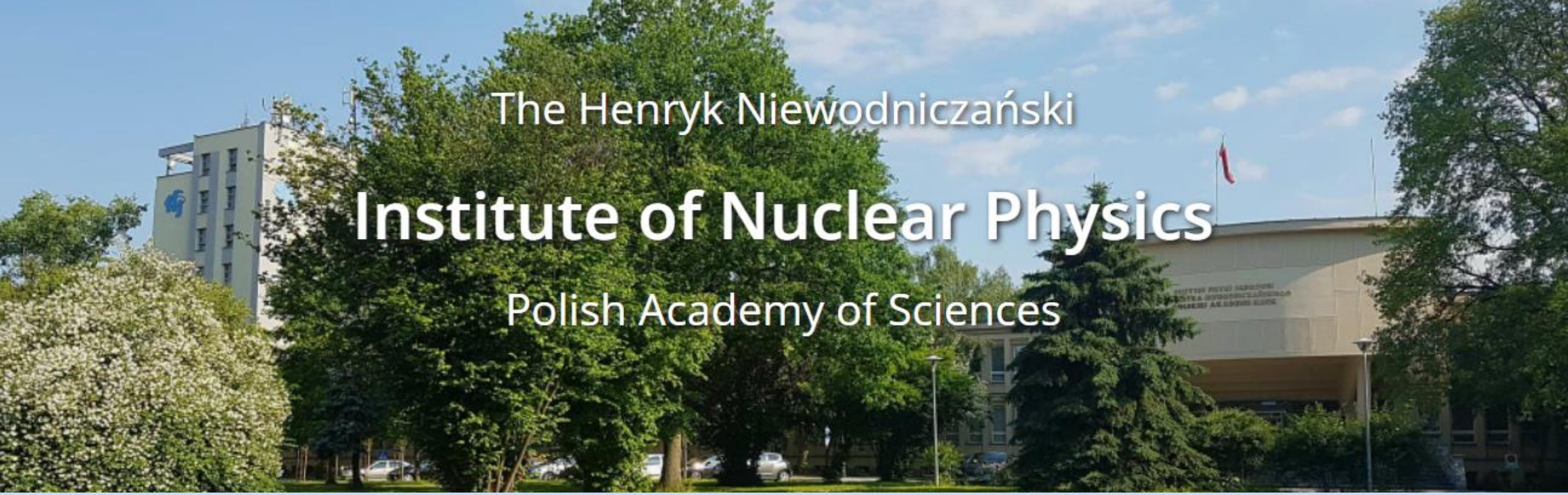


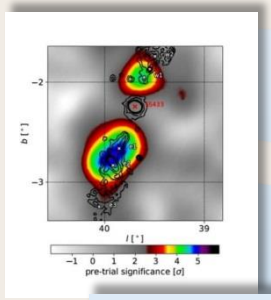
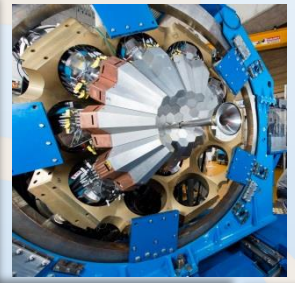
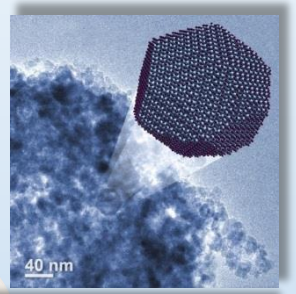
The experience gained by IFJ PAN and its implementation into the projects

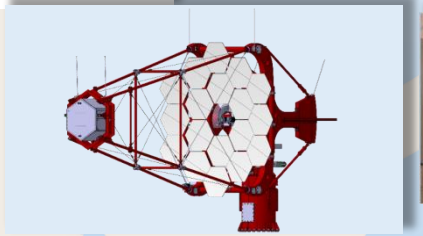
Dariusz Bocian
Jacek Świerblewski

The Division of Scientific Equipment and Infrastructure Construction (DAI)

General Information about IFJ PAN

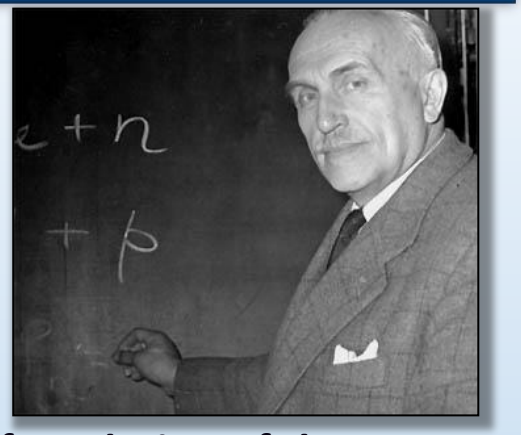
- **Personnel: 561; Prof. 30, Assoc. Prof. 61, Ph.D. 101, engineers 117**
- **Scientific Divisions:**
  - Division of Particle and Astroparticle Physics
  - Division of Nuclear Physics and Strong Interactions
  - Division of Condensed Matter Physics
  - Division of Theoretical Physics
  - Division of Interdisciplinary Research
  - Division of Applications of Physics
- **Researcher Departments:**
  - Cyclotron Centre Bronowice
  - Division of Scientific Equipment and Infrastructure Construction
  - Four accredited laboratories
- **Education:**
  - International Ph.D. Studies
  - Interdisciplinary Doctoral Studies
  - Kraków Interdisciplinary Doctoral School
- **Scientific output: > 650 publications annually**





Genesis and History



(Fot. Archiwum of the IFJ PAN)

- **1955 – foundation of the IFJ – as a branch of the Institute of Nuclear Research – Prof. Henryk Niewodniczański (1900-1968)**

- **1960 – IFJ as a standalone unit**

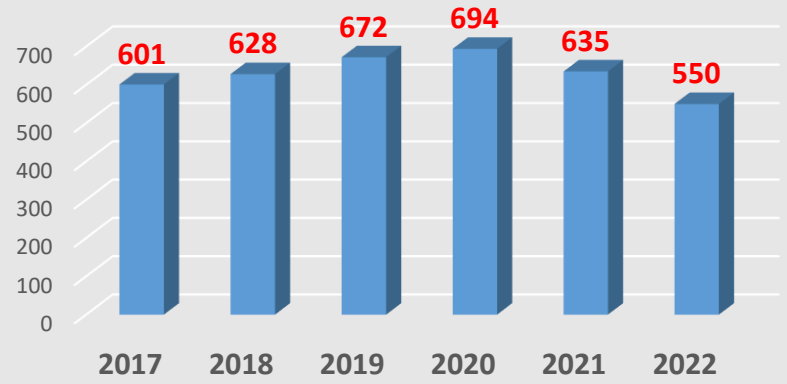
- **1970 – Particle physics enters – Prof. Marian Mięsowicz (1907-1992)**

- **1988 – IFJ gets the name of its patron – Henryk Niewodniczański**

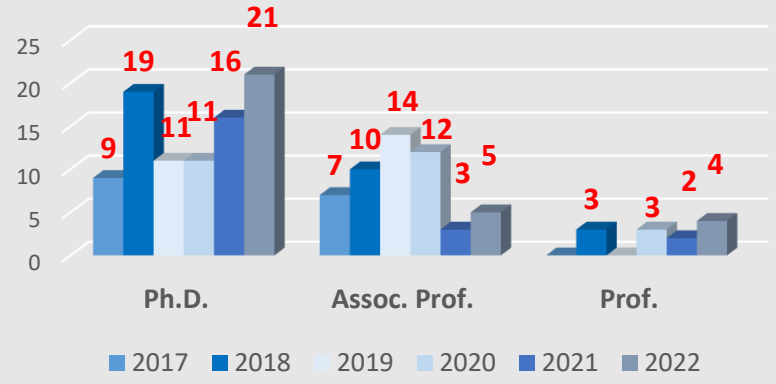
- **2003 – IFJ gets the status of a Research Institute of Polish Academy of Sciences**

Scientific Activity (2017-2022)

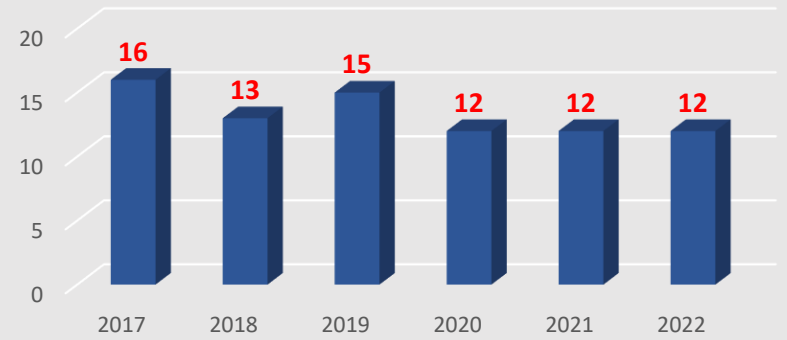
Publications



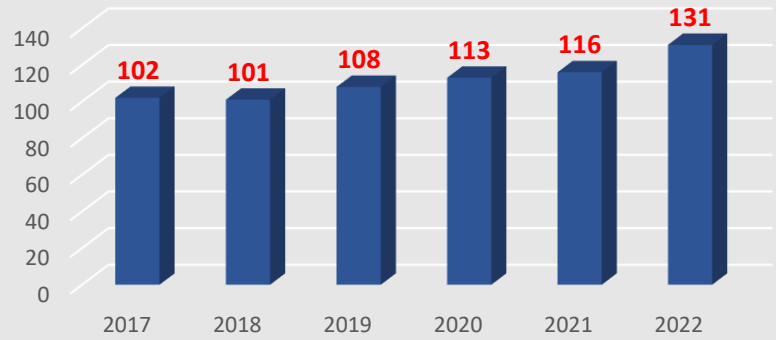
Scientific careers



International grants
(EC, F4E, VF, SNF)



National grants
(NCN, NCBiR, FNP, MEiN, NAWA)



Integration of European Accelerator Research Infrastructures

Participation of IFJ PAN in projects aimed at the Development of Innovation and Cooperation of European Technological Infrastructures for Accelerators and Magnets

TIARA – Test Infrastructure and Accelerator Research Area (2 years, 2011-2013)

In Poland, the project was carried out by a consortium of 7 scientific institutions: the Henryk Niewodniczański Institute of Nuclear Physics of the Polish Academy of Sciences, the AGH University of Science and Technology, the Cracow University of Technology, the Andrzej Sołtan Institute of Nuclear Problems, the Warsaw University of Technology, the Lodz University of Technology, the Wrocław University of Technology.

AMICI – Accelerator and Magnet Infrastructure for Cooperation and Innovation (2017-2019)

In Poland, the project was carried out by the Henryk Niewodniczański Institute of Nuclear Physics of the Polish Academy of Sciences

i.FAST – Innovation Fostering in Accelerator Science and Technology (2021-2025)

WP13 activities are carried out by the Henryk Niewodniczański Institute of Nuclear Physics of the Polish Academy of Sciences

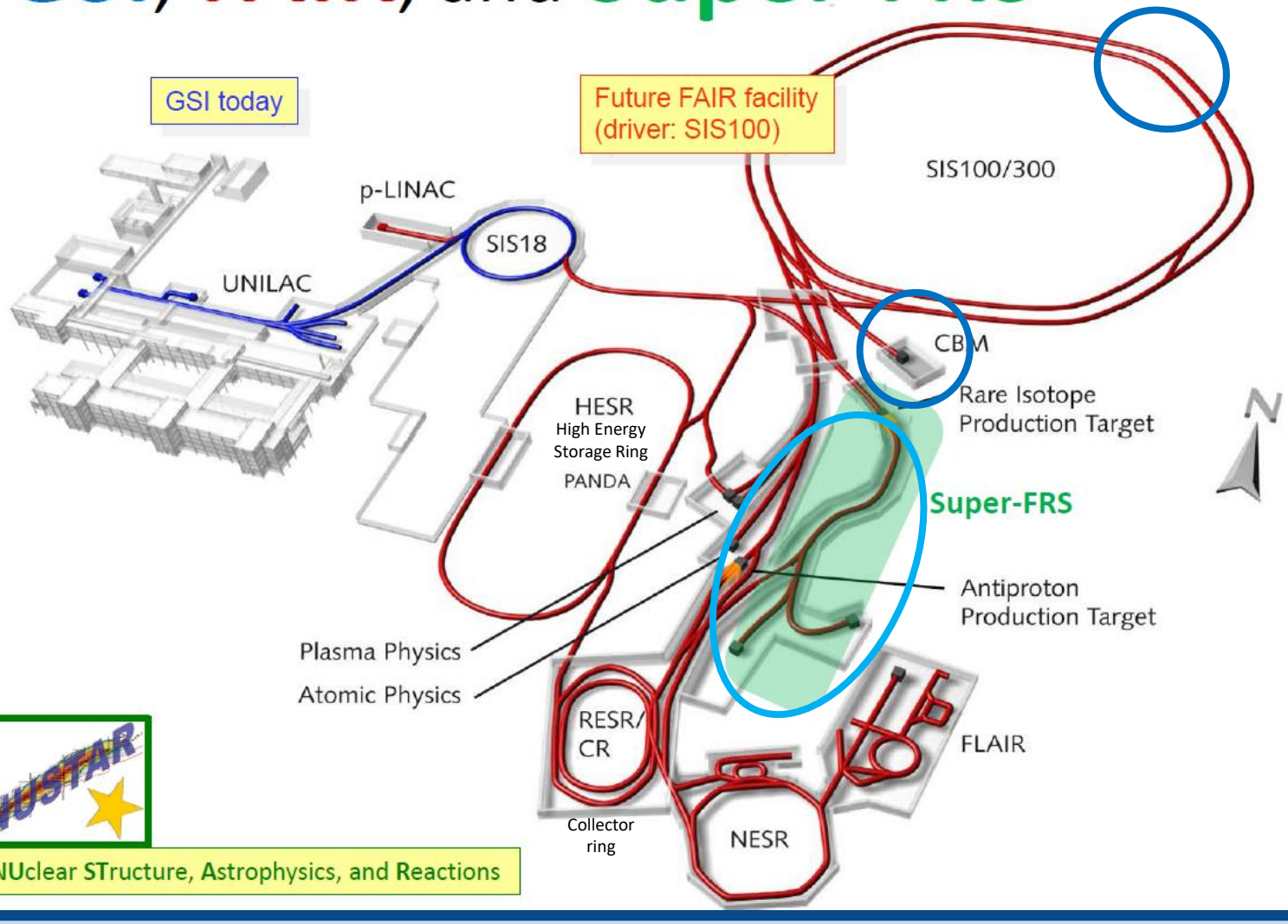
FuSuMaTech - Future Superconducting Magnet Technology (2017-2019, 2021-2025)

In Poland, the project is was carried out by the Henryk Niewodniczański Institute of Nuclear Physics of the Polish Academy of Sciences

Proposed involvement into FAIR

courtesy GSI/FAIR Colleagues

GSI, FAIR, and Super-FRS



Primary Beams

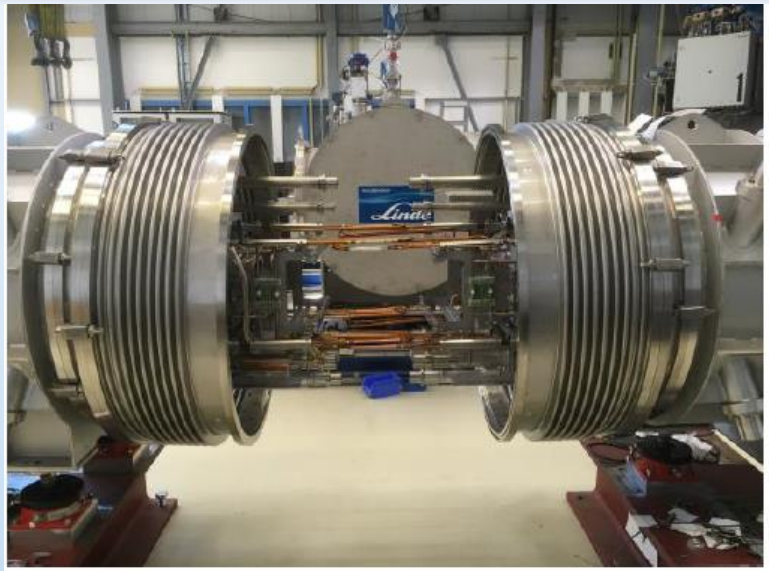
- **$3.5 \cdot 10^{11}$ $^{238}U^{28+}$/s (DC)** @ 1.5 GeV/u
- **$5 \cdot 10^{11}$ $^{238}U^{28+}$ (pulsed)** @ 1 GeV/u
- factor **100-1000** in intensity over present

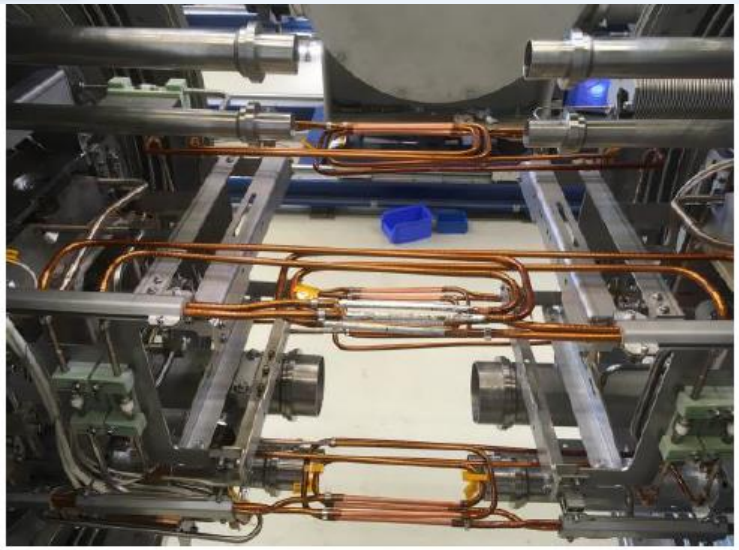
Secondary Beams

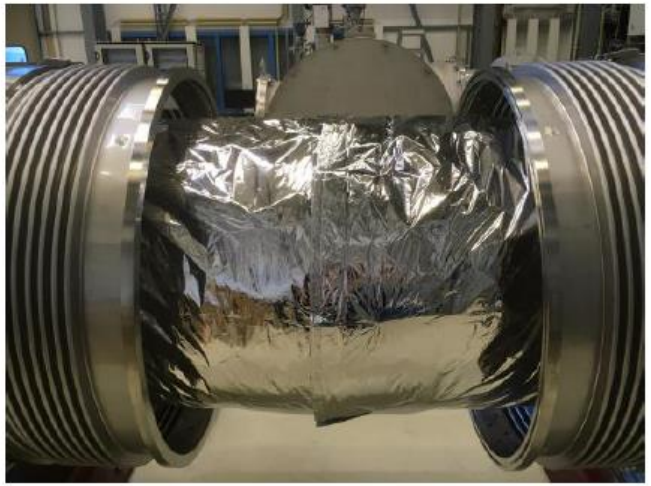
- Broad range of short-lived (= "exotic") beams up to **1.5 GeV/u**
- up to **factor 10 000 in intensity** over present (GSI+FRS)

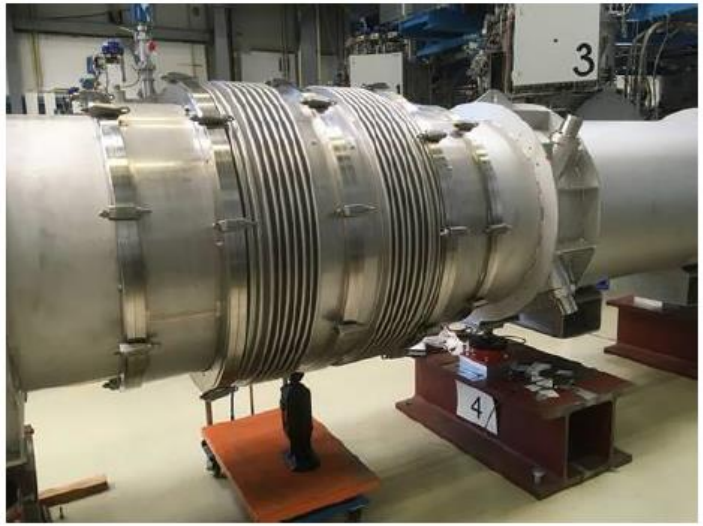
NUclear STructure, Astrophysics, and Reactions

FAIR: string test interconnection areas









courtesy GSI/FAIR Colleagues

IFJ PAN in-kind contribution to ESS – Technical Annexes

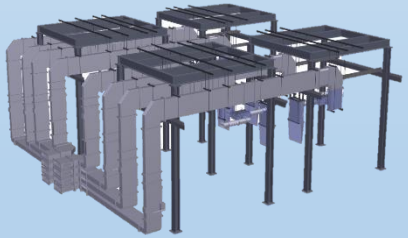
SCHEDULE AIK 10.1-Cryomodule test

- Reception of Cryomodule units
- Preparation of Cryomodule units for the test bench
- Installation on the test bench
- Initial testing
- Cool down
- Heat load measurements
- Warm up
- Disconnection
- Preparation for the tunnel
- Participation in site activity coordination
- Final review

2017 - 2026

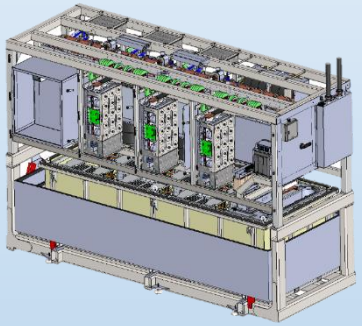
SCHEDULE AIK 8.6 -RF Installation

- Stub installation
- LLRF installation
- LPS installation
- Distribution system installation
- High Power Amplifier installation



SCHEDULE AIK 17.3 -PC Installation

- Klystrons Modulators for RFQ and DTL
- Klystron Modulators for Medium / High Beta
- Magnet Power Converters



SCHEDULE AIK 8.8

CONTRIBUTION TO THE LOW AND HIGH-POWER TESTS OF RF EQUIPMENT AND TESTING AND INSTALLATION OF RFPS'S IN TS3 AND IN G02.

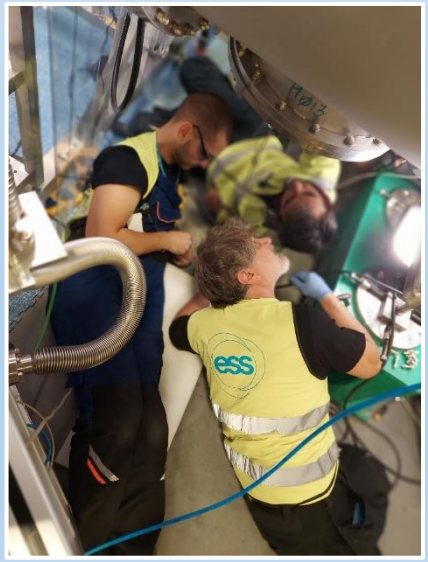
2022 - 2023

IFJ PAN (DAI) at ESS

THE HENRYK NIEWODNICZAŃSKI INSTITUTE OF NUCLEAR PHYSICS POLISH ACADEMY OF SCIENCES

EUROPEAN SPALLATION SOURCE

- Cryogenic experts,
- Mechanical and electrical specialists,
- RF engineers,
- Vacuum specialists,
- Skilled technicians,

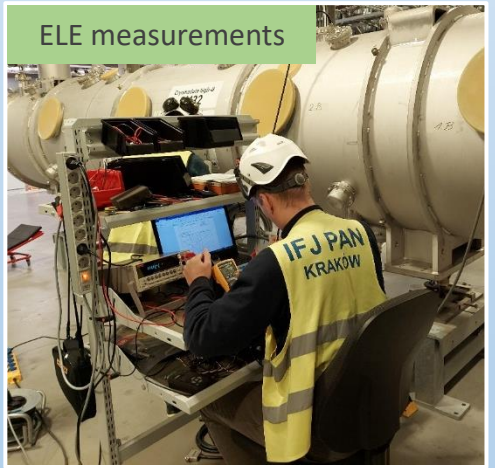


MECH inspection

CRYO operations

VAC activities

TECH work



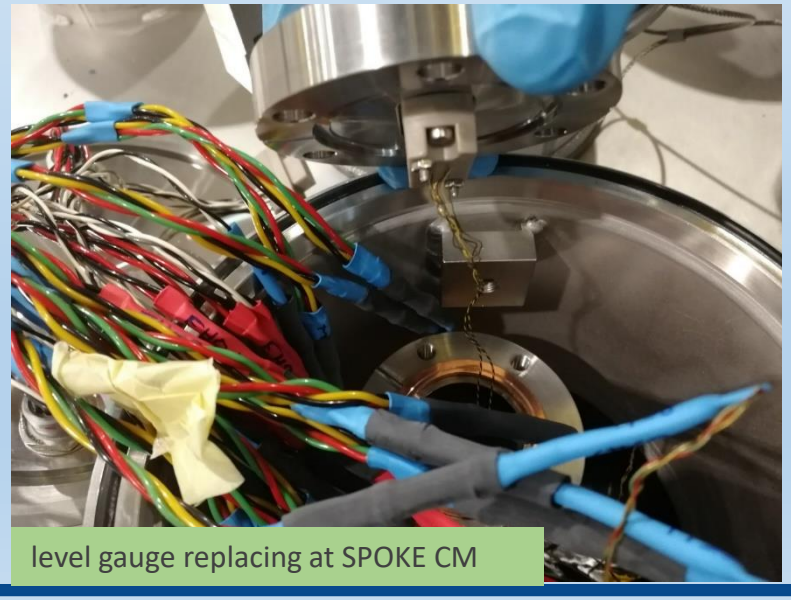
ELE measurements

IFJ PAN (DAI) at ESS

Supported activities at ESS side

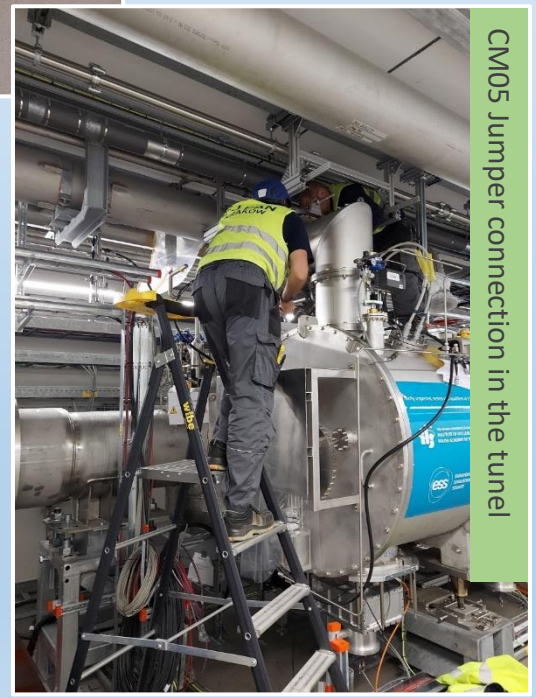
- Support with installation trial of elliptical CM05 & spoke CM02 in the tunel,
- Support with SPOKE CM10 CTS motor replacing,
- Replacing of the LG at all SPOKE CM's,
- Various leak tests for choosen SPOKE CM's,
- Support with MLI installation for ACCP-CTL interconnections,
- And …

CM05 waveguides connection in the tunnel



level gauge replacing at SPOKE CM

CTS motor repairing at SPOKE CM

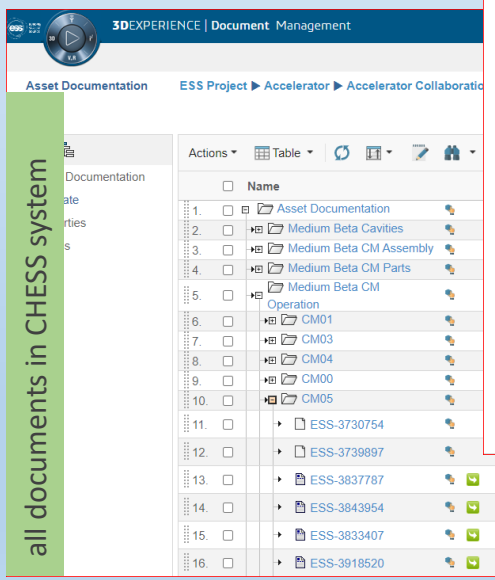


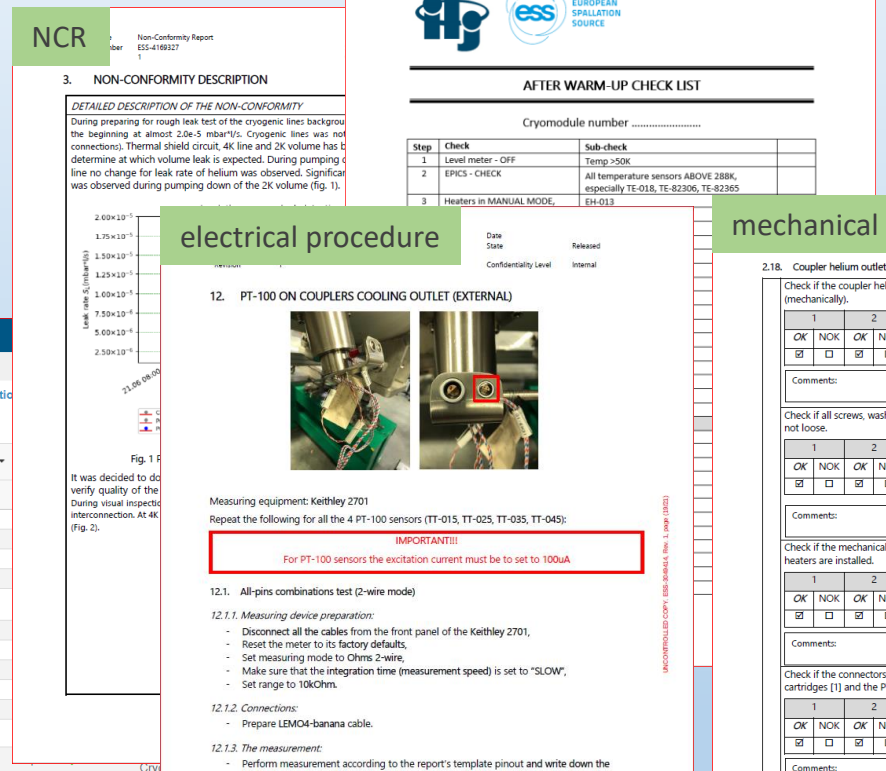
CM05 Jumper connection in the tunel

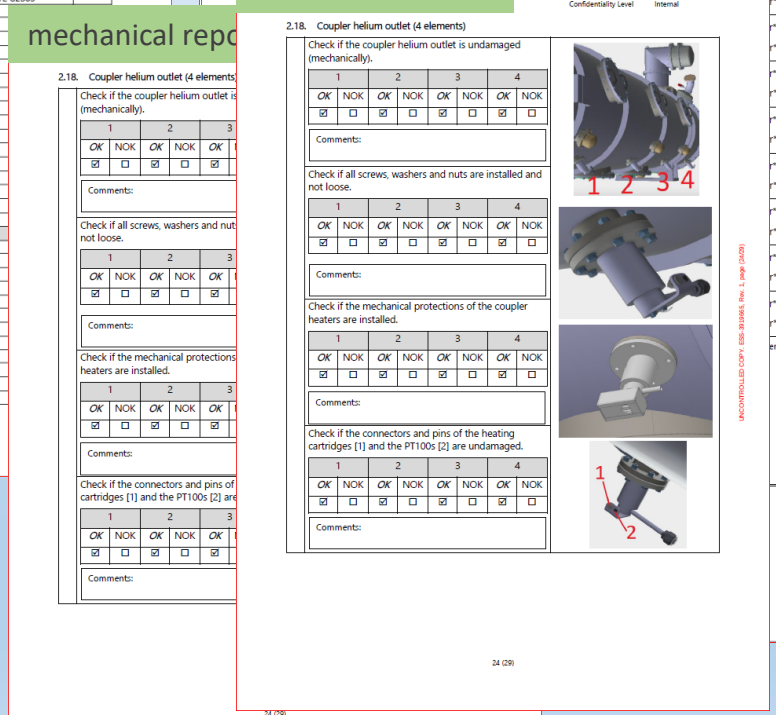
IFJ PAN (DAI) at ESS

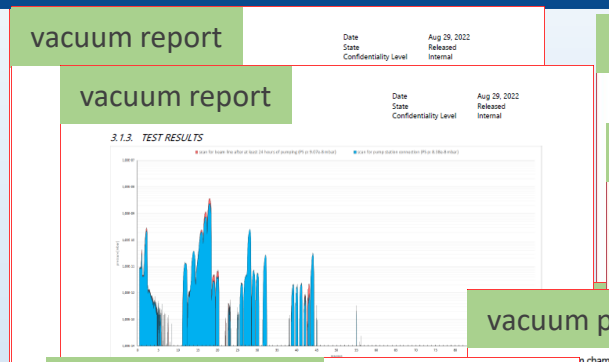
Documents

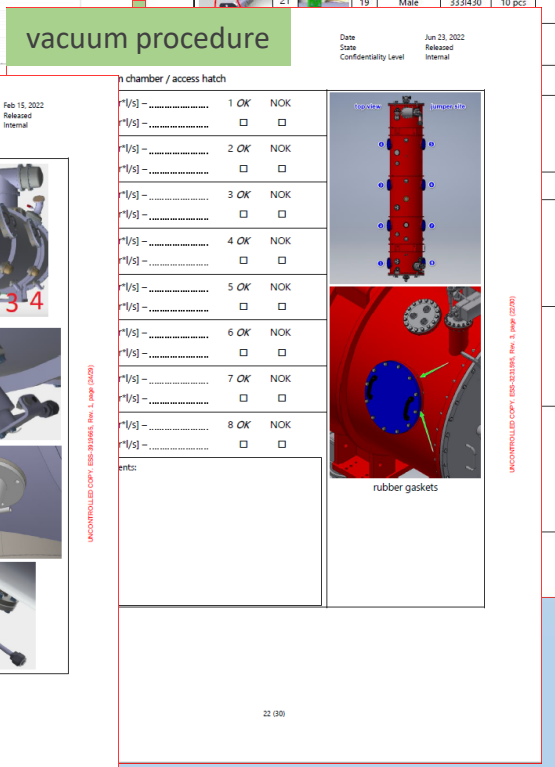
- 10 procedures
- 47 reports
- 15 check lists
- 13 NCR's











Support for Low and High-Power test of the Klystrons

THE HENRYK NIEWODNICZAŃSKI INSTITUTE OF NUCLEAR PHYSICS POLISH ACADEMY OF SCIENCES

EUROPEAN SPALLATION SOURCE

High Power test procedure includes:

- DC conditioning;
- RF conditioning;
- RF test to check the functionality of the klystron.

Low Power test includes:

- Checking the cables;
- Checking electronic devices installed in RACK's;
- Setting the interlocks thresholds;
- Checking the response in GUI.

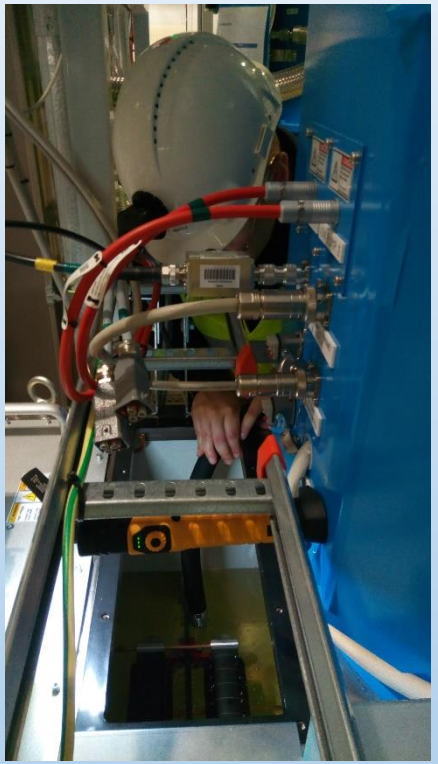
Support for Low and High-Power test of the Klystrons

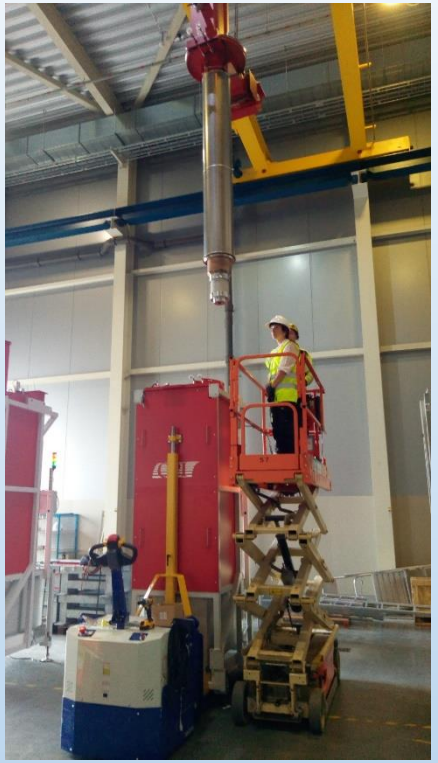
THE HENRYK NIEWODNICZAŃSKI INSTITUTE OF NUCLEAR PHYSICS POLISH ACADEMY OF SCIENCES

ess EUROPEAN SPALLATION SOURCE

Additional tasks done by IFJ PAN:

- Klystron preparation before LPT;
- Filling klystron with oil;
- Participation during cavity tuning in NCL klystron (together with Thales and ESS experts);
- Participation during swapping the vacuum tube for CPI klystron between two magnet





IFJ PAN (DAI) at LHC

LHC - construction, commissioning, consolidation

Signing of the agreement in 2005-2010 between IFJ PAN

- ✓ Design and implementation of automatic measurement systems for testing superconducting LHC circuits
- ✓ Quality Control of superconducting electrical circuits
- ✓ Inspection of LHC superconducting magnet connections

Quality Control of superconducting electrical circuits
ELQA TEAM

LHC during Long Shutdown

New measurement systems

Damage disclosed during QC–ICIT TEAM

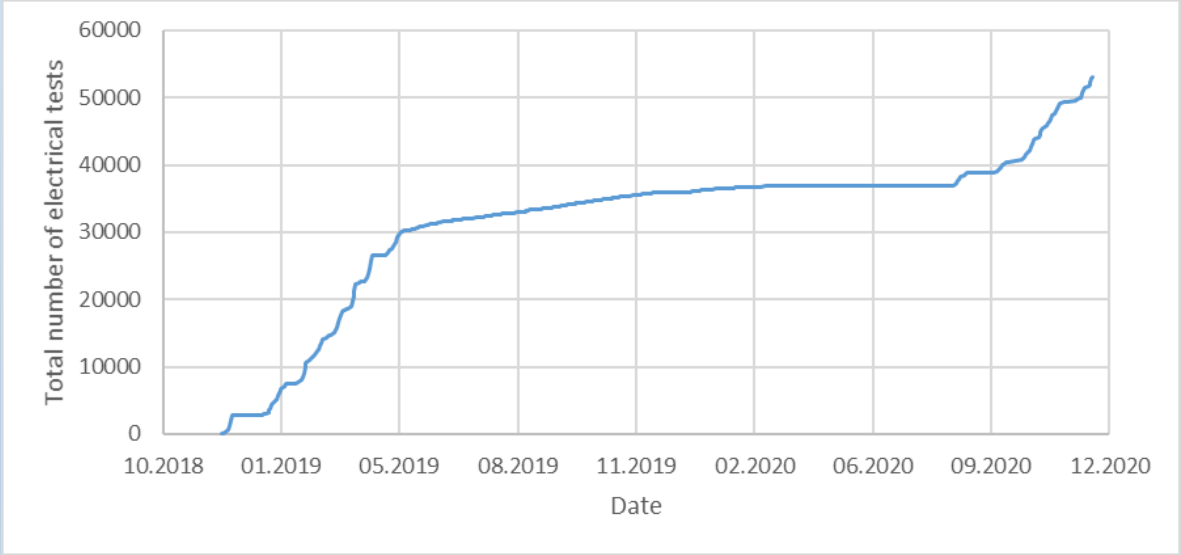
- ✓ The work managing of the multinational team "Alpha-Omega"

Measurements in the LHC during Long Shutdown 2

Standard ELQA measurements in the LHC during Long Shutdown 2.

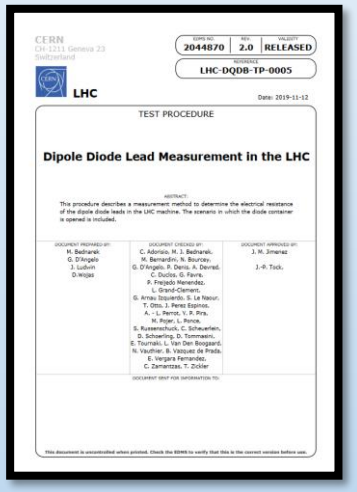
- Standard measurements on more than 1600 LHC superconducting circuits and their instrumentation before and after warm-up of the LHC.
- Software development, design and fabrication of four dedicated diode lead measurement systems.

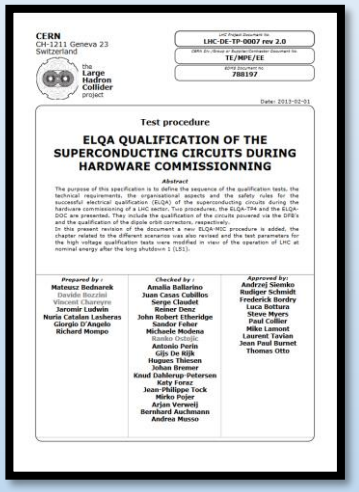
Up to 25 engineers and technicians from IFJ PAN on CERN site

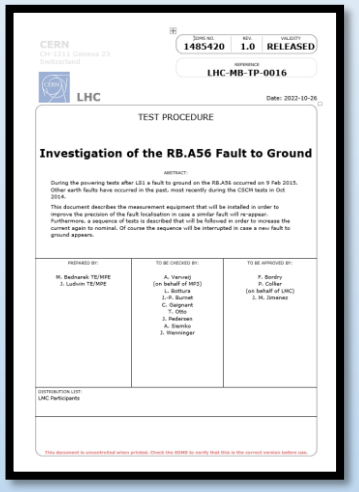


Number of ELQA measurements performed by IFJ PAN personnel during LS2 until the end of 2020.

Procedures at CERN


CERN
CH-1211 Geneva 23
Switzerland
EDMS NO. 2044870 | REV. 2.0 | VALIDITY RELEASED
REFERENCE LHC-DQDB-TP-0005
LHC
Date: 2019-11-12
TEST PROCEDURE
Dipole Diode Lead Measurement in the LHC


CERN
CH-1211 Geneva 23
Switzerland
LHC-DE-TP-0007 rev 2.0
TE/MPE/EE
788197
The Large Hadron Collider project
Date: 2013-02-01
Test procedure
ELQA QUALIFICATION OF THE SUPERCONDUCTING CIRCUITS DURING HARDWARE COMMISSIONNING
Abstract
The purpose of this specification is to define the sequence of the qualification tests, the technical requirements, the organisational aspects and the safety rules for the successful electrical qualification (ELQA) of the superconducting circuits during the hardware commissioning of a LHC sector. Two procedures, the ELQA-TP4 and the ELQA-DOC are presented. They include the qualification of the circuits powered via the DFB's and the qualification of the dipole orbit correctors, respectively.
In this present revision of the document a new ELQA-MCC procedure is added, the chapter related to the different scenarios was also revised and the test parameters for the high voltage qualification tests were modified in view of the operation of LHC at nominal energy after the long shutdown 1 (LS1).
Prepared by : Mateusz Bednarek, Davide Bozzini, Vincent Chareyre, Jaromir Ludwin, Noria Catalan Lasheras, Giorgio D'Angelo, Richard Mompo
Checked by : Amalia Ballarino, Juan Casas Cubillos, Serge Claudet, Reiner Denz, John Robert Etheridge, Sandor Feher, Michaele Modena, Radko Ostojic, Antonio Perin, Gijs De Rijk, Hugues Thiesen, Johan Bremer, Knud Dahlerup-Petersen, Katy Foraz, Jean-Philippe Tock, Mirko Pojer, Arjan Verweij, Bernhard Auchmann, Andrea Musso
Approved by: Andrzej Siemko, Rudiger Schmidt, Frederick Bordry, Luca Bottura, Steve Myers, Paul Collier, Mike Lamont, Laurent Tavian, Jean Paul Burnet, Thomas Otto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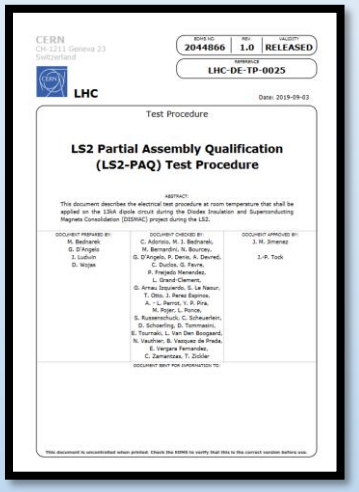
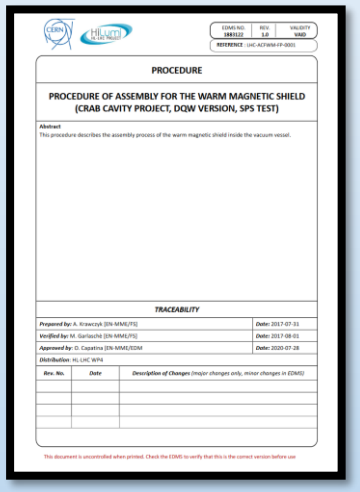
CH-1211 Geneva 23
Switzerland
EDMS NO. 1485420 | REV. 1.0 | VALIDITY RELEASED
REFERENCE LHC-MB-TP-0016
LHC
Date: 2022-10-26
TEST PROCEDURE
Investigation of the RB.A56 Fault to Ground
ABSTRACT:
During the powering tests after LS1 a fault to ground on the RB.A56 occurred on 9 Feb 2015. Other earth faults have occurred in the past, most recently during the CSCM tests in Oct 2014.
This document describes the measurement equipment that will be installed in order to improve the precision of the fault localisation in case a similar fault will re-appear. Furthermore, a sequence of tests is described that will be followed in order to increase the current again to nominal. Of course the sequence will be interrupted in case a new fault to ground appears.
PREPARED BY: M. Bednarek TE/MPE, J. Ludwin TE/MPE
TO BE CHECKED BY: A. Verweij (on behalf of MP3), L. Bottura, J.-P. Burnet, C. Daignant, T. Otto, J. Pedersen, A. Siemko, J. Wenninger
TO BE APPROVED BY: F. Bordry, P. Collier (on behalf of LHCC), J. M. Jimenez
DISTRIBUTION LIST: LHC Participants


CERN
CH-1211 Geneva 23
Switzerland
EDMS NO. 2044866 | REV. 1.0 | VALIDITY RELEASED
REFERENCE LHC-DE-TP-0025
LHC
Date: 2019-09-03
Test Procedure
LS2 Partial Assembly Qualification (LS2-PAQ) Test Procedure
ABSTRACT:
This document describes the electrical test procedure at room temperature that shall be applied on the 13kA dipole circuit during the Diodes Insulation and Superconducting Magnets Consolidation (DISMAC) project during the LS2.
DOCUMENT PREPARED BY: M. Bednarek, G. D'Angelo, J. Ludwin, D. Wojas
DOCUMENT CHECKED BY: C. Adonizio, M. J. Bednarek, N. Bourcey, G. D'Angelo, P. Denis, A. Devred, C. Ducos, G. Favre, P. Freijedo Menendez, L. Grand-Clement, G. Arrau Izquierdo, S. Le Naour, T. Otto, J. Perez Espinos, A. -L. Perrot, Y. P. Pira, M. Pojer, L. Ponce, S. Russenschuck, C. Scheuerlein, D. Schoerling, D. Tommasini, E. Tournaki, L. Van Den Boogaard, N. Vauthier, B. Vazquez de Prada, E. Vergara Fernandez, C. Zamantzas, T. Zickler
DOCUMENT APPROVED BY: J. M. Jimenez, J.-P. Tock
DOCUMENT SENT FOR INFORMATION TO:


CERN
HL-LHC
EDMS NO. 1893122 | REV. 1.0 | VALIDITY VALID
REFERENCE : LHC-ACFWM-FP-0001
PROCEDURE
PROCEDURE OF ASSEMBLY FOR THE WARM MAGNETIC SHIELD (CRAB CAVITY PROJECT, DQW VERSION, SPS TEST)
Abstract
This procedure describes the assembly process of the warm magnetic shield inside the vacuum vessel.
TRACEABILITY
Prepared by: A. Krawczyk [EN-MME/FS] Date: 2017-07-31
Verified by: M. Garlasché [EN-MME/FS] Date: 2017-08-01
Approved by: D. Capatina [EN-MME/EDM] Date: 2020-07-28
Distribution: HL-LHC WP4
Rev. No. | Date | Description of Changes (major changes only, minor changes in EDMS)

- Co-authorship of 10 procedures related to electrical quality assurance of LHC and HL-LHC superconducting circuits
- Prototype crab cavity assembly procedure

IFJ PAN (DAI) at XFEL

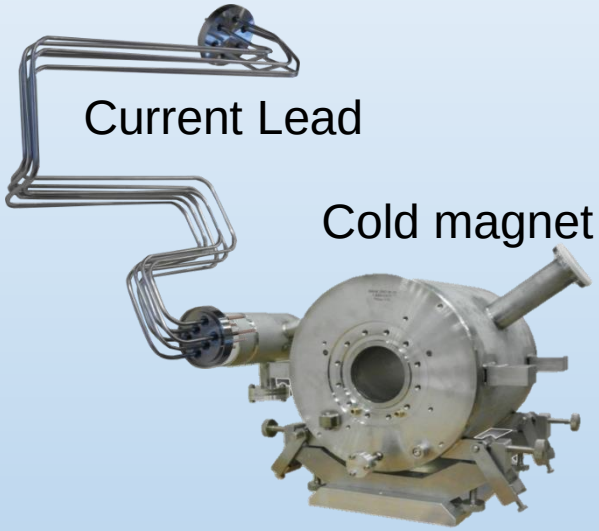
Acceptance tests of superconducting components of the XFEL accelerator

IFJ PAN in-kind contribution to the XFEL 2010 – 2016

840 x

Cavity

103 x



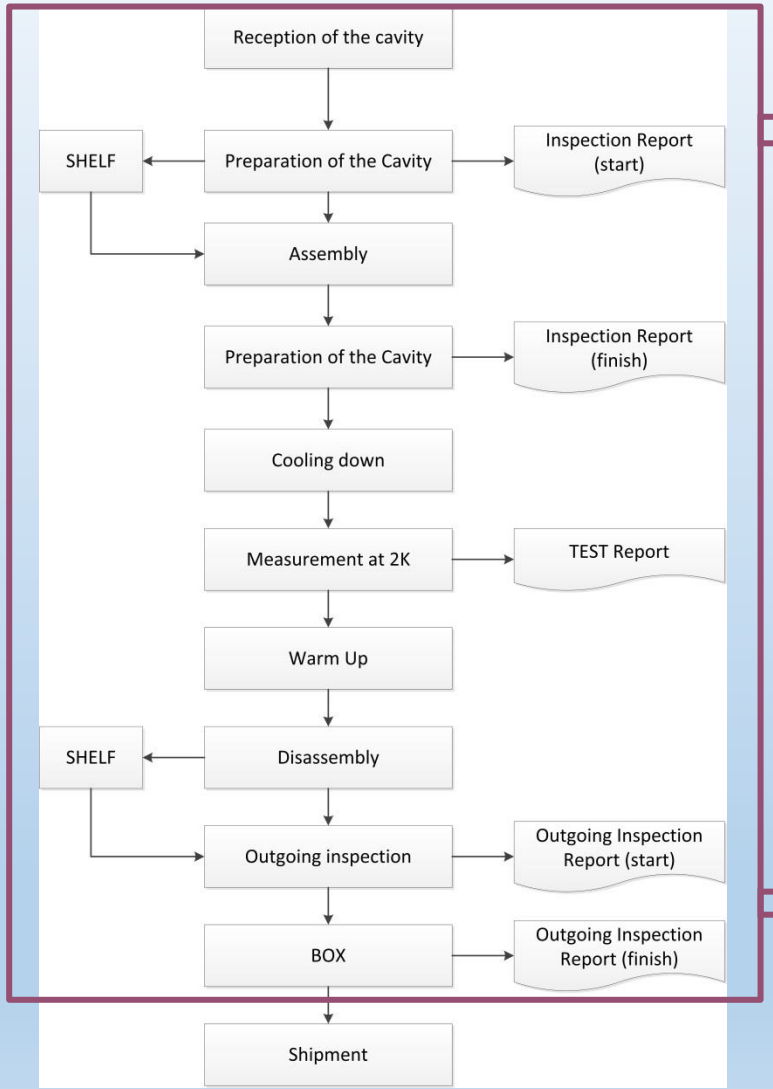
Current Lead

Cold magnet

103 x

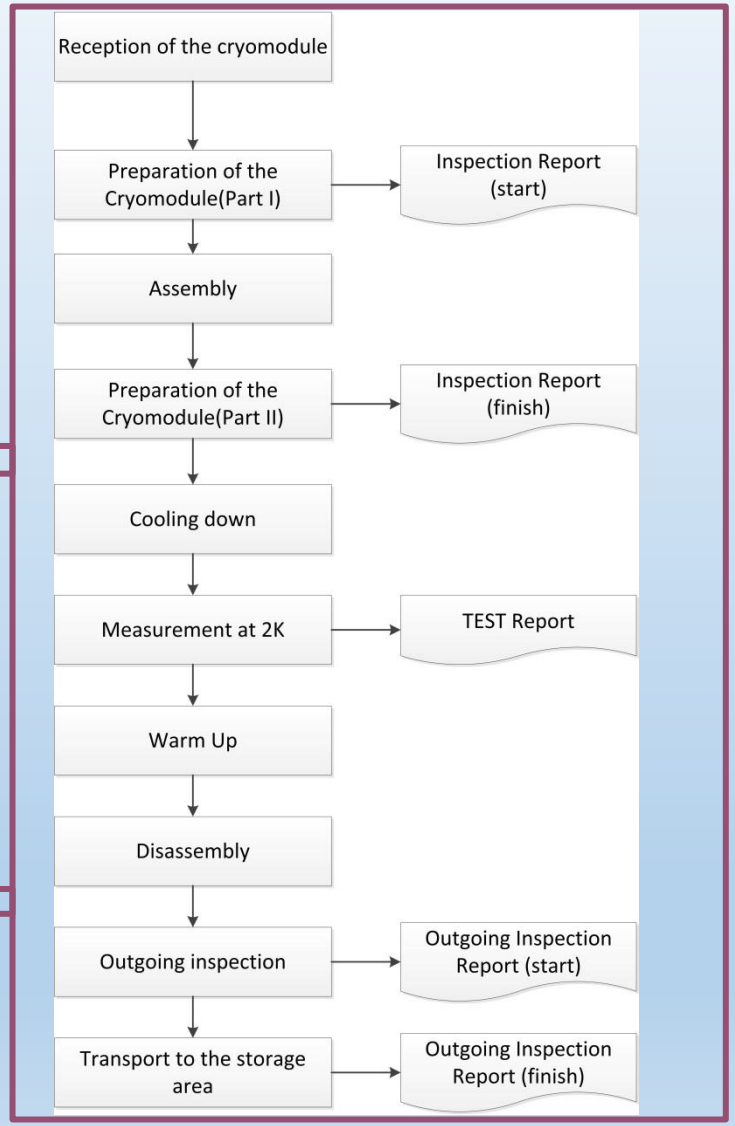
Cryomodule

TEST - What does it mean ?



Cavity test main flow diagram

Cryomodule test main flow diagram



TEST

The test program is realized according to the written procedures

TEST - What does it mean ?

AMTF Hall - Cryomodule

Unloading of the cryomodule after transport

Cryomodule preparation area

Cryomodule test stand

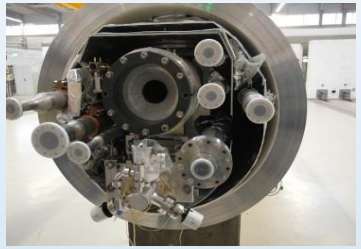
Cryomodule test stand – module inside

Cryomodule test stand – front view

Preparation and assembling of cryomodules at AMTF hall

European XFEL



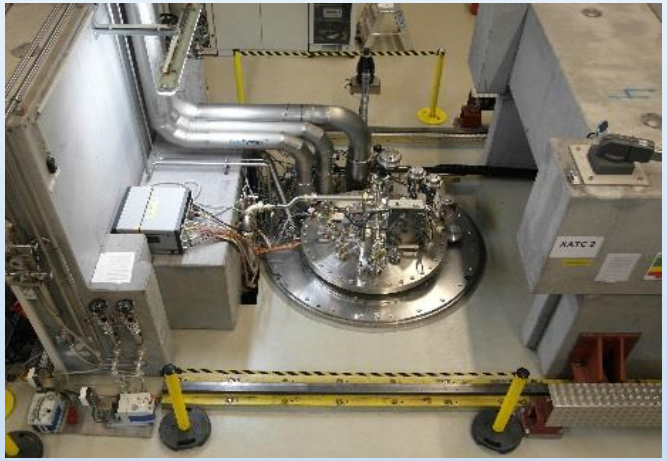


DESY

Main tasks:

- Unload the cryomodule from the truck
- Incoming checks
- Load the cryomodule to the movable support
- Assembling Cryomodule at the test stand
- Connecting Cryomodule beam line to the test stand under clean room conditions
- Leak check of beam line interconnections and mass spectroscopy of the beam line
- Connecting of the waveguides
- Connecting of all electrical cables
- Connect of all cryomodule process pipes to the test stands
- Leak check of cryomodule vessel (ISO-VAC)
- Leak check of cryomodule cryogenic lines
- Assembly and isolating thermal shields
- Pumping down of isolation vacuum


AMTF Hall - Cavity



Vertical Cryostat

Radiation protection shielding

Cavity preparation area

Cavity storage area

Cavity incoming check area

Clean room

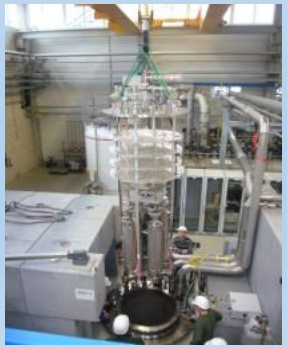
Preparation and assembling of cavities at AMTF hall



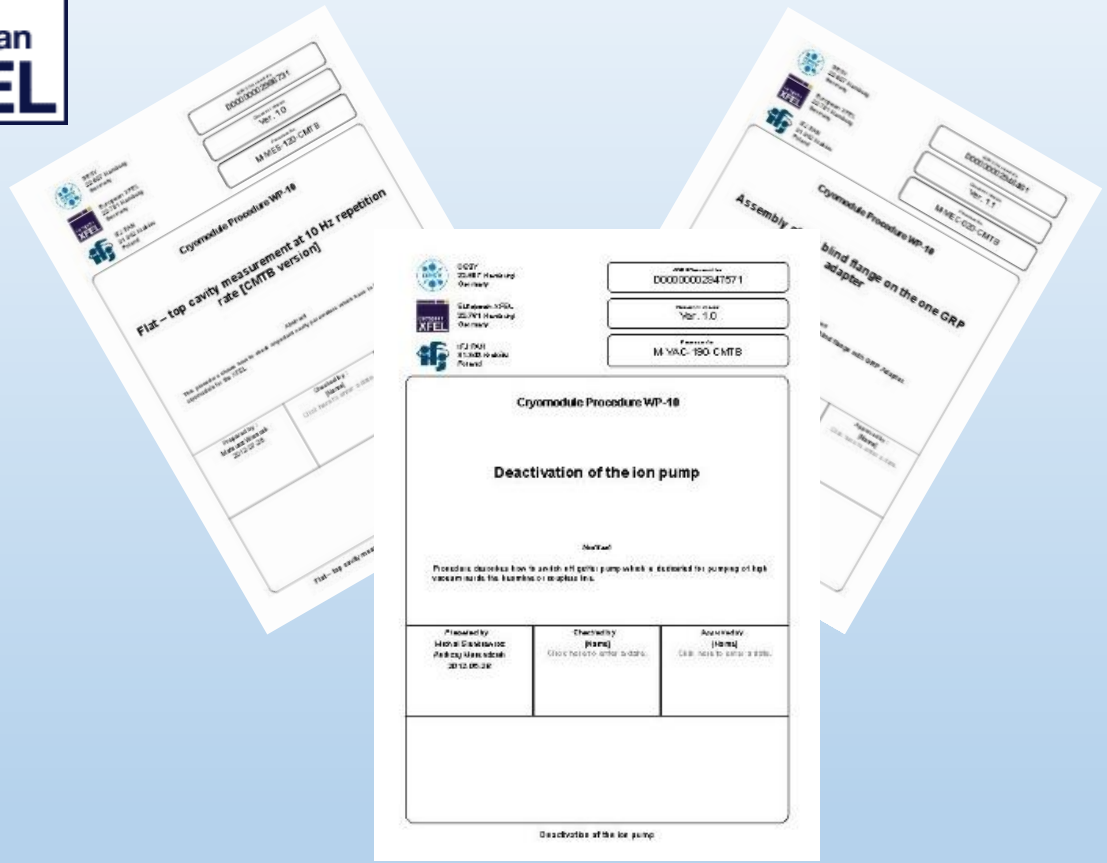

Main tasks:

- Incoming checks
- Assembling Cavity to the Insert
- Connecting Cavity to the vacuum line (in cleanroom conditions)
- Tuning of Fundamental Mode Rejection Filters of both HOM couplers + Cables connection
- Leak check of the Cavity
- Transport of the Insert to the cryostat + vacuum connection



XFEL Procedures



Number of created procedures:

~50 for Cryomodule (AMTF)
~19 for Cavity (AMTF)

~146 for Cryomodule (CMTB)
~21 for Cavity (HALL 3)

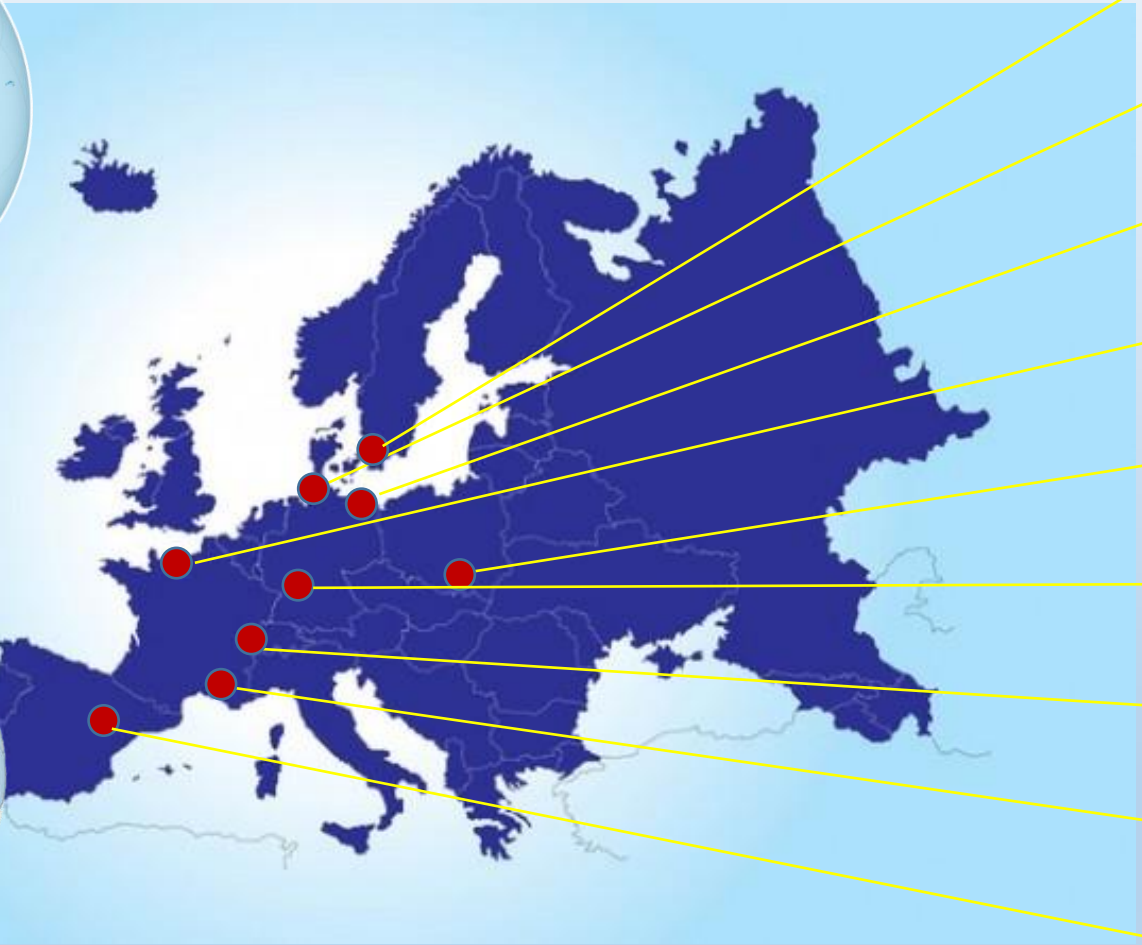
Activation and deactivation of Ion Pump	D00000006689411	09.02.2016
Activation of Titanium Sublimation Pump (TSP)	D00000006689491	09.02.2016
Alignment_of_the_crymodule	D00000006678751	26.01.2016
Assembly final tightening and connection of GRP adapter	D00000006651881	26.01.2016
Cavities fine tuning and module calibration	D00000006630821	11.12.2015
Closing of the sliding muff	D00000006650681	20.01.2016
Connection of all process pipes	D00000006651941	26.01.2016
Connection of the beamline	D00000006790331	24.03.2016
Connection_of_the_waveguides	D00000006853821	25.04.2016
COOL DOWN_XATB	D00000006563271	08.01.2016
COOL DOWN_XATB_checklist	D00000006552401	09.01.2016
Coupler tuner bellow check at warm	D00000006637781	18.12.2015
Cryomodule Heat Loads measurements	D00000006710641	23.03.2016
Detune all cavities after cold test	D00000006632411	14.12.2015
Disconnection of all process pipes	D00000006652001	21.01.2016
Disconnection of the beamline	D00000006790571	24.03.2016
Disconnection_of_the_waveguides	D00000006853921	25.04.2016
Dismounting of GRP adapter	D00000006652061	26.01.2016
Flat - top measurement	D00000006638681	18.12.2015
Heat Loads Measurements at 2K RF	D00000006637201	18.12.2015
Installation of the 80K thermal shield at End-cap and Feed-cap sides	D00000006678511	26.01.2016
Installation of the 8K thermal shield at End-Cap and Feed-cap sides	D00000006678461	26.01.2016
Integral leak check of the cryomodule	D00000006633341	15.01.2016
Isolating of all process pipes	D00000006652431	20.01.2016
Isolation of the 80K thermal shield using MLI at End-cap and Feed-cap sides	D00000006678631	26.01.2016
Isolation of the 8K thermal shield using MLI at End-cap and Feed-cap sides	D00000006678571	26.01.2016
Leak check of the cryomodule	D00000006711021	15.02.2016
LLRF measurements at AMTF	D00000006637721	05.01.2016
Low power RF measurement at 2K	D00000006630761	11.12.2015
Magnet test at 2K	D00000006632351	21.12.2015
Opening and closing of the cold valve	D00000006710831	15.02.2016
Opening of the sliding muff	D00000006651091	20.01.2016
Post caps installation	D00000006651331	20.01.2016
Pumping down of the cryomodule insulation vacuum	D00000006789801	24.03.2016
Removal of Post caps	D00000006651391	20.01.2016
Removal of the transport-cap at downstream side	D00000006651451	21.01.2016
Removal of the transport-cap at upstream side	D00000006651501	21.01.2016
Unloading of the XFEL cryomodule from the trailer and transfer to the preparation area	D00000006678691	26.01.2016
Vacuum incoming inspection for crymodule	D00000006632481	15.01.2016
Warm coupler conditioning	D00000006637261	18.12.2015

A small drop of our experience

Concluding

T2K, J-PARC
BELLE 2, KEK

CTA
Pierre Auger



- ESS LUND
- E-XFEL DESY
- W7X IPP GREIFSWALD
- SPIRAL 2 GANIL, CAEN
- **IFJ PAN KRAKÓW**
- FAIR GSI DARMSTADT
- LHC, ATLAS CERN
- ITER CADARACHE
- F4E BARCELONA

Understanding of the Quality

Quality Assurance

Quality assurance can be defined as "part of quality management focused on providing confidence that quality requirements will be fulfilled." The confidence provided by quality assurance is twofold—internally to management and externally to customers, government agencies, regulators, certifiers, and third parties.

Quality Control

Quality control can be defined as "part of quality management focused on fulfilling quality requirements." While quality assurance relates to how a process is performed or how a product is made, quality control is more the inspection aspect of quality management.

QC focuses on the results of the work performed, whereas QA is concerned with the adequacy of the underlying processes, methodology, and standards in place to create the output.

Project Management Theory and Practice, Third Edition,2019

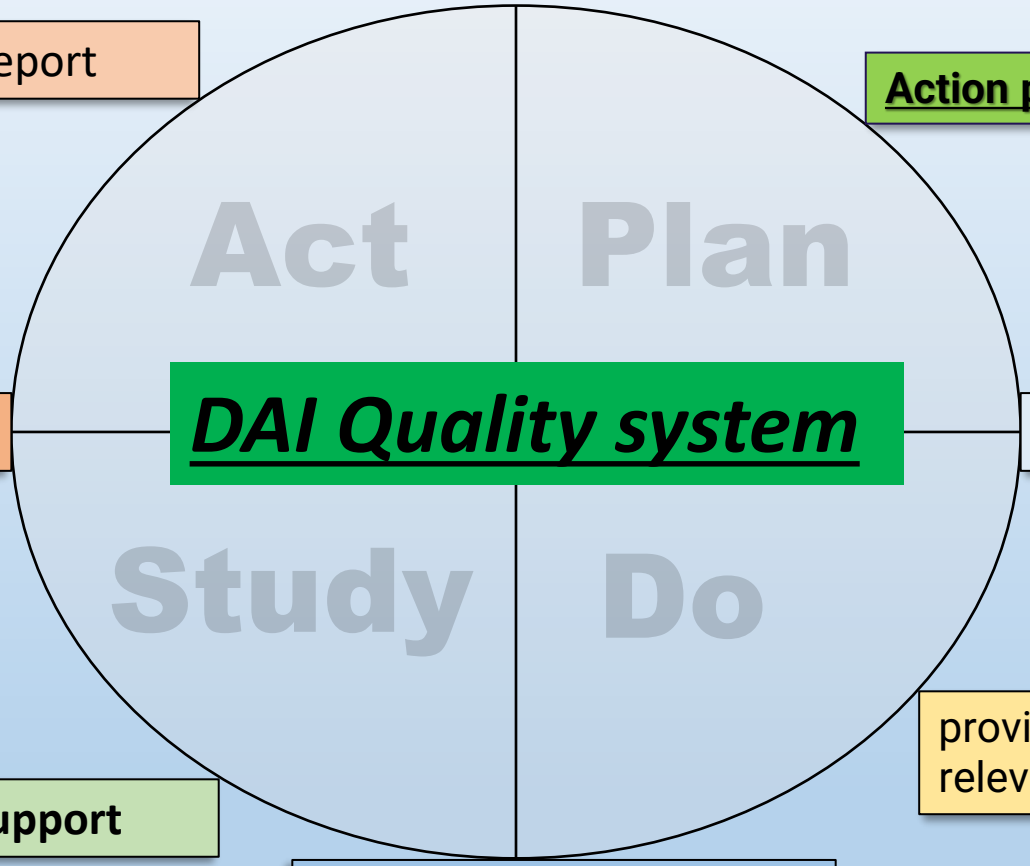
https://asq.org/quality-resources/quality-assurance-vs-control

Quality Relationships. ISO 9000 definitions from ISO 9000:2015: Quality management systems

This standard describes the fundamental concepts and principles of quality management which are universally applicable to the following:

- organizations seeking sustained success through the implementation of a quality management system;
- customers seeking confidence in an organization's ability to consistently provide products and services conforming to their requirements;
- organizations seeking confidence in their supply chain that product and service requirements will be met;
- organizations and interested parties seeking to improve communication through a common understanding of the vocabulary used in quality management;
- organizations performing conformity assessments against the requirements of ISO 9001;
- providers of training, assessment or advice in quality management;
- developers of related standards.

IFJ PAN *in-kind contribution* to……



daily / shifts report

Action plan - design and optimization

team management

DAI Quality system

real communications

providing access to control data and relevant information

dedicated system for QC and QA support

daily meeting – briefing

Action plan - design and optimization

STEP I

Required to perform ~10% tests of the all tested component

Conceptual design of the action plan for testing object

Creation of the procedures

Preliminary design of the action plan for testing object

Improvement of the procedures

Final design of the action plan for testing object

Improvement and approval of the procedures

RESULT

STEP II

Required to perform ~10% tests of the rest tested component

Analysis of the achieved testing information vs. costs and time

Analysis of the modifying procedures possibility without losing quality, cost and time.

Analysis of the possibility of a potential damage, failure occurrence for the tested component during its operational phase and its effects.

acceptance

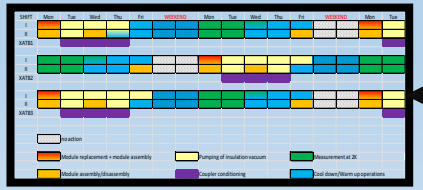
NO

YES

Optimal design of the action plan for testing object

Improvement and approval of the procedures

Optimal result

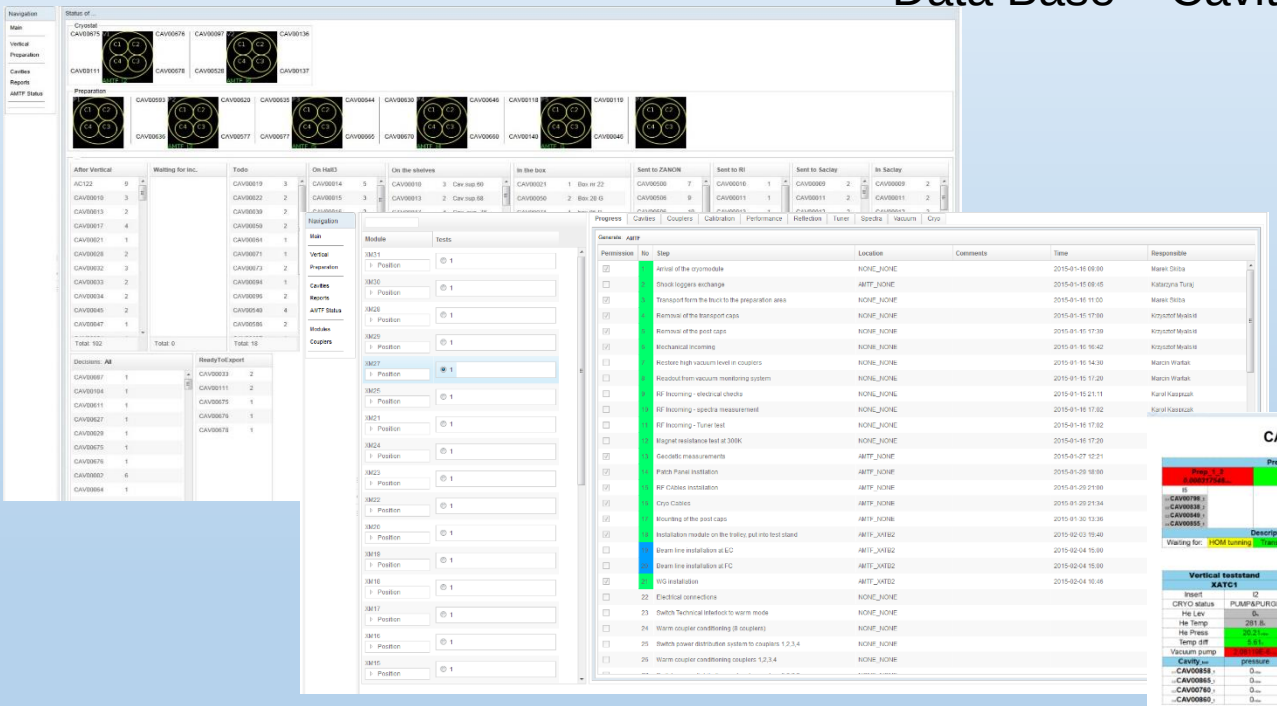


dedicated system for QC and QA support

Data management - systems

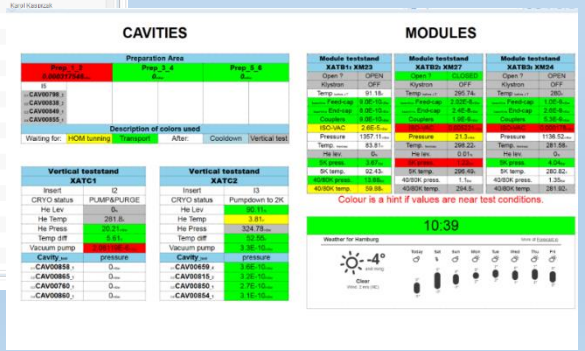
- ***quality control***
- ***problem analysis***
- automatic report generation (in development)
- electronic logbook

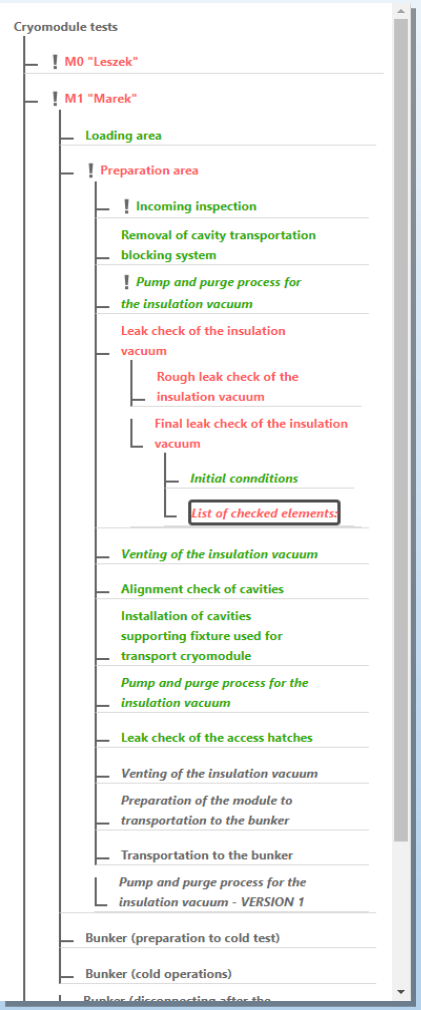
Data Base – Cavity status at AMTF



Data Base – cryomodule tasks XFEL

Screen at hall





Cryomodule tasks ESS