BILFINGER BERGER
Power Services

BABCOCK NOELL

European Industrial Experience

with Large International Projects

25 Years of Experience at Babcock Noell

Superconducting RF Cavity

Technology and Industrialization

(A Sattelite Workshop at IPAC-2010)

Wolfgang Walter

BABCOCK NOELL

Outline

1. Introduction to Babcock Noell GmbH
2. International Industrial Network for Wendelstein 7-X
3. Best Practice Sharing for LHC
4. Collaboration and Risks
5. Summary/Conclusions

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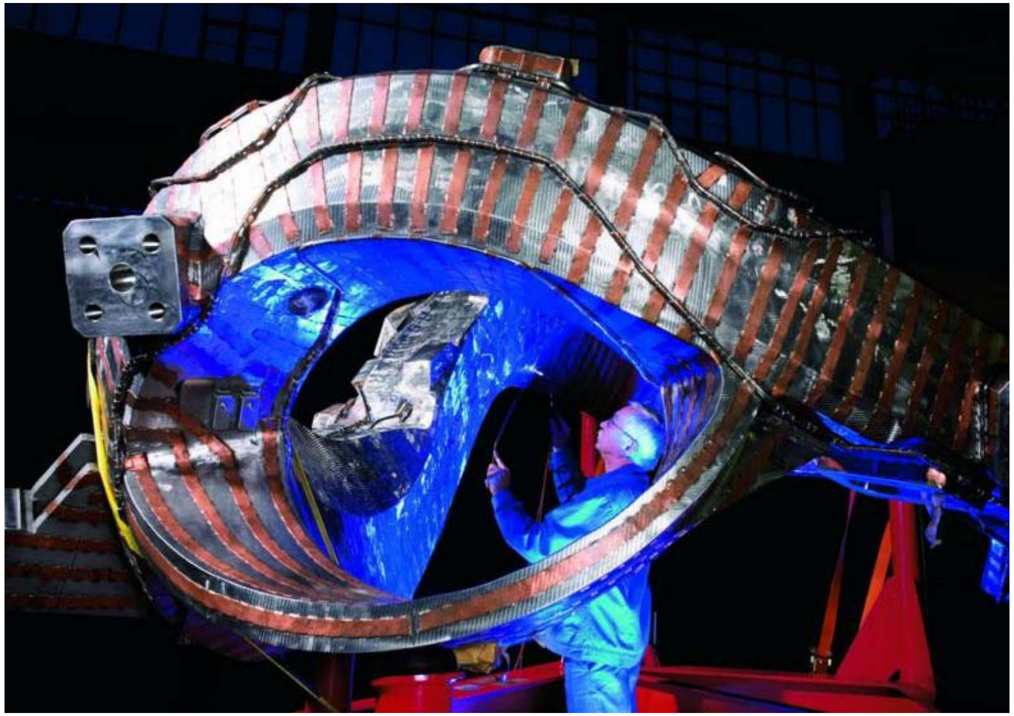
Product Areas

Nuclear Service	Nuclear Technology	Magnet **Technology**	**Environment Technology**
			
Containment lock - preparation of seal for leakage test	**Positioning of a Liner-Segment on EPR Reactor OL 3 Finland**	**Superconducting dipole for the LHC accelerator, CERN, Geneva**	**Components for flue gas cleaning systems**

Division Magnet Technology



Non-planar modular field coils for Wendelstein 7-X, Germany

- Magnets and components for accelerators and fusion experiments
- Development and fabrication of superconducting magnets and magnet systems, e. g. dipoles, quadrupoles, solenoids
- Cryostats and vacuum vessels
- Special-purpose tools for fabrication of magnets
- Manipulator systems for magnets
- Feasibility and fabrication studies
- Design and calculation of magnets
- Special development projects

Magnet Technology References

Superconducting dipole magnets for the accelerator LHC, CERN, Geneva

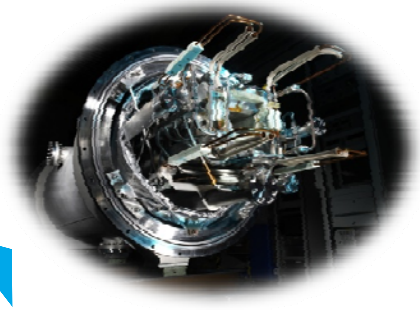
- 120 Cryostats and 233 corrector magnets for the superconducting quadrupole magnets of the ring accelerator HERA.
- Superconducting non-planar modular field coils for the stellerator experiment WENDELSTEIN 7-X, IPP Greifswald, Germany
- Superconducting dipole magnets for the accelerator LHC, CERN, Geneva
- Studies for TESLA & XFEL at DESY:

source: BM CD-Rom

Babcock Noell's Industrial Experience

HERA

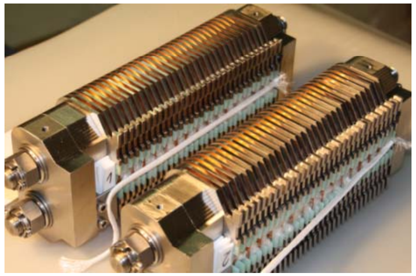
LHC



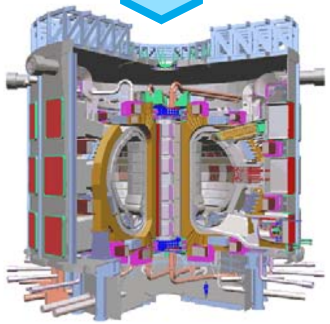
FAIR

Industry

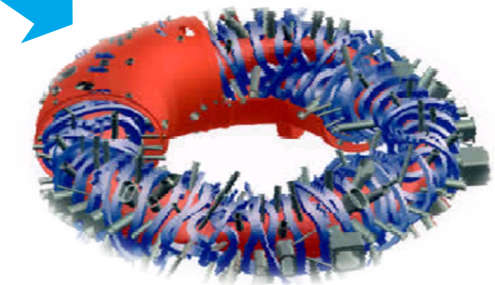
Future



Development of superconducting undulators



ILC, CLIC, Xfel, FAIR, …



Wendelstein 7-X

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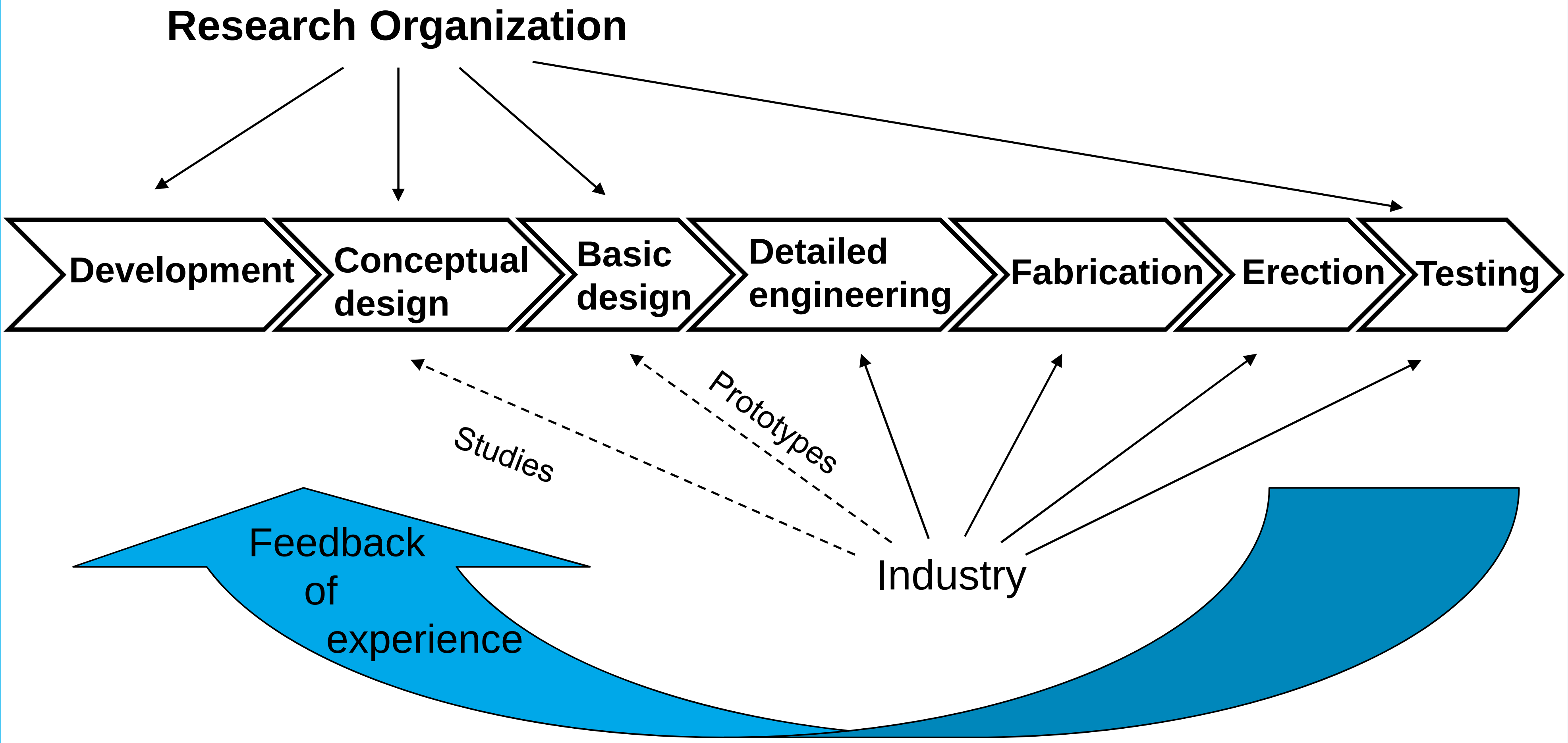
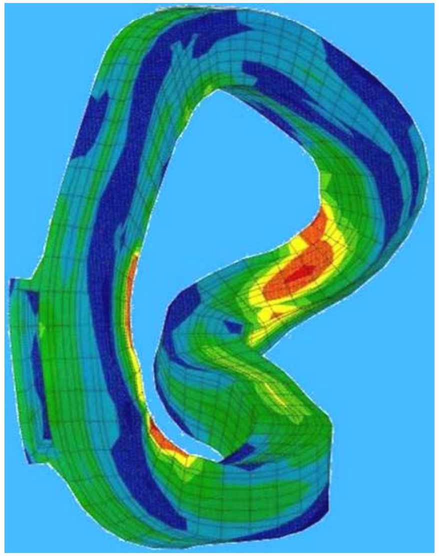
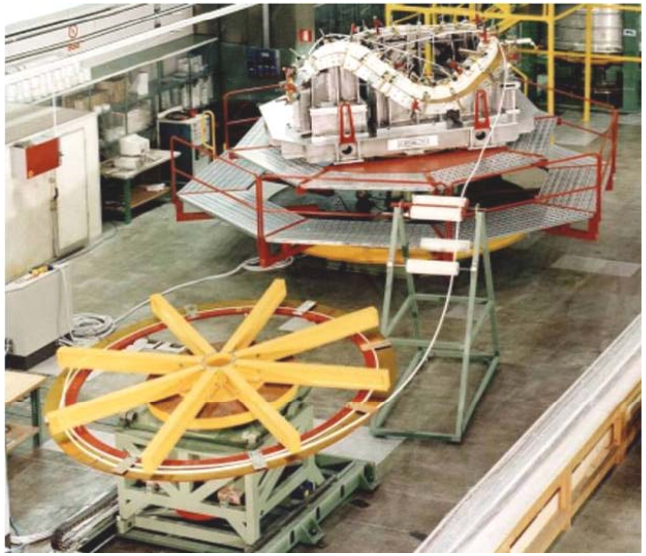
Cooperation between research organisations and industry



Experience with “Non-planar coils for W7-X)”

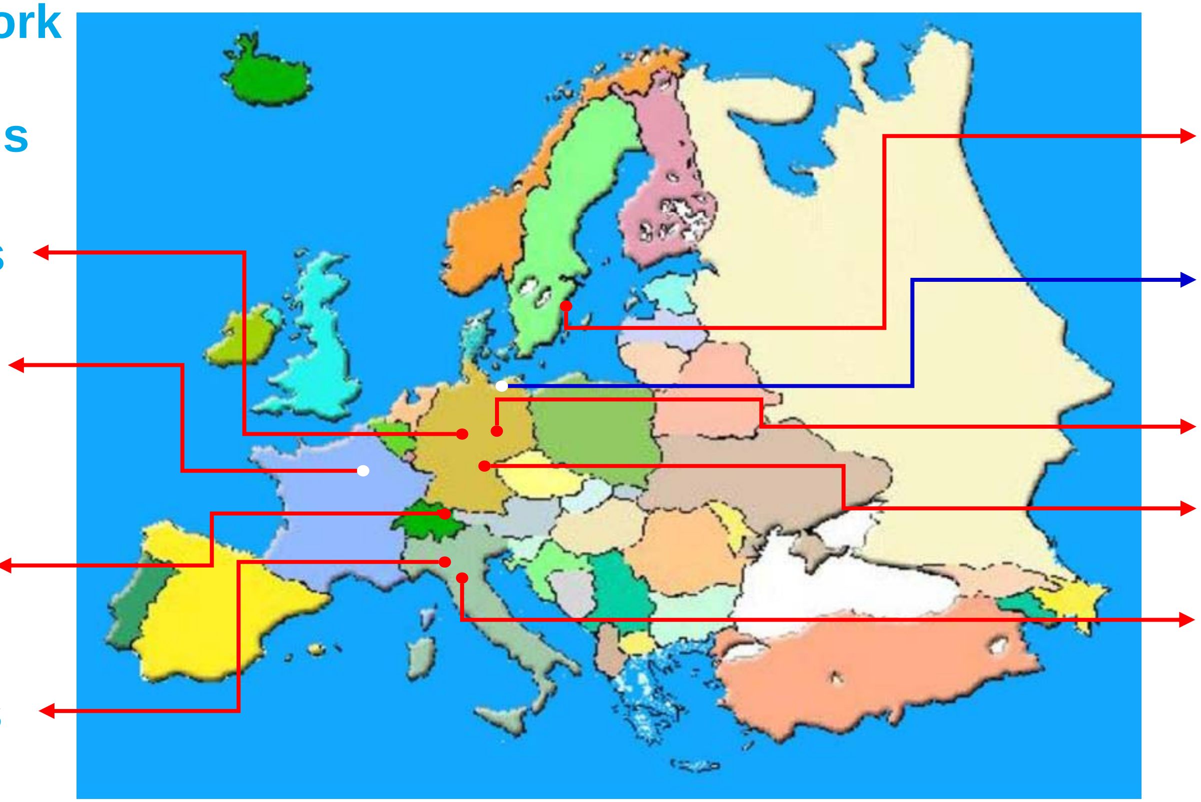




- Conductor development transferred to industry in early phase
- DEMO coil manufactured with industrial responsibility
- Industrial network in the contractual phase for main components established (conductor, case, winding pack, etc.)

Industrial Collaboration: Example W7-X

Industrial Network for W7-X Non-Planar Coils



- **International industrial consortium for fabrication**
- **Many companies from all over Europe involved**
- **Network established by industry**

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Oesterby: Sub-supplier for Wendelstein

- Demand: Casting of coil cases (segments or half rings)
- Exploration of technology with experienced SMEs in D, GB, I, SE, USA (11 Companies)
- Evaluation Matrix for technology
- Selection of technology and pre-selection of supplier
- Development of casting method with prototype half ring
- Selection of supplier

Coil case for W 7-X non-planar modular field coil

Benefits from Collaboration with Oesterby

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- For the Customer:
  - Exploitation of optimum technology under quality and cost aspects
  - No time and cost responsibility for interface, less manpower needed for expediting of subcontractors
- For BNG:
  - Experienced partner for castings of complex structures
- For Oesterby:
  - New field explored (special material, new customers)
  - Additional investments to expand technical capability

Reason for success: Collaboration with a dedicated sub-supplier for one special task in the project after careful evaluation and with dedicated quality control.

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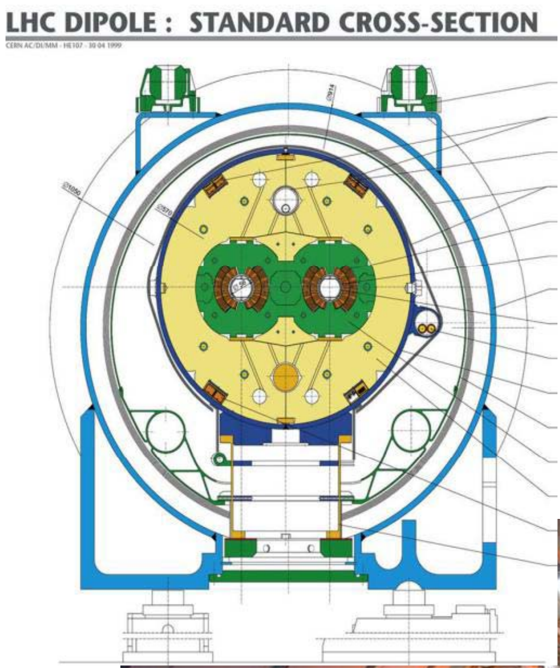
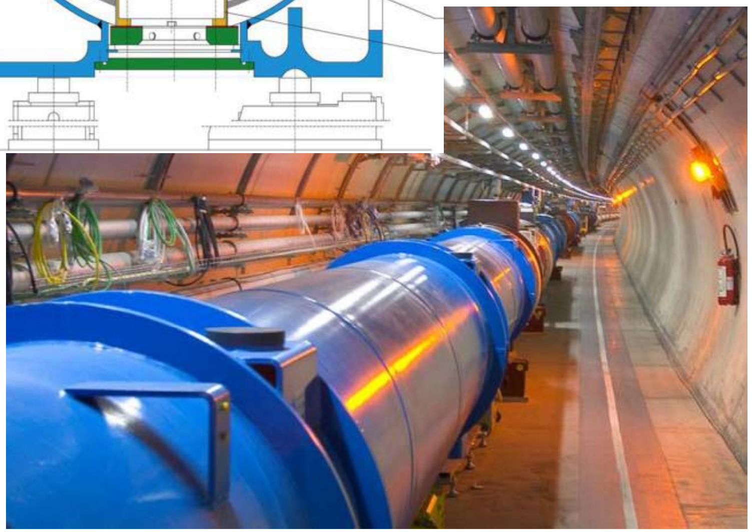
LHC Main Dipoles for CERN





1250 superconducting dipoles:

Length:	~ 15 m
Weight:	~ 35 t
Operating temperature:	1.9 K
Working current:	11,800 A
Nominal magnetic field:	8.33 T

Development of LHC Dipoles at Babcock Noell

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Independent contracts for the development and the construction of prototype magnets and tools between 1990 and 1999 for Babcock Noell:

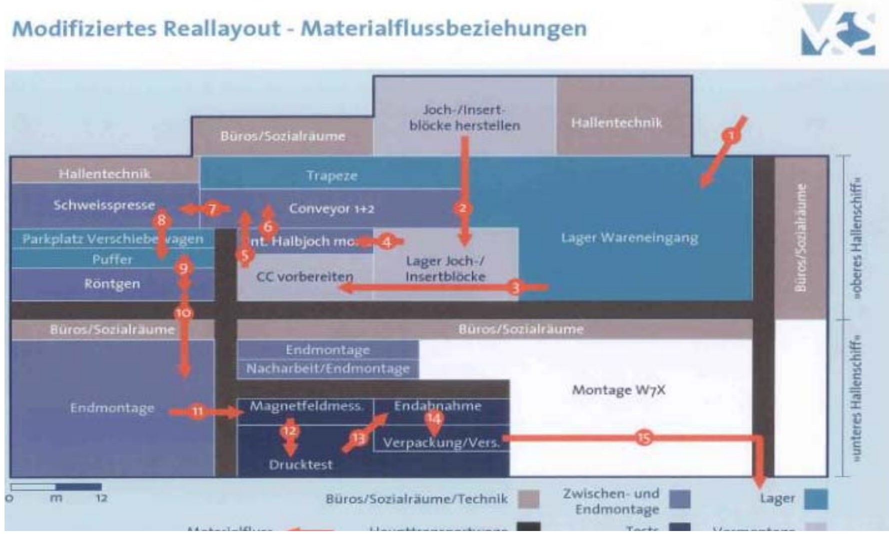
- 6 prototype dipole magnets
- 15m long winding and curing tools
- Multifunctional press (force 270 MN)
- 20m long PLC-controlled winding machine
- Production of prototype cryostats for dipoles

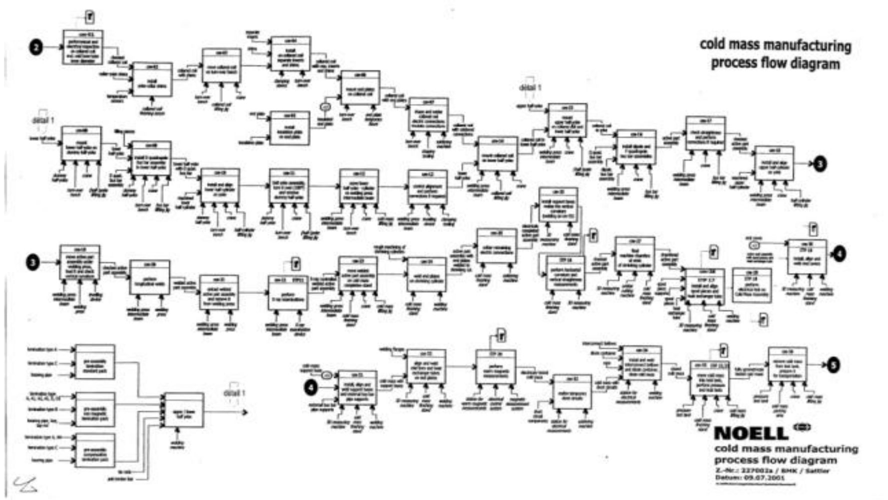
Similar dipole development activities of CERN together with other industrial partners: Alstom, Ansaldo, Elin

From Prototypes to Industrial Production

1990 – 1999: Prototyping
1999 – 2002: Pre-Series
2002 – 2006: Series Production

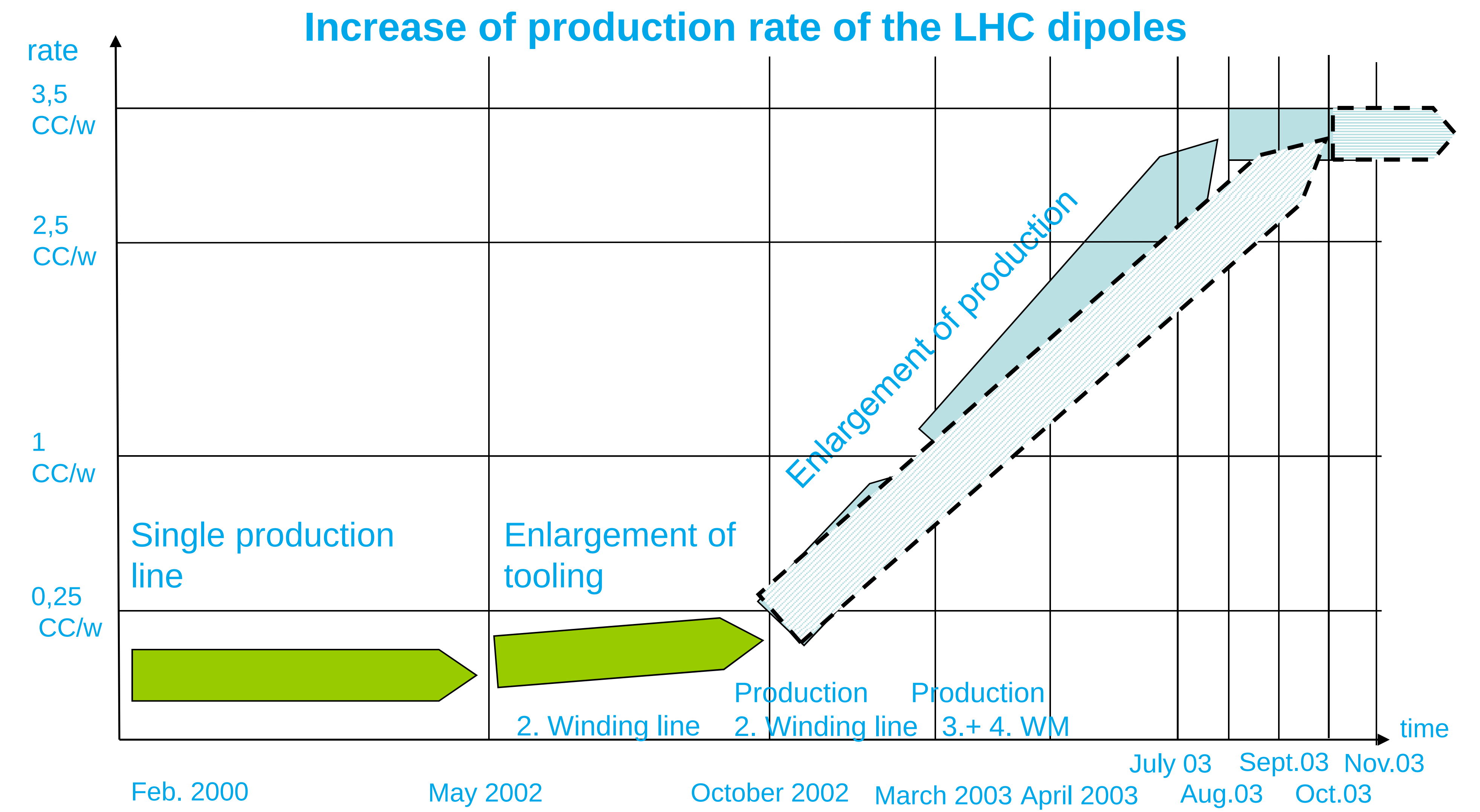
Transition from prototype to (finite) series production needs careful planning (facilities incl. layout, man power, tooling, ramp-up and ramp-down concept etc.)





Process and Material Flow diagrams

LHC Fabrication - Commitment



Impressions of Production at BNG

Production area ~ 10,000 m²

Nearly 200 employees worked in two shifts

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Dipole Production: Main Issues

- Mastering key technologies
- Optimising fabrication layout and logistics
- Excellent QA
- Organisation and good management
- Staff dedication
- Best Practice Sharing with former competitors

  → Completing the contract 7 months ahead of schedule

Babcock Noell

was honoured with the

GOLDEN HADRON AWARD

by CERN

Best Practice Sharing: Precondition

Best practice sharing: A technical exchange between companies in the interest of the project.

Precondition:

- Several companies produce (nearly) the same product
- Competition phase is finished, i.e. contracts are placed by the customer
- Customer and companies agree to a best practice sharing process
- Core know-how which differentiates companies is not affected
- Comparable competence of companies

Best Practice Sharing:
Example LHC Dipoles

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Contractual Situation:

- 3 Suppliers: Alstom, Ansaldo, Babcock Noell

  manufacturing the same amount of an identical product:
  - 1999: Pre-Series Contract for 30 Cold Masses each
  - 2002: Series contract for 386 Cold Masses each

- Manufacturing including tooling within responsibility of suppliers

- Various material (Rutherford Cable, Joke Sheets, ...) and measurement equipment supplied by the customer

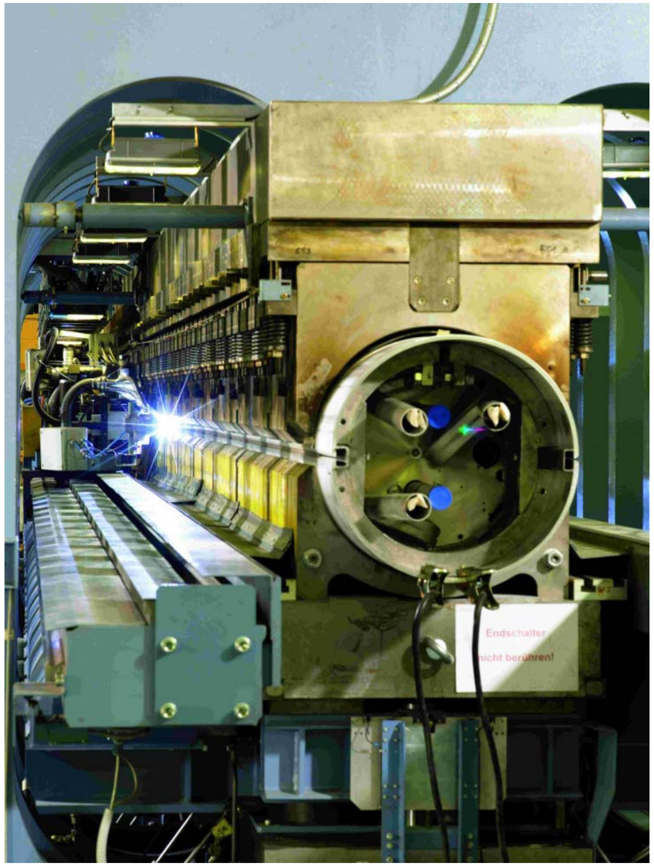
Best Practice Sharing: Example LHC Dipoles

Best Practice Sharing Process:

- Process started on initiative of Babcock Noell with support by CERN
- Triggering event: For problem with soldering of layerjump and insulation quality, CERN actively initiated exchange between companies
- Various meetings between the 3 suppliers (bilateral and all parties) at their respective fabrication sites
- Meetings consisted of:
  - site visit, mutual presentations on project progress and discussion

Layerjumps on LHC main dipole winding package

Best Practice Sharing: Example LHC Dipoles



Welding of LHC main dipole cold mass

Benefit from Best Practice Sharing - Examples:

- Welding process for shrinking cylinder improved with CERN
  → solution distributed via best practice sharing
- Avoiding of interruption in the production process by exchange of: copper wedges, endspacers, collars, coil protection sheets, ...
- Alternative supplier for: diode-container, turn over device for cold mass, quenchheaters, ...

Best Practice Sharing: Companies Exchange

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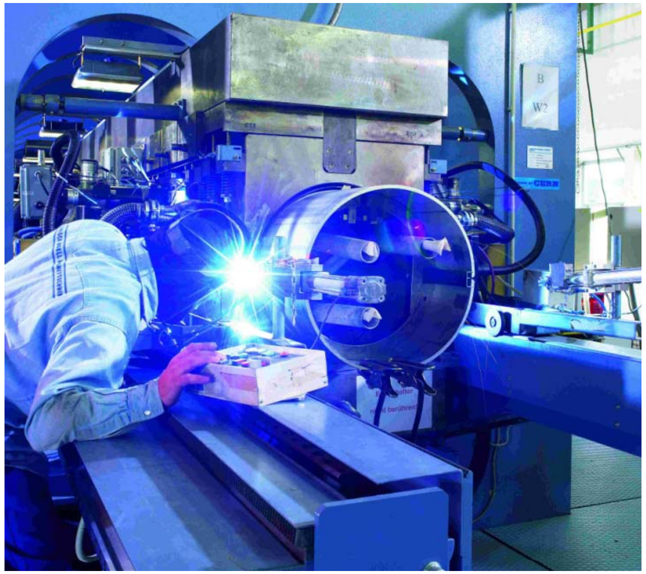
Exchange between companies in the interest of the project:

- **Goals:**
  - Exchange on technical information with respect to the production, tooling and material
  - Discussion on the project status (excluding commercial issues)
  - Mutual support in acquisition of material and tooling
  - Mutual support in case of material shortage or production bottlenecks
- **Information exchange is at best a direct exchange of the people doing the job, i.e.:**
  - Mutual visits of the fabrication of the other companies
  - Personal discussion between project managers, heads of production, main technicians



Manufacturing of LHC main dipoles

Best Practice Sharing: Benefits

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Benefit for the customer:

- Repetition of mistakes is avoided → higher quality of the final product
- Production process is optimized due to mutual learning → acceleration of delivery time
- More uniform products from the various companies

Benefit for the companies:

- Higher quality of the final product → satisfied customer
- Acceleration of delivery time → reduced cost due to reduced project duration
- Additional back-up solutions for shortages and bottlenecks

Benefit for both sides:

- Direct exchange with no intermediate customer, i.e. → no loss of information or possible misunderstanding
- Purely technical exchange, alternative solutions from others may be used or not, without discussion on contractual obligations, responsibilities etc.

LHC and ILC

From best practice sharing point of view there is a similar situation:

- Multiple production of components
- Production of same components by different suppliers
- International project
- Series production after prototyping
- ...

LHC and ILC

For the successful operation of the machine, the **individual items** of one component series must be as uniform as possible even though the items may be from **different vendors**.

Necessary but for complex products maybe not sufficient precondition: Production according to the same specification for all vendors.

For complex high tech components the **details of the processes** and quality system at the individual components **should closely resemble**. An improved similarity of the transfer of the specification into practice will lead to more uniform productions at the individual vendors.

Best practice sharing is a **good tool** to transfer the details of the processes between companies.

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Collaboration during R&D

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Collaboration in Phases

- Qualification Phase:
  - Institute: Technical qualification of companies
  - Industry: Assessment of technology and chances vs. risks
  - Common goal: establish a partnership to improve the product
  - Images: W7-X DEMO and LHC Prototyping
  - Example: 10 years of continuous collaboration for LHC Main Dipole development
  - Industry can bring in its know-how and experience, but a clear perspective is required (funding, time-schedule, in-kind situation)

Tendering, Contracting and Risks

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EU has general regulations for tendering processes. Institutes can formulate the concrete tendering process within the regulations. Your effort is essential here, in order to be able to co-operate with the best partner later on.

- Clear and transparent criteria are essential for
  - preparation of the best offer for the customer ⟶ industrial point of view
  - identification of the most economic tender ⟶ institutes point of view
- Weighting of price vs. quality decides on the most economic offer. For contracting of a building, the price might be of higher importance, whereas for a high-tech key component, the quality is of highest importance usually.
- Unreasonable or unusual contractual conditions (liabilities, termination clauses, ...) can eliminate interesting bidders from the process.

It is important that researchers involve themselves in the formal tendering process.

Sharing of Risk

- Research projects are characterised e.g. as
  - beeign at the forefront of technology
  - having delicate interfaces (organization, quality inspection, ...)
  - involving R&D work

→ Risks → Sharing of existing risks between contractor and supplier necessary

- Industry is accepting certain risks:
  Risks must be evaluated and quantified (money-wise, time-wise). Quantifiable risks will be reflected in the product price. Unlimited/uncapped or not quantifiable risks cannot be taken.

- Examples for unlimited or not quantifiable risks: unlimited liablity for consequential damages, unreasonable termination clauses, responsibility for customer's provision without "market price". Existence of such risks can prevent otherwise competent bidders from providing you a conform offer.

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4. Project Organisation and Procurement for Present Projects
5. Deductions for Future Projects
6. Summary

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Summary

There is **experience available** in EU industry from large scale research projects that can be transferred to ITER.

Best practice sharing is of **advantage for customers and suppliers** when applicable. It has been **demonstrated,** e.g. for the LHC Main Dipole production and **could be applicable for ILC** in certain cases, too.

Industrial networks can minimize interfaces for the customer and in certain cases lead to efficient solutions. The work-load for expediting of customers can be limited to the essential cases for the customer.

A fair competition with a clear project information and a transparent and suitable tendering process help to qualify and co-operate with the best suited industrial partners.

Thank you

for

your attention!