The Henryk Niewodniczanski
Institute of Nuclear Physics
Polish Academy of Sciences

Overview of IFJ PAN involvement in international projects

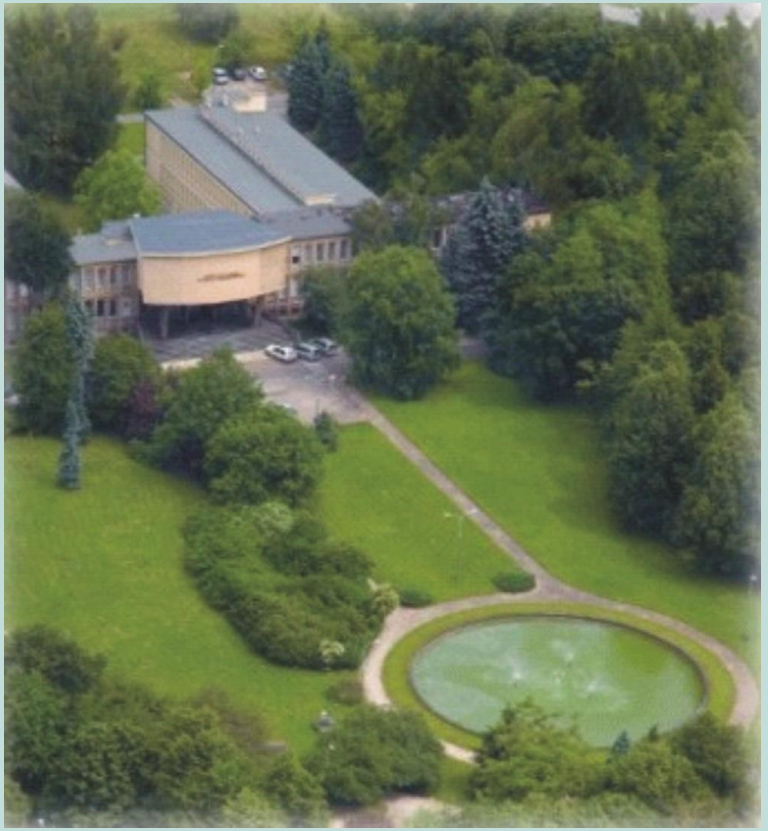
D. Bocian

IFJ PAN - ESS technical meeting

Kraków, 24th March 2014

Outline

- General information
- Accelerator activities at IFJ
- IFJ PAN and selected projects
  - European XFEL
  - LHC consolidation and upgrade
  - Wendelstein 7X
- Scientific equipment construction
- Summary

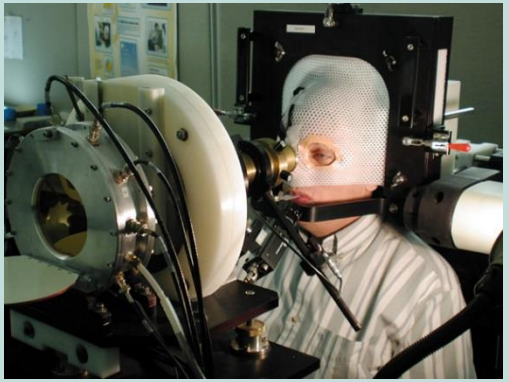


General information

- 530 personnel
- Prof. 39, Assoc. Prof. 52, Ph.D. 108
- PhD studies – 61 students
- Interdisciplinary PhD studies
- 6 divisions: 28 departments
- centre of excellence
- centre of advanced technology
- 4 accredited laboratories
- Equipment and Scientific Infrastructure Construction Division (DAI)

Accelerator activities at IFJ

- **cyclotron AIC-144**
  - proton beam energy: 60 MeV
  - Proton Radiotherapy of Eye Melanoma
- **Cyclotron Proteus C-235**
  - National Centre for Hadron Radiotherapy
  - under construction (2013)
- **neutron generator**
  - 14 MeV
- **VdG high stability**
  - 2.5 MeV



IFJ PAN and international projects

Running projects:

- **XFEL, DESY, Hamburg, 2009 – 2015**
- **LHC, CERN, Geneva, 2013 – 2014**
- ITER, Cadarache, 2010-2015
- Cherenkov Telescope Array (CTA), 2008 – 2013

Completed projects

- **LHC, CERN Geneva, 2005 – 2012**
- **Wendelstein 7X, IPP Greifswald, 2007 – 2012**
- ATLAS, CERN Geneva, 2004 - 2012
- T2K, J-PARC Tokai, Krakow/J-PARC, 2007 – 2009

IFJ PAN in-kind contribution to XFEL construction
(2009 - 2015)

1) Performance of acceptance tests of ***cavities*** for a series of 840 units on DESY infrastructure and delivering the corresponding test reports

2) Performance of acceptance tests of ***cryomodules*** for a series of 103 units on DESY infrastructure and delivering the corresponding test reports

3) Performance of acceptance tests of ***cold magnets*** for a series of 103 units on DESY infrastructure and delivering the corresponding tests reports – common effort with DESY

XFEL RF cavities tests

XFEL quadrupole magnets tests

XFEL cryomodules tests

IFJ PAN in-kind contribution to XFEL construction

IFJ PAN tasks

- **Tests of cavities and cryomodules in the AMTF Hall**
- **Tests of cold magnets**

Each IFJ PAN task is split in two phases:

Preparatory phase

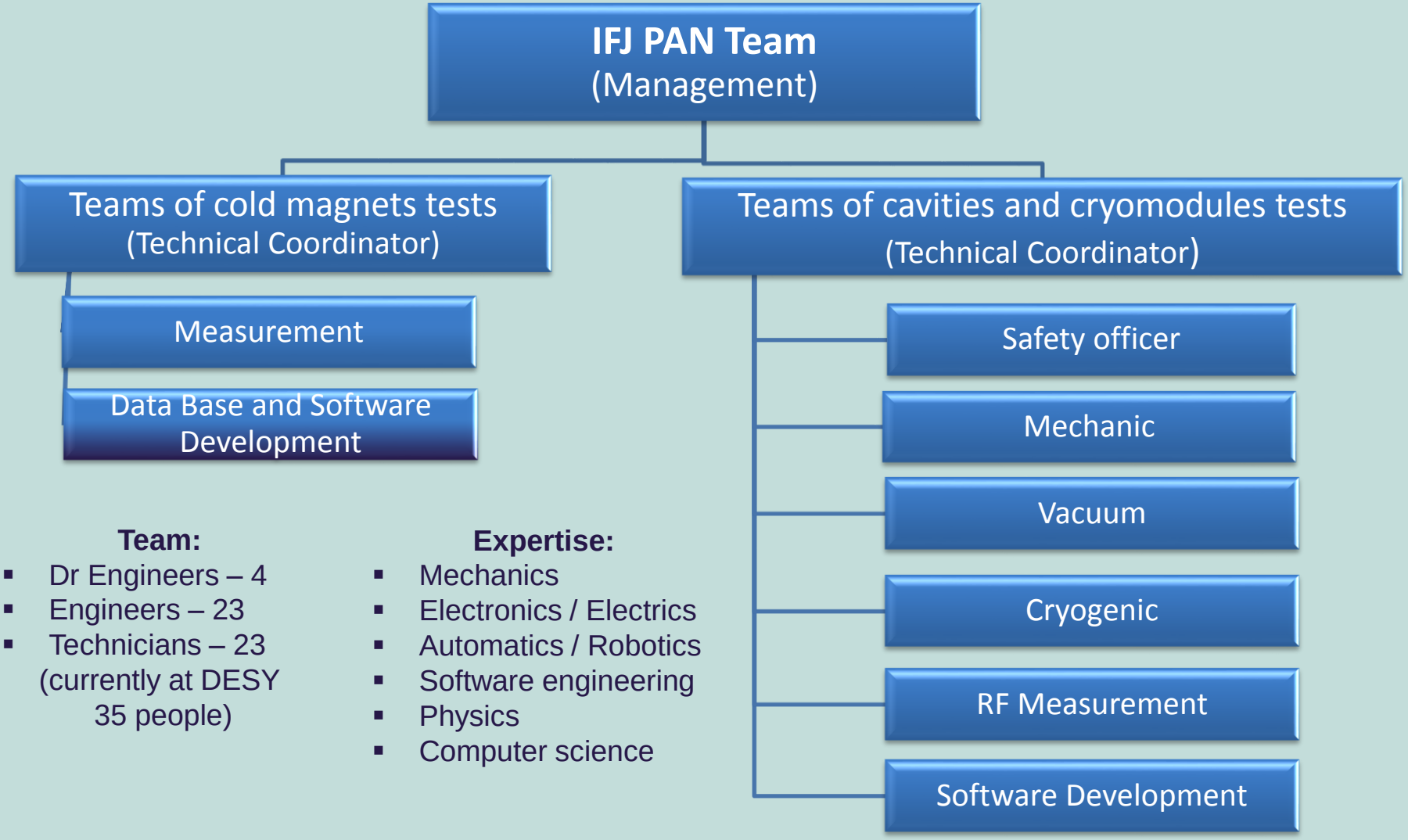
- Knowledge acquiring (learning, trainings, meetings with DESY experts);
- Procedures writing;
- Software preparation;
- Performance of preseries tests: (3 cold magnets and 3 CL, 24 cavities and 3 cryomodules).

Serial tests phase

- Performance of serial tests:
  - Cold magnets – 100
  - Current leads – 100
  - Cavities – 816
  - Cryomodules – 100
- Data analysis and reporting;
- Software upgrade.

IFJ PAN in-kind contribution to XFEL construction

IFJ PAN team structure



Team:

- Dr Engineers – 4
- Engineers – 23
- Technicians – 23

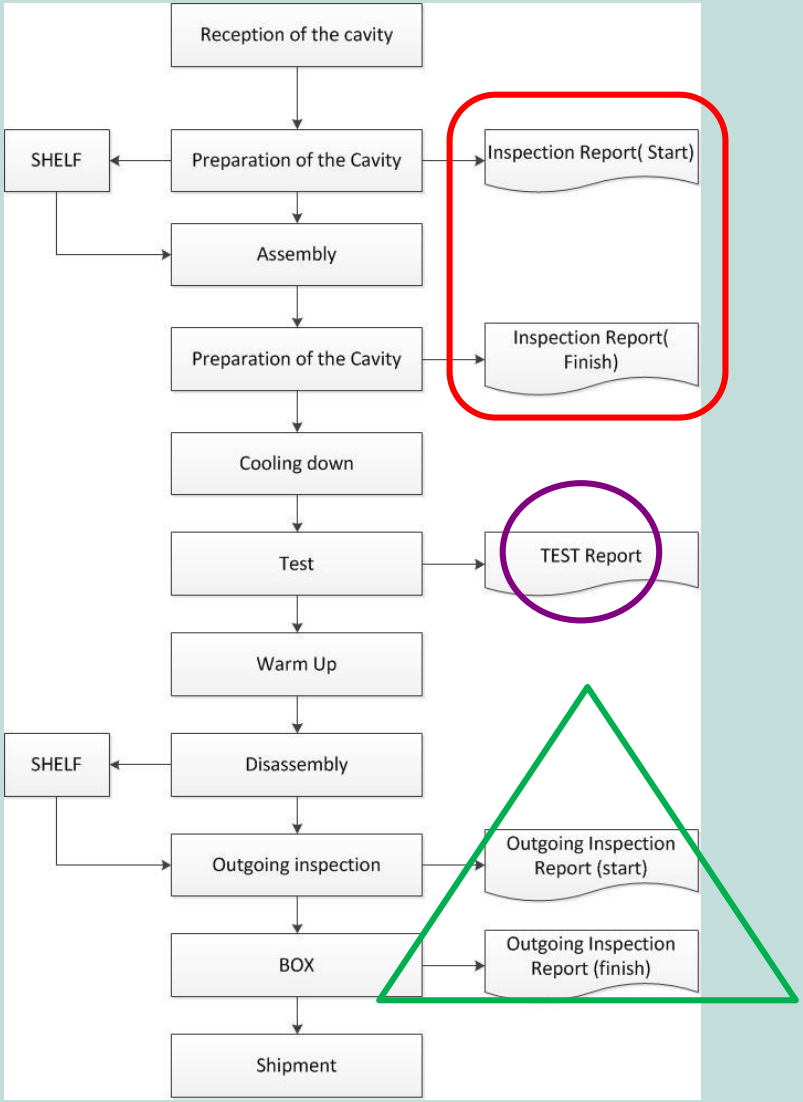
(currently at DESY 35 people)

Expertise:

- Mechanics
- Electronics / Electrics
- Automatics / Robotics
- Software engineering
- Physics
- Computer science

IFJ PAN in-kind contribution to XFEL construction

Cavity Test Flow chart



We create 3 reports from each test and upload them to the EDMS:

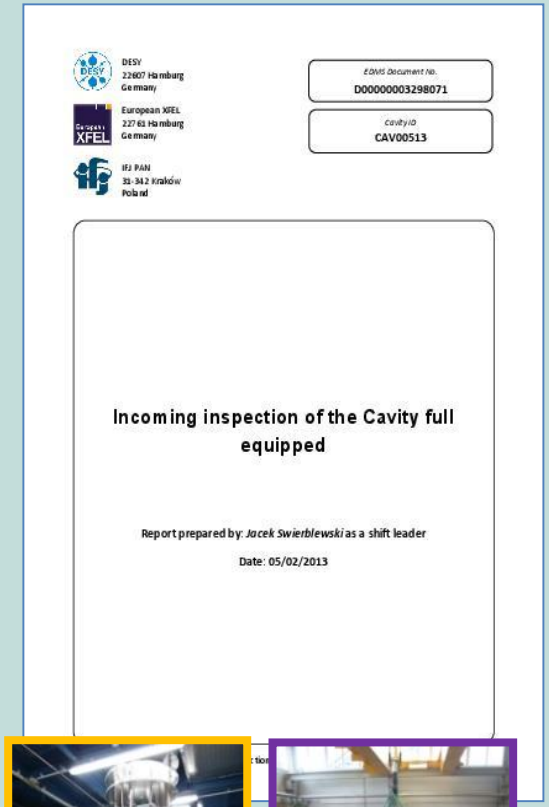
- Incoming inspection report
- Final test report
- Outgoing inspection report

IFJ PAN in-kind contribution to XFEL construction

Cavity test: Incoming inspection & preparation for test

Main tasks:

- ❑ Incoming Report
  - Mechanical check of the cavity
  - Vaccum check
  - Electrical check
  - Cavity spectrum check & HOM tuning
- ❑ Assembling cavity to the insert
- ❑ Connecting cavity to the vacuum line (in cleanroom conditions)
- ❑ Cables connection with TDR
- ❑ Leak check of the cavity
- ❑ Transport of the insert to the cryostat
- ❑ Connecting of the insert to the vacuum line


DESY
22607 Hamburg
Germany

European XFEL
22761 Hamburg
Germany

IFJ PAN
31-342 Kraków
Poland

EDMS Document No.
D00000003298071

Cavity ID
CAV00513

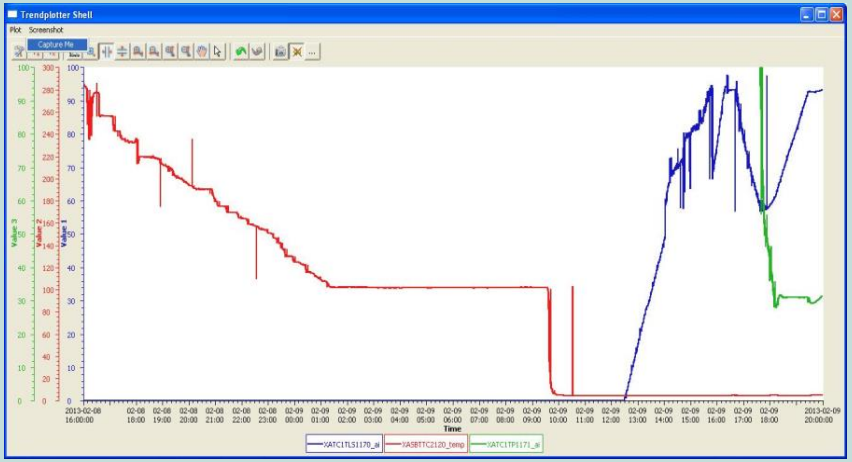
Incoming inspection of the Cavity full equipped

Report prepared by: *Jacek Swierblewski* as a shift leader

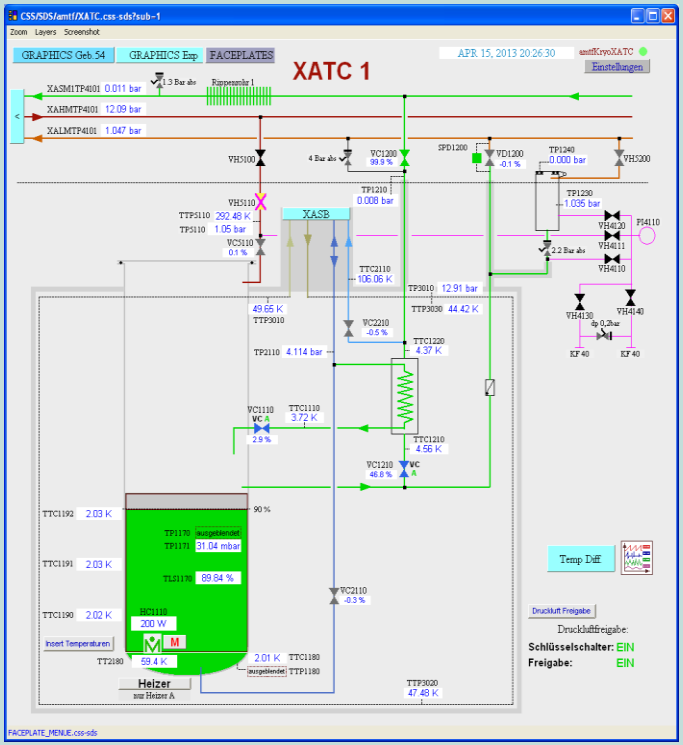
Date: 05/02/2013

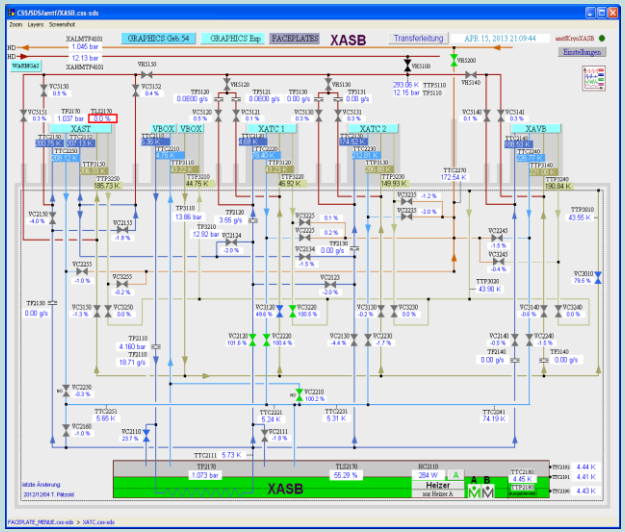
Cryogenic activities at AMTF:

- ❑ Cool down
- ❑ Maintenance during the test
- ❑ Warm up



Cool down process from 300 K to 2 K





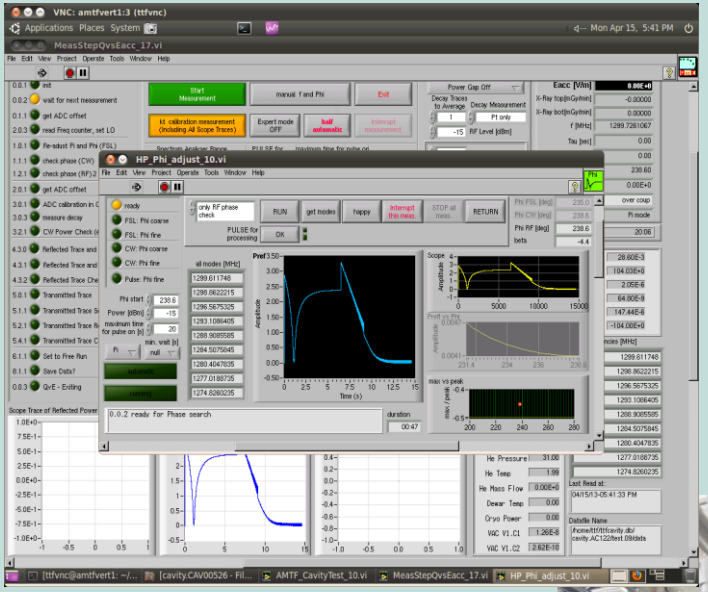
Cryogenics operator's control panel for test cryostat (left) and subcooler box (right) at AMTF.

Cavity cryostat at AMTF

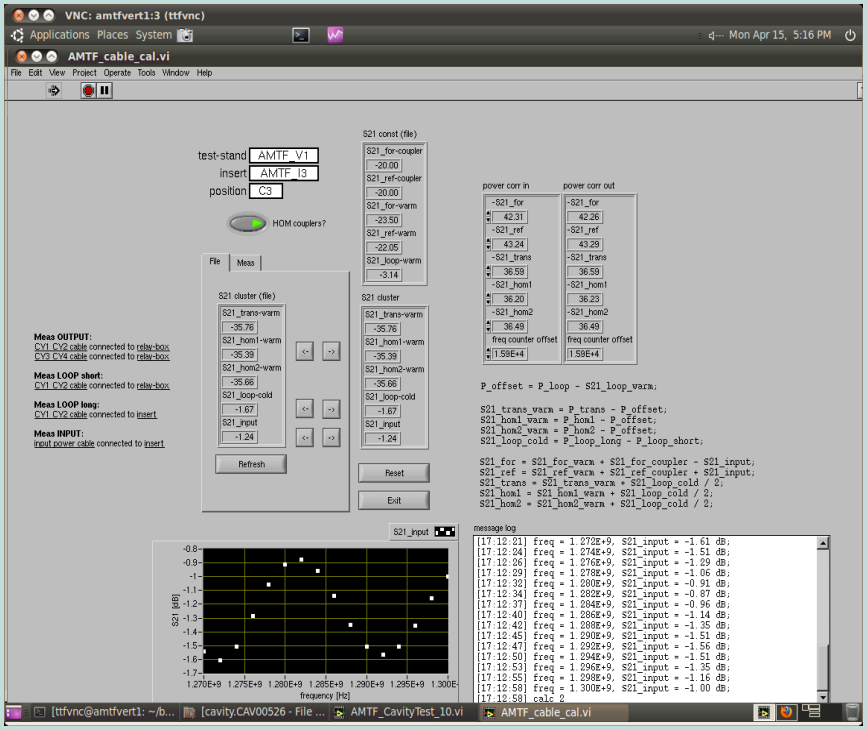
IFJ PAN in-kind contribution to XFEL construction

Cavity test in vertical cryostat at 2K

- Part of software written by IFJ PAN engineers
- Q vs E measurement



Vertical measurements application



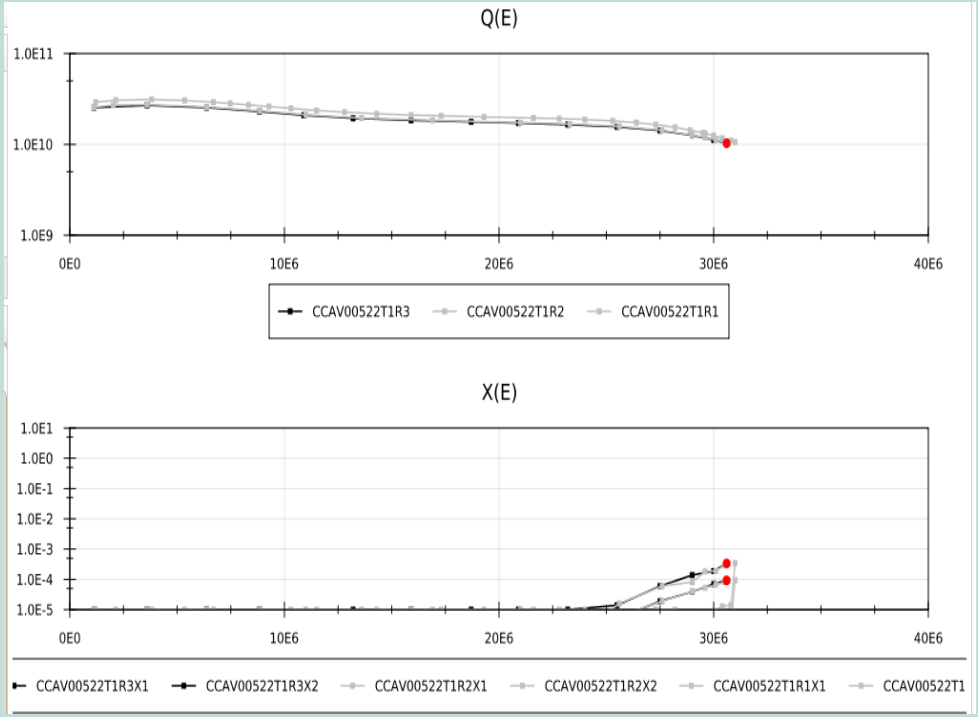
Cable calibration application

Cavity test-stand, cryostat (left) and electronic racks (right)

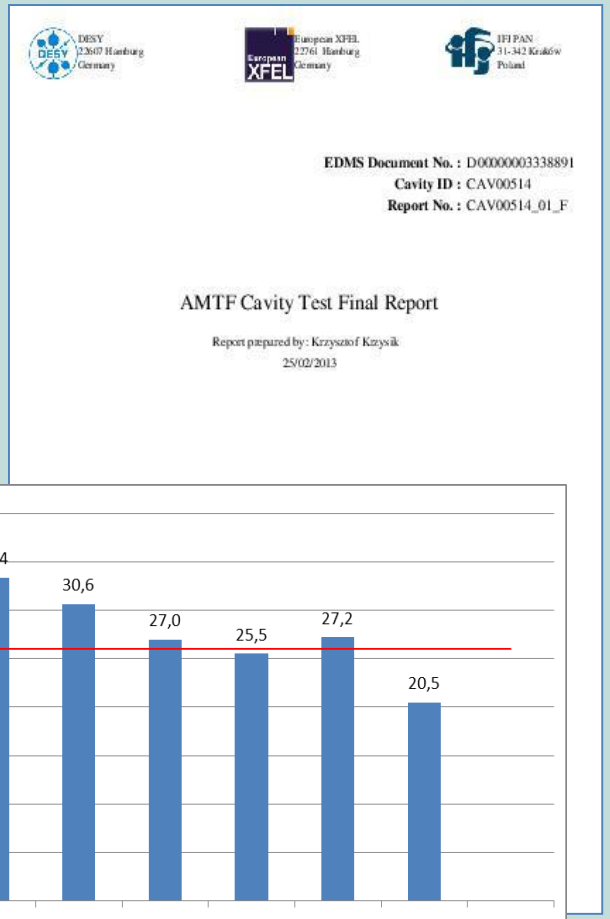
IFJ PAN in-kind contribution to XFEL construction

Cavity test in vertical cryostat at 2K

- Maximal E_{acc} (> 26 MV/m)
- Q_0 factor vs. E_{acc} (>10^{10})
- Radiation vs. E_{acc} (<10^{-2} mGy/min)



Results overview from IFJ PAN cavitiy database



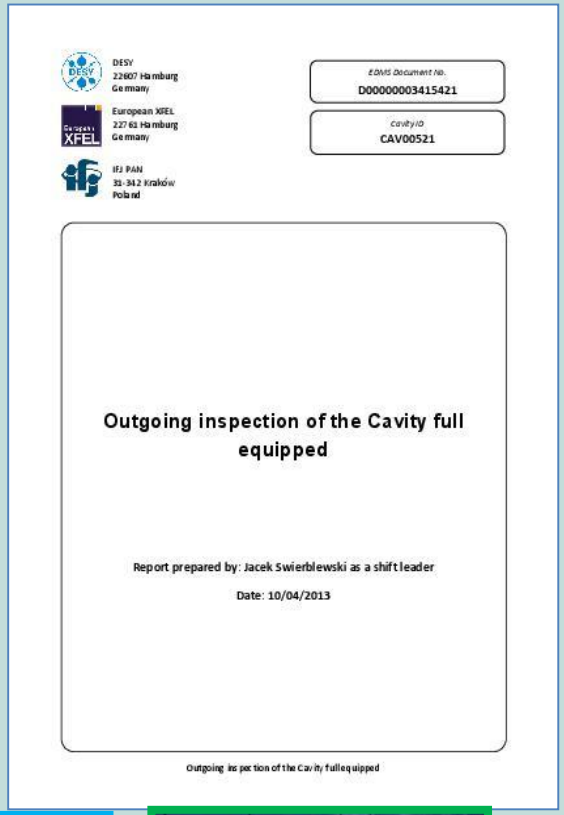
Example of series cavities test results

IFJ PAN in-kind contribution to XFEL construction

Cavity test: Disassembling and outgoing

Main tasks

- ❑ Disconnecting of the insert from the vacuum line
- ❑ Transport of the insert to the preparation area
- ❑ Leak check of the cavity
- ❑ Disconnecting cavity from the vacuum line (in cleanroom conditions)
- ❑ Disassembling cavity from the insert
- ❑ Outgoing check
  - Mechanical check of the cavity
  - Vacuum check
  - Electrical check
  - Cavity spectrum check
- ❑ Preparation for shipment



DESY
22607 Hamburg
Germany

European XFEL
22761 Hamburg
Germany

IFJ PAN
31-342 Kraków
Poland

EDMS Document No.
D00000003415421

Cavity ID
CAV00521

Outgoing inspection of the Cavity full equipped

Report prepared by: Jacek Swierblewski as a shift leader

Date: 10/04/2013

Outgoing inspection of the Cavity full equipped

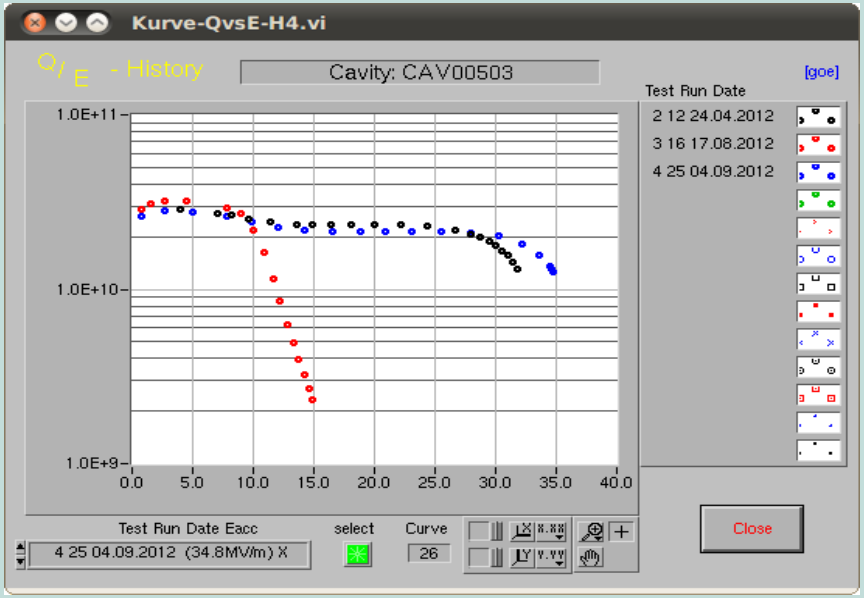
IFJ PAN in-kind contribution to XFEL construction

Cavity test: Summary

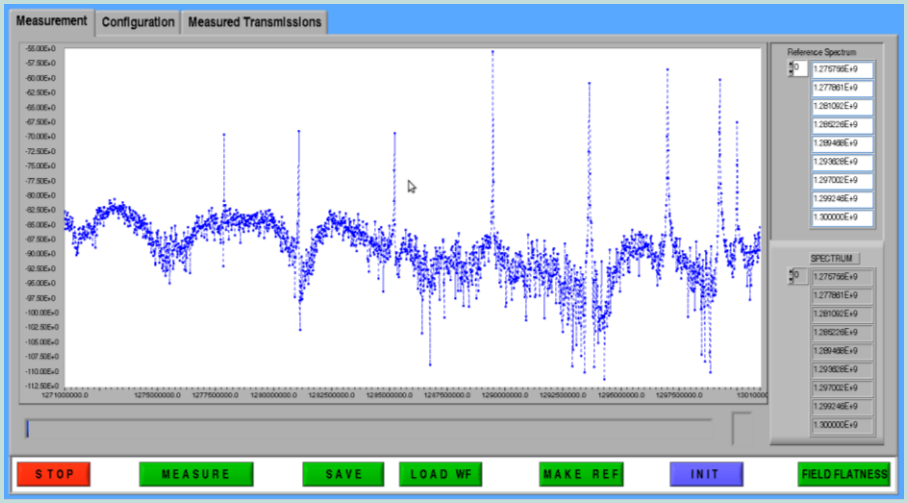
60 prototype and pre-series cavities – tested

800 production cavities - ~20% tested (end 2013)

Insertion of the cavity into the vertical cryostat



Results of RF cavity measurement

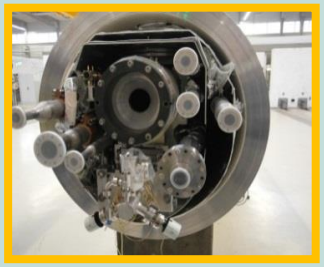


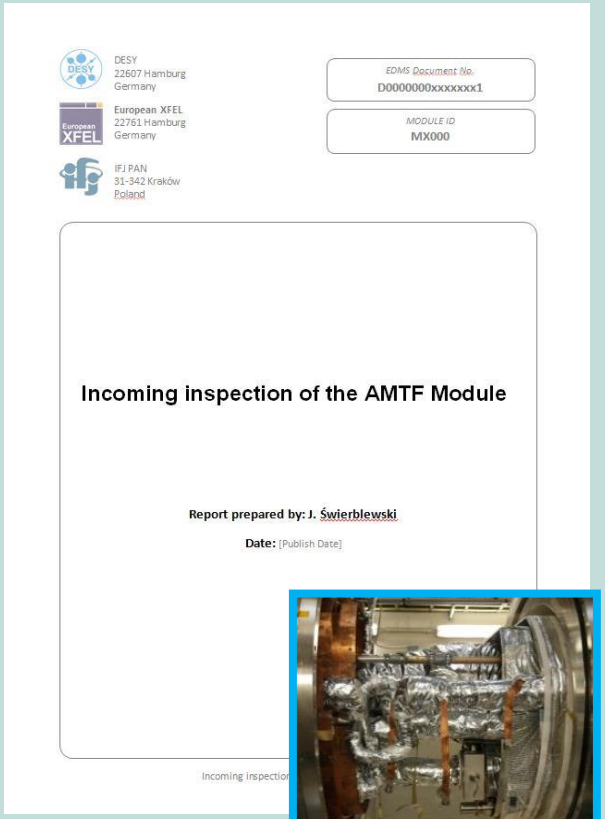
Measurement of the cavity fundamental mode spectra

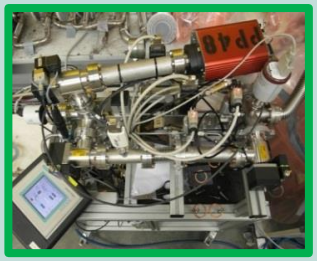
IFJ PAN in-kind contribution to XFEL construction

Cryomodule test: Incoming inspection and preparation for cold test

- Incoming checks
  - Mechanical check
  - Vacuum check
  - Check of the cavities fundamental mode spectra
  - Electrical check
  - Cavities tuner check
  - Shock loggers readout
- 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 and electrical cables
- Connect of all cryomodule process pipes to the test stands
- Leak check of cryomodule vessel (ISO-VAC) and cryogenic valves
- Assembly and isolating thermal shields
- Pumping down of vacuum insulation



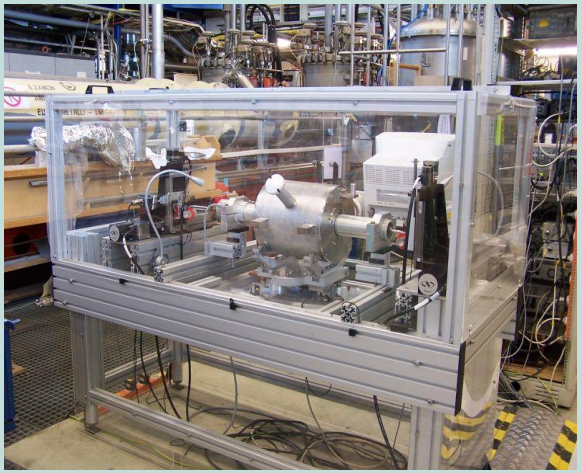




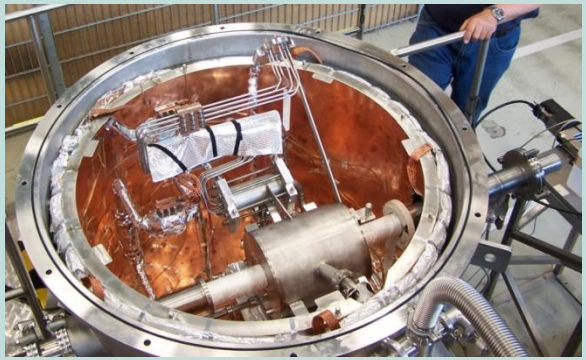
IFJ PAN in-kind contribution to XFEL construction

Cold magnet test: Test-stand

Hall 55 with cryogenic infrastructure for magnet tests



Test stand for magnet tests at warm (top) and electronic rack (left).



Test stand for magnet tests at cold (top) and electronic racks (right)

CL electrical check test-stand

IFJ PAN in-kind contribution to XFEL construction

Cold magnet test: Preparation and cold test

COLD MAGNET TEST at COLD

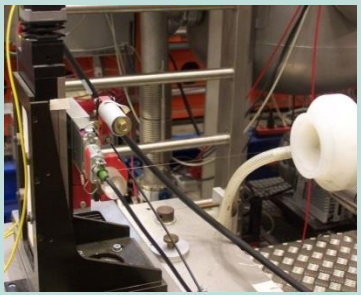
- POWER SUPPLY PRE-TEST COMMISSIIONING
- POWER SUPPLY STABILITY TEST
- HARMONICS MEASUREMENT DC
- HARMONIC MEASUREMENT FINISHING
- STRETCHED WIRE MEASUREMENT DC
- STRETCHED WIRE MEASUREMENT FINISHING
- TEST COMPLETION

COLD MAGNET FINAL WORKS

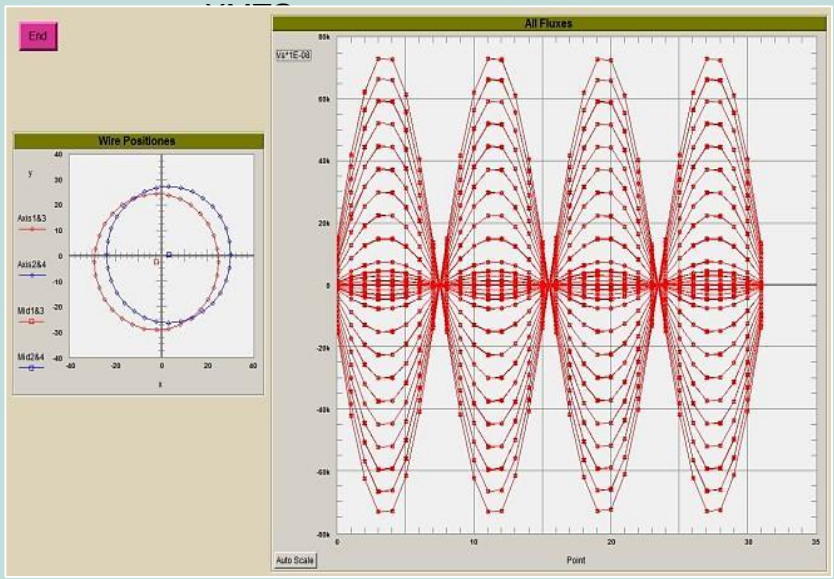
Electrical check of current leads connections

Magnet with CL installation in cryostat

Thermal insulation CL and magnet



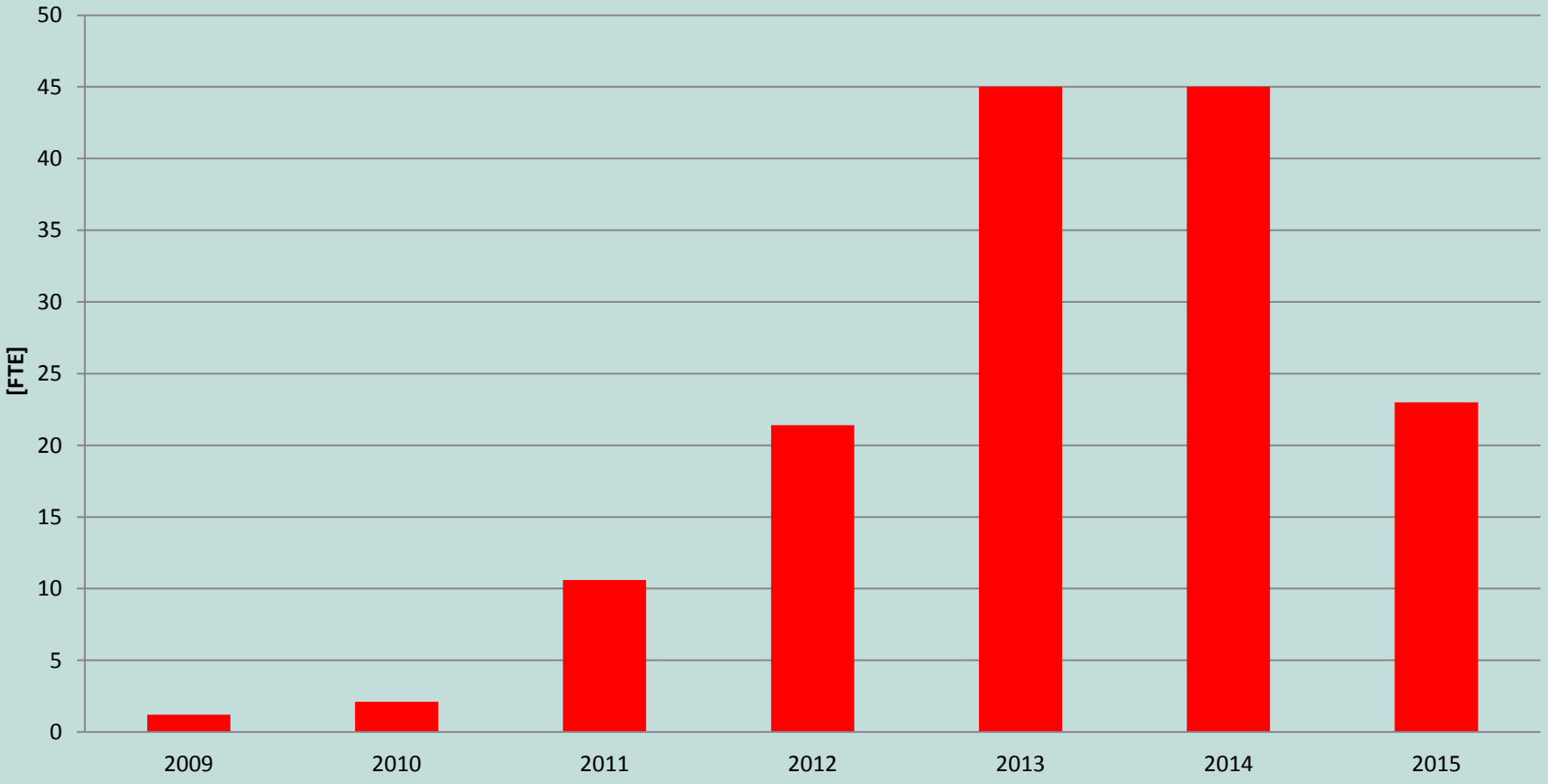
Stretched wire test at 2K



Results of stretched wire test at 2K

IFJ PAN effort to XFEL construction

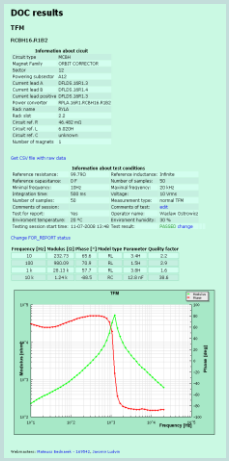
Total number of FTE's over 7 years	~150
Total number of trained IFJ PAN staff	~ 60



IFJ PAN and LHC
(2005-2014)

1) design & construction of measuring/testing devices
2) preparation of necessary software and data bases
3) manufacturing of superconducting N-lines
4) development of measuring/testing methods
5) organization, performance & documentation of electrical measurements /tests
6) organization, performance & documentation of interconnection inspection

Mobil test stations in LHC tunnel



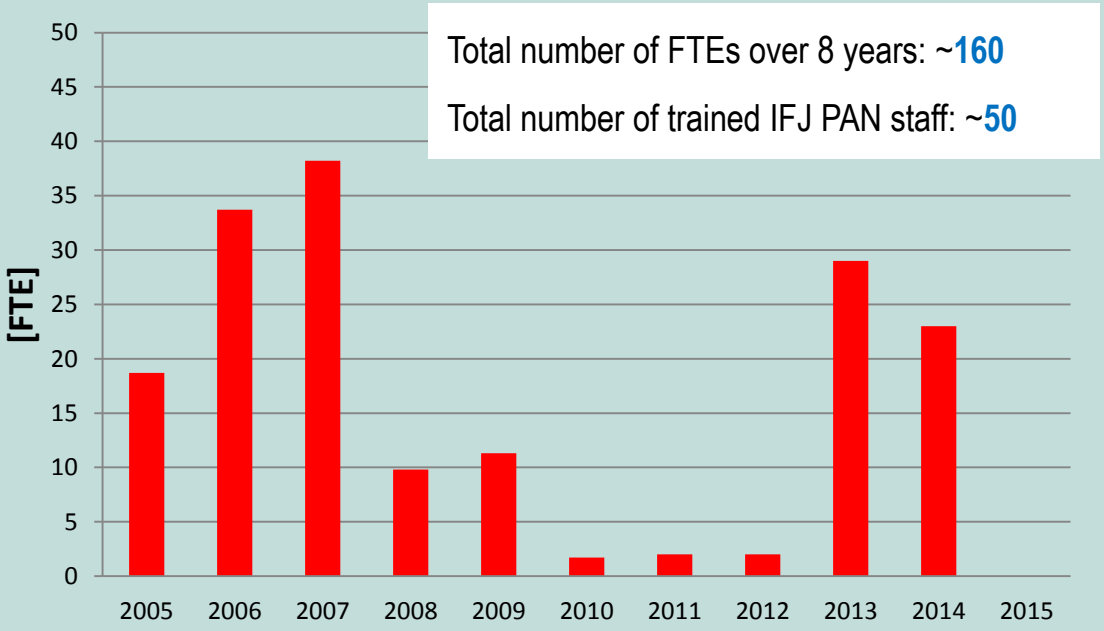
User interface

Damaged PIM (*Plug-In Module)*

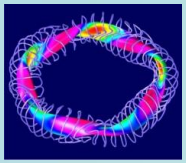
IFJ PAN and LHC

Summary

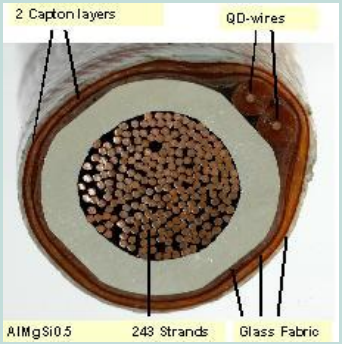
- Just recently group of 25 people (engineers and technicians) from the IFJ-PAN was performing the reference measurements before consolidation of the LHC superconducting circuits during Long Shutdown 1. The measurements are now completed.
- Exactly the same tests will be performed before machine start-up.
- Currently we are monitoring to the circuits' health during the consolidation.
- Part of the team is working on investigation and solving of the nonconformities revealed during standard measurements: short circuits caused by thermal cycle, abnormal resistances, etc.



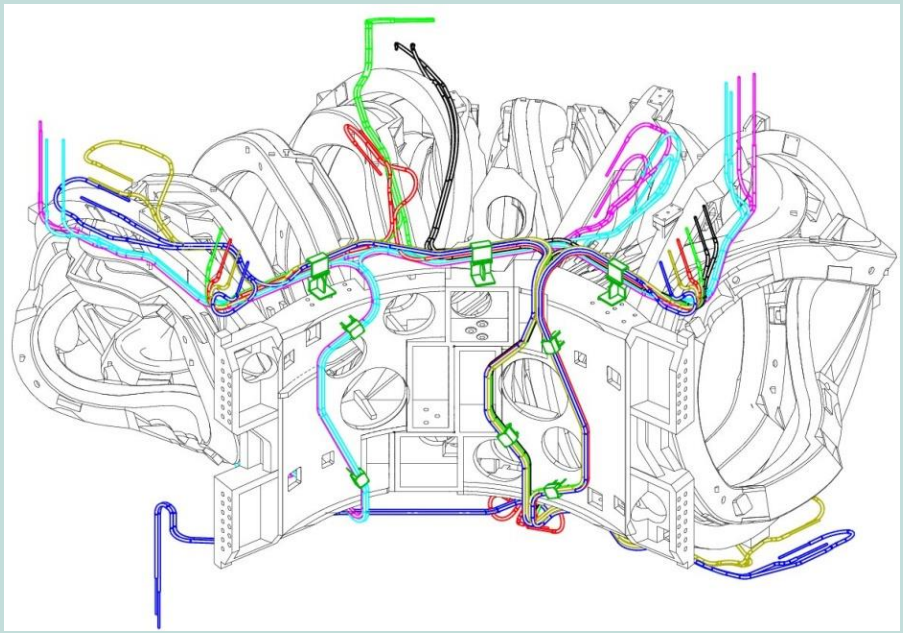
IFJ PAN contribution to W7-X construction
(2007 – 2012)



- IFJ PAN was responsible for the assembly of the bus bar system powering 70 superconducting coils on five modules of the stellarator.
- The bus bars are made of the NbTi superconductors in an aluminium jacket.
- There are 24 bus bars on each module.



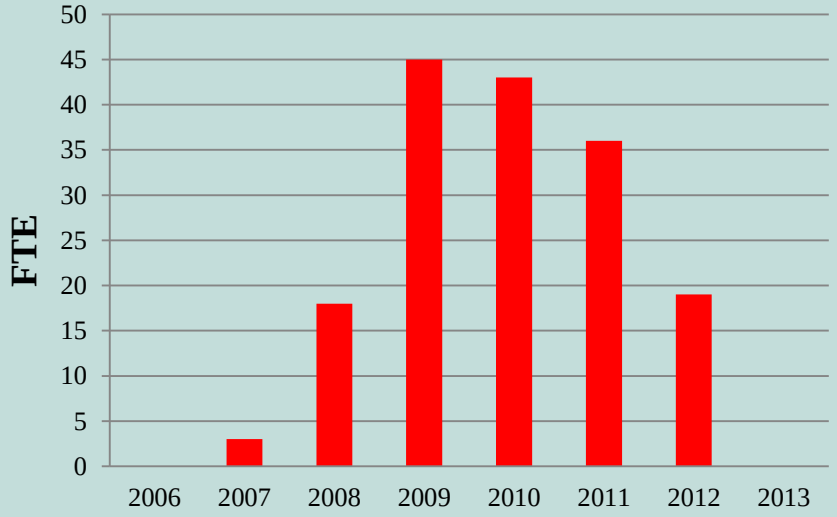
Bus bar cross section

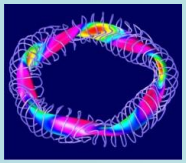


Example of bus bars routing on one module

Total number of FTE over 6 years > 160

Total number of trained IFJ PAN staff > 50

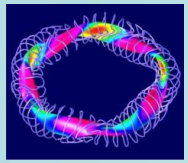




Mechanical and electrical connection of the superconductors

Electrical connection of 81 triplets

Connected triplets squizzed with clamps
and covered by stainless steel caps



Electrical insulation of the assembled joints (divided into three steps)

All joints (184) passed successfully tightness and HV tests

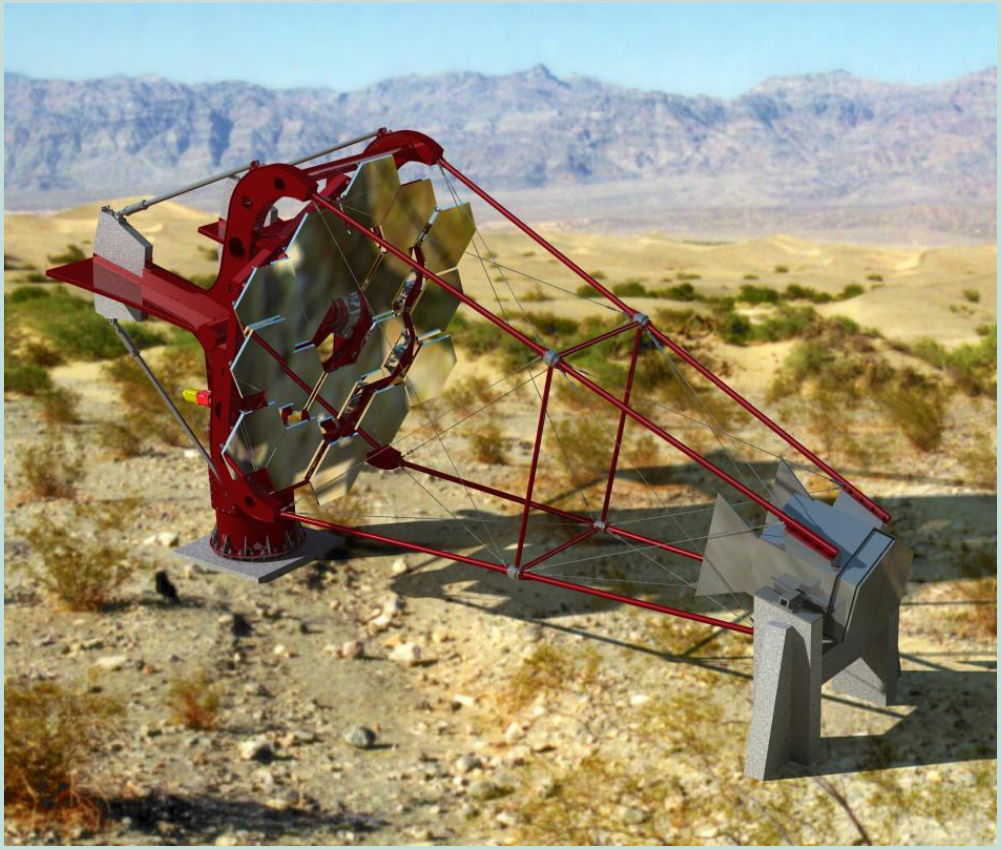
Installation of 24 bus bars on the module
and final shaping of the bus bar ends

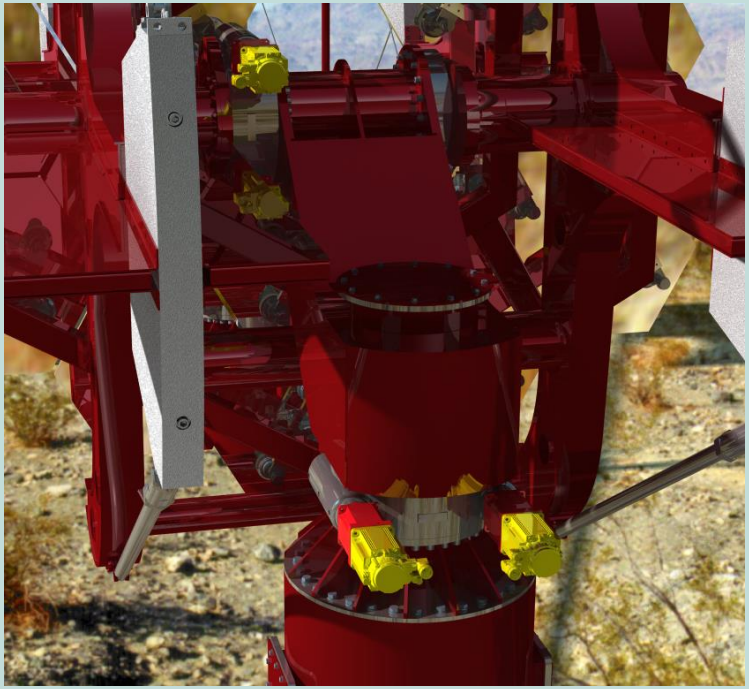
Module Separation Plane
set of six joints painted and clamped

Scientific equipment construction

Cherenkov Telescope Array (CTA)

1) **Small Size Telescope Structure -** prototype to be built by end 2013
   dish diameter 4 m; focal length 9.6 m; weight 8.8 t



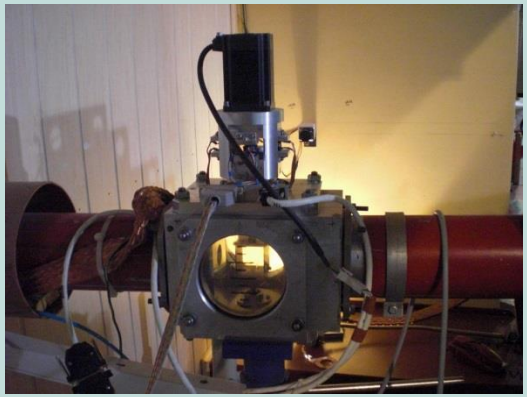


3-D model based on the technical documentation

2) **Open structure mirrors** for Medium Size Telescope – 10 prototypes under tests
hexagonal shape 1.2 m f-t-f, curvature radius 32 m, weight 35 kg

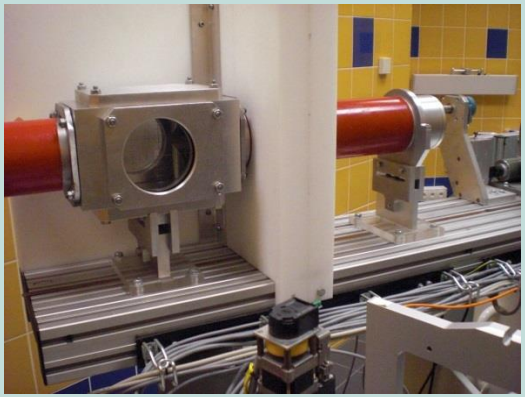
Front (left) and rear (right) view of the prototype mirrors

Components of eye melanoma setup – to be finished in 2013



Device for immediate proton beam cut-off, so called shutter

range discriminators and beam collimators

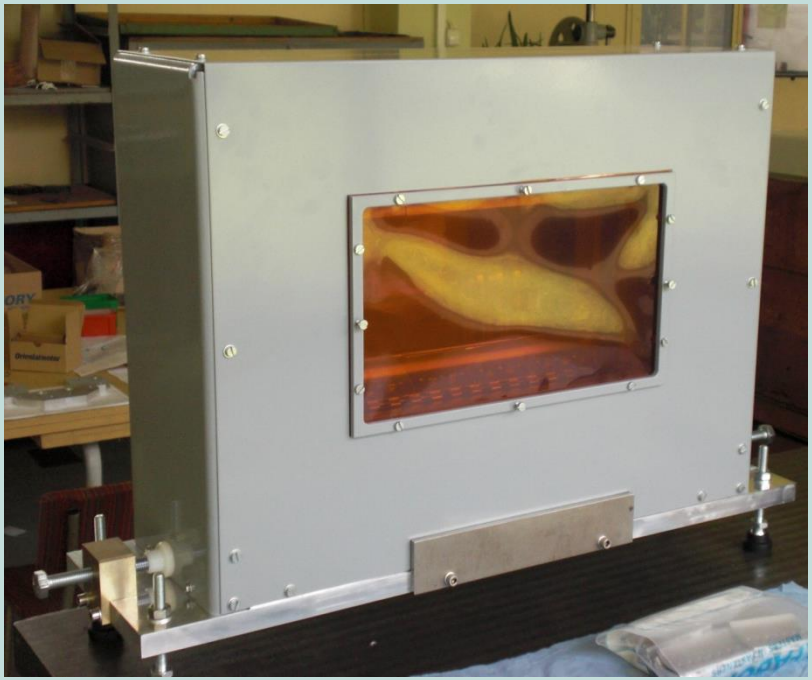


Supports for the end of beam line

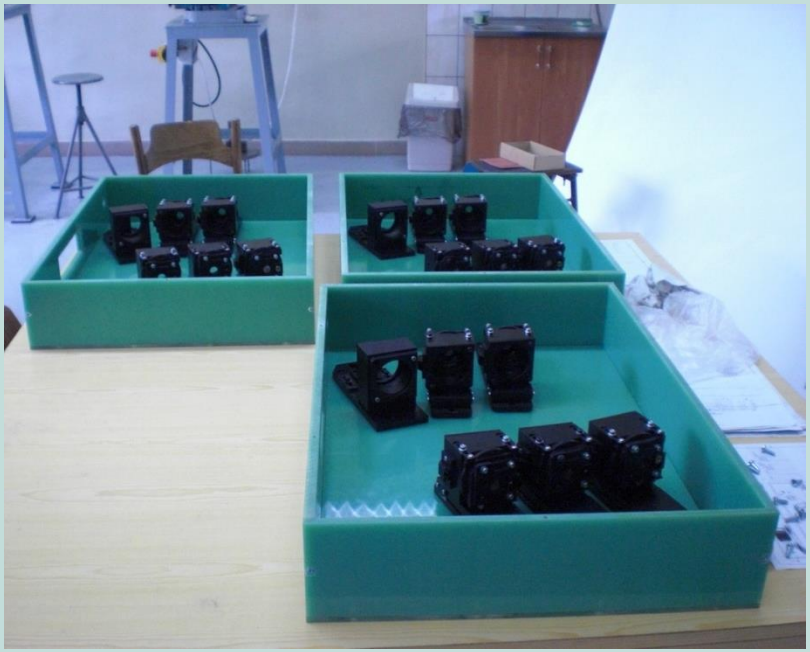
Holders for digital x-ray recorders

Adjustable supports for x-ray lamps

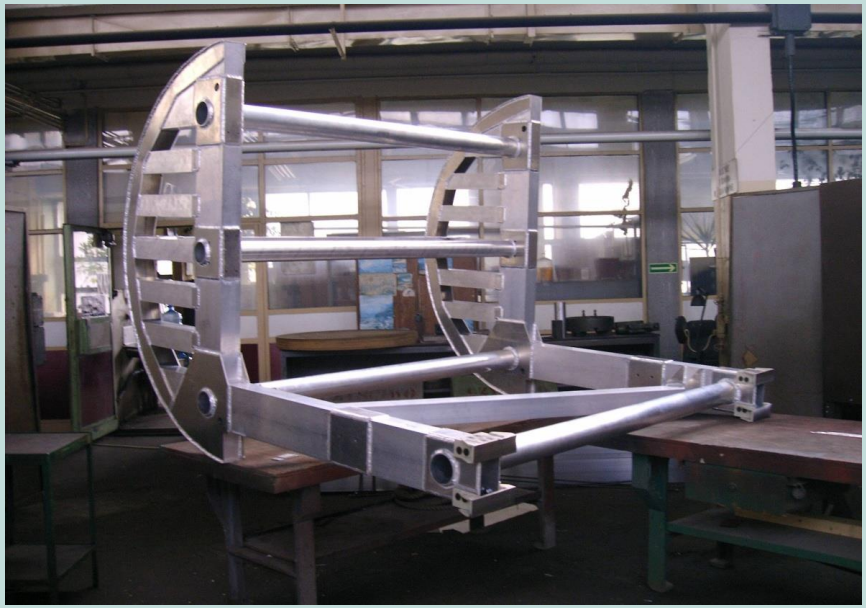
Mechanics for one detector – completed in 2012



Mechanics for 30 sets of polychromators – completed in 2011



Aluminium frame to install Muon Chambers – completed in 2006



The frame at IFJ PAN

The frame used during installation in the ATLAS cavern

Conclusions

Expertise:

→ XFEL (construction)

→ LHC (construction, consolidation, upgrade)

→ W7-X (construction)

→ AIC-144 (construction, medical applications)

→ Proteus C235 (medical applications, research)

Team:

→ Scientists: 5

→ Engineers: 34

→ Technicians: 65

- IFJ PAN groups contribute to major world experiments in particle physics, astrophysics and nuclear physics.
- IFJ PAN contributes to XFEL and LHC
- IFJ PAN is involved in fusion projects (W7X, ITER)