

**WP5 2nd Meeting**  
September 07th, 2016

# **WP5: Electron Beam Design and Optimization**

*Progress status*

**INFN ([enrica.chiadroni@Inf.infn.it](mailto:enrica.chiadroni@Inf.infn.it))**

**CEA ([antoine.chance@cea.fr](mailto:antoine.chance@cea.fr))**

- Reports on the progress status of the tasks
- Status of the preparation of the next workshop in Frascati on RF technology
- Discussion on Andy's parameters list
- AOB

Task n°	Description	Progress	People	Comments	Actions
<b>Task 5.2: Electron Beam for external injection (RF injector)</b>					
5.2.1	Define the regimes of operation: Charge, energy, length, rep rate, ...				
5.2.1.1	LWFA external injection (ultra-short, low charge)		Elena Svytun (DESY), Christelle Bruni (LAL)	Input from WP3 (contact person B. Cross) concerning charge, bunch length, ...	List of parameters by the end of August
5.2.1.2	Resonant PWFA: driver and witness (Multi-bunch train generation)		Alberto Marocchino (INFN)	Input from WP9 (contact person M. Ferrario/J. Osterhoff) concerning number of bunches in the train, temporal spacing and duration, and transverse drivers distribution (e.g. hollow beams)	List of parameters by the end of August
5.2.2	<b>Survey of RF injectors</b>		LAL (Nicolas Delerue, Pierre Lepercq), INFN, David Garzella (CEA)	Mini-Workshop (1.5days) on Novel RF technologies before Annual EuPRAXIA meeting, to be ready for the 1st Milestone. Possible dates: 5-6 October after the WP9-meeting at LNF	Start organization now
5.2.2.1	Photo-cathode laser, cathode, gun, first acceleration stages (i.e. RF linac accelerating modules)		Nicolas Delerue (LAL), INFN	<b>MILESTONE 5.2</b> Preliminary RF accelerator specifications => <b>November 1st</b>	
<b>Task 5.3: Electron Beam Manipulation</b>					
5.3.1	<b>RF injector to plasma structure</b> Hybrid solution: conventional and plasma-based		CEA		
5.3.2	<b>Inter-plasma stage beamline</b>  Plasma-based for injection and extraction: Active plasma lens and adiabatic plasma lens		CEA, INFN, DESY (?)	Input from WP2 (contact person A. Marocchino) and WP3	
5.3.3	<b>Transport to applications</b>		CEA		
5.3.3.1	FEL user		Alexander Molodozhentsev (ELI)		
5.3.3.2	HEP user				
<b>Task 5.4: Electron Beam Diagnostics and Practical Issues</b>					
5.4.1	<b>Survey of electron beam diagnostics</b>		C. Simon (CEA)	Mini-workshop on electron beam diagnostics	
5.4.2	<b>Before injection</b>				
5.4.2.1	Beam transverse size (um resolution)		CI, CEA		
5.4.2.2	Longitudinal diagnostics (e.g. EOS based for temporal separation between drivers and/or for relative time of arrival jitter between laser and electron beam)		S. Jamison ? (CI), INFN, Christelle Bruni (LAL)		
5.4.2.3	um resolution beam position monitor for perfect alignment into the capillary		CI, C. Simon (CEA)		
5.4.3	<b>After acceleration (fs, GeV, mm mrad)</b>				
5.4.3.1	6D phase space (single shot)		LAL (Delerue), CI, INFN		
5.4.3.2	Alternative, e.g. plasma-based, diagnostics (see recent paper on plasma-based deflecting cavity)		DESY ?		

October 5th - 6th, 2016 (1.5 days)

## ● Expected outcomes

- ▶ Definition of injector technology and layout????
- ▶ This mini-workshop aims to lay the groundworks for the preliminary RF accelerator specification, in order to accomplish the first WP5 scientific milestone (M5.2). This mini-workshop is addressed to those, within the EuPRAXIA collaboration, interested in the topic and directly involved in the Milestone 5.2, i.e. WP5,WP2,WP3,WP6,WP7,WP9,WP12,WP14.
  - A limited number of people (max 20) within the EuPRAXIA collaboration together with at list one representative person of WPs involved in Milestone 5.2
- ▶ **M 5.2: Preliminary RF accelerator specifications [M12]**
  - Project report (WPs involved: 5,2,3,6,7,9,12,14)
    - *Charge, average and peak current, energy, both for laser and particle driven plasma acceleration to drive the choice of the most suitable injector*

● The **webpage** has been created and the announcement is **ready** to be sent and published on EuPRAXIA webpage

## ● Draft program

- ▶ Scientific case focus, highlighting basic requests from pilot experiments
- ▶ Presentation of parameter table for externally injected (RF generated) electron beams
- ▶ Overview on RF electron guns, highlighting pros&cons
- ▶ Next generation cryogenics RF photocathode sources
- ▶ Operational experience at both test and users facilities, e.g. SPARC\_LAB, FLASH, etc.
  - Highlight of critical issues concerning
    - beam stability (e.g. charge, energy, time duration, temporal separation in case of multi-drivers, pointing, ...)
    - synchronization
    - repetition rate
- ▶ ...
- ▶ Visit of the SPARC\_LAB test facility



## EuPRAXIA Mini-workshop on novel RF technologies in the framework of WP5.

5-6 October 2016 *LNF*  
Europe/Rome timezone

### Overview

[Scientific Programme](#)

[Timetable](#)

[Registration](#)

[Registration Form](#)

[List of registrants](#)

[How to get here](#)

[Lunch & Coffee Break](#)

[Guesthouse Accomodation](#)

[Support](#)

**This mini-workshop aims to lay the groundworks for the preliminary RF accelerator specification, in order to accomplish the first WP5 scientific milestone (M5.2).**

**This mini-workshop is addressed to those, within the EuPRAXIA collaboration, interested in the topic and directly involved in the Milestone 5.2, i.e. WP5,WP2,WP3,WP6,WP7,WP9,WP12,WP14.**

### **The discussion will focus on:**

- **Scientific cases, highlighting basic requests from pilot experiments**
- **Overview on RF electron guns, highlighting pros&cons**
- **Discussion about next generation cryogenics RF photocathode sources**
- **Operational experience at both test and users facilities, e.g. SPARC\_LAB, FLASH, etc.**

### **Highlight of critical issues concerning**

- **beam stability (e.g. charge, energy, time duration, temporal separation in case of multi-drivers, pointing, ...)**
- **synchronization**
- **repetition rate**

**Dates:** from 05 October 2016 08:00 to 06 October 2016 18:00

**Timezone:** Europe/Rome

**Location:** *LNF*  
Via E. Fermi 40  
00044 Frascati (RM) Italy

Announcement tomorrow

Injector beams				
Quantity	Symbol	Baseline value	Range of exploration	
			Lower limit	Upper limit
<b>150 MeV - RF injector beam: at entrance of plasma 2 for LWFA with external injection</b>				
Energy	E	150 MeV	100 MeV	200 MeV
Charge	Q	50 pC	10 pC	50 pC
Bunch length (FWHM)	$\tau$	5 fs	3 fs	30 fs
Peak current per bunch	I	10 kA	1 - 10 kA	
Repetition rate	f	$\geq 10$ Hz	$\geq 10$ Hz	
Number of bunches	N	1	1	20
Shaped profile	-	tbd	tbd	
Total energy spread (RMS)	$\sigma_E/E$	0.1 %	0.1 %	
Transverse normalized emittance	$\epsilon_{N,x}, \epsilon_{N,y}$	0.5 mm mrad	0.5 mm mrad	
Alpha function	$\alpha_x, \alpha_y$	0	0	
Beta function	$\beta_x, \beta_y$	30 mm	30 mm	
Transverse beam size (RMS)	$\sigma_x, \sigma_y$	7.1 $\mu\text{m}$	6.1 - 8.6 $\mu\text{m}$	
Transverse divergence (RMS)	$\sigma_{x'}, \sigma_{y'}$	0.24 mrad	0.2 - 0.29 mrad	
Jitter, beam to global reference (RMS)	$\sigma_{\Delta t}$	10 fs	10 fs	

<b>500 MeV - RF driver: at entrance of plasma 2 for PWFA</b>				
Energy	E	500 MeV	300 MeV	500 MeV
Charge	Q	250 pC	100 pC	500 pC
Bunch length (FWHM)	$\tau$	100 fs	100 fs	
Peak current per bunch	I	2.5 kA	1 kA	5 kA
Repetition rate	f	$\geq 10$ Hz	$\geq 10$ Hz	
Number of bunches	N	$\geq 1$	$\geq 1$	
Total energy spread (RMS)	$\sigma_E/E$	1%	1%	
Transverse normalized emittance	$\epsilon_{N,x}, \epsilon_{N,y}$	1 mm mrad	1 mm mrad	
Alpha function	$\alpha_x, \alpha_y$	0	0	
Beta function	$\beta_x, \beta_y$	100 mm	60 mm	100 mm
Transverse beam size (RMS)	$\sigma_x, \sigma_y$	10 $\mu\text{m}$	10 $\mu\text{m}$	10 $\mu\text{m}$
Transverse divergence (RMS)	$\sigma_{x'}, \sigma_{y'}$	100 $\mu\text{rad}$	167 $\mu\text{rad}$	100 $\mu\text{rad}$
Transformer ratio	R	1	1	2
Jitter, beam to global reference (RMS)	$\sigma_{\Delta t}$	10 fs	10 fs	

- II WP5 meeting
  - ▶ September 7th
  
- Mini Workshop on Novel RF Injectors
  - ▶ October 5th-6th
    - I suggest to fix our III WP5 meeting at the end of the mini-workshop, e.g. after lunch ?
  
- Mini Workshop on beamlines to be scheduled
  
- Mini Workshop on electron beam diagnostics to be scheduled