Abstract

At the Institut für Kernphysik of Johannes Gutenberg-Universität Mainz, the new multi-turn energy recovery linac MESA is under construction. Two modified ELBE-type cryomodules with two 9-cell TESLA/XFEL cavities each will provide an energy gain of 50 MeV per turn. Those are currently in the production process at Rö Research Instruments GmbH, Bergisch Gladbach, Germany. Modifications for the tuner and the HOM damper are under development. In addition, a 4K/2K Joule Thomson expansion stage will also be integrated into the cryomodule. The current status of the development of the cryomodules and their modifications will be discussed.

Mainz Energy Recovering Superconducting Accelerator (MESA)

MESA will be a small energy recovering accelerator with two modified ELBE-type cryomodules.

Possible configuration of MESA. The existing beam dump is in the centre of the beamline.

- MESA will be installed in already existing halls of the Institut für Kernphysik and in an additional experimental hall
- Two different operation modes: External Beam (EB) and Energy Recovery Linac (ERL)
- EB: parity violation experiment P2, fixed target
- ERL: high resolution spectrometer MAGIX, pseudo internal target

Specifications of MESA Cryomodules

- Cryomodules are based on ELBE-type, used at HZDR, Germany
- Each module contains two 9-cell TESLA/XFEL-type cavities
- Major modifications are made to:
  - the tuner (XFEL/Saclay tuner)
  - the higher order mode damper (sapphire feedthrough)
- the helium supply (4K/2K expansion)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Energy gain per cryomodule</td>
<td>≥ 25 MeV</td>
</tr>
<tr>
<td>Specified cryogenic losses per cryomodule</td>
<td>≤ 4 W @ 2K</td>
</tr>
<tr>
<td>Accelerating field per cavity</td>
<td>≥ 12.5 MV/m</td>
</tr>
<tr>
<td>Operation Mode / Beam duty cycle</td>
<td>Continuous Wave / 100%</td>
</tr>
<tr>
<td>Passes in EB mode</td>
<td>4 (2 ramp up, 2 ramp down)</td>
</tr>
<tr>
<td>Passes in ERL mode</td>
<td>4 (2 ramp up, 2 ramp down)</td>
</tr>
<tr>
<td>Beam current (EB/ERL)</td>
<td>150 µA / 1 (10) mA</td>
</tr>
</tbody>
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Tuner Changes

ELBE tuner used at HZDR. XFEL/Saclay tuner, may be used by MESA.

Changes:
- The ELBE-type tuner will be replaced by XFEL/Saclay-type tuner
- Piezo support at XFEL/Saclay tuner will allow fast feedback (needed for multi-turn and ERL)
- Tuning range is ±460kHz at 2K

Higher Order Mode (HOM) Damper

Changes:
- Because of the c.w. operation mode with duty cycle of 100%, the heating of the HOM antenna could cause quenching
- Replacement of the insulator of the HOM antenna with sapphire to optimize the thermal conductivity

Left: HOM antenna with sapphire insulator (blue) for better thermal conductivity in order to damp the HOMs of c.w. usage. Design by Kyocera.
Right: Coupling of the F-part and the HOM antenna (both silver) into the cavity (light blue). F-part design by DESY.
- Simulations are ongoing
- Additional copper wires as heat bridges will be installed after simulation

4K/2K Joule Thomson Expansion

Preliminary diagram of the 4K/2K helium stage

Quality Control of the Niobium Sheets

- Quality control of the 78 niobium sheets was made by an optical analysis and an eddy current scan. A small signal can be seen at the coord. -2/70

Status of Manufacturing the Cryomodules

- Most components are ordered and delivered
- The niobium sheets to build the half cells are delivered and tested with eddy current scan.
- The half cell fabrication will start in October 2015
- The cryomodules will be delivered in mid 2017
- First test with electron beam at 2K will be done within the same year

Outlook and Acknowledgement

Within the next 2 years, the cavities and cryomodules will be built. A horizontal RF test of the cavities will be done mid to end 2016. Simulations of the thermal conductivity will be done until end of 2015. The detailed planning of the 4K/2K expansion will be done with consultation of DESY.

We would like to thank DESYSRF-staff for all their help, especially J. Ivensen for the opportunity to measure the niobium sheets in no time.