RF systems & Power Converters installation

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Division of Scientific Equipment and Infrastructure Construction (DAI)

ESS Technical Advisory Committee
06.10.2016

IFJ PAN facts and figures

- The Institute of Nuclear Physics was established in Cracow in 1955. Currently IFJ PAN is the largest research institute of the Polish Academy of Sciences. The Institute is located in the western part of Cracow and in southern Poland.
- The Institute employs of over 550 people inc. 41 Professors, 55 Associate Professors, 120 Assistant Professors and 68 PhD students.
- The average yearly yield of the IFJ PAN in recent years encompasses more than 500 scientific papers in the Journal Citation Reports published by the Thomson Reuters. The Institute is of A+ Category (leading level in Poland) in the field of sciences and engineering.

Cooperation with:
BNL – Brookhaven, CERN – Geneva, DESY – Hamburg, ENEA – Frascati, GANIL – Caen, GSI – Darmstadt, ILL – Grenoble, JINR – Dubna, KEK – Tsukuba, KFZ – Juelich, LNGS – Gran Sasso, LNL – Legnaro, MIT – Cambridge, MPI – Greifswald.

IFJ PAN structure

- Scientific divisions
  - Division of Particle and Astroparticle Physics (7)
  - Division of Nuclear Physics and Strong Interactions (4)
  - Division of Condensed Matter Physics (4)
  - Division of Theoretical Physics (4)
  - Division of Applications of Physics and Interdisciplinary Research (7)
- Accredited laboratories
  - Laboratory of Individual and Environmental Dosimetry
  - Laboratory of Radiometric Expertise
  - Laboratory of Radioactivity Analyses
  - Laboratory for Calibration of Radiation Protection Instruments

- Cyclotron Center Bronowice (CCB)
  - Radiotherapy of central nervous system tumors
  - Eye melanoma radiotherapy facility
- Krakow Research Center for Ion Engineering (IONMED)
- *Division of Scientific Equipment and Infrastructure Construction (DAI)*

RF Installation Phase I and Phase II

Scope of work:

- **Stub installation** (installation support for waveguides in 21 stubs)
- **LLRF installation**. (installation of 155 LLRF systems)
- **LPS installation**. (installation of 155 LPS systems)
- **Distribution system installation**. (installation of 155 complete RF distribution systems)
- **High Power Amplifier installation**. (installation of 129 High Power Amplifier systems)

Project start date: **1 July, 2017**
Project finish date: **30 June, 2022**

Phase 1: 1 July 2017 - 30 June 2019
Phase 2: 1 July 2020 - 30 June 2022

Total contribution 57 FTE

Phase 1 - **30.1 FTEs**
Phase 2 - **26.9 FTEs**
The overall contribution: 6 156 000 $€_{2013}$

Status: recommended for acceptance by In-Kind Review Committee

RF Installation Phase I and Phase II

#	Activity	Support Period Start (preliminary date)	Support Period End (preliminary date)
Preliminary Schedule – Phase 1			
1	Stub waveguide installation	T0 = 3 July 2017	T0+6M
2	Low level RF (LLRF) and Local Protection System (LPS) installation, phase 1	T1 = 1 Sep 2017	T1+18M
3	Distribution System installation, phase 1	T2 = 1 Sep 2017	T2+17M
4	High Power Amplifier installation, phase 1	T3 = 1 Nov 2017	T3+20M
5	System level tests for RF commissioning, phase 1	T4 = 3 May 2018	T4+13M
Preliminary Schedule – Phase 2			
6	LLRF and LPS installation, phase 2	T5 = 1 June 2020	T5+24M
7	Distribution System Installation, phase 2	T6 = 1 June 2020	T6+24M
8	High Power Amplifier installation, phase 2	T7 = 1June 2020	T7+24M
9	System level tests for RF commissioning, phase 2	T8 = 1 October 2020	T8+20M

PC Installation Phase I and Phase II

Scope of work:

- **Klystrons Modulators for RFQ and DTL installation**(installation of 4 units)
- **Klystron Modulators for Medium / High Beta installation** (installation of 10 units)
- **Magnet Power Converters installation** (installation of 38 crates (3U 19”), 133 crates (4U 19”), 7 cabinets (19”, 45U)

Project start date: **1 August, 2017**
Project finish date: **31 July, 2022**

Phase 1: 1 August 2017 - 30 June 2019
Phase 2: 1 August 2020 - 31 July 2022

Total contribution 6.15 FTE

Phase 1 - **4.35 FTEs**
Phase 2 - **1.8 FTEs**
The overall contribution: 664 200 $€_{2013}$

Status: recommended for acceptance by In-Kind Review Committee

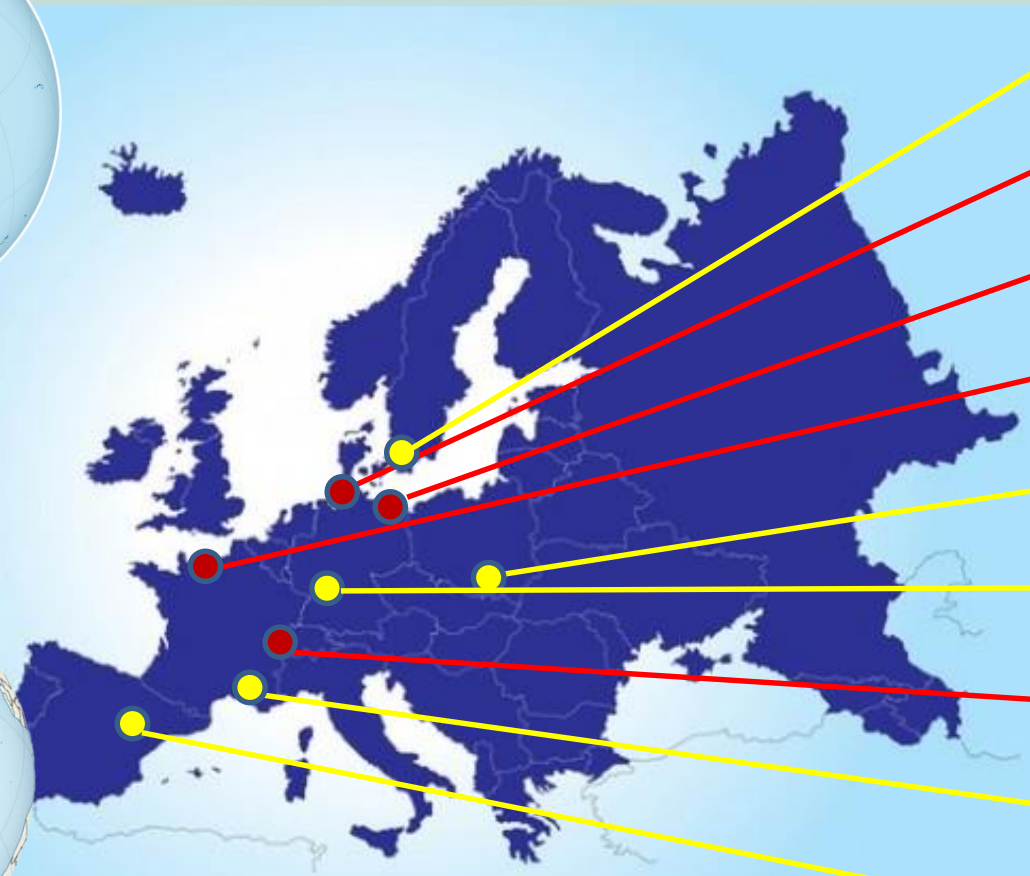
PC Installation Phase I and Phase II

#	Activity	Support Period Start (preliminary date)	Support Period End (preliminary date)
1.1	Klystron Modulators installation for RFQ and DTL, phase 1 (2017)	T1.1 = 15 Nov 2017	T1.1+1.5M
1.2	Klystron Modulators installation for RFQ and DTL, phase 1 (2018/2019)	T1.2 = 1 January 2018	T1.2+12M
2.1	Klystron Modulators installation for Medium Beta, phase 1 (2017/2018)	T2.1= 1 May 2018	T2.1+6M
2.2	Klystron Modulators installation for Medium, phase 1 (2018/2019)	T2.2 = 1 Nov 2018	T2.2+7M
2.3	Klystron Modulators installation for High Beta, phase 2 (2020/2022)	T2.3 = 1 Aug 2020	T2.3 + 24M
3.1	Magnet Power Converters installation, phase 1 (2017)	T3.1 = 1 Sept 2017	T3.1+4M
3.2	Magnet Power Converters installation, phase 1 (2018/2019)	T3.2 = 1 January 2018	T3.2+14M

IFJ PAN expertise

T2K, J-PARC
BELLE 2, KEK

CTA
CHILE



ESS
LUND

E-XFEL
DESY

W7X
IPP GREIFSWALD

SPIRAL 2
GANIL

IFJ PAN
KRAKÓW

FAIR
DARMSTAT

LHC, ATLAS
CERN

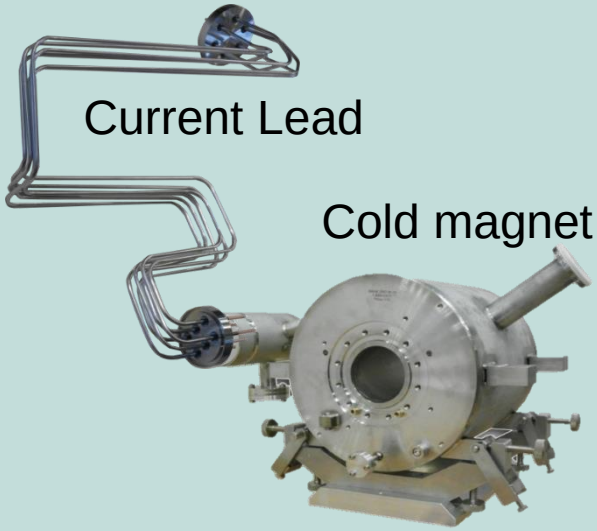
ITER
CADARACHE

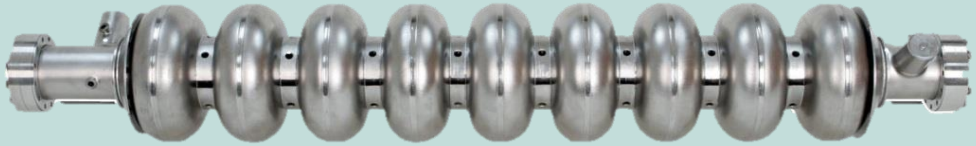
F4E
BARCELONA

Acceptance tests of superconducting components of the XFEL accelerator

2010–2012 preparatory phase to perform the acceptance tests of:

- 100 Cold magnets + 100 Current Leads
- 816 Cavities
- 100 Cryomodules



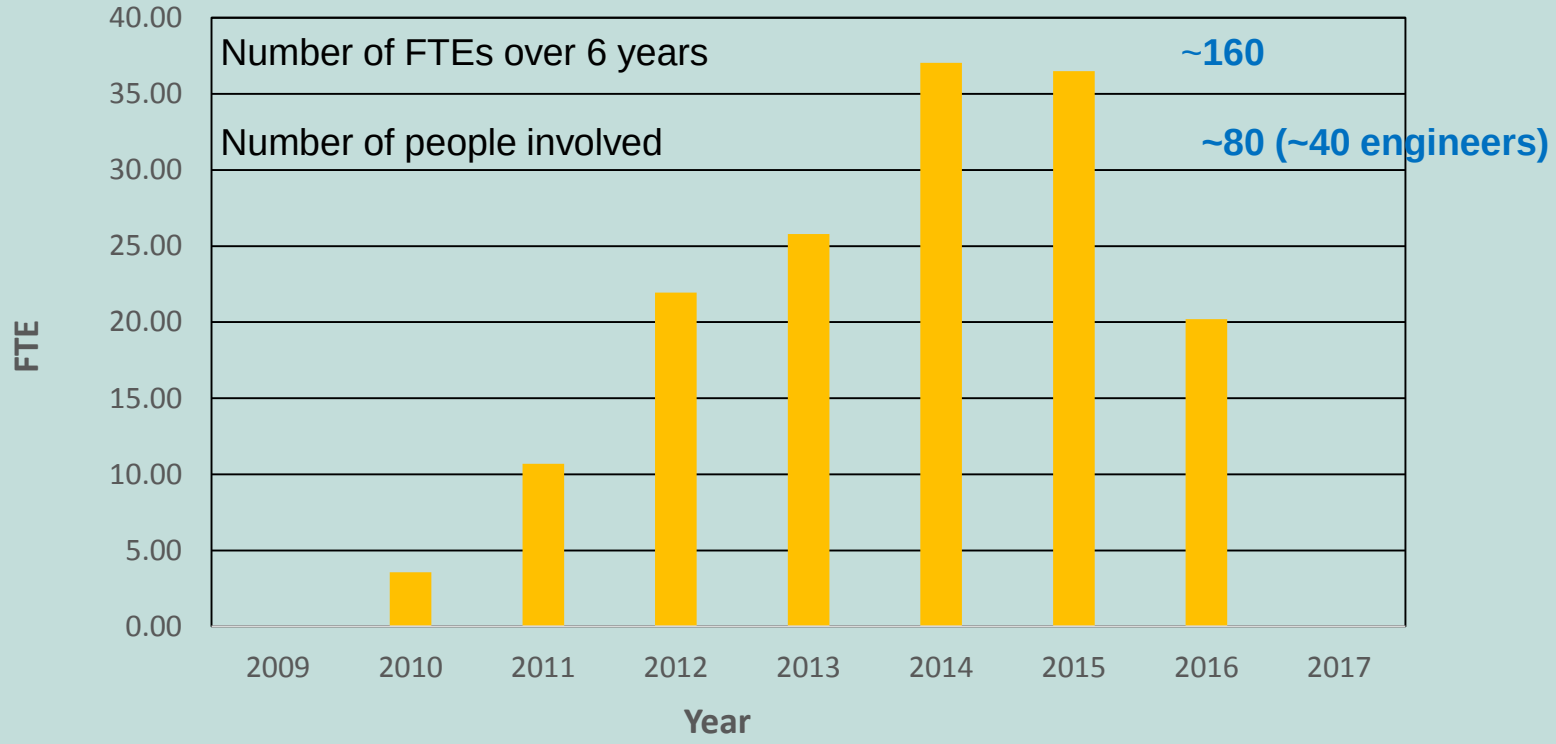


Cavity

Cryomodule

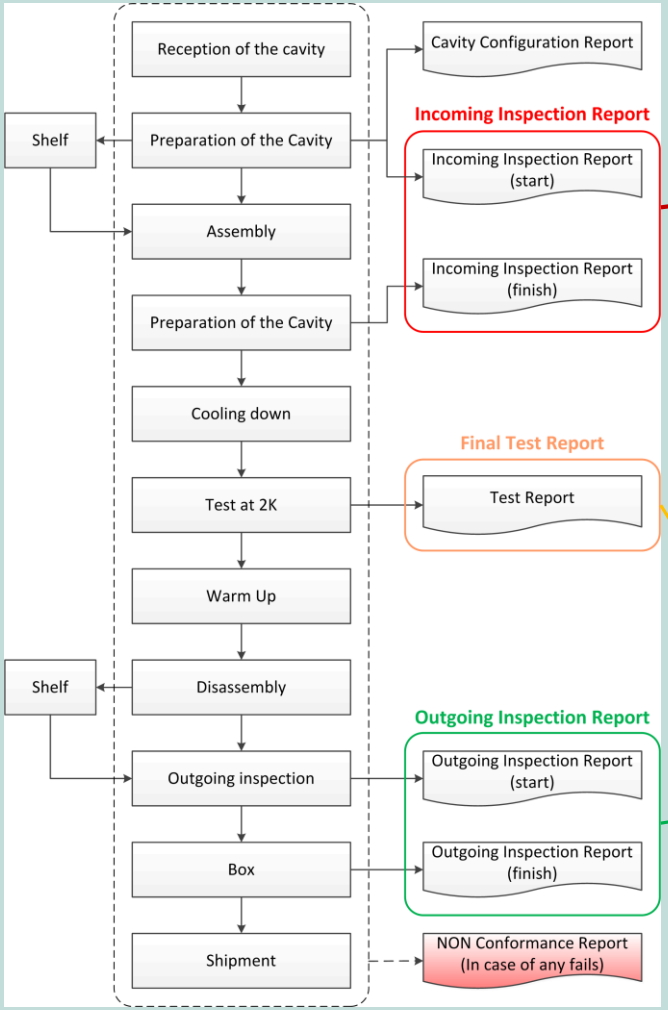
IFJ PAN in-kind contribution 2010 – 2016

IFJ PAN at XFEL

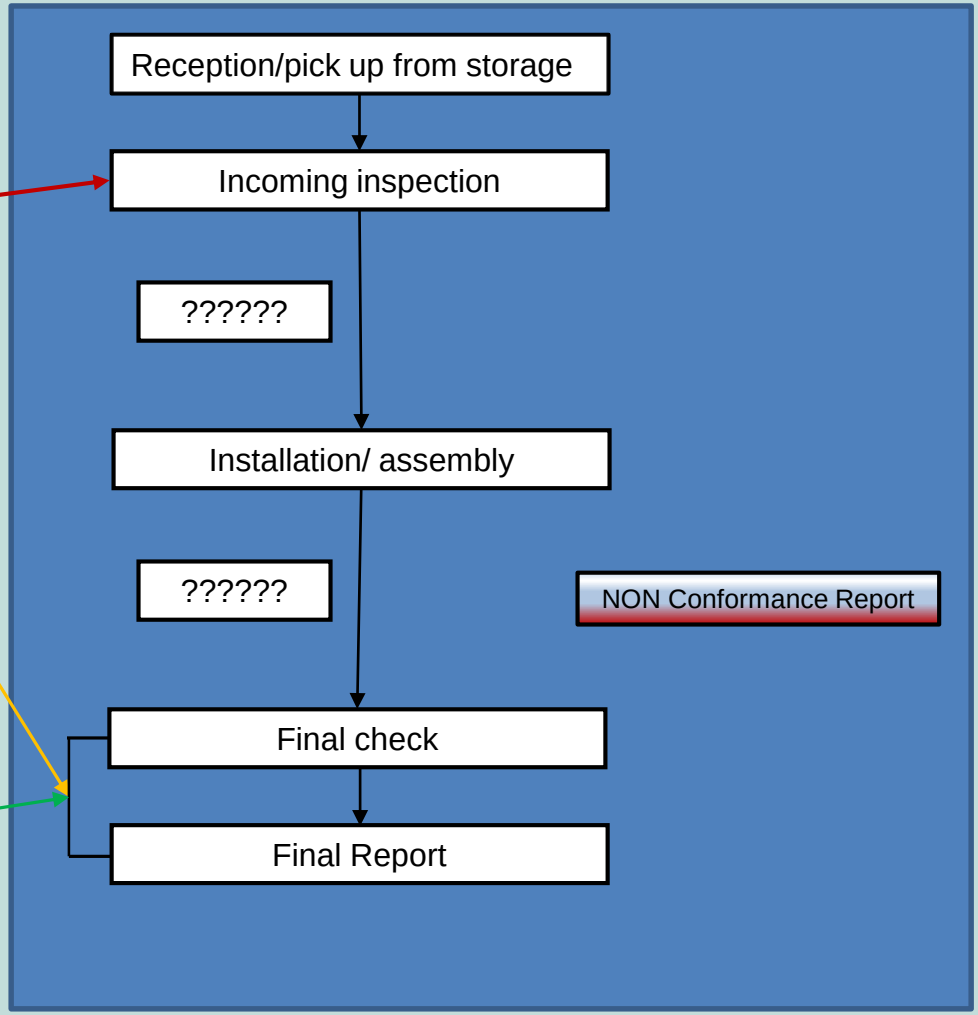


In total following number of tests were performer by IFJ PAN team

1214 tests of **813** series cavities
108 tests of **101** series cold magnets and current leads
107 tests of **100** series cryomodules



XFEL Cavity test flow chart



ESS RF component installation chart - proposal

Selected tasks performed for the XFEL cavities (with using VNA):

- Spectrum measurement at warm – during incoming inspection of the cavity
- HOM tuning
- Connection of the all cables needed to perform the test at cold
- HOM spectra at cold
- Spectrum measurement at warm + HOM tuning – during outgoing inspection of the cavity

Incoming inspection of the cavity

HOM tuning and cable connection

HOM spectra measurement

Selected tasks performed for the XFEL cryomodules :

- Cabling of the module (RF, signal, sensors)
- Connecting of the waveguides inside the test stand
- Cable calibration and attenuation measurement – using VNA
- Spectrum measurement at warm – incoming inspection – VNA
- Operating of the klystron, LLRF system
- Work with personal and technical interlock

Cabling of the cryomodule

Spectrum measurement at 2K

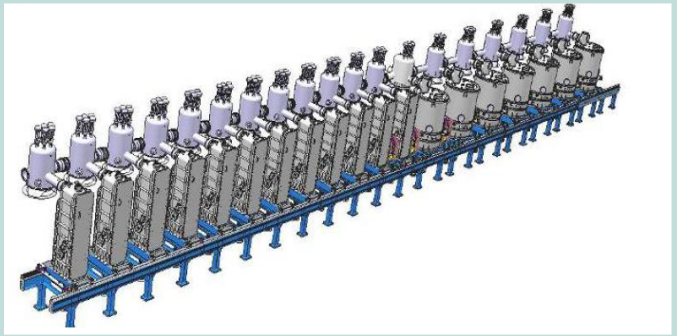
Incoming inspection of the cryomodule

Waveguides connection

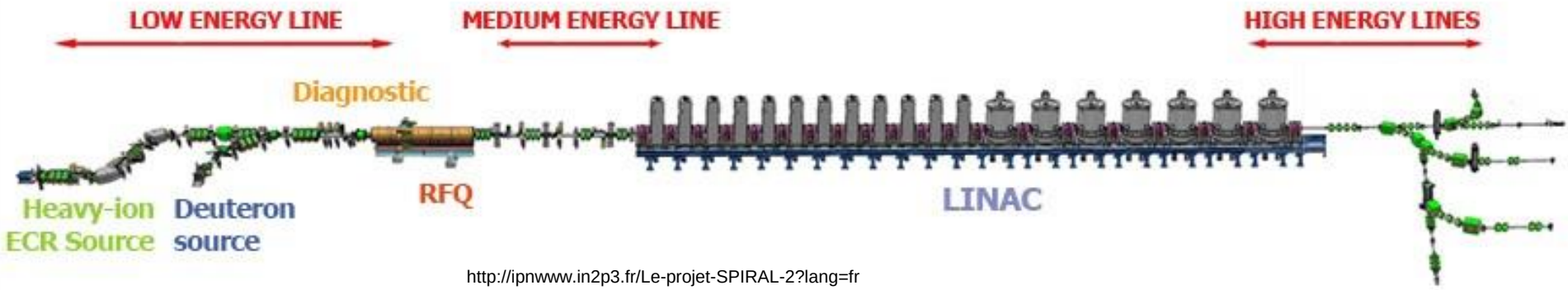
Summary:

- Gained experience with some RF equipment
- Gained experience with general work organization
- Experience with reports preparation
- Experience with preparation and realization of the procedures and NON conformance reports

ASSEMBLY OF THE LINEAR ACCELERATOR AT GANIL 2015 - 2016



CRYOGENIC SYSTEM DESIGN FOR SPIRAL 2 PRJECT AT GANIL
S. Crispel



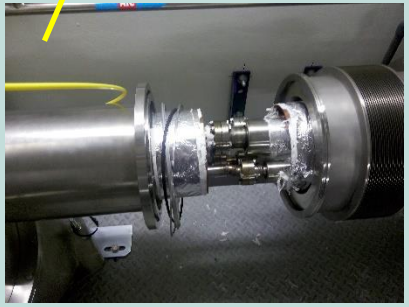
http://ipnwww.in2p3.fr/Le-projet-SPIRAL-2?lang=fr

VALVE BOX installation and testing

- Electrical tests
- Assembly: sensor and pneumatic connection
- Positioning on gangway in the tunnel
- Connection: Low(liquid) and High (thermal screen) pressure line in the tunnel

LOWERING IN TUNNEL

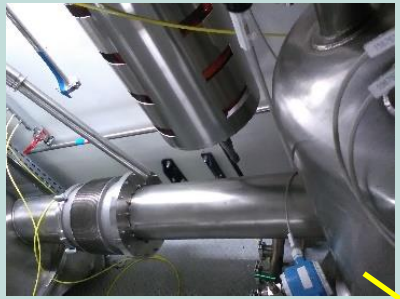
CONNECTION

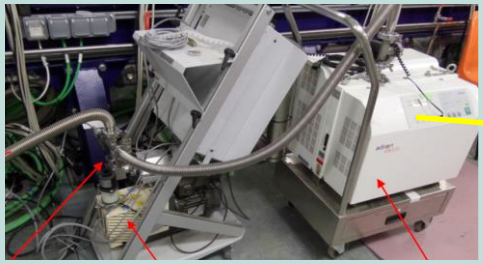


- Testing the leak tightness (vacuum insulation)
- Testing the pressure of the cryogenic circuits

- Assembly: screen & superinsulation & closing the sleeve

SUPERINSULATION





THE LEAK TIGHTNINESS OF THE VACUUM ISOLATION

CLOSE THE SLEEVE

CRYOMODULES installation and tests

Incoming inspection
- Electrical tests
- Checking the cavity vacuum
- Starting the shock recorder

In the tunnel
- Positioning on the assembly support
- Assembly the barometric compensations
- Positioning on the accelerator
- Checking the shock recorder
- Checking the cavity vacuum
- Connection: Low(liquid) and High (thermal screen) pressure

LOWERING IN TUNNEL

POSITIONING ON THE ASSEMBLY SUPPORT

- Testing the leak tightness (vacuum insulation)
- Testing the pressure of the cryogenic circuits

- Assembly: screen & superinsulation & closing the sleeve
- Assembly the drive of the tunning systems

POSITIONING ON THE ACCELERATOR

Wendelstein W7X stellarator assembly at IPP Greifswald

Final preparation of the bus bars
– 121 pieces, ~70 technological steps per piece

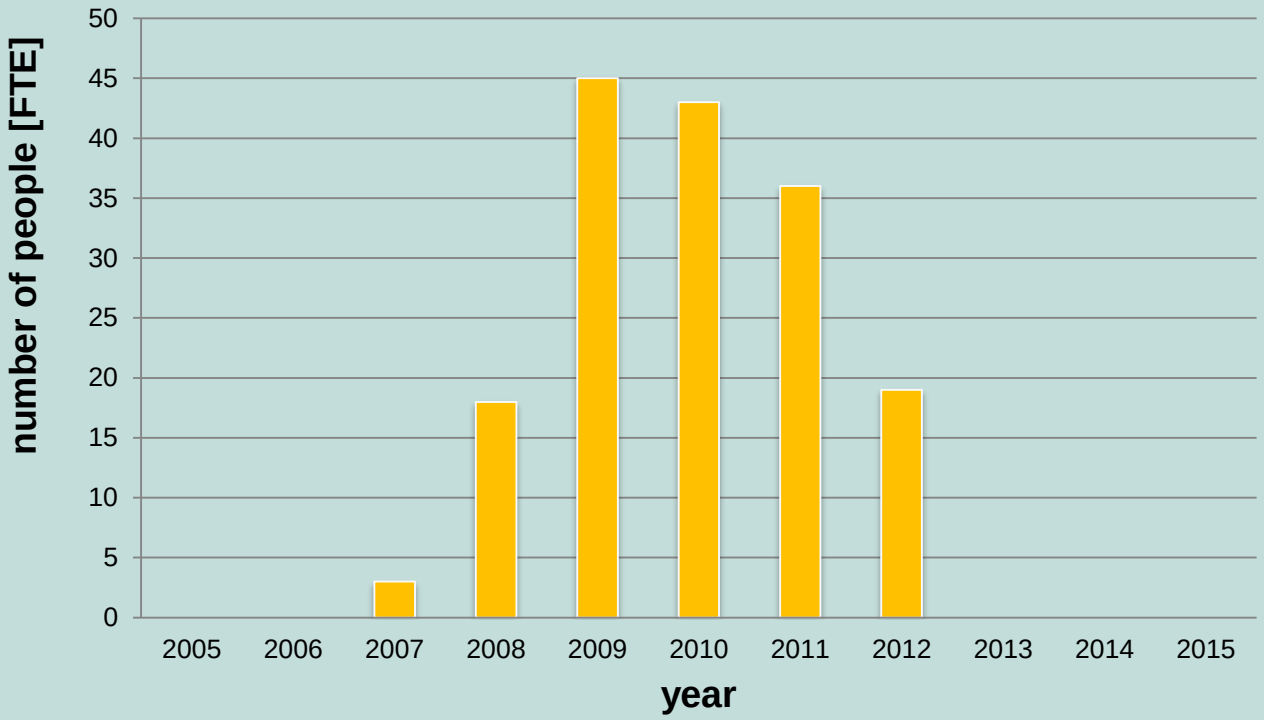
Assembly of the bus bar systems on the modules
– 140 joints, ~60 technological steps per joint

Connection of bus bars systems between modules
– 46 joints, ~60 technological steps per joint

Modification and installation of QD (Quench Detection) system wiring

IFJ PAN at W-7X

Wendelstein W7X stellarator assembly at IPP Greifswald



Total number of FTEs over 6 years	**~164**
Total number of IFJ PAN people involved	**~ 50**

Assembly of the bus bar systems on the modules

Transportation of a single bus bar to the preparation area

Tinning of the bus bar super conductors

Handling of the bus bars in the preparation area

Installation of the bus bars on the module

Electrical connection of the coil current leads and bus bars

Connection of the bus bar systems between modules

Electrical connection

Wet insulation

Electrical measurements

Clamping of the bus bars to the structure

IFJ PAN at CERN (selected)

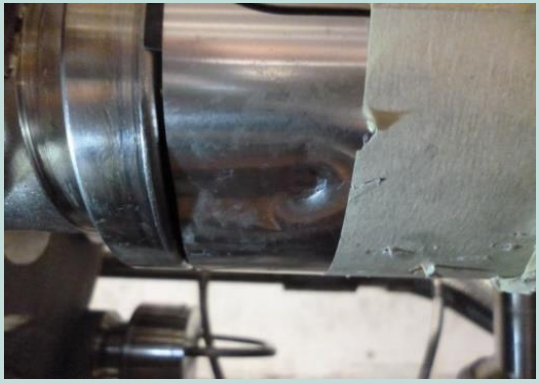
Contribution to LHC assembly 2005 - 2009

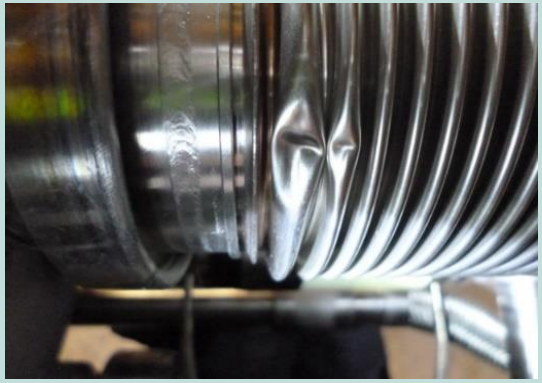
Quality Assurance of Interconnections of the LHC magnets

A plug-in module (PIM) damaged during a cool-down/warm-up thermal cycle of the magnets

Non-conforming weld (left) and compensation bellow (right)

Plug-In-Module (PIM) damages

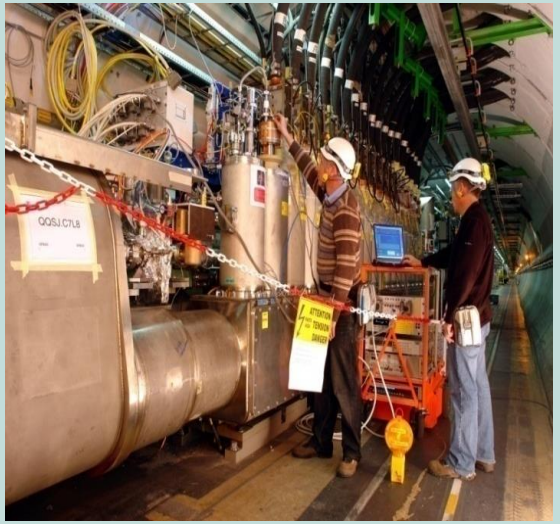




IFJ PAN at CERN (selected)

Collaboration with CERN - Contribution to LHC assembly 2005 - 2009

Electrical Quality Assurance of interconnections of the LHC magnets



During LHC assembly phase, almost 2500 electrical tests of 8 types were done. The tests were performed on different configuration of the superconducting magnets. Every test verified 20 to 76 circuits or lines in terms of continuity, resistance and HV qualification. During LHC hardware commissioning phase more than 12000 tests were performed to check nearly 1600 superconducting circuits in warm and cold states.

IFJ PAN at CERN (selected)

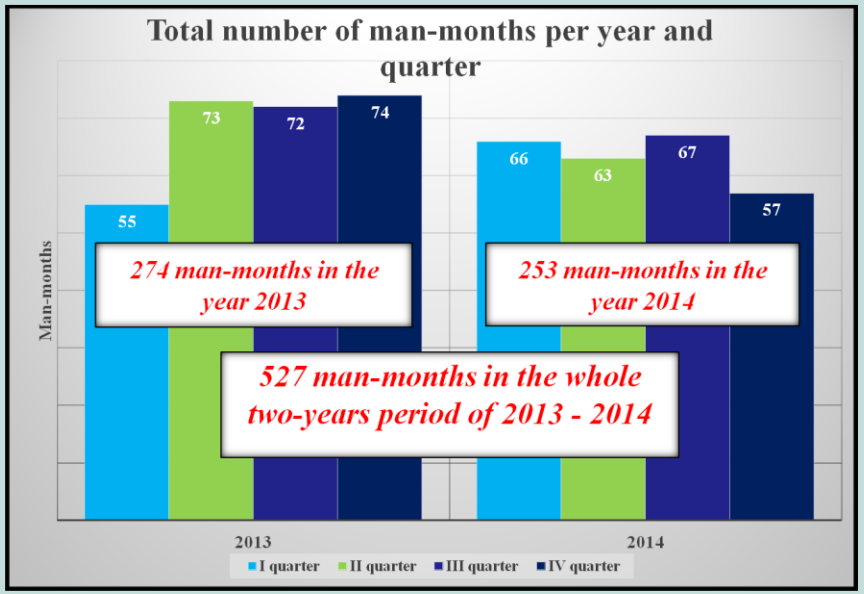
Collaboration with CERN – continuation

Long Shutdown 1 – 2013 – 2014

Electrical Quality Assurance of interconnections of the LHC magnets

Quality Assurance of interconnections of the LHC magnets

128 man-months foreseen – 6 people working most of the time



IFJ PAN at ESS

- Polish goverment supports this contribution

  - decision about financial suport was taken in June 2016

- IFJ PAN has started preparatory work

  - collecting of vital information for our team
  - creation of team for RF and PC systems installation

- IFJ PAN signed three Technical Annexes with ESS

  - SCHEDULE AIK 8.6 - RF Installation Phase I and Phase II
  - SCHEDULE AIK 10.1 - Cryomodule testing
  - SCHEDULE AIK 17.3 - PC Installation Phase I and Phase II

Challenges: install a big team in Lund

- ESS HR in-kind contribution is needed at the beginning