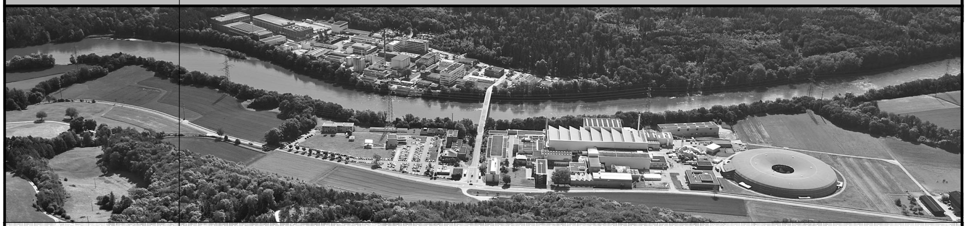

Wir schaffen Wissen – heute für morgen

Paul Scherrer Institut

M. Wohlmuther

REMOTE HANDLING

CERN ACCELERATOR SCHOOL

24 May – 2 June 2011, Bilbao

Acknowledgement

This talk would not have been possible without the help, support and collaboration of many colleagues.

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CERN
K. Kershaw

Thank you very much for your help and support!

Remote Handling

In some areas of accelerator complexes beam losses are high →activation levels (some mSv/h to several Sv/h) → occupation of areas by humans severely harms health → handling of components exchange, repair (if possible) and maintainance done remotely

Remote handling …
• has to be planned from the start of designing a new facility
• has to be done in close cooperation with radiation safety
• is very site specific (remote handling techniques might even change within a facility, e.g. tunnel system of accelerator – target systems)

Requirements for Remote Handling

• Predictions of radiation dose levels in areas → MC simulations
• Predictions of dose inventories of components → dose rates → requirements on shielding and occupation time for personell → BE CONSERVATIVE
• Accurate planning of all remote handling steps in advance to „real intervention“ → Documents describing actions on a step by step basis, people that have to be involved, tools that are needed …
• Practicing (training) of the remote handling on dummies or real components before start-up of the facility and before intervention.

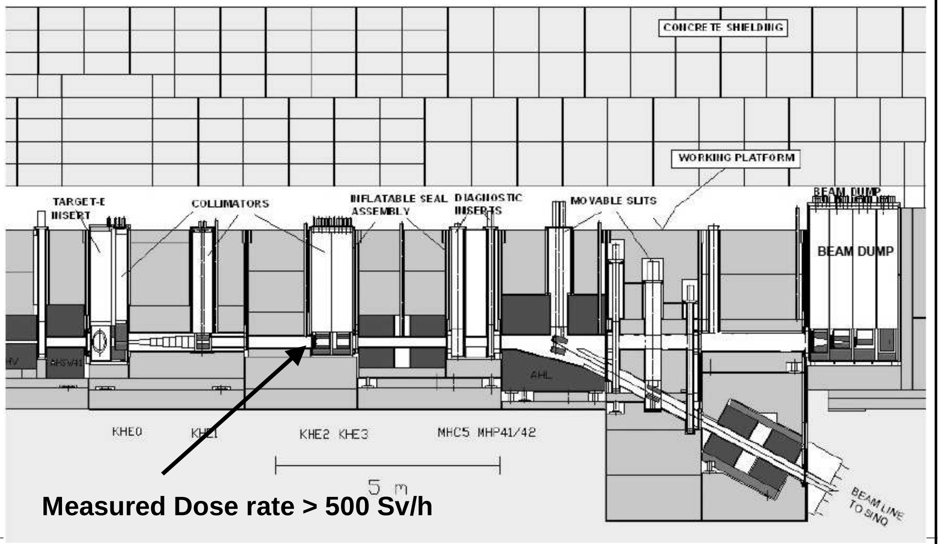
In short: A full documentation (best with photos) of the whole remote handling process.

The documentation of such processes is essential because one is never sure when remote handling will be necessary. It can be weeks, months, years … (and things tend to get forgotten!!!!)

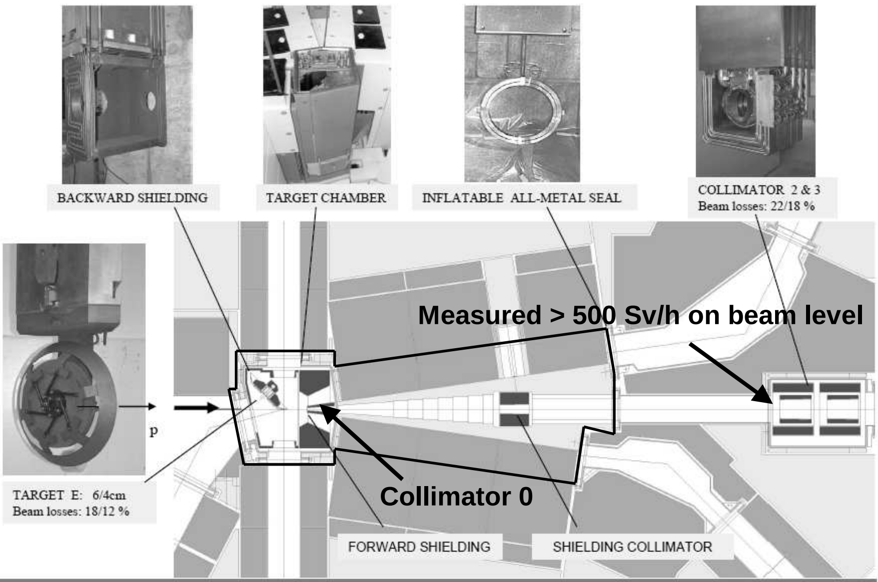
- Remote Handling @ PSI (exchange of collimators, quadrupoles)
- Remote Handling @ CERN (tunnel system)
- MEGAPIE

Design of „p-Kanal“, Target E, collimators & beam dump

Dose rates on the beam level (2 meters below working platform) very high, due to beam losses (1/3 of the beam from Target E to collimator 3)



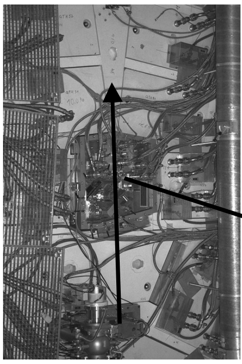
P-Kanal around Target E



P-Kanal – The working platform

During shutdown/maintainance – concrete blocks removed

Target E



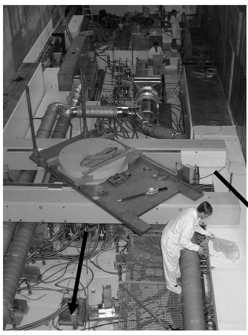
Beam Dump

All cooling water pipes, power supplies … accessible on working platform

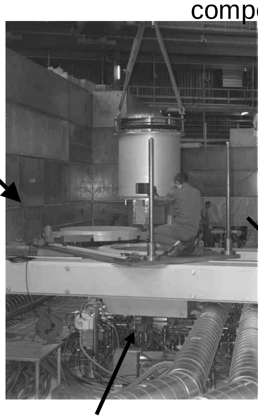
Protons

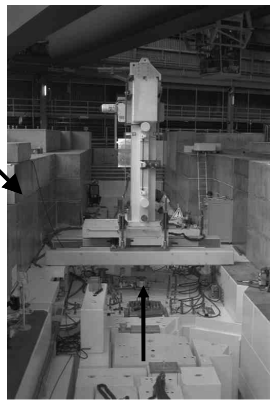
Exchange of component – Exchange flasks

Component disconnected from power, water … → Exchange flasks basis mounted on working platform (left picture)



Contamination shield put directly above component (middle picture)





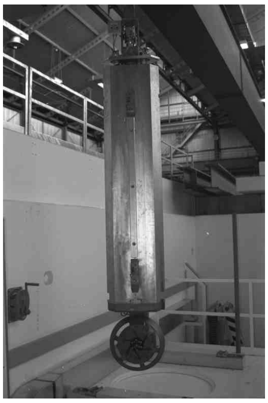
Shielded flask to extract devices from p-Kanal mounted on its support (right picture)

Exchange flasks

For different components there are different exchange flasks.

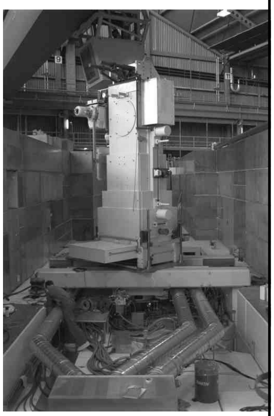
Exchange flasks are shielded „mini cranes“ that can be remote controlled – on a step by step basis - from a safe distance.

Exchange of Target E insert



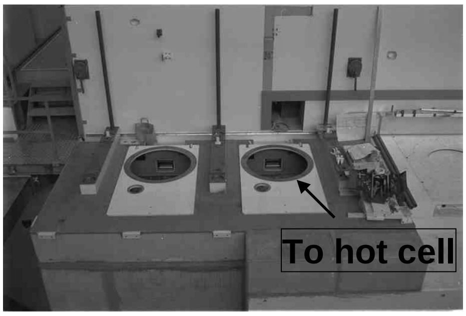
Accelerator components

- 3 parts
  - Connections to necessary supplies and motors (water, TCs, power ..)
  - Shielding part (length ~ 2 meters)
  - Accelerator compontent (Target E, collimator, BPMs…)

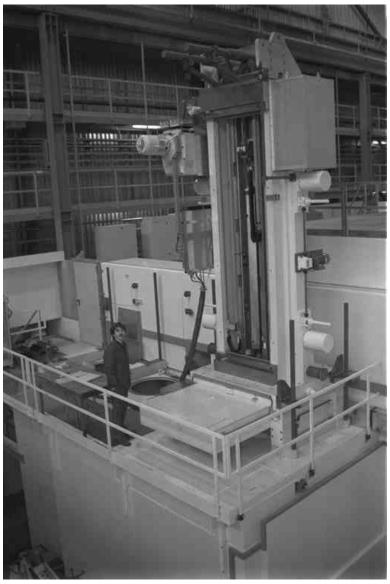


- Disconnection of supplies (not remote, but on working platform), installation of special grippers
- Installation of exchange flask
- Component lifted into exchange flask
- Brought to Hot Cell for repair/inspection

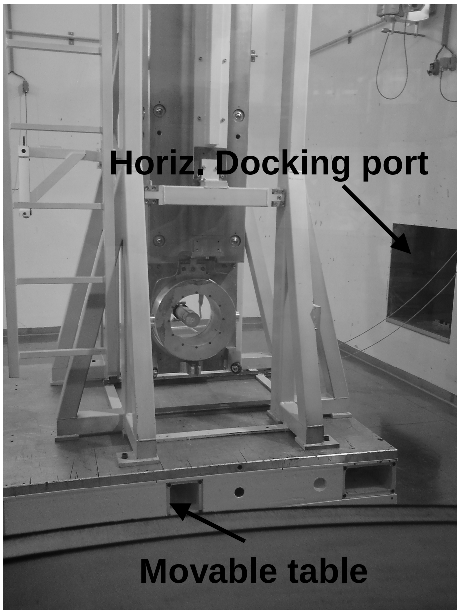
Docking station to the Hot cell



- 2 Docking stations
  - 1st to dock and handle over active component
  - 2nd can contain spare component
- Exchanges of Target E ~ 3-4 days operation

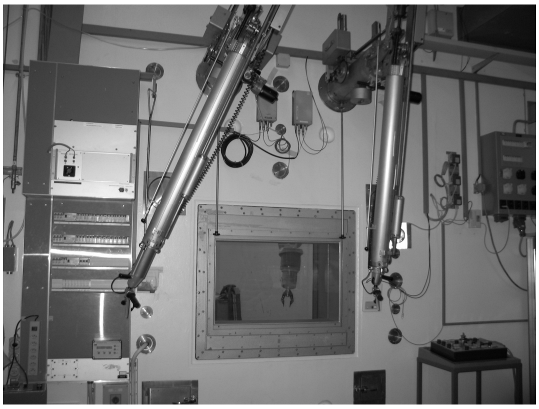


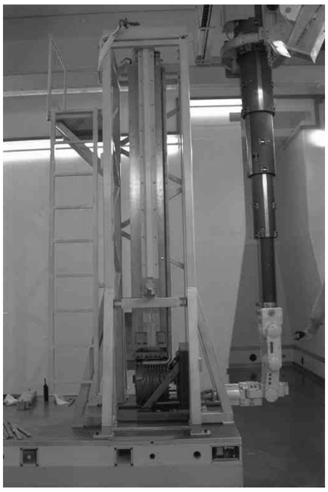
Inside the Hot cell



- Component is lowered into a rack directly positioned below the exchange flask docking port
- Rack mounted on movable table
- Installation moved to middle of Hot cell (good visibility with cameras and through window)
- Repaired or dismantled
- Example: Beam current measurement device (resonator) MHC5

Hot cell



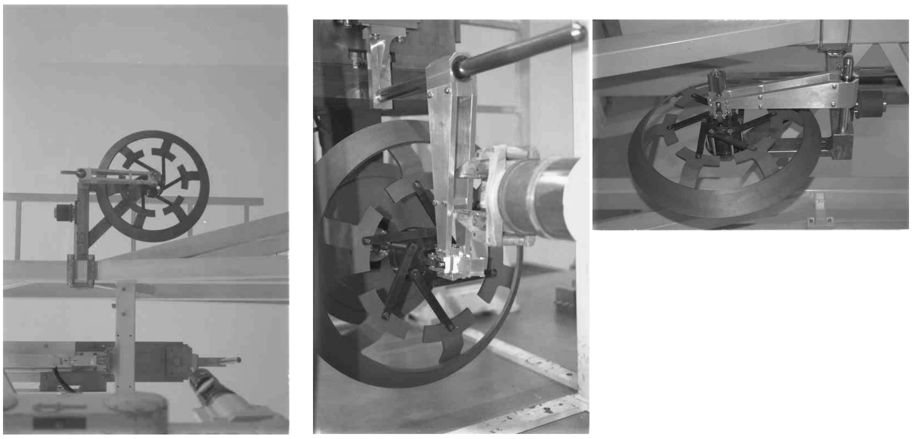


Repair, Dismantle or Inspect

Dismantling of Target E Carbon wheel

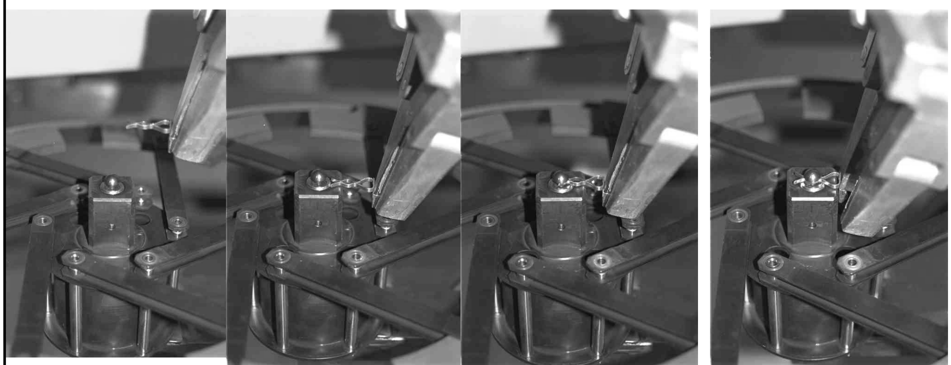
Special tools (like the saw) brought into hot cell in advance to handling → Carbon can be probed (harvesting for nuclides or radiation damage investigation)

Repair, Dismantle or Inspect



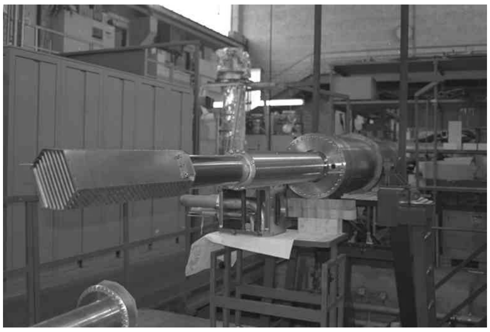
Ball bearings of Target E suffer from radiation damage → have to be exchanged on a (half)-yearly basis

Repair, Dismantle or Inspect



Exchange of bearings

Repair, dismantle or inspect



SINQ Target Exchange flask

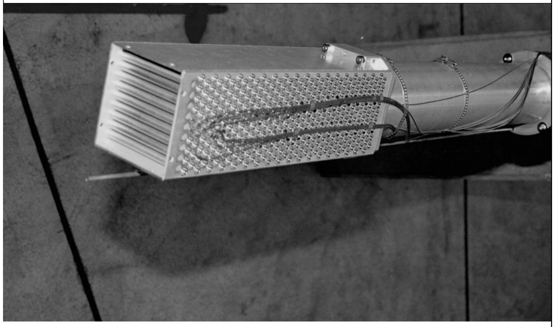
- Mounted vertically on SINQ
- At the hot cell brought into horizontal position
- Target is handed over horizontally

Since 2000: SINQ-Target Mark 3

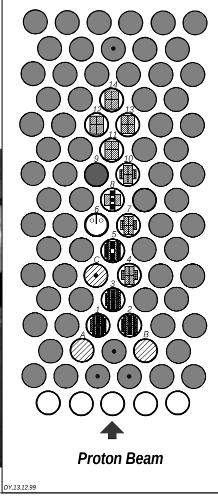
Lead rods, cladded by steel tubes (‚cannelloni' target)

• carrying STIP samples: SINQ Target Irradiation Program

⇨ 42% increase in neutron yield compared to solid Zircaloy (Mark 2)



STIP samples loading plan



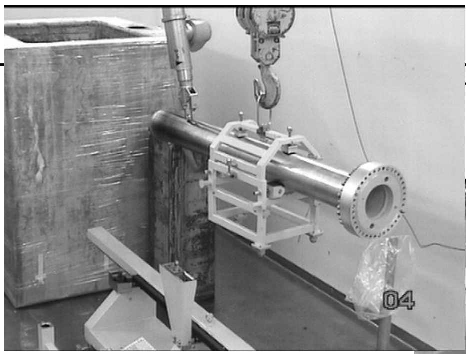
Rod	Including samples
A	Hg Capsules
B	Pb-Bi Capsules
C	Pb-Bi Capsules
1	Tensile, Fatigue, TEM
2	Tensile, Fatigue, TEM
3	Tensile, Fatigue, TEM
4	Bend bar, Tensile, TEM
5	Tensile, TEM
6	CT, Tal-clad W, SiC SANS
7	Bend bar, Tensile, TEM
8	Fatigue, SANS, TAP
9	Carbon fibre samples
10	Bend bar, Tensile, TEM
11	Charpy samples
12	Charpy samples
13	Charpy samples
14	Charpy samples

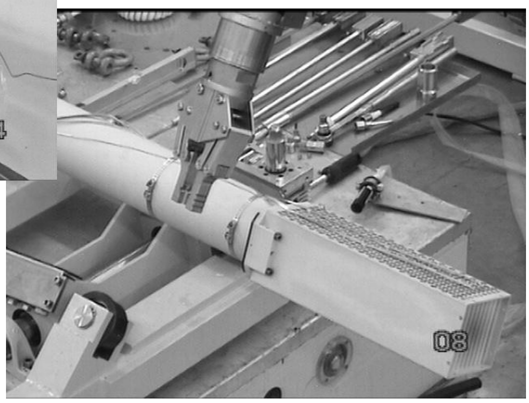
Note: The materials of the samples are Steel, Inconel Zircaloy mainly.

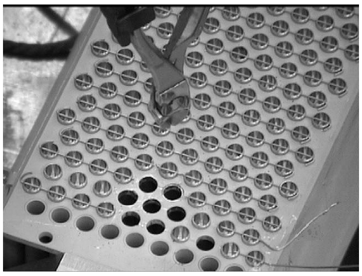
● Thermocouple

ulator

Target handling and dismantling in ATEC hotcell







Kurt Geissmann et al.

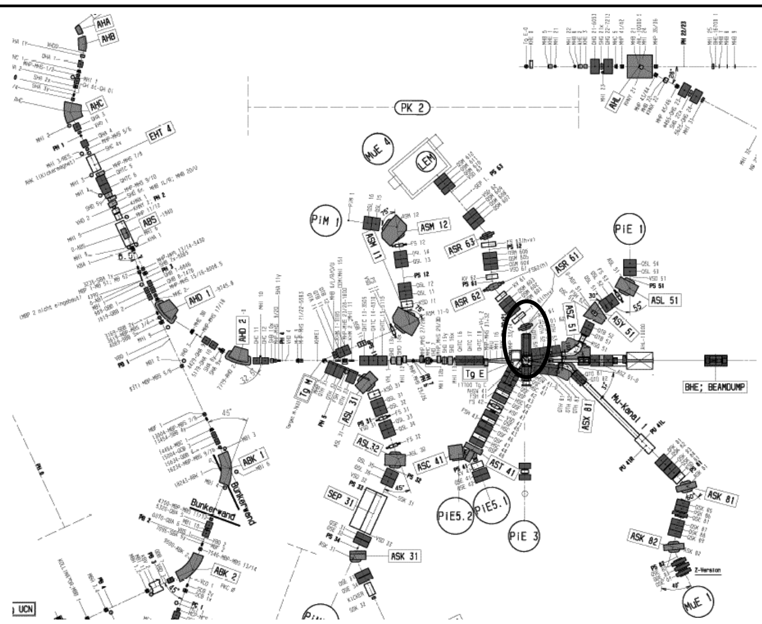
Practicing for the Exchange of QTH51

Practice, practice, practice …

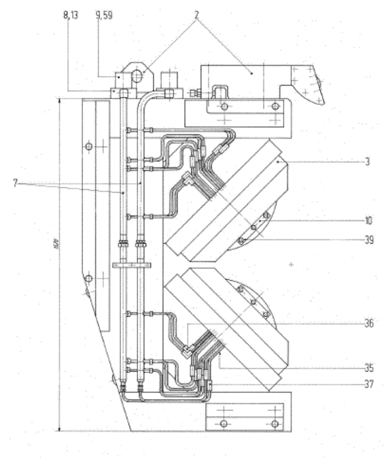
Although remote handling concepts have been made for (almost) all components at PSI, there are situations were one has to simulate the exchange processes over and over and over again. The reasons are:

High dose rates
Training of people
Very tricky handling steps

QTH 51 Location



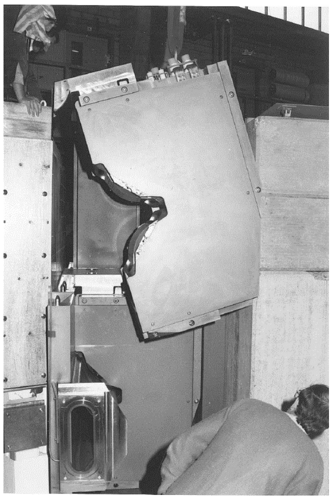
QTH 51 Design



weight: 6,5 t
Mounting: hanging !!!

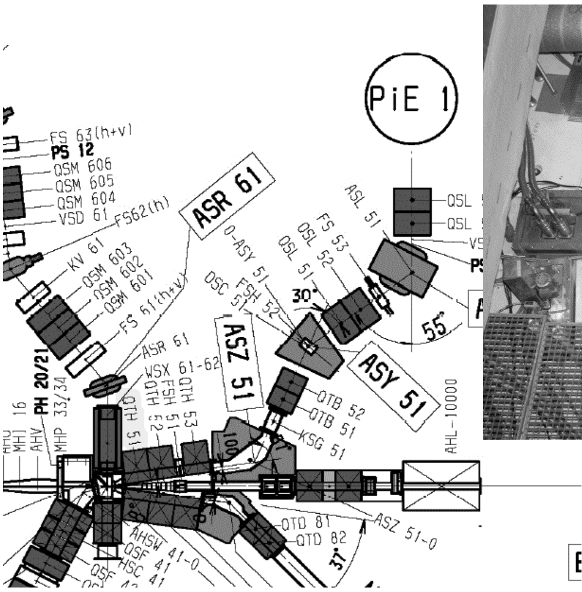
QTH 51 Montage

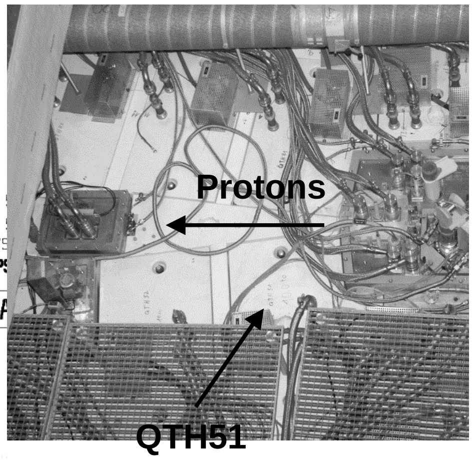
Magnet is hung onto the vacuum chamber



Fotoarchiv: Vakuumgruppe (ca. 1985)

QTH 51 Standortproblematik



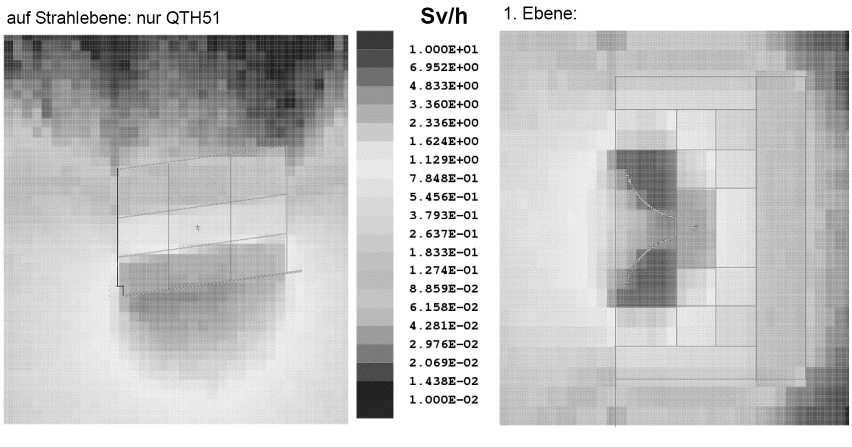


QTH 51 Dose rate calculations

nach 3 Monaten Kühlzeit: März 2011

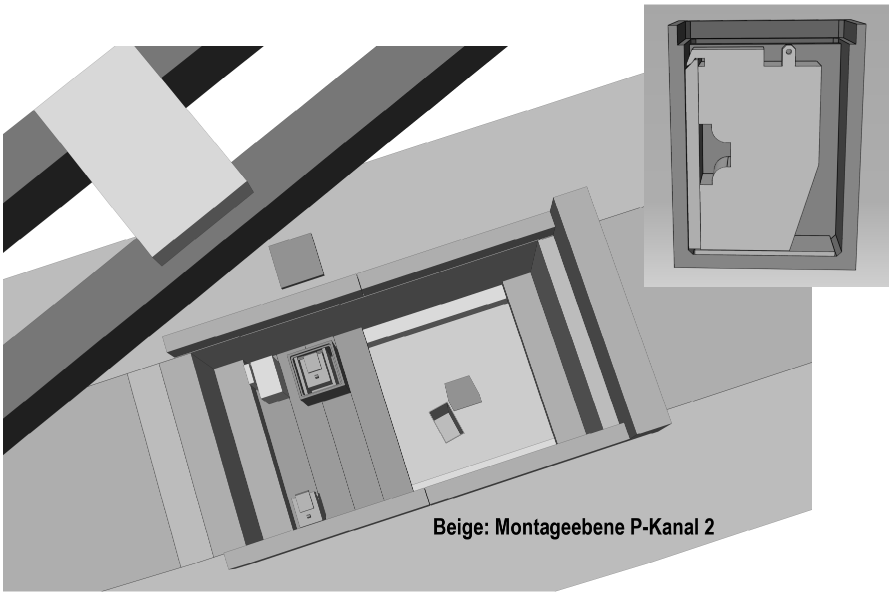
auf Strahlebene: nur QTH51

1. Ebene:



Daniela Kiselev

QTH 51 Ausbausituation



Beige: Montageebene P-Kanal 2

QTH 51 Ausbausimulation

Koordinatenmesssystem

Nachbau der Vakuumkammer

Nachbau der kleinen Abschirmung

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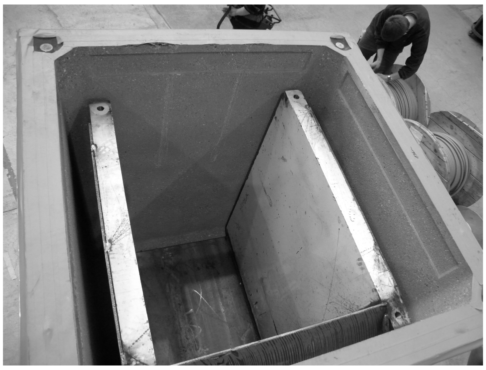
QTH 51 Ausbausimulation

Anhängevorrichtung



Betoncontainer mit Zusatzabschirmung

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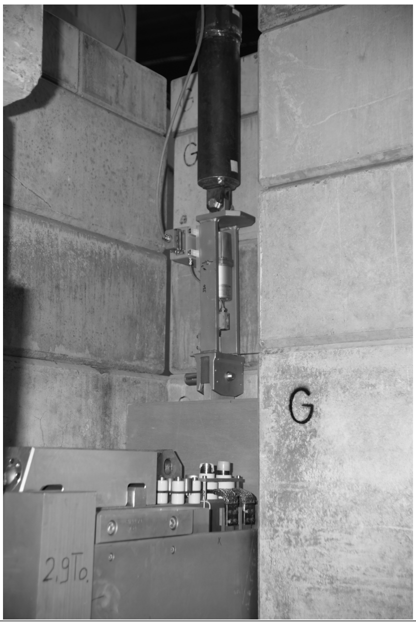
QTH 51 Ausbausimulation

Wirelesskamera am Kran

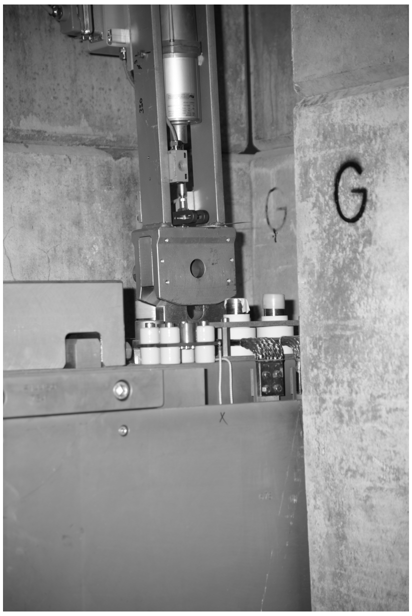
Testaufbau parallel zu P-Kanal aufgestellt

QTH 51 Ausbausimulation



Abschirmung ziehen

QTH 51 Ausbausimulation

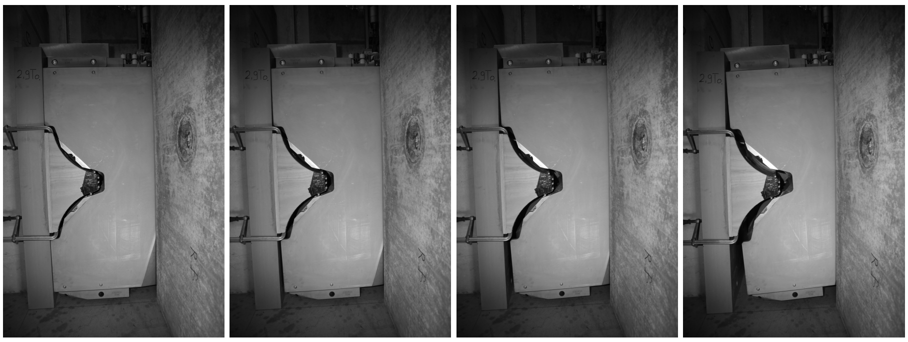


Anhängen

QTH 51 Ausbausimulation

Ziehen

QTH 51 Ausbausimulation



Ziehen

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QTH 51 Ausbausimulation

Ziehen

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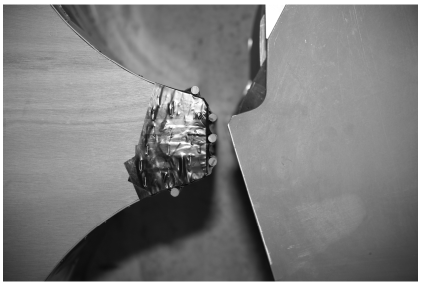
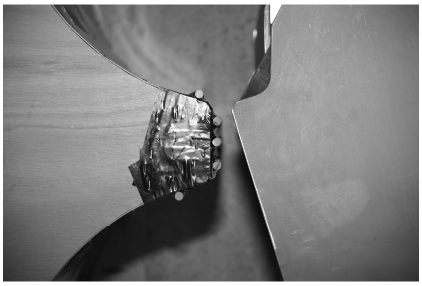
QTH 51 Ausbausimulation

Ziehen

QTH 51 Ausbausimulation





Ziehen

QTH 51 Ausbausimulation

Remote handling at CERN

Special thanks to Keith Kershaw

Contents

EN-HE

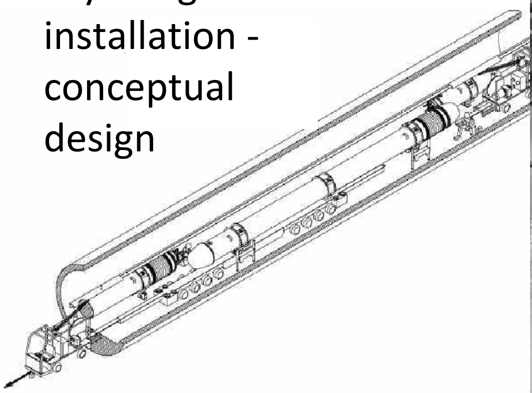
The mandate of the *Handling Engineering* (HE) Group is to provide transport and handling services for the technical infrastructure of CERN, accelerators and experiments….

EN-HE-HT

The *Handling Technologies* (HT) section…..provides optimized means and procedures for remote inspection, measurement and handling ….as well as custom-built transport and handling equipment.

LHC installation

Cryomagnet installation - conceptual design



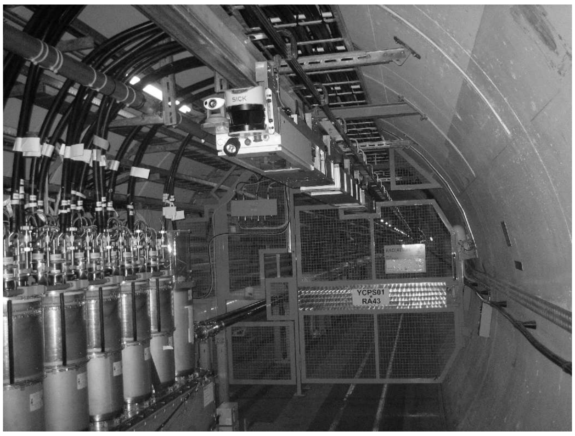
Operation

TIM – Train Inspection Monorail

Remote controlled inspection vehicle for LHC tunnel
Control from surface
Visual Inspection
Runs on LHC monorail (Train Inspection Monorail)
Communication via mobile telephone network
Power from batteries /charged from monorail

TIM operation during LHC initial cooldown

TIM 30-30



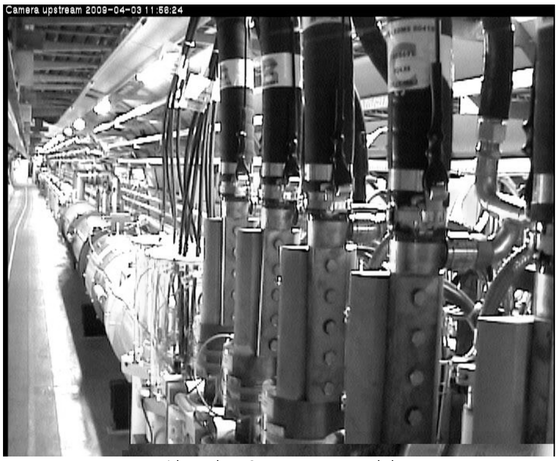
Passing an LHC sector door

TIM 30-30

Visual Inspection
Radiation + oxygen measurements
Parks in P5 by-pass during LHC operation
Pass from P5 - P2 and from P5 - P8 (six 3km sectors)
Max speed 8km/h
Control from CERN Control Centre (CCC)

TIM 30-30 CCC operation

TIM 30-30 inspection of DFBM
General view looking upstream (low resolution)



Current lead detail looking upstream

Current lead detail looking upstream

TIM Radiation measurements

Collaboration with CERN Radiation Protection
In all CERN tunnels measurements of induced activity are made before authorising access
The aim is to have an overview of radiation levels and compare levels over time.
The use of a remote TIM-based system will reduce the doses received by the personnel regularly carrying out these measurements.

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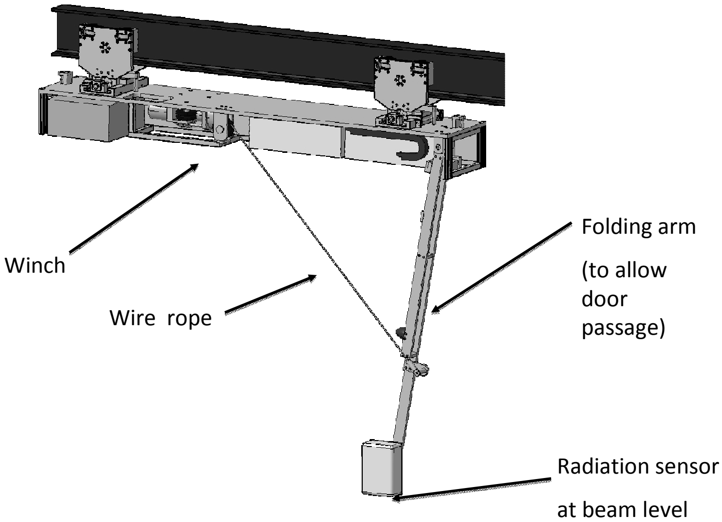
TIM 30 x 30 radiation dose rate measurement wagon



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Testing in mock-up

TIM Radiation protection wagon in LHC Tunnel

Radiation Measurements

Data acquisition system for dose rate mapping along the LHC machine
Measurements every 250ms, with TIM speed of 6km/h, readings are taken every 40cm.
Data is transmitted via the tunnel mobile phone network to the CERN Control Centre

Ventilation doors

Testing of TIM 30-30 passage through automatic opening in LHC ventilation door. (new requirement in 2009)

TIM Geodesic Survey

Precise remote measurement of radioactive collimator alignment in LHC tunnel. Collaboration between Handling Engineering and CERN Survey team

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Survey requirements - classical method

- High dose rates for personnel (up to 4mSv/h in contact)
- 500m of beamline at LHC point 7
- 26 quadrupoles and 37 collimators to check in vertical and transversal direction
- Standard method would need 3 people over five days ≈ 90h

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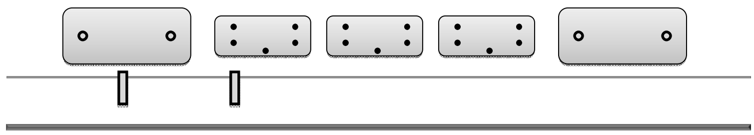
Survey remote measurements

- Check of collimator alignment in vertical and transversal direction
- Relative to the neighbouring quadrupoles
- Requested precision 0.1-0.2 mm

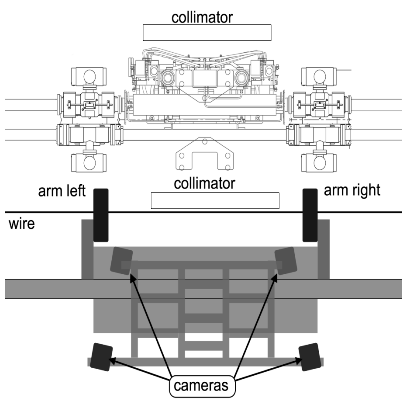
- Train installation and de-installation ≈ 90 min, 2 people
- Startup and wire installation ≈ 60 min, 1 person

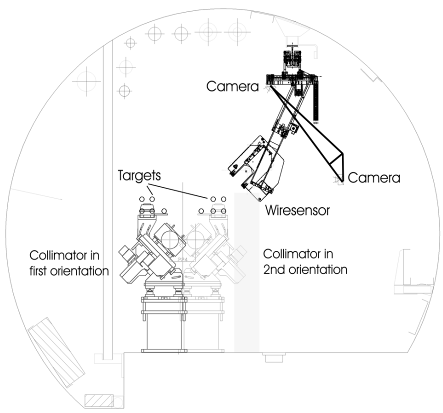
Remote survey Concept (1)

- Wire offset measurements to detect train position
  - ➢ Reliable reference over long distances
- Digital photogrammetry as link between collimators and train position
  - ➢ Rapid and non contact measurements of the radioactive collimators

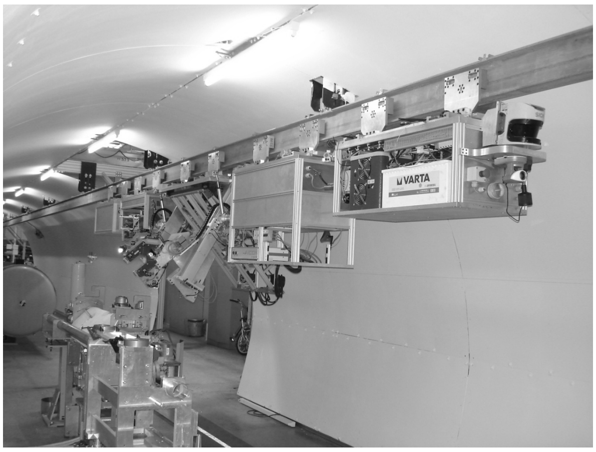


Remote survey concept (2)





TIM survey train in mock-up



Train and Survey wagon controlled remotely via WiFi.
Automatic wire following

Camera view used for initial positioning of wire detectors

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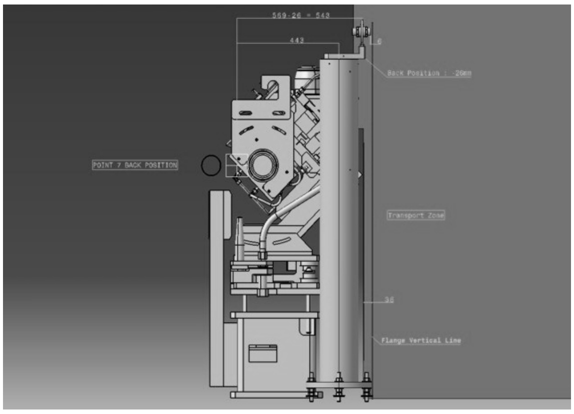
Tunnel Installation

- 5 overlapping vectran high tension wires
- 10 pillars
- 2x 111 m
- 2x 85 m
- 1x 146 m
- 250 targets



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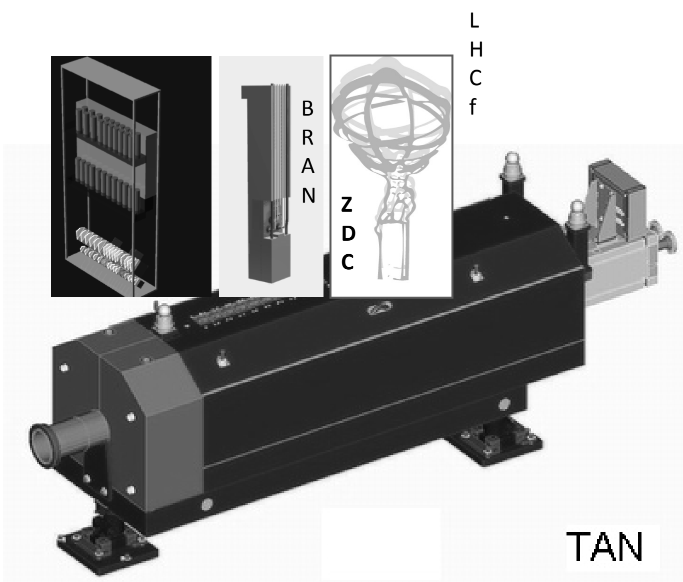
Tests at LHC point 7

- All sensors within working range
- Arms automatically follow the wire
- No additional obstacles

TIM Survey status

- Tunnel installation complete
- Hardware and sensors operational
- Minor changes to cables and plugs
- Internal train software almost finished
- Global guidance and calculation software is being developped by EN-ICE-MTA
- Complete system ready for test run end of summer 2010
- Preparation for IR3 installation

TAN detector and shielding exchange



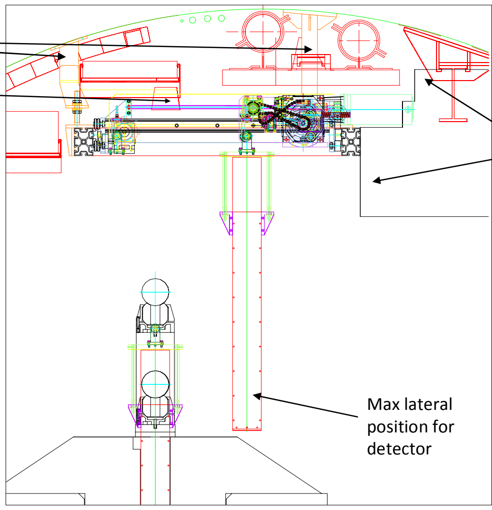
TAN - First installation and removal trials

Reduced lost height tooling
for lift truck boom

Hands-on guidance needed

TAN mini crane design

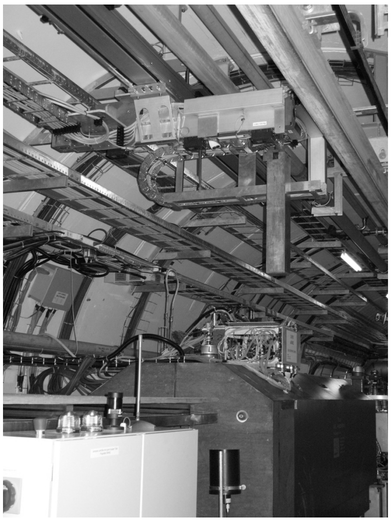
Miniaturized mini-crane due to limited available space

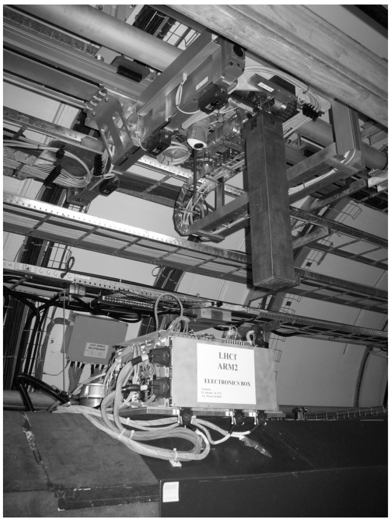


TAN Mini Crane characteristics and requirements

Miniaturized crane with remote control and visualization for physics detectors and shielding
Lifting capacity : 100 kg
Lifting height 2.6m
Servo drives for precise movement (smallest movement 0.5mm)
No electronics on crane (installation of the control cabinet and video camera only when operated)

TAN mini crane copper bar handling





TAN Mini crane mobile control station and vision

Viewing system with 4 pan tilt cameras. Control system with 2 joysticks installed behind shielding. Communication with WiFi over 100m

TAN Point 1 handling radiation dose summary

Manual methods - approx 15mSv per person
With mini crane - approx 0.2-0.3mSv per person
Reduction factor is ~50.

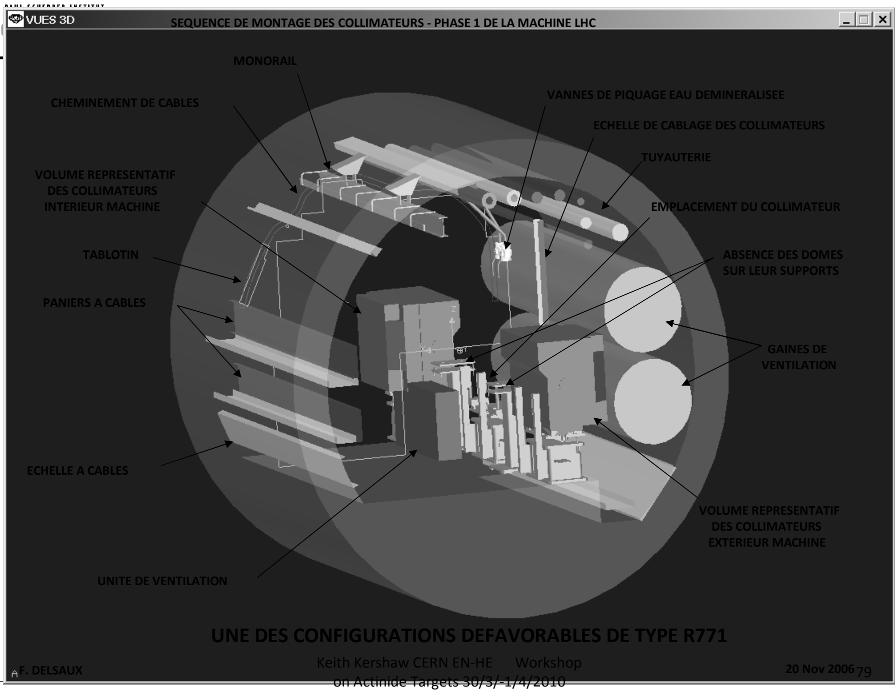
Cu bars will reach 2-3mSv/h at nominal luminosity (and approx 0,1mSv/h after 6 months cooling) and TAN detectors 20-30mSv/h after one year nominal run and 1 day cool down.
There are 3 ZDC's to remove and 8 Cu bars to insert.
Exposure time without remote handling will be ~15 min per item that roughly means 15mSv per person.
With the mini-crane the exposure of our operators is limited to 20-30 min in the aisle side (0.1mSv/h), that means that one can expect 0.2-0.3mSv per person.

Collimator installation and radioactive collimator exchange

Objectives:
Develop transport and installation method and equipment
Prepare for future remote handling
Note: LHC collimator project has considered remote handling aspects during design and construction (e.g. plug-in bases with guidance and special vacuum flanges)

First mock up tests

Dummy collimator installed on base using modified truck loader crane with camera viewing and remote control



Collimator installation

- Trailer crane in position
- Attachment of lifting beam

Collimator installation

Beginning of transfer

Collimator installation

Need to pass over adjacent beam tube
Space above collimators very tight
Cooling pipes integration

Optimized collimator handling

To-Date:

Poles to rotate /position spreader

Shielded trailer

Future…

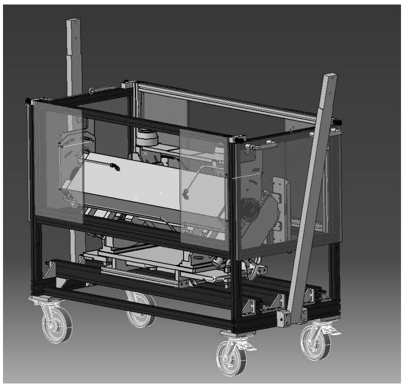
Smaller (shielded) tractors

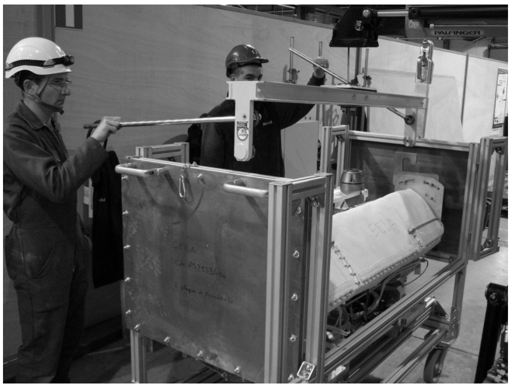
Remote controlled pallet trucks

Optimized collimator handling (1)

Mock-up trials

Optimized collimator handling (2)





Shielded trailer for transfers (compatible with 1 tonne lift): shielding + distance increase

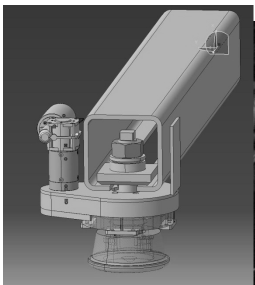
Collimator exchange – some radiation dose reductions (phase 1 collimators)

Stage	Using initial installation techniques	After optimization	Comments
1)Transport of collimator from PM76 to UJ76 with hand pallet truck	4 mSv/h 500µSv/person	600 uSv/h 80 µSv/person	Shielding + distance: Factor 6.75
4)Lifting of collimator from hand pallet truck and placing onto Palfinger: a)remote control	4 mSv/h 500µSv/person	1.3 mSv/h 170 µSv/person	Shielding: Factor3
4 b) Guiding collimator	3 mSv/h 350 µSv/person	250 µSv/h 30 µSv/person	Shielding + distance: Factor 12
7) Placing collimator onto support	3 mSv/h 150 µSv/person	750 µSv/h 40 µSv/person	Distance: Factor 4

Remote collimator exchange handling

Remote handling is a Radiation Protection Group requirement for phase 2 collimation.
Remote controlled vehicle equipped with crane with rotating hook/spreader beam
Remote control pallet trucks for transfers underground and on surface
Tele-operated manipulator/robot arm for vacuum disconnection

WANF dismantling (HiRadMat preparation)

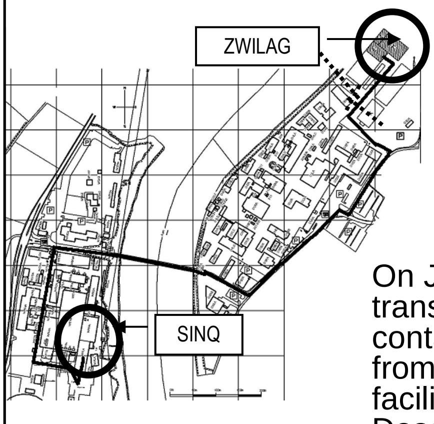


Powered rotation hook to handle radioactive shielding blocks

Fork lift equipped with powered rotation hook and operator shielding

MEGAPIE

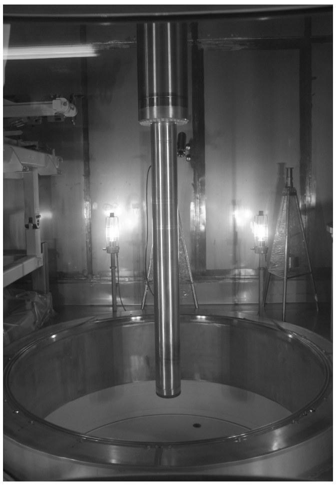
Transfer of MEGAPIE



On July 6th the MEGAPIE target was transferred with a special transport container (TC1), fabricated by Skoda, from PSI to ZWILAG (Interim storage facility for nuclear power plant waste).
Dose rate at surface of TC1 ~ 1 µSv/h.
The transfer started at ~21:10 and took roughly 2 hours.
Authorities (BAG/ENSI) were present and monitored the procedure.

Transfer of Target in Hot Cell (HC)

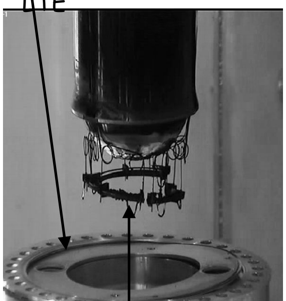
MEGAPIE with LTE



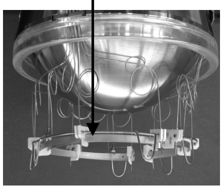
TC1 docked to HC from below.
The MEGAPIE target was connected to the crane of the hot cell and pulled out of TC1 into HC (July 9th).
First visual inspection by rotation the target. No special findings; slight color change in high neutron flux region.
The Lower Target Enclosure (Aluminum Safety shroud, LTE) was unscrewed.

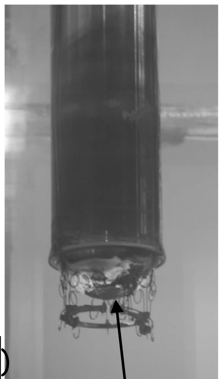
Unscrewing of LTE

Unscrewed LTE



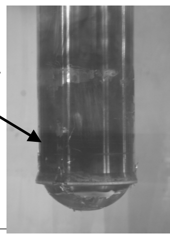
Leak Detector (LD)





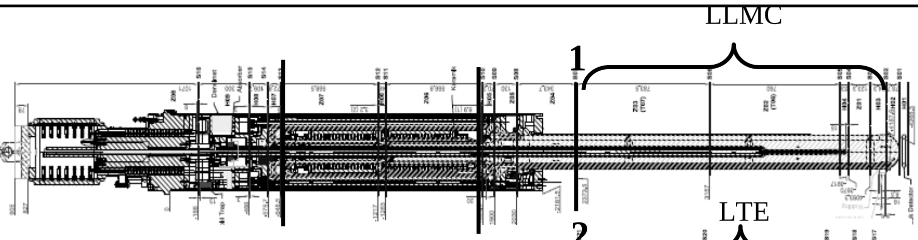
LLMC and BEW

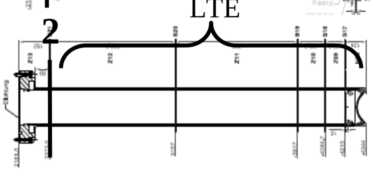
The LTE was unscrewed (July 9th 2009).
First visual inspection of the Lower Liquid Metal Container (LLMC, T91 steel).
Black smut was deposited on one side of the LD (which partly fell off when the target was moved).
The sides of the LLMC were covered with dark debris.



At the Beam Entrance Window (BEW) a whitish coverage was observed.

Cutting Plan





In the first phase (1) the LLMC was cut.
The LTE was re-screwed to the target and cut (2).
Cutting times were on the order of 45 minutes.
In the last phase the upper part of the target was cut.
Cutting times increased to over 2 hours.

No problems in phase 1 and 2.
Strong degradation of the saw band while cutting upper part of the target.
The nominal cutting speed was 5 mm/min, band velocity 15 m/min.

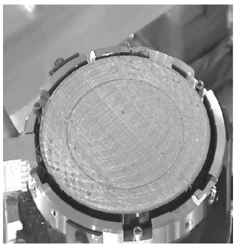
The first cut, July 15th 2009

As the target had to be cut from bottom to top (hanging on a crane) the first cut was already one of the most important ones, the Beam Entrance Window.

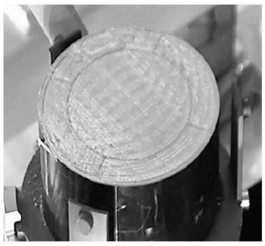
Samples - LLMC

Each piece cut from the target was caught in a special steel basket, which could be moved with a special lifting devices (Glocke).
After each cut the piece was cleaned using a vacuum cleaner and subsequently lifted to an interim parking position using the power manipulator of ZWILAGs hot cell.
The cutting of the LLMC could be done with a single saw blade.
No degradation was observed.

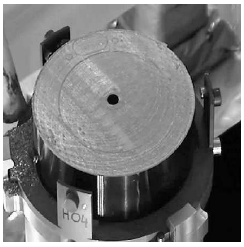
H02 – The Beam Entrance Window (BEW)

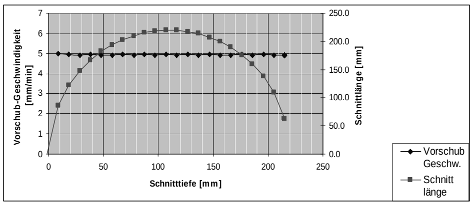


H03

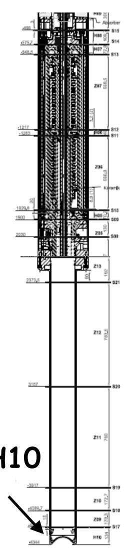


H04





Cutting the LTE

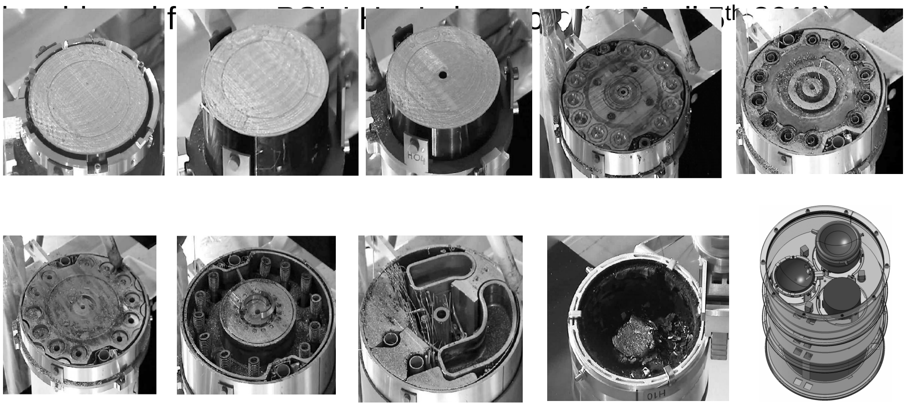


H10

After cutting the lowest part of the LTE (beam entrance region), sample piece H10, a metallic gleaming piece of material (LBE/Carbon?) was found inside the AlMg3 shroud.
The piece of material was loose, sitting in the center of inverted calotte (ø 6 – 8 cm, thickness ~ 2 cm).
The side walls and bottom part of H10 were covered with black flaky smut (most probably remains of oil that entered the insulation gap system).
Together with some of the flaky smut the material piece has been put in a plastic bag and will be shipped to the Hot Laboratory for detailed analysis.

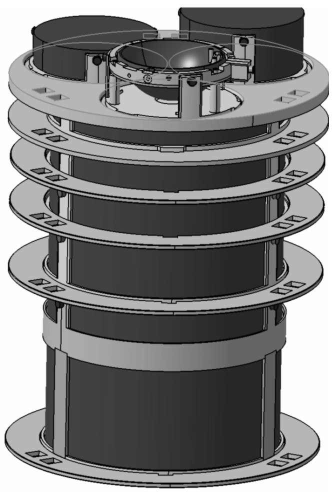
MEGAPIE @ ZWILAG

The dismantling of the MEGAPIE Target in ZWILAG has been completed.
All cuts of the target could be accomplished successfully.
Overall 10 sample pieces have been produced. They they will



Package of the target sample pieces

The shipment of the sample container (TC3) from ZWILAG to the Hot Laboratory (HL) of PSI is scheduled for February of 2011.



MEGAPIE @ ZWILAG

The Hot Cell of ZWILAG was cleaned and now can be entered by personnel again.

Most of the devices used during the dismantling process could be cleaned in the β-γ box of ZWILAG and have been delivered back to PSI. The TC1 container is currently stored at ZWILAG and will be shipped to PSI in the 4th quarter of 2010 for decontamination (only the inner container is contaminated do to slight scraping of the AlMg3 safety hull during insertion).

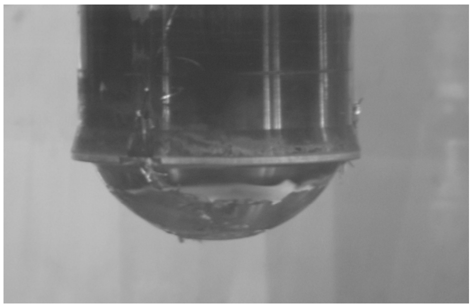
The dismantling campaign in ZWILAG was a full success and is finished.

Preparation of PIE sample extraction

The sample extraction process in the HL will consist of 6 major steps:

1. Visual inspection of all sample pieces delivered from ZWILAG. Gamma scan of the tip of the AlMg3 safety hull. Thickness measurements of the beam entrance window.
2. LBE PIE Sample taking.
3. Segregation of LBE from structural materials by melting the LBE in an oven.
4. Raw-Cutting of the PIE structural material samples.
5. Cleaning (where needed) of the PIE structural material samples.
6. Fine-Cutting of the PIE structural material samples.

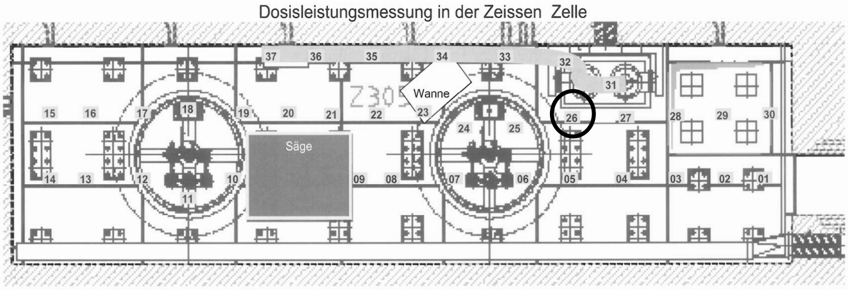
PIE sample extraction – Visual Inspection



The status of each target sample piece delivered from ZWILAG shall be investigated. Photos of all pieces shall be made with the highest possible accuracy. The aim is to document the condition of the target pieces, and to identify changes e.g. cracks, deposits, and so forth.

Dose rates (µSv/h) in the HC

Dosisleistungsmessung in der Zeissen Zelle



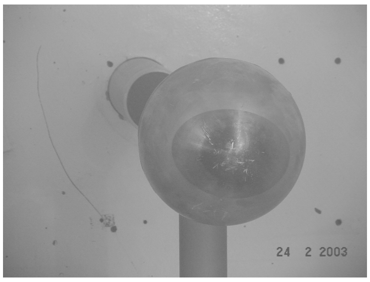
Messpunkt	Messung (µSv/h)	Messpunkt	Messung (µSv/h)	Messpunkt	Messung (µSv/h)	Messpunkt	Messung (µSv/h)	DL Lüftungsschlauch in 5cm Abstand		DL Rundfilter in 5cm Abstand
Nr.1	12	Nr.9	42	Nr.17	9	Nr.25	88	Messpunkt	Messung (µSv/h)	
Nr.2	10	Nr.10	27	Nr.18	4	Nr.26 →	230	Nr.31	128	240µSv/h
Nr.3	18	Nr.11	17	Nr.19	10	Nr.27	80	Nr.32	124	
Nr.4	30	Nr.12	8	Nr.20	13	Nr.28	25	Nr.33	89	800 µSv/h
Nr.5	40	Nr.13	5	Nr.21	25	Nr.29	13	Nr.34	122	650 µSv/h
Nr.6	37	Nr.14	3	Nr.22	32	Nr.30	5	Nr.35	131	
Nr.7	68	Nr.15	5	Nr.23	38			Nr.36	115	
Nr.8	76	Nr.16	10	Nr.24	35			Nr.37	90	

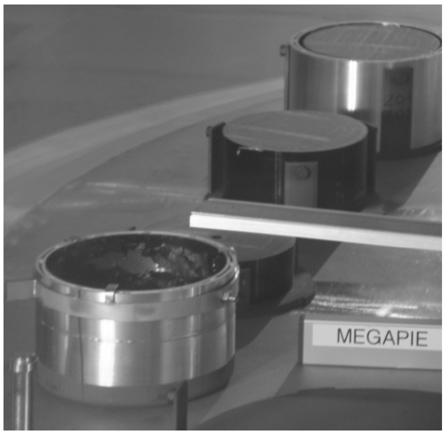
Bemerkung: Gemessene DL nach dem entfernen der Quellen in der Heissen Zelle.

Datum: 06.10.2009 Visum: mme

PIE sample extraction – Gamma scan

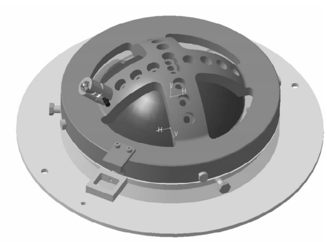
A gamma scan of the AlMg3 safety hull tip will be done. This gamma scan will measure the time-averaged proton beam profile

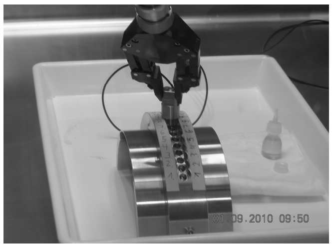




The obtained profile will be used as an input condition to Monte-Carlo calculations of the X9 group to establish new and more realistic calculations of dpa-rates for the different sample regions of interest. This will directly support the PIE program.

Ultrasonic measurement of BEW





UPG-07CW

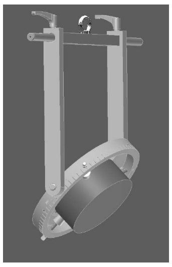
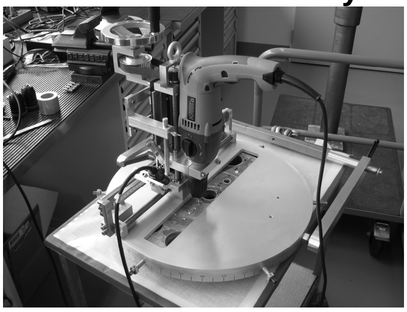
An ultrasonic measurement of the tip of the LLMC will be performed. These measurements will be directly compared to pre-operation measurements of the calotte performed by Y. Dai.
The information gained will give insight to erosion and/or corrosion issues at the beam entrance window.
The handling of the US device has been proven to work under hot cell condition. However, the US device used up to now (CL3DL) a strange behavior when measuring the curved surface of the BEW. Therefore, a new US device (UPG-07CW) has been ordered.
A mock-up (see Picture) has been tested in the HL and will now, with minor adaptions, be fabricated in the workshop of PSI.

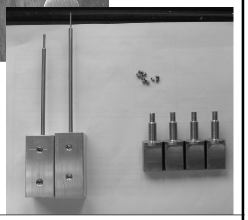
PIE sample extraction – LBE sample taking

A special drilling device for the LBE sample taking has been designed (50 samples to be taken), constructed, and tested by the HL.

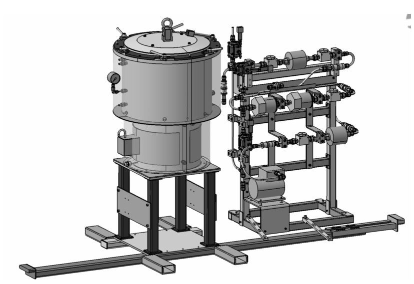
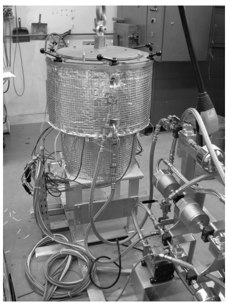
The tests showed that the devices for the LBE sample taking works reliably. Difficulties to take LBE samples in the vicinity of structural materials (vibrations) have been solved.

The device is ready for usage.

Segregation of LBE and structural materials

To segregate the structural materials from the LBE a special oven has been designed and constructed by the engineering department of PSI.

The oven is heated with 6 heaters (0.8 kW each) built into the intermediate floor on which the target sample pieces are positioned. The lower part of the oven serves as a collector of the LBE and can be separately be heated (heater band of 1.5 kW).

The oven was vacuum tested – a leak was found and tightened. First heating tests showed a slow temperature response in the most upper part of the oven. Therefore, an additional strip heater (1.5 kW) was installed.

Tests have successfully been conducted.

Ofen tests






Segregation of LBE and structural materials

Filters:

- Aerosol
- Activated carbon filter
- Tritium filter

gas inlet from the oven

exhaust gas

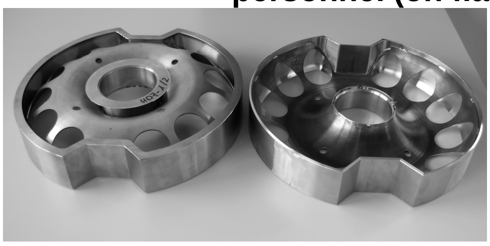
air sampling

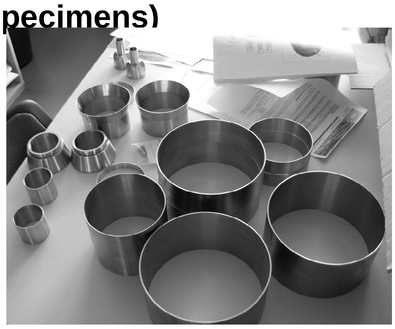
Tritium filter

Cutting of the structural material samples

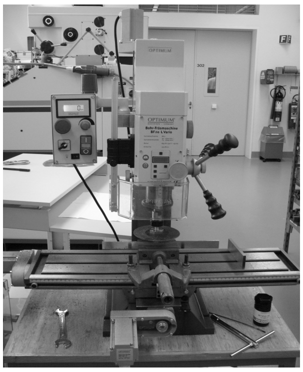
After the LBE has been molten, the structural material samples (more than 700) will be raw cut. To test the handling of the diamond disk, 1:1 mock-ups all sample pieces have been manufactured with original materials and dimensions.

The cutting tests have partly been performed by HL personnel (on flat specimens)





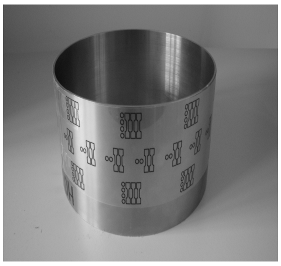
Cutting of the samples

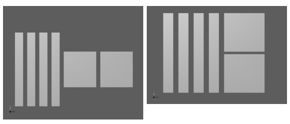


Clean cut with grinding disc

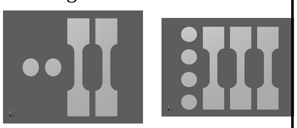
Left:
Cutting devices to do the raw cutting with; a grinding disc will be used.

Right:
Fine cutting of samples (in total 4 groups).
A diamond blade saw will be used for samples with LBE.
An EDM machine will be used for tensile and TEM samples.



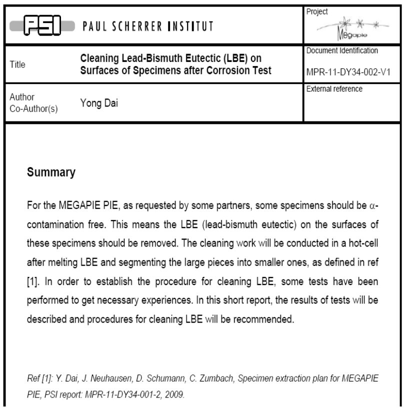


Cutting with diamond blade saw



Wire cutting

Cleaning of structural material samples



PAUL SCHERRER INSTITUT	Project
Title: Cleaning Lead-Bismuth Eutectic (LBE) on Surfaces of Specimens after Corrosion Test	Document Identification: MPR-11-DY34-002-V1
Author Co-Author(s): Yong Dai	External reference

Summary

For the MEGAPIE PIE, as requested by some partners, some specimens should be α-contamination free. This means the LBE (lead-bismuth eutectic) on the surfaces of these specimens should be removed. The cleaning work will be conducted in a hot-cell after melting LBE and segmenting the large pieces into smaller ones, as defined in ref [1]. In order to establish the procedure for cleaning LBE, some tests have been performed to get necessary experiences. In this short report, the results of tests will be described and procedures for cleaning LBE will be recommended.

Ref [1]: Y. Dai, J. Neuhausen, D. Schumann, C. Zumbach, Specimen extraction plan for MEGAPIE PIE, PSI report: MPR-11-DY34-001-2, 2009.

A good fraction of the structural material samples has to be cleaned, in order to minimize the remainder of LBE on the surface. Hence, cleaning procedures have been developed and tested by Y. Dai.

A report on the most promising procedures has been issued. Two possible cleaning scenarios are described.

The most promising proposed process consists of five steps:

❖Sweeping off LBE after bath in 150ºC a special Oil.

❖Cleaning in Ultrasonic bath

❖Cleaning with nitric acid

❖Cleaning in Ultrasonic bath

Small amounts of LBE.

PSI cannot guarantee 100% α-free samples!

Thank you for your attention.