DAI

Division of Scientific Equipment and Infrastructure Construction

(DAI – Dział Budowy **A**paratury i **I**nfrastruktury Naukowej**)**

Marek Stodulski

IFJ PAN, February 5, 2009

DAI Structure and Resources

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Division of Scientific Equipment and Infrastructure Construction (DAI) was established in April, 2007. The staff consists of **32** people : **5** doctors, **12** engineers and **15** technicians, grouped in four sections:

Section Name	Head	Doctors	Engineers	Technicians
Scientific Equipment Section (SES)	M.Stodulski Dr.eng.	3	4	11
Electronics and Electrical Equipment Section (EEES)	A.Kotarba M.Sc.		6	
Scientific Infrastructure Section (SIS)	Z.Sułek Ph.D.	1	1	2
Composite Materials Section (CMS)	J.Michałowski Dr.eng.	1	1	2

DAI Activities

DAI

Project	Participants
[507] **CONSTRUCTION OF DETECTORS AND RESEARCH INFRASTRUCTURE FOR PHYSICS EXPERIMENTS AND RELATED DISCIPLINES**	SES EEES SIS CMS
[505] **CARBON COMPOSITES OF SPECIAL PROPERTIES**	CMS SES

Division of Scientific Equipment and Infrastructure Construction (DAI) has conducted two projects [507] and [505]. All four sections contributed to the project [507] while two sections were involved in the project [505].

The members of other technical and scientific divisions of IFJ PAN also participated in the project [507].

[507] LHC at CERN – ELQA

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DAI and other IFJ PAN emloyees were involved in the following activities of the Electrical Quality Assurance (ELQA) Group at CERN:

Design, construction and programming of a movable measurement equipment and required accessories. 46 mobile systems of 6 types were done for verification of the LHC superconducting electrical circuits. All the measurement systems were controlled by computers with dedicated LabView software application and connected to Oracle data base.

During LHC assembly (left) phase, almost 2500 electrical tests of 8 types were done. The tests were performed on different configuration groups 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** (right) phase more than 12000 tests were performed to check nearly 1600 superconducting circuits in warm and cold states.

Manufacturing and checking (right) about 450 segments (one segment 40-180 m length) of the auxiliary multi-wires superconducting cables.

The performed tests of the LHC superconducting electrical circuits resulted in the opening of around 400 nonconformities,

[507] LHC at CERN – ICIT

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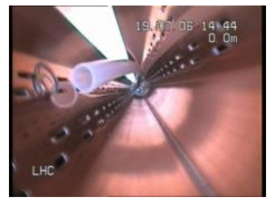
DAI and other IFJ PAN employees were involved in the following activities of the Interconnection Inspection Team (ICIT) at CERN:

- **Pre-inspection** of single magnets on the surface and in the tunnel - visual inspection of all magnet components and checking of beam lines by means of microwave reflectometry and endoscopy methods

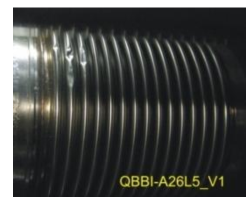
Metallic chip (left) and plastic shaving found and removed during reflectometry and endoscopic (right) inspections of the beam lines



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

- **Visual inspection** of interconnections after orbital and ultra-sonic welding

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



- **Microwave reflectometry measurements** of the beam lines in series of connected magnets
- **Final visual inspection** just before the closure of each interconnection

One of the important ICIT achievement was elaboration of a method enabling localization of damaged plug-in modules during hardware commissioning without opening the interconnections. During inspection of around 2000 interconnections more than 3000 nonconformity reports (NCR) were opened.

[507] ATLAS experiment at CERN

DAI

In 2007 – 2008 DAI and other technical groups from IFJ PAN participated in the final stage of installation and commissioning of the ATLAS **cooling and gas systems**.

Cooling systems:

• Assembly, installation and commissioning of two cooling stations for Muon and general-purpose application, including connection of Big and Small Wheels

• Design, manufacturing, supervision, installation, piping and commissioning of thermal screens cooling system inside ATLAS Muon Barrel.

• CFD simulations, design, installation and commissioning of VA beam pipe and LUCID detector cooling system during bake-out

• Piping, connection and commissioning of End-cap Toroid diffusion pumps cooling system

Cooling stations

Big Wheel

Muon Barrel piping

Gas systems:

• Big Wheels and Small Wheels piping, connection to the distribution racks including leak tests

• TGC EIL4 piping from distribution racks to the chambers

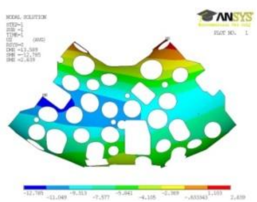
• MDT EO wheels - piping from gas racks on HO to distribution manifolds

• Muon Barrel –piping from gas racks to the distribution manifolds for MDT and RPC systems

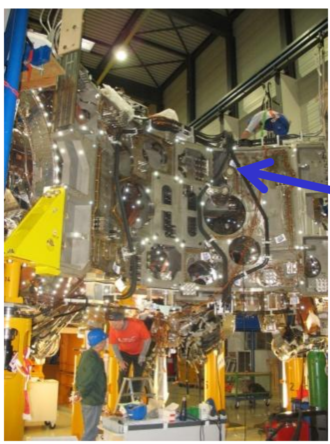
[507] W7-X stellarator, Greifswald

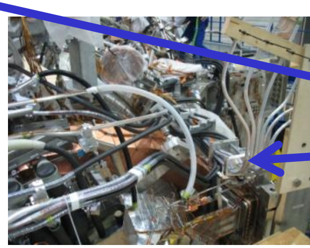
DAI

IFJ PAN and IPP Greifswald signed off a bilateral agreement in 2007. Within the frame of the agreement, IFJ PAN (DAI) is responsible for **assembly of bus bars** powering superconducting coils; DAI also participates in **design of tools** used to handle and assemble outer vessels.



- ***Special tools*** used for handling and facilitating the assembly process of outer vessels have been designed (left top). Deformation requirements for these shells have been checked by simulations using ANSYS code (left bottom).The first tool was manufactured according to the design in 2008 (right).





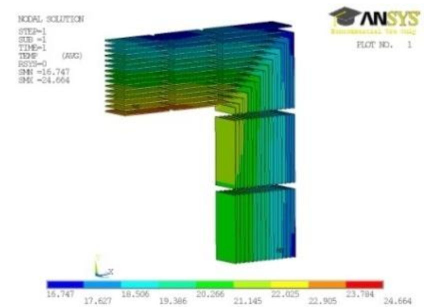
- ***Assembly of superconducting bus bars*** for the first module started in 2008. Scope of the work included:
  - revision and up-date of work procedures and other documents for quality assurance
  - design and construction of tooling and equipment
  - installation and alignment of bus bar positioning holders
  - pre-installation of bus bars on the module Nr 5 and their preparation for the final installation

[507] T2K experiment at J-PARC, Japan; LUMICAL detector for ILC

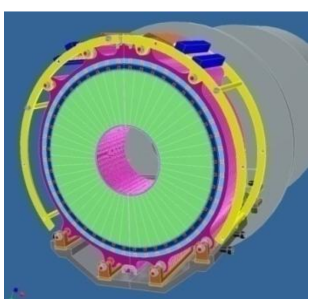
DAI

In 2007-2008 DAI contributed to the construction of the **T2K** experiment in two fields: **temperature stabilization** of the magnet yoke; **SMRD module design** and **installation**.

- A cooling system design, including thermal analysis of the magnet yoke (right) was proposed to achieve required uniformity of the **T2K** magnet temperature.



- A mockup of the **T2K** magnet towers was built in Krakow (left) in 2008. The final **design of SMRD modules** (right) and the procedure of their installation were elaborated on the basis of tests on the magnet mockup. All items and tooling required during module assembly and installation were designed and manufactured. The modules will be assembled and installed at J-PARC in 2009.



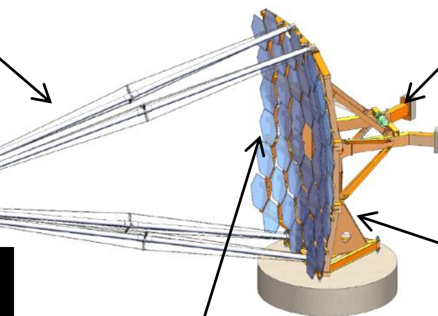
The mechanical structure of the very forward calorimeter **LUMICAL** has been proposed. 3D CAD model was built and deformations of the structure were simulated. The LUMICAL structure was incorporated into 3D model of the ILC detector in order to search for potential conflicts.

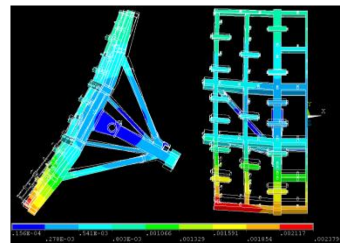
[507] Cherenkov Telescope Array (CTA)

DAI

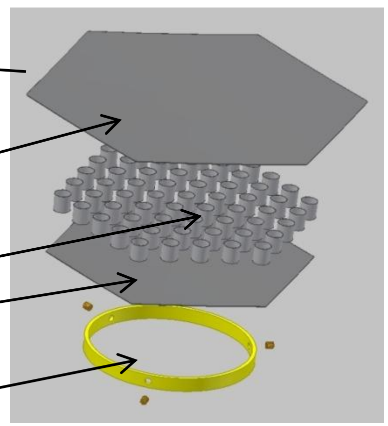
In 2008 DAI joined the CTA project in two fields: design of **telescope structures** and prototyping of **composite mirrors**.

- MPI-K Heidelberg designs the **6 m telescope structure** while DAI provides FEM analysis. The analysis will enable an optimization of the design in terms of structural deformations to meet technical specification.





Structure of the 6 m telescope (right) and FEM results of dish deformation analysis (left)



Proposed design of the composite mirror (right); two panels (OD 200 mm) with deposited spherical layers (left)

- The design of a **composite mirror prototype** (OD - 600 mm, radius of curvature – 30 m), based on a sandwich structure, has been proposed. Spherical layers to be coated are deposited on laminated panels by means of the infusion method. The prototype mirror is planned to be done in 2009 and then tested in the H.E.E.S. I telescope.

[507] Setup for proton eye radiotherapy

DAI

In 2007 – 2008 DAI provided technical support for the design and modernization of the setup to be used in proton radiotherapy of eye tumor. Specifically, we were involved in development, design and manufacturing of the following systems:

Below ***- the range-modulating propeller*** *for shaping Spread-out Bragg Peak*

Below - ***XYZ scanner and water phantom fixtures*** *on the ETC (Eye Therapy Chair)*

Above - ***support of the optical bench*** *and its positioning system*

Above ***- CR plate fixtures*** *in the X-ray positioning system*

[505] Carbon composites of special properties

DAI

In 2007 – 2008 R&D activities focused on **two applications** of the carbon composites: **high temperature** and **medical**.

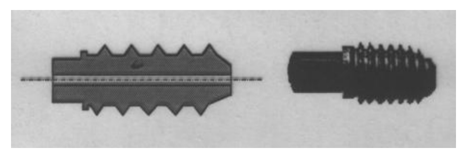
High temperature:

C/C samples were prepared from carbon fibers impregnated with pitch. To improve oxidation resistance the porous C/C samples are impregnated with polysiloxane resin followed by thermal treatment of C/C up to 1700 ºC. During the treatment the polymeric precursor (preceram) is transformed into silicon carbide (**SiC**). The obtained composite (C/C/SiC) demonstrates oxidation resistance in high temperatures better than C/C composite. After 2 hours at **600 ºC**, the former composite **loses 30%** of its mass while the latter one –100%.

Photo: the press forming carbon fibers/pitch samples in 420 ºC, 100 Bar

Medical:

Hydroxyapatite (HAP) in the form of nano-powder was used to modify carbon matrix of C/C composite. Nano-powder was mixed with liquid isotropic pitch. After various treatments the obtained composition was used to prepare biologically active implants (e.g. screws) for bone tissue. The results indicate that **10 %** addition of **HAP** to C/C composite does **not affect mechanical characteristics** of the final composition (C/C /HAP) while the **biological features remain unchanged** in spite of thermal treatment.



C/C screws as examples of medical application

Achivements

DAI

The main goal of DAI activities is to accomplish the undertaken tasks well and on time. The main achievements are listed below:

• completion of quality assurance of electrical and mechanical connections of the **LHC** magnet.

*The LHC management was the initiator of the **symposium summarizing results of IFJ PAN contribution** to LHC construction. Prof. Marek Jezabek got **a congratulation letter** from the Polish Ministry of Science and Higher Education. The leaders of the ELQA and ICIT groups received **the Bronze Crosses of Merit**. LHC management and IFJ PAN signed off the **new agreement on future collaboration**.*

• completion of construction, installation and commissioning of the **ATLAS** gas and cooling systems

• elaboration of SMRD module design and installation procedure (**T2K** experiment)

• completion of tools design to be used in handling, transportation and assembly of the outer vessels (**W7-X** stellarator)

Moreover, DAI activities have resulted in **co-authorship** of 14 papers, 11 conference proceedings and 17 reports. DAI members have also given 18 presentations during various collaboration meetings.

Perspectives

DAI

DAI plans the following activities in next few years:

• to participate in assembly and installation of the **SMRD** modules at J-PARC (2009)

• to accomplish assembly of the superconducting bus bars on all (5) modules of the **W7- X** stellarator in Greifswald (2011)

• to participate in the **X-FEL** construction (2009 – 2013)

• to continue participation in the **CTA** project (telescope structures, composite mirrors)

• to contribute to maintenance of the **LHC** magnets and the **ATLAS** cooling/gas systems during shut-downs (2009 – 2013)

• to contribute to projects running at **IFJ PAN** (e.g. proton eye radiotherapy,…)