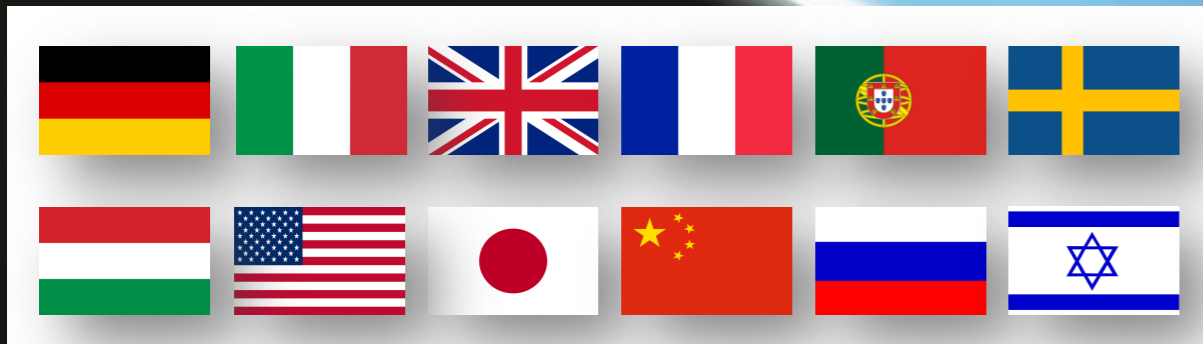


EUROPEAN
PLASMA RESEARCH
ACCELERATOR WITH
EXCELLENCE IN
APPLICATIONS



WP5 - Summary

E. Chiadroni/INFN - 1st Collaboration Week, 19-23 June, 2017



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- **LWFA External Injection**

- **Start-to-end simulation from cathode to the plasma exit: full RF compression, final focus (um size) at the plasma and interaction**
 - **higher witness injected energy** to preserve 6D phase space
 - confirmed by independent studies by J. Zhu et al.
 - **Hybrid compression scheme** (Velocity bunching + magnetic chicane) with slit collimator to minimize jitters and improve LPS => sensitivity studies

| LWFA | Injected witness beam | Accelerated witness beam |
|-------------------|-----------------------|--------------------------|
| E (MeV) | 536.5 | 1044 |
| Q (pC) | 30 | 26.5 |
| Bunch length (fs) | 12 (rms) | |
| $\Delta E/E$ (%) | 0.06 | 0.09 |
| en (mm) | 0.4 | 0.45 |

- **PWFA (quasi-non linear regime)**

- **Start-to-end simulation of a comb-like beam from cathode to the plasma exit: velocity bunching, final focus (2 um size) at the plasma**
 - **slice energy spread ~ 0.7% in 27 cm plasma**
 - the plasma-accelerated beam has good quality to drive a FEL

| PWFA COMB | Driver beam | Injected witness | Accelerated witness |
|-------------------|-------------|------------------|---------------------|
| E (MeV) | 500 | 500 | ~1000 |
| Q (pC) | 200 | 30 | 30 |
| Bunch length (fs) | 126 (rms) | 10 (FWHM) | |
| $\Delta E/E$ (%) | 0.07 | 0.06 | 0.7 |
| en (mm) | 3 | 0.46 | 0.6 |

- **Diagnostics**

- For **injected beam**: TDS in X-band with different streaking directions
 - **Tomography: 3D charge distribution**
- **Survey of conventional and novel diagnostics for injected and extracted beams**
 - single shot emittance measurement
 - compact BPM or integrated in X-band cavities

- **Transfer lines**

- **First tentative capture of the extracted beam from LPA** (input parameters from the delivery table) and matching to the undulator

Further detailed study required

- **Laser removal**
 - axicon mirrors (WP14)
 - plasma mirrors: experiment under preparation in WP3
 - investigate the effect of multiple scattering and eventually the effect of the plasma plume created by the laser which might affect the incoming electron beam
- **Driver bunch removal**
 - plasma lenses, chicane..
- **Plasma target** has to be better defined: WP3 will provide more detailed specifications on the plasma target **geometry for both LWFA and PWFA**, and tolerances (e.g. pointing stability) at the plasma entrance
- **Driver beam shaping** to increase transformer ratio (WP9)
 - triangular bunch (less charge on the head) and/or multi-ramped bunch
 - feasibility studies with the X-band linac: particular care on the alignment of each bunch with each other to limit hose instability
- **Superconducting linac studies** (WP9)
- Definition of a **reference case** (for instance, the one witness-one driver beam), **to benchmark codes** (WP2-WP9)
- Investigations of **additional beam lines for “other user applications”**: WP7 will provide the requirements of the beam together with tolerances, in order to design proper beam lines
- Concerning the beam diagnostics, the Smith-Purcell one can be tested at SPARC_LAB starting from Spring 2018 (WP12)

- Driver pulse shaping and control
- Diagnostics of the extraction beam, in particular the longitudinal phase space
- Study of transfer lines from plasma to pilot applications for different set of parameters at the plasma exit, starting from simulation results, not from initial parameters table
 - Optimize the matching to the undulator and the parallel beam lines for other applications

