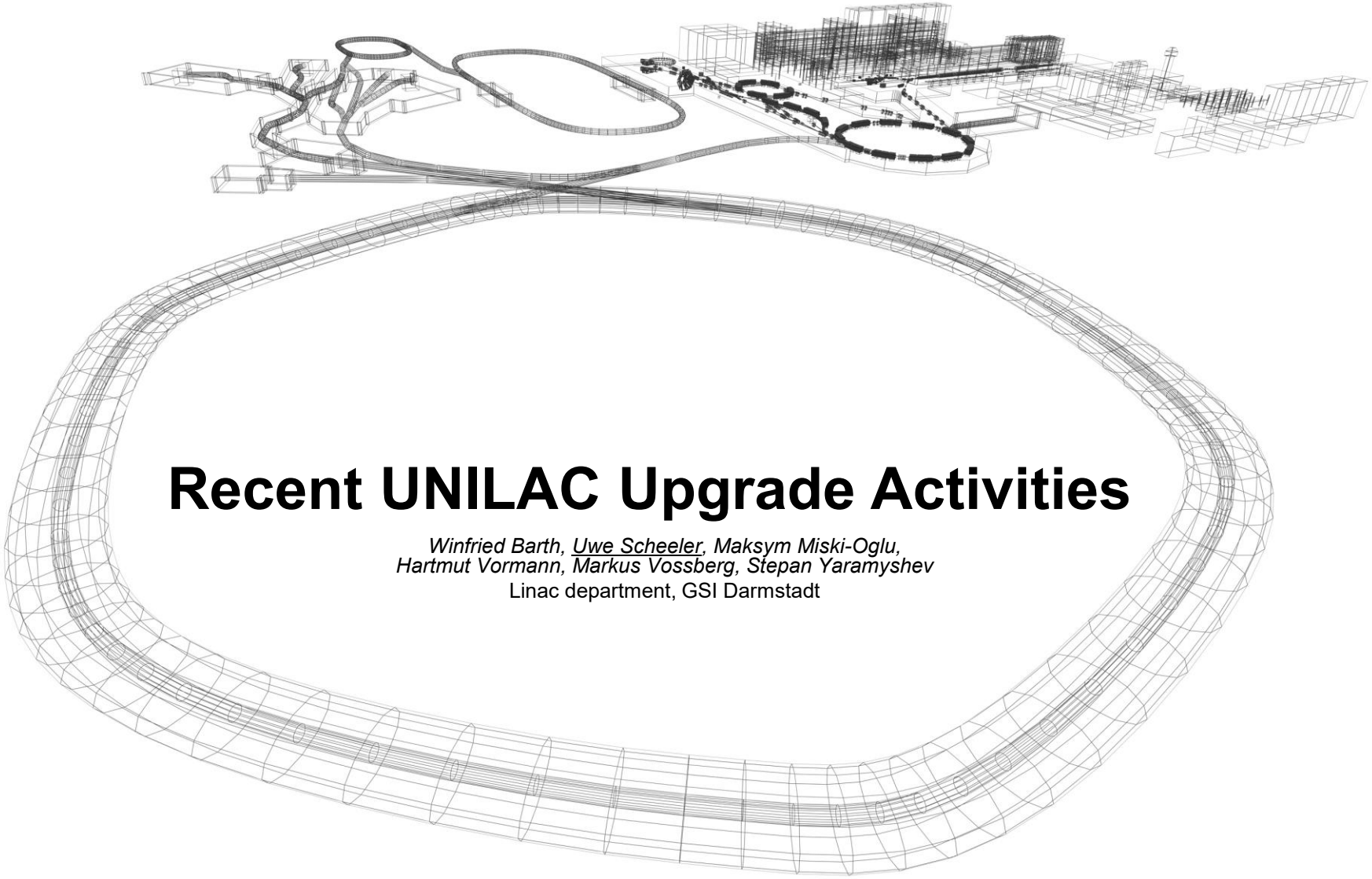
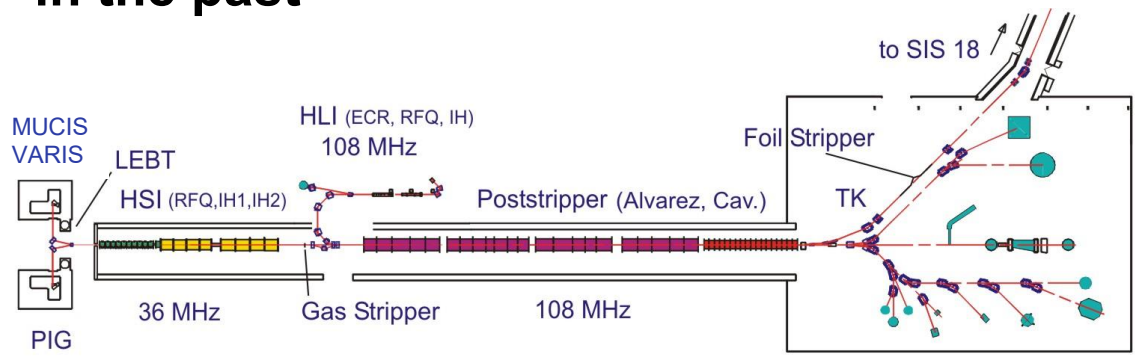


Recent UNILAC Upgrade Activities

Winfried Barth, Uwe Scheeler, Maksym Miski-Oglu,
Hartmut Vormann, Markus Vossberg, Stepan Yaramyshev
Linac department, GSI Darmstadt

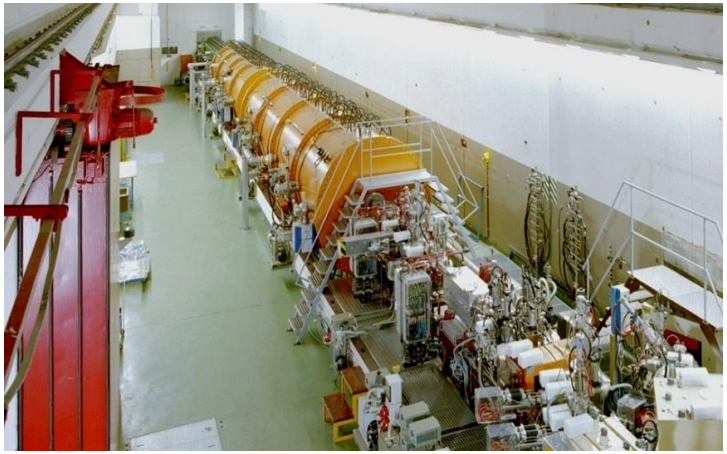
Introduction

Commissioning mile stones in the past

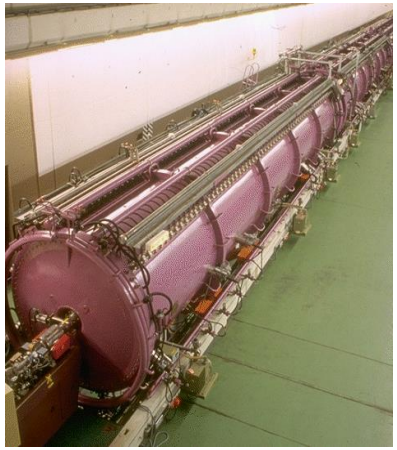


Single gap resonators

High Current Injector



Alvarez cavities



- 1975 Alvarez und Single Gap Resonators
- 1992 High Charge State Injector
- 1999 High Current Injector
- mid 90's: second version of control system
- after 2000: upgrade of stripper sections

Most of the components are in operation for more than 20 years but also long term operation experience and a lot of optimization effort have been established.

Overview of different upgrade measures

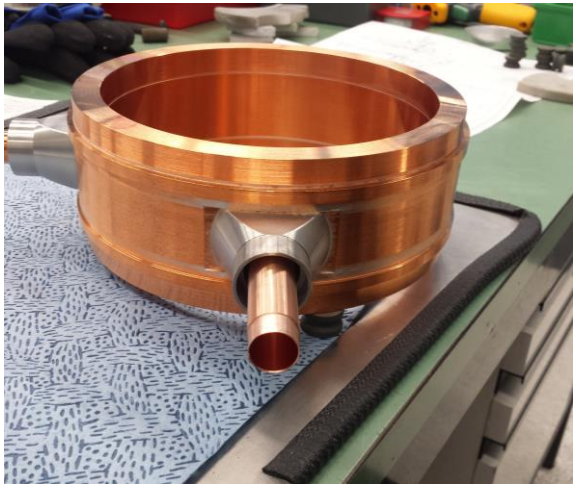
- **Replacement of defective complex accelerator components (drift tubes, vacuum chambers, septum coils..)**
- **Upgrades for FAIR operation**
  - **HSI intensity performance**
  - ***Pulsed hydrogen gas stripper (see invited talk of P. Gerhard on Monday)***
  - **Non destructive beam diagnostics**
- ***Complete system renewal***
  - ***ACC Control system (FAIR standard)***
  - ***vacuum control***
  - ***RF amplifier systems***
- ***Exchange of accelerator sections***
  - ***Poststripper upgrade program (Alvarez DTL)***
  - ***Development and procurement of HELIAC (cw-linac)***

Spare parts management

Exchange of drift tubes

- The five Alvarez cavities are equipped with 176 drift tubes
- A little less than one defect per year occurred in the past
- In case of a defect operation can be continued with restrictions
- Concerning fabrication two types are in use (body consists of full copper or double walled stainless steel)

cavity inside



shell of the copper version

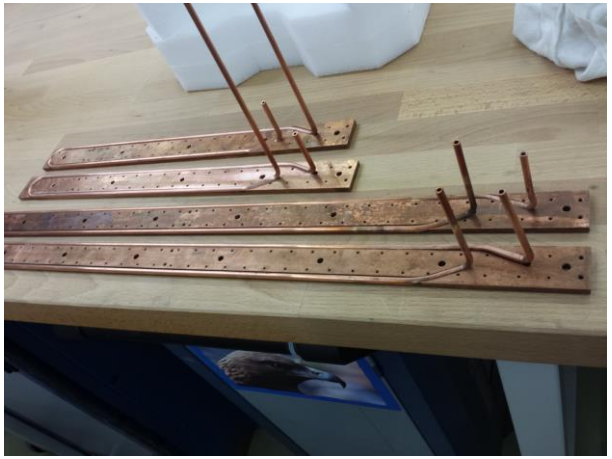
inner yoke with magnet coils

Spare parts management

Baffle plates of dipols

- Often water leaks are responsible for serious vacuum failures
- The bending radius of the cooling pipes has been increased in order to reduce cavitation and the electrical isolation of the fastening has been removed to simplify the construction
- The rectangular feed through flange is difficult to seal
- Careful monitoring of the vacuum pressure is organized in order to avoid serious damage of any cooled component due to water leaks

defect baffle plates with corrosion



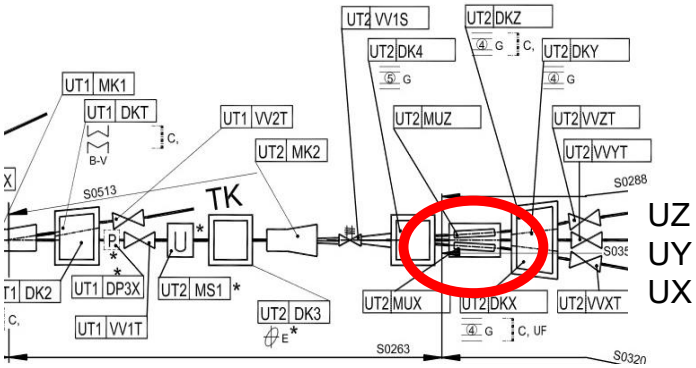
fabrication of new cooling channels

final vacuum test

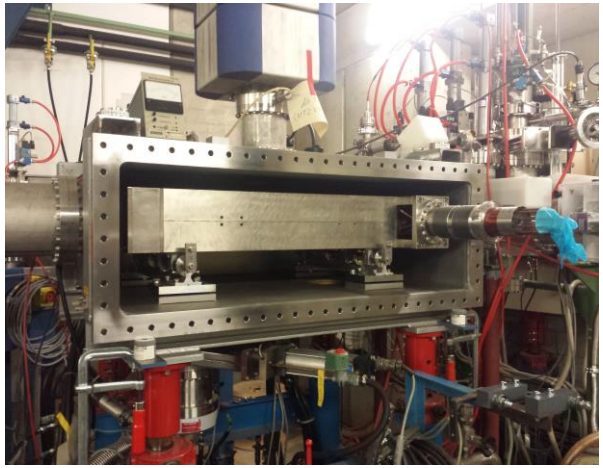
Spare parts management

Septum magnet UT2MUZ

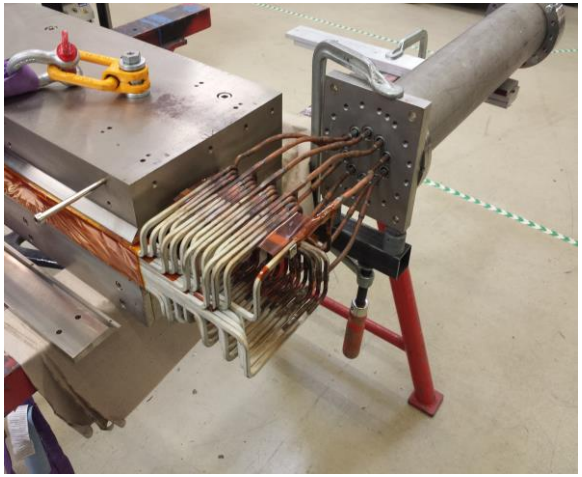
- In case of any defect the repair of the coils (installed in vacuum) is difficult and time consuming
- The tight structure and complex construction has to be handled
- Three septa together have been in operation for little less than 50 years
- Last spare part is irreparable due to a ground fault of the coil, the fabrication of new coils has been started



sketch of beamline in front of experimental hall



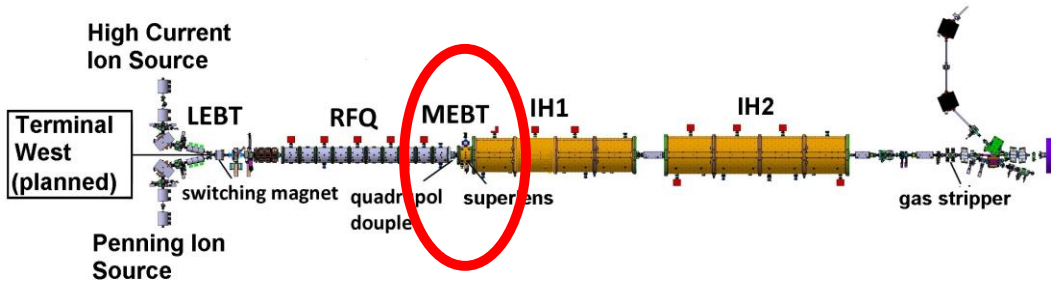
open vacuum chamber with right septum magnet



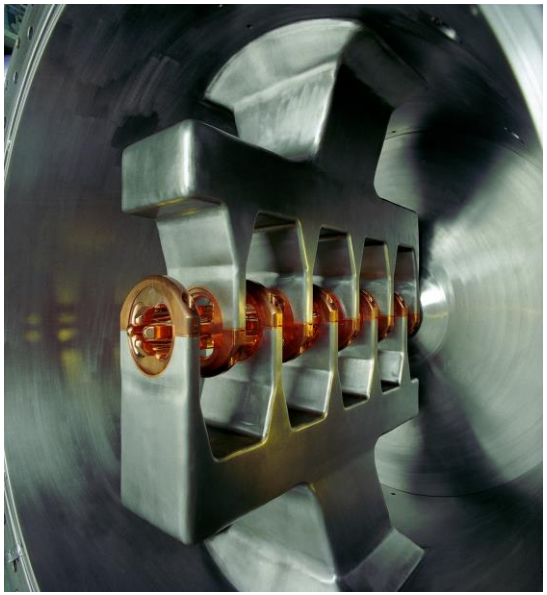
water and current supply of the single coil windings

Intensity upgrade at High Current Injector

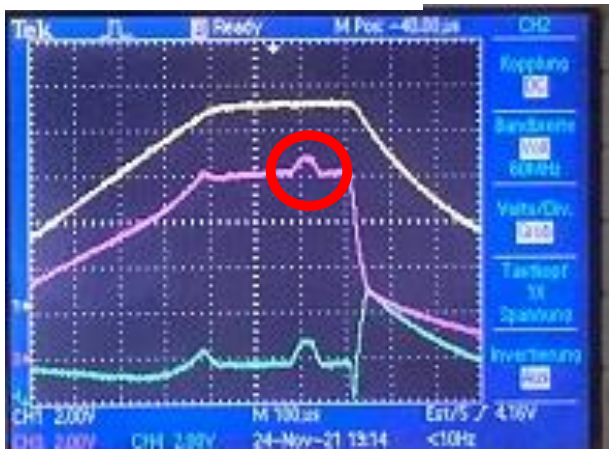
Upgrade MEBT (Quadrupols + Superlens)



- Next step: exchange of superlens rods after 18 years operation
- Long term task: increase aperture and focusing strength of quadrupoles and superlens



superlens

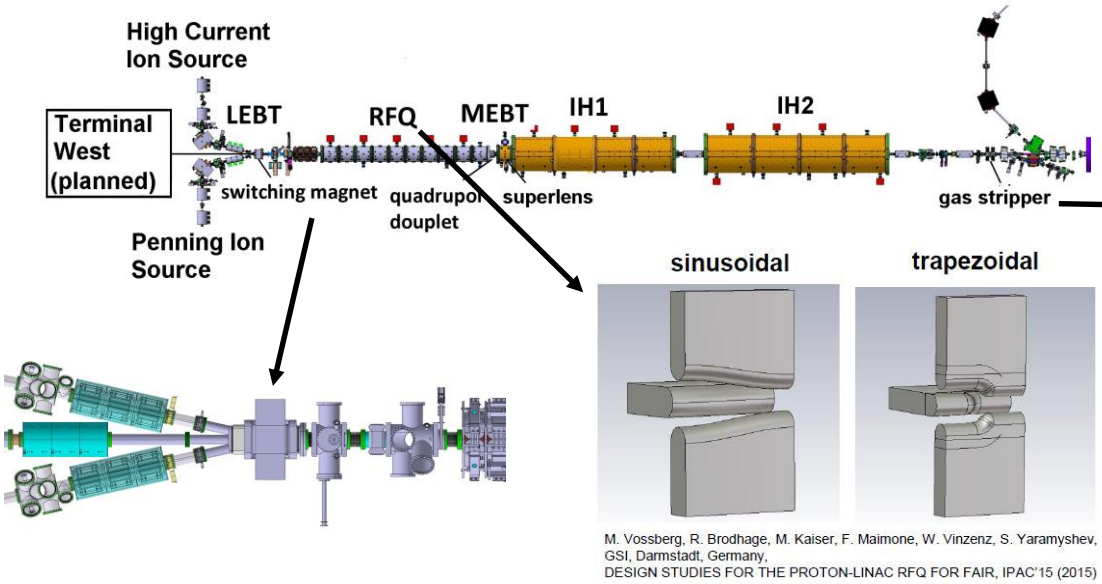


RF amplitude (yellow) and RF power signal (magenta): additional power needed during beam pulse

the coupling of the cavity could not be significantly improved by exchange of coupling loop in 2021

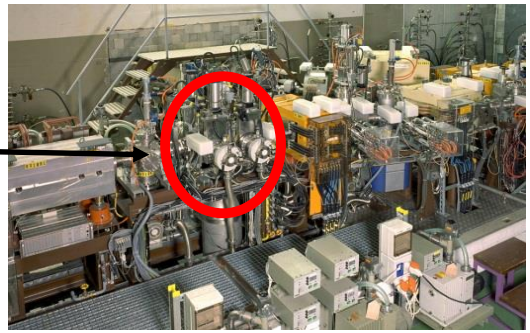
Intensity upgrade at High Current Injector

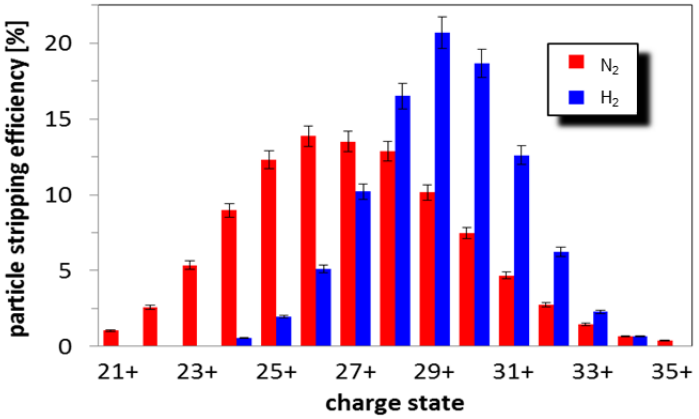
Improvement of LEBT matching and upgrade of RFQ



M. Vossberg, R. Brodhage, M. Kaiser, F. Maimone, W. Vinzenz, S. Yaramyshev, GSI, Darmstadt, Germany,
DESIGN STUDIES FOR THE PROTON-LINAC RFQ FOR FAIR, IPAC'15 (2015)

- Main step to higher uranium intensity is related to pulsed gas stripper operation with Hydrogen





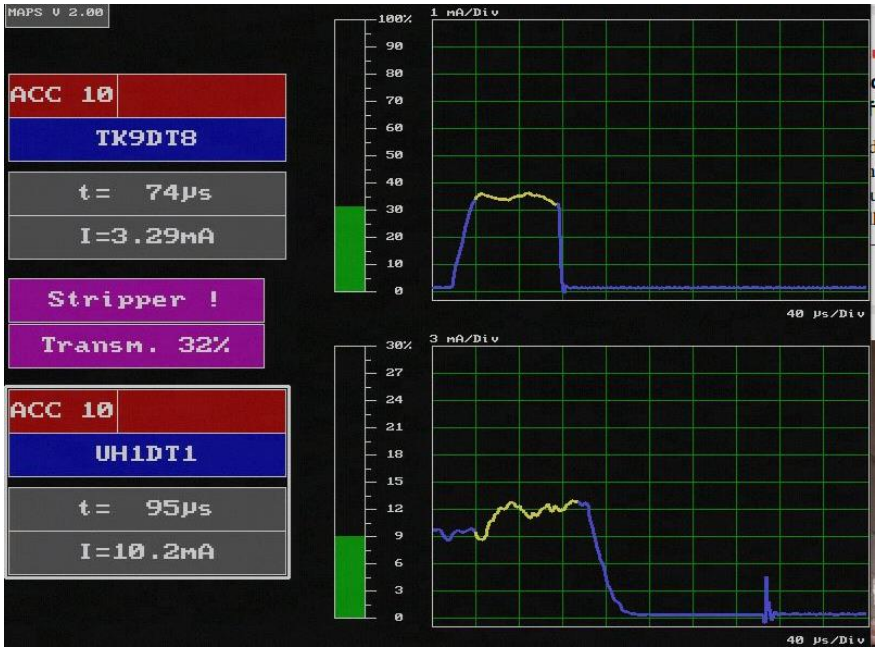
charge distribution for Uranium beam

- The design and installation of a new switching magnet with increased vertical aperture allows to improve beam matching between LEBT and RFQ
- A new trapezoidal design of RFQ electrodes is proposed
- An optimization process is needed to check increasing aperture versus reduced field strength-> increased operation reliability

Beam Diagnostics for high current operation

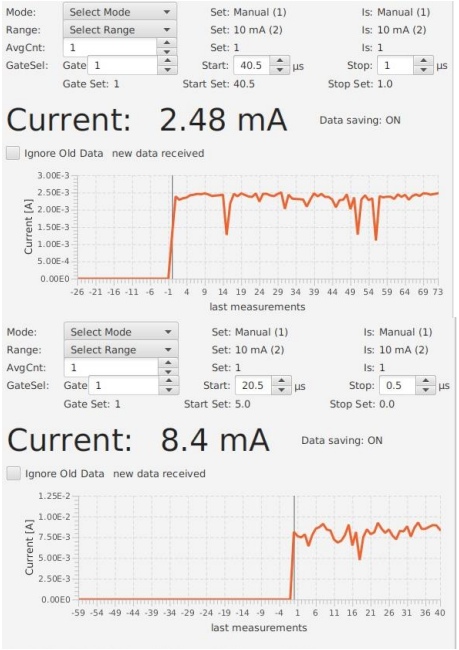
Intensity measurement

- Beam intensity measurements are performed by beam transformers since many years
- The observation of the pulse shape is needed to survey the stability of all devices during the beam pulse
- In order to handle intensity fluctuations the measurement of all transformers has to be performed in the same pulse along the whole accelerator



transfer channel

LEBT



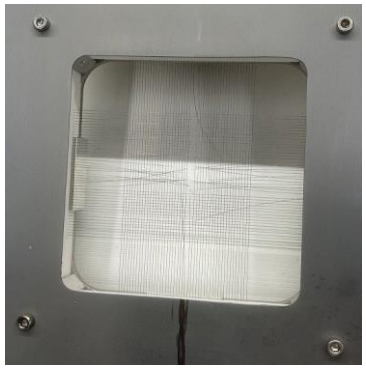
transmission control V.a (pulse shape)

transmission control V.b (trending)

Beam Diagnostics for high current operation

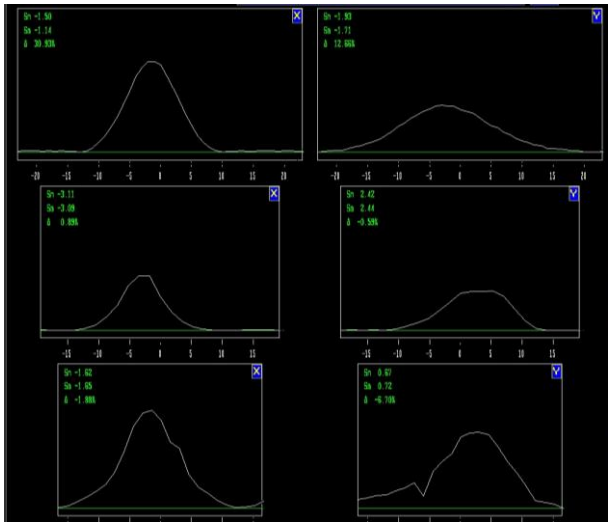
Beam profile and position measurement

- SEM grids are used at UNILAC widely
- An increased damage rate for SEM grids have been observed in the recent past, even so we have a protection system
- Reduced pulse duration and repetition rate can only be performed to a technical minimum
- The BIF (beam induced fluorescence) system has to be optimized to provide the same quality of the measurement data



SEM grid with defective wires

Uranium beam, intensity about 3mA

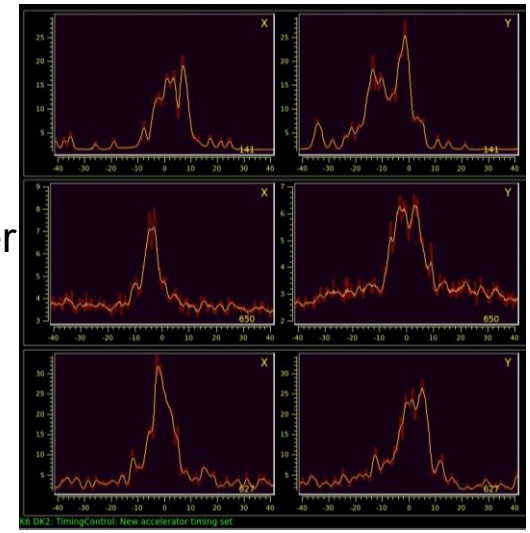


beam profiles (SEM grid)

transfer channel

poststriper entrance

HSI exit



beam profiles (BIF)

Conclusion

- The presented information covers only a small fraction of the effort (ongoing and to be organized) to fulfill all necessary tasks.
- Spare parts management is mandatory for operation reliability and challenging especially for special beam line installations and cavity built-in components.
- The proposed intensity upgrade at HSI covers the critical points based on operation experience. The planning process is ongoing but additional resources are needed (personnel and budget) to implement the improvements.
- The available non destructive beam diagnostic HW has to be updated and the software has to be transferred to the new control system and introduced into standard daily operation.

Recent UNILAC Upgrade Activities

HIAT 2022 | Darmstadt

Thank you for your attention!

Many thanks to all GSI colleagues, especially from the LINAC department, who provides efforts to the different activities in order to make UNILAC operation reliably and successfully.