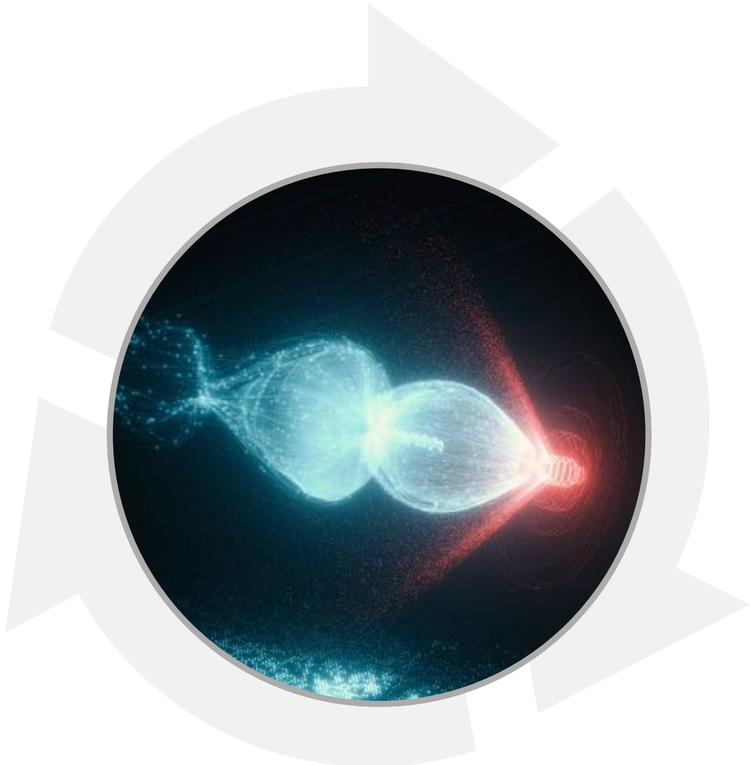
High Rep-Rate LPA Module — 10 yrs Vision

Introducing the following talks.

Andreas Maier (DESY)
Leonida Gizzi (CNR)

The Challenges

Drive Laser Development



Facility Considerations

Targetry

Drive Laser Development

See also talks by Laura Corner, Paul Mason and Leo Gizzi later this workshop

- Ti:Sapphire
  - Work-horse solution for the next 5-10 years
  - Supports 100-1000 Hz rep rate
  - Supports technology development, especially
    - Targetry
    - Machine learning and active stabilization
    - Technology demonstrator
  - OPCPA as possible (complex) complement for low-energy and large-BW drive pulses. Energy efficiency still an issue.
- Novel Concepts
  - Timescale: beyond Ti:Sa
  - wall-plug efficiency significantly improved (absolutely required for collider applications)
  - Rep rate significantly above 1 kHz
  - However, still in early development
  - Technology candidates
    - Coherently combined fibers
    - Novel materials (Tm:YLF and others)
    - …

- *Ti:Sa will support our very next steps*
- *New technologies are on the horizon*

Targetry - Challenges

See also talk by Brigitte Cros & Simon Hooker

Tailored plasma densities

> Injection and extraction of beams
> Phase space manipulation

Cooling

> The driver will heat up the plasma

Guiding techniques

> Study plasma channels (discharge and HOFI) and flying-focus type techniques

Target life-time

> Eventually, we need a high rep-rate source to develop targets that survive many billion shots

Remove the laser

> A tricky problem

> *Development fully synergistic between photon science and collider applications.*

Facility considerations

See also talk by Andreas Döpp & Dan Symes

Performance

> Controls system integration
> Improved by active stabilization, feedback, and machine learning
> Enabled by kHz-level repetition rates

Availability

> Uptime becomes a figure of merit
> Machine protection systems
> Completely re-design your drive-laser

The way we work…

> Will be more about electronics and software; less about optics and plasma.
> We need to get (laser) industry on board:
  > RF folks don’t build their own klystrons
  > Drive lasers need to become mass products, which will only happen if there is a market for industrial, medical, manufacturing, … applications.
  > Energy efficient laser architectures will require massive investments.

> *Development fully synergistic between photon science and collider applications.*

Our Vision — In 10 Years* We Could/Should

* if things go well…

> … have an energy efficient drive laser.

> … generate electron beams at kHz repetition rate and beyond.

> … tune the machine and stabilize performance using active stabilization, feedback and ML techniques.

> … have the building blocks for plasma-based photon science machines, as a basis for future collider applications.

> … have a strong industry engagement.

Key activities for the next 3+ years

> Demonstrator: A 100-1000 Hz drive laser

> Demonstrator: Sub-percent electron energy stability

> Concept: Next-gen energy efficient drive laser