New Vulcan PetaWatt Beamline: Ultra-broadband, picosecond OPCPA FrontEnd

- EAAC 2019 Workshop -

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Contents

Vulcan laser facility

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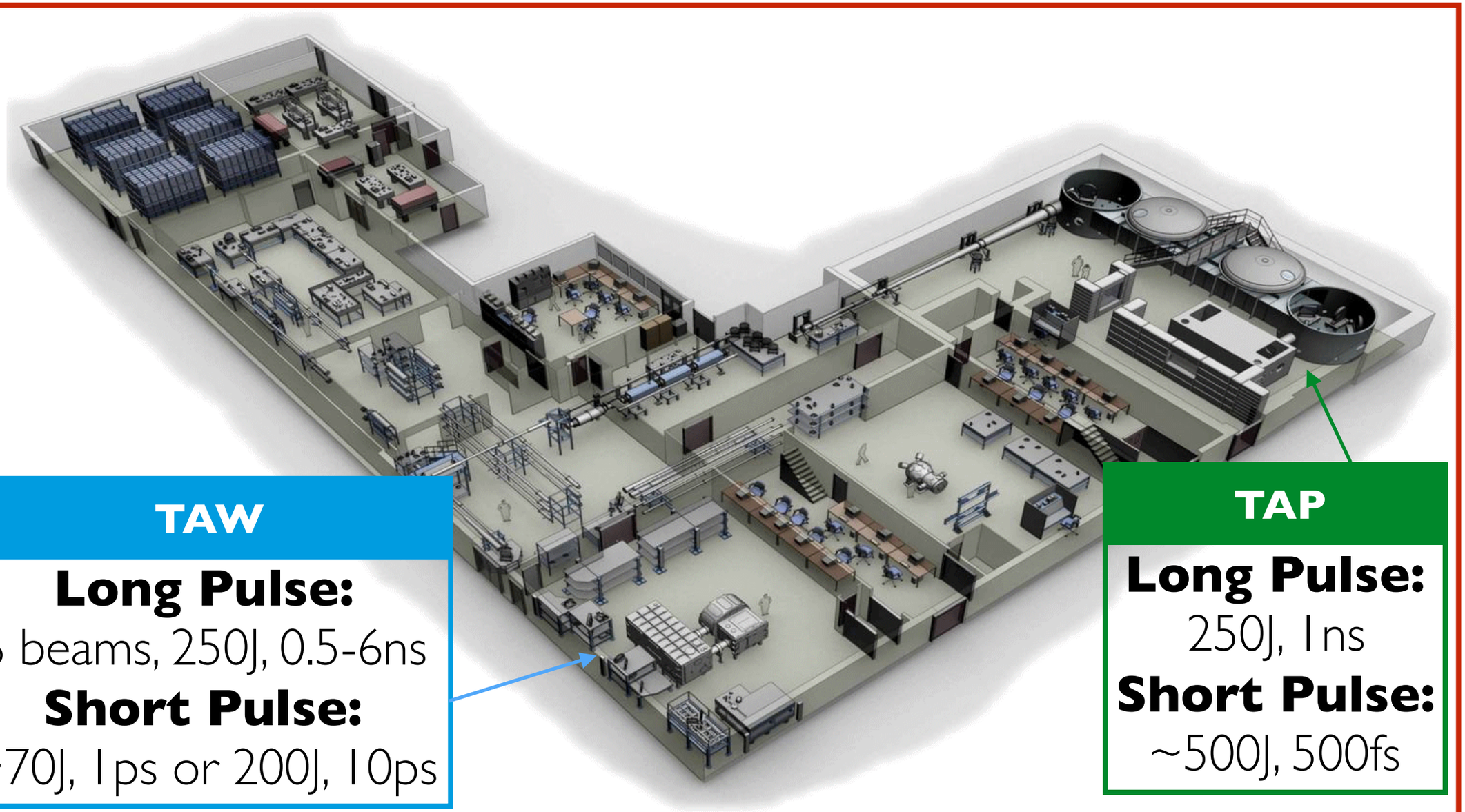
Nd:Glass laser system delivering 8 beams.
It is Based on the CPA technique with an OPCPA Front End.



TAW

Long Pulse:
6 beams, 250J, 0.5-6ns
Short Pulse:
~70J, 1ps or 200J, 10ps

TAP

Long Pulse:
250J, 1ns
Short Pulse:
~500J, 500fs

VOPEL beamline

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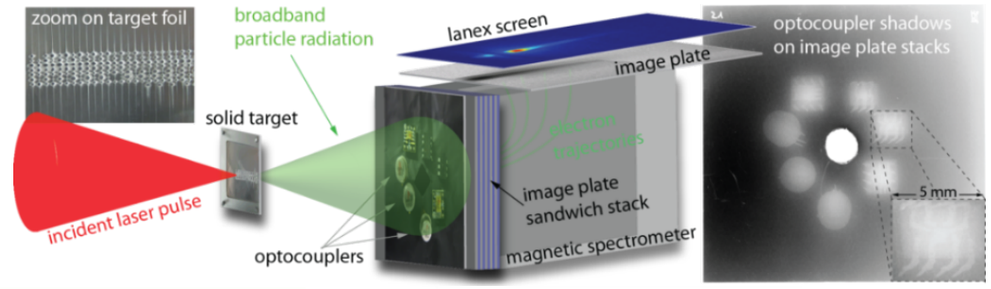
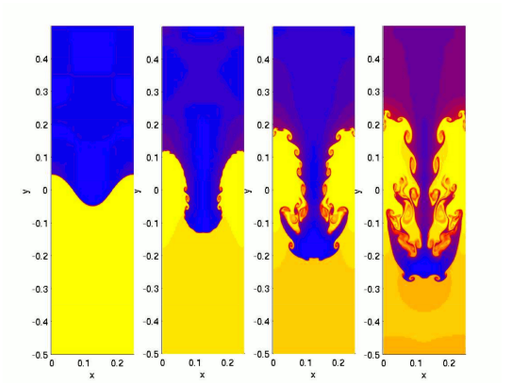
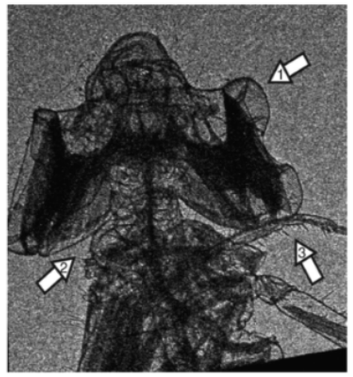
Combining two PW beamlines will allow us:

- **Pump-probe** experiments
  - Combining e^- and p^+
  - Space Radiation Reproduction
- New **imaging** capability
  - Betatron/ X-ray Imaging

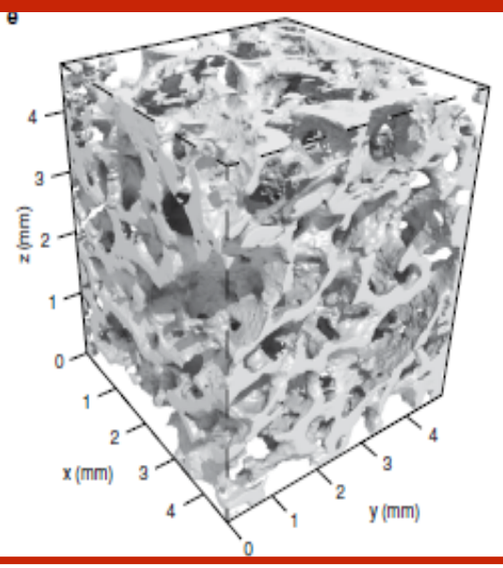


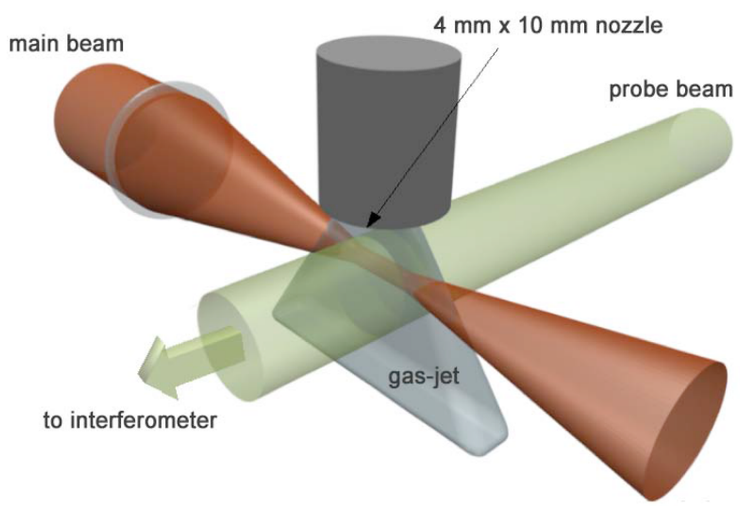




Adopting only the auxiliary PW beam line will allow us:

- Betatron imaging
- X-ray imaging
- Acceleration experiments: e^-, p^+ and light ions





VOPEL beamline site

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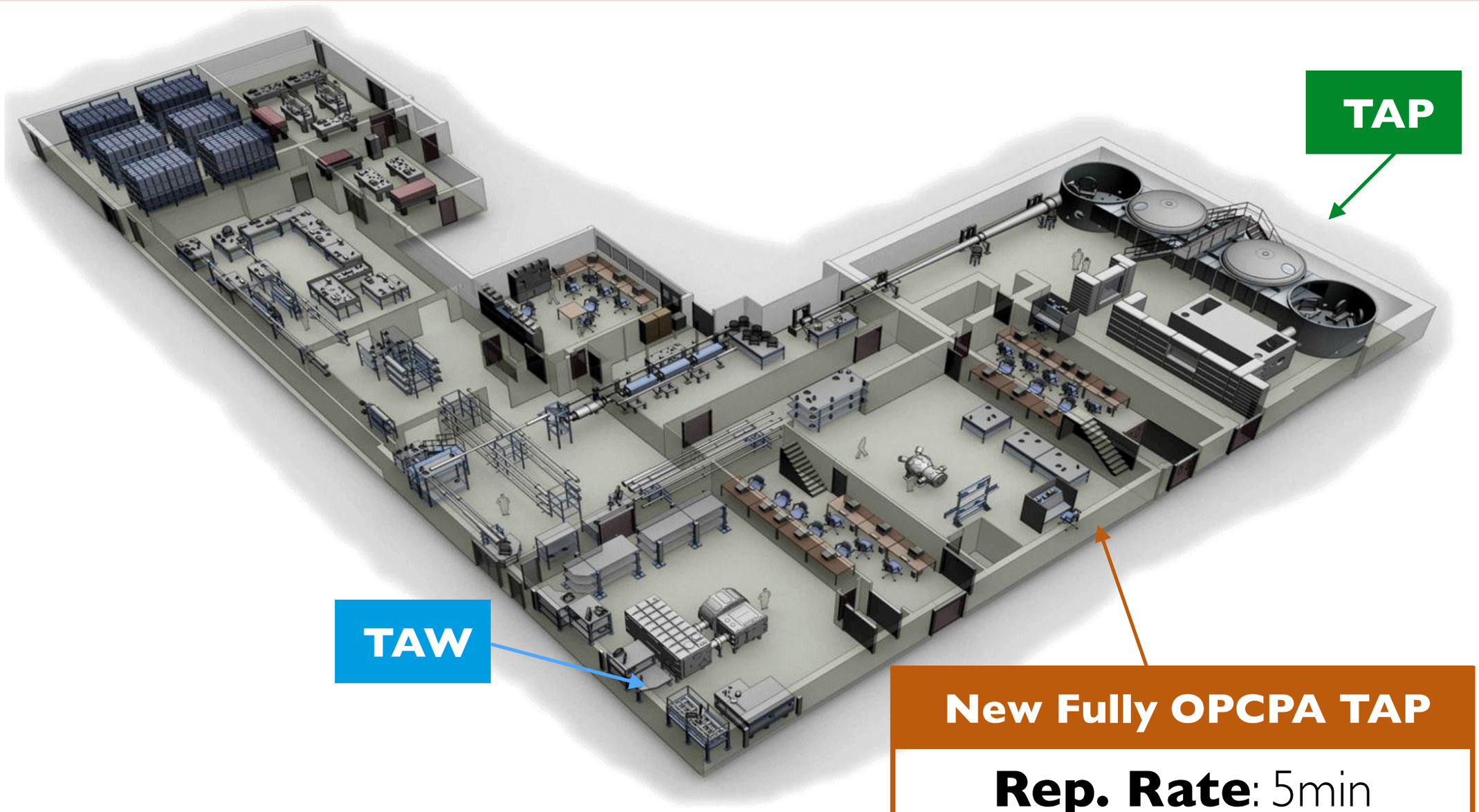

New Fully OPCPA TAP

Rep. Rate: 5min
Wavelength: 880nm
Pulse energy: 30J
Pulse duration: 30fs

Contents

Overview of the PW Beamline

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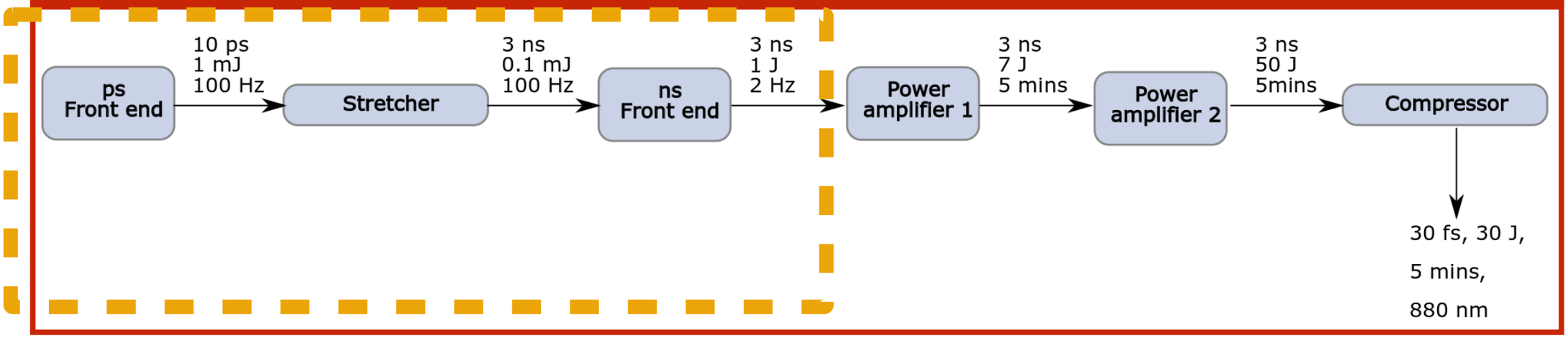
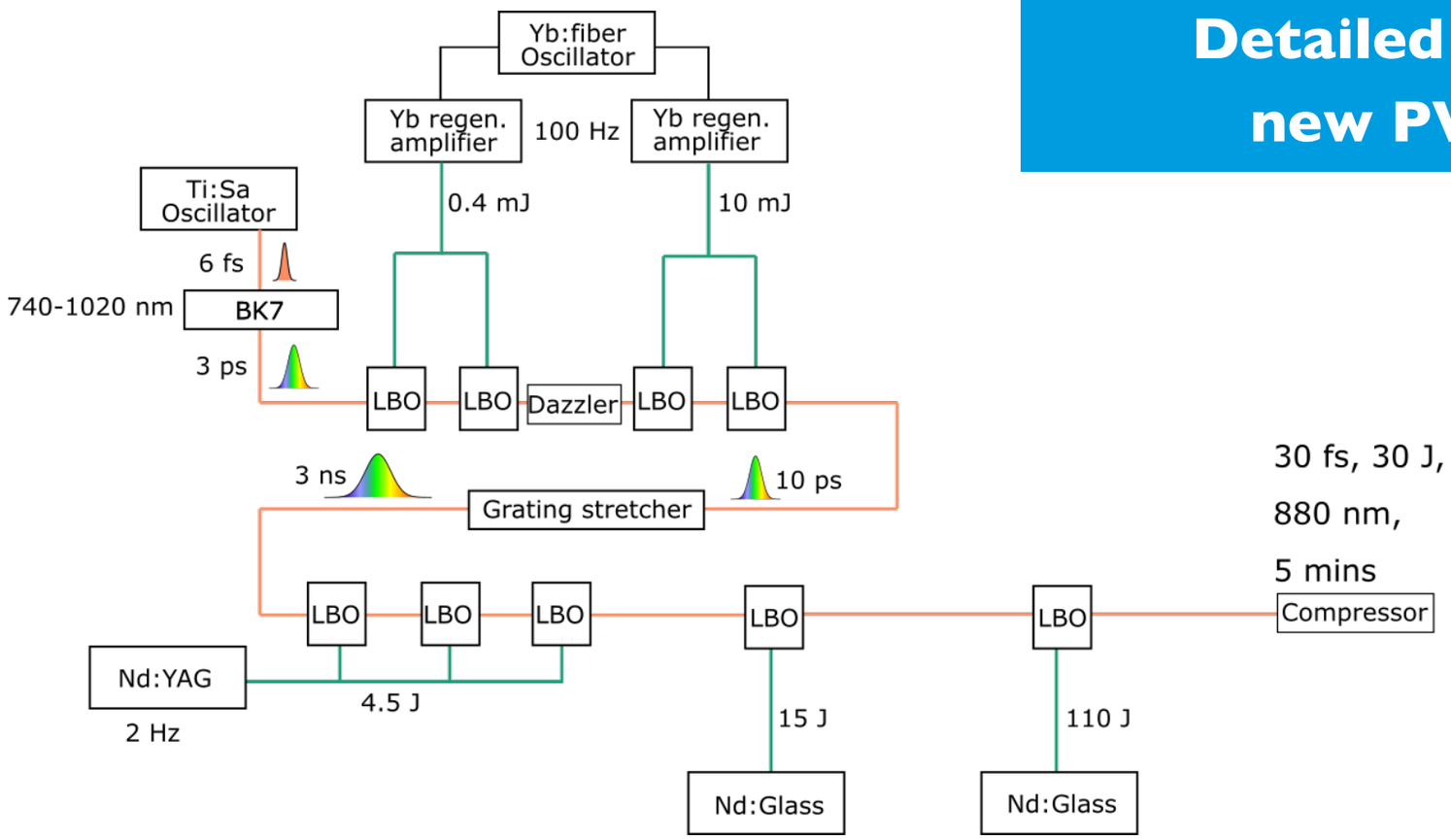
Sketch of the new PW beamline



Detailed sketch of the new PW beamline



Overview of the PW Beamline

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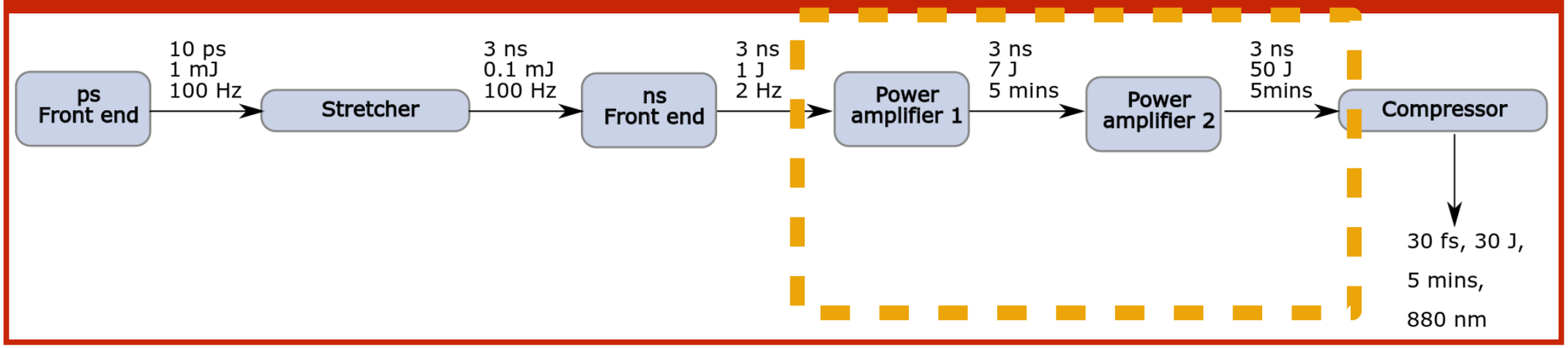
Sketch of the new PW beamline



High energy amplification stage1

Seed 3 ns, ~1 J

Pump Nd:glass rods

5 min rep. rate, 30 J, 1053 nm, 3 ns

SHG pump in KDP 60% eff, 18 J.

Amplified signal 7 J

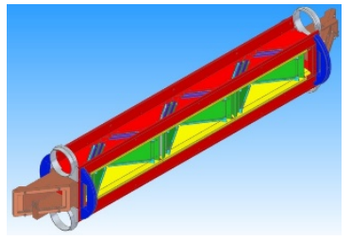
High energy amplification stage2

Seed 3 ns, ~7 J

Pump Nd:glass disk (108 mm)

20 min rep. rate, 220 J, 1053 nm, 3 ns

Upgraded to **air cooled disk** amplifier.



SHG pump in KDP 65%, 140 J

Amplified signal 50 J

Overview of the PW Beamline

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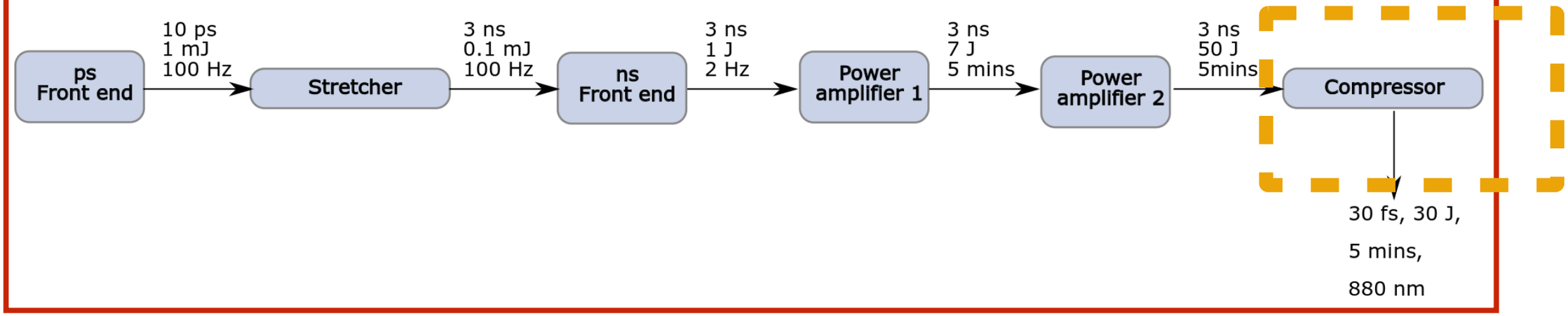
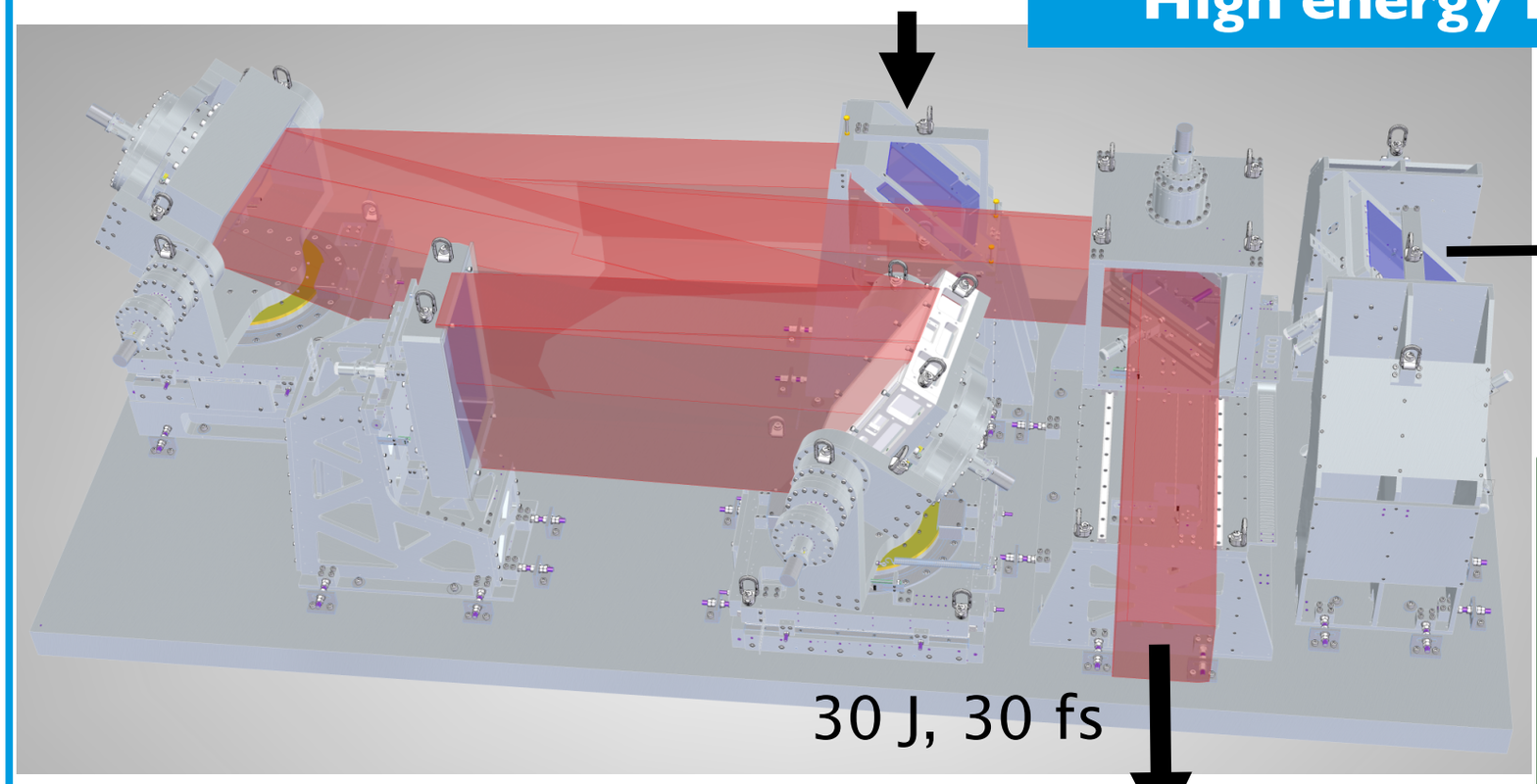
Sketch of the new PW beamline



High energy Ns Compressor



1% of the beam dedicated to the diagnostic

Compressor Parameters

- Gold gratings
- 1100 Grooves/mm
- Transmission 60%.

Overview of the PW Beamline

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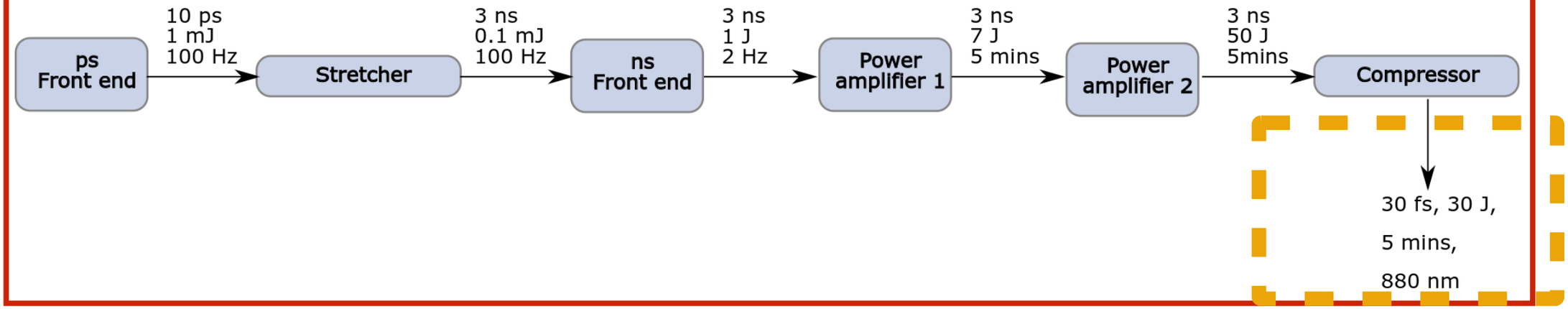
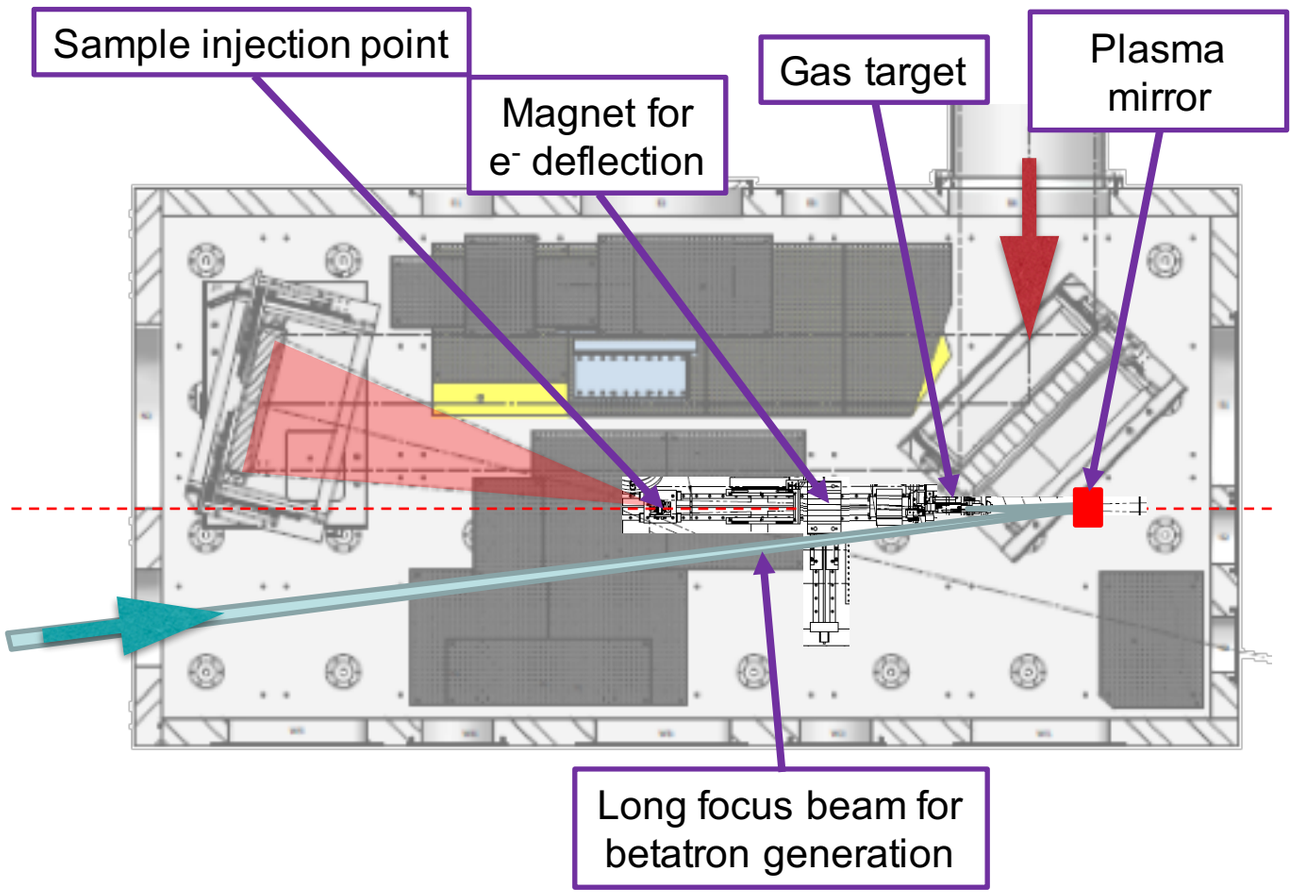
Sketch of the new PW beamline

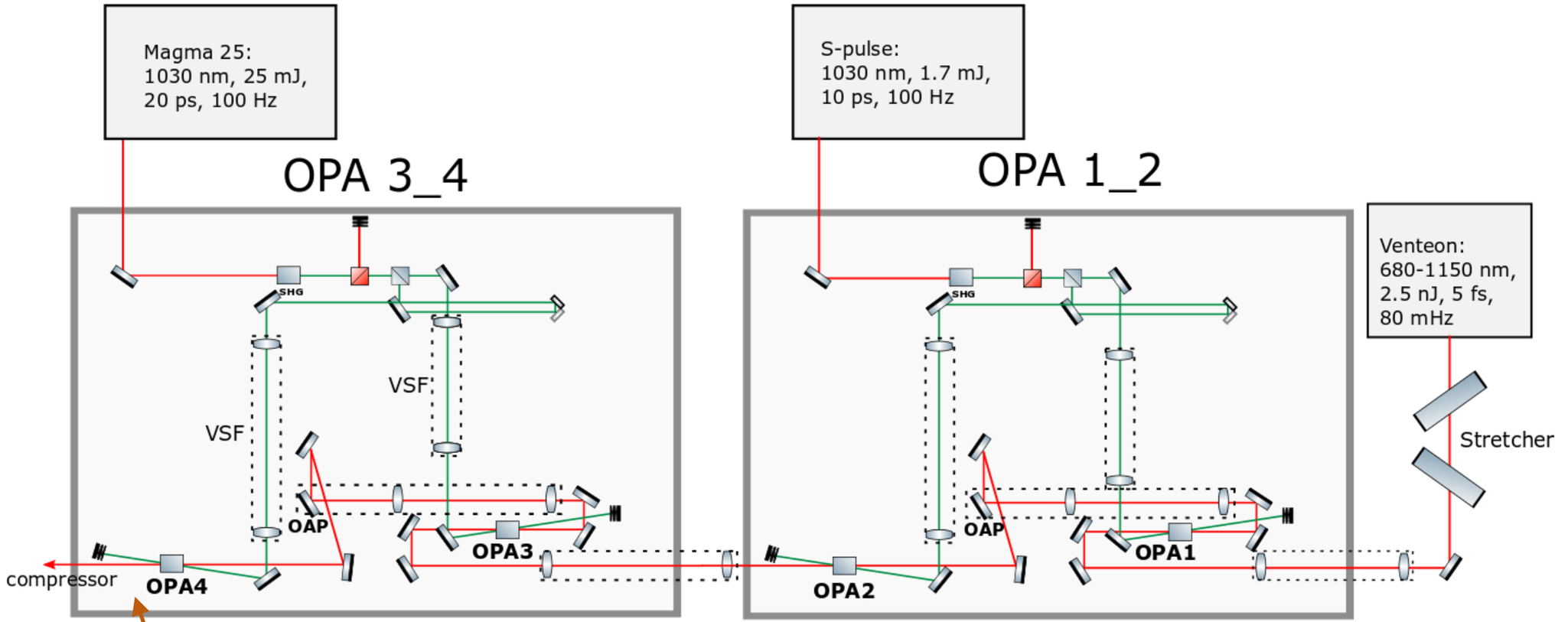




New interaction Chamber: Betatron Imaging Setup

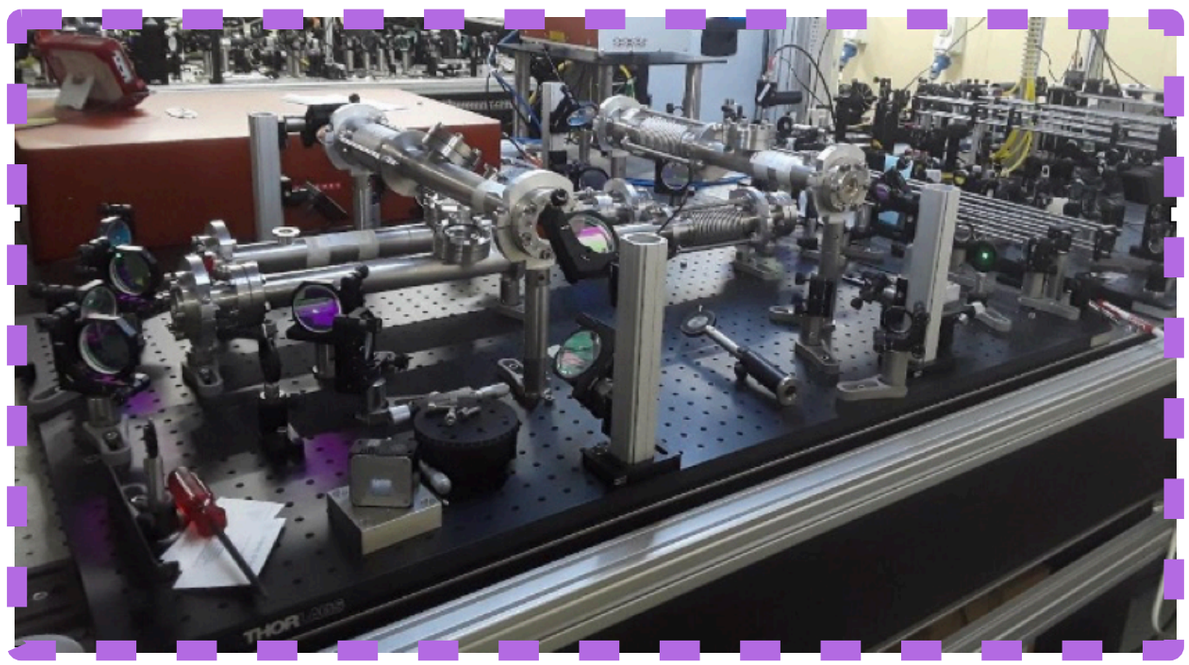
Contents

Ultra-broadband ps FrontEnd



New Fully OPCPA TAP

Rep. Rate: 100 Hz
Wavelength: 880nm
Pulse energy: ~1.5 mJ
Pulse duration: 10 ps



Current status of the Front End

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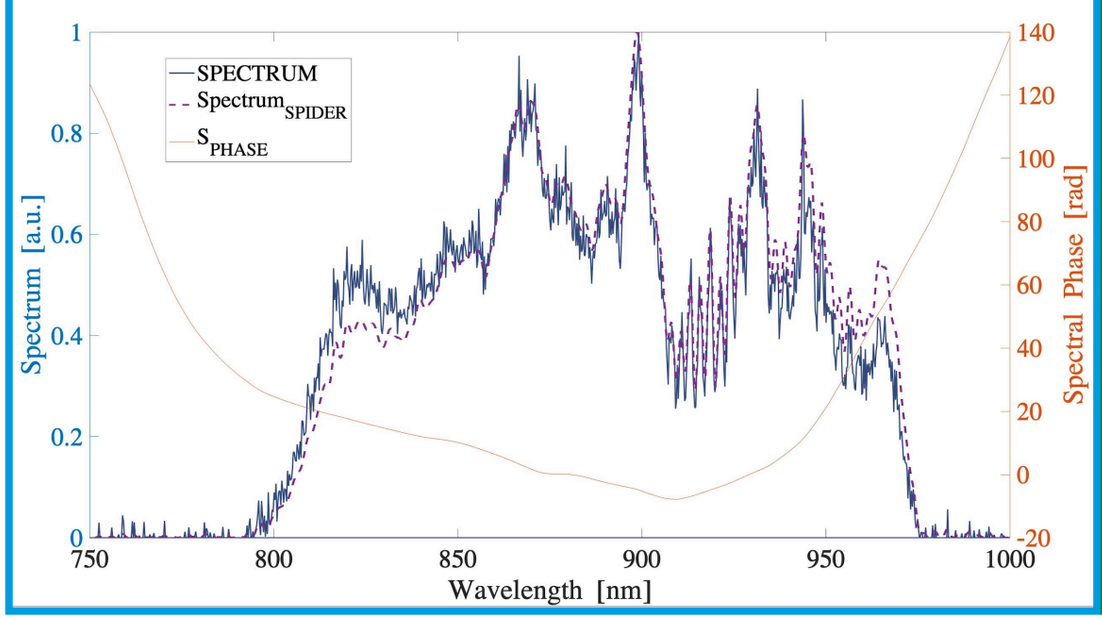
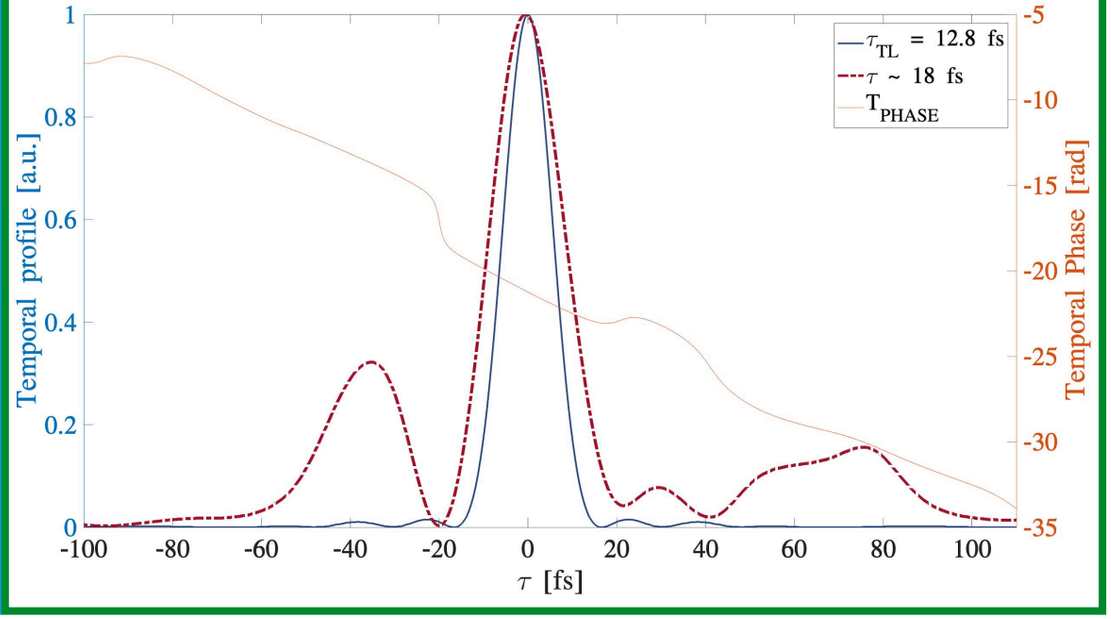
Goal: sub-30 fs, 1 mJ, 160 nm @880 nm.

OPA4 spectrum



OPA4 temporal length



The ps NOPA4 stage deliver pulses:

up to **1.5 mJ, down to 15 fs, >160 nm.**

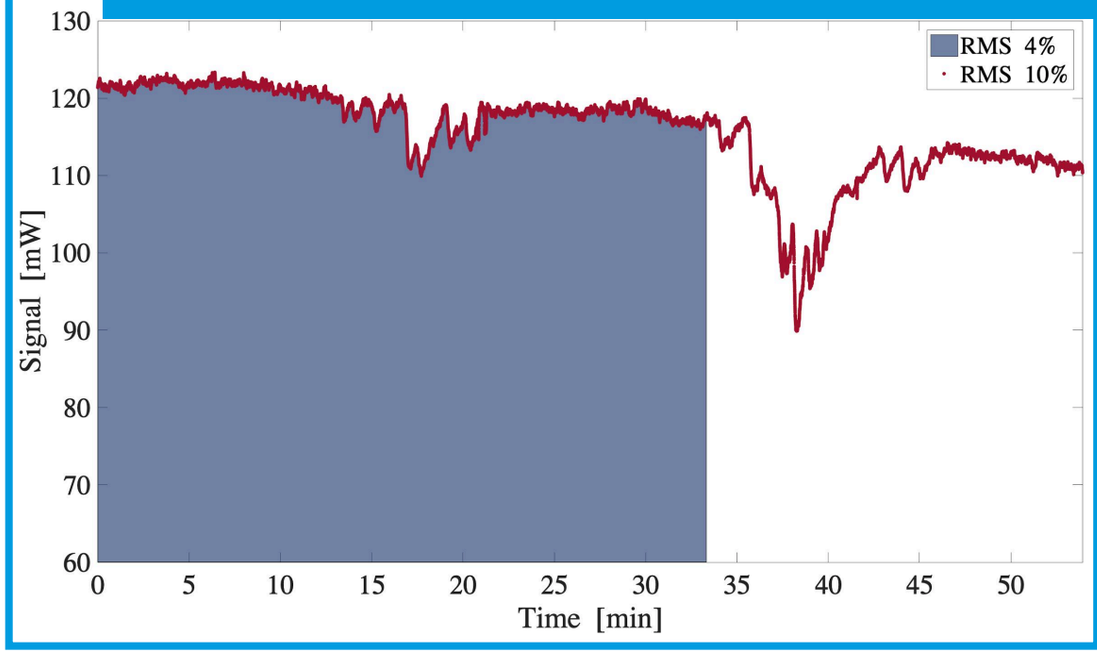
The NOPA4 efficiency is ~15%.

Current status of the Front End

TÉCNICO LISBOA

Goal: sub-30 fs, 1 mJ, 160 nm @880 nm.

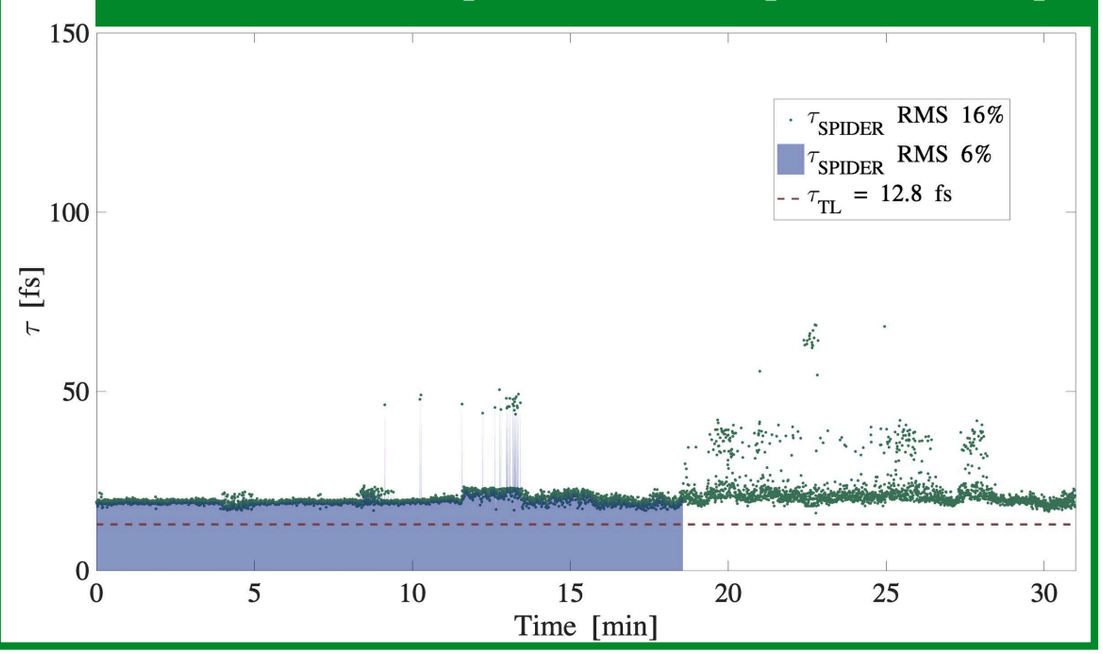
OPA4 energy stability



- The temporal jitter influences the first two NOPA stages, which could be corrected by minor adjustment of the delay between signal and pump.

- **Active stabilisation** on going.

OPA4 compressibility stability



- The non-compensation of the 3rd order spectral phase, visible with **pre-post pulses**, creates these instabilities in the temporal length.
- **Dazzler** implemented but not a feedback loop

Summary

We presented **VOPEL: a fully OPCPA, PW beamline** for the Vulcan laser facility.

The full beamline will be ready mid-2021.

The ps Front End is on commissioning:

~1.5 mJ, 100 Hz, compressed to 18 fs, BW~170 nm centred @880nm.

On time of the project plan schedule

Compressor fully designed, large crystal on order.

Colleagues

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Laser

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Mario Galletti*

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Ian Musgrave

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Dave Pepler

Waseem Shaikh

Trevor Winstone

Mechanical

Paul Johnson

Andrew Stallwood

Jonathan Saa

Steve Blake

Brian Wyborn

Target Area

Nicola Booth

Rob Clarke

Rob Heathcote

Dave Neely

Margaret Notley

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Paul Amos

Rich Bickerton

Mark Dearing

Jorge Suarez Merchan

Adrian Thomas

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