



# Summary of Positron Sources and Positron LWFA Sessions

Working Group 8

# Session on Positron Sources

We discussed 5 topics:

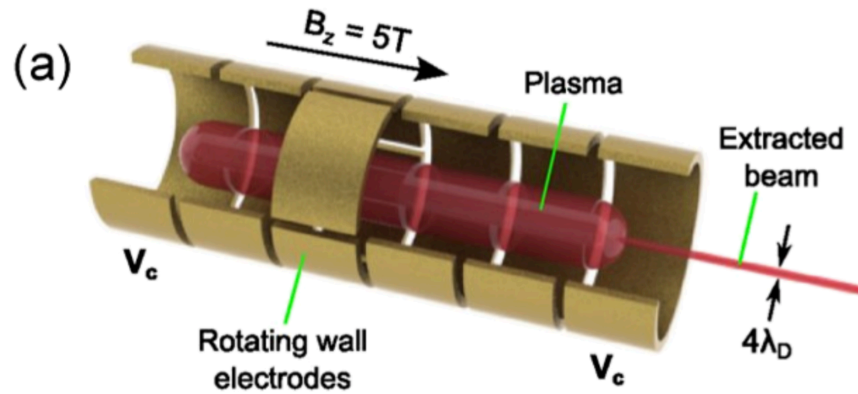
1. Positrons generated from a high intensity electron beam for FACET-II.
2. Positrons generated from a high intensity proton beam for the AWAKE experiment.
3. “In-situ” positron generation.
4. Positron beams from electro-static traps.
5. Positron beams from a high-power laser.

## Timetable

	Mon 26/03	Tue 27/03	Wed 28/03	Thu 29/03	All days
	<a href="#">Print</a> <a href="#">PDF</a> <a href="#">Full screen</a> <a href="#">Detailed view</a> <a href="#">Filter</a>				
09:00	<b>Parallel WG session 1:: WG4, LWFA driver strategies</b> <i>Brigitte Cros, Carl S...</i>	<b>Parallel WG session 1:: WG3 TMS, Needs/state-of-the-art LWFA/PWFA</b> <i>Dr. Henri Vincenti, Je...</i>	<b>Parallel WG session 1:: WG5, PWFA: Strategy</b> <i>Edda Gschwendtner, Jens ...</i>	<b>Parallel WG session 1:: WG7, DLA: Strategy and Prioritization</b> <i>Dr. Ben Cowan...</i>	<b>Parallel WG session 1:: WG6, SWFA: Intro + Strategies toward a SWFA collider</b> <i>John Power, ...</i>
10:00	<i>Dennis Sciama LT, DWB</i>	<i>Fisher Room, DWB</i>	<i>Seminar Room, DWB</i>	<i>JAI 614, DWB</i>	<i>Conference Room, DWB</i>
	<b>Coffee break</b> <i>Foyer on level 5, DWB</i> <span style="float: right;">10:15 - 10:30</span>				
11:00	<b>Parallel WG session 2: WG4: Electron sources and staging</b> <i>Brigitte Cros, Carl S...</i>	<b>Parallel WG session 2: WG3 TMS, Future LWFA/PWFA, Challenges new architectures</b> <i>Dr. Henri Vincenti, Je...</i>	<b>Parallel WG session 2: WG5 PWFA: Plasma based injectors</b> <i>Edda Gschwendtner, Jens ...</i>	<b>Parallel WG session 2: WG8 PAC: Novel positron sources</b> <i>Sebastien Corde...</i>	<b>Parallel WG session 2: WG6, SWFA: Accelerating structures</b> <i>John Power, ...</i>
	<i>Dennis Sciama LT, DWB</i>	<i>Fisher Room, DWB</i>	<i>Seminar Room, DWB</i>	<i>JAI 614, DWB</i>	<i>Conference Room, DWB</i>
12:00	<b>Lunch break</b>				
	<i>Hall, Somerville College</i> <span style="float: right;">11:45 - 13:00</span>				

# Session on Positron Sources

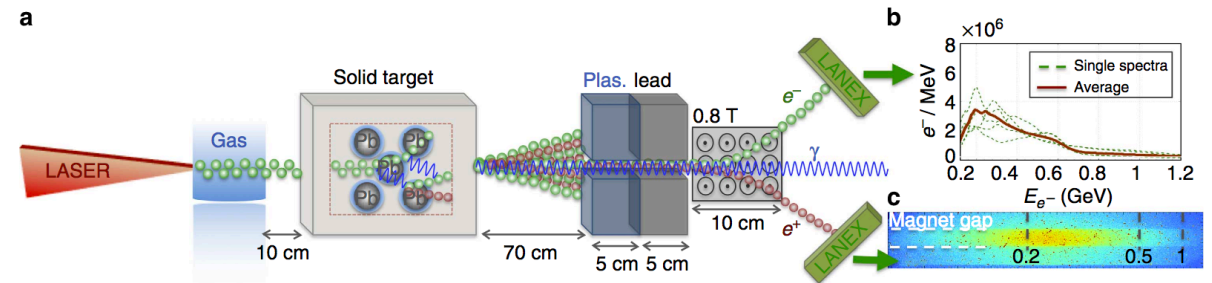
## Positron beams from electro-static traps



Talk by R. Greaves, First Point Scientific:

- Ultra cold positron beams have excellent emittance.
- They are also very long. Existing bunch compression techniques are limited to about a nanosecond for low energy beams.
- Possibly interesting for multi-bunch acceleration.

## Positron beams from laser-driven sources



Talk by G. Sarri, Queen's University Belfast:

- Positron beams produced in this manner are very short. Appropriate for LWFA/PWFA experiments.
- Excellent option for high-power laser laboratories.

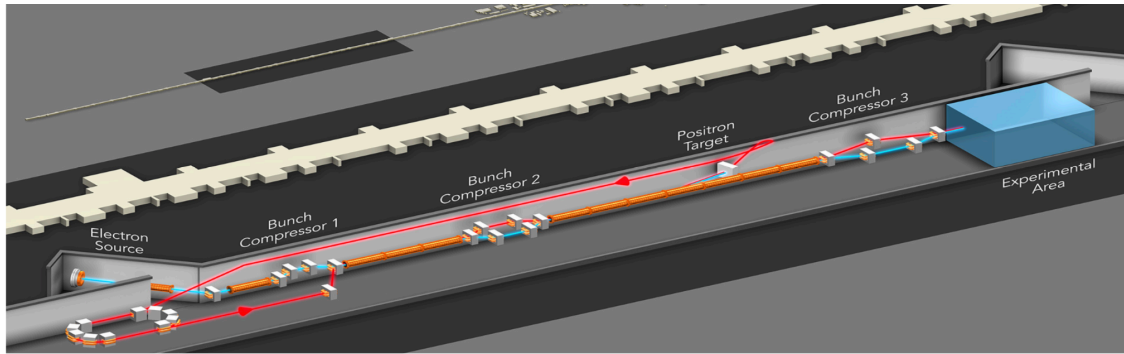
# Session on Positron Sources

Concept	Beam Charge	Rep Rate	Emittance	Bunch Length	Energy Spread	Driver/Source	Facilities	Required Infrastructure	Comments
Positrons from high energy electron beams with damping ring	2 nC	5 Hz	6 mm mrad	8 um	<1%	10 GeV, 3 nC electron beam	FACET-II	2.9 meter diameter damping ring, modification to the return line, target infrastructure already exists.	Parameters come from FACET-II TDR. We take the optimistic values. SLAC is the only laboratory that has delivered positrons for PWFA experiments.
Positrons from high energy proton beams with damping ring	1 nC	0.033 Hz	6 mm mrad	8 um	<1%	400 GeV, 30 nC proton beam	AWAKE	Requires target and capture system, return line, damping ring, and beamline to the plasma.	Only a rough study has been done on this topic. We assume we can use the same damping ring design as FACET-II.
"In-situ" positron beam generation	10-100 pC	10 Hz	Large	8 um	100%	10 GeV, 3 nC electron beam	FACET-II	High-Z foil compatible with plasma oven	Cheap but messy solution.
Positron beams from electro-static traps	10 pC	0.1 Hz	Extremely small	10 cm	Small	Radioactive sodium		Positron trap (\$0.5-1.0M) plus RF compression system	No systematic studies on this topic exist. Could be interesting for AWAKE which does not require ultrashort beams or a multi-bunch accelerator.
Positron beams from a high-power laser sources	OVERALL: 0.1 - 1 nC. 5% BW at 1 GeV: 1 - 10 pC	Existing: 10 Hz. Developing: 0.1 - 1 kHz	Geometrical emittance at 1 GeV ~ 0.01 mm mrad	micron-scale	100%	Ultra-relativistic electrons driven by a high-intensity laser	RAL, HERCULES, EuPRAXIA, ELI	Dedicated line and energy selection	Only drawback is the energy spread. Need precise energy selection and transport. Would be ideal to have a dedicated line (EuPRAXIA?) to use this source for post-acceleration and transport proof-of-concept studies

<https://docs.google.com/spreadsheets/d/1aCRvU-clJM0HO9ABd5AzVqzthx5cyRd8YUyIWuO1Qic/edit?usp=sharing>

# Session on Positron Sources

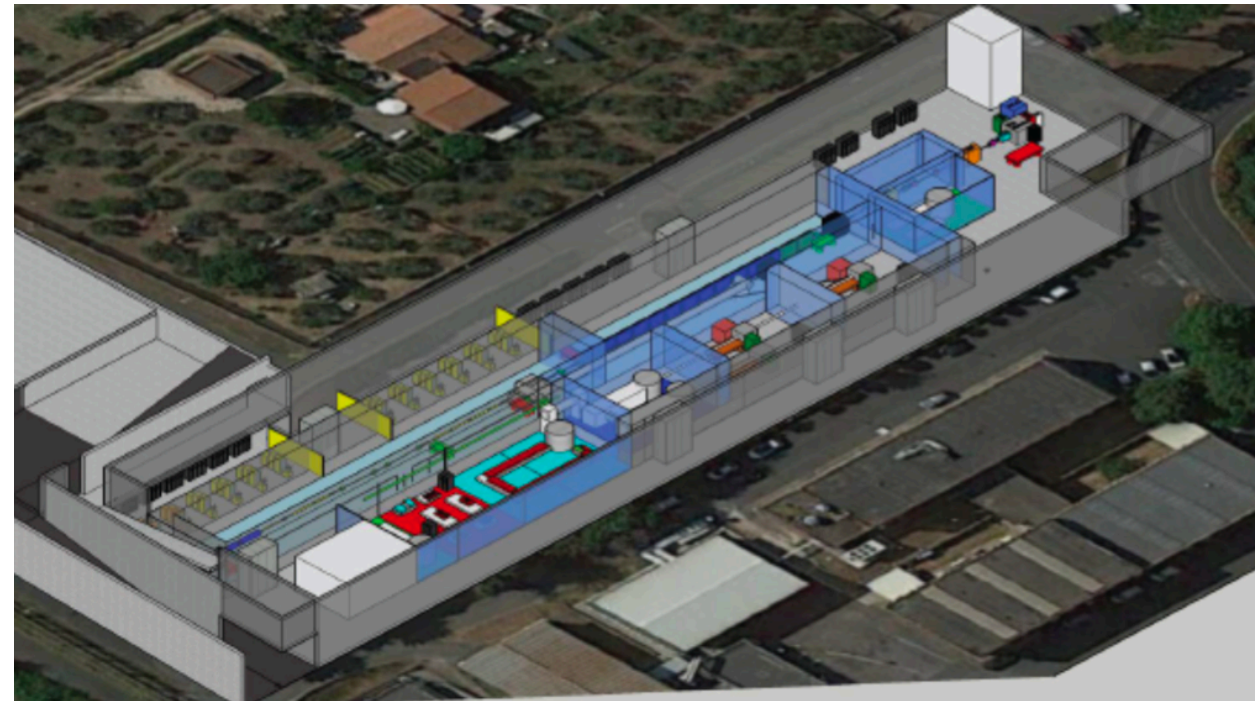
## FACET-II @ SLAC



Electron Beam Parameter	Baseline Design	Operational Ranges	Positron Beam Parameter	Baseline Design	Operational Ranges
Final Energy [GeV]	10	4.0-13.5	Final Energy [GeV]	10	4.0-13.5
Charge per pulse [nC]	2	0.7-5	Charge per pulse [nC]	1	0.7-2
Repetition Rate [Hz]	30	1-30	Repetition Rate [Hz]	5	1-5
Norm. Emittance $\gamma\epsilon_{x,y}$ at S19 [ $\mu\text{m}$ ]	4.4, 3.2	3-6	Norm. Emittance $\gamma\epsilon_{x,y}$ at S19	10, 10	6-20
Spot Size at IP $\sigma_{x,y}$ [ $\mu\text{m}$ ]	18, 12	5-20	Spot Size at IP $\sigma_{x,y}$ [ $\mu\text{m}$ ]	16, 16	5-20
Min. Bunch Length $\sigma_z$ (rms) [ $\mu\text{m}$ ]	1.8	0.7-20	Min. Bunch Length $\sigma_z$ (rms)	16	8
Max. Peak current $I_{pk}$ [kA]	72	10-200	Max. Peak current $I_{pk}$ [kA]	6	12

FACET-II is the only facility that plans to provide positron beams for PWFA experiments. Contact M. Hogan for more information: [hogan@slac.stanford.edu](mailto:hogan@slac.stanford.edu)

## EUPRAXIA @ LNF



The design for EUPRAXIA includes a user facility for positron beams. An exciting development! Contact R. Walczak for details: [roman.walczak@physics.ox.ac.uk](mailto:roman.walczak@physics.ox.ac.uk)



# Joint Session on Positron LWFA with WG4

Our goal is to *identify the most promising paths forward*.

We considered several options:

- Nonlinear
- Quasi-linear (uniform)
- Quasi-linear (hollow channel)

The focus of the session was on hollow-channel acceleration of positron beams.

Hall, Somerville College					11:45 - 13:00	
3:00	<b>Parallel WG session 3: WG4: Laser technology</b> <i>Brigitte Cros, Carl S...</i>	<b>Parallel WG session 3: WG3 TMS, Joint session WG3+WG6+WG7 on modeling DLA/SWFA</b> <i>Dr. Henri Vincenti, J...</i>	<b>Parallel WG session 3: WG5 PWFA: Beam quality preservation + staging</b> <i>Edda Gschwendtner, Jens...</i>	<b>Parallel WG session 3: WG1 Physics case</b> <i>Dr. Junping Tia...</i>	<b>Parallel WG session 3: WG6, SWFA: Drive-bunch Physics</b> <i>John Power, ...</i>	
4:00	<i>Dennis Sciamia LT, DWB</i>	<i>Fisher Room, DWB</i>	<i>Seminar Room, DWB</i>	<i>JAI 614, DWB</i>	<i>Conference Room, DWB</i>	
5:00	<b>Tea break</b> <i>Foyer on level 5, DWB</i>					15:00 - 15:30
5:00	<b>Parallel WG session 4: WG4: Positron acceleration in LWFAs, joint session with WG8 and other interested WGs</b> <i>Brigitte Cros, Carl S...</i>	<b>Parallel WG session 4: WG3 TMS, Roadmap for development of modeling capability</b> <i>Dr. Henri Vincenti, J...</i>	<b>Parallel WG session 4: WG7, DLA: Sources and Beam Transport</b> <i>Dr. Ben Cowan...</i>	<b>Parallel WG session 4: WG2 - WG1- WG5 joint session</b> <i>Andrei Seryi, Daniel S...</i>	<b>Parallel WG session 4: WG6, SWFA: Witness-bunch Physics</b> <i>John Power, ...</i>	
7:00	<i>Dennis Sciamia LT, DWB</i>	<i>Fisher Room, DWB</i>	<i>JAI 614, DWB</i>	<i>Seminar Room, DWB</i>	<i>Conference Room, DWB</i>	
8:00						

# Recap of Mini-Workshop at CERN

We held a 1-day mini-workshop on positron acceleration in plasma at CERN on 9 February, 2018.

The goal of the workshop was to review the state of the field. It was essentially a *fact-finding mission*.

We had 11 presentations/speakers and 25 participants total.

The screenshot shows the agenda for the "ALEGRO Positron Acceleration in Plasma Mini-Workshop" held on Friday, 9 Feb 2018, from 09:00 to 18:00 in the BE Auditorium Meyrin at CERN. The agenda is as follows:

- 09:00 - 10:15 Introduction: Introduction and Review of Experimental Results**
  - 09:00 Introduction** (15m): Speaker: Spencer Gessner (CERN). File: ALEGRO\_intro.pdf
  - 09:15 Experiments at FFTB** (30m): Speaker: Patric Muggli (Max Planck Institute for Physics). File: PositronsCERNFeb...
  - 09:45 Experiments at FACET** (30m): Speaker: Sebastien Corde (Ecole Polytechnique). File: 2018\_02\_ALEGRO-P...
- 10:15 - 10:30 Coffee** (15m)
- 10:30 - 12:00 Challenges and Solutions: Challenges and Solutions 1**
  - 10:30 Proton driven hollow channel** (30m): Speaker: Yangmei Li (University of Manchester/Cockcroft Institute). File: ALEGRO Positron A...
  - 11:00 Novel Schemes** (30m): Speaker: Jorge Vieira (Instituto Superior Técnico). File: vieira\_positrons.pdf
- 12:00 - 13:30 Lunch** (1h 30m)
- 13:30 - 14:30 Challenges and Solutions: Challenges and Solutions 2**
  - 13:30 Mitigating transverse wakefields in the hollow channel** (30m): Speaker: Carl Andreas Lindstrom. File: Mitigation of transv...

Link to full agenda and talks:

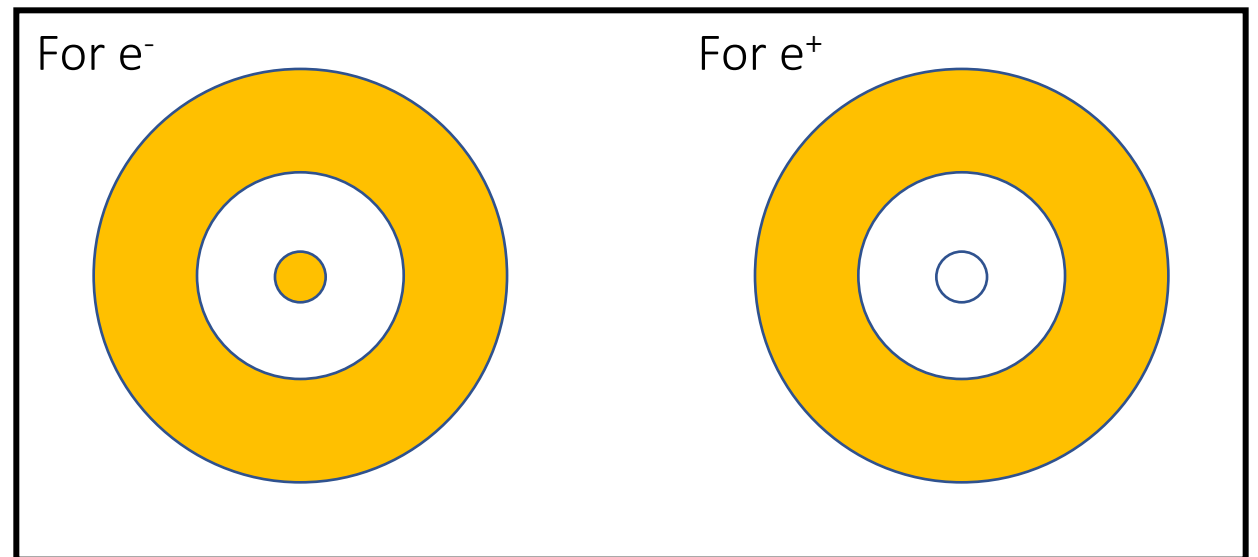
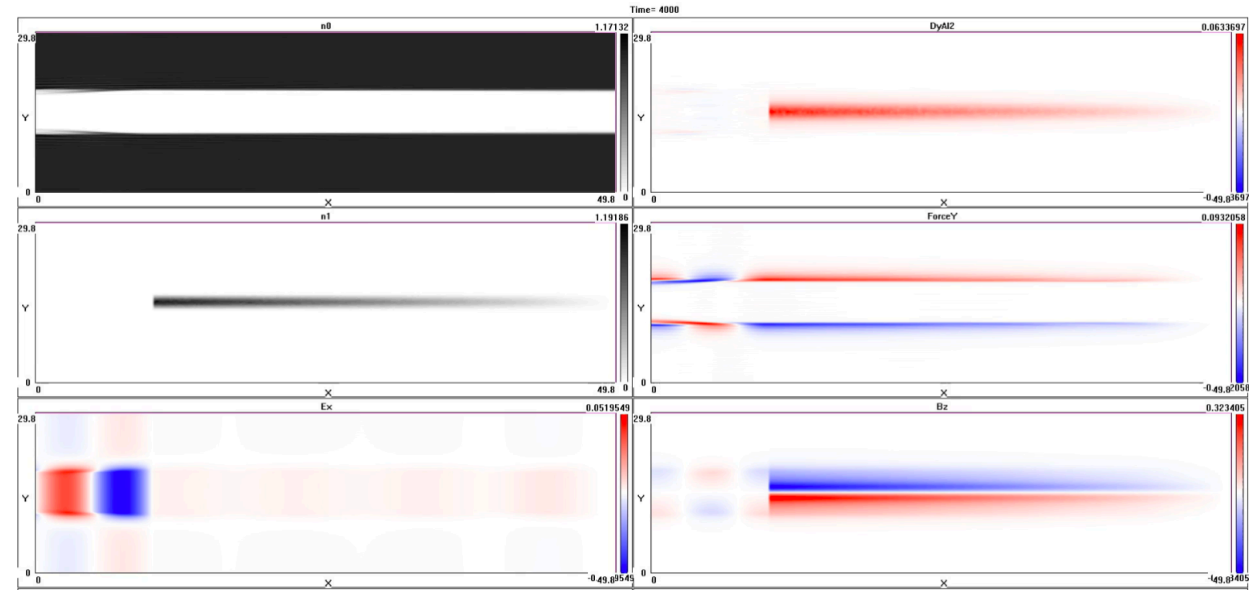
<https://indico.cern.ch/event/702515/>

# Hollow Channel Acceleration

There is a consensus that without a BBU suppression mechanism, the hollow channel does not work.

One idea is BNS damping with 10% energy spread, but this passes on the problem to the focusing system.

Another idea was presented by A. Pukhov: The “Co-axial hollow channel”. In this scenario, there is a filament of plasma on axis to provide focusing and suppress BBU.





# Today: Joint Session on Positron PWFA with WG5

After this session, we will discuss options for PWFA, including an afterburner for the ILC/CLIC.

We will also hear from C. Lindstrøm on hollow channel based linear colliders.

Calendar interface for Wednesday 28/03. The interface includes navigation tabs for Mon 26/03, Tue 27/03, Wed 28/03, Thu 29/03, and All days. Action buttons for Print, PDF, Full screen, Detailed view, and Filter are present. The schedule is as follows:

Time	Event	Location
09:00 - 10:30	Plenary session: Brief summary of each WG previous session and plans for discussion	Dennis Sciamia LT, DWB
10:30 - 10:45	Coffee break	Foyer on level 5, DWB
11:00 - 12:00	Parallel WG session 5: WG4: Identification of possible machines and strategy	Dennis Sciamia LT, DWB
11:00 - 12:00	Parallel WG session 5: WG5, Joint with WG8: positron acceleration	Seminar Room, DWB
11:00 - 12:00	Parallel WG session 5: WG6, SWFA: Simulations tools for SWFA accelerators	Conference Room, DWB
11:00 - 12:00	Parallel WG session 5: WG2 and WG? joint session	Fisher Room, DWB
11:00 - 12:00	Parallel WG session 5: WG7, DLA: Collider Parameters and Calculations	JAI 614, DWB
12:00 - 13:00	Lunch break	

# Input to ALEGRO document

At minimum, we will request strong support for facilities that can provide positrons for LWFA/PWFA facilities.

We would also like to make concrete suggestions on positron R&D. More discussion with WG4 and WG5 is needed.