

MEGAPIE Project Status

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(presented by Werner Wagner)

2nd High Power Targetry Workshop
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Outline

Introduction

Manufacturing Status and Experience

Commissioning and Testing Status

Licensing Process

Outlook and Schedule

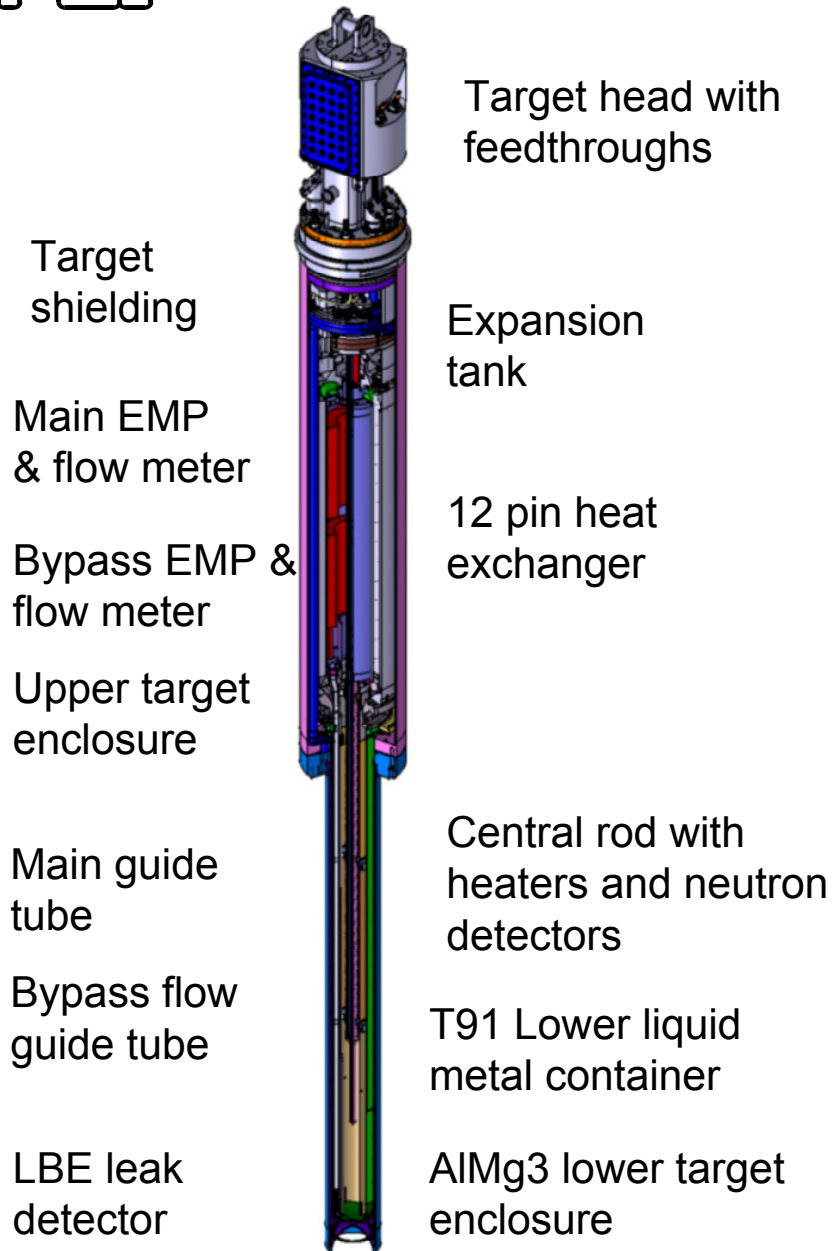
Introduction

The **project objectives** to develop and build 1 MW class liquid metal target and operate it for a one-year cycle in SINQ **are unchanged** and **have been endorsed by the project SC** at its last meeting

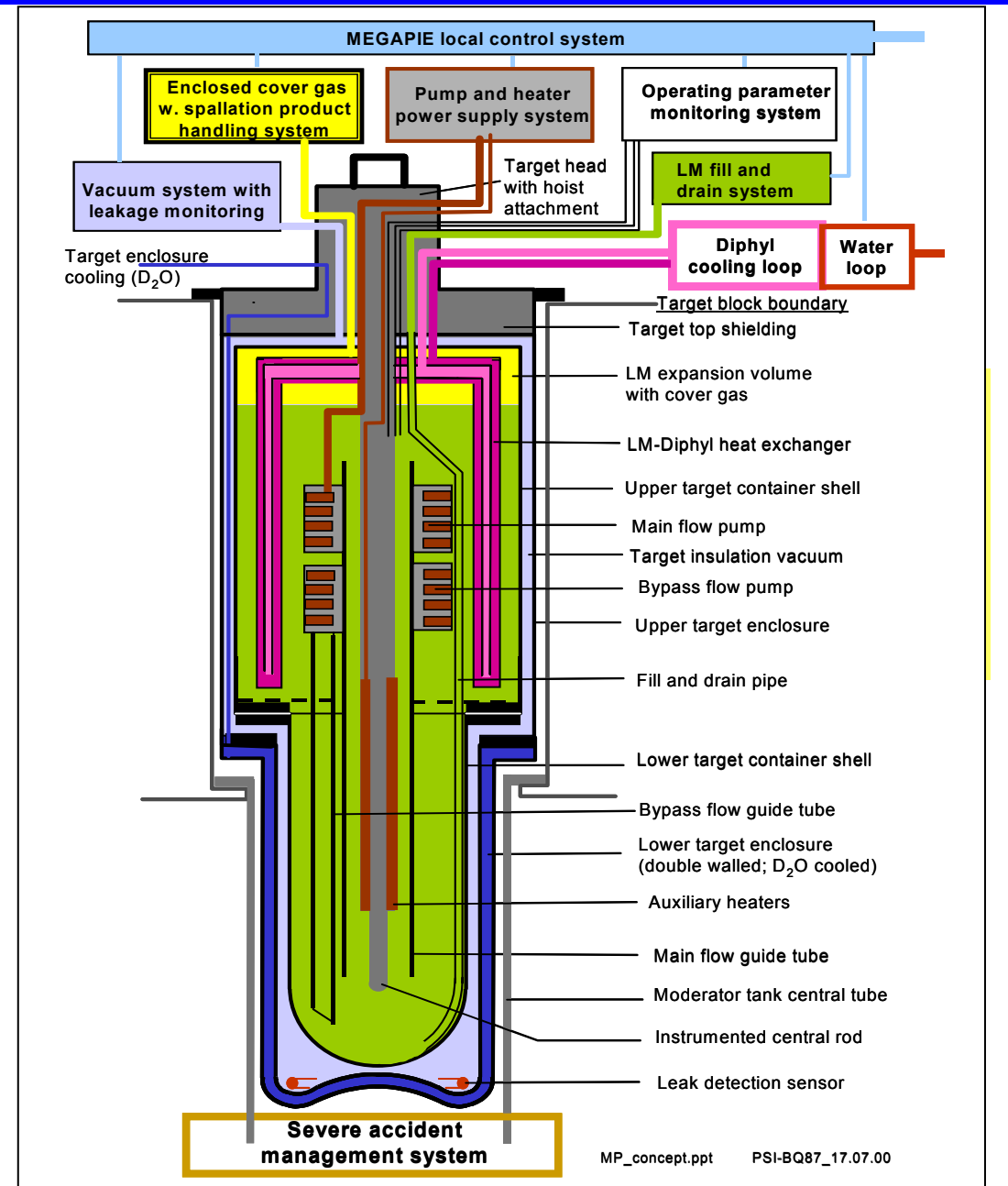
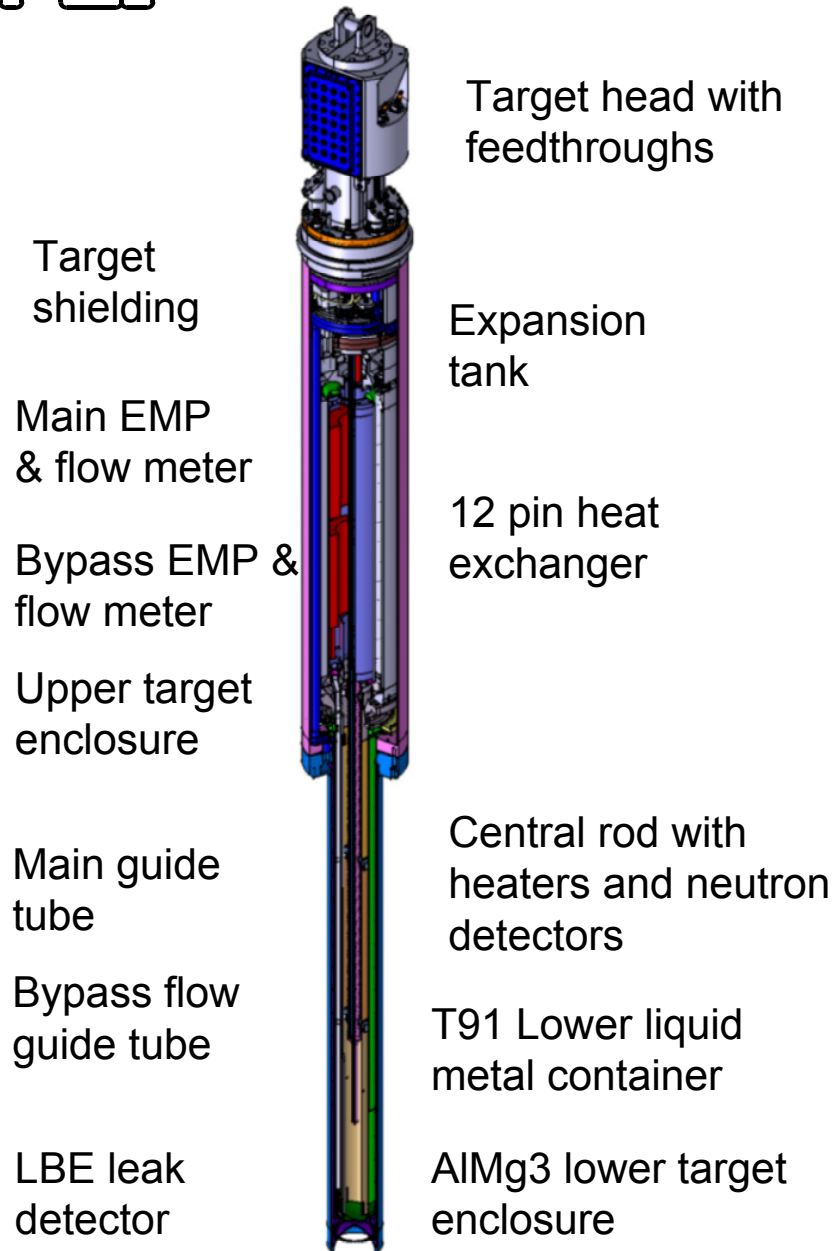
Progress in the project towards completion **is substantial**

The **Technical Review** and **TAC Committee's** Meetings in June 2005 judge the design and manufacturing **fit for testing**. Some issues still have to be solved to conclude fitness for irradiation.

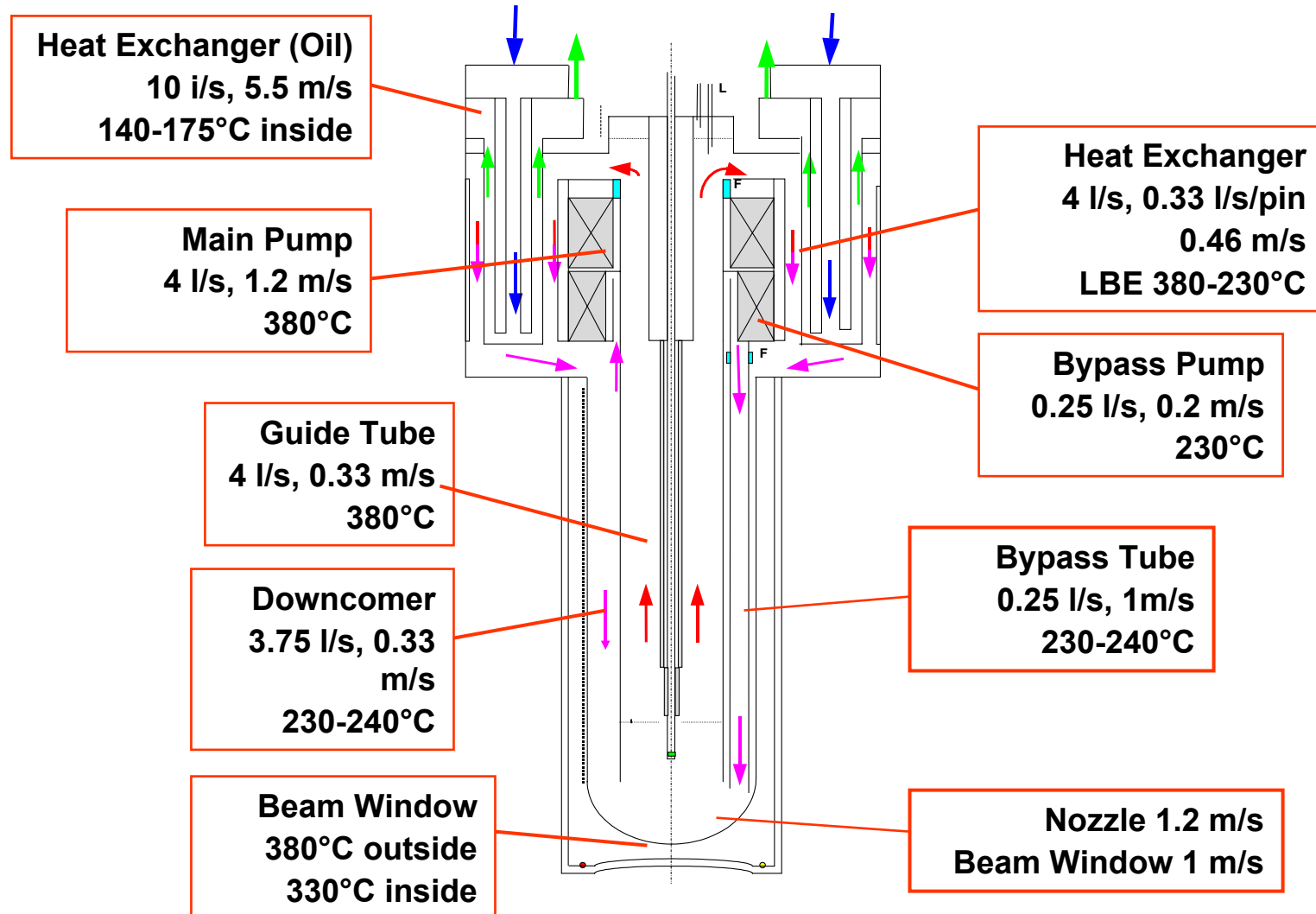
PSI management judges the **readiness for irradiation** achievable within the projected time frame and decided **to start the 2005/2006 shutdown** with insertion of the MEGAPIE target

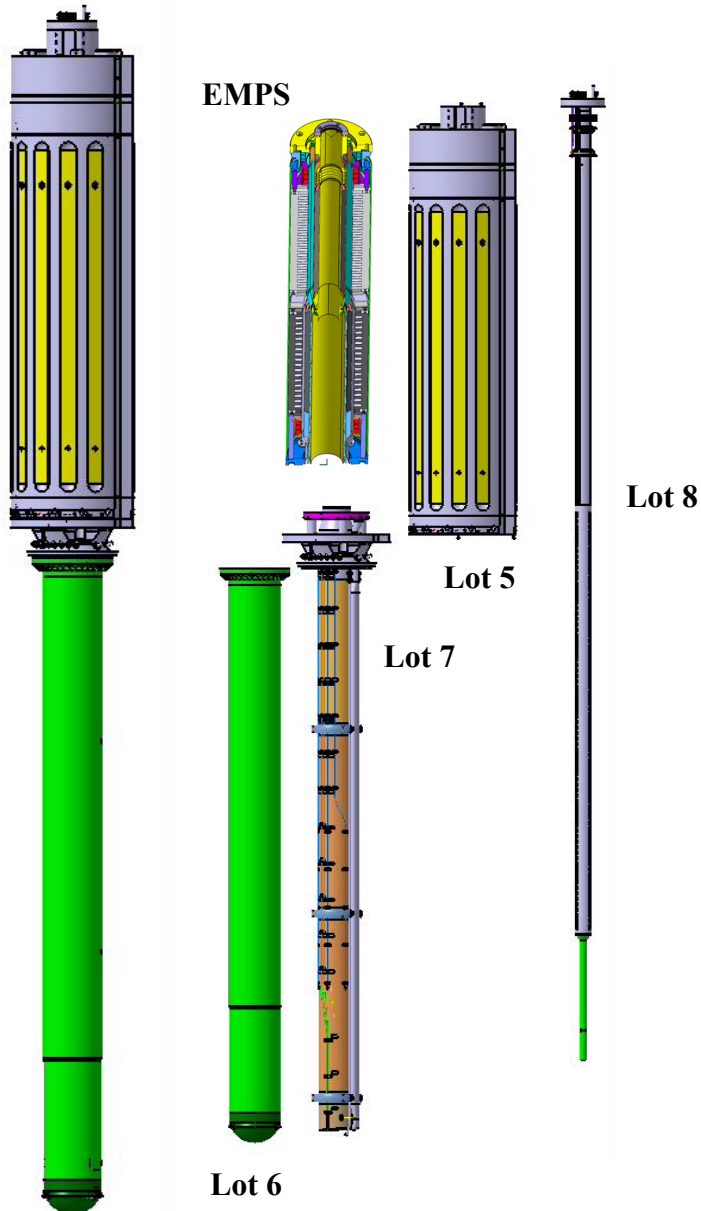


Beam energy: 575 MeV
Beam current: 1.74 mA (design)
Design life: 1 year of operation
(6000 mAh)
Radiation Damage: 20-25 dpa



Operating Conditions





Manufacturing and Assembly of Primary Enclosure

Liquid metal containment

Complex components manufactured by different sub-suppliers → preassembled into lots and instrumented

Leak and pressure tests of the lots

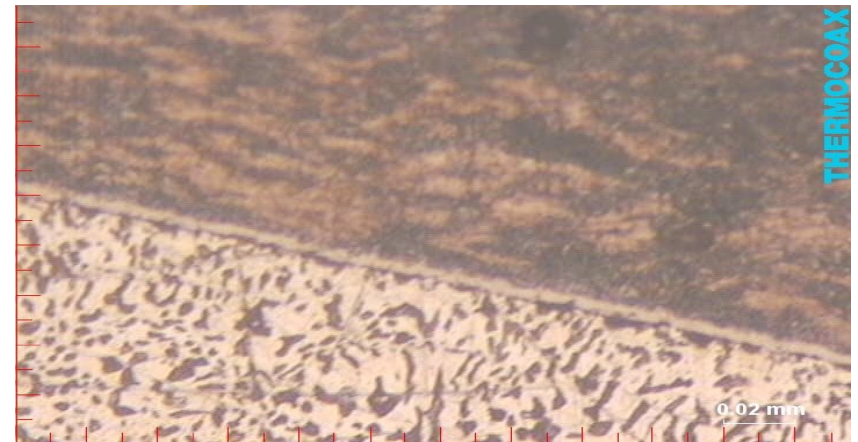
Final assembly at ATEA

Metallic seals (Helicoflex)

Pressure and leak tests, electric checks prior to shipping to PSI

Target Manufacturing: Technical Challenges

- 3D & 5 axis Machining
- Tolerances
- Deep Drilling
- Long Tubes Machining
- Complex Shapes EB Welding
- Brazing
- Metallic Gaskets Tightness
- TCs and Heaters Integrity
- Instrumentation



Assembly for MITS

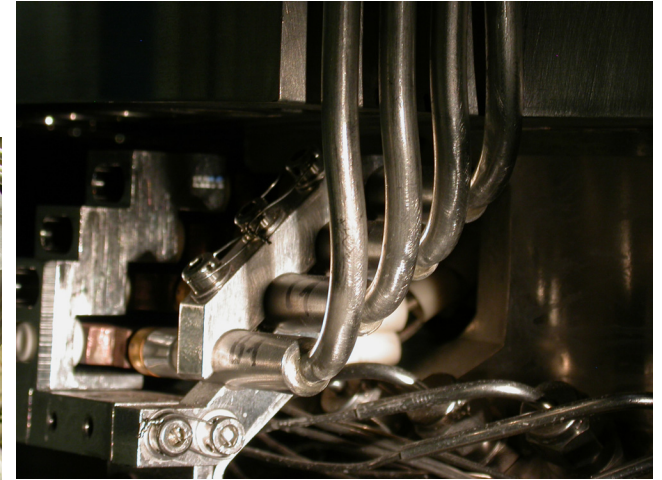
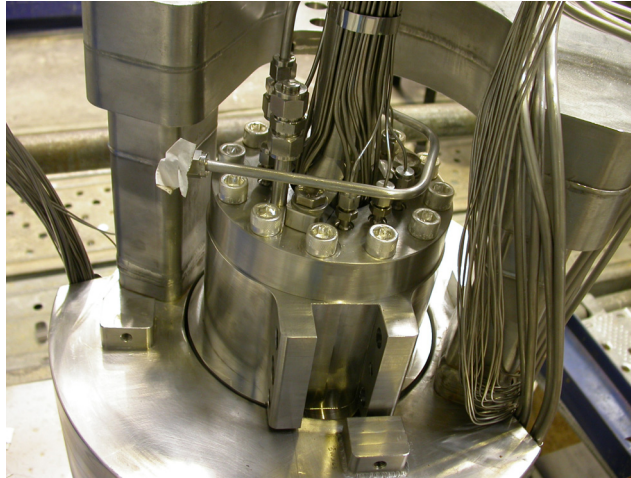
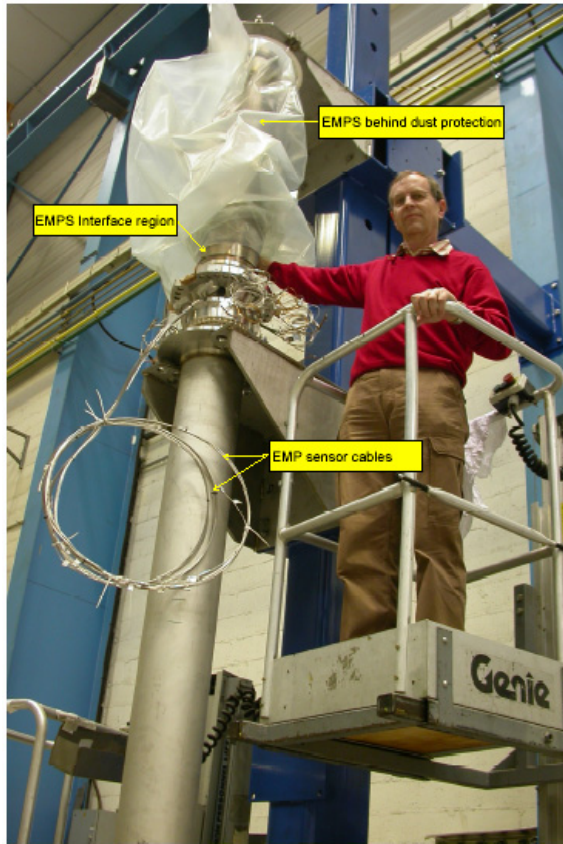


Provisional cable connections

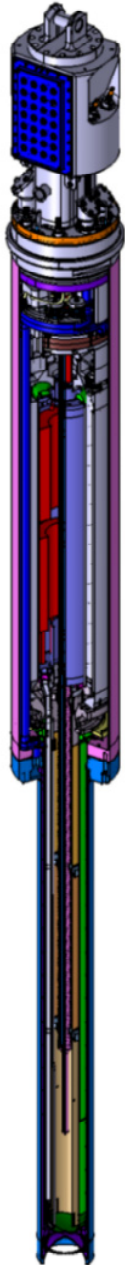
Shielding and pipe connections (HRS, CGS, D₂O, F&D)

LLMC replaced by dummy LMC with bottom flange

Assembly



Target Delivery



Manufacturing and Assembly completed at ATEA and delivered to PSI on June 23, 2005

70 non conformances
30 design changes



Lot 3

Secondary Enclosure

Final assembly at PSI after the MITS test phase

Lot 1

- Insertion of n-flux meter
- Mounting of LBE leak detector
- Final cable connections in target head
- Mounting of outer enclosure

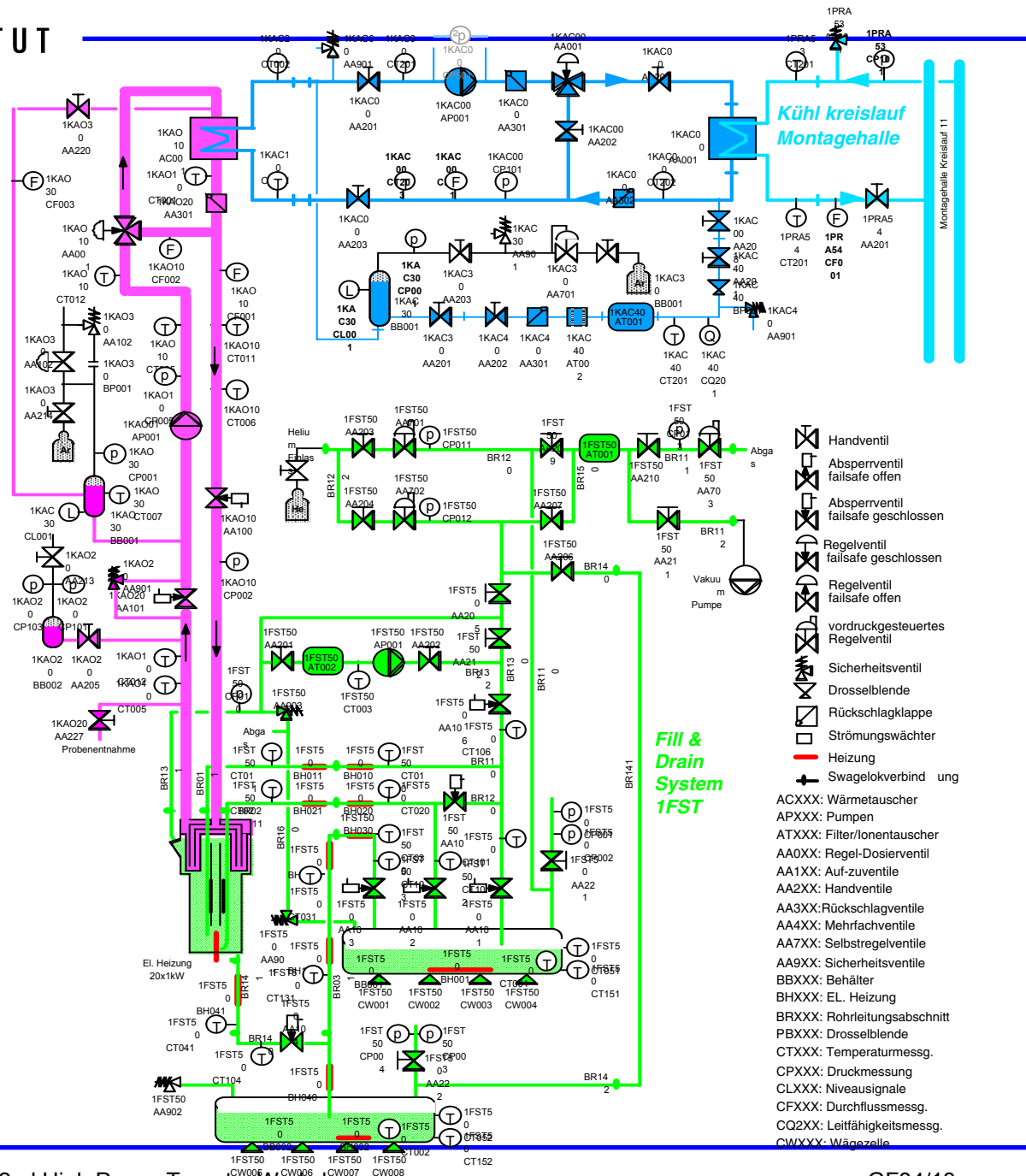
Lot 2

MITs Systems

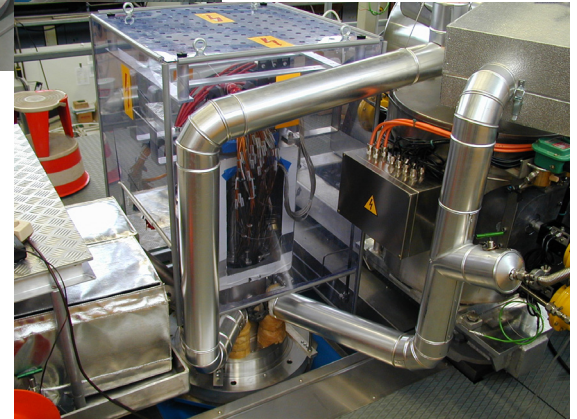
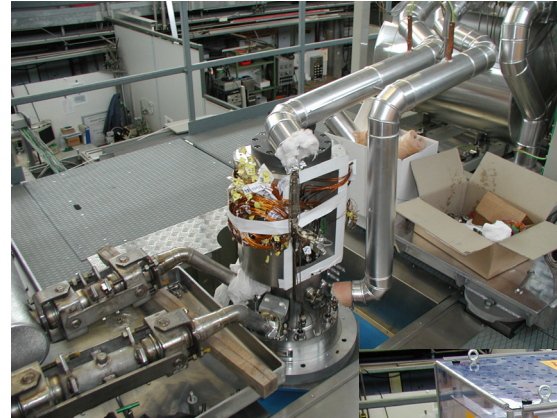
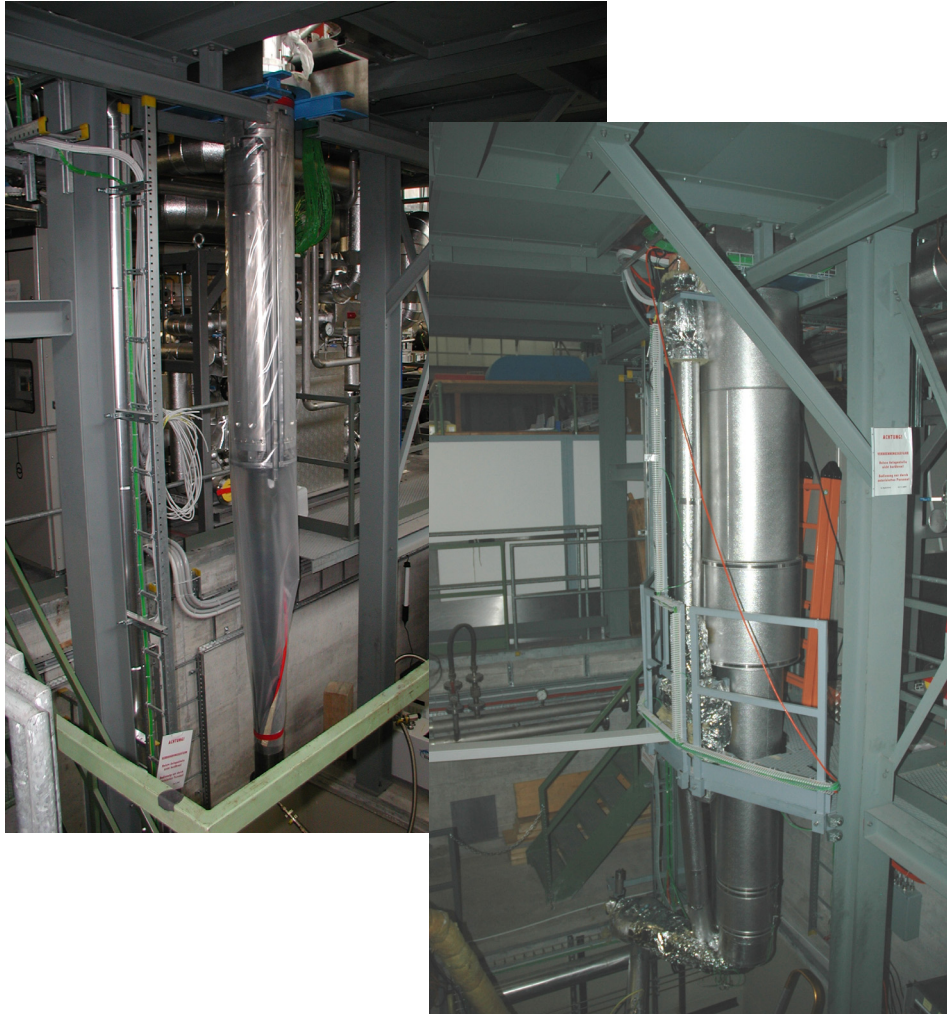
HRS schematic

WCL schematic

Fill & Drain schematic

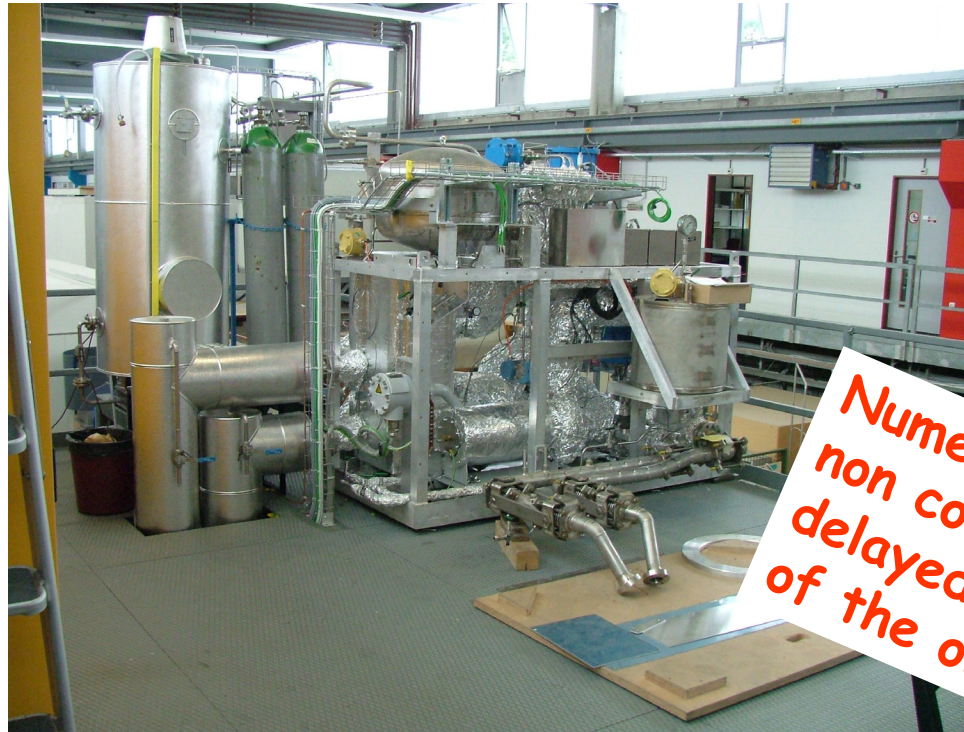


MITs: Target Integration



Target installed
HRS and FDS connected
Provisional cable connections

Heat Removal System

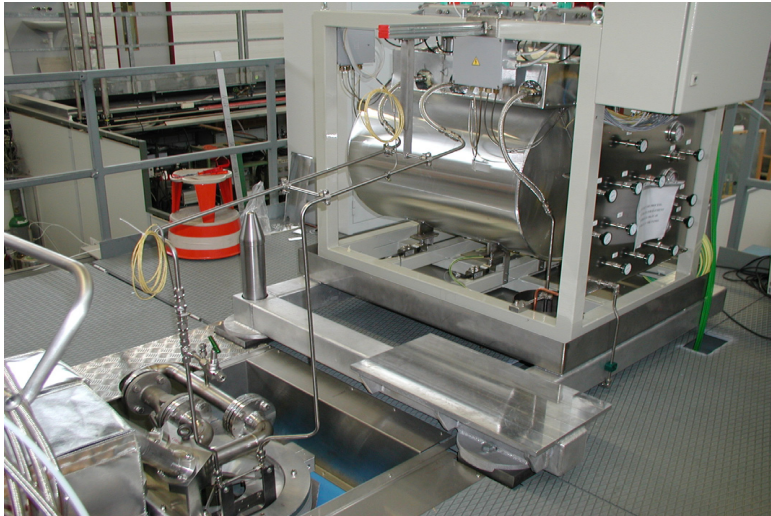


Commissioning completed in June 05

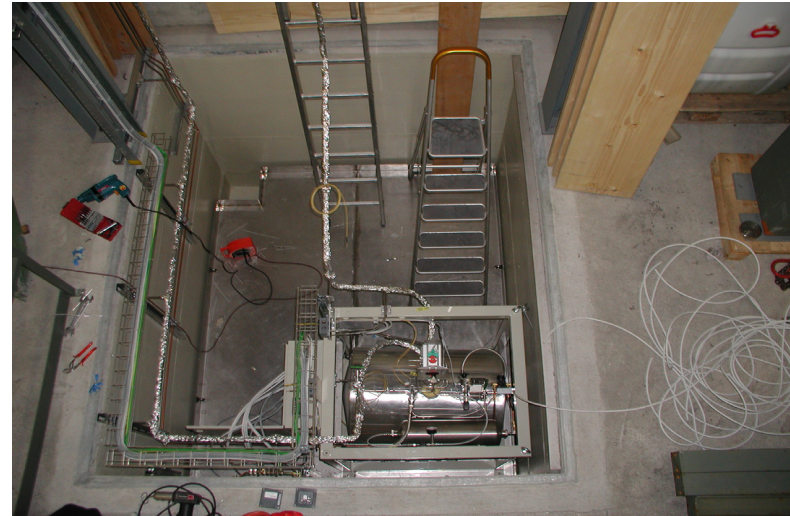
- small debugging still pending (trace heating, pump bearings, leak tightness)

F&D System at MITS

Upper F&D vessel



Lower draining vessel



Delivery of vessels in Dec 04; piping made by PSI
Commissioned end of June 05 (new filter, software check, new relief valve)

MITs Test Program

Target configuration: Flowmeter calibration calotte

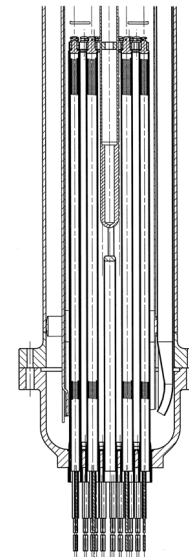
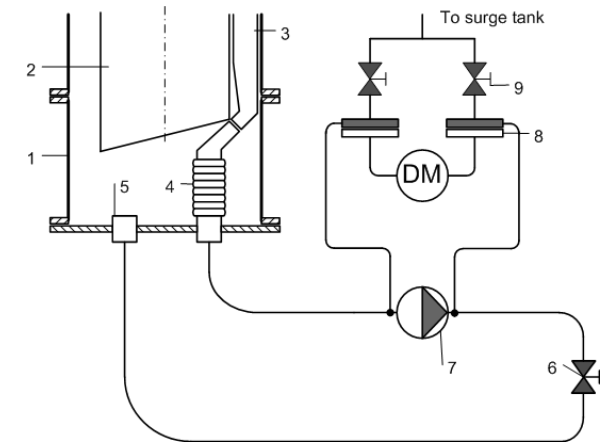
- preheating, filling&draining, general performance
- EMP1/EMF1 check, EMP2/EMF2 checks
- EMF2 calibration

Target configuration: 200 kW heater calotte

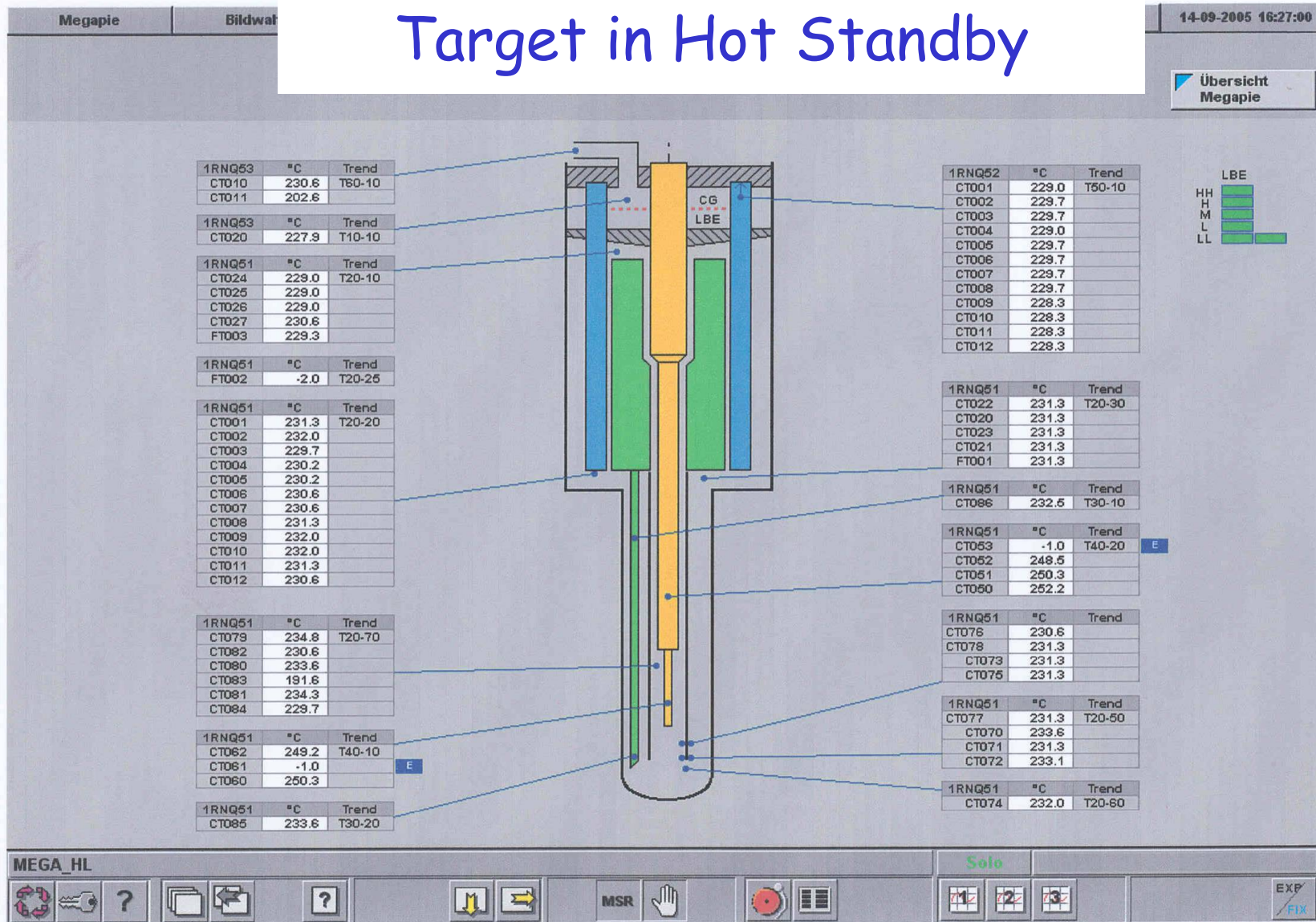
- TH tests, transient behaviour
- Test of IHX
- Beam window cooling test
- neutron flux meter test

Target configuration: LLMC

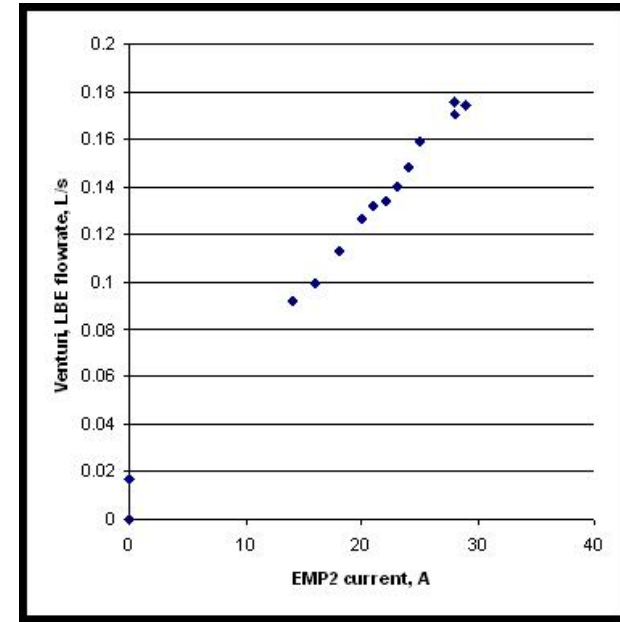
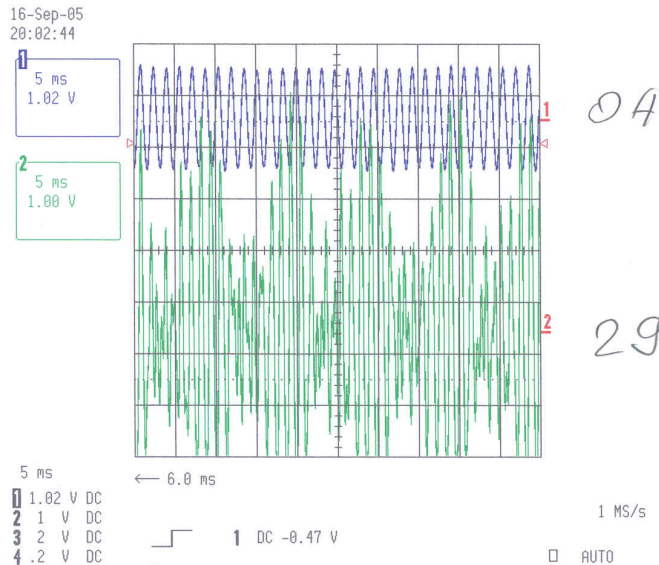
- Preheating, filling&draining
- System behaviour
- Safety checks



Target in Hot Standby



EMF1/EMF2-Check



- Minor effect of EMP1 on EMF1 signal
- Strong effect of EMP2 on EMF2 signal
- Data acquisition and processing to be optimized

Insufficient flow rate – Inconsistent with IPUL tests

→ Inversed flow direction

→ Systematic error in cable connection for EMP2 and EMP1

EMF2 calibration was repeated and yielded promising results

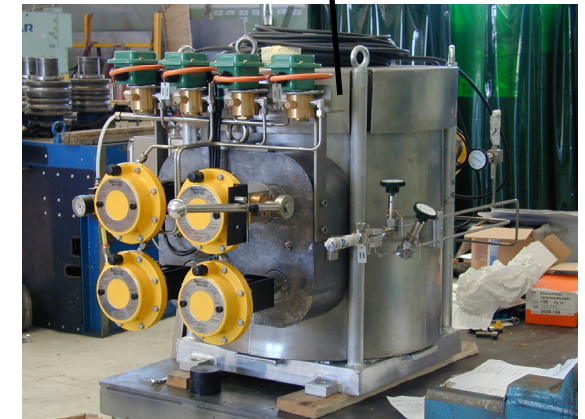
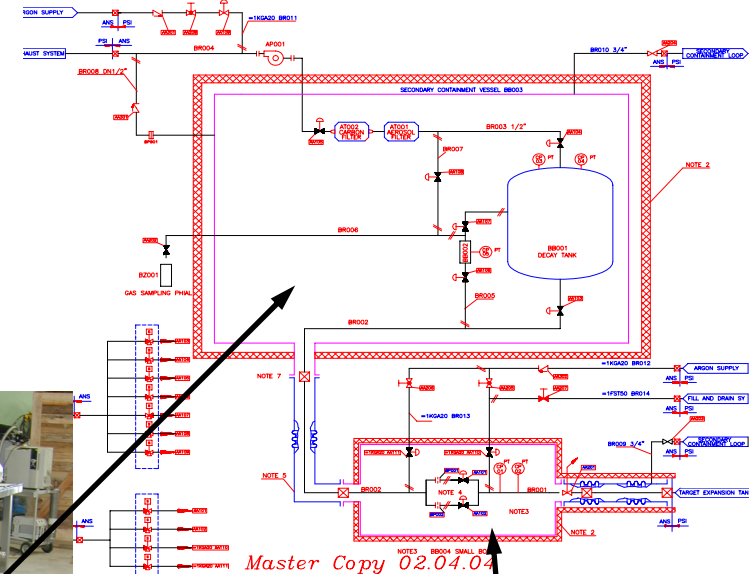
Other Ancillary Systems

Cover Gas System

- ❖ Delivered to PSI in July
- ❖ Implementation in MITS by end of October
- ❖ Commissioning in November

Insulation Gas System

- ❖ Contracted
- ❖ Delivery in January 06
- ❖ Installation directly at SINQ



Licensing

5 Milestones and 52 Prerequisites according to BAG licensing statement

Clearance for

- Inactive operation of heat removal system: **granted !!**
- Inactive operation of the target: **documentation submitted**
- Inactive operation of cover gas system: **documentation submitted**
- Handling of active target and waste disposal: **Positive statement of NAGRA and HSK received, submitted to BAG**
- Active operation **pending**

About 15 (out of 52) prerequisites have been cleared

- SINQ target block integrity
- Upgrading of SINQ ventilation system
- Emergency power supply
- Inertisation of TKE
- QA aspects

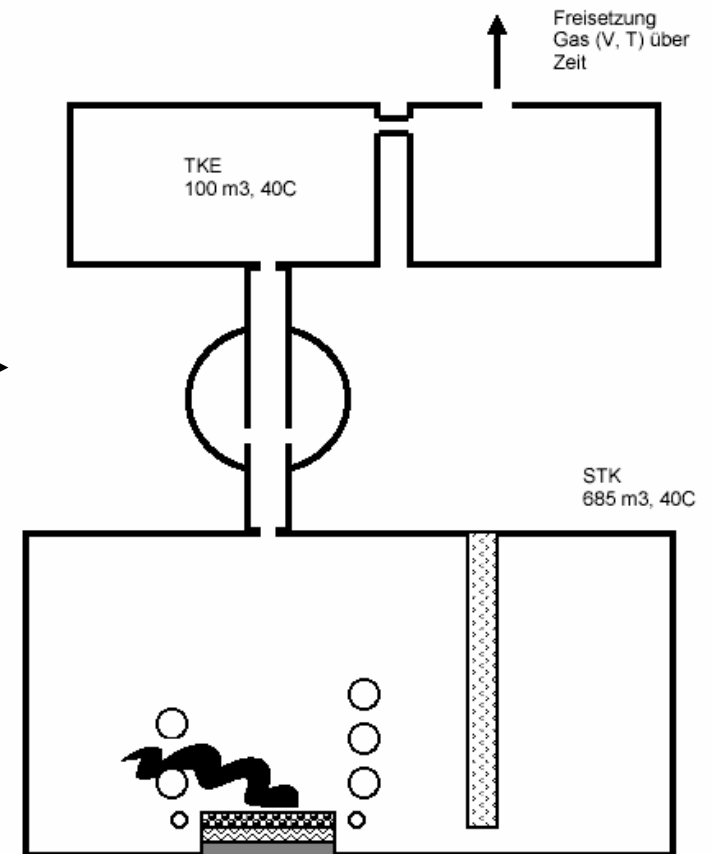
Licensing

2 prerequisites are critical

- Enclosure concept for last barrier – automatic closing valves for penetrations (60.M9/10 und 60.M30/31)
- Reference accident case (60.M48) →

Both prerequisites are connected with the protective dose limit to the population:

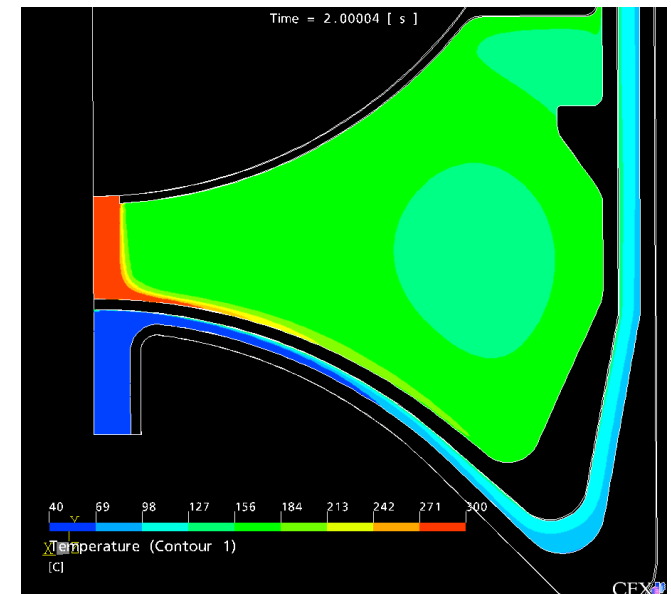
A maximum dose limit below 1 mSv has to be demonstrated !!



LBE 4 m2, 2 cm dick (analog Sicherheitsbericht)
D2O (7.5 l Fensterkühlung und/oder 4 m3 Moderatortank)
Diphyl (25 l)

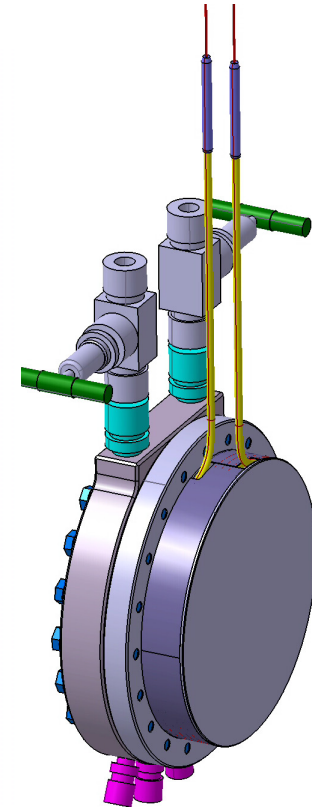
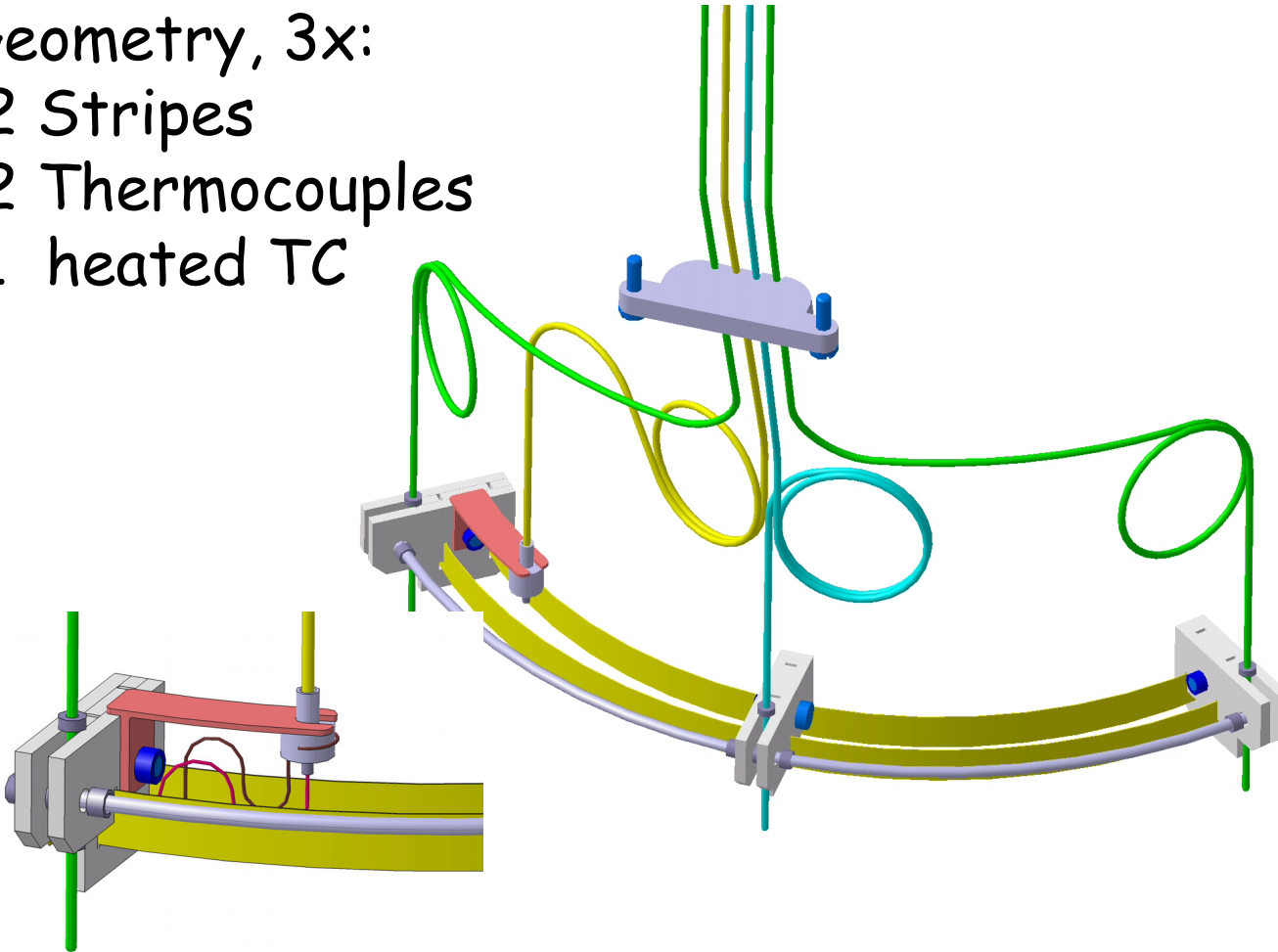
LBE enclosure in case of LLMC failure

- **Calculations** show that LBE can be contained and frozen safely provided the failure is detected within 2 seconds and the beam is shut-off
- **LBE Leak detector** has been developed and is currently tested in LISOR facility to check radiation resistance
- **LTE Full scale test** scheduled for end of October to validate calculations and demonstrate feasibility



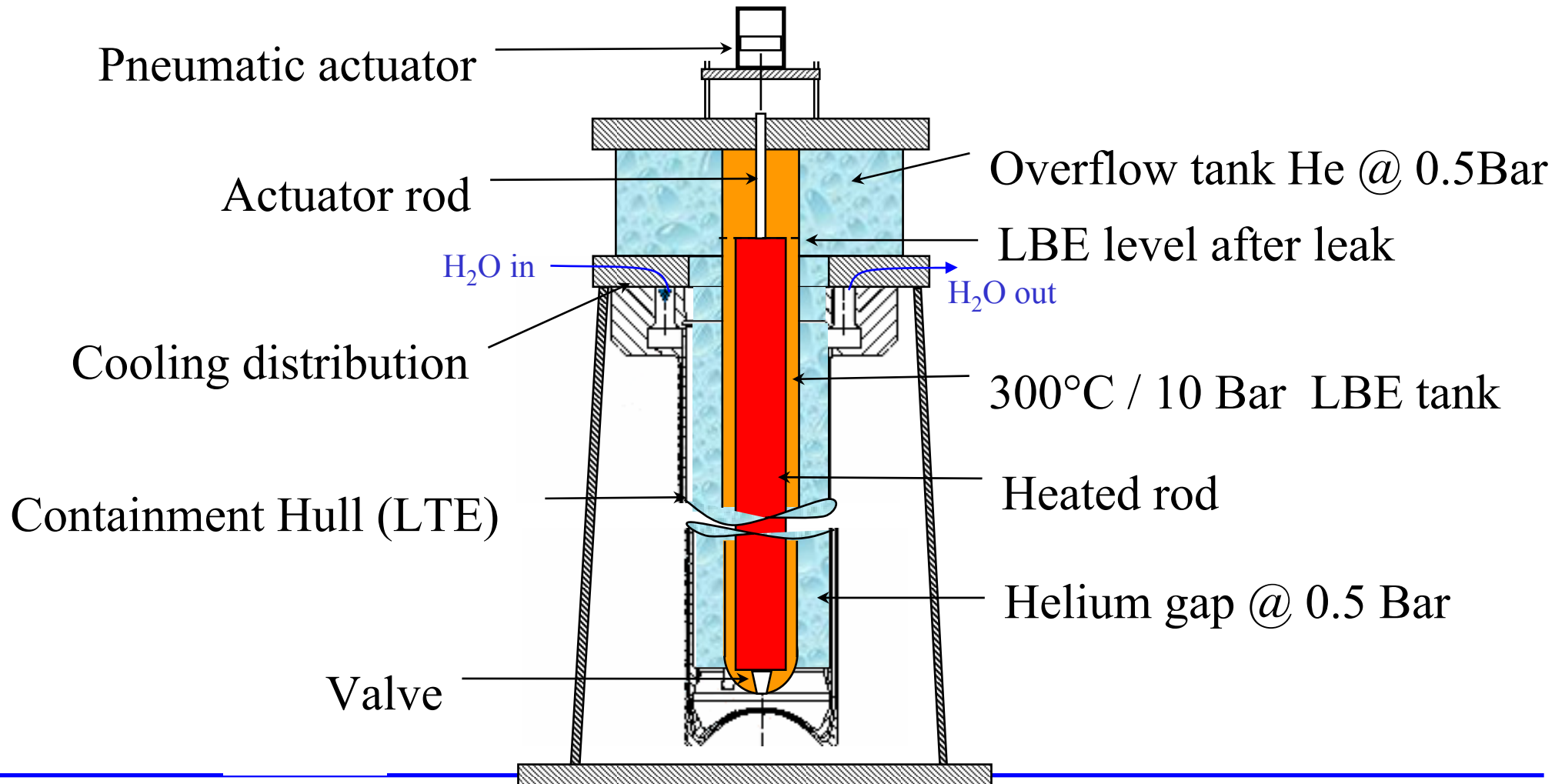
LBE Leak Detector

Geometry, 3x:
2 Stripes
2 Thermocouples
1 heated TC

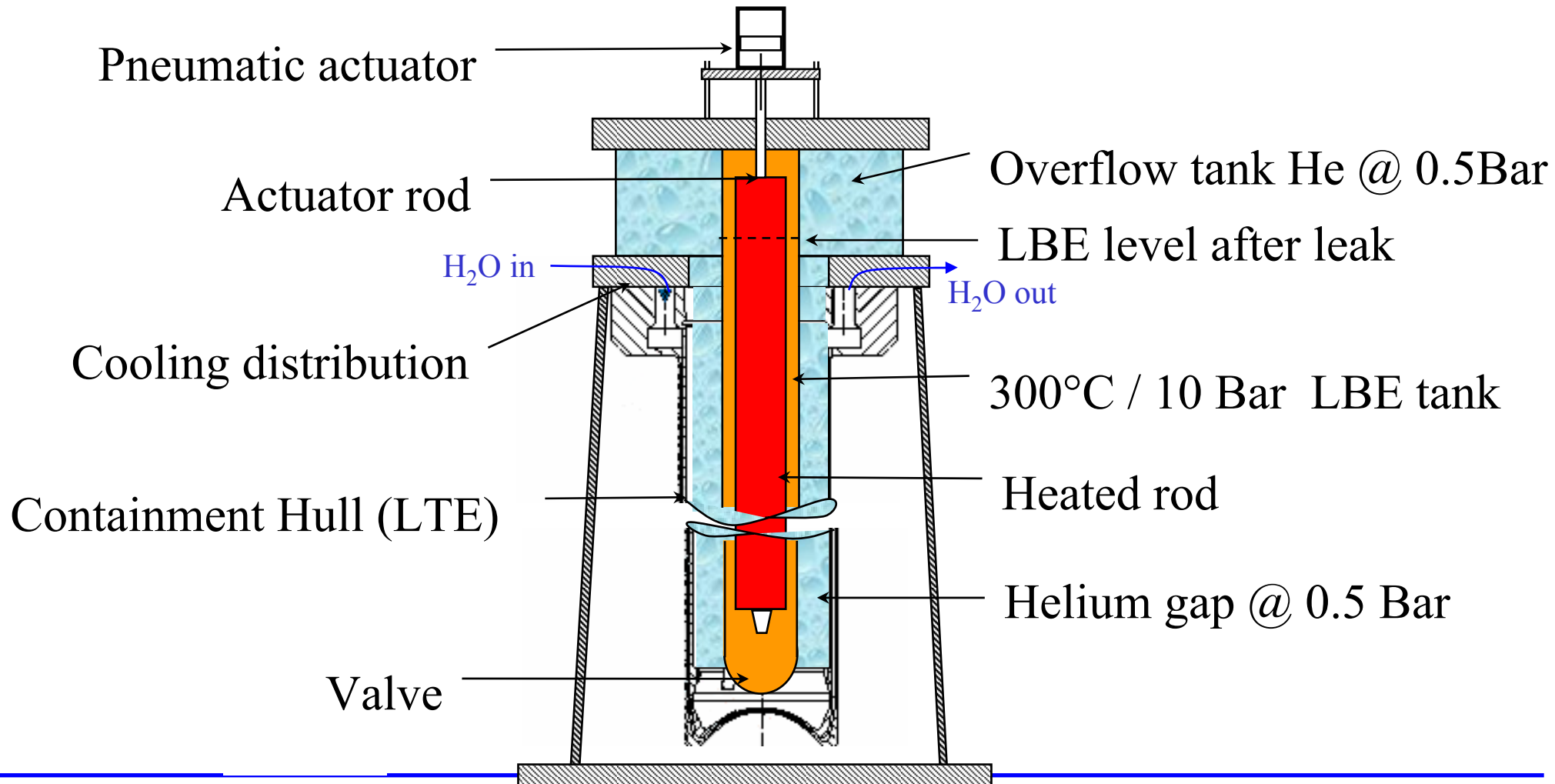


LISOR test
chamber

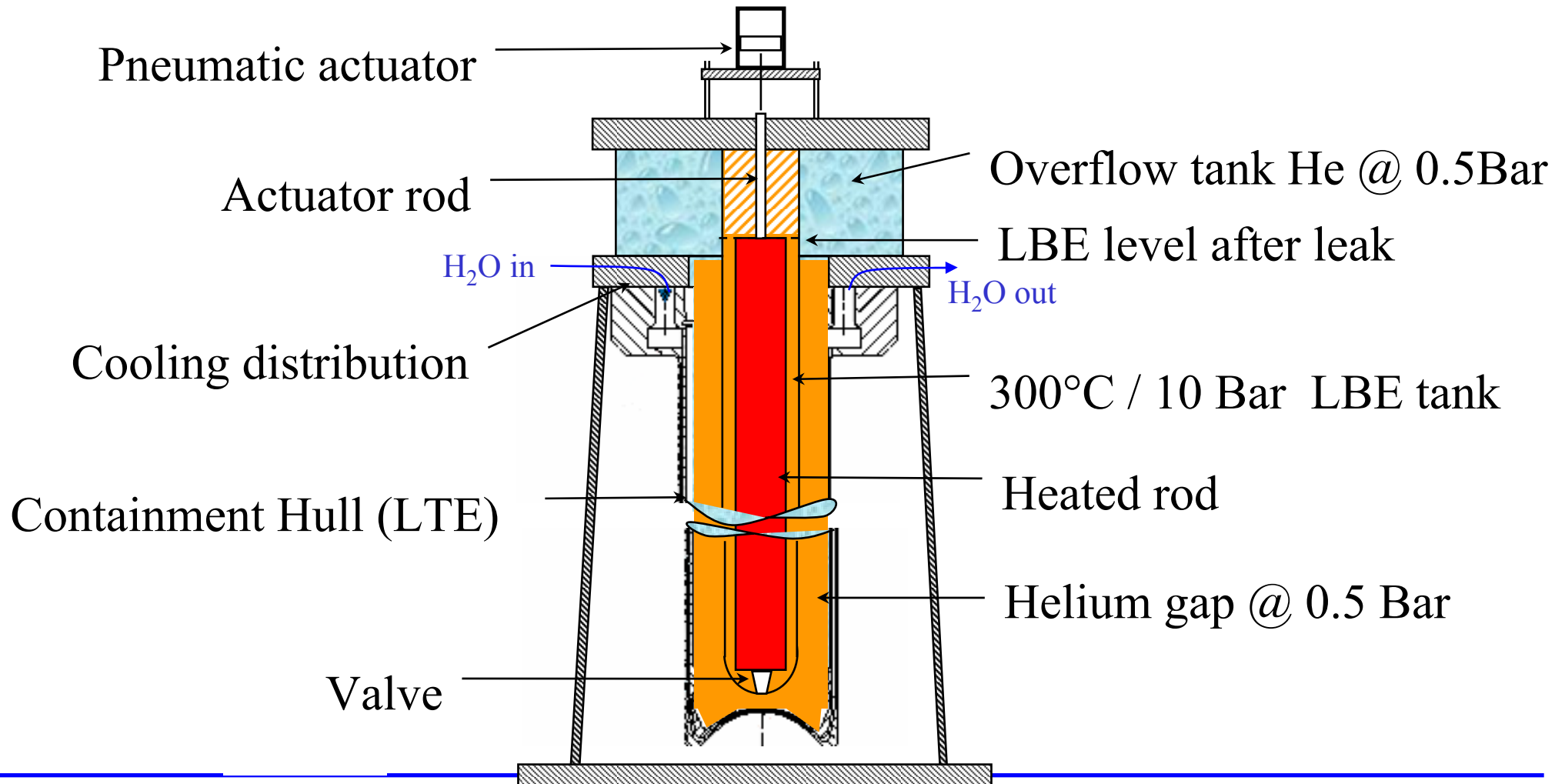
Full-Scale Leak Test Scheme



Full-Scale Leak Test Scheme



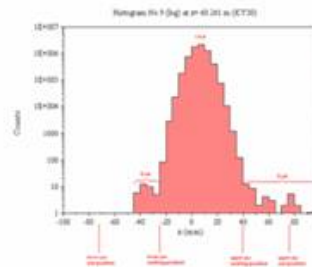
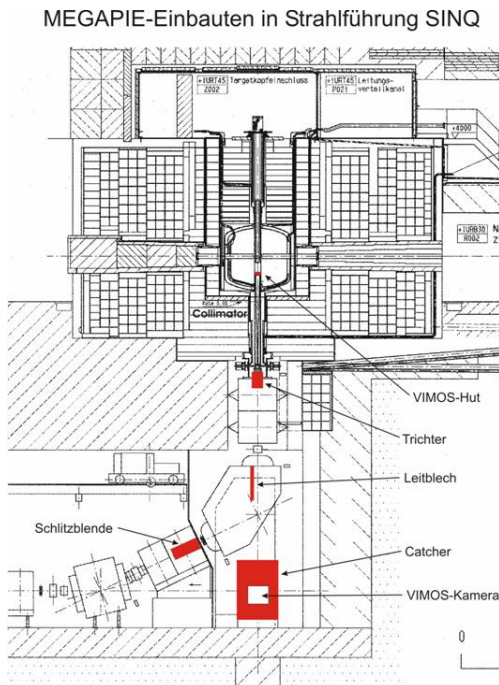
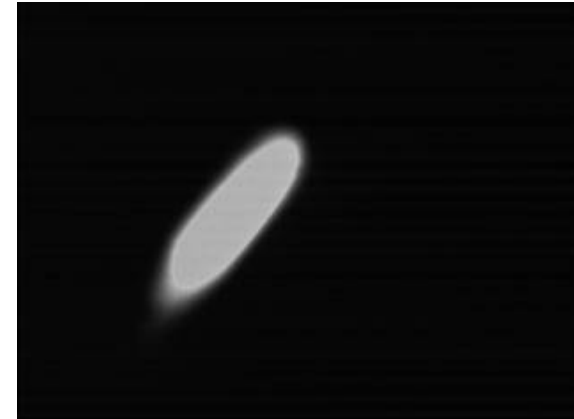
Full-Scale Leak Test Scheme



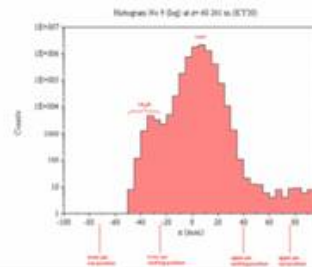
Beam diagnostics

- Target E transmission monitor
- Rohrer slit
- VIMOS

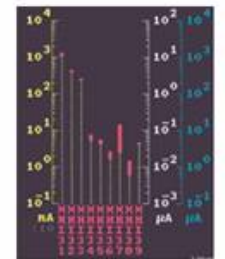
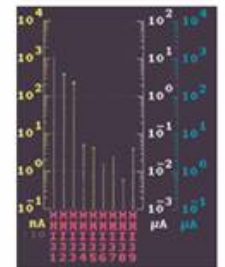
Installed and tested since early 2005



Well-centered Beam



beam shifted 1.5 mm
appr. 0.1 % protons
by-pass Target E



Readiness for 2006

- Target functioning
- Reference accident case
- LTE integrity
- Safe beam
- LBE detector
- TAC statement
- BAG statement

November
2005

Conclusions

Target integration and tests at MITS were rather successful and roughly according to schedule. Tests are scheduled to run until end of 2005

Licensing process progressing smoothly due to regular meetings with authorities. Critical issues are in work and solutions seem achievable

Target integration in SINQ is scheduled for early next year and a first beam on the target is expected in June 2006

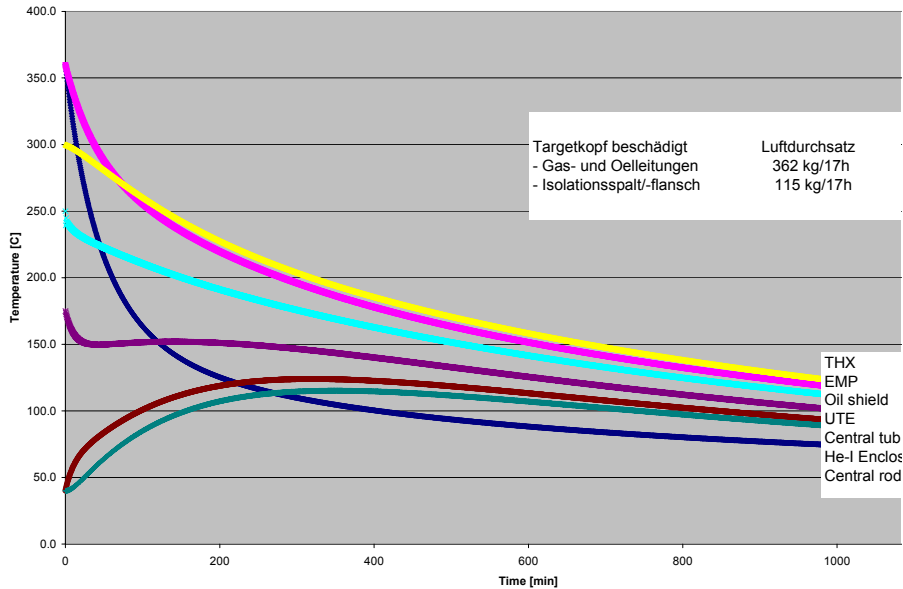
Thank you for your attention

Reference Accident Case: Internal Initiator

- TKE/STK enclosures remain intact (ventilation remains operable)
- Leak rates remain unchanged, under pressure is kept (short pressure surge due to LBE-water interaction)
- Source terms: cover gas, LBE-spill in STK, LBE-film in Target
- Filters are designed to cope with pressure surge and steam
- Evacuation via ventilation

Reference Accident Case: External Initiator

- External initiator (e.g. heavy earthquake)
- TKE/STK-enclosures are breached (e.g. pipe break)
- Ventilation may be inoperable → earthquake resistant shut-off valves
- Leak rates very high, no under pressure
- Source term: Cover gas, LBE-spill in STK, LBE-film in target
- Autonomous, earthquake resistant filter unit evacuates excess air volume from stack effect in target assures directed air flow towards filters
- Installation of mobile filter unit after first clean-up



Cool down of the target components in case of perforation of beam window and target head damage

Evaporation of Hg from 20 μm LBE film during target cool down

