# MINUTES OF THE ARIES WP16 MEETING AT IAP

## 8/9 November 2018
## IAP, Frankfurt

### PARTICIPANTS

CERN: A. Rossi, S. Sadovich
GSI: D. Ondreka (WP Coordinator), K. Schulte-Urlichs
IAP: O. Meusel, M. Droba, K. Thoma
RTU: P. Apse-Apsitis, I. Streiks

Excused: None

### WEBSITE

https://indico.cern.ch/event/766940/

### AGENDA

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|---|---|---|
| 8.11. | 14:50 | **Welcome** |
| | 15:00 | **Task reports** |
| | 17:00 | **Technical discussions: E-lens test stand requirements** |
| 9.11. | 11:00 | **Technical discussions: SCC lens modulator requirements** |
| | 13:00 | **Business lunch: Next steps** |

## 1. TASK REPORTS

### Status Gun and SCC Lens (K. Schulte-Urlichs)

This contribution presented the status of the design of the grid-modulated electron gun for SCC at GSI. The major results can be summarized as follows:

- The conceptual design for a gun providing a Gaussian shaped transverse beam profile has been completed. The design includes a quadrupole integrated into the solenoid for changing the beam cross-section created by the round cathode into an ellipse with adjustable aspect ratio. Beam loss and heat load on grid have been estimated and found tolerable. A final set of operational parameters for the gun has been defined. In particular, the gun requires an extraction voltage of 30 kV to achieve 10 A peak electron current behind the grid.
- A preliminary design of a cathode and grid for the creation of a homogeneous transverse profile exists, in accordance with the latest results from the ion beam dynamics studies performed by the associated partner TUD.
- A tungsten mock-up of the Gaussian cathode and grid has been ordered. It will be integrated into an existing volume ion source at IAP to perform heat load and electrical tests. The fabrication is completed, delivery is expected very soon.
- Two solenoids (gun and collector) with a maximum field of 0.6 T for the SCC lens test stand at IAP will be ordered this year by GSI, to be delivered by end of next year.

Regarding the status of the system integration task as well as the status of the electron beam dynamics simulations, the following statements were made:

- A study on the magnetic design of the main interaction solenoid with a maximum field of 0.6 t for the SCC lens has been ordered and shall be available by mid of December. It will be used as basis for the overall layout of the SCC lens.
- Regarding the electron beam dynamics studies, bench marking simulations have been started for beam transport in the interaction solenoid, comparing the results of the three codes CST, WARP, and Bender as well as analytical expressions. This benchmarking has become necessary because the CST results show a significant deviation from the prediction of analytical expressions.

### Status Modulator (P. Apse-Apsitis)

This contribution presented the status of the design of the power modulator for the SCC lens. The major results can be summarized as follows:

- The development of the final modulator is based on a staged approach involving a series of low-power models. Two low-power models have been built, the first has been tested in July with the proof-of-concept experiment set-up (mini-gun test stand) at IAP, the second one is ready for testing. A third model is under development implementing all requirements on frequency range and bandwidth for the SCC lens.
- A signal generator for creation of test signals resembling the real ion beam pulses as closely as possible is under development.
- A conceptual layout for the final power modulator has been developed. It will include the option of providing a measured ion beam profile as input to the modulator.

### Status E-Lens Test Stand (S. Sadovich)

This contribution presented the status of the design of the CERN electron lens test stand. The major results can be summarized as follows:

- The design of the test stand (stage 1) is almost completed, with the exception of the final design of the diagnostic chamber which depends on requirements for testing the SCC lens.
- Magnets, supports, and power converters are available and ready for installation.
- Infrastructure at the test site has been prepared (electricity, cooling water).
- The design of the high voltage supply circuit has been completed.

## 2. TECHNICAL DISCUSSIONS

### E-Lens Test Stand: Requirements

The design of stage 1 of the CERN e-lens test stand needs to be finalized urgently, because otherwise certain components can't be manufactured in time due to limited availability of CERN workshop resources.

The following open questions needed to be addressed:

- Maximum field at the gun for the SCC lens: this parameter determines the size of the electron beam along the test stand and thus the required apertures.
- Pulse pattern for the tests of the SCC lens: this parameter determines the power dissipated in the diagnostics devices, especially the YAG screen, and the collector.
- Maximum extraction voltage: depending on this value the CERN high voltage supply may or may not be usable for the SCC lens.

The following list summarized the results of the discussions about these topics:

- The maximum field at the gun for the SCC lens when operated at the CERN test stand will be fixed to 0.3 T.
- The diagnostic chamber will be shortened such as to reduce the distance between gun and collector solenoids. This requires using oval shaped pipes for the 'arms' of the diagnostic chamber.
- GSI will design a pulse pattern for testing the SCC lens compatible with the maximum allowed power dissipation on the YAG screen. To this end, CERN will provide the material properties of the YAG screen to GSI, which will then simulate the energy dissipation.

Under the conditions above, the SCC electron beam can be transported through the stage 1 test stand and the diagnostic elements can be used to measure its properties.

It is, however, not yet clear whether the vacuum chamber downstream the diagnostics chamber and the collector can be used for testing the SCC lens as well. The design of these components has been optimized for measurement of the CERN hollow electron lens. The two main issues are the protection of the view port for observing the YAG screen and the collection of the broad and quickly diverging beam of the SCC gun. It was decided to disregard these open issues for the finalization of the stage 1 design. Most probably, the vacuum chamber behind the diagnostic chamber and the collector need to be redesigned for testing the SCC gun. In any event, this can only be decided once the engineering design of the SCC gun has been completed.

In this context, the option of using a GSI solenoid at the CERN test stand was also discussed, the main advantage being its significantly larger bore (200 mm compared to 130 mm), allowing for an easier design of vacuum chamber and collector with larger aperture. Even though the GSI solenoid has at nominal field a DC power consumption exceeding the limits of the available cooling power at the CERN test site, pulsed operation of the solenoid might still make its usage feasible. However, this will also be considered only after the finalization of the SCC gun design.

### Modulator: Requirements

As mentioned above, the third model power modulator will have extended capabilities for signal generation in order to resemble realistic pulse shapes including frequency sweep and amplitude modulation on a slow time scale. Nevertheless, it would be desirable to be able to supply the modulator with a modulation signal generated from beam profiles measured in SIS18. This option shall be investigated.

For the design of the final full power modulator a realistic load resembling cathode and grid is required. Several options were discussed:

- A simple air filled plate capacitor with the design capacitance of the grid. Such a device could be manufactured at RTU.
- Usage of the tungsten mock-up in the volume ion source. However, this option might be ruled out if the load was required at RTU simultaneously with the tests of this mock-up at IAP.

- Construction of an electrical mock-up of the SSC gun at IAP. Such a mock-up should resemble the final gun as closely as possible regarding the electrical properties. However, it would contain dummy insertions only equivalent in shape replacing cathode, grid, and other parts. This option might have the advantage of learning something about the manufacturing of the gun. On the other hand, considerable effort would be required.

Which of these options shall be pursued depends on a more detailed planning of the two time lines for the tungsten mock-up tests at IAP and for the design steps of the final modulator.

Attention needs to be drawn to the fact that the grid will be a sink for a considerable amount (estimated to several amperes) of electron current. Removal of this current needs to be taken into account during the design of the final modulator.

The capacitance driven by the modulator needs to be kept as small as possible. Therefore, RTU decided to use flat feeder cables to connect the modulator to the gun. In addition, the modulator should be placed as close to the gun as possible. The design of the whole electron lens should take this into account and foresee installation of the modulator very close to the gun.

## 3. NEXT STEPS

The following immediate next steps were agreed upon:

- Model two of the low power modulator series will be tested with the mini-gun at IAP at the beginning of next year.
- GSI, IAP, and RTU will work out integrated schedules for the design of the modulator and the tungsten mock-up tests.
- CERN will finalize the design of the diagnostics chamber for the stage 1 test stand and inform GSI about the extra cost for oval shaped pipes.

These steps should be completed until the next WP meeting.

## 4. NEXT MEETINGS

Next meetings:

- Monthly video meeting
- WP meeting at CERN around end of February/beginning of March 2019
- ARIES annual meeting April 2019