EO at FLASH

Outline

• Engineering of EOSD
  – Development of an Yb fibre laser
  – EO Monitor
  – Implementation & Automatisation

• Research
  – New crystals: GaAs, DAST
  – Other lasers: erbium fiber laser
Yb fiber laser

Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>40 nm</td>
</tr>
<tr>
<td>Pulse energy</td>
<td>1 nJ</td>
</tr>
<tr>
<td>Pulse length</td>
<td>comp. to &lt;100 fs</td>
</tr>
<tr>
<td>int. tim. Jitter</td>
<td>1k-10M: &lt; 30 fs</td>
</tr>
</tbody>
</table>

---

![Diagram of Yb fiber laser setup]

- Collimator mounted on motorised delay stage
- Isolator
- Stretcher
- Gain fibre
- WDM
- Monitor Port
- Pump

---

![Graph showing wavelength vs. log(intensity) and SSB Phase Noise L vs. Offset Frequency]

- Wavelength (nm)
- log(intensity) (dB)
- Offset Frequency (Hz)
- Integrated Timing Jitter (fs)

Examples:
- SSB Phase Noise L
- Integrated Timing Jitter (fs)
Yb fibre laser: Synchronisation

-20 dB

MO @ 1.3 GHz

: 24

Phase detector

1.3 GHz

-20 dB

Fibre laser

Monitor port

Delay stage in cavity

Piezo fibre stretcher

Motor control box

Piezo driver

ADC

1.9 MHz

DSP

DAC

I Q

-20 dB

-20 dB

-20 dB

SSB Phase Noise $L_\phi$ (dBc/Hz)

Integrated Timing Jitter (fs)

Offset Frequency (Hz)

58.8 fs 130.5 fs 115.9 fs 14.3 fs 17.2 fs 50.4 fs 44.5 fs
Own Laser / MENLO Orange

Comparison

<table>
<thead>
<tr>
<th></th>
<th>Home-build laser</th>
<th>MENLO Orange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth (nm)</td>
<td>40</td>
<td>55</td>
</tr>
<tr>
<td>Pulse Energy (nJ)</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Pulse width (fs)</td>
<td>100</td>
<td>&lt; 60</td>
</tr>
<tr>
<td>Int. Tim. Jitter</td>
<td>&lt; 20</td>
<td>?</td>
</tr>
<tr>
<td>No. of iteration</td>
<td>first</td>
<td>fourth</td>
</tr>
</tbody>
</table>
The EO monitor

- Engineered version, from PSI
- Is currently being installed at 31 m (H8DBC2)
- Uses 0.5 mm GaP crystal
- Fibre coupled
Automatisation & Implementation

• Laser in tunnel -> remotely controlled setup
  – Several wave plates, laser power, synchronisation, gating, readout, laser diagnostics, data processing, …

• Operator interface
  – Real-time data processing with MatLab
  – EO panel for non-experts in DOOCS

• Uptime cares!
New crystals

- **GaAs**
  - Nearly matched to 1550 nm
  - Good quality crystals available
- **DAST**
  - 4-N,N-dimethylamino-4’-N’ methyl stilbazolium tosylate
  - Organic crystal -> no strong lattice vibrations
  - Extremely large EO coefficient
  - But high residual birefringence
  - More than 15 THz bandwidth
Other lasers: Erbium laser

- Fundamental nearly matched to GaAs
- Optical synchronisation feasible
- Frequency doubled EDFL:
  - Direct seeding for amplifier -> EOTD
  - Matched to ZnTe
  - EO Sampling with optical synchronisation
Thank You