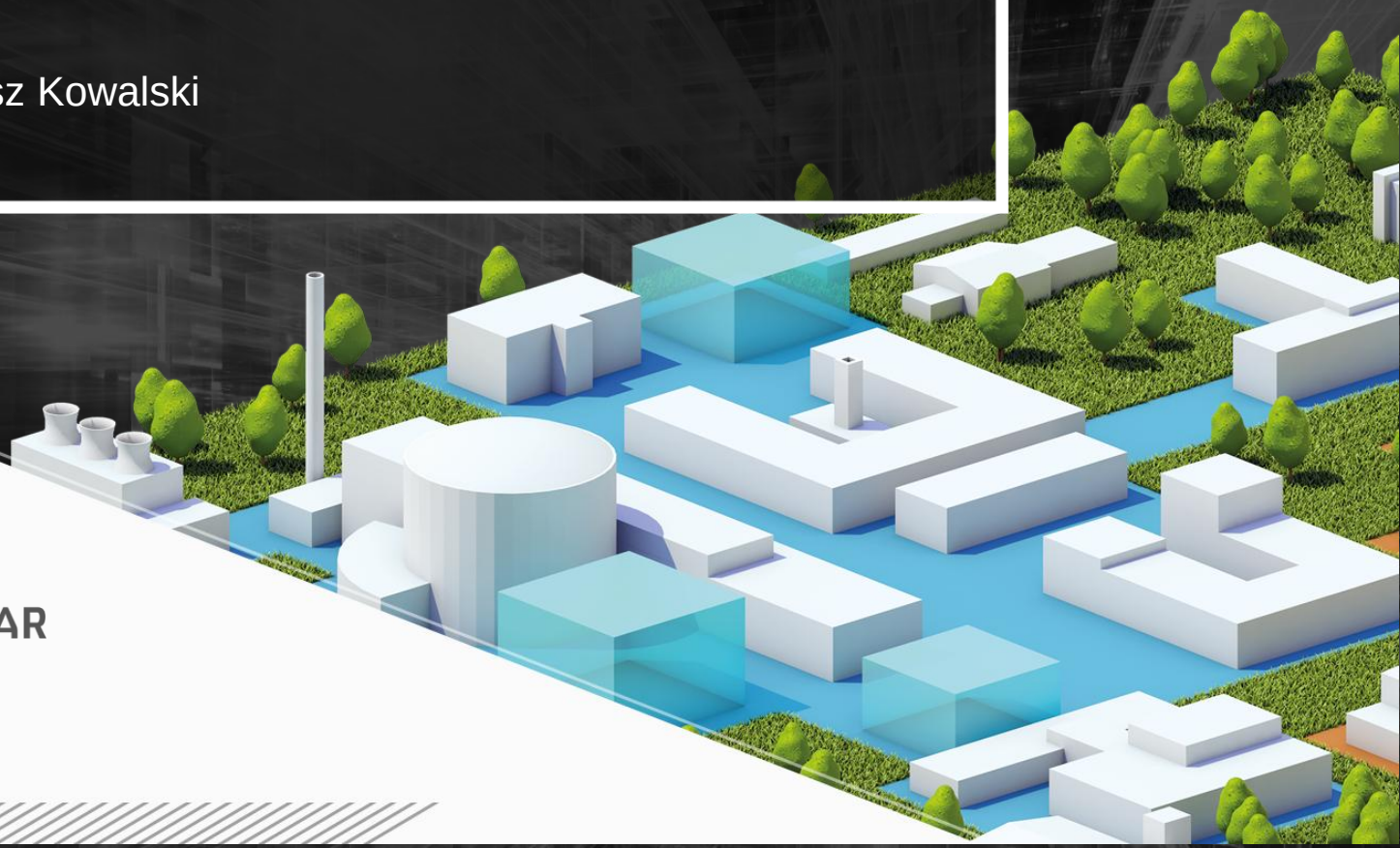
PEG Contribution to ESS

Tomasz Kowalski



NATIONAL CENTRE FOR NUCLEAR RESEARCH ŚWIERK

Agenda

- **Highlights of our contribution to ESS**
- Our experience in related areas
- Possible areas in ESS where we could contribute

ESS – European Spallation Source

- International agreement for the provision of goods and services for ESS as part of the Polish in-kind contribution
- Scope of delivery: 80 LLRF systems for M-Beta (36) and H-Beta (44) sections along with auxillary components, testing, installation
- Project implementation period: **1.10.2016 – 31.07.2025**
- Project budget: **4877 kEuro**
- Agreement carried out as PEG consortium (Polish Electronic Group):
  - NCBJ (consortium leader)
  - Warsaw University of Technology
  - Łódź University of Technology

Overview of Components Delivered by PEG – from Table 2 of AIK

No	Components/Services	Type	Total Number of Components (M-Beta/H-Beta)	Responsible Side
8	AMC: RTM Carrier	Hardware	150 (45/105)	Partner
9	RTM: LO Generation	Hardware	30 (9/21)	Partner
10	Piezo Driver	Hardware	120 (36/84)	Partner
11	Inner Rack Cabling	Hardware	All related to above and between Patch Panel and Split Box	Partner
12	Preparation of Test Facility (including cavity simulator)	N/A	4	Partner
14	Software suite for Testing and Commissioning	Software	N/A	Partner
		Firmware	N/A	Partner
15	System Testing and Assembly	N/A	N/A	Partner
16	System Installation at ESS ERIC site	N/A	N/A	ESS ERIC/Partner
21	Electronic Pick-up Units	Hardware	118	Partner
23	External Piezo Power Supplies	Hardware	120	Partner
25	RF Split Box Units	Hardware	131 (55 @ 352 MHz + 86 @ 704 MHz)	Partner
27	PIN Diode Units	Hardware	125	Partner
30	PSS Switch	Hardware	125	Partner
32	Patch Panel	Hardware	131	Partner
33	Initial Firmware and Software Development [Spec FW]	FW / SW	N/A	Partner
34	Cavity Simulator	Hardware	4 (1 for ESS / 3 for Partner)	Partner

Collective

NCBJ

WuT

LuT

RTM Carrier Board

Low Cost AMC board for LO RTM and Piezo RTM

MTCA.4 support:

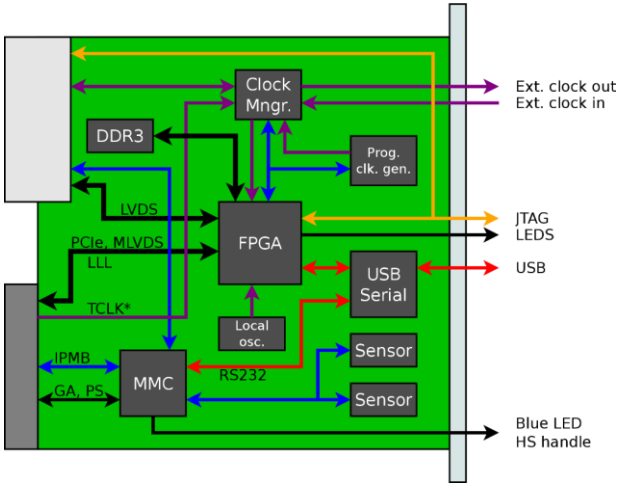
- Zone 3 (RTM) support compatible with DESY D1.0 recommendation (96 LVDS lines, no gigabit transceivers)
- MMC (IPMI) support (mandatory LEDs, Hot-Swap handle, sensors)
- PCI Express support on AMC ports 4-7
- MLVDS clock and trigger lines on AMC ports 17-20
- Low latency links on AMC ports 12-15 (optional, if PCI Express is x1 or x2)

FPGA:

- Artix-7 device (Latest family, Low cost)
- Package: FFG484/FBG484
- Available user pins: 250/285
- Available gigabit transceivers: 4

Communication:

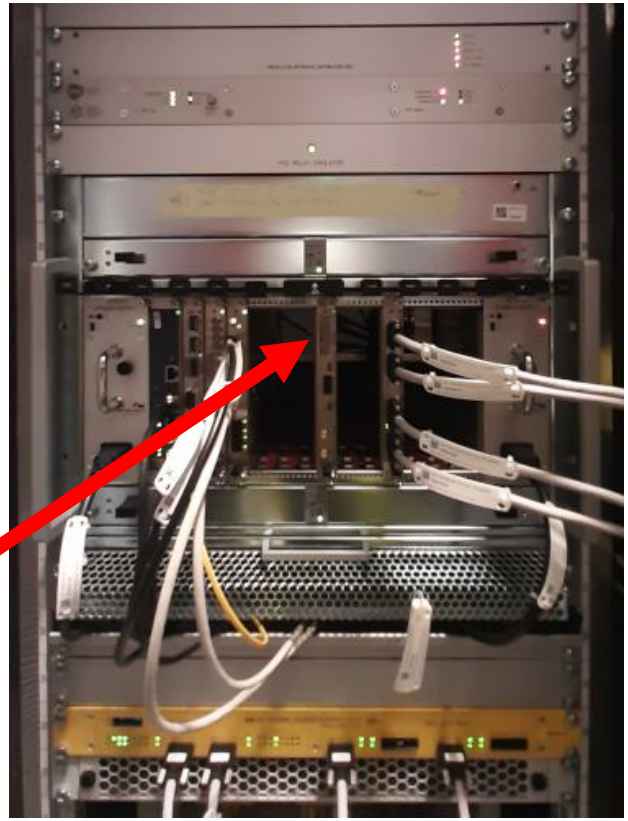
- PCI Express x2
- I2C (MMC, IPMI, debug)
- USB-Serial (debug)
- Low latency links on AMC ports 12-15



RTM Carrier Board

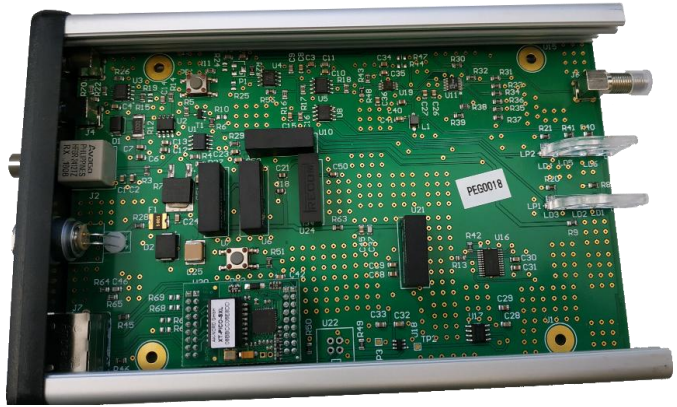
Low Cost AMC board for LO RTM and Piezo RTM

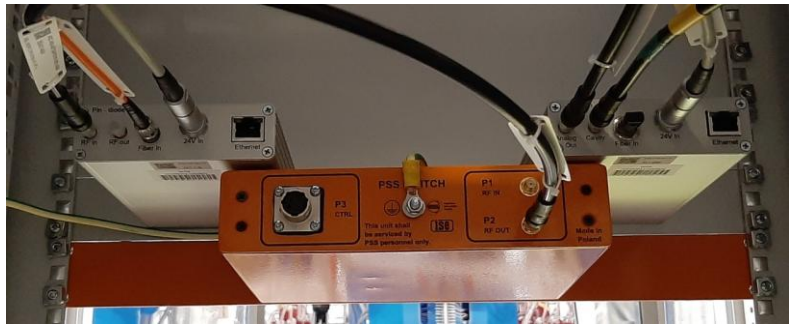
- Design
- Production
- Testing + reference firmware + test report
- Installation
- **150 units** to ESS
  - **45 units** for M-Beta
  - **105 units** for H-Beta



Electron Pickup

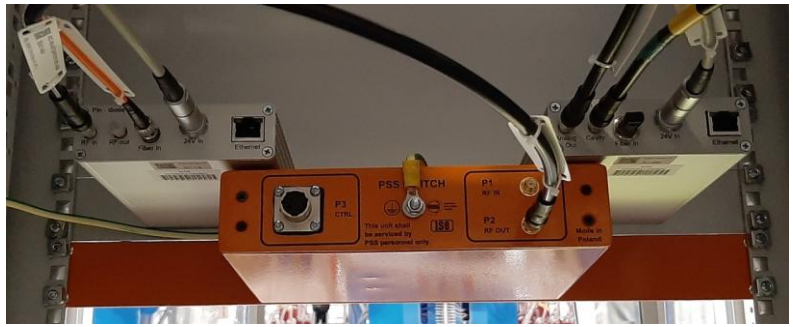
- **Electron Pickup** collects the electrons coming from the multipacting phenomenon and triggers MPS event
- Production
- Testing + test report
- Installation
- **118 devices** have been delivered and installed





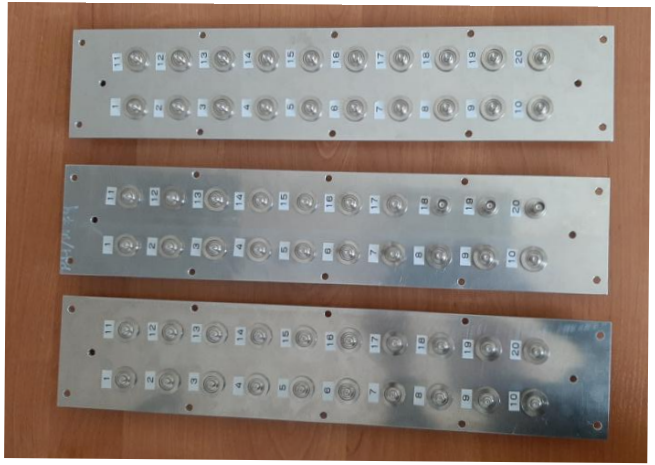
PIN-Diode

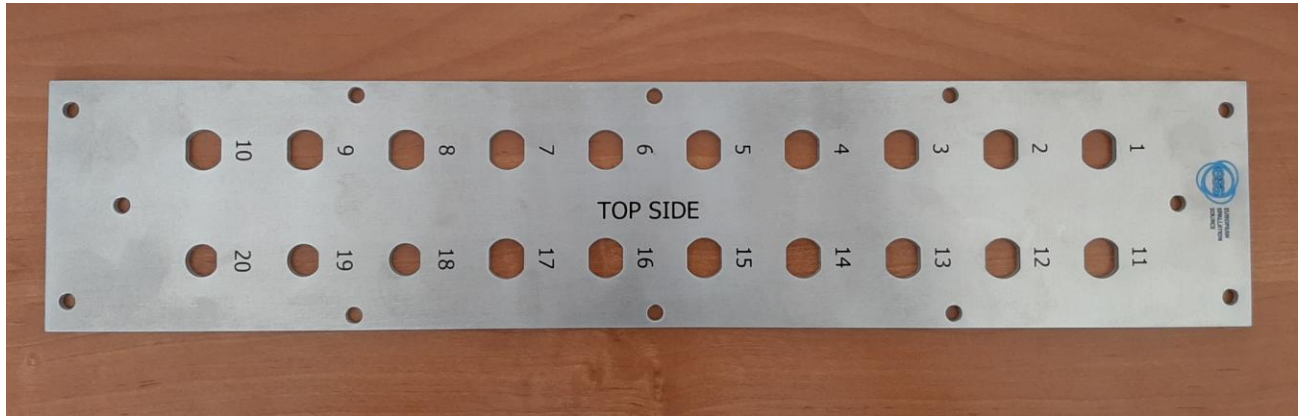
- **PIN-Diode** – Fast RF gate used to block LLRF output to the high power amplifier in case of MPS event
- Production
- Testing + test report
- Installation
- **125 devices** have been delivered and installed

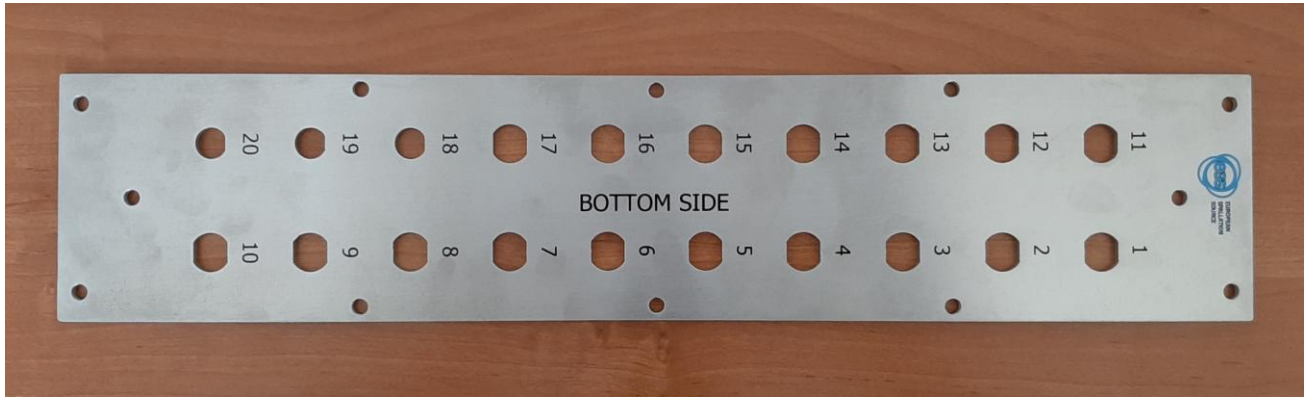


RF Patch Panels

- Provides connectivity for the RF Cables on the top of the racks
- Manufactured in-house
- **Total of 131** patch-panels delivered

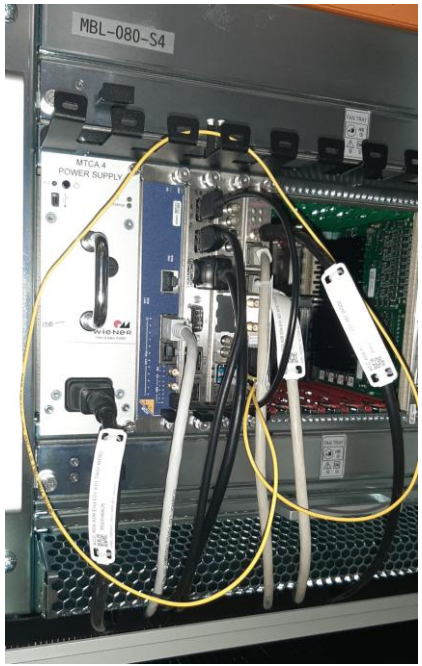


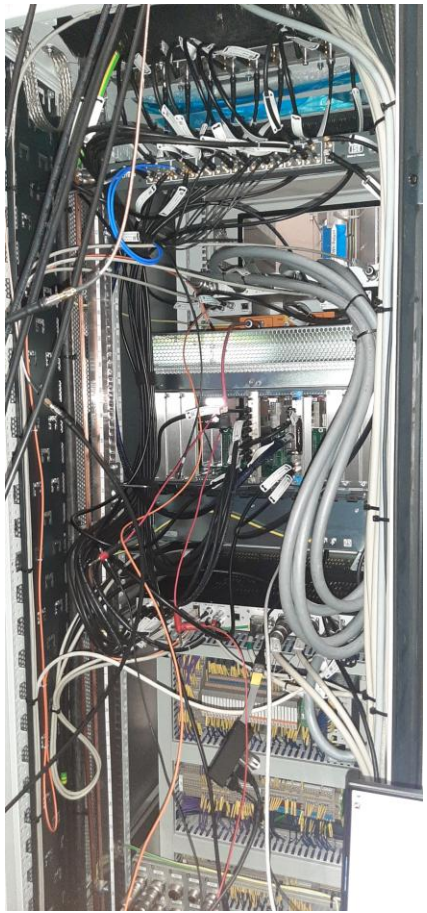




Inner rack cabling

- Procurment and installation of inner-rack cables according to plan from WuT



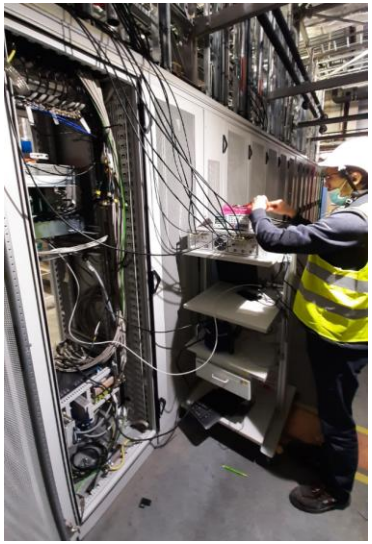


Cable type	Amount
LMR240-390	500
LMR240-350	100
LMR240-700	80
LMR240-1100	150
LMR240-1550	150
LMR240-1600	60
LMR240-1700	60
LMR240-1800	60
LMR240-1900	20
LMR240-390-PS	150

LLRF Systems Installation

- 6 weeks over 5 visits
- All 36 M-Beta system have been installed
- All 44 H-Beta system have been installed
- A dedicated mobile test stand with the cavity symulator has been developed
- Test reports for each systems
- Many thanks to Anders Svensson and Linus Ternelius Svensson



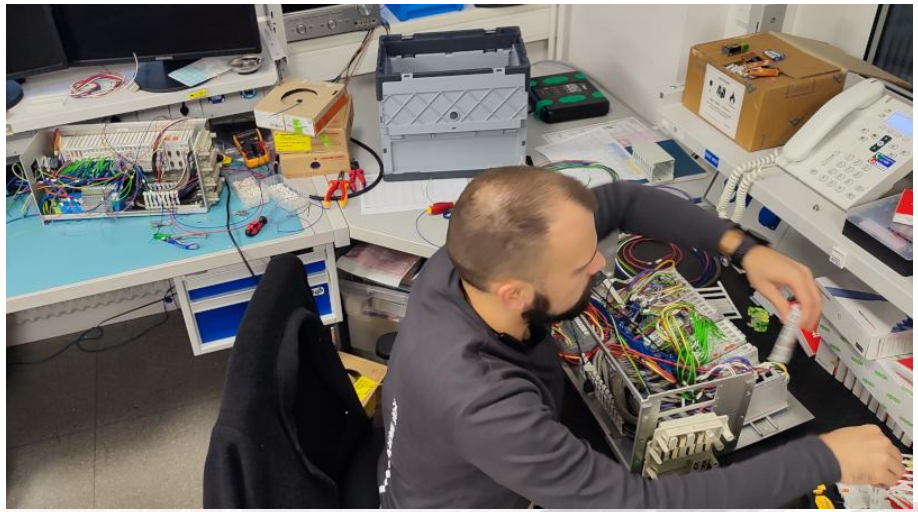



Agenda

- Highlights of our contribution to ESS
- **Our experience in related areas**
- Possible areas in ESS where we could contribute

Cooperation with X-FEL GmbH

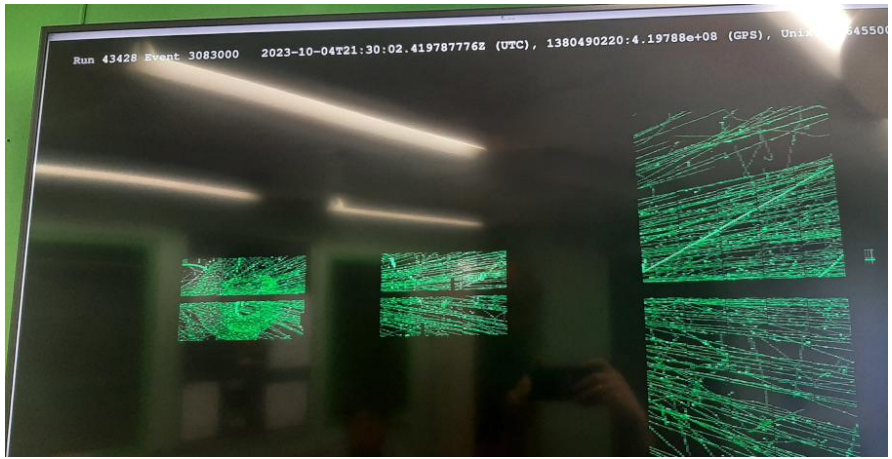
- We cooperate with X-FEL GMBH since 2015, since we finished our contracts with DESY for X-FEL construction and developent phase
- We asseble, test, deliver and maintain Beckhoff based PLC devices
- It started as an in-kind contribution, but it was so succesful, that X-FEL continued placing commercial contracts
- All-togther we have delivered over **500 units**, and continously we provide technical support for those systems on-site in Hamburg.
- **These systems support all X-FEL experimantal stations: MID, HED, SPB, FXE, SQS, SCS**

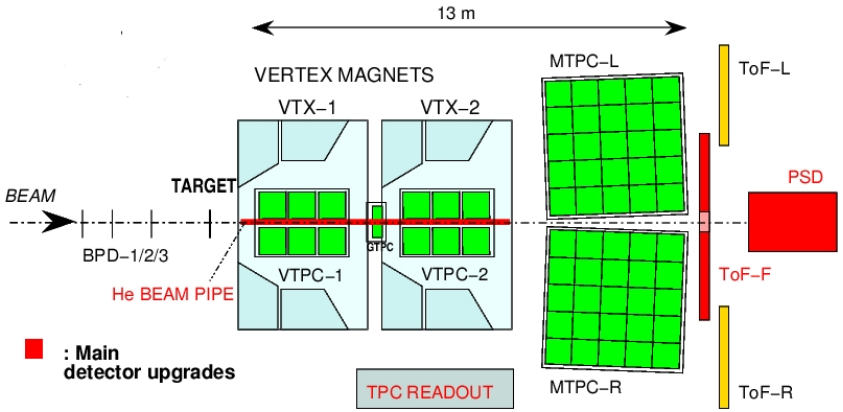


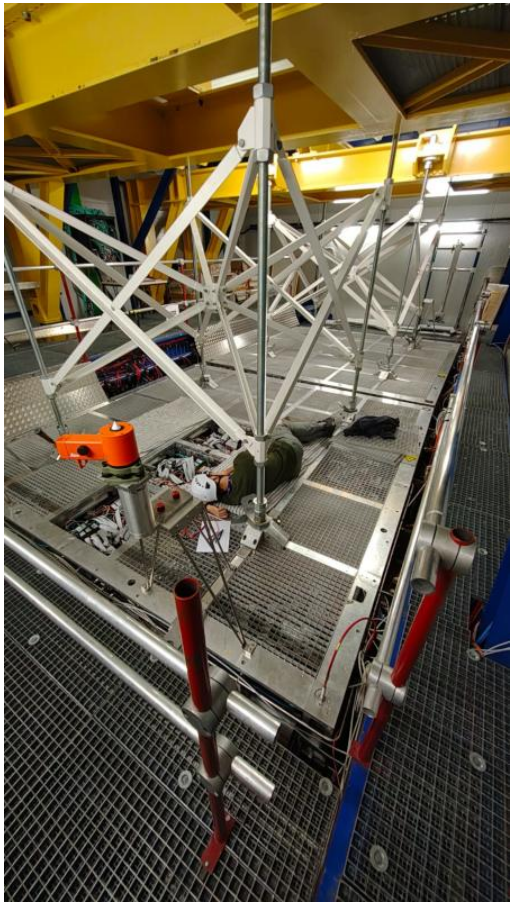
Participation in NA61/Shine at CERN

Expert support for various subsystems of the experiment

- Trigger system
- Data acquisition system
- Electronic readout (DRS)
- Time-projection chambers (TPC)
- Projectile Spectator Detector (PSD)
- Monte Carlo simulations

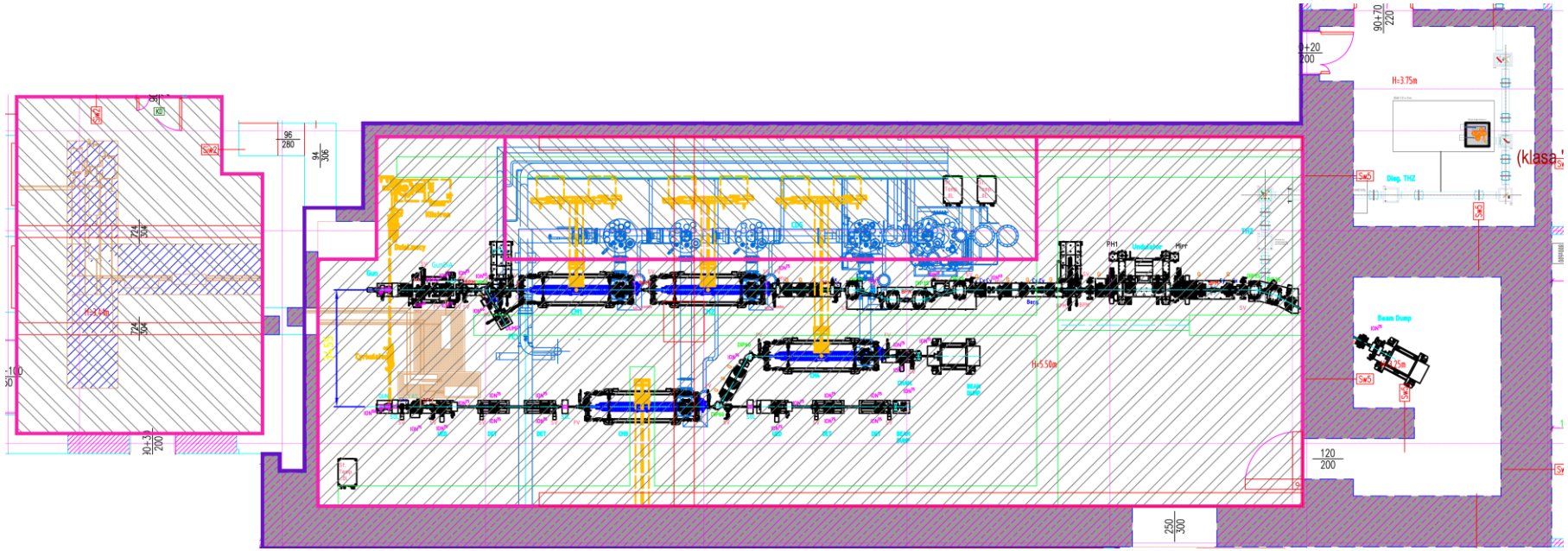






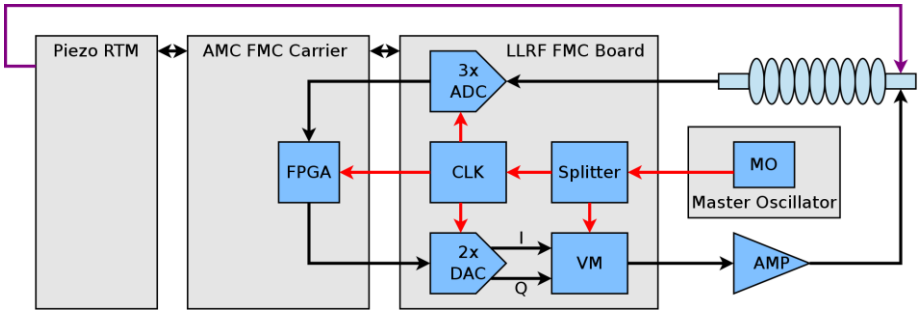
NCBJ is building a new research facillity based on linear superconducting electron accelerators including a superconducting electron gun

- Free Electron Laser
- Ultrafast Electron Diffractometry

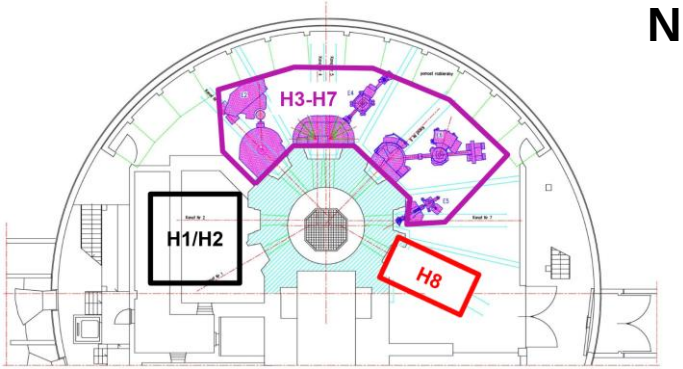


Development of custom electronics tailored for PolFEL accelerators

- Custom LLRF(hardware and fpga programming)
- Custom Control system software development
- Custom Radiation monitoring system hardware and software
- Various PLC based systems



Maria Nuclear Reactor



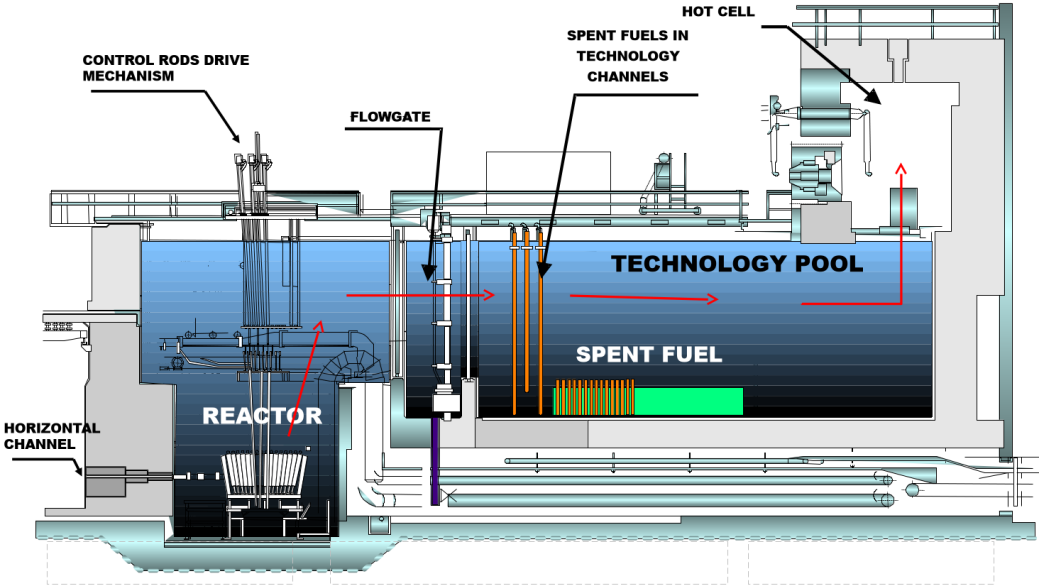
NCBJ has a scientific nuclear reactor Maria on site.

Major reaserach areas:

Medical: BNCT, radioisotopes
Nuclear: fuel, materials, shieldings
Dosimetry: n-g radiation, high doses
Physics: radiography, neutrons

Paramerers:

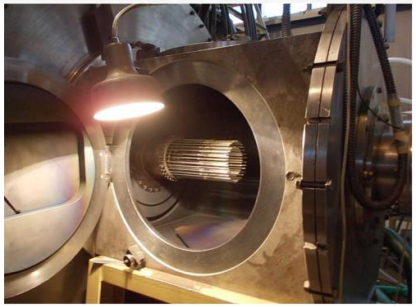
Thermal neutrons: **$4x10^{14}$ cm^{-2} s^{-1}**
Fast neutrons **$3x10^{13}$ cm^{-2} s^{-1}**
14 MeV neutrons: **$5x10^{9}$ cm^{-2} s^{-1}**
Radioisotopes: **600 TBq/y**
Mo-99: **6000 TBq/y**

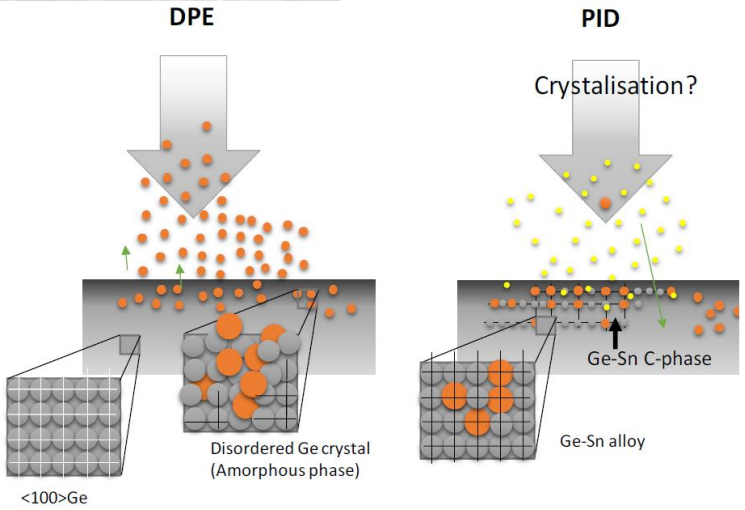


Material synthesis and characterization

Synthesis methods:

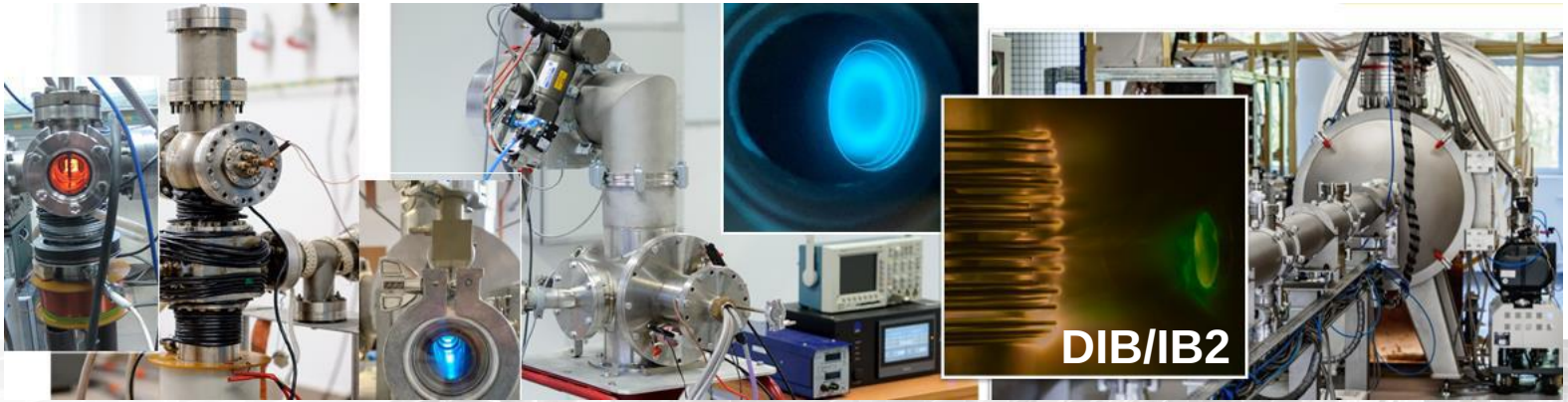
- Magnetron Sputtering (Including Pulse and Annealing modes)
- Arc Synthesis Technique Instruments
- High-Energy Plasma Beams (RPI – IBIS)





Possible Scientific collaboration with ESS:

- Analysis of the cluster formation (size and density)
- Detection of local changes in lattice parameters and strain gradients
- Cracks, porosity, and nonlinear damage distributions (defect mobility)
- Identification of local phase changes: amorphization, precipitates, and lattice reconstruction



Possible areas in ESS where we could contribute

- Maintnace and support of existing LLRF installation
- Delivery and installation of further High-B systems
- LLRF upgrade (hardware/firmware/software)
- FPGA programming
- Programming of control system components
- PLC devices (programming/assemby/testing)
- Other assembly/cabling/installation work
- Scientific cooperation in the area of neutron science

Thank you for attention!