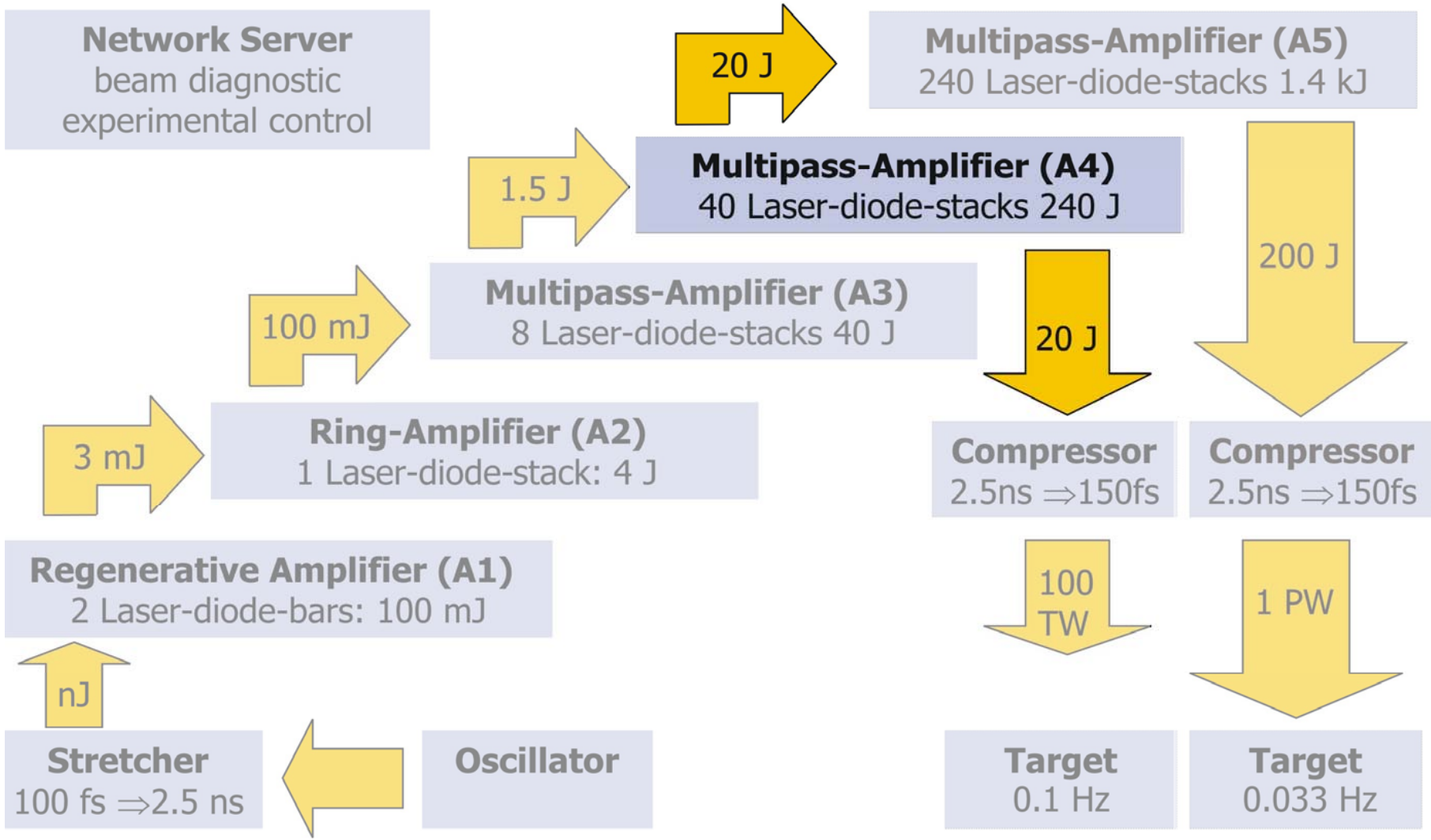
A3 – Setup

12 pass amplifier



6 mm beam diameter

POLARIS A4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100
TW
1 PW
nJ
Stretcher
100 fs ⇒2.5 ns
Oscillator
Target
0.1 Hz
Target
0.033 Hz

A4 – 20 J Amplifier

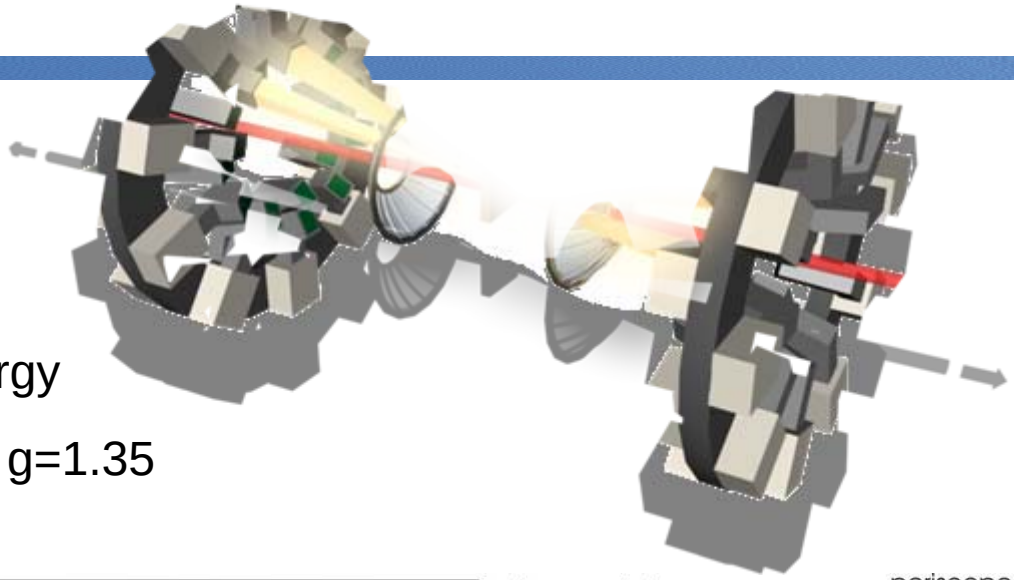
18 mm beam diameter

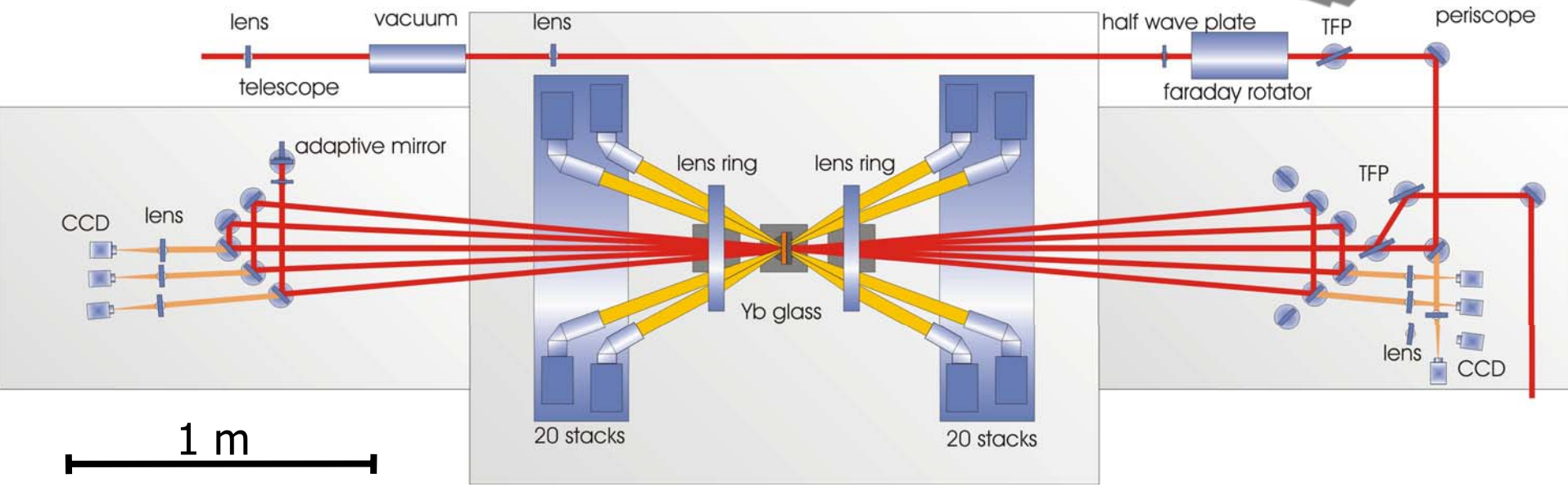
10 pass (G=20)

30 m beam path

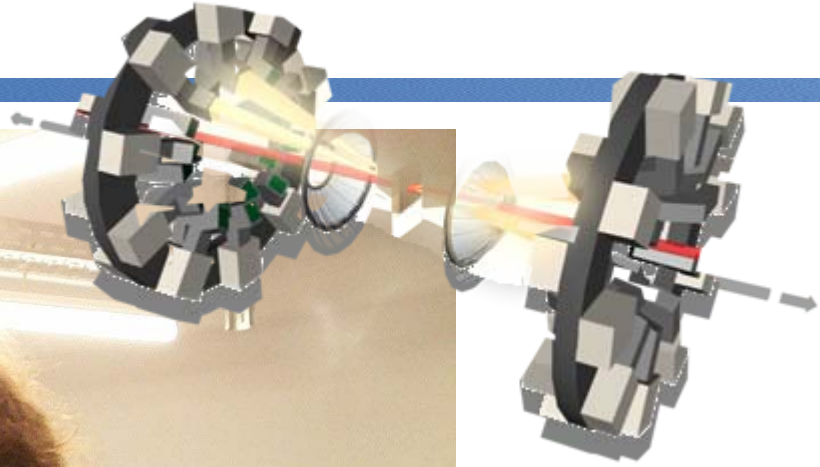
240 J pump energy

single pass gain g=1.35



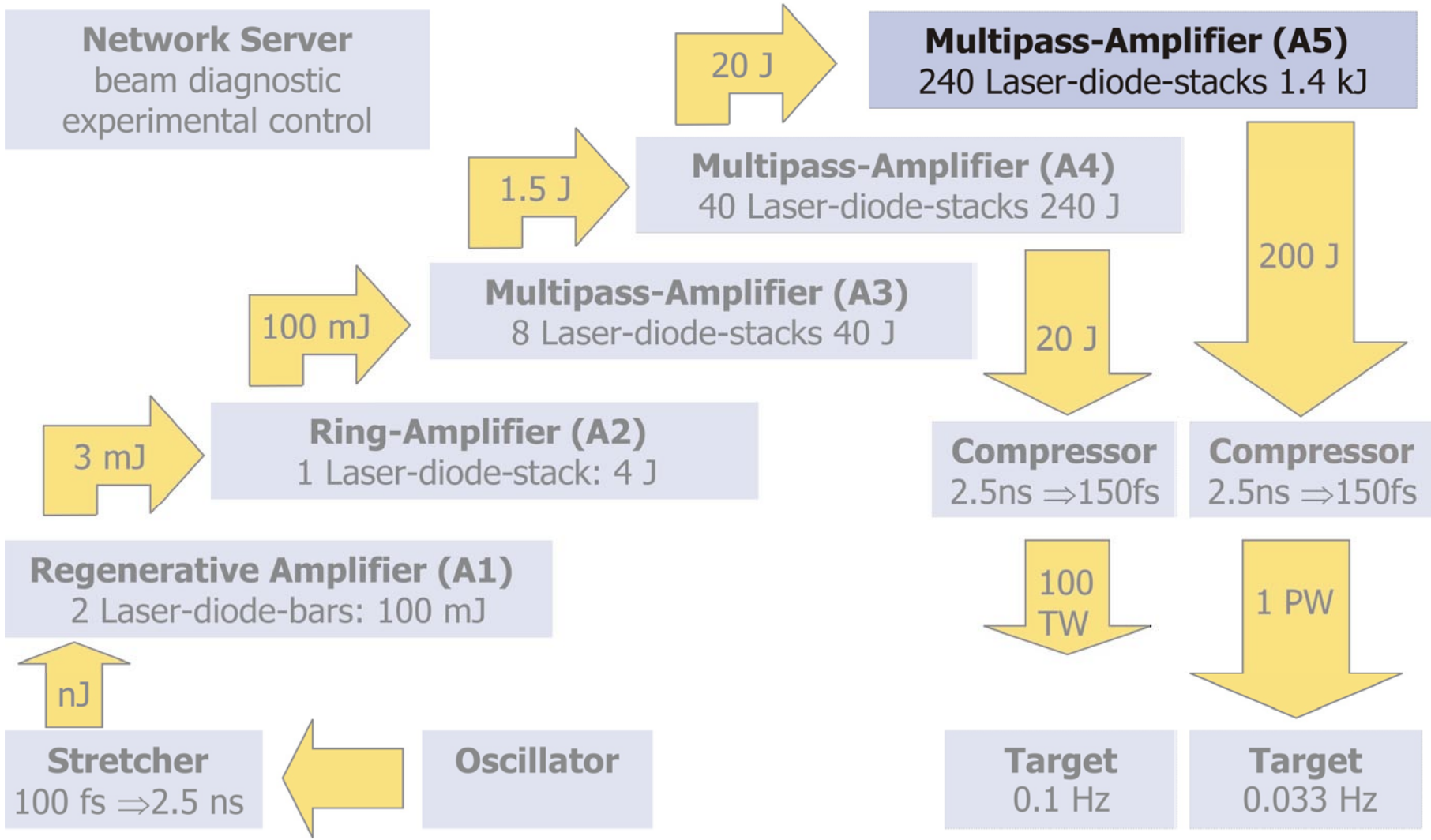


A4 – 20 J Amplifier



A1-A4

POLARIS A5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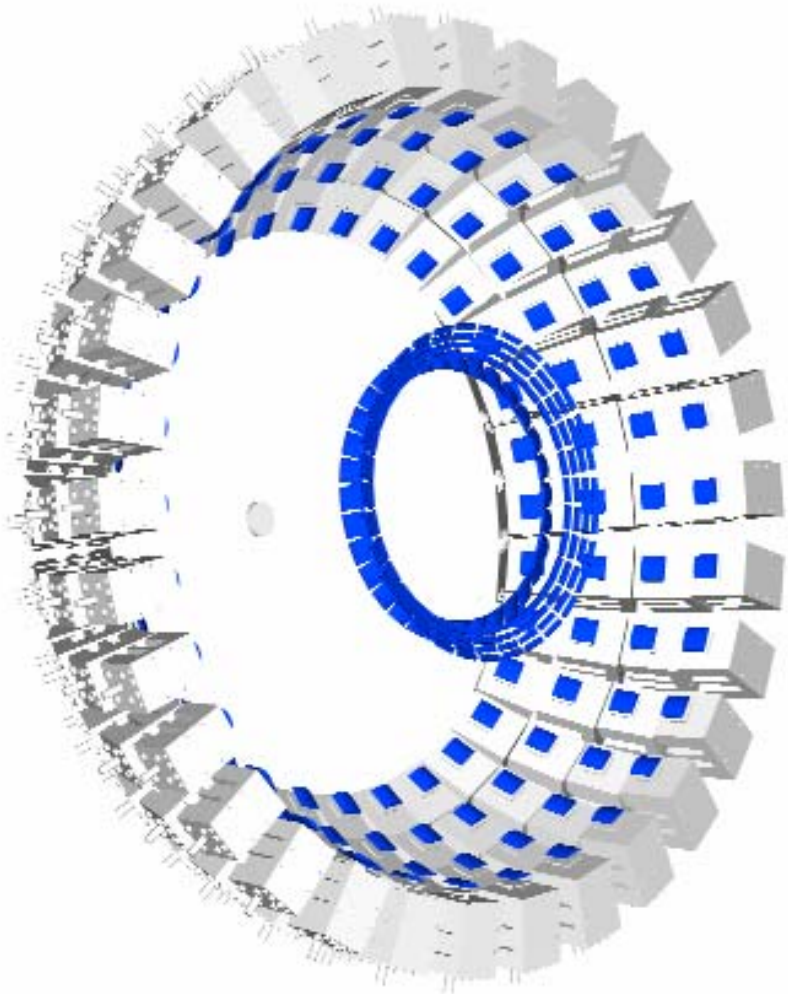
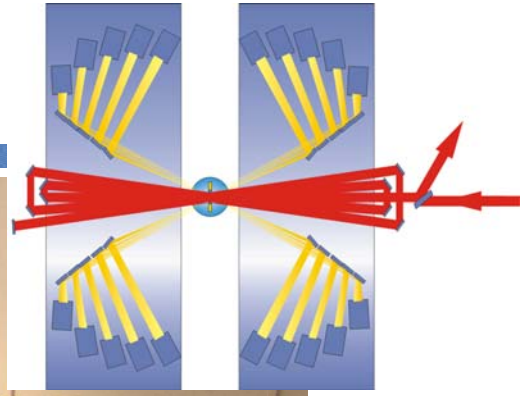
1 PW
nJ
Stretcher
100 fs ⇒2.5 ns
Oscillator
Target
0.1 Hz
Target
0.033 Hz

A5 Laser Amplifier - Data



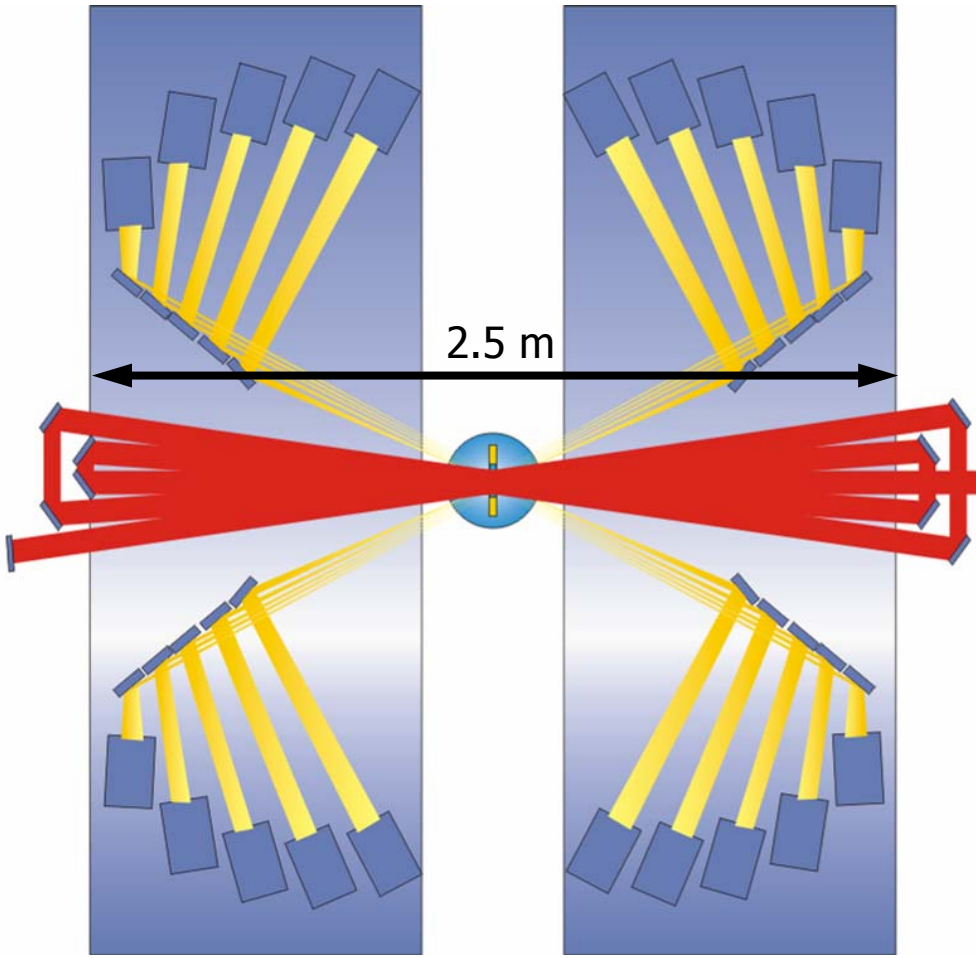
Energy per pulse	1.4 kJ (@ 2.6 ms)
No. of diodes	6000 (@ 940 nm)
No. of diode stacks	240
Emitting area	2.5 m^2
Pumped area	2 x 11 cm^2
Diameter Yb:glass	50 mm
Pump intensity	50 kW / cm^2
Weight of pump optics	56 kg
Weight of diode stacks	800 kg
Acceptance angle - laser (full width)	22.8°
Dimension (H x W x L)	2.4 x 2.4 x 1.9 m^3

Towards Amplifier A5

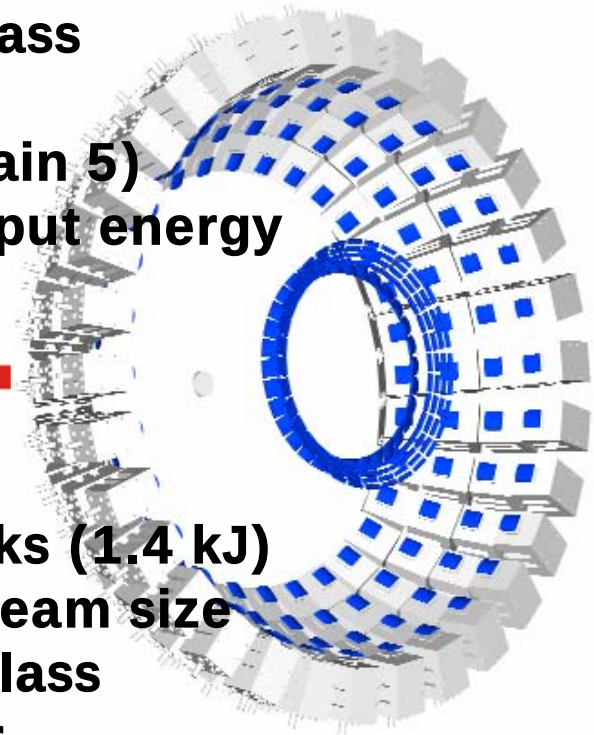


48 Modules, 5 Stacks each
240 Thoric Lenses
240 Turning Mirrors
- 480 Motorized Axis
60 Diode Drivers – 4 outputs
Control System
Laser Optics
Adaptive Mirrors
Beam Line

A5 – Two Phases

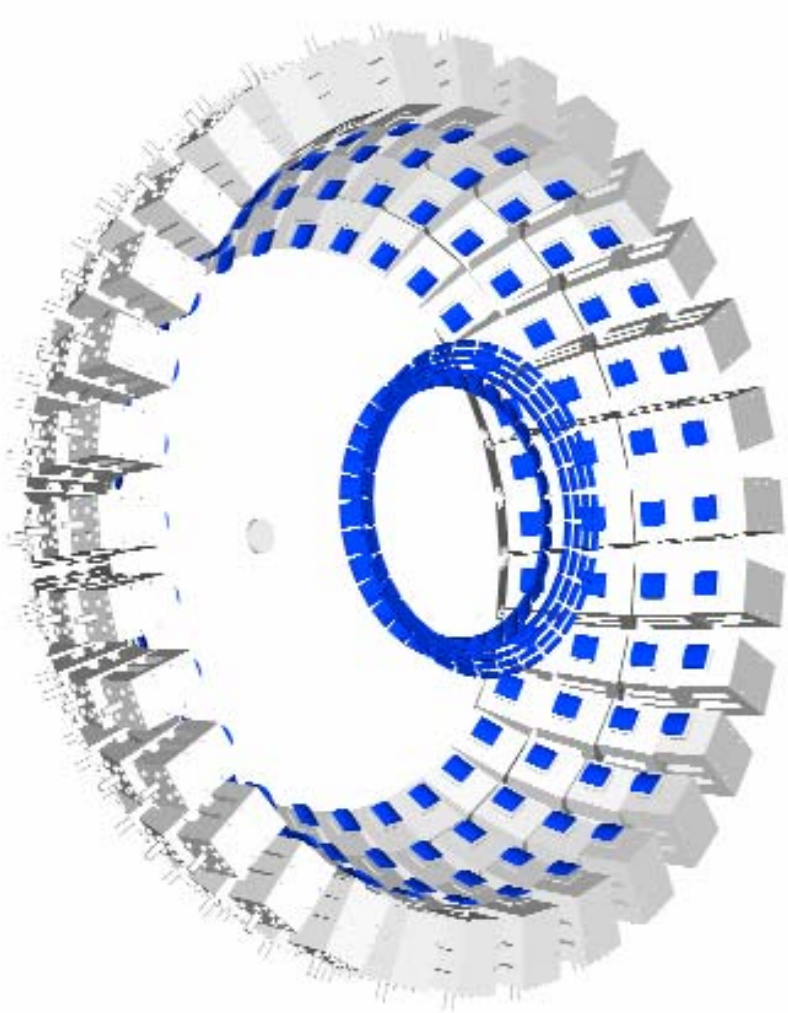


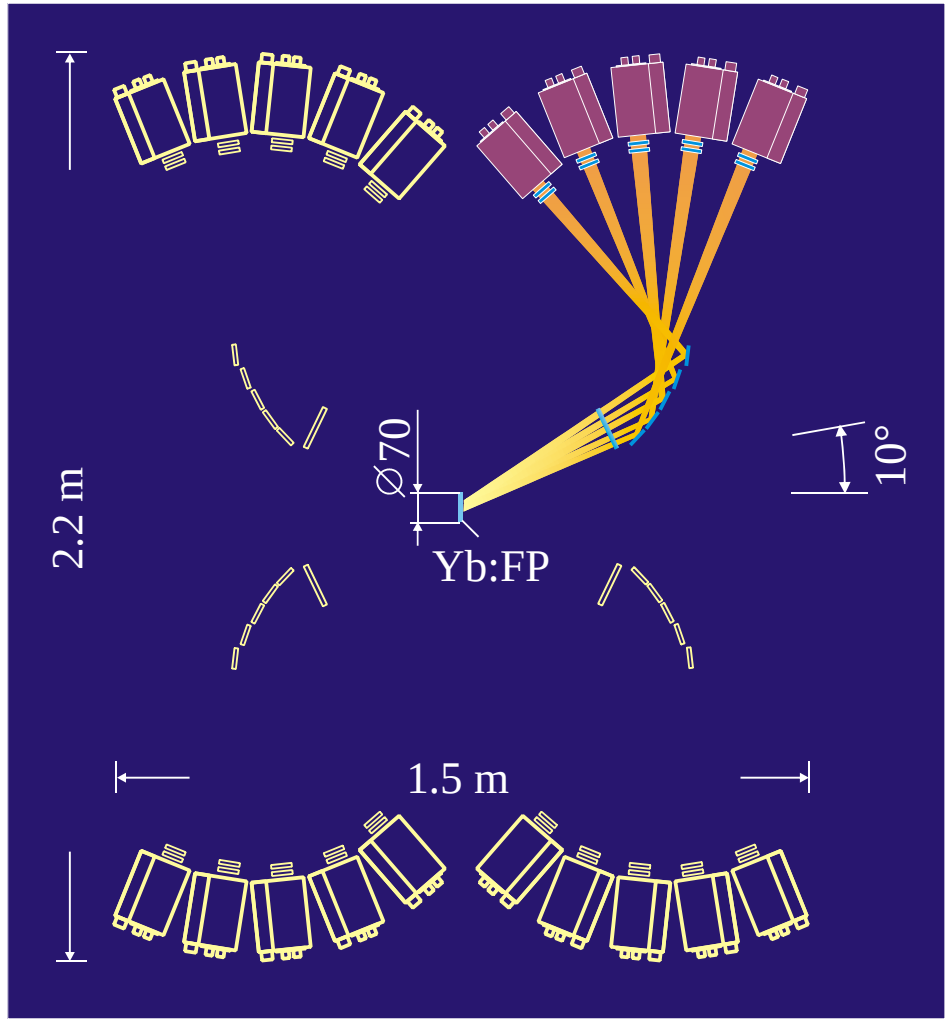
Phase 1:
120 stacks (700 J)
50 mm beam size
70 mm glass diameter
7 pass (gain 5)
100 J output energy



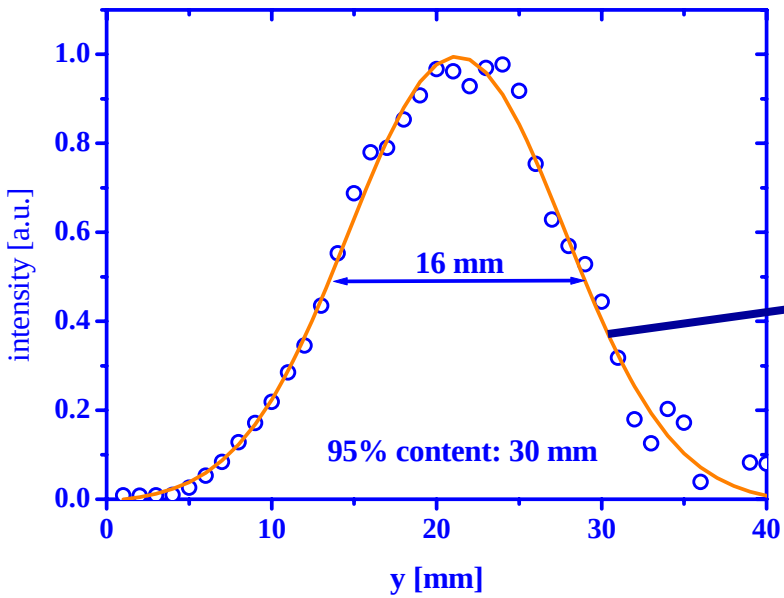
Phase 2:
240 stacks (1.4 kJ)
70 mm beam size
80 mm glass diameter
10 pass (gain 10)
200 J output energy

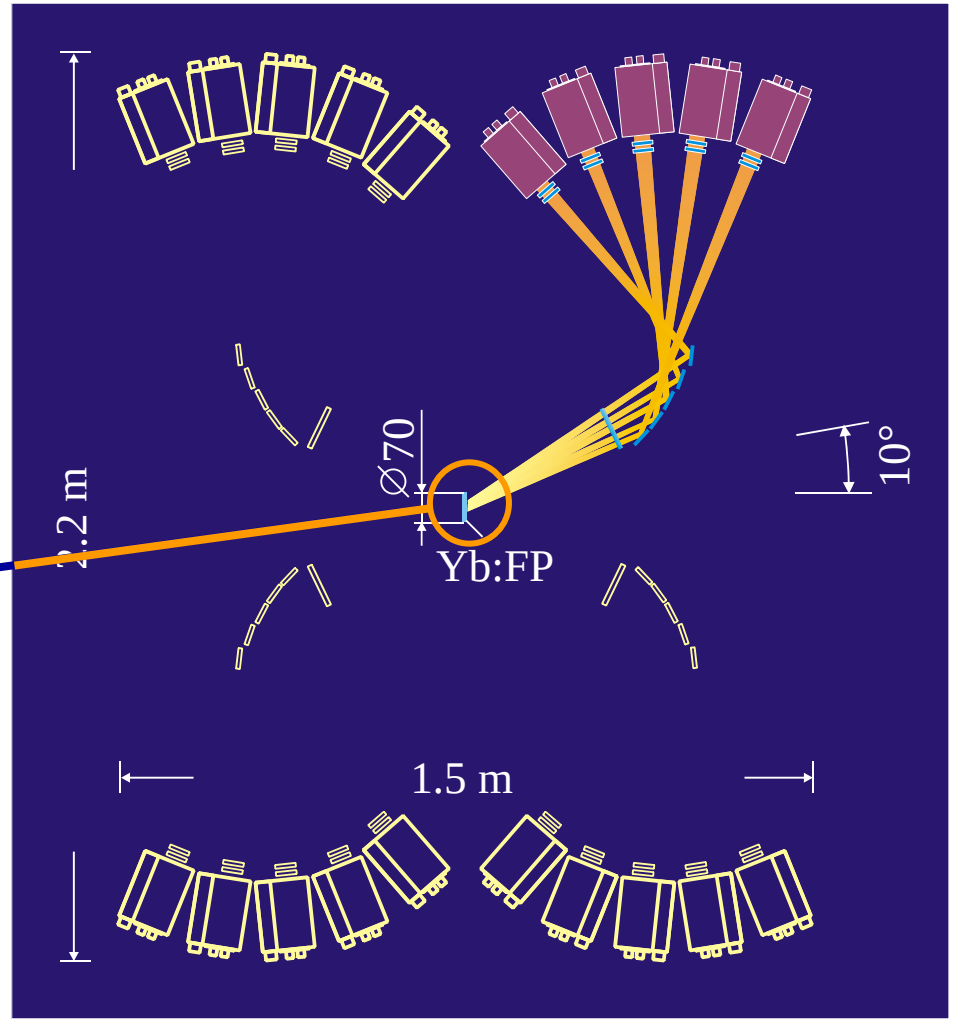
A5 Laser Amplifier



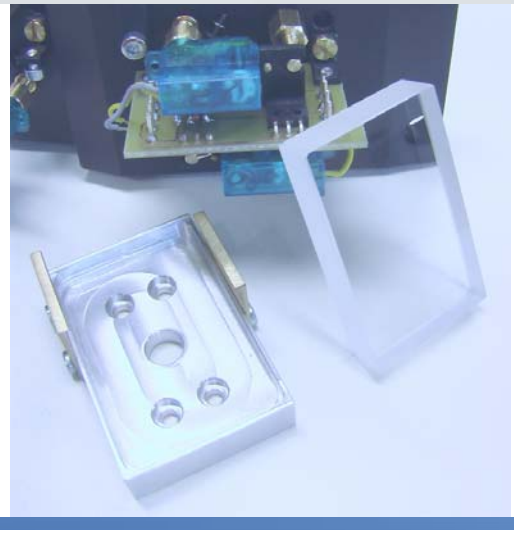


A5 Laser Amplifier



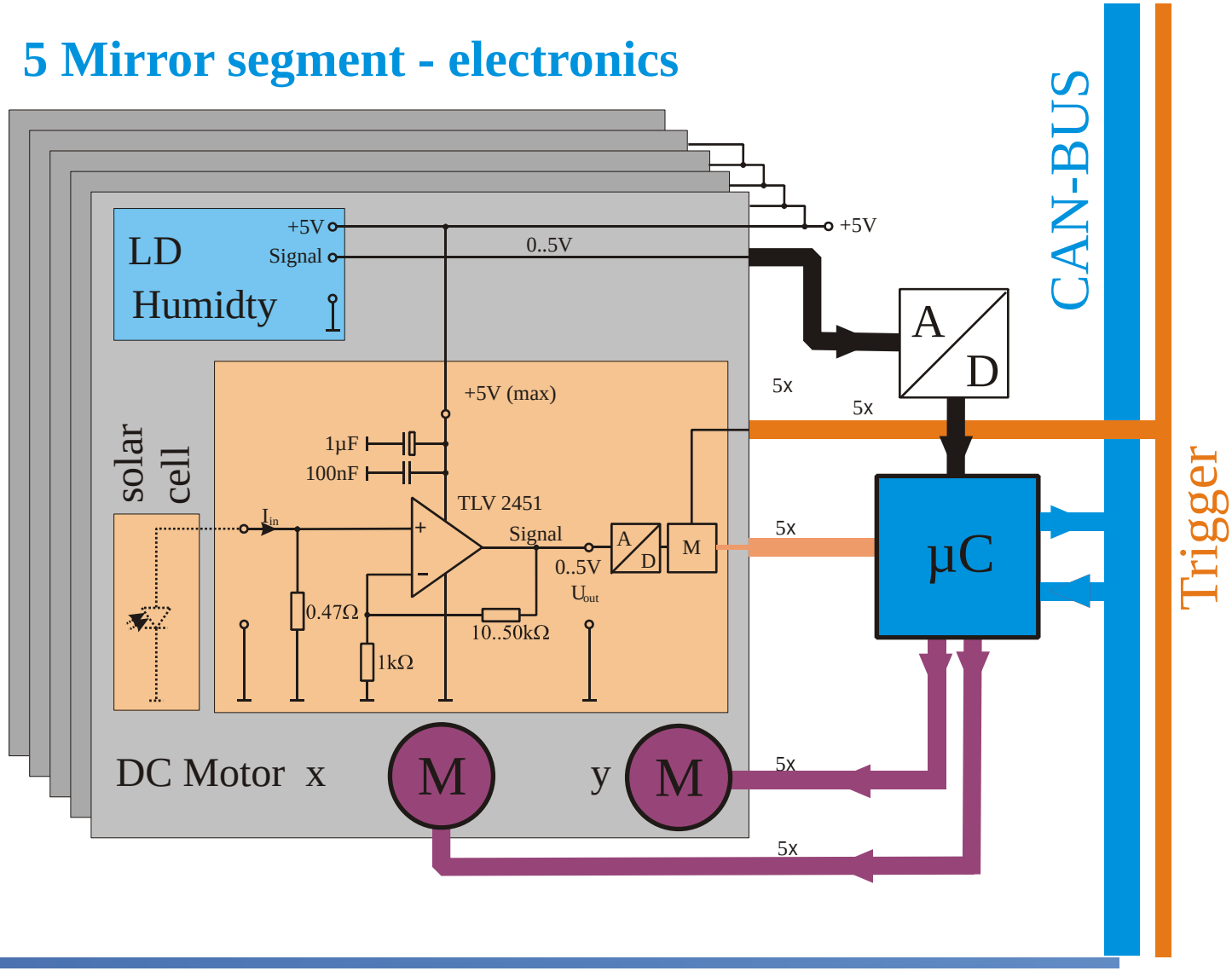


A5 Laser Amplifier - Pump optics prototype

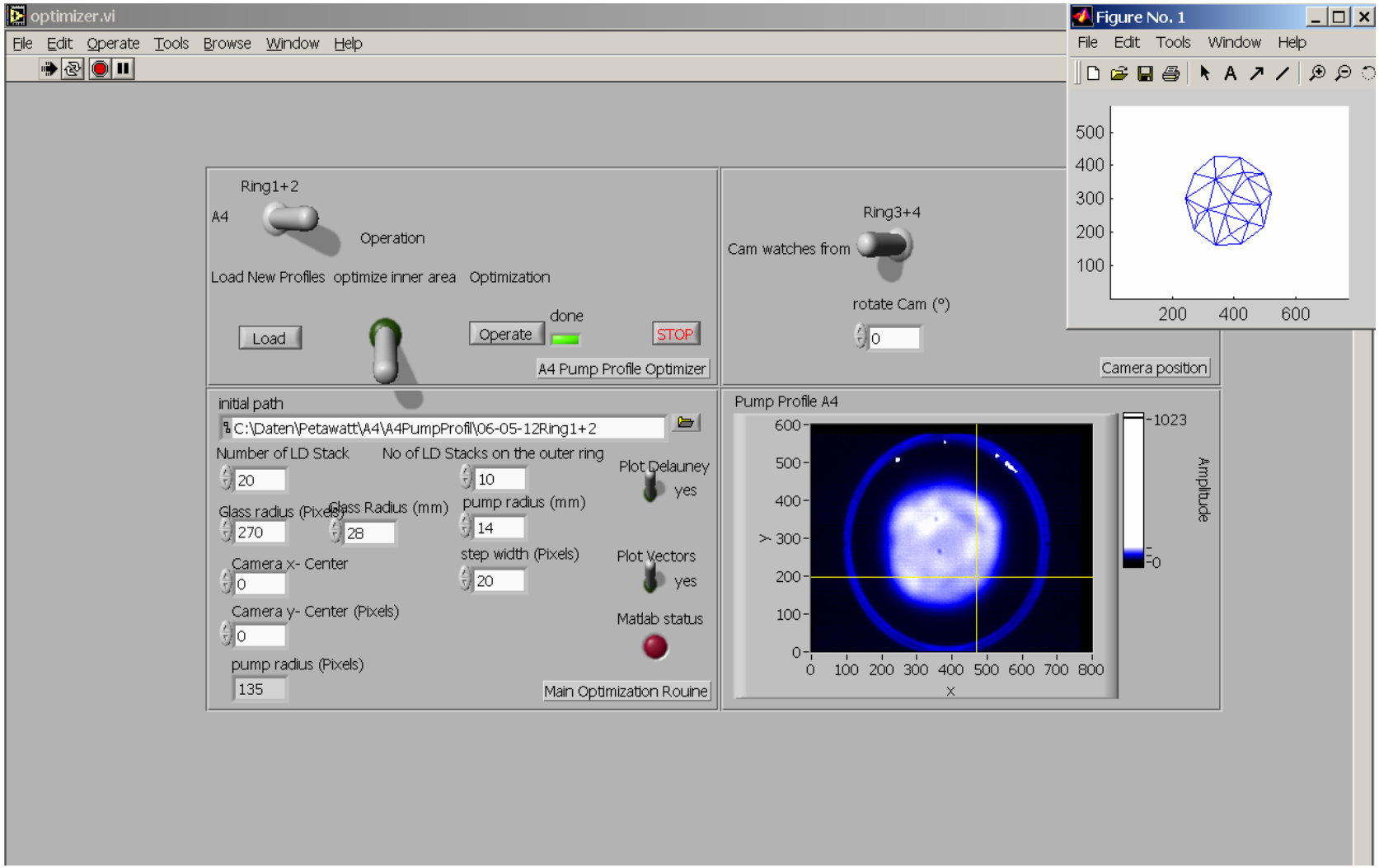


A5 Laser Amplifier - Signal flow chart

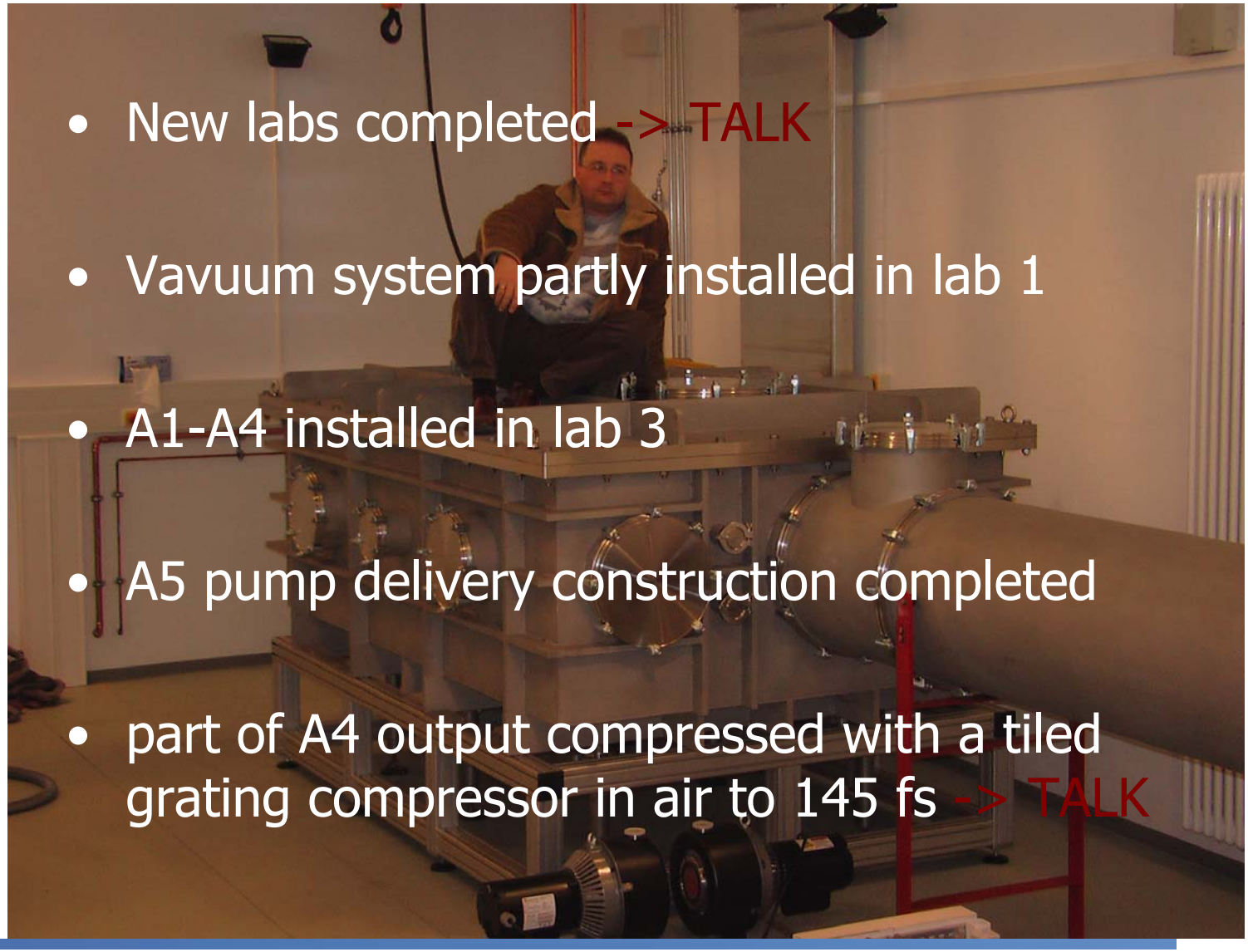
5 Mirror segment - electronics



A5 Laser Amplifier - Pump Profile Optimization Interface



Summary



- New labs completed -> TALK
- Vavuum system partly installed in lab 1
- A1-A4 installed in lab 3
- A5 pump delivery construction completed
- part of A4 output compressed with a tiled grating compressor in air to 145 fs -> TALK