High Repetition rate plasma sources

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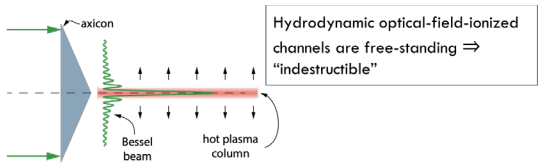
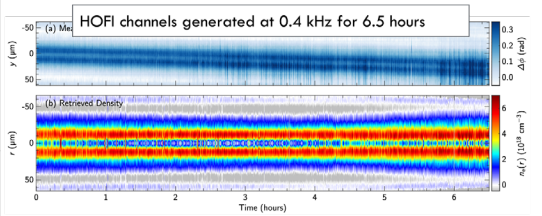
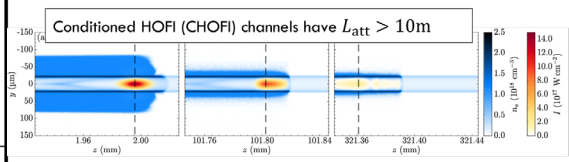
Challenges

Challenges	Possible / partial solution?
▶Guide drive pulse over 10 - 100 cm of plasma @ 10^{17} cm^{-3}	▶HOFI channels have guided 10^{18} W cm^{-2} pulses over 10 cm @ $10^{17} cm^{-3}$. ▶Power attenuation length > 10 m ▶Extension to ~ 1 m possible
▶Form waveguide @ high rep-rate (kHz - MHz?)	▶Proof-of-principle demonstration of operation of HOFI channels @ 0.4 kHz for > 6 hours
▶Move gas in / out	▶Continuous flow? ▶Gas cell or gas jet?
▶Remove unused energy	▶Flow gas? ▶Use additional laser pulses?
▶….	▶….







Shalloo, Ph.D. thesis, University of Oxford (2018)
Shalloo et al. Phys Rev. Acc. Beam 22 041302 (2019)
Picksley et al. Phys. Rev. E 102 53201 (2020)
Picksley et al. Phys Rev Accel Beam 23 81303 (2020)
Feder et al., Phys. Rev. Res. 2 043173 (2020)
Shrock et al., Phys Plasm. 29 073101 (2022)
Alejo et al. Phys Rev Acc. Beams 25 011301 (2022)

Possible 3-year programme

Task	Details
1. Design low-rep-rate plasma source(s)	▶Determine required laser & plasma parameters (density, length, matched spot size) ▶Design & construct gas jet / cell system ▶Characterize plasma properties at ~ 10 Hz
2. Develop 100 Hz plasma source	▶Develop gas delivery & extraction @ 100 Hz ▶Construct & test 100 Hz system
3. Demonstrate drive pulse guiding in 100 Hz system	▶Guide low-intensity pulses @ 100 Hz ▶Operate waveguide @ 100 Hz & guide high-intensity pulses at available rep-rate
4. Demonstrate electron acceleration in 100 Hz system	▶Demonstrate acceleration of self-injected electrons in at available rep-rate

Required resources

Resource	Details
PI, post-doc, graduate student(s)	▶PI: leadership & overview of programme ▶Post-doc: contribute to all aspects of programme ▶Graduate student(s): good opportunity to train next generation!
Equipment (€100k?)	▶High-flow pumping system
Consumables (€150k)	▶Channel-forming & diagnostic optics ▶Vacuum consumables ▶Pulsed gas valves & controlers ▶Computer control ▶Travel & subsistence ▶…

How to organise this work package?

- What is the scope?
- Laser and/or beam driven facility
- Plasma accelerator components: electron source, accelerator module
- Other components (eg plasma lenses, plasma mirrors),

- Include other groups and coordinate the activity