Standardisation and material databases: a successful example

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PART I: Steffen Grohmann (KIT)

STANDARDISATION (AMICI WP5.3)

WP5.3 – Description

The challenge

- ***Safety aspect*** of cryogenic equipment is a recurrent matter
- ***Differences*** of design practices, understanding of risk and technical solutions
- ***Many difficulties*** inside international collaborations and between labs and industry
- Potentially ***serious consequences*** on project schedules and expenses

The AMICI proposal

- ***Organise*** and ***coordinate*** a CEN working group
- Compose a ***draft European safety Standard*** for cryogenic equipment
- ***Assess dynamic codes*** for incident modelling
- Define ***scope of future development*** for standardisation of a dynamic model

Motivation

- Helium **dewars** vs. helium **cryostats**

Strong influence on potential risk of excessive pressure

Helium cryostats have **active components**

Sc. magnets
Sc. RF cavities
Heat exchangers
Valves
Flexible hoses
Pumps

EN 1626 EN 12434 EN 24490

E.g. European
- Machine Directive 2006/24/EC
- Low-voltage Directive 2014/35/EU
- Electromagnetic Compatibility Directive 2004/108/EC
- ...

Liquid helium **dewar**

ISO 21009 (substituting EN 13458)
Cryogenic vessels –
Static vacuum insulated vessels

➡ No dedicated Standard existing that covers the conditions in helium cryostats and which is harmonized with the European PED

New working group

CEN/TC 268 - Cryogenic vessels

General | Structure | Work programme | Published Standards

CEN/TC 268 Scope

Standardization in the field of insulated vessels (vacuum or non- vacuum) for the storage and the transport of refrigerated liquefied gases ,as defined in Class 2 of "Recommendations on the Transport of dangerous goods - Model regulation" , in particular concerning the design of the vessels and their safety accessories, gas/materials compatibility, insulation performance, the operational requirements of the equipment and accessories. The one-off preparation of standards for hydrogen technologies strictly meeting the European mandate on the draft Directive deployment of alternative fuels infrastructure.

Officers

Chairperson	Dr Hervé Barthélémy
Secretary	Ms Laurie Jardel

General | Structure | Work programme | Published Standards

CEN/TC 268 Subcommittees and Working Groups

Working group		Title
CEN/TC 268/WG 1		Design
CEN/TC 268/WG 2		Compatibility, insulation, accessories
CEN/TC 268/WG 3		Operational requirements
CEN/TC 268/WG 5		Specific hydrogen technologies applications
CEN/TC 268/WG 6	July 2017	Specific helium technology applications

Aim of CEN/TC 268/WG6:

New European Standard on *„Helium Cryostats – Protection against excessive pressure“*

Organisations contributing to CEN/TC 268/WG6

- National Standardisation Bodies:

DIN afnor GROUPE bsi.

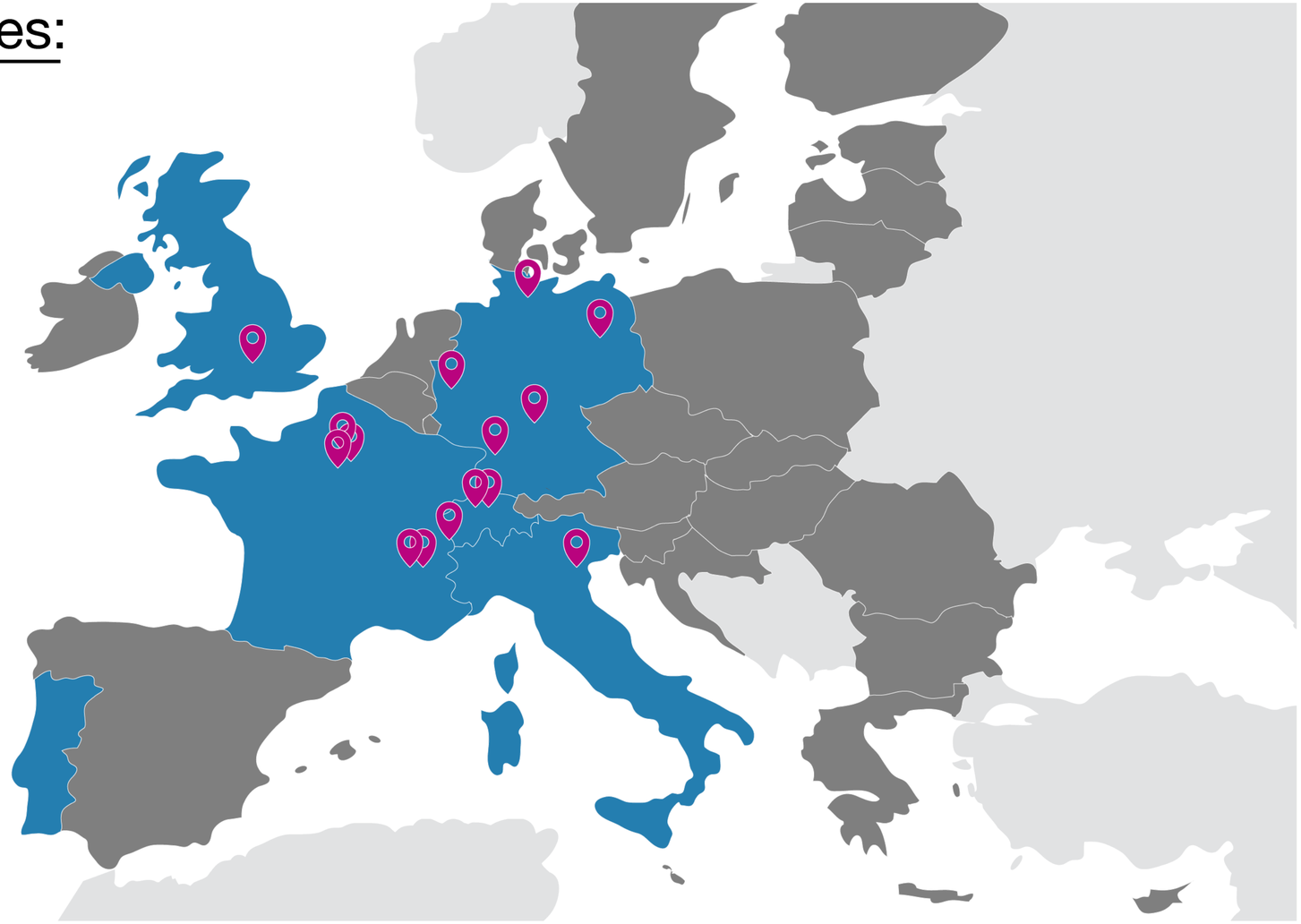
UNI ENTE ITALIANO DI NORMAZIONE Instituto Português da Qualidade SNV

- Organizations:

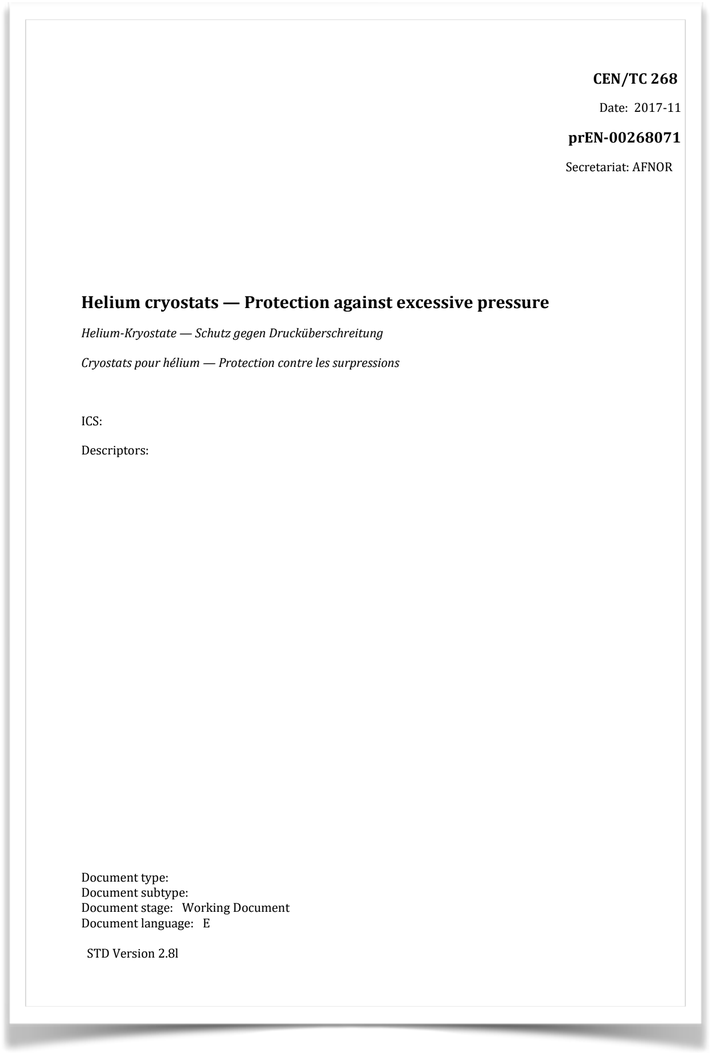
Air Liquide creative oxygen BiLFINGER cea CERN

HEROSE INFN KIT Karlsruhe Institute of Technology THE LINDE GROUP Linde

PAUL SCHERRER INSTITUT PSI Science & Technology Facilities Council



Structure and contents



CEN/TC 268

Date: 2017-11

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Secretariat: AFNOR

Helium cryostats — Protection against excessive pressure

Helium-Kryostate — Schutz gegen Drucküberschreitung

Cryostats pour hélium — Protection contre les surpressions

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STD Version 2.8l

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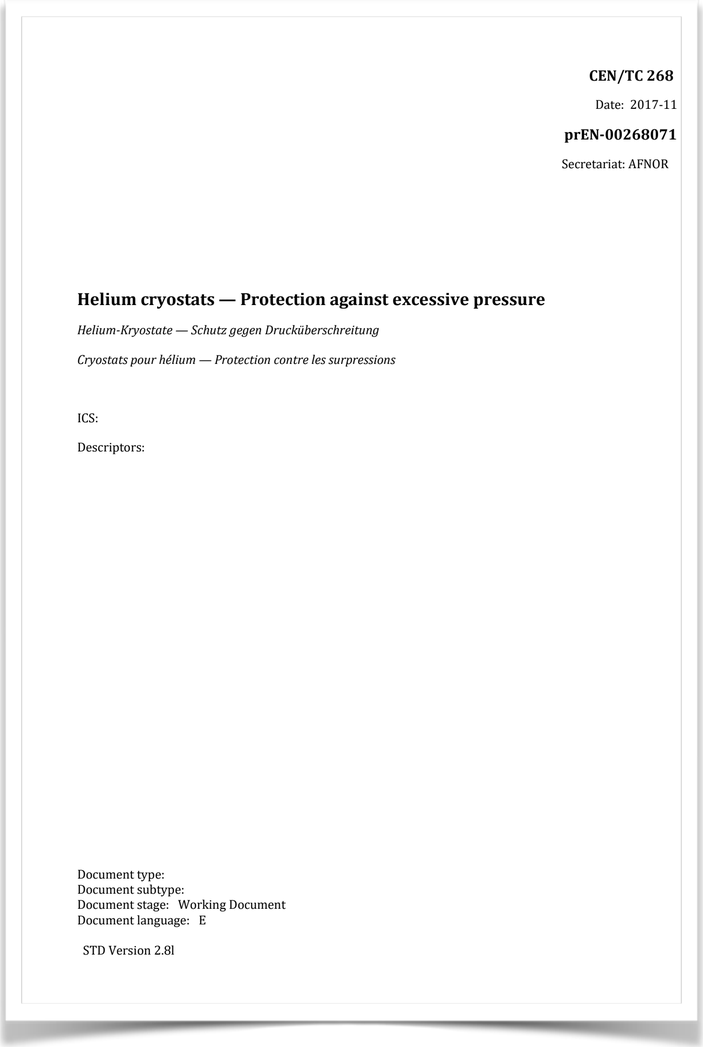
Summary of Standardisation project



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- ☑ ***11 site meetings*** + web conferences of CEN/TC 268/WG6
- ☑ Publication of the ***draft European Standard*** planned for end 2019
- ☐ ***Harmonisation*** with the Pressure Equipment Directive (PED) in a subsequent step via CEN ***HAS Consultants*** after publication

Dynamic modelling of incidents

Actual status

- ☑ PICARD test stand at KIT
- ☑ 2 PhD thesis
- ☑ KIT-CERN cooperation
- ☑ 6 publications

Future development

- ☐ Planned 3rd PhD project on ***dynamic helium cryostat safety model*** within KIT-CERN cooperation
- ☐ ***20-30 additional tests*** with different types of multi-layer insulation
- ☐ Probabilistic modelling approach
- ☐ Explore possibilities of ***normative dynamic algorithm*** and ***normative solution strategy***

PART II: Mohammed Fouaidy (IPN)

MATERIAL DATABASES (AMICI WP5.2)

Main goal of WP5.2

Main objective:

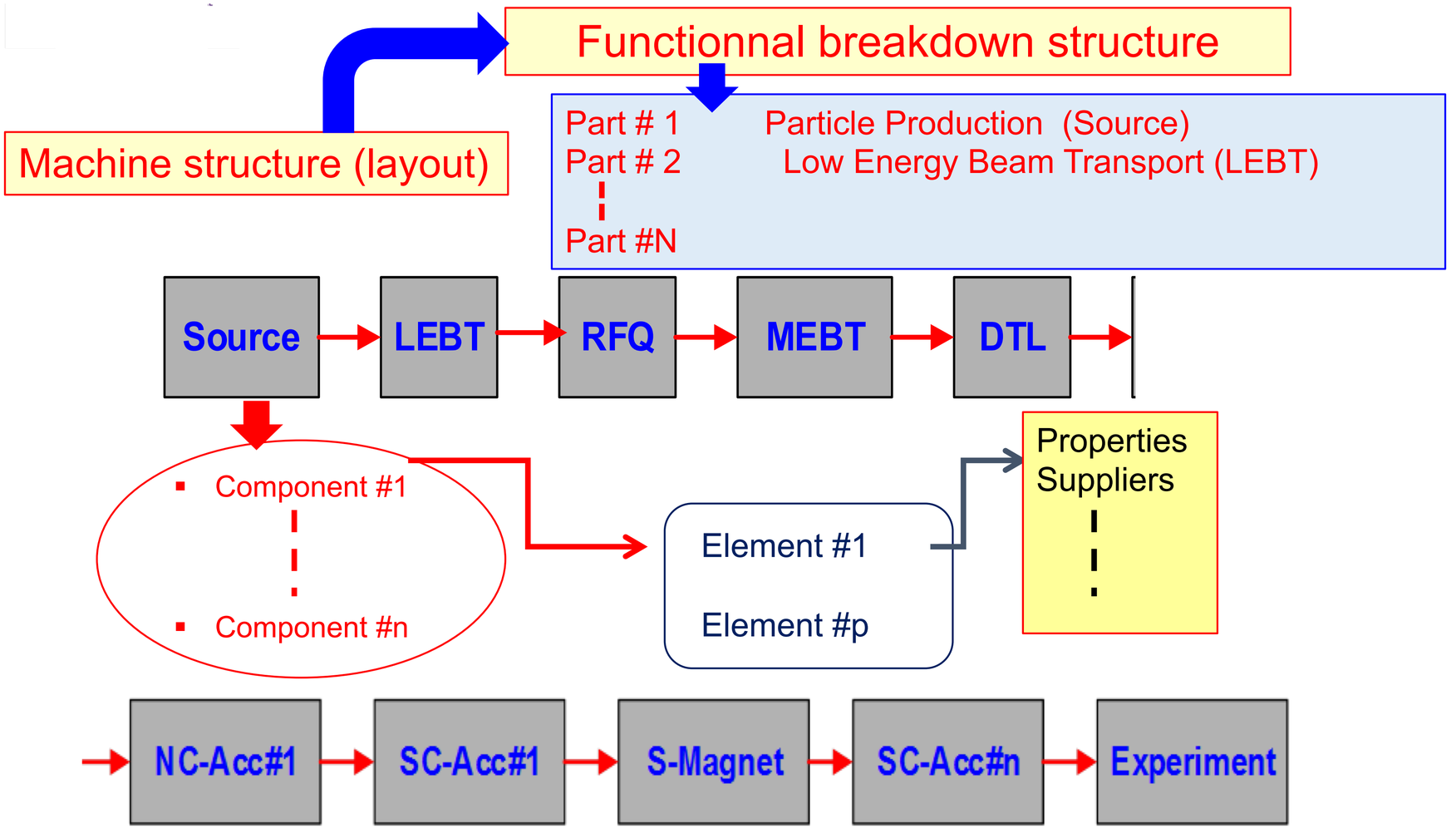
- Create a common reference database dedicated to
  - Materials and components for accelerators
  - Large SC magnets
- Start to fill it with relevant data

Three steps approach:

1. Collect an initial set of basic data relevant to material and components specifications
2. Provide a possible structure for the database
3. Develop and implement a professional database

- Only steps 1) and 2) in the framework of AMICI
- Step 3) to be resourced in a next phase

Philosophy of the DB structure



Example: SRF cryomodule

Database input

Key word : SRF cryomodule

Material

Components

- SRF cavity
- Lhe Tank
- Cold Tuner
- Power Coupler
- Magnetic shields
- Thermal Shields
- Vacuum vessel

Cavity : Nb
Flanges : SS, NbTi

Tank : SS, Ti

Thermal Shield: Cu, Al

Vacuum vessel: SS

Properties

Material, Grade, Purity treatment, metallurgy
Mechanical (Young and shear modulus, YS,UTS,)
Thermal (Conductivity, diffusiviy,
Electrical (Resistivity
Superconducting (TC, HC,JC..)
Magnetic properties (permeability,
Radiation (neutrons, Xrays,..)

Database output

AMICI material DB demonstrator

Components | Material | Properties

Implemented (web application)

Components

- SRF Cavity
- Lhe Tank
- Magnetic Shields
- Thermal Shields

Material

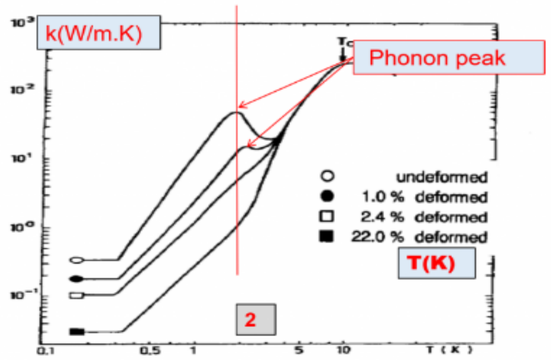
- Nb
- NbTi

Properties

- Conductivity
- Resistivity
- Thermal data
- Thermal conductivity
- Young modulus

Thermal data

Nobium



Tc: 9.26 K

Hc: 0.82 T

Type: II

Source: Physical and mechanical metallurgy of high purity Nb for accelerator cavities, T. R. Bieler, et al.

Download Source

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Example:

- SRF Niobium (Nb) Accelerating Cavity
- Effect of plastic deformation on the thermal conductivity of Nb

Status of WP5.2 and outlook

- [x] Philosophy of AMICI DB structure (based on functional breakdown)
- [x] Definition of what should be included in the AMICI–DB
- [x] Survey of existing databases and data useful for accelerators and magnets
- [x] Bibliography, collection of first set of data for AMICI–DB
- [x] Choice of software for DB development and architecture
- [x] Development of AMICI–DB demonstrator
- [ ] Deliverable D5.1 *‘Definition of the possible structure and content of a database for materials and components’* (In final reviewing stage)
- [ ] AMICI–DB implementation (To be done in a next EU supported project?)

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THANK YOU FOR YOUR ATTENTION!