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

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Vulcan laser facility
Motivation for the new PW beamline

VOPEL: Fully OPCPA, PW beamline
Overview and its design

Ultra-broadband, ps Front End
Current status of the research

Summary & future plans
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
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

**New Fully OPCPA TAP**

- **Rep. Rate:** 5min
- **Wavelength:** 880nm
- **Pulse energy:** 30J
- **Pulse duration:** 30fs
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Overview of the PW Beamline

Sketch of the new PW beamline

Detailed sketch of the new PW beamline
Overview of the PW Beamline

**Sketch of the new PW beamline**

- **Ps Front end**
  - 10 ps
  - 1 mJ
  - 100 Hz

- **Stretcher**
  - 3 ns
  - 0.1 mJ
  - 100 Hz

- **Ns Front end**
  - 3 ns
  - 1 J
  - 2 Hz

- **Power amplifier 1**
  - 3 ns
  - 7 J
  - 5 mins

- **Power amplifier 2**
  - 3 ns
  - 50 J
  - 5 mins

- **Compressor**
  - 30 fs
  - 30 J
  - 5 mins
  - 880 nm

**High energy amplification stage 1**

- **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 stage 2**

- **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

Sketch of the new PW beamline

High energy Ns Compressor

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

1% of the beam dedicated to the diagnostic

Compressor Parameters

- 30 J, 30 fs
- 10 ps, 1 mJ, 100 Hz
- 3 ns, 0.1 mJ, 100 Hz
- 3 ns, 1 J, 2 Hz
- 3 ns, 7 J, 5 mins
- 3 ns, 50 J, 5 mins
- 30 fs, 30 J, 5 mins, 880 nm
Overview of the PW Beamline

Sketch of the new PW beamline

New interaction Chamber: Betatron Imaging Setup
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- **Summary & future plans**
Ultra-broadband ps FrontEnd

- Rep. Rate: 100 Hz
- Wavelength: 880nm
- Pulse energy: ~1.5 mJ
- Pulse duration: 10 ps
**Goal:** sub-30 fs, 1 mJ, 160 nm @880 nm.

The ps NOPA4 stage deliver pulses:

- up to **1.5 mJ**, down to **15 fs**, >160 nm.
- The NOPA4 efficiency is ~15%.
**Goal:** sub-30 fs, 1 mJ, 160 nm @880 nm.

- 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.

- 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.
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.
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