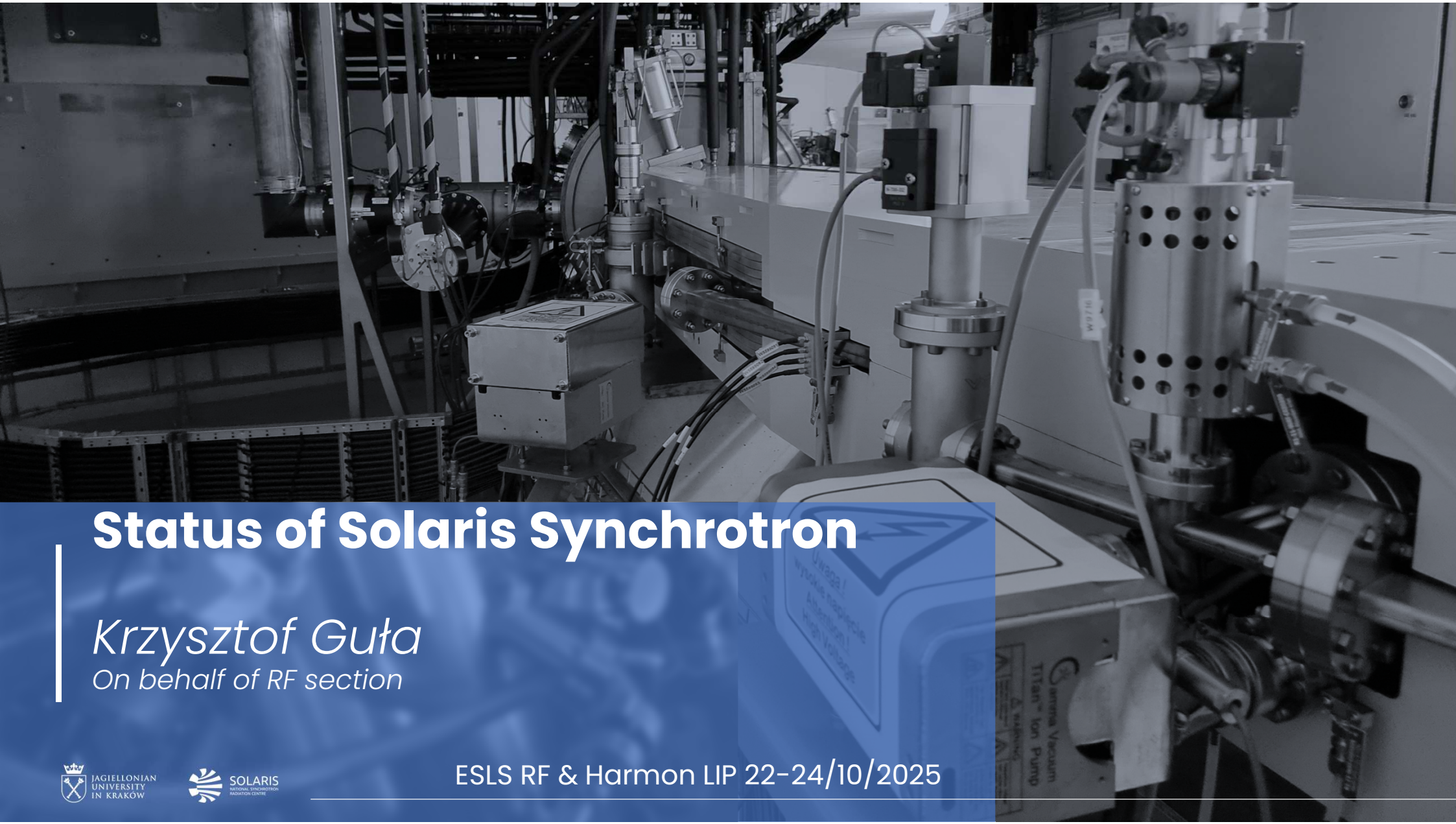


Status of Solaris Synchrotron

Krzysztof Guła
On behalf of RF section

JAGIELLONIAN UNIVERSITY IN KRAKÓW

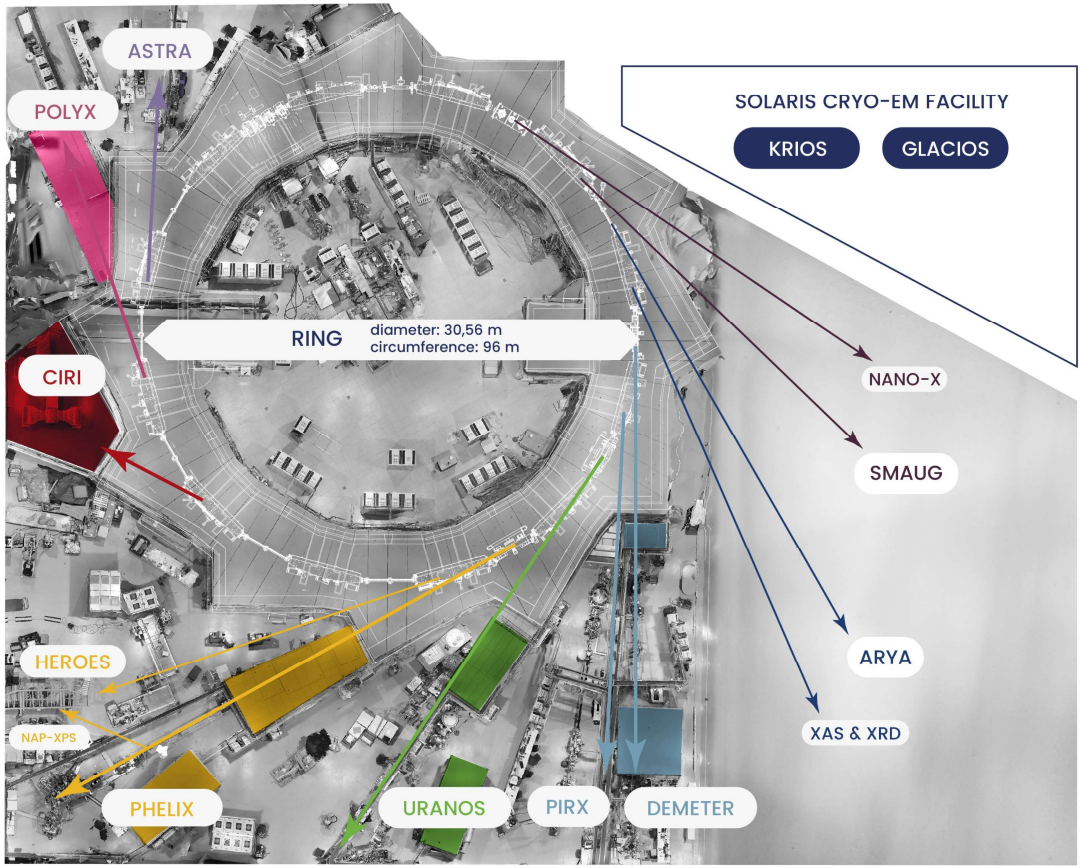
SOLARIS NATIONAL SYNCHROTRON RADIATION CENTRE

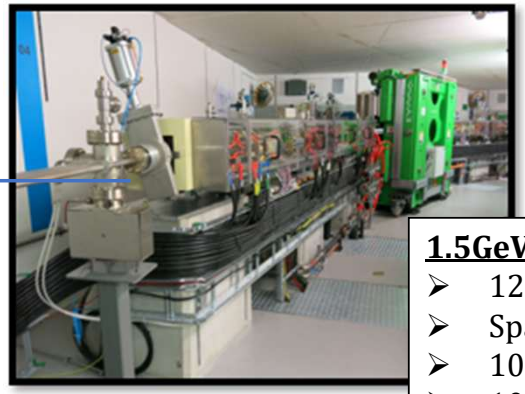
ESLS RF & Harmon LIP 22-24/10/2025

TIME LINE

- Accelerator overview
- RF components
- Failures
- Development
- Future
- Summary

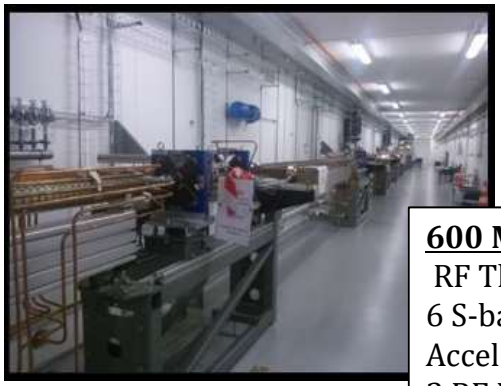
ACCELERATORS OVERVIEW





1.5GeV Storage ring

- 12 DBA Cells – 96 m circumference
- Space for ID's (10 sections) ~ 3.5 m
- 10 straight sections for IDs
- 100 MHz RF system
- 300 MHz Landau Cavities
- Injection dipole kicker
- Ramping
- In operation since May 2015



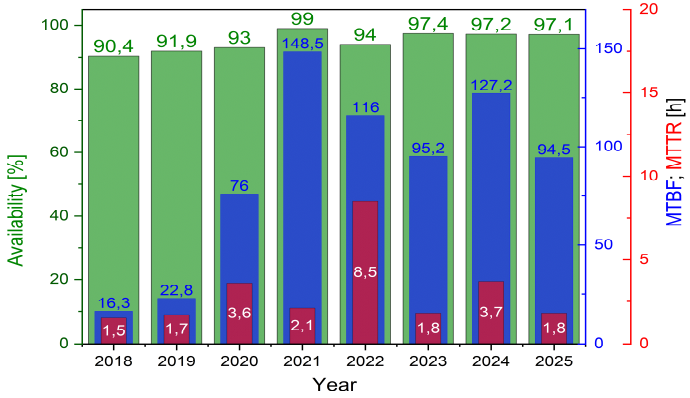
600 MeV Linac

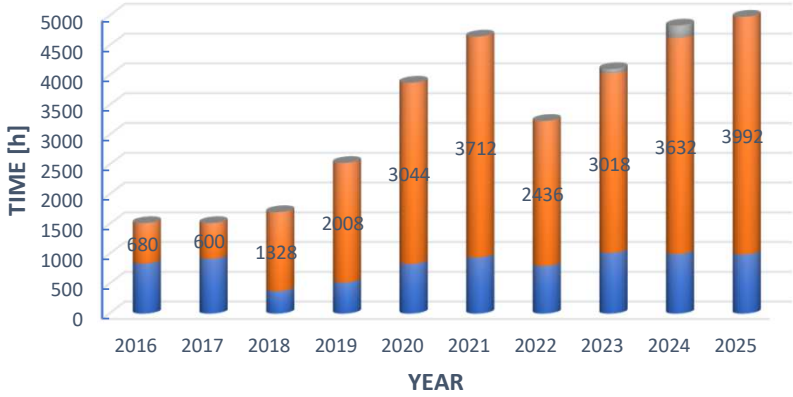
RF Thermionic Gun
6 S-band 2998.5 MHz acc. structures
Accelerating gradient 20 MeV/m
3 RF Units & SLED cavities
Dog-leg vertical transfer line
In operation since Dec. 2014

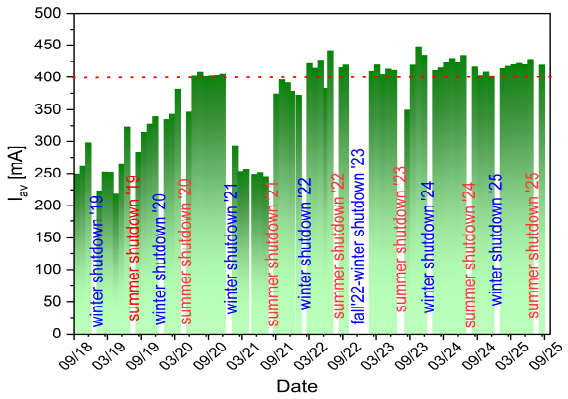
Operation info

STANDRAD OPERATION 24/7 since 2025r.

- 2 shifts (8:00-16:00; 14:00-22:00),
- Mondays (from 8:00 am) for machine studies, developments and maintenance
- Tue-Mon (until 8:00 am) –User Operation
- On-call duties 22:00-2:00
- Operation in decay mode, full filling pattern
- 2 injections/day



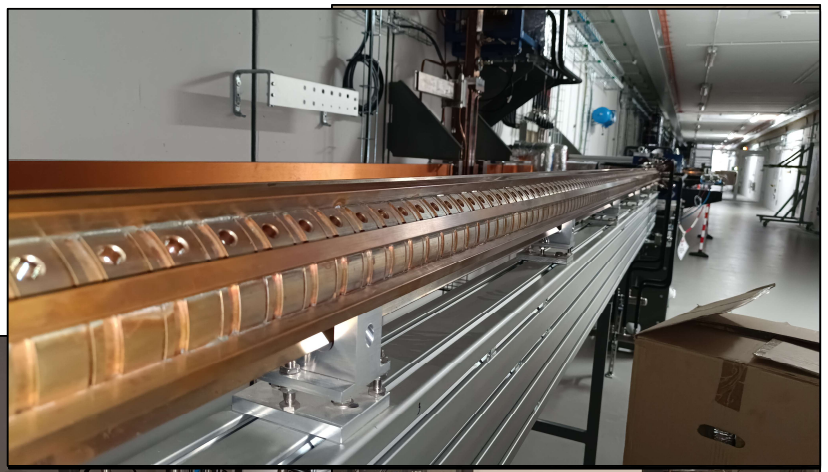




RF COMPONENTS

Linear accelerator

- 3GHz CW generator
- Phase shifters
- Thermionic Electron Gun
- Pulsed pre-amplifire
- Klystron Thales with modulator (for GUN)
- Chopper 100MHz
- SLEDs, Waveguides, etc.
- Accelerating structures

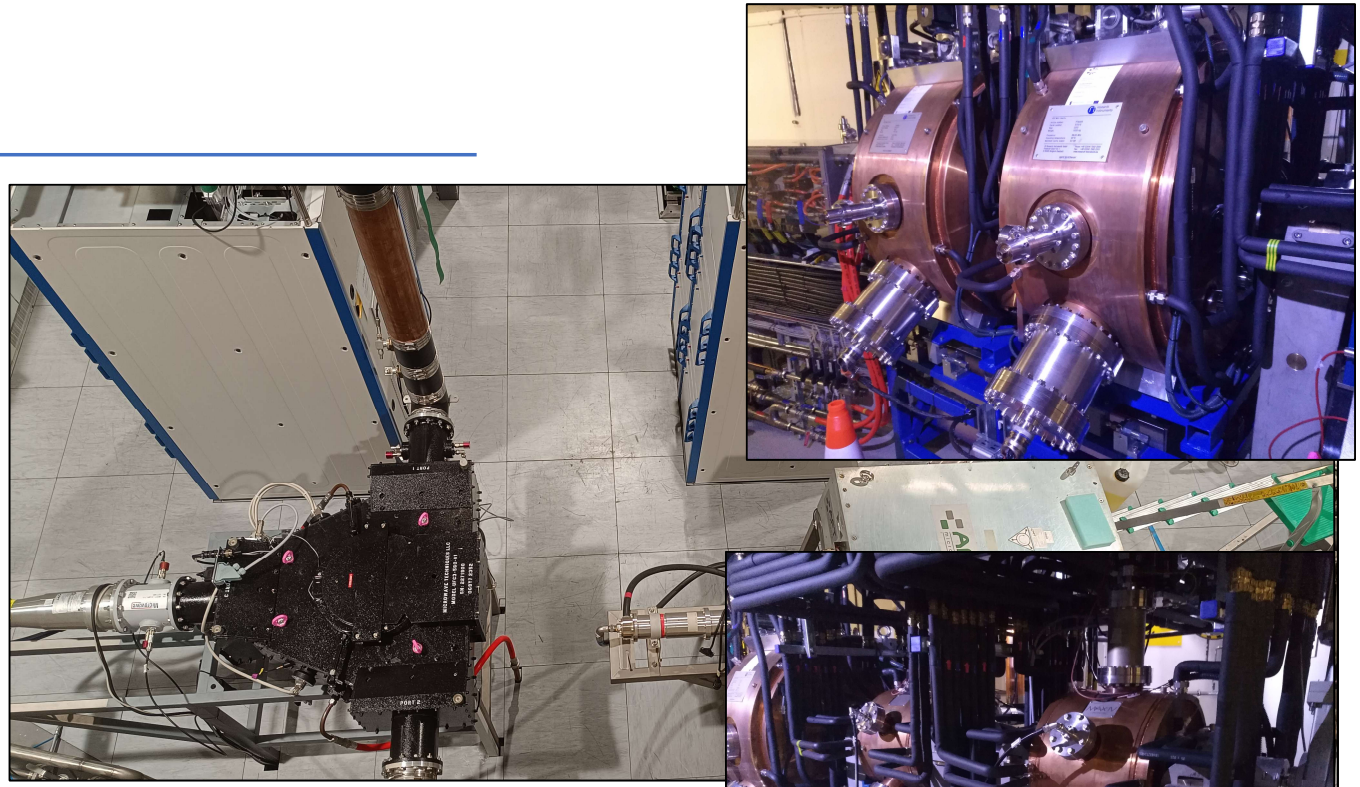


5 cavities

RF COMPONENTS

Storage Ring

- LLRF
- Transmitters
- Circulators
- Main Cavities
- Harmonic Cavities with plungers

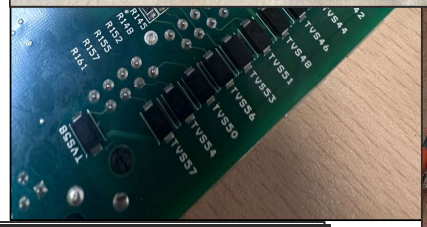


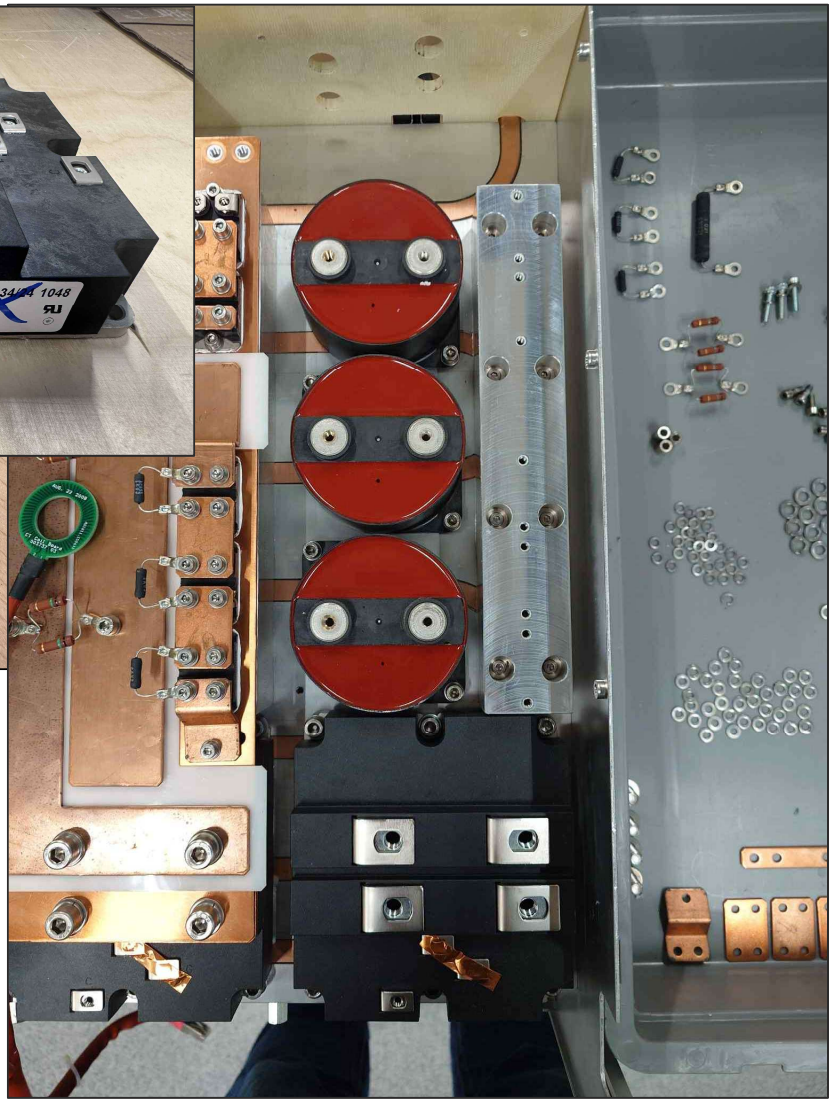
Pwr. w/o beam: 30kW

FAILURES

Linear accelerator

- Klystron
- HPSU
- HVPS
- Tank Control Unit
- RF Chopper





FAILURES

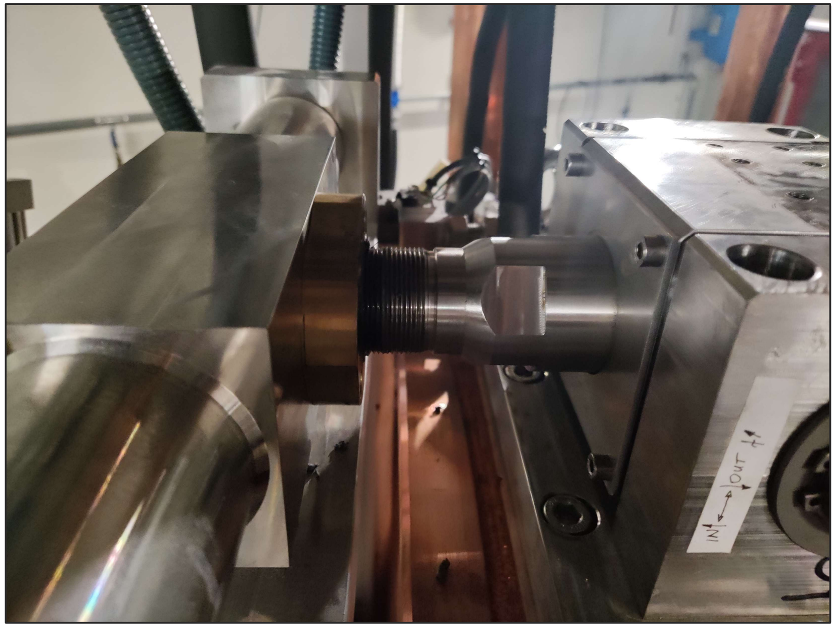
Storage Ring

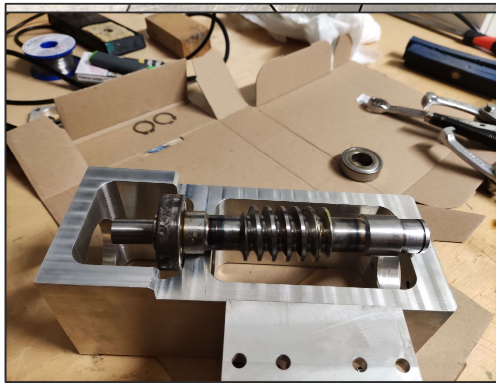
- Cicrulators
- Transmitter amplifire modules
- Main cavity motor gear
- Spare LLRF – NUTAQ unit

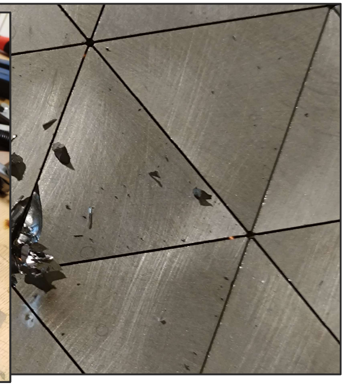
Some time ago, arcing occurred in the AFT circulator. Internal inspection revealed [illegible] AC load ferrites and many particles around them. We sent it to AFT for repair and decided to order a new one. The tender was indirectly won by Microwave Techniques from the USA, but there were also problems with the new one. We are currently operating with 1 AFT circulator and 1 MT circulator, however, both AFT circulators have damaged ferrite material.

Some [illegible] amplifier modules are damaged [illegible] power supplies [illegible] the cause of power supply failures (1 small capacitor in the converter), and we now repair the power supplies at minimal cost.

Two years ago, one resonant cavity was found to be untunable. Detailed inspection revealed that the drive mechanism (fine-pitch screw) had seized. A complete overhaul of all drive mechanisms was performed, and proper lubrication procedures have been implemented since.





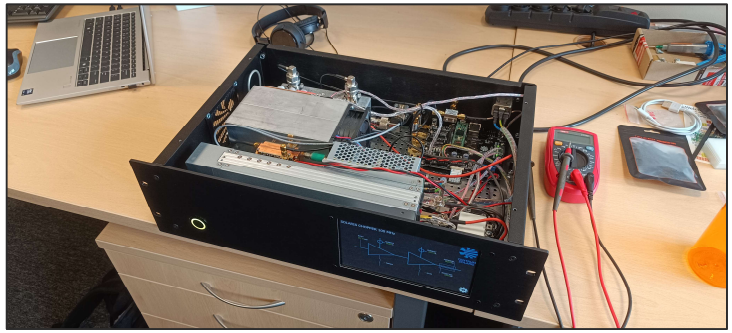


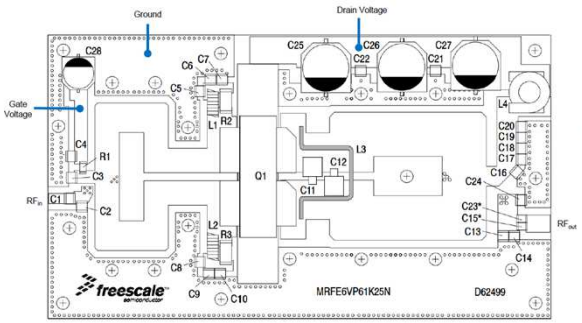
DEVELOPMENT

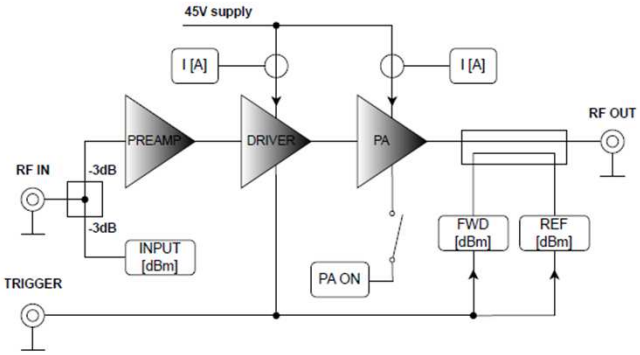
Linear accelerator

RF Chopper

Pulsed power Amplifire 100MHz – 1kW.
Due to a failure of the operational amplifier (chopper), despite quick repair, the decision was made to build a new one based on an in-house design, using key components
NXP MRFE6VP61K25N
such as LDMOS power transistors compatible with other equipment. This will ensure standardization of spare parts inventory, and given the significant cost of transistors, building a new amplifier is also economically justified.
The project is almost finished, and detailed documentation will be provided after completion.





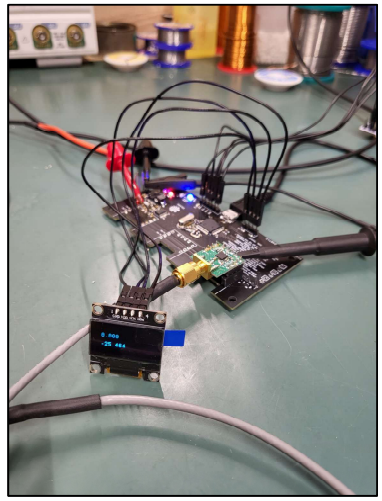


DEVELOPMENT

Linear accelerator

Pulsed Power Measurement

Pulsed Power Measurement Device for preamplifiers at Modulators. The goal of this project is to obtain accurate RF power values feeding the modulators. Due to the pulsed nature of the signal, the existing measurement in the preamplifiers themselves is neither stable nor accurate. Precise measurement of the power incident on the klystrons will allow for accurate drive control, which will affect their lifespan. The prototype has been completed and installed. It operates correctly. Work on the final version is 90% complete.

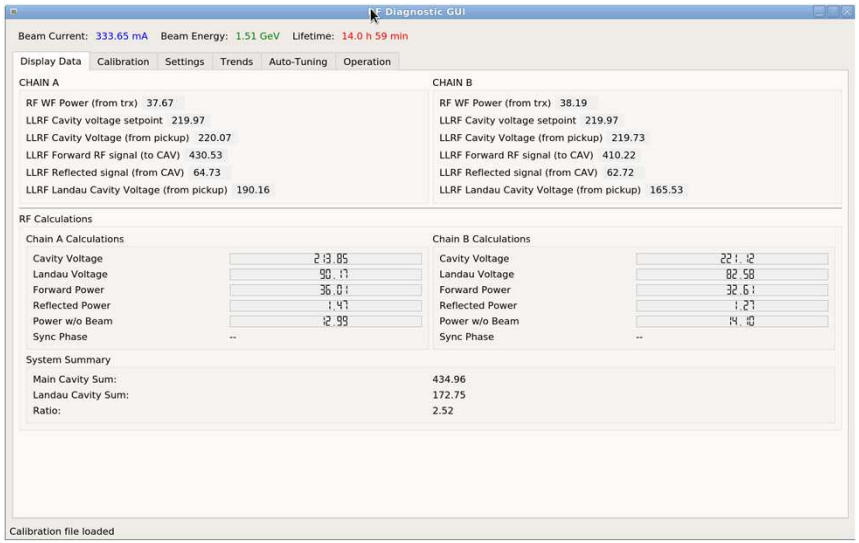


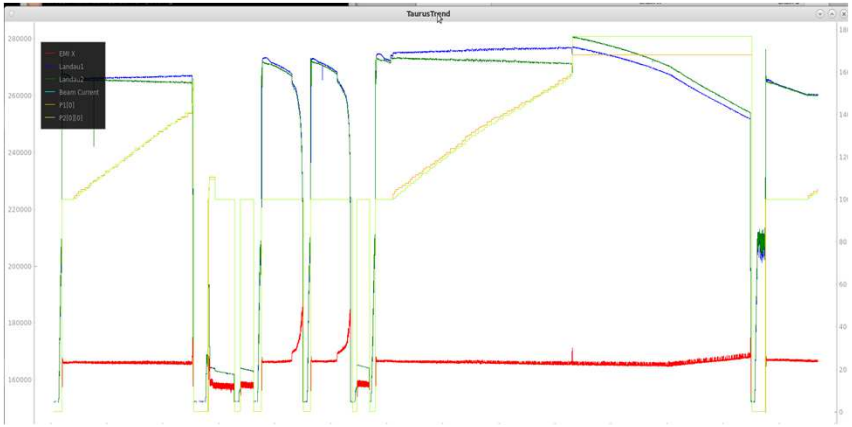
DEVELOPMENT

Storage Ring

Tunning application

RF Diagnostic GUI
An in-house RF section development for real-time RF parameter calculation and visualization, resonant cavity calibration assistance, key signal archiving via trend logging, and critically, automatic harmonic cavity tuning during operations to maintain constant emittance with stable cavity fields. Testing is complete, with implemented modifications providing dynamic response to beam instabilities. The system is operationally deployed with the baseline version considered complete; however, given its open architecture, ongoing development will continue (e.g., mini operator GUI, machine learning integration, etc.).



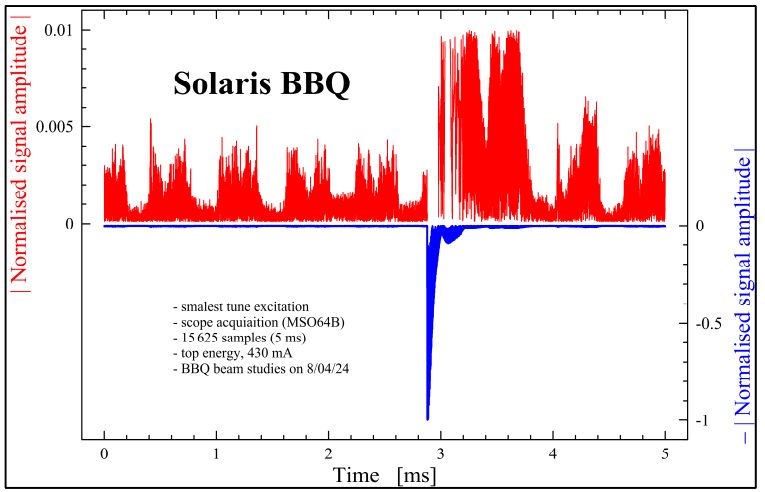


DEVELOPMENT

Storage Ring

BBQ Tune Measurement

BBQ – Tune Measurement – This project was developed as a modernized continuation of the synchrotron tune measurement system, with no impact on the beam. It was realized in collaboration with Marek Gasior from CERN. The project was successfully completed; however, due to the implementation of BBB Feedback, which uses the same stripline, it is currently not in use, and tune measurement is provided by BBB FB. Nevertheless, the project resulted in continued collaboration with CERN in the construction of a short diagnostic beamline for testing BPMs for CERN's needs.

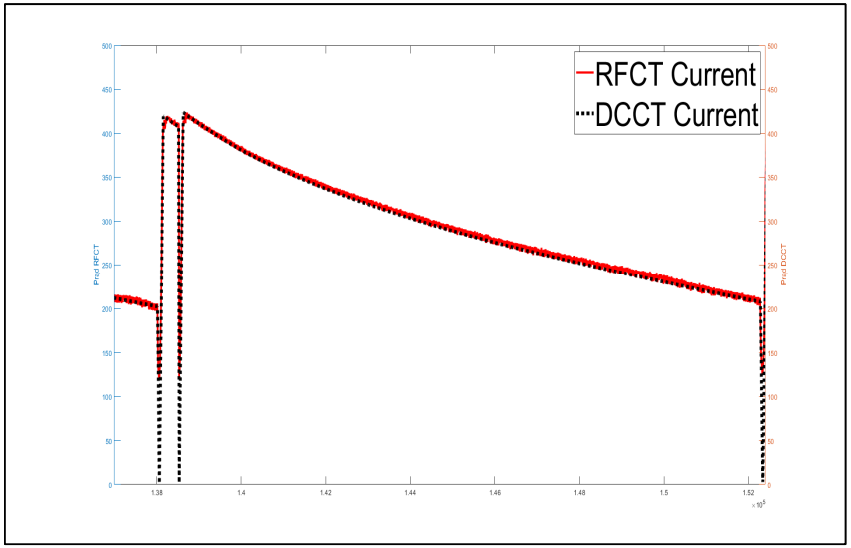


DEVELOPMENT

Storage Ring

RFCT

RFCT (RF Current Transformer) – an in-house project initiated by an intern from the diagnostics and electronics section in collaboration with the RF section. The project is completed but still in the testing phase due to unstable behavior during injection and consequently unrepresentative results. Under stable conditions, after beam ramping, it operates correctly.

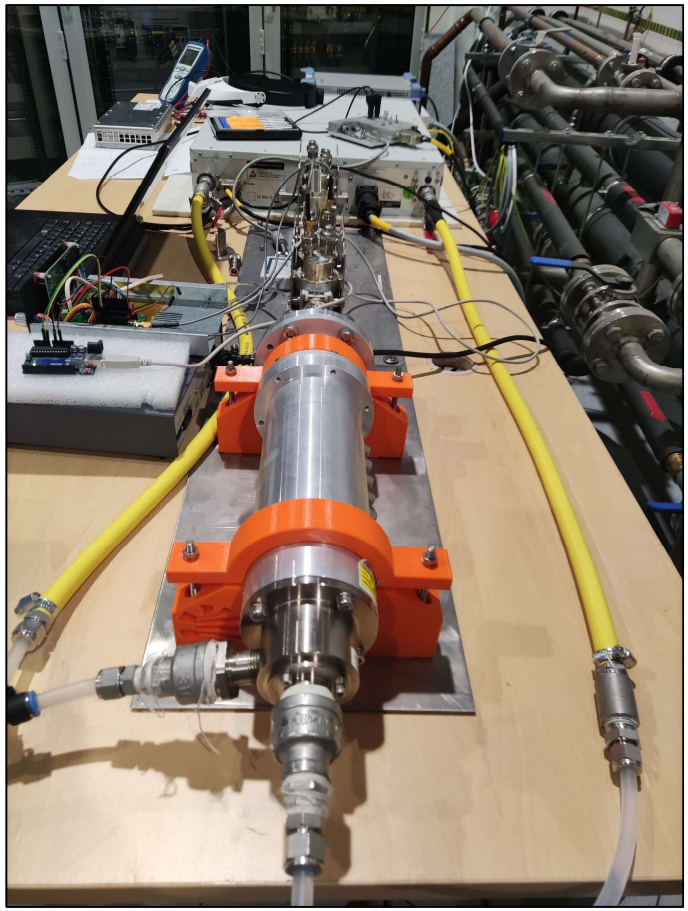


Compare DCCT and RFCT beam current

DEVELOPMENT

Storage Ring

Transmitter Cassette Repair Station.
A dedicated facility for repairing R&S PA cassettes, coupled with service training, enables in-house repair of damaged modules.



DEVELOPMENT

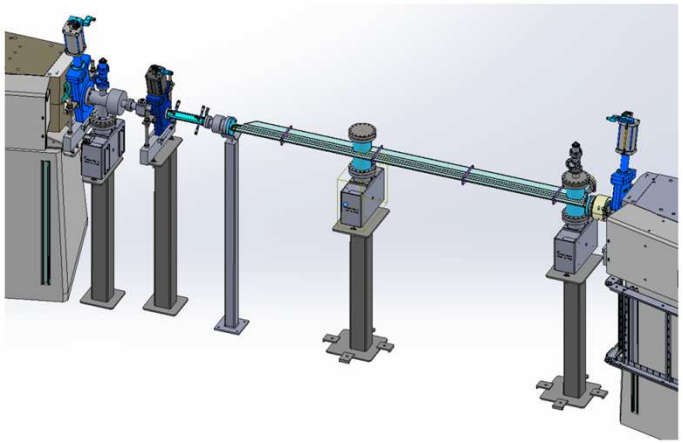
RF Laboratory

We are in the process of building an advanced RF laboratory that will include the same components as those operating in the synchrotron: LLRF with peripherals, 30kW transmitter, circulator, 100MHz resonant cavity, and cooling system. The components used will also serve as backup for those operating in the storage ring.
Project completion (cavity delivery) is planned for the end of 2026.

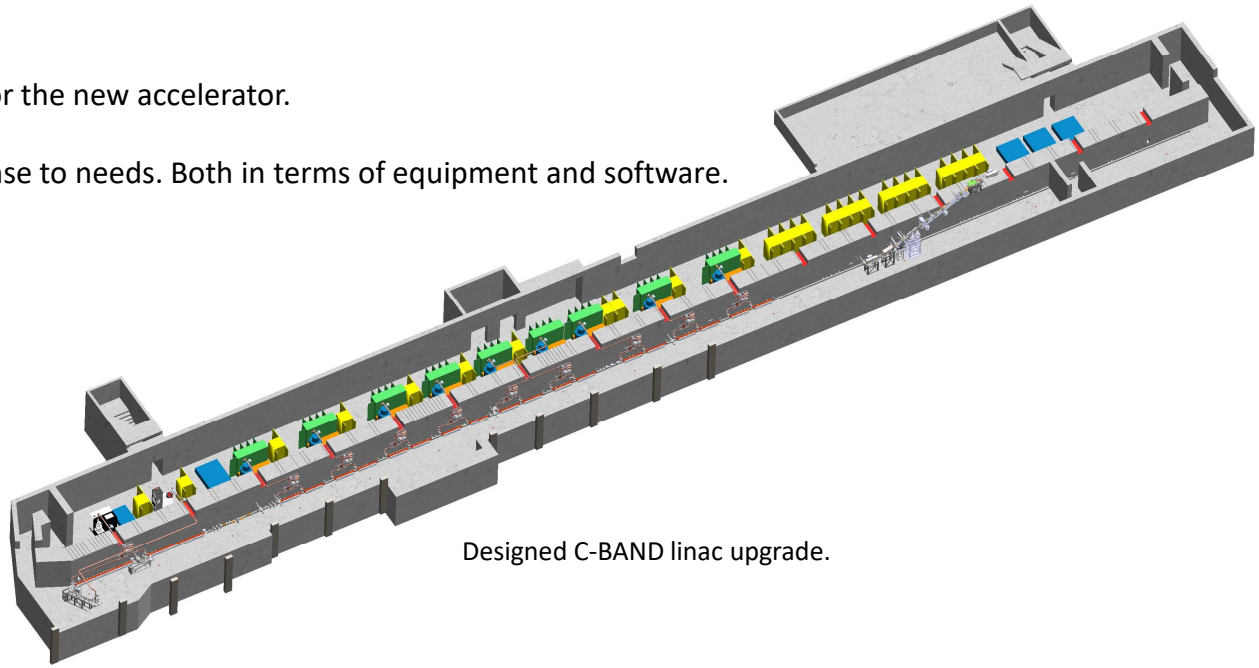
FUTURE

Development

1. RF Laboratory – continuation
2. Linac 2.0. Linac upgrade and expantion project.
3. Design and construction of a new LLRF system.
4. Construction of electron gun (possibly 1 accelerating structure) for the new accelerator.
5. Construction of a straight section in collaboration with CERN.
6. Other minor projects resulting from ongoing activities and response to needs. Both in terms of equipment and software.



Designed straight section for CERN and new stripline



Designed C-BAND linac upgrade.

SUMMARY

- We are still a learning team gaining experience, but
- We can diagnose and repair most of failures in-house
- We execute ambitious projects
- Three of us also operate the synchrotron

RF Team (from left):
Mateusz Szczepaniak – young enineer
Janusz Tylec - a new RF technician (since September 2025)
STEFAN
Grzegorz Cioś – RF specialist
Krzysztof Guła – head of RF group
Lucjan Niewiedział – RF specialist

THANK YOU FOR YOUR ATTENTION