

# DISCUSSION ON THE FEASIBILITY OF A DPS TEST IN AWAKE TUNNEL DURING YETS-2022

## MEETING MINUTES

Indico page: <https://indico.cern.ch/event/1102387/>

Date: 08.12.2021 14:30 - 16:45 / online Zoom meeting / minutes by Alban Sublet 08.12.2021

Participants:

Edda Gschwendtner, Carolina Amoedo, Ans Pardons, Eloise Guran, Nelson Lopes, Vincent Clerc, Giovanni Zevi Della Porta, Zulfikar Najmudin, Patric Muggli, Chiara Pasquino (excused), Mauro Taborelli, Nicolas Sebastien Chritin, Ben Chen, John Farmer, Alban Sublet

Goal:

- go through the technical and physics objectives of such a test,
- assess the preparation work and resources needed for such a test,
- highlight open points and limitations,
- evaluate its feasibility,
- define a decision point limit (go/no go date) within the AWAKE project plan.

### I. Introduction (Alban) and objectives of a discharge plasma source experiment early 2023 (Patric)

Introduction:

This meeting aimed at presenting an overview of the proposal for a discharge plasma source test in the tunnel during YETS 2022 in order to evaluate its feasibility and the resources needed. The approach should remain as simple as possible with as much adaptation of existing installations/infrastructure as possible.

It details the technical and physics objectives (Patric Muggli's presentation), the different tasks, deadlines and decision points (Alban Sublet's presentation) and the technical aspects of the discharge plasma source itself (Nelson Lopes's presentation).

Technical and Physics objectives:

- Trial different plasma length (5 m + 5 m or 3 m + 7 m) and measure its impact on the SMI/wakefield
- Measure the effect of the ion mass on the ion motion by using different discharge gases (Ar, He)
- Measure plasma light to have an idea of the wakefield dissipation along the cell (as far as the plasma emission can allow this...)

## DISCHARGE SOURCE

**Why?**



- ✦ Laser ionization does not scale to long plasma lengths
  - ✦ Energy depletion, focusing geometry
- ✦ ~100GeV, ~1GeV/m => ~100m plasma
- ✦ Need scalable plasma source
  - ✦ SM acceleration requires  $\Delta n_e/n_{e0} \sim 0.2\%$

**Why now?**

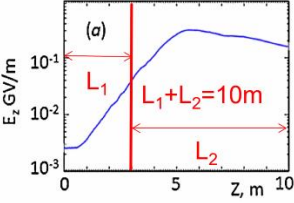
- ✦ Motivation, it may take some time to get there ...
- ✦ Integration
  - ✦ Source itself (Nelson, Alban)
  - ✦ Vacuum interface with static fill (e-bunch)
- ✦ Natural time between two vapor sources
  - ✦ "Simpler" system

**Physics?**

- ✦ Vary the plasma length: 5+5, 3+7?
- ✦ Ion motion: heavy Ar, light He, H<sub>2</sub>
- ✦ Plasma light diagnostic?
- ✦ No laser, no e-beam (only SMI experiments)

Pukhov, PRL107 145003 (2011)



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P. Muggli, DisSousMeet 12/09/2021

	<b>Ans Pardons</b>
<b>Vincent Clerc</b>	<b>Mauro Taborelli</b>
<b>John Farmer (he...)</b>	<b>Carolina Amoedo</b>
<b>Ben Chen</b>	

- Natural time window for such a test between the two vapour sources swap during YETS 2022.
- This test should remain as simple as possible in terms of setup and with only SMI experiment (proton beam only).
- Beyond its relative "simplicity", this test should be seen as a step forward for the AWAKE project to demonstrate the feasibility of a scalable plasma source and pave the way to run 2c/d.

Question (Zulfikar):

- laser and e-beam compatibility and the need of e-beam for seeding the proton beam SMI → limited by the presence of windows to confine the low pressure discharge gas (~ 5 Pa of argon), alternative scheme might be studied but beyond the scope of this test. SMI grows with laser ionised Rb alone (w/o need of e-beam) and should grow in an Ar plasma as well.
- Cell diagnostics: longitudinal (not practical) or transverse thanks to the tube transparency → nice to have on medium or long term, for the test, due to the short term schedule, concentrate on easy to implement plasma imaging

Finally (Patric's comment), the plasma uniformity is not a required for this test as it is not a key factor for the SMI, but it is required for electron acceleration.

## II. Needs for a tunnel test (Alban)

Presentation of the needs to prepare and achieve the DPS test during YETS 2022.

Split of tasks among the different AWAKE workpackages.

Proposed 3 decision points:

1. Decision point by AWAKE to endorse this project → AWAKE project go/no go, TB+PEB 20<sup>th</sup> January 2022
2. Yes, global resources are available for this plan → CERN to decide by February 2022
3. 10 m cell ready for tunnel test? → go/no go October 2022

The timeline has to be clarified with a detailed breakdown of activities and plan for all the WP leaders (Edda) and this proposal has to be internally approved by the AWAKE project (Ans + Edda).

To support this, Edda proposed to make two presentations of the test proposal at the TB and PEB and detail the technical and physics aspects respectively, with prior agreement on the different tasks and resources.

Patric highlighted that the different tasks should remain as reasonable as possible, considering the relatively “simple” DPS approach, adapting things for the sake of the test, not do complete re-design of the installation and facilities. This should be echoed in the TB/PEB presentations as well.

### III. Discharge plasma source overview (Nelson)

Presentation of the past and last achievement at IC, IST and CERN on the DPS, the concept of a 10 m long DPS for the tunnel test and its powering, control and interface, including a technical overview of the up/downstream vacuum interfaces, cell supports design and control scheme, and a preliminary planning of activities for the development of the 10 m cell and its installation/experiment in the tunnel.

Preliminary longitudinal interferometry measurement of density along the 5 m test tube at IST has been shown, highlighting a lower than expected ionisation degree of about 27.5% in 15 Pa Ar and an electron density of about  $1 \times 10^{21} \text{ m}^{-3}$  with a  $\sim 700 \text{ A} / 20 \mu\text{s}$  heater current pulse.

### IV. Discussion

The presentation of Nelson opens up on a general discussion of the test proposal with focused technical questions and project/planning/deadline decisions and concerns (see detailed in next paragraph) to be addressed in order to evaluate the feasibility of the DPS tunnel test during YETS 2022.

→ The AWAKE project must take a decision regarding the YETS 2022 DPS test proposal:

1. Are the proposed test measurements and potential learnings interesting for the project?
2. How much time could be allowed for this test?

### V. Actions

The technical points and open questions listed below will be addressed off line by the DPS team and CERN AWAKE WP leaders, under the coordination of Alban.

A summary of the actions taken together with a breakdown of activities and planning will be presented in the next DPS-YETS2022 meeting, scheduled on the 14<sup>th</sup> January at 14:00, prior to the TB/PEB meetings of 19/20<sup>th</sup> January.

Open points to be addressed split in 4 categories:

#### 1. Mechanical design

##### - Design of the up/downstream vacuum interfaces and tube:

Evaluate the resources needed and define who is doing what (if the vacuum design is made by TE/VSC or EN/MME?) and discuss the best design allowing the shortest transition from the Al-window to the plasma, with vacuum ports for pumping and gauges connections, anode

→ Chiara, Nicolas, Nelson, Alban

- **Design of the mechanical supports of the cell and alignment scheme:**

Resources needed and who, simple design re-using most of existing infrastructures

→ Nicolas, Vincent, Ans, Alban, Nelson

2. Safety, integration, cabling, control, transport

Evaluate the resources needed with the different CERN services to conduct this test in the tunnel

→ Ans, Carolina, Alban

3. Tunnel test possible planning

1. Eloise to start with an overview of the baseline for the Rb density step vapour source schedule, including the dates of YETS 2022 and include the proposal for the DPS test and availability of p-beam after YETS 2022.

→ Eloise, Alban

2. Propose a schedule scenario for the test itself and evaluate its feasibility based on project baseline deadlines and priorities. The end time could be defined as the end of the first week of p-beam (date to be defined/agreed). Starting time depends on the removal of the existing Rb cell and motivation for the DPS test! The rest of the schedule could be back-propagated according to this and depending on project priorities/deadlines/p-beam availability for 2023

→ Edda + Patric + AWAKE project to propose a possible window for the test + Eloise, Ans, Alban

4. DPS technical program

DPS team (Nelson, Nuno from IST, Carolina, Alban from CERN and Ben, Zulfikar from IC) to define the detailed technical program for the development of the discharge plasma source hardware itself (tube, electrodes, power supplies).

Next meeting: 14<sup>th</sup> January at 14:00