International Conference on Ultrahigh Intensity Lasers-2008

Generation of 700TW femtosecond Ti:sapphire laser by optimizing the efficiency in a CPA facility with three amplifier stages

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Outline

- Background
- General design and front stages
- 100J glass pump laser at 527nm
- Main amplifier and compressor
- Conclusion and Prospect

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Some multi-100TW laser facilities in the world

Facility	Peak Power	Type	Pulse duration	Pulse Energy
RAL, UK	1PW	Nd:glass/OPCPA	600fs	600J
ILE, Japan	700TW	Nd:glass/OPCPA	700fs	350J
JAERI, Japan	850TW	Ti:sapphire	33fs	28J
MBI, Germany	100TW	Ti:sapphire	50fs	5J
Phelix, Germany	1PW	Ti:s/Nd:glass	500 fs	500 J
LLNL, USA	200TW	Ti:sapphire	100fs	20J
LULI, France	100TW	Nd:glass	300fs	30J
CEDEX, France	100TW	Ti:sapphire	25fs	2.5J
SILEX-I (四川)	**286TW**	**Ti:sapphire**	**30fs**	**8.7J**
XL-III（北京）	**355TW**	**Ti:sapphire**	**31fs**	**11J**
QG-III（上海)	**890TW**	**Ti:sapphire**	**34fs**	**30J**

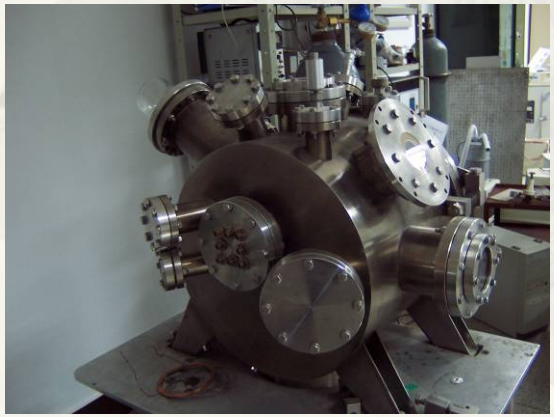
High-power laser facilities in China

Development of laser systems in IOP

XL-I laser system

XL-II laser system

XL-III laser system



1.4 TW (1999)

20 TW (2001)

350 TW (2006)

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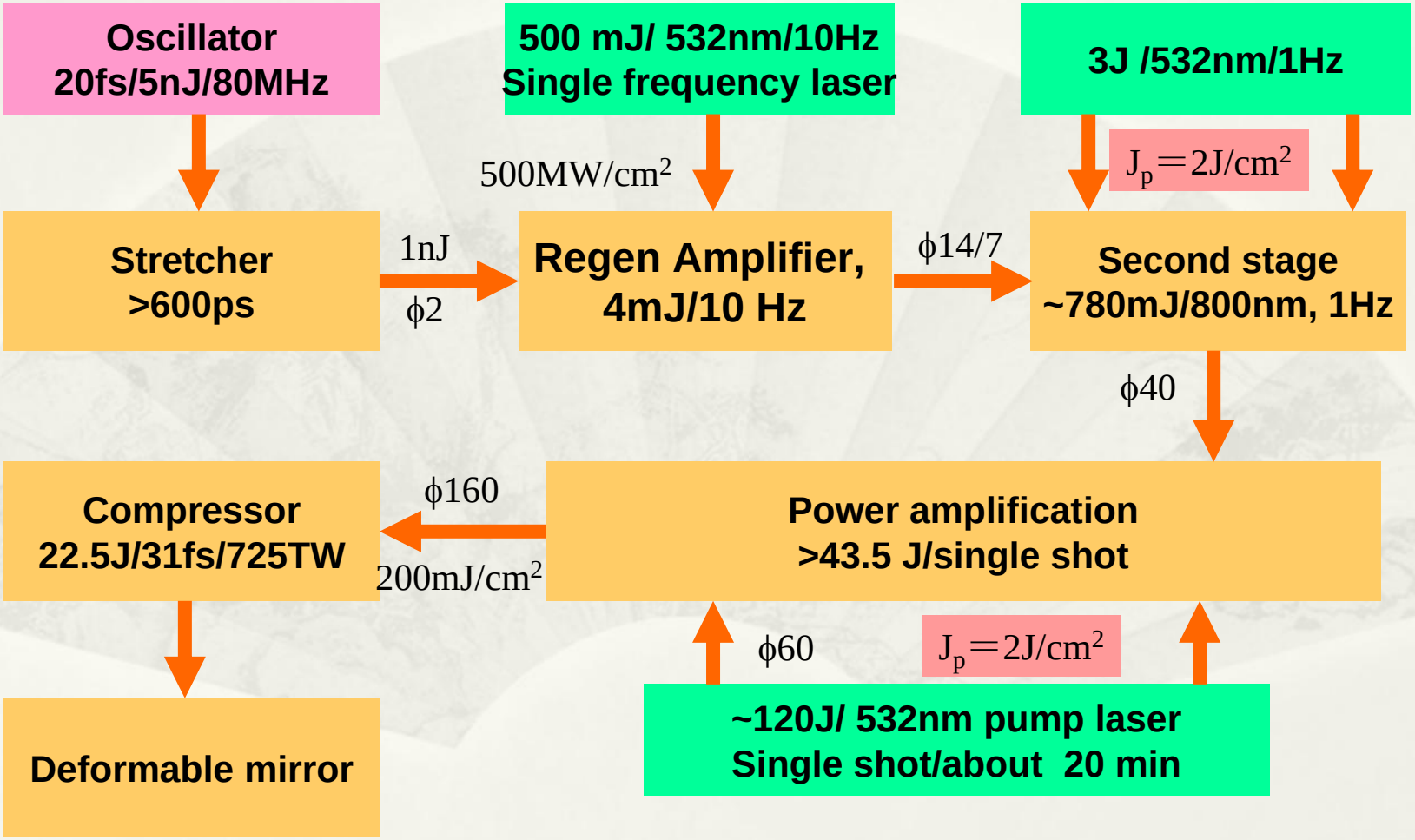
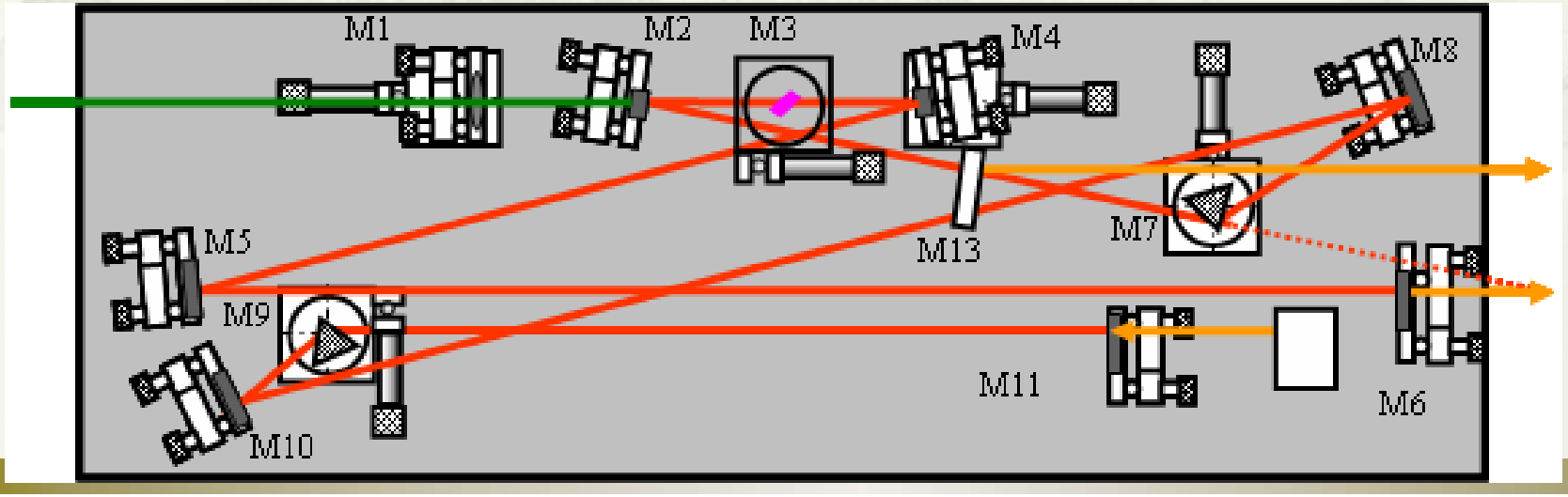
General design of 700TW laser



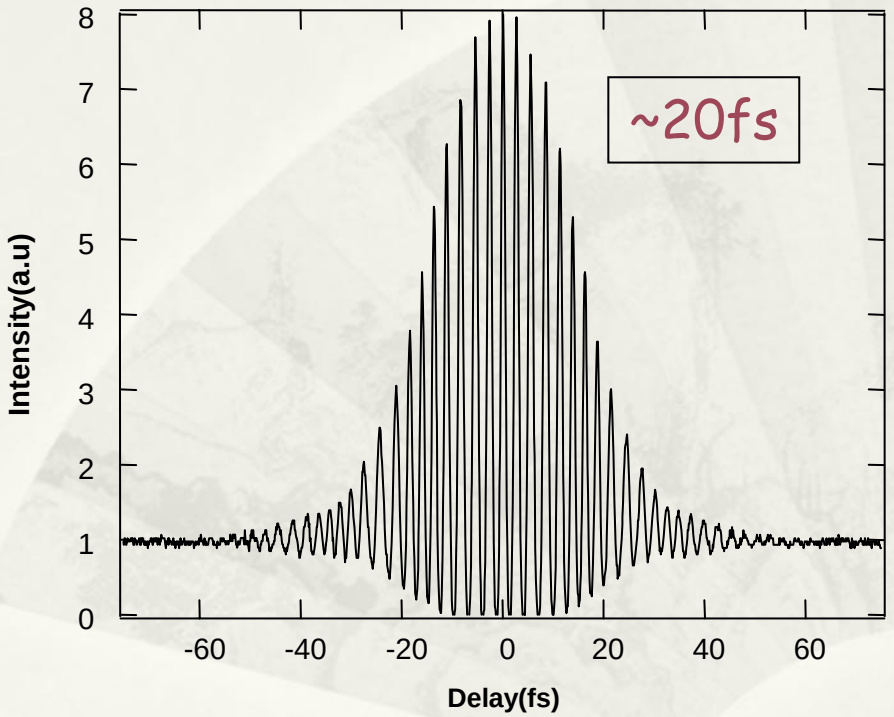
Femtosecond Ti:sapphire Oscillator

Specifications:

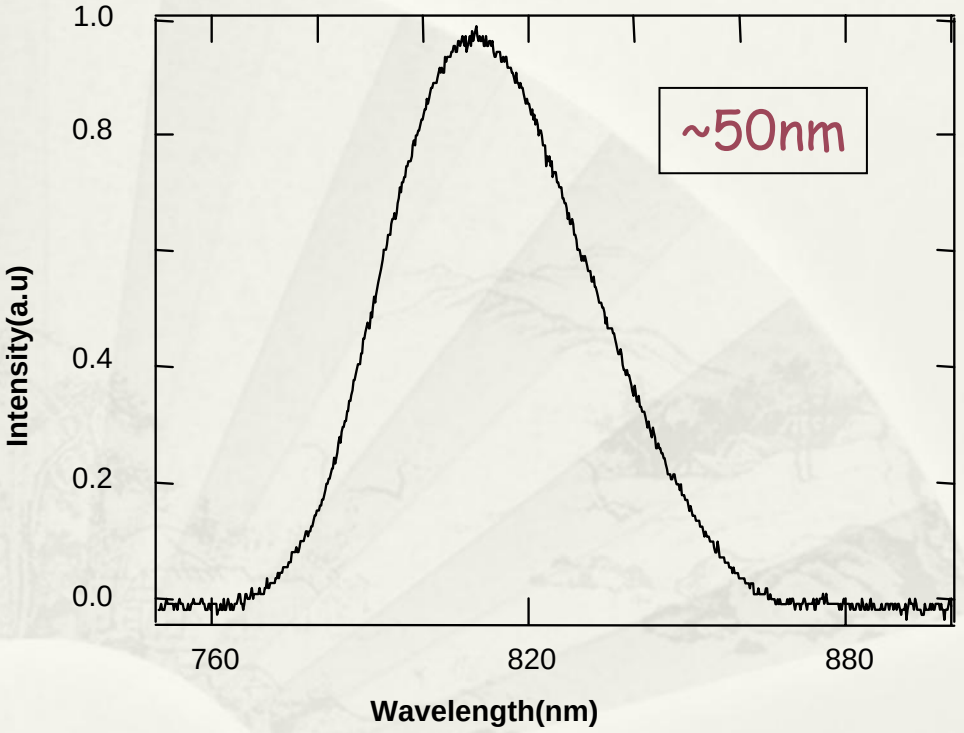
- Stability: <±1%
- Average power: >500mW(>1W)
- Pulse duration: ~ 20fs
- Peak power: >0.3MW(>1MW)
- Tunable range: 740~860nm
- Repetition rate: ~100MHz



Pulse duration and spectrum

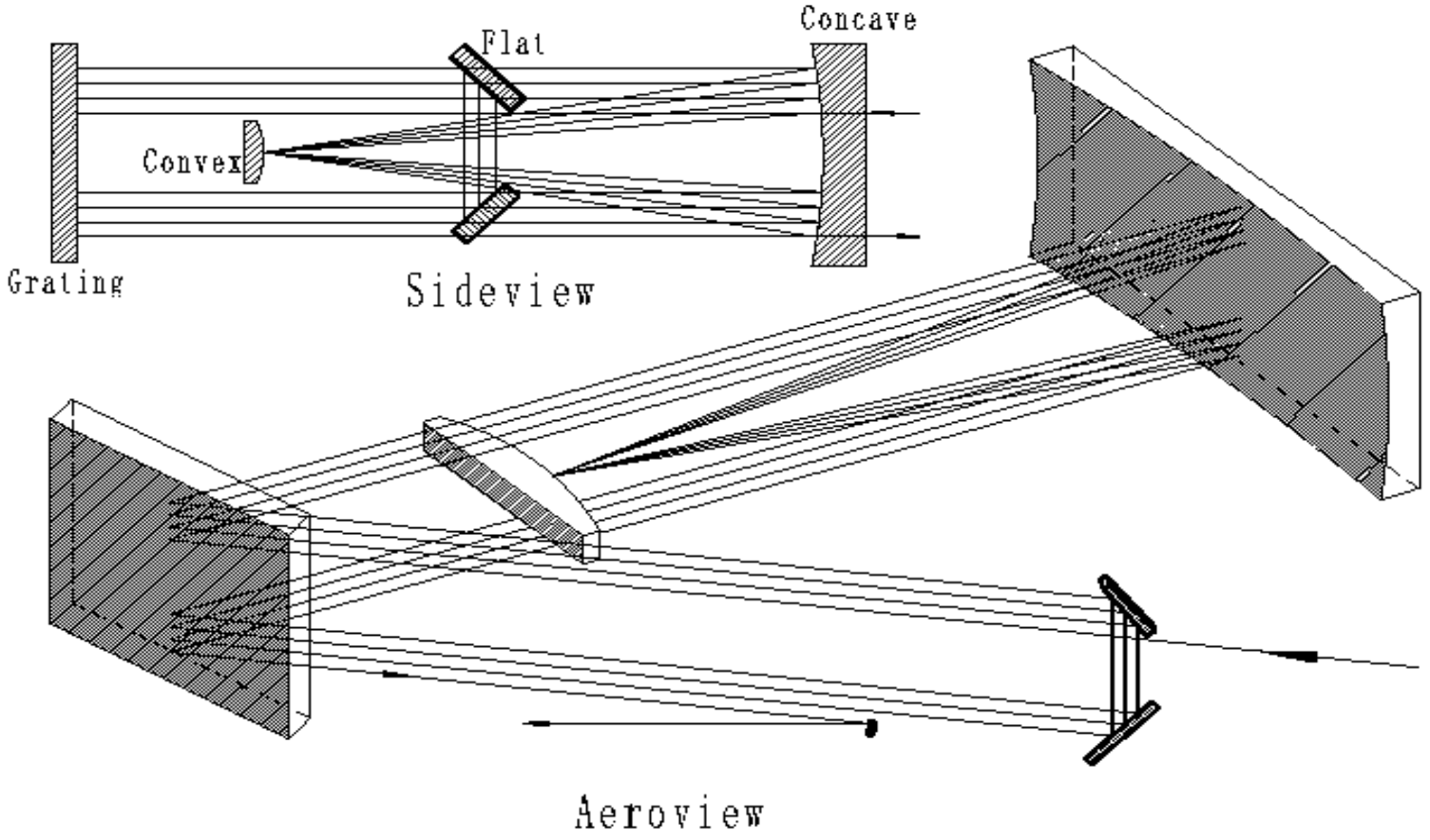


Pulse duration

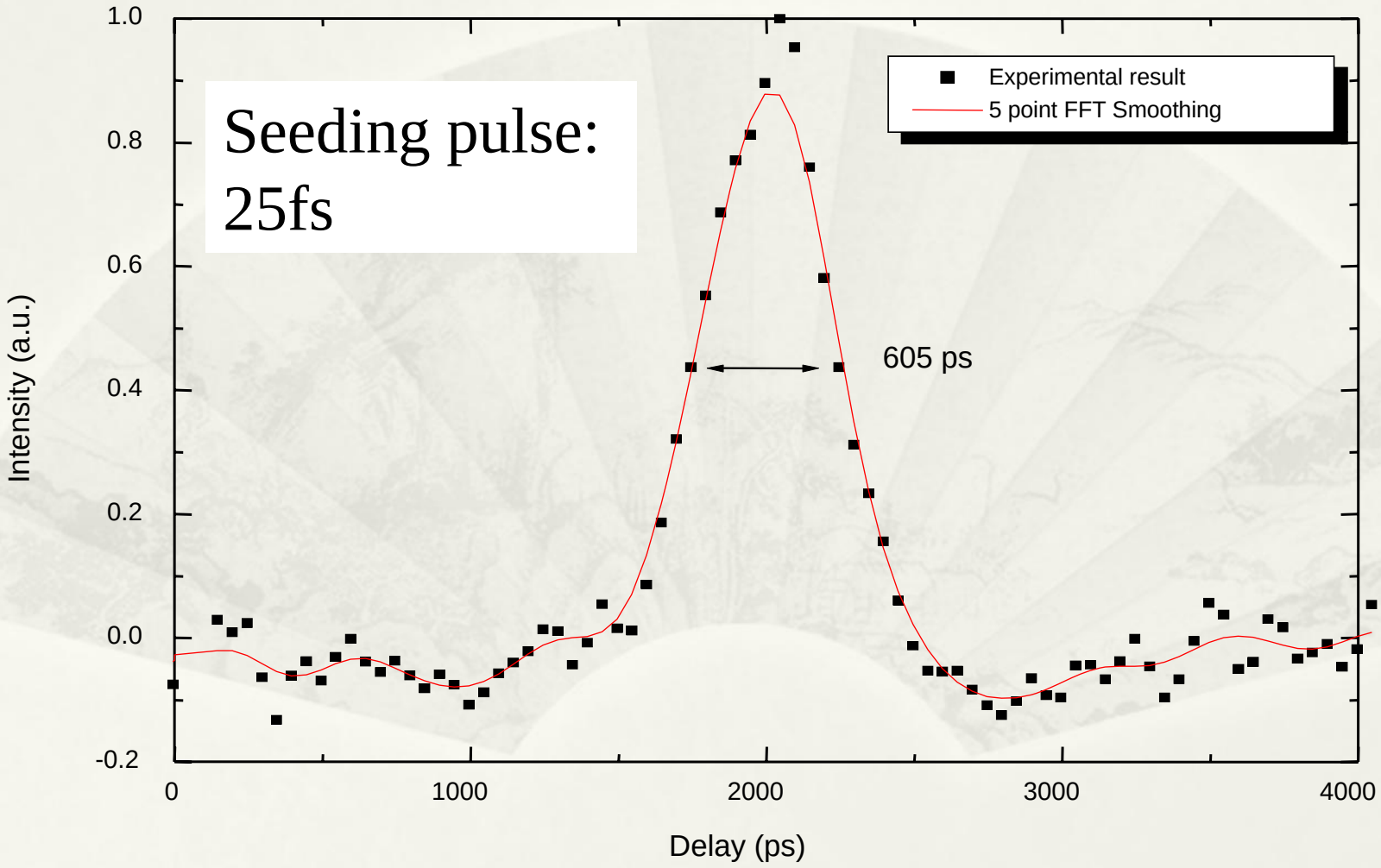


Spectrum

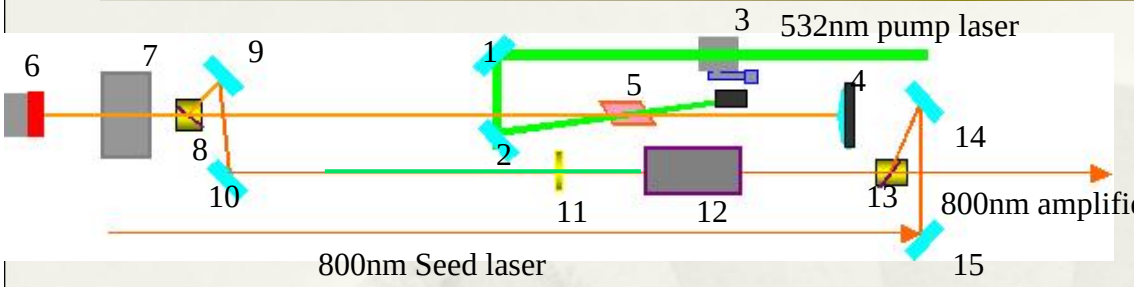
Doubled trip stretcher

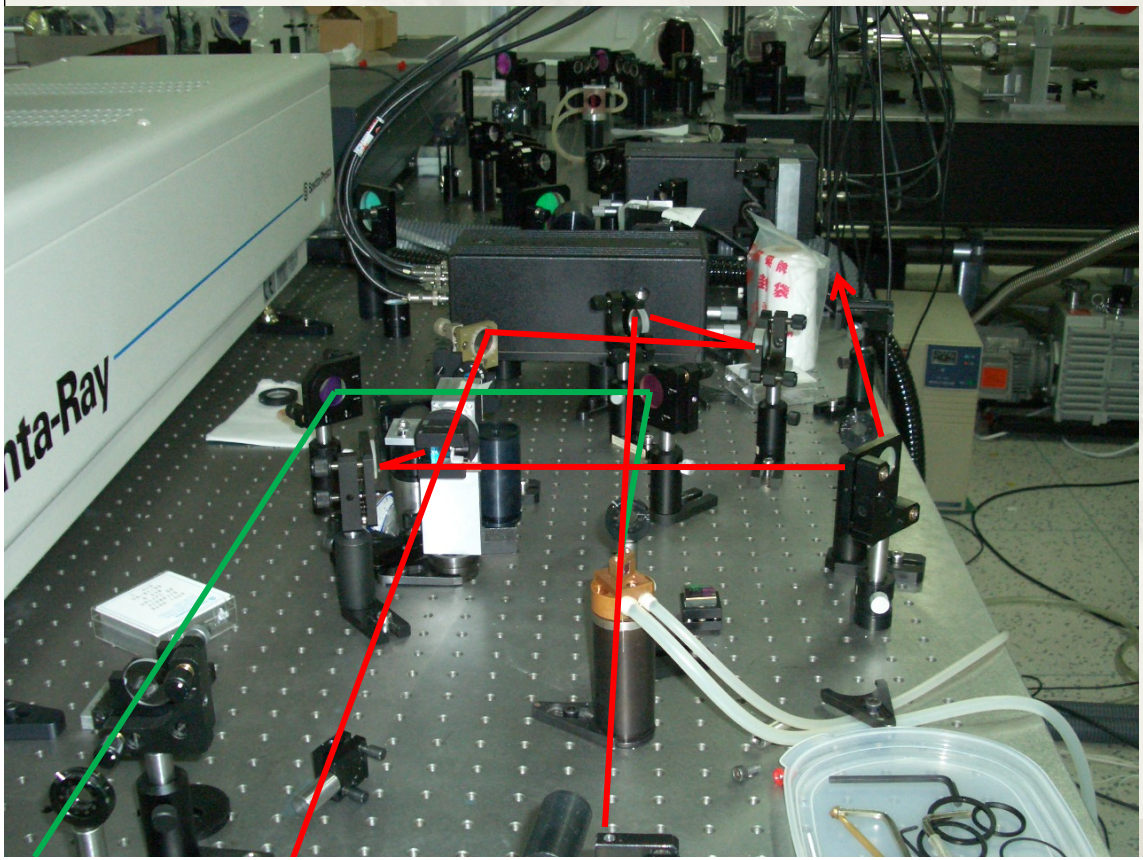


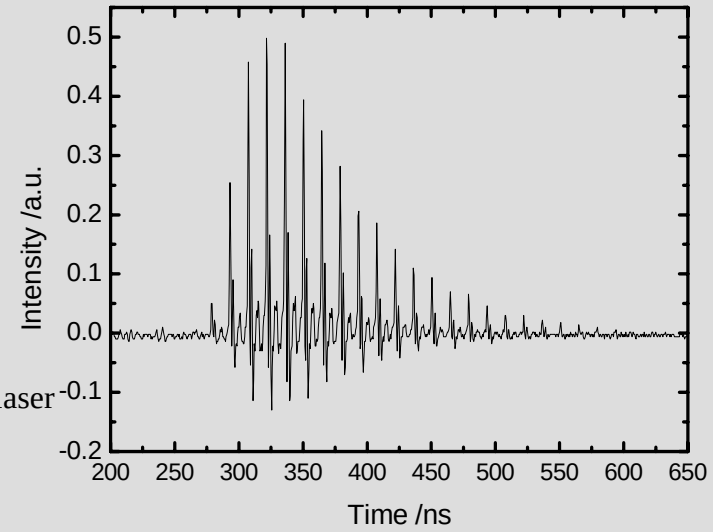
Pulse duration after stretcher

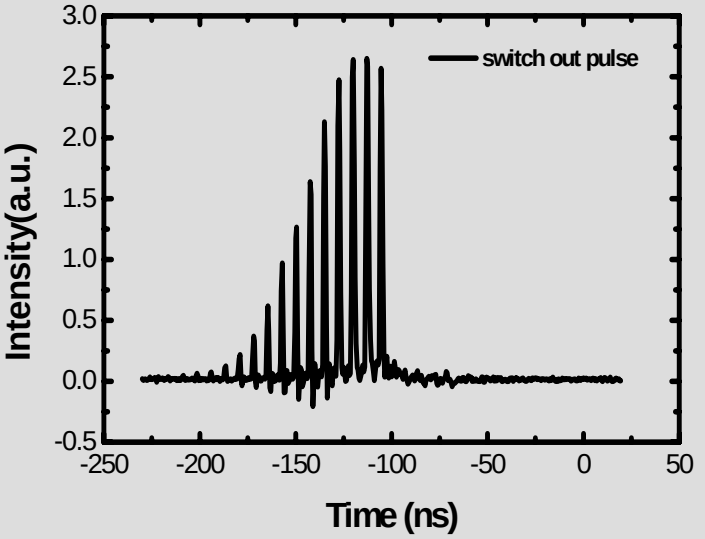


Regenerative amplifier

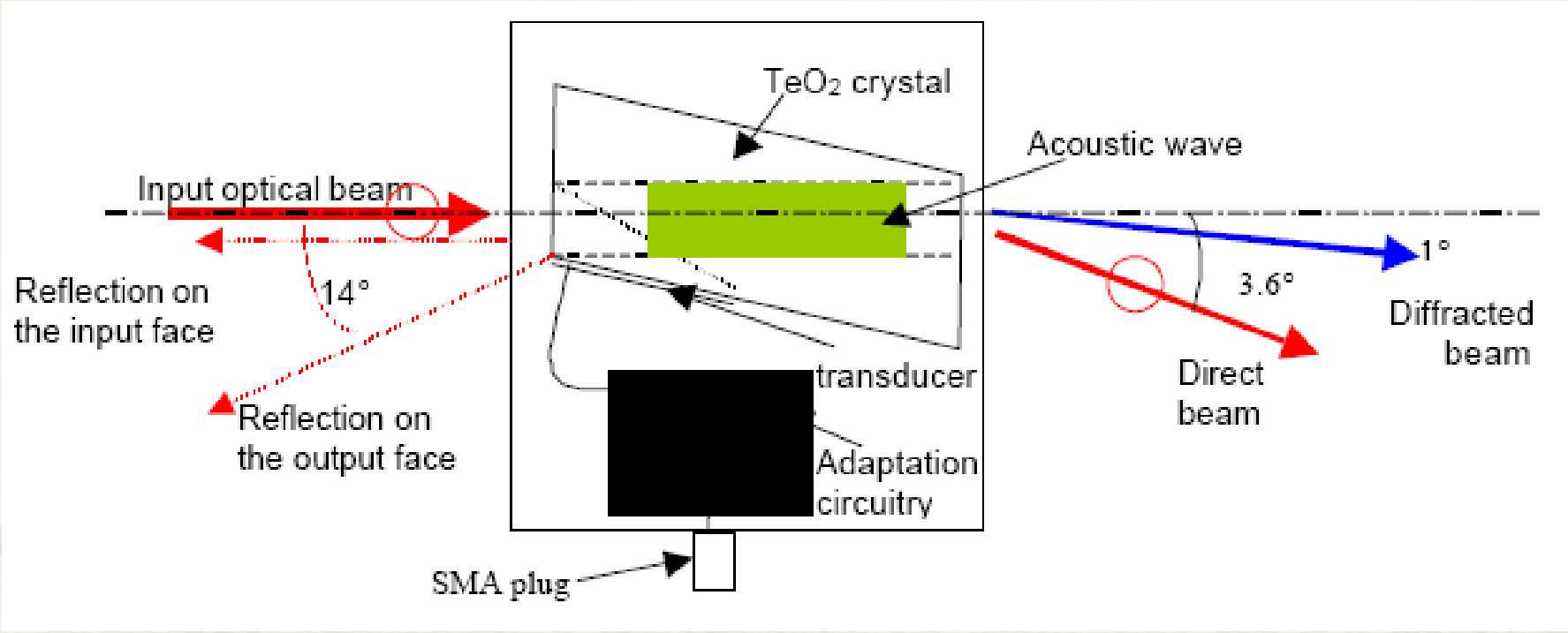








AOM for spectrum shaping



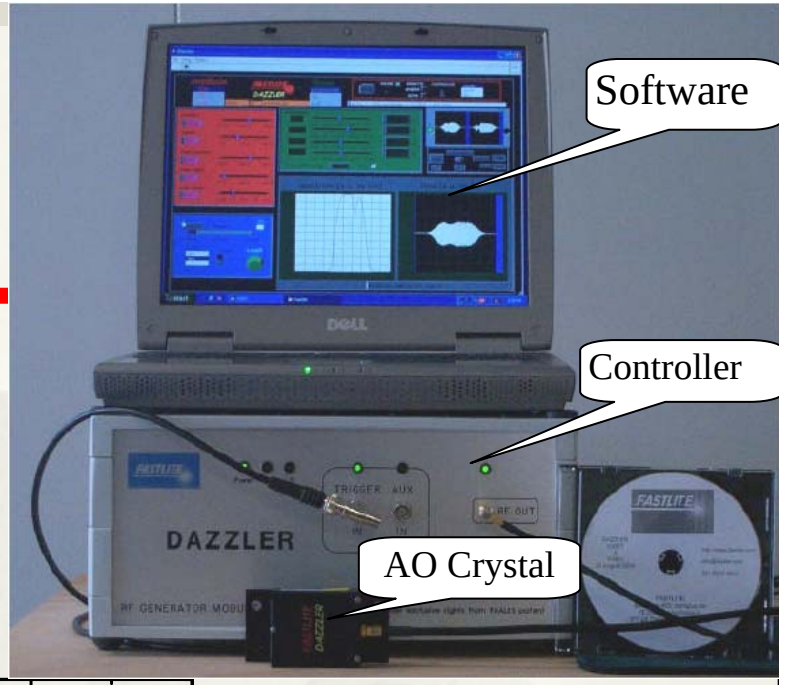
FASTLITE

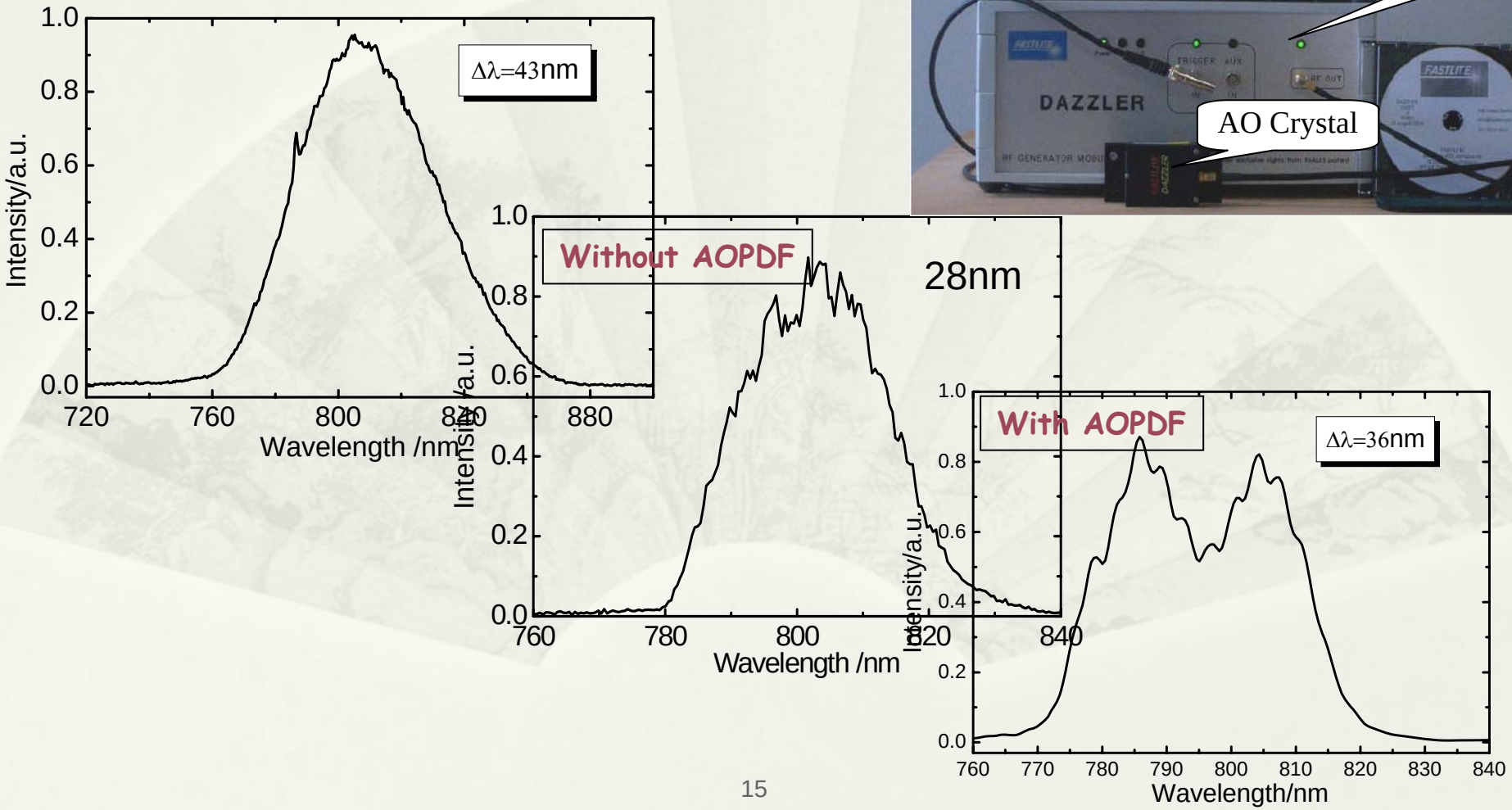
Acoustic-optics modulator

DAZZLER™

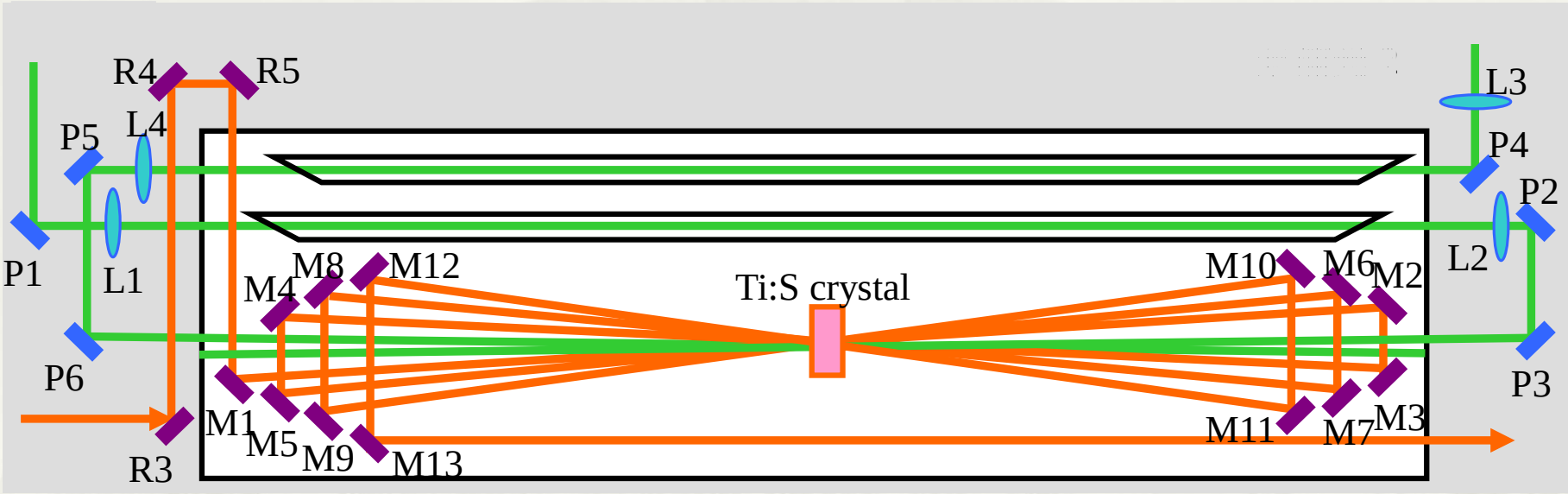
UWB-650-1100/T1

Shaped spectra from Regenerative amplifier

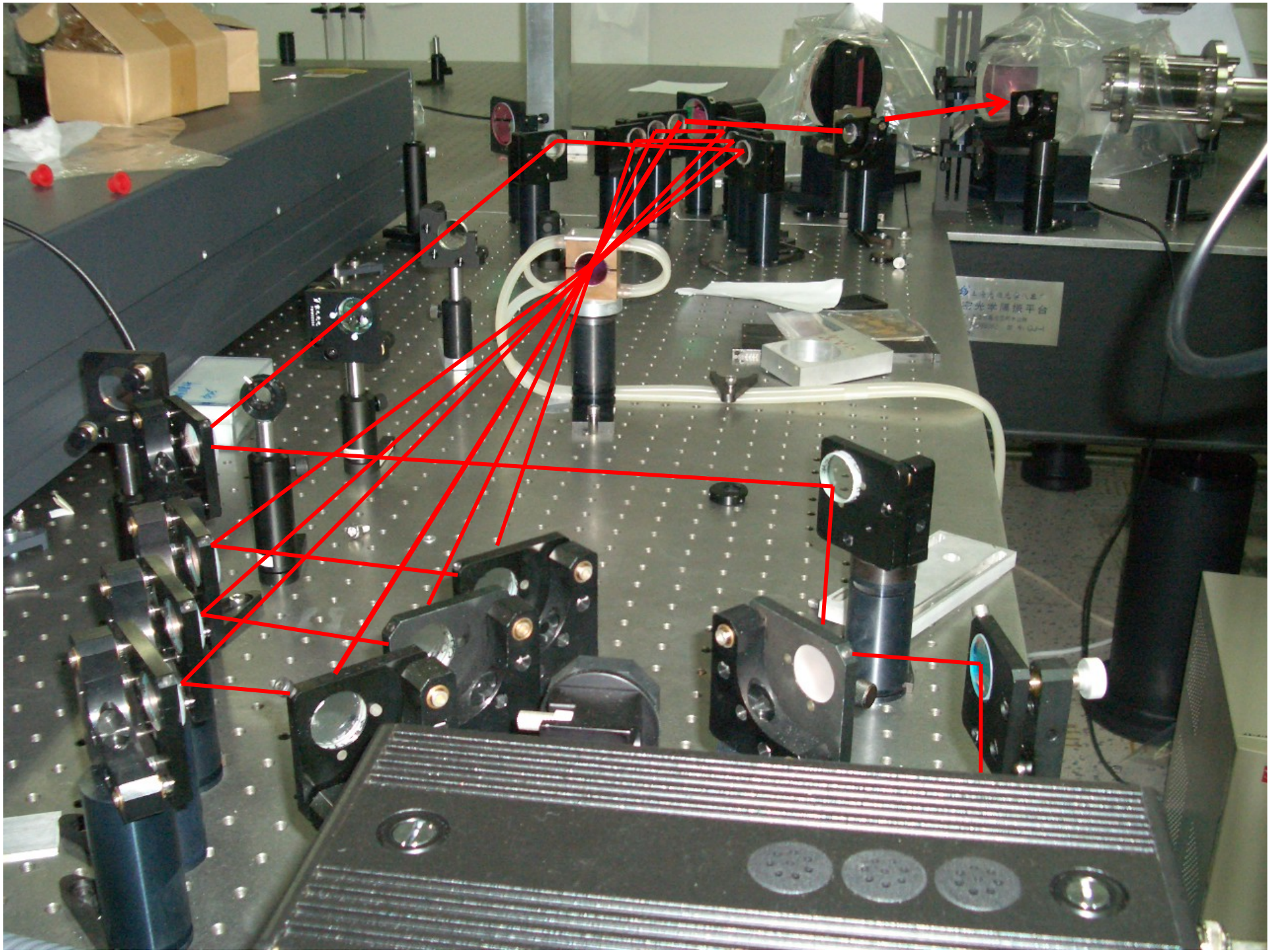




Second stage amplifier



With 2.6J pump laser energy, amplified laser of 780mJ was obtained, corresponding to the efficiency of 27%



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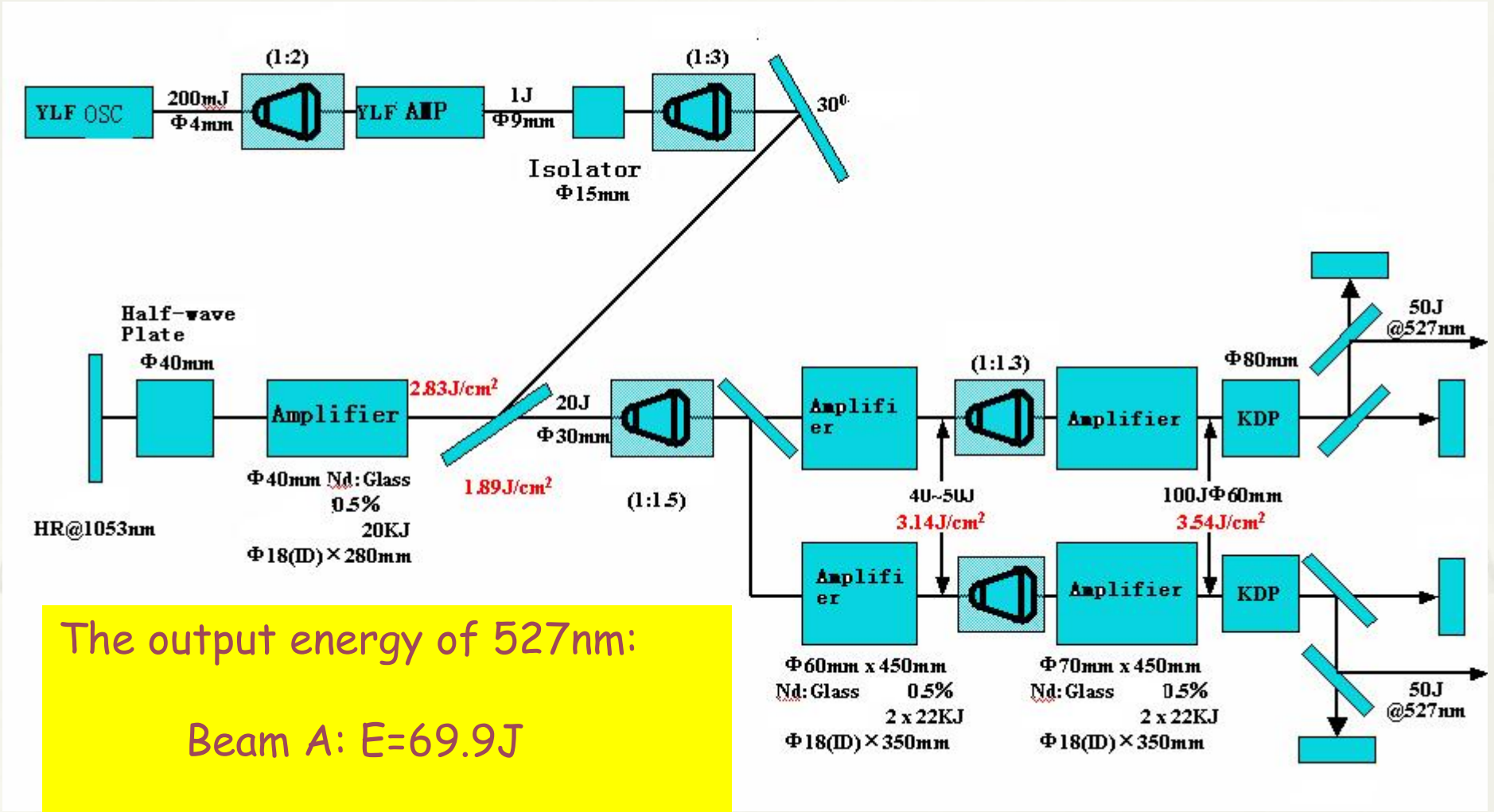
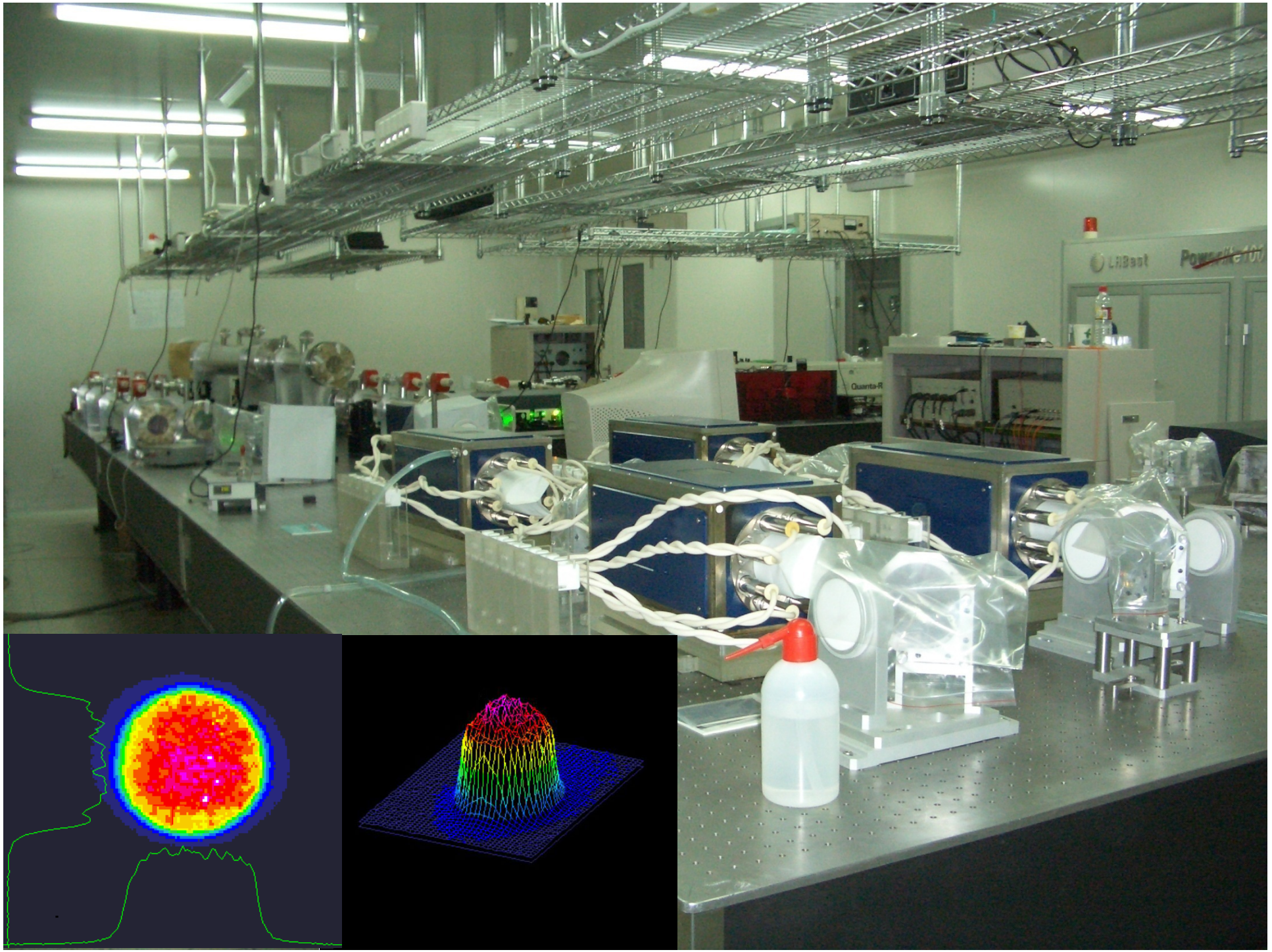
Layout of 100J pump laser



The output energy of 527nm:

Beam A: E=69.9J

Beam B: E=53.04J


LABest

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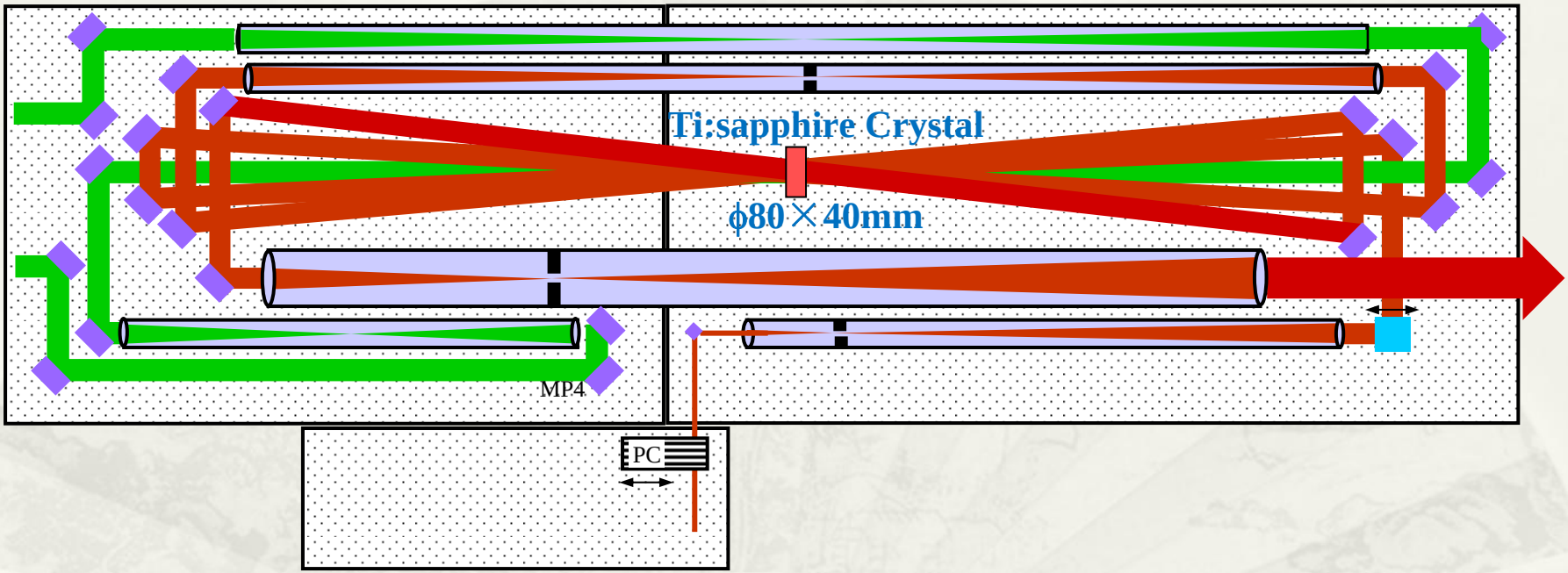
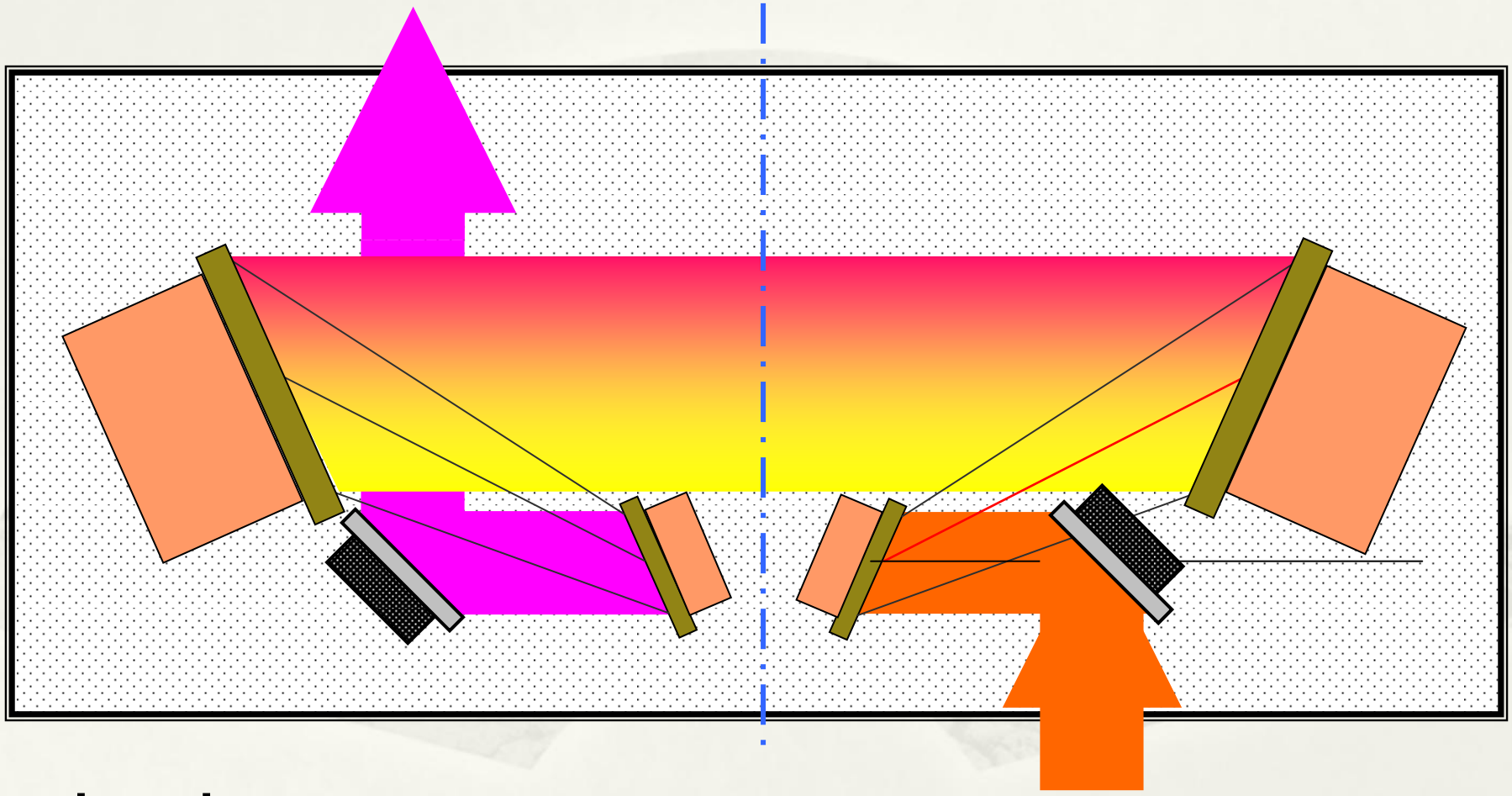
Design of final amplifier



Pumped the final amplifier with 120J laser at 527nm, laser energy only 43.5J was obtained.


DAZZLER
Powerflite100

Vacuum compressor

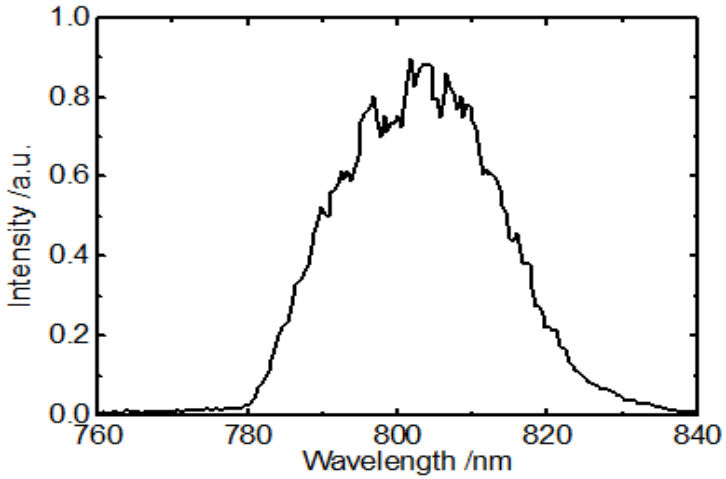


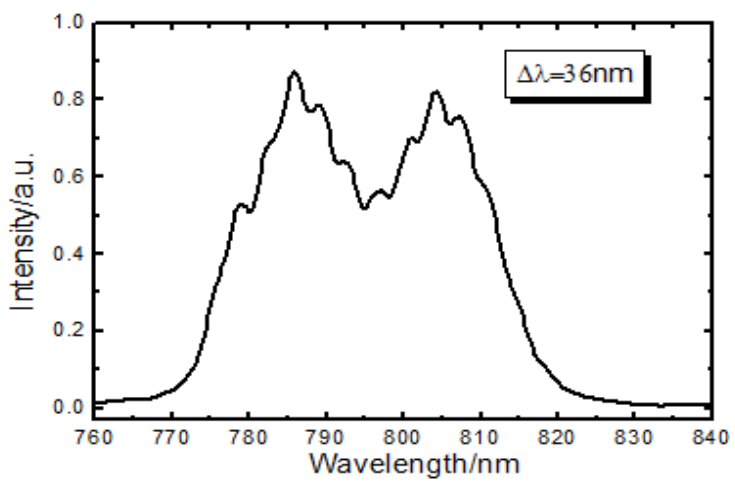
Grating size: larger one: 460x210x50mm; Smaller one: 230x180x30mm

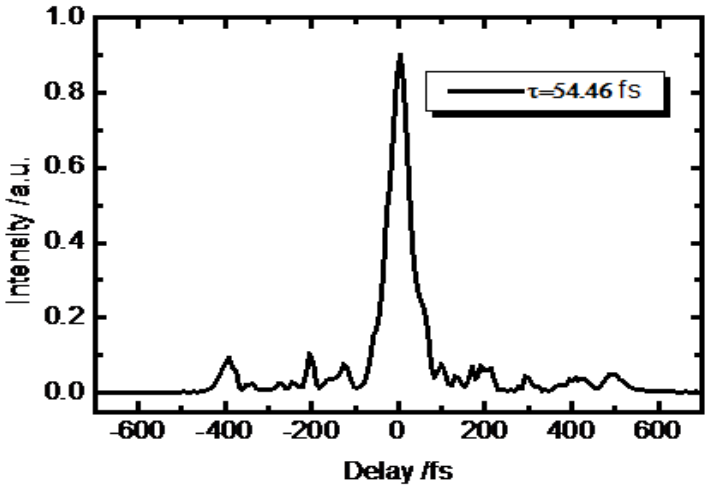
Transmissivity: ~52%; Pulse Energy: 43.5×52%=22.5J

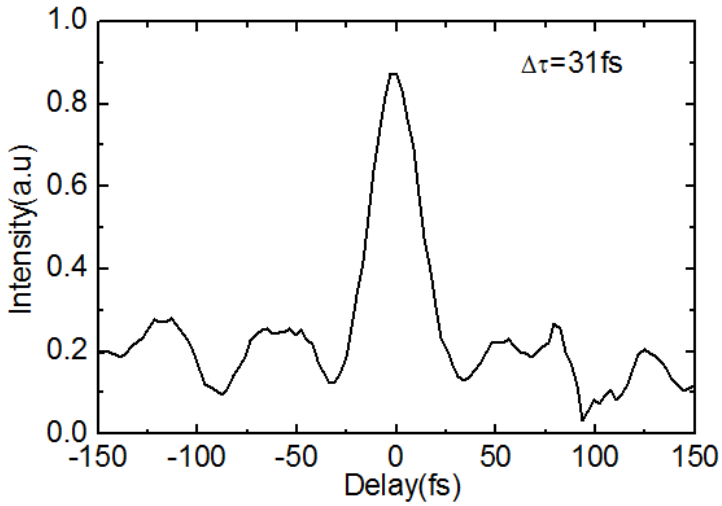
Compressor Chamber and diagnostic instruments

compressed pulse autocorrelation









Peak Power: 22.5J/31fs=725TW

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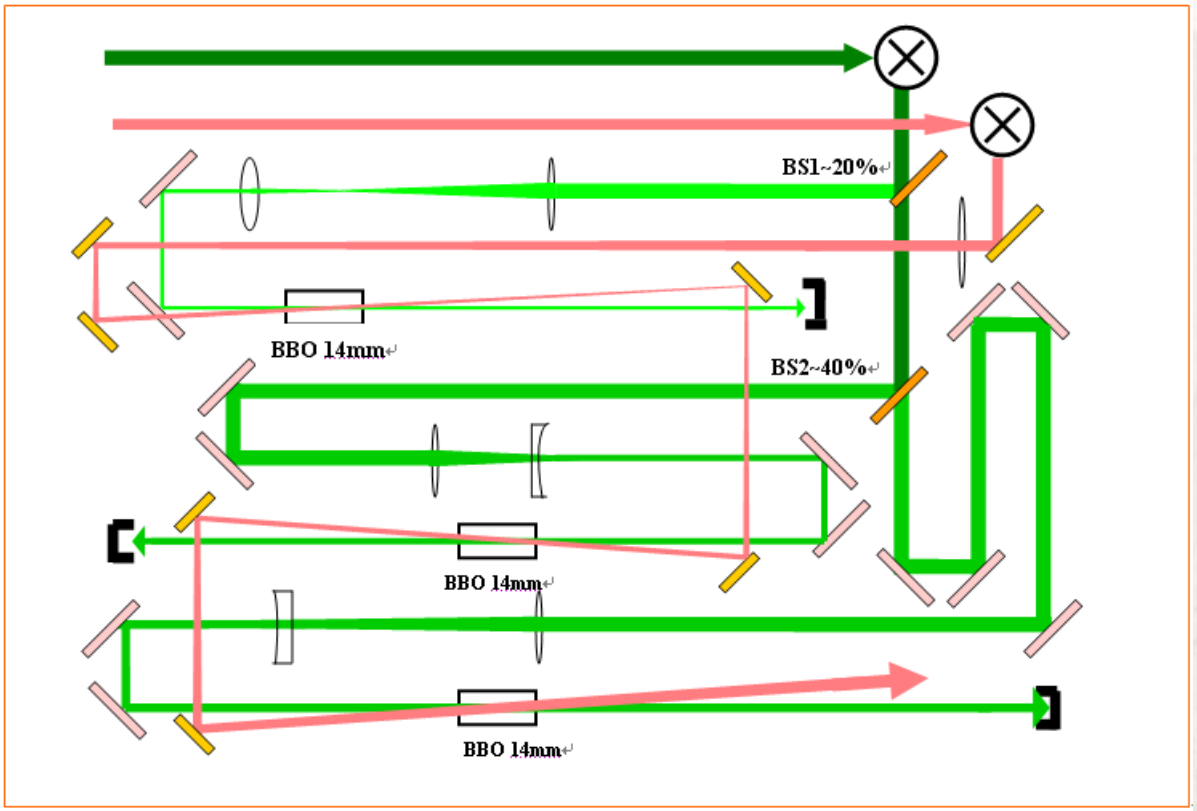
Conclusions

◆We designed and established a CPA laser facility which is capable of multi-100TW peak power with three stage amplifiers.

◆With the pump energy of 120J, amplified laser energy of 43.5J was obtained. After the compressor, the pulse energy was up to 22.5J and the pulse duration was as short as 31fs, which corresponds to peak power of 725TW.

Prospect

◆A new high contrast ratio amplifier and OPCPA amplifier will be used for improving the contrast ratio in front stages.

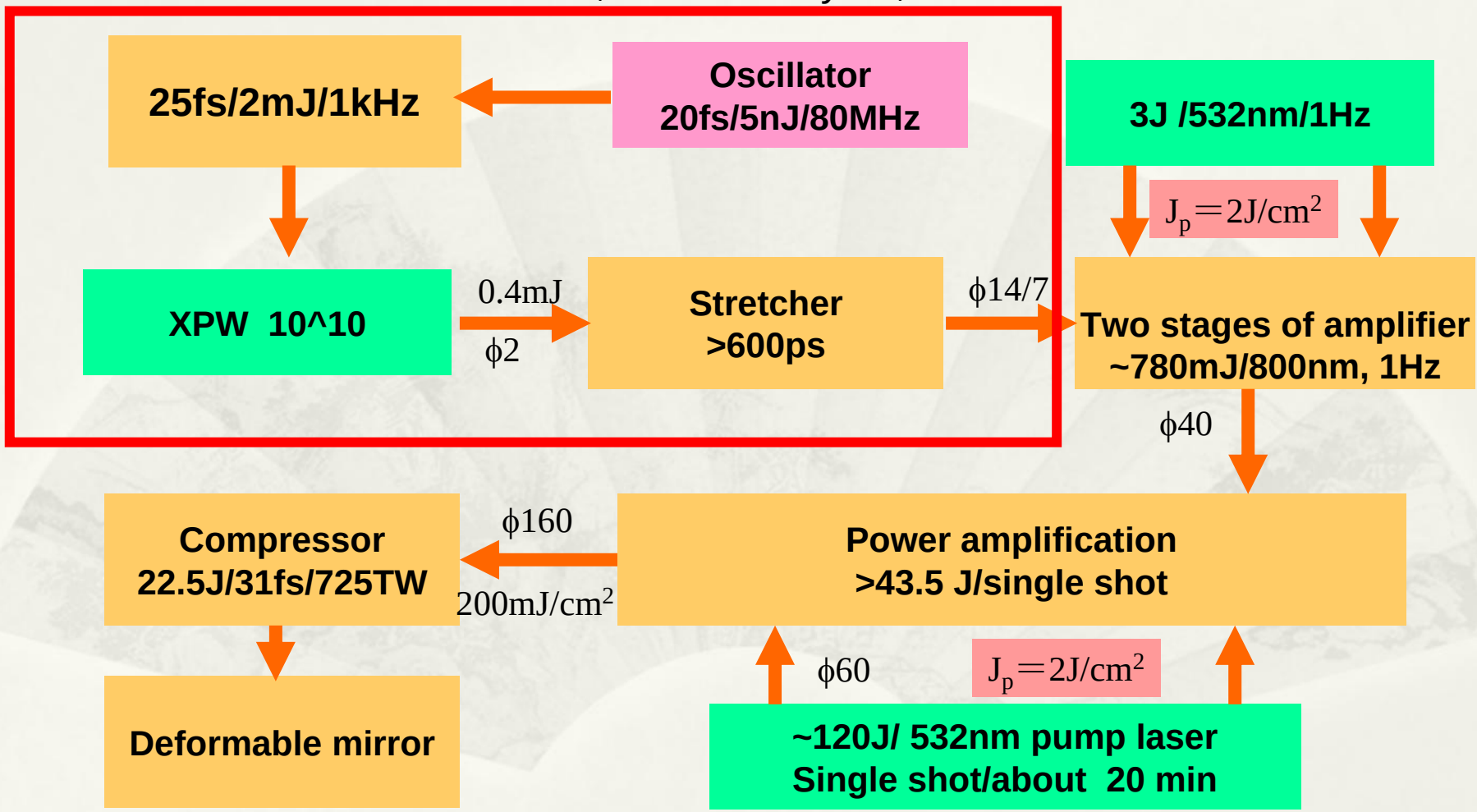


	Pump Energy (532nm)	Output Energy (800nm)
First Stage	35mJ	200nJ
Second Stage	74mJ	0.1mJ
Third Stage	113mJ	4mJ

Poster Section I: 17 Changwen Xu, "Improvement of output energy in OPCPA based on Ti:sapphire laser by the gain distribution among the nonlinear crystals"

Prospect

1. OPTICS LETTERS / Vol. 30, No. 8 / April 15, 2005
2. OPTICS LETTERS / Vol. 31, No. 10 / May 15, 2006



With those improved techniques, we expect to generate laser pulses with contrast ratio of about 10^{10}

Thank You for your attention!