

Recent Progress on Hybrid (Solid/Gas) Blue-Green fs Laser System

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Hybrid (solid/gas) femtosecond laser sketch

Tl:Sa



Solid state

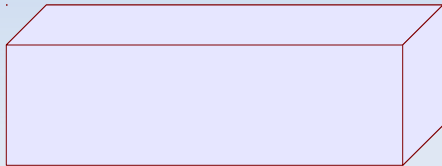
XeF(C—A)



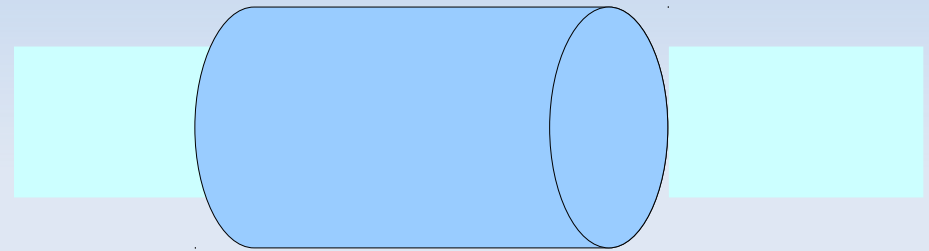
+ gas media

Hybrid femtosecond laser sketch

Tl:Sa



XeF(C—A)



VUV-Pump

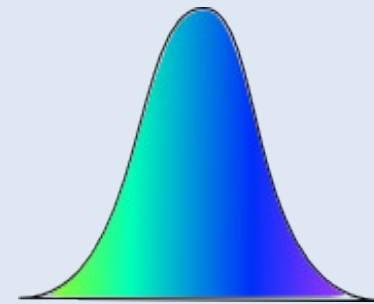


Saturation fluence 50 mJ/cm²

2 TW/cm² in 25 fs pulse

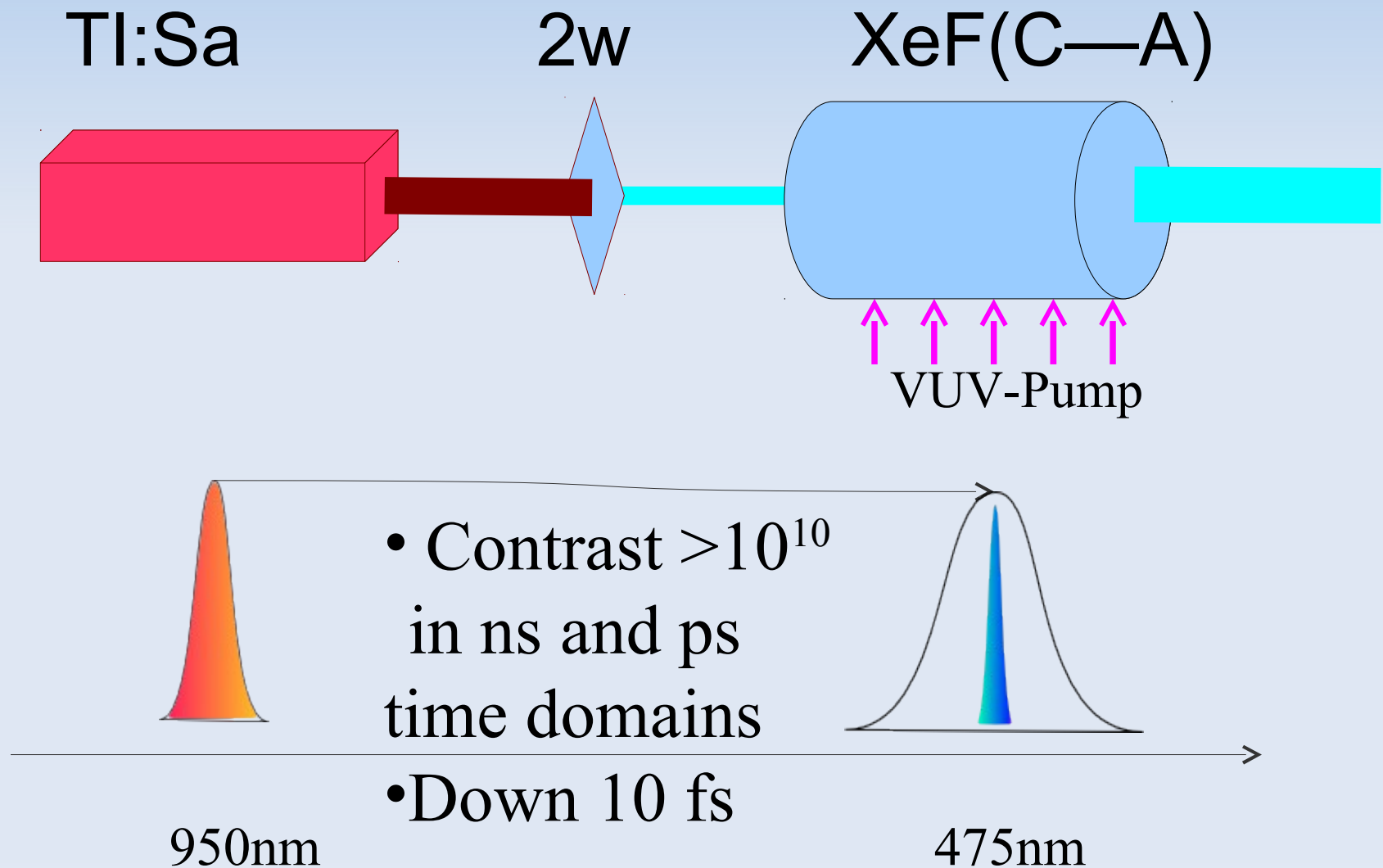
Down to 10 fs bw

Low nonlinearity!

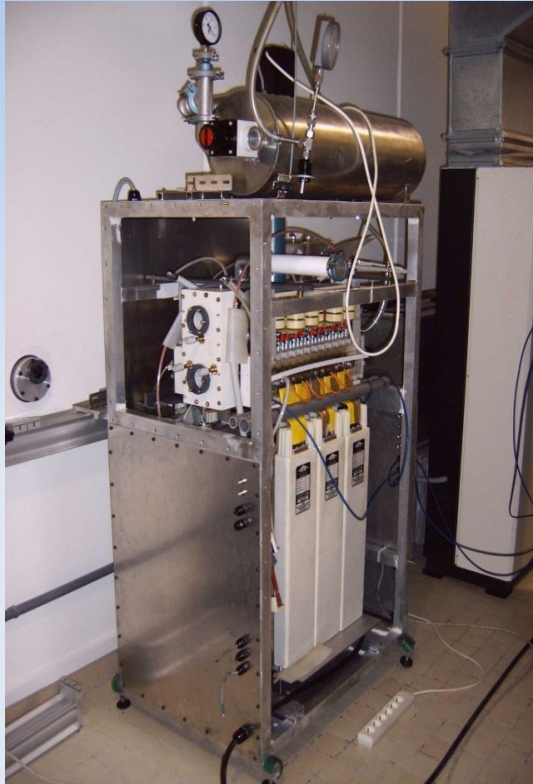


475@70 nm

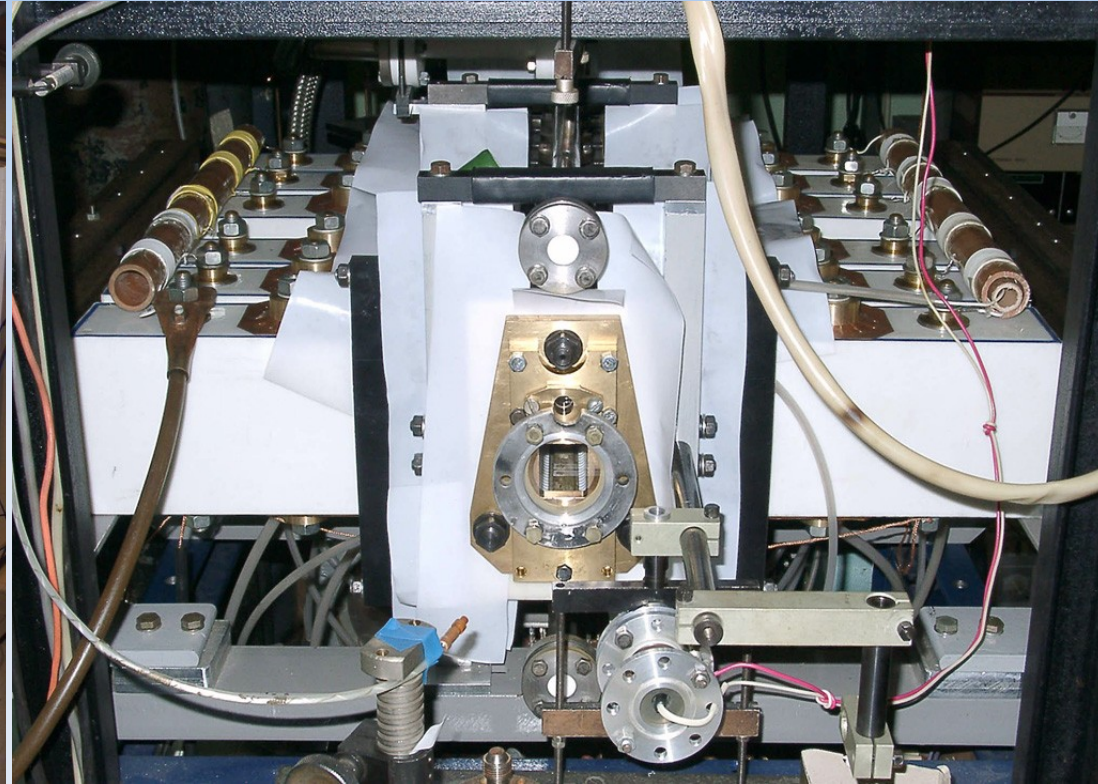
Spectral matching



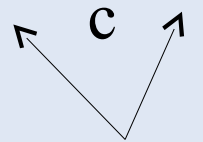
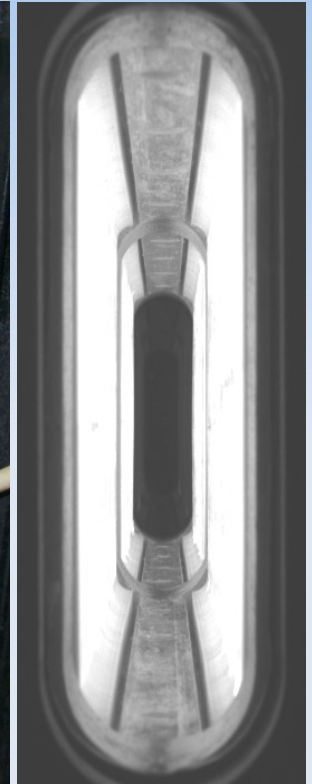
Suface Discharge Pumped Amplifier



a



b



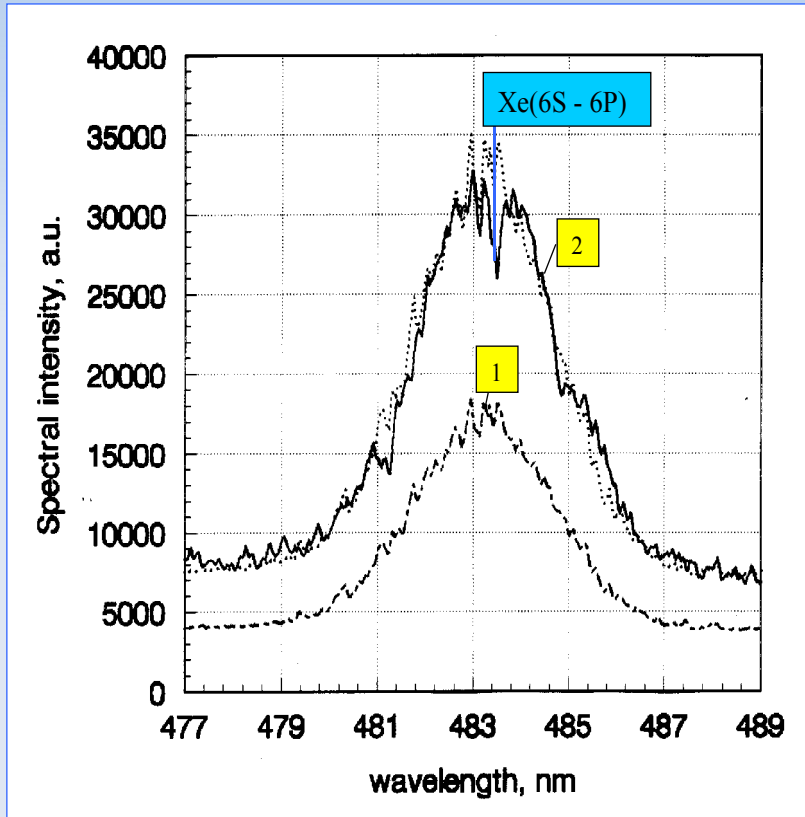
20kK

Photos of the photolytical XeF(C-A) amplifiers:

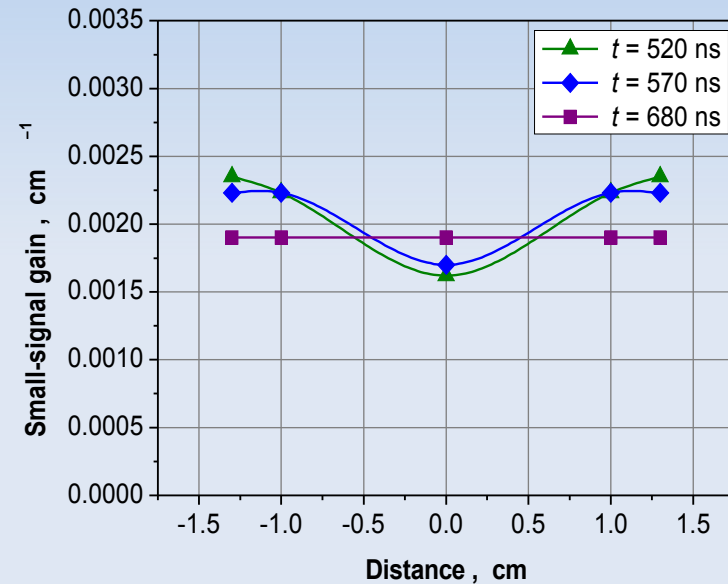
- a) LP3 of Marseille Univ.(active volume: $5 \times 18 \times 40 \text{ cm}^3$);
- b) P.N.Lebedev Inst. (active volume: $3 \times 11 \times 50 \text{ cm}^3$);
- c) XeF(C-A) amplifier viewed from its front when surface discharge is initiated.

Small-signal gain: $2 \times 10^{-3} \text{ cm}^{-1}$
Total amplification factor: 10^2

Great spatial and spectral homogeneity

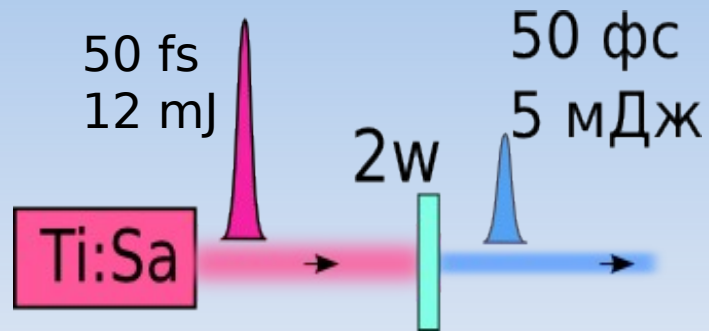


Spectra of fs pulse before (1) and after (2) amplification



Gain distributions versus the distance from the central plane of the amplifier at different instants of time

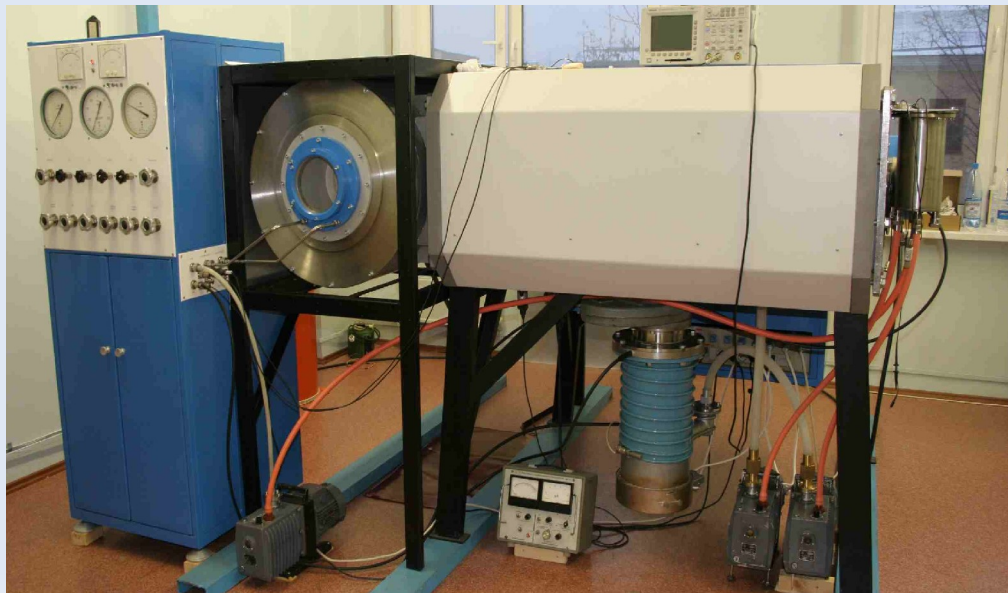
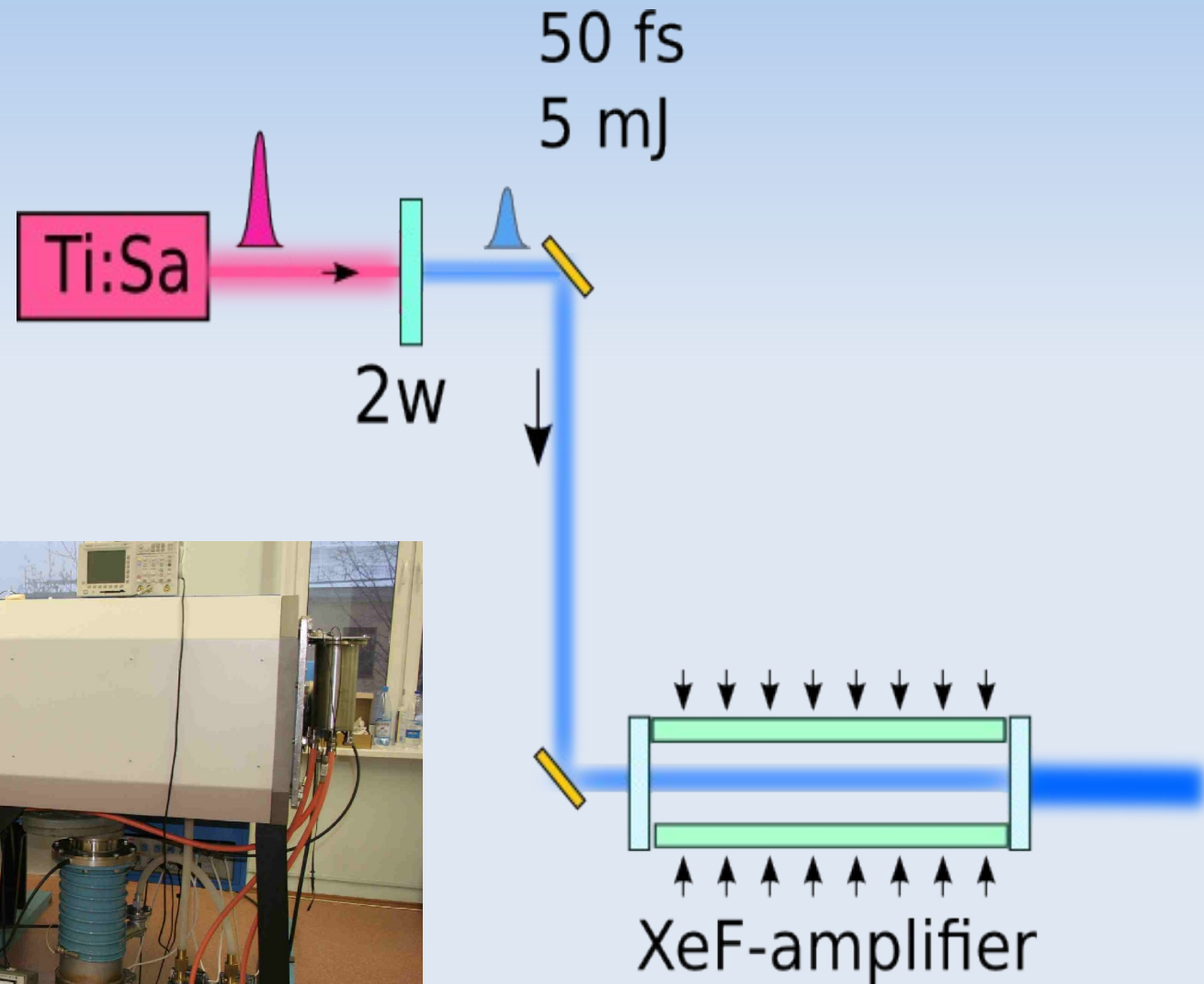
Seed Pulse Generator



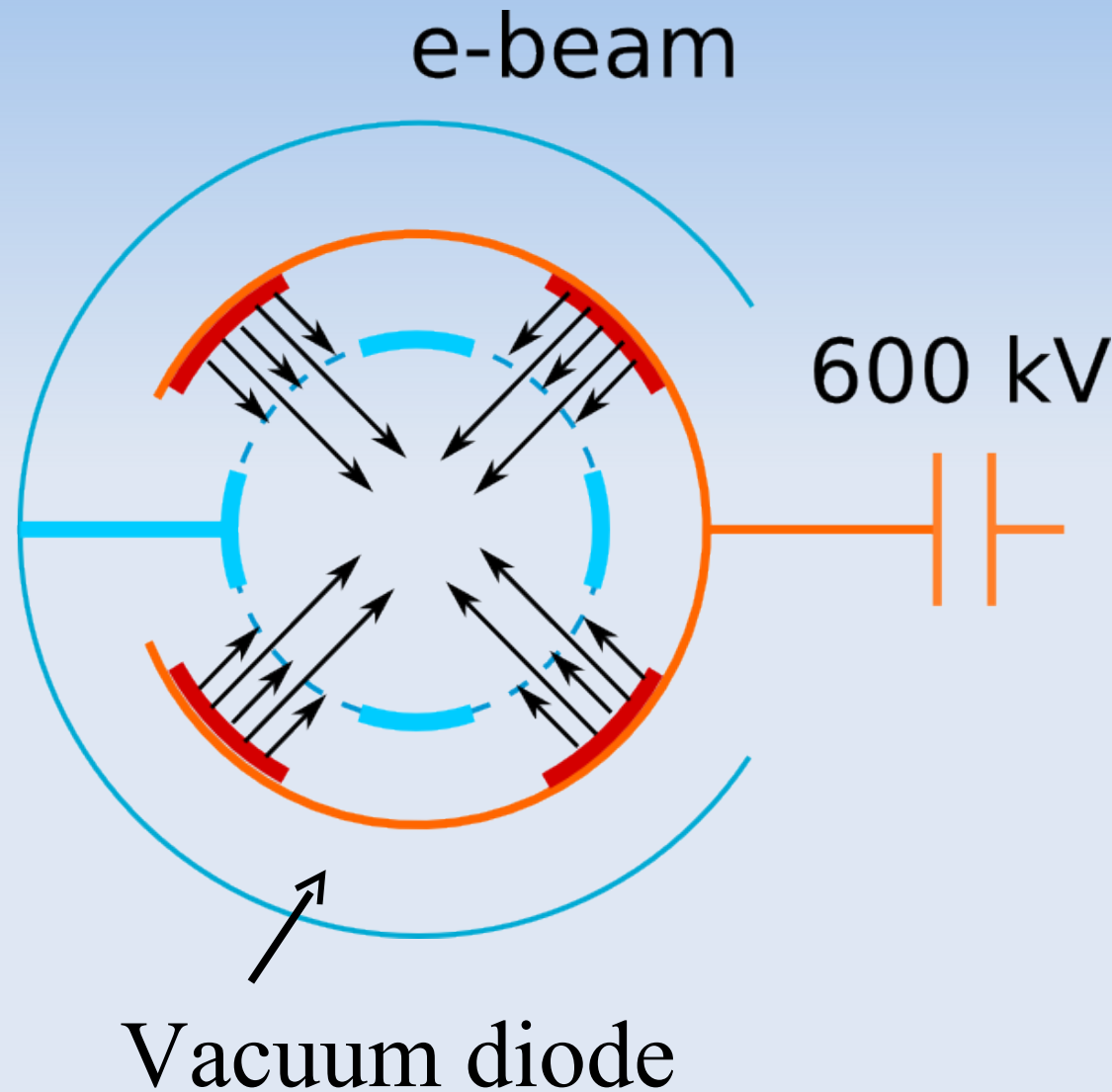
Avesta Project:
950/475 nm
0.1 TW
(5 mJ / 50 fs)
@10 Hz



Xe-converter pumped amplifier

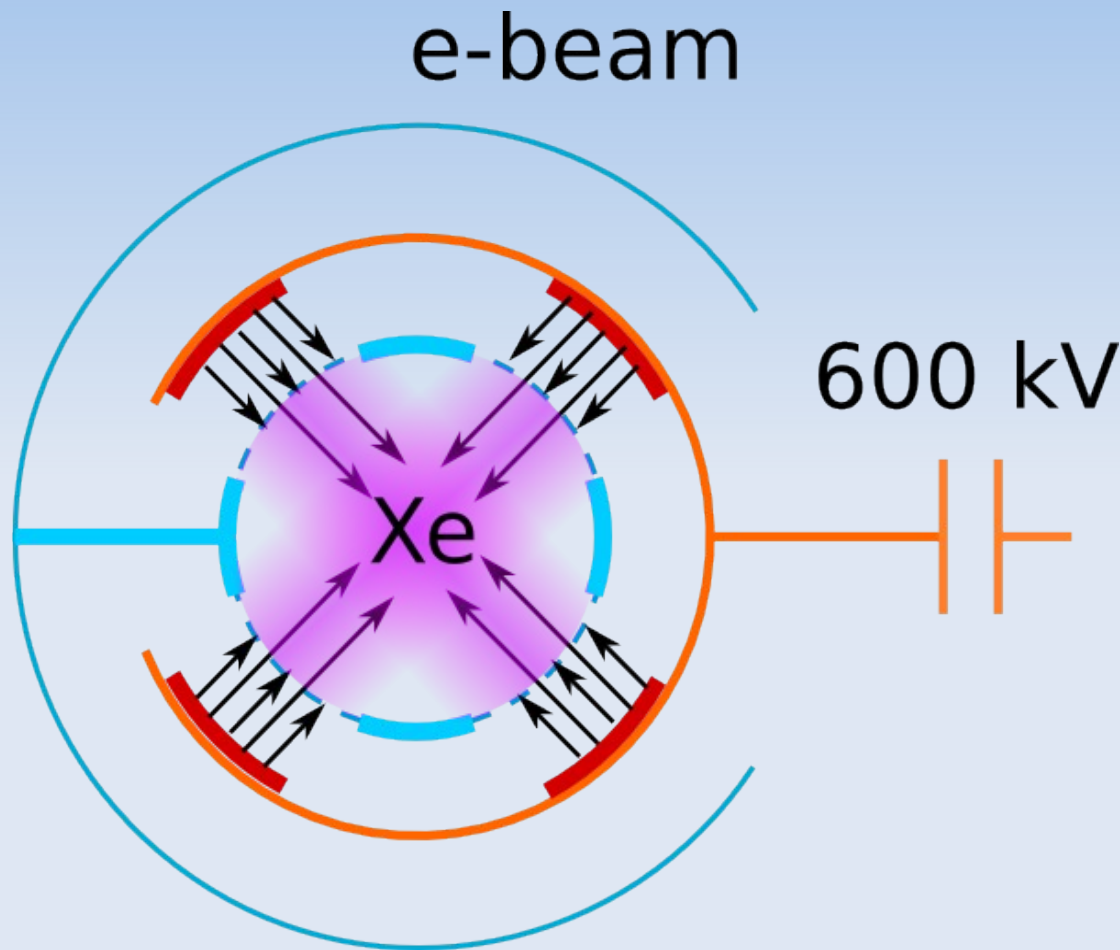


Final XeF(C-A) amplifier photochemically driven by 172 nm radiation from an e-beam pumped Xe converter



E-beam:
length - 120 cm, width - 12 cm,
(4 beams)
 $I = 70 \text{ } \mu\text{A}$, $U_e = 450 \text{ keV}$,
pulse-width - 400 ns

Final XeF(C-A) amplifier photochemically driven by 172 nm radiation from an e-beam pumped Xe converter



E-beam:

length - 120 cm, width - 12 cm,
(4 beams)

$I=70 \text{ kA}$, $U_e = \underline{450 \text{ keV}}$,
pulse-width - 400 ns

Converter:

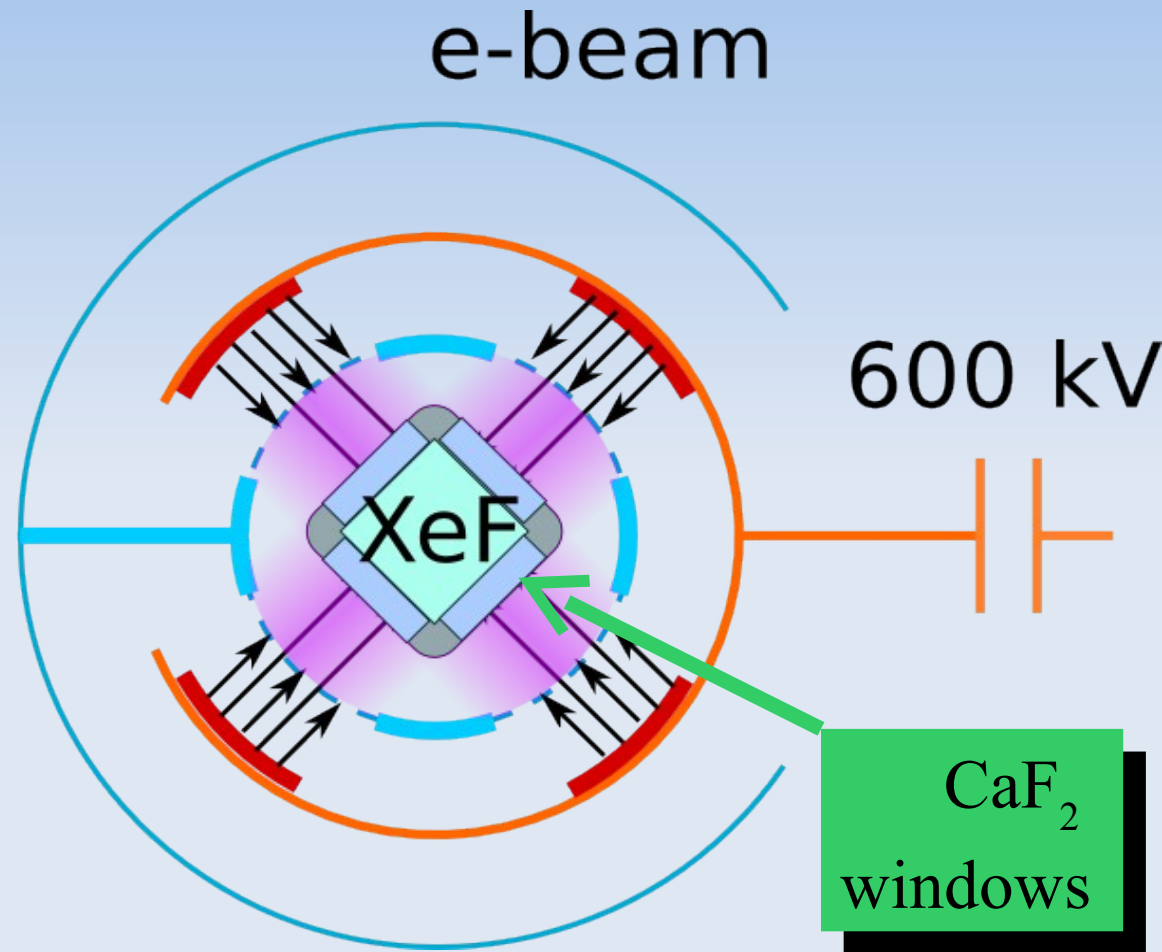
energy deposited into Xe
~2.5 kJ,

Xe_2 fluorescence efficiency
related to e-beam energy
is 30 - 40%,

optical coupling efficiency
is ~15%

pump energy available in the
laser cell ~ 150 J

Final XeF(C-A) amplifier photochemically driven by 172 nm radiation from an e-beam pumped Xe converter

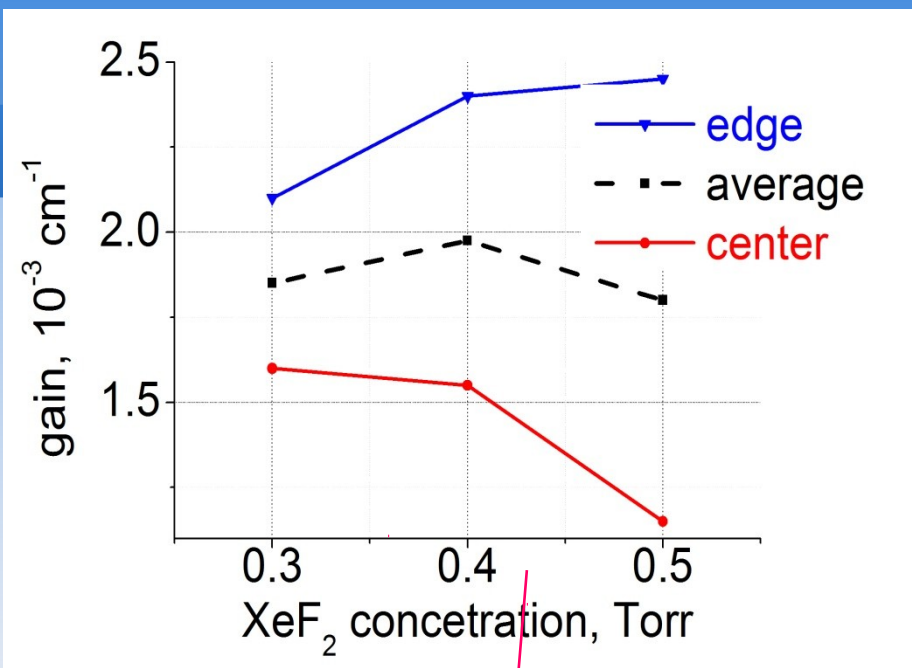


Active medium:
length - **120 cm**, clear aperture – **12 × 12 cm**,
pump energy absorbed in the active medium ~ **50 J**

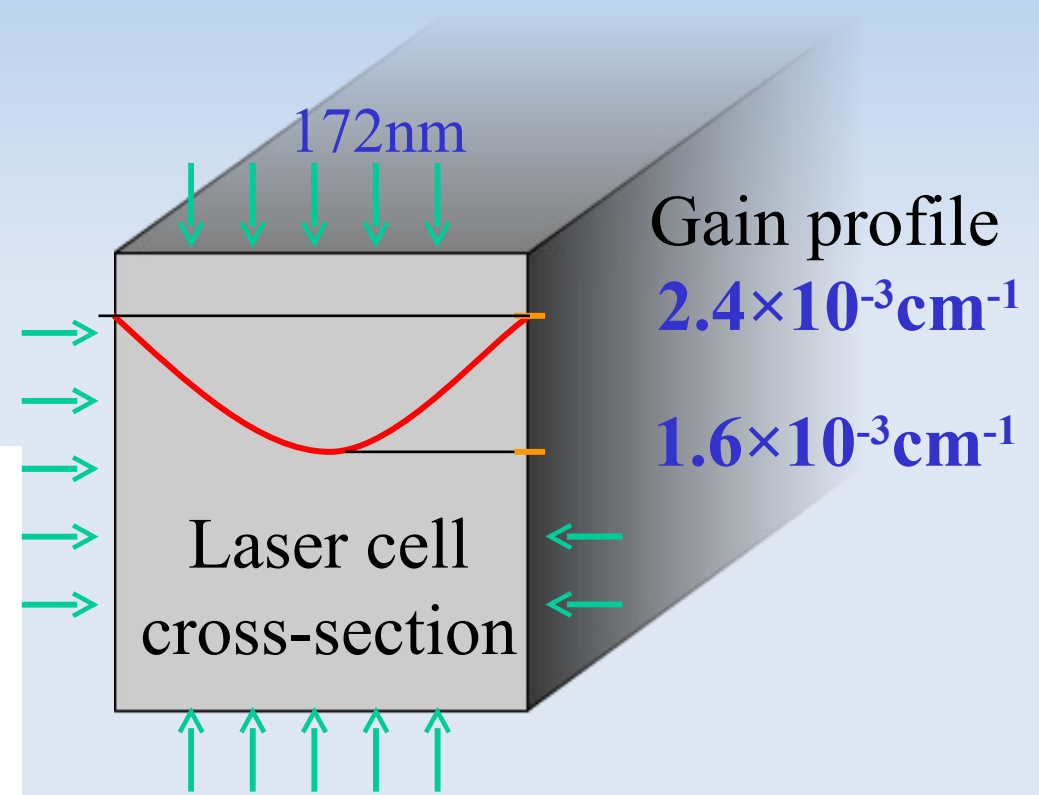
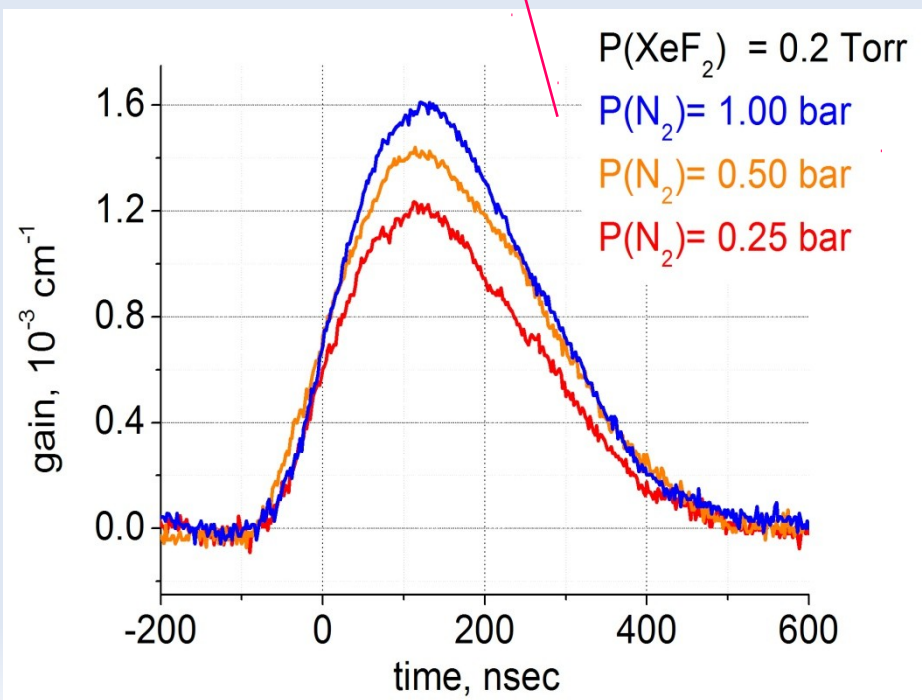
E-beam:
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 $I = 70 \text{ kA}$, $U_e = \text{450 keV}$,
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Converter:
energy deposited into Xe
~2.5 kJ,
Xe₂ fluorescence efficiency
related to e-beam energy
is 30 - 40%,
optical coupling efficiency
is ~15%
pump energy available in the
laser cell ~ **150 J**

Experimental results obtained in the final XeF(C-A) amplifier

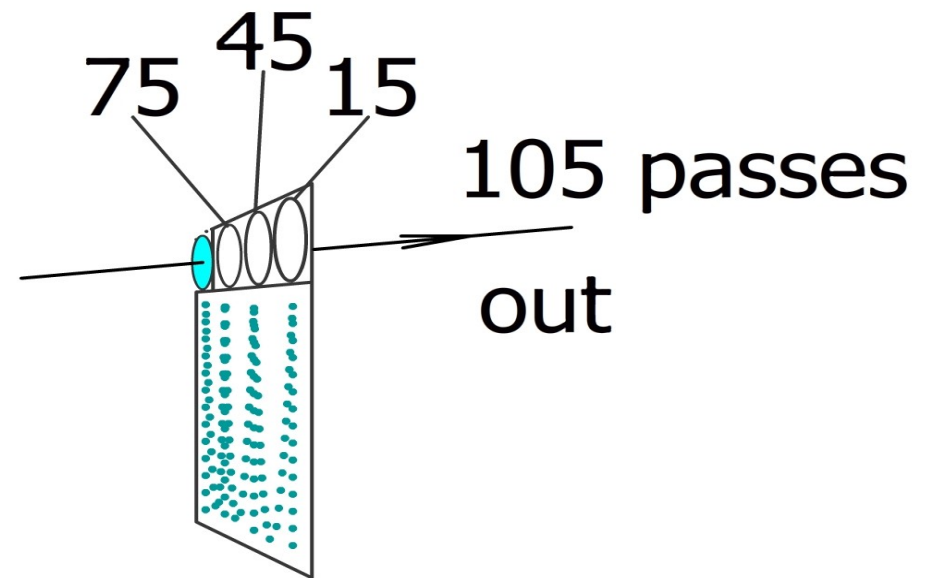
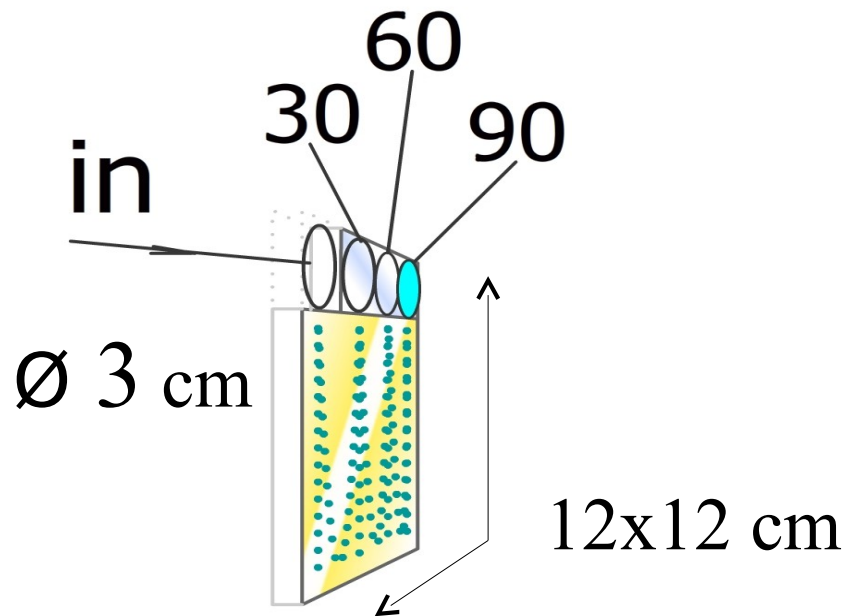


Optimal mixture



Av. gain $2 \times 10^{-3} \text{ cm}^{-1}$

Intra-cavity multipass scheme



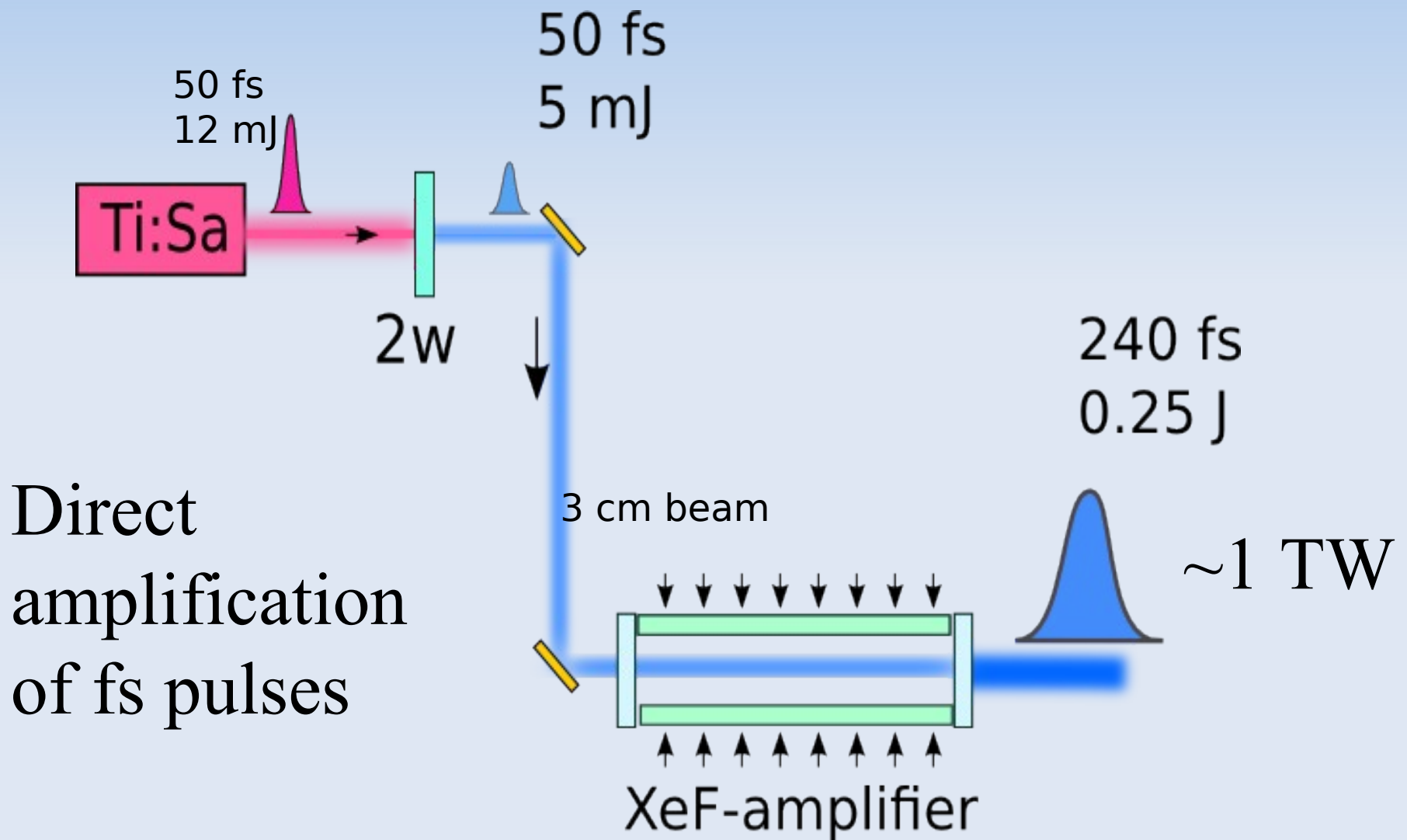
Numerical modeling:

$E_{\text{out}} = 1.5 \text{ J}$

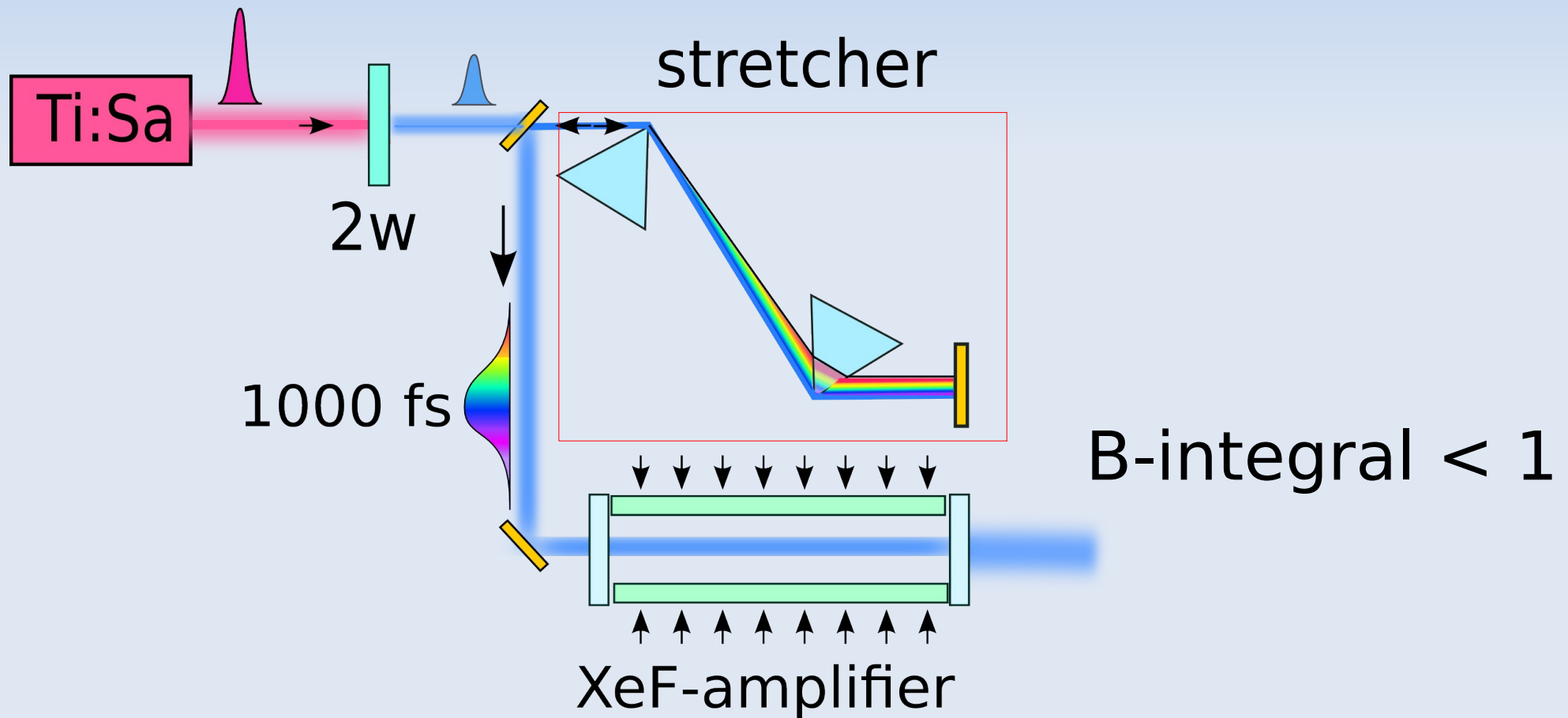
$P_{\text{out}} = 30 \text{ TW}$

in a 50 fs pulse

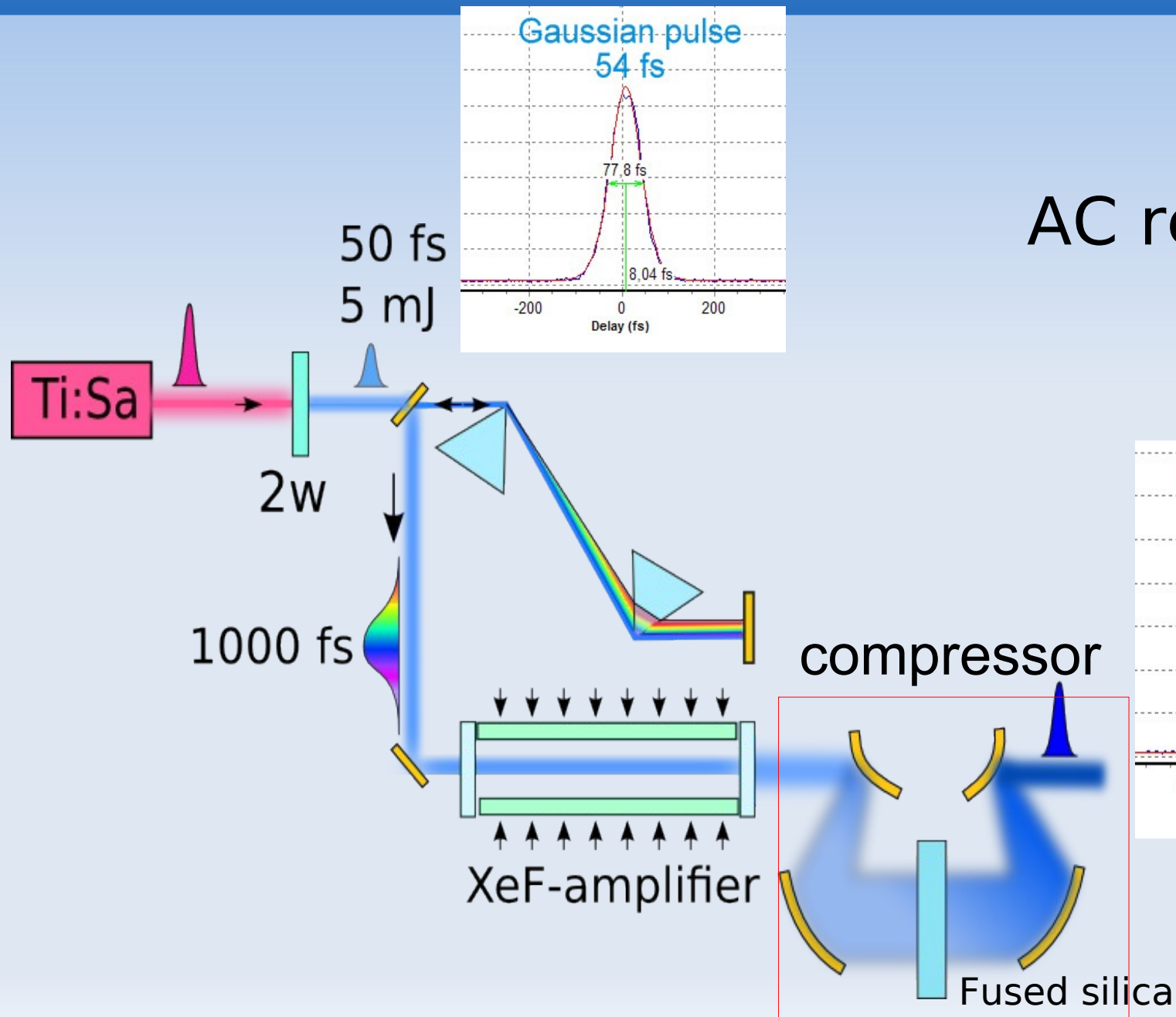
Pilot experiment



Nonlinearity reduction

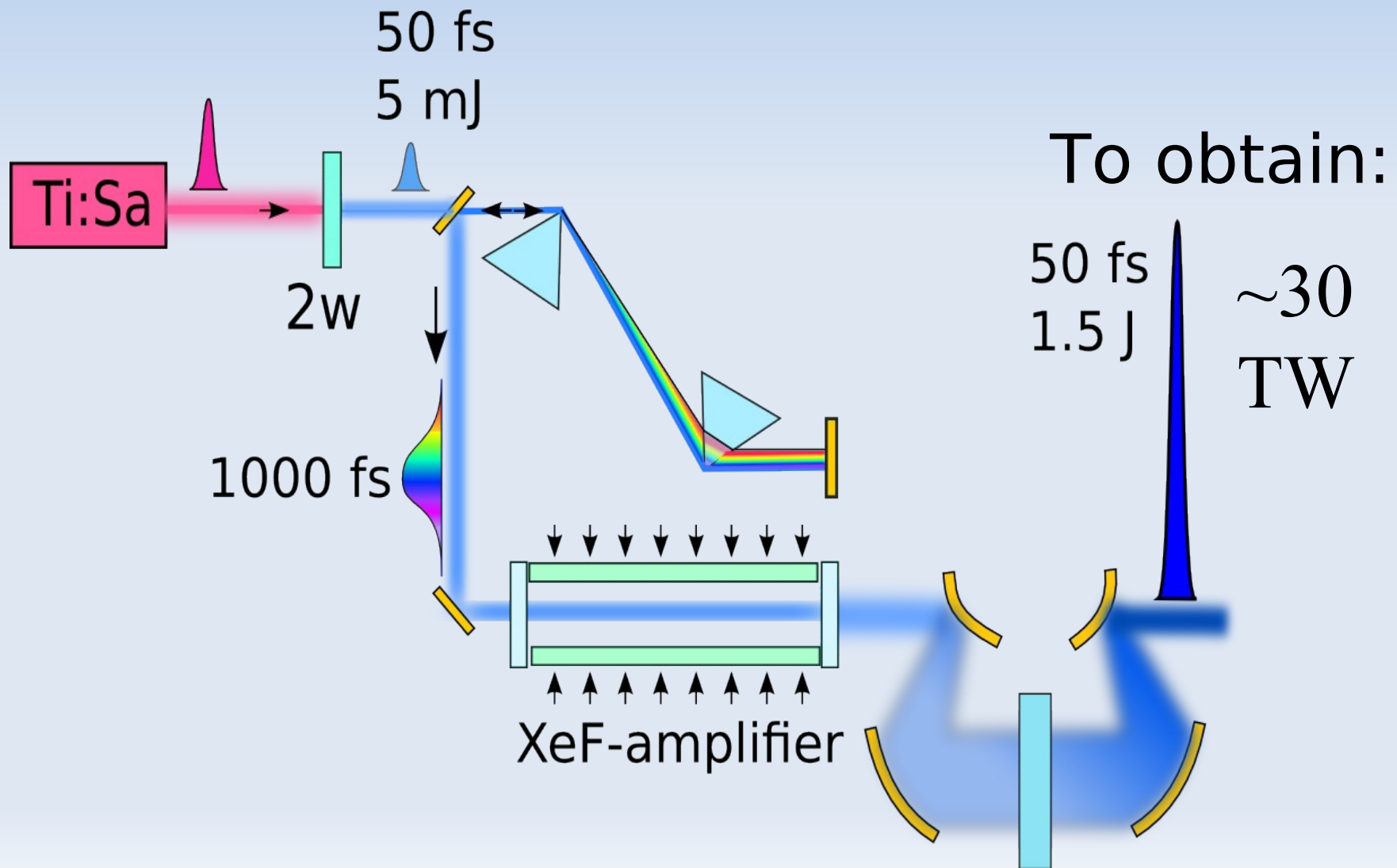


Pulse shape reconstruction

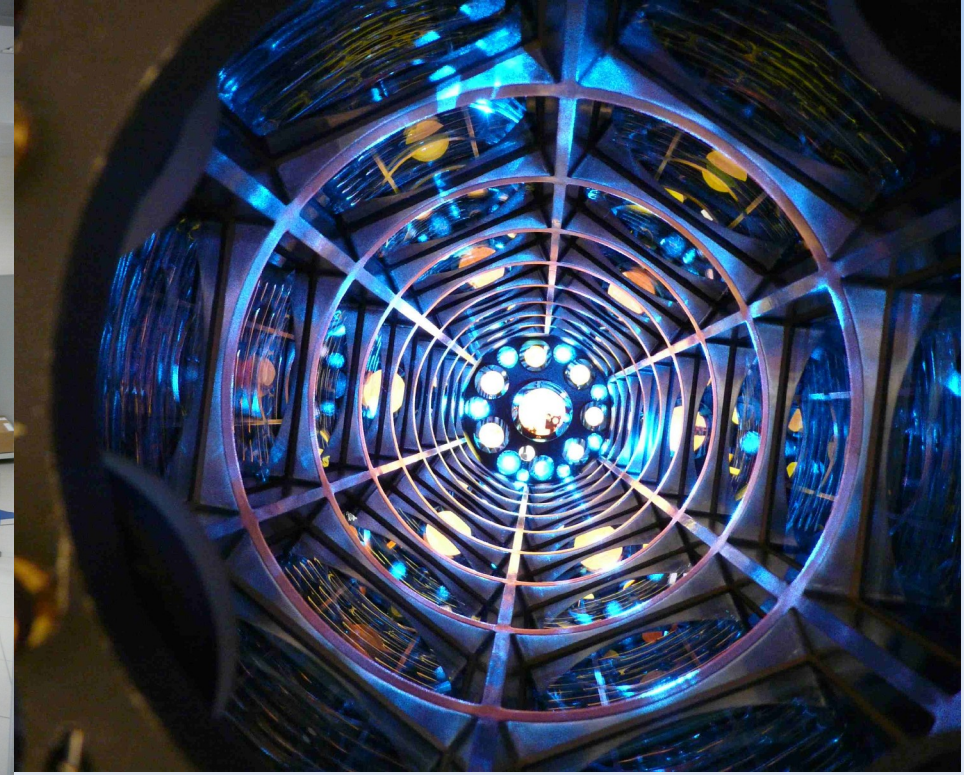


AC results

Final scheme: THL-30



Tomsk Setup 100 TW

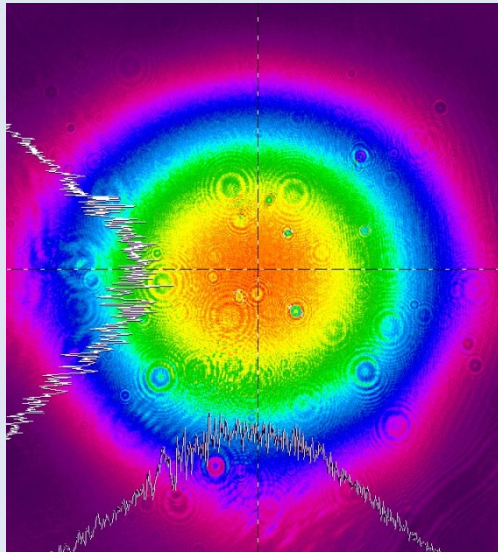
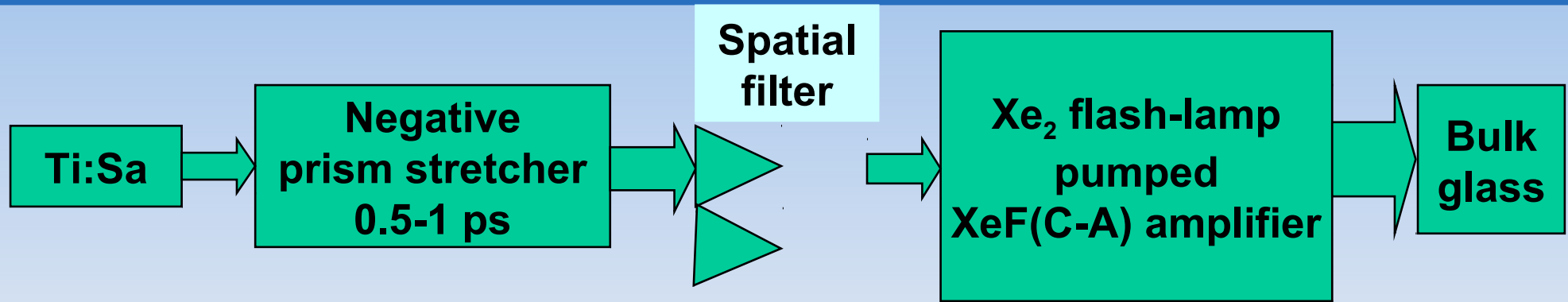


Conclusions

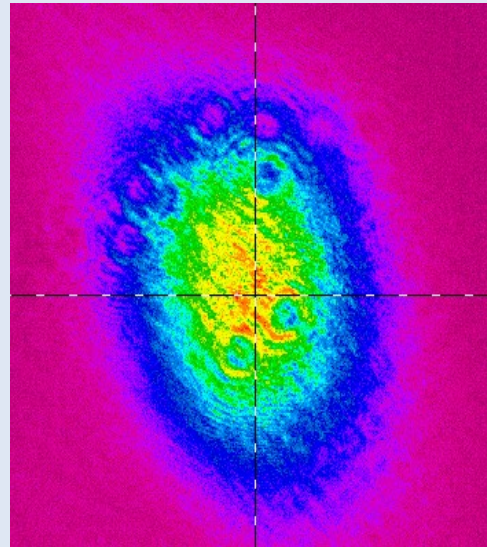
- Grating-compressor-free,**
 - Easy scalable,**
 - High temporal contrast system (ns and ps)**
- is ready for experiments towards 30 TW (100 TW in Tomsk) output power**
- in the unique blue-green spectral region.**

Thank you for your kind attention!

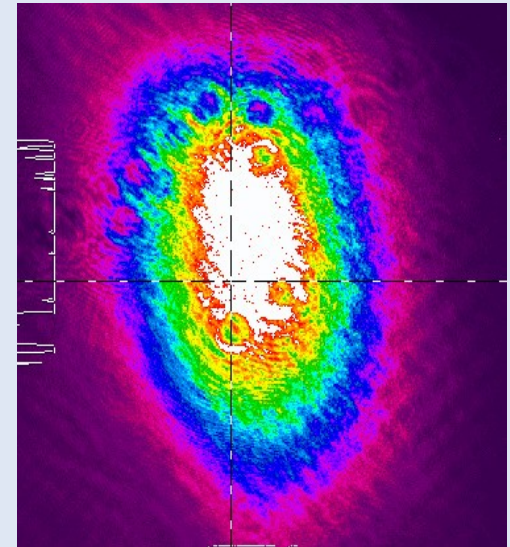
Experimental scheme for fs pulse amplification



Input beam



Output beam without amplification



Output beam after amplification

Final XeF(C-A) amplifier (IHCE, Tomsk)



Project:

$E_{\text{out}} = 1-1.5 \text{ J}$
 $P_{\text{out}} = 30 \text{ TW}$
in 50 fs pulse
 $P_{\text{out}} = 60 \text{ TW}$
in 25 fs pulse

