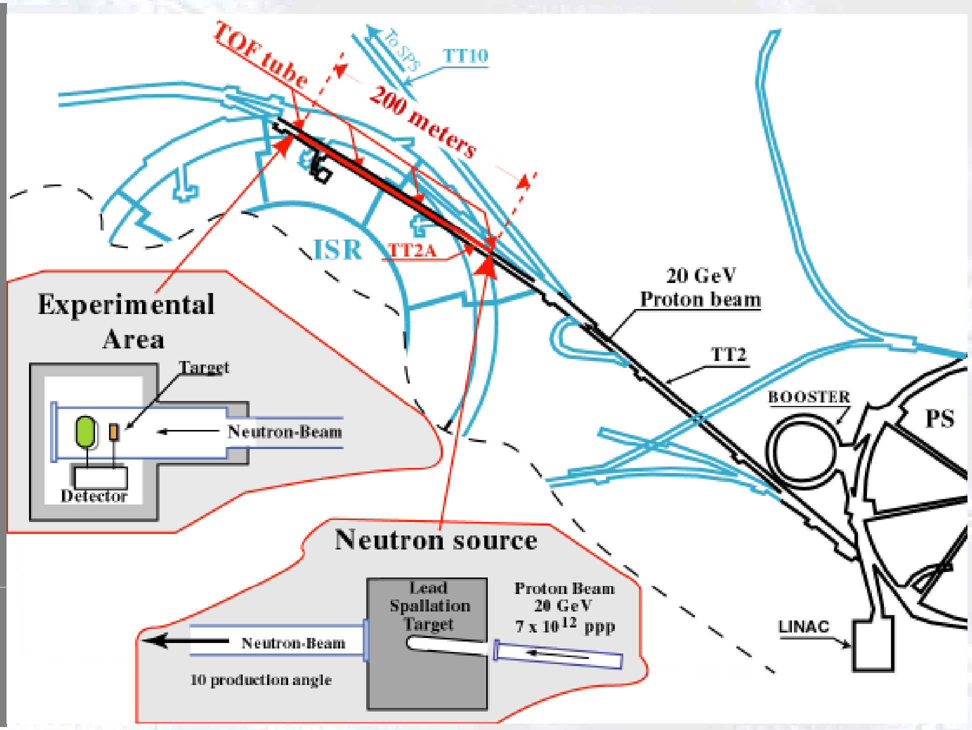
The n_TOF Facility Today

Presented by P. Cennini
n_TOF Technical Coordinator

- Facility overview
- Status of the main components of the Facility
- What has to be done to restart the Facility
- Operation Resources and budget



Main components of the Facility:
The proton Line

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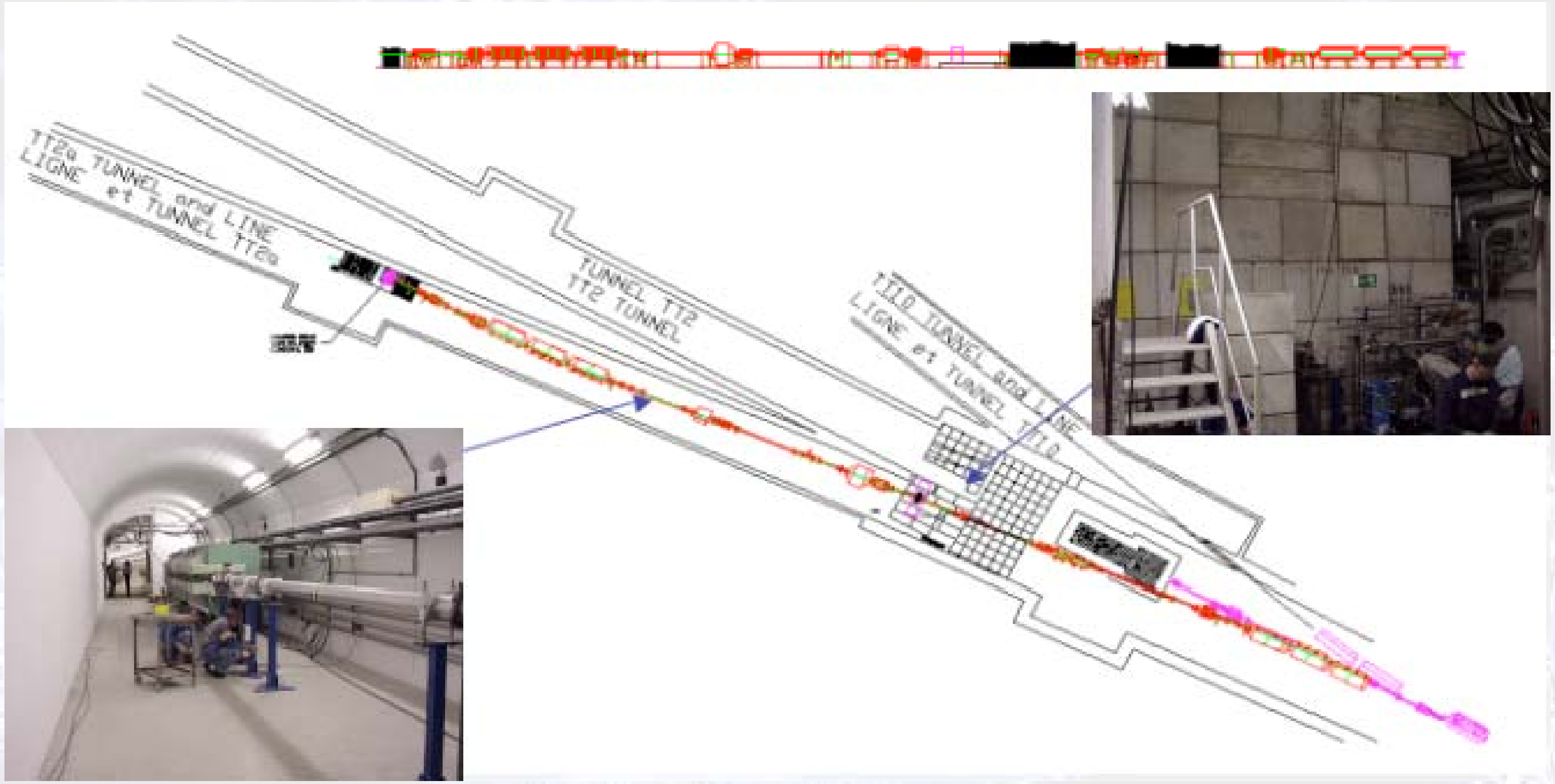
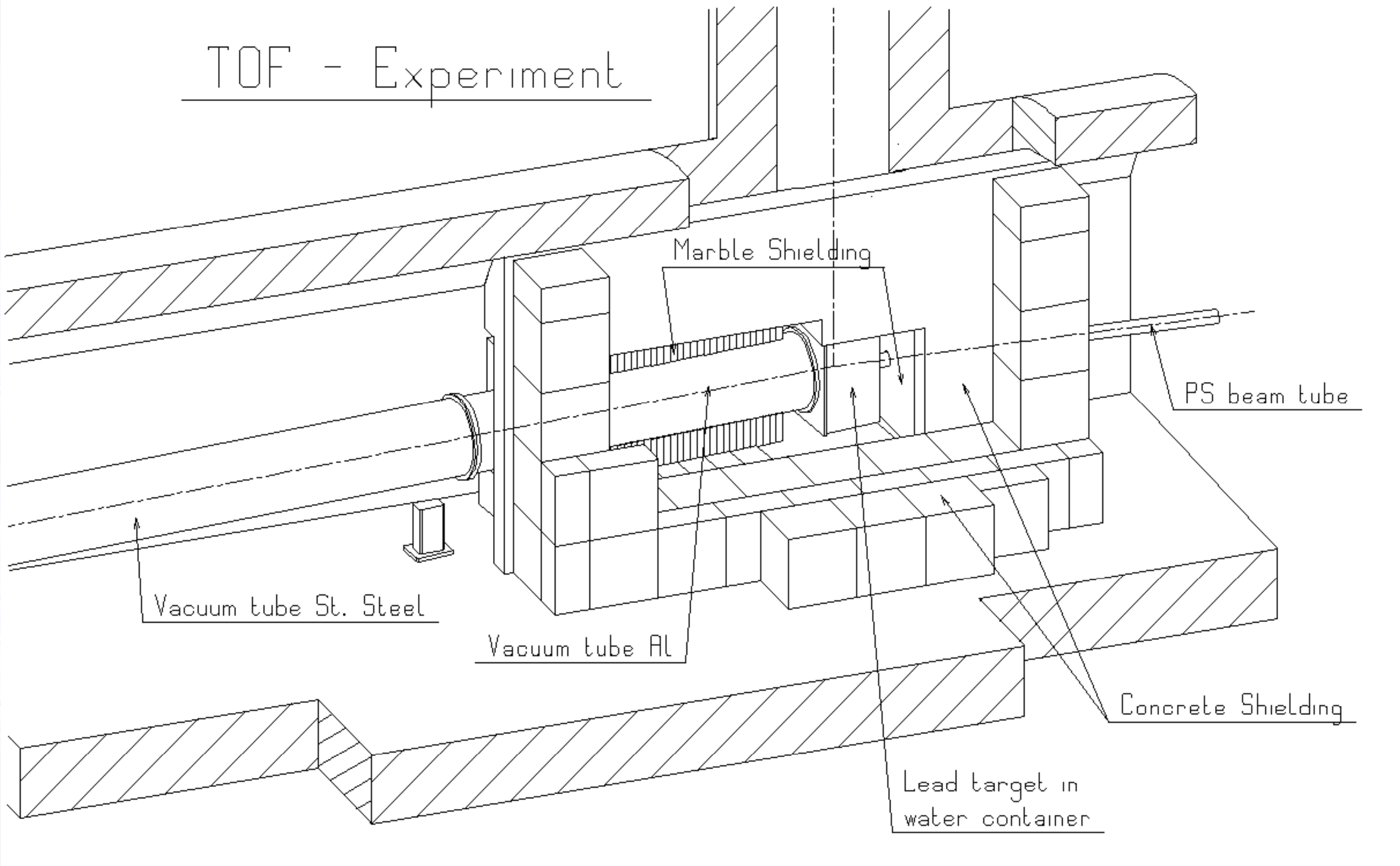


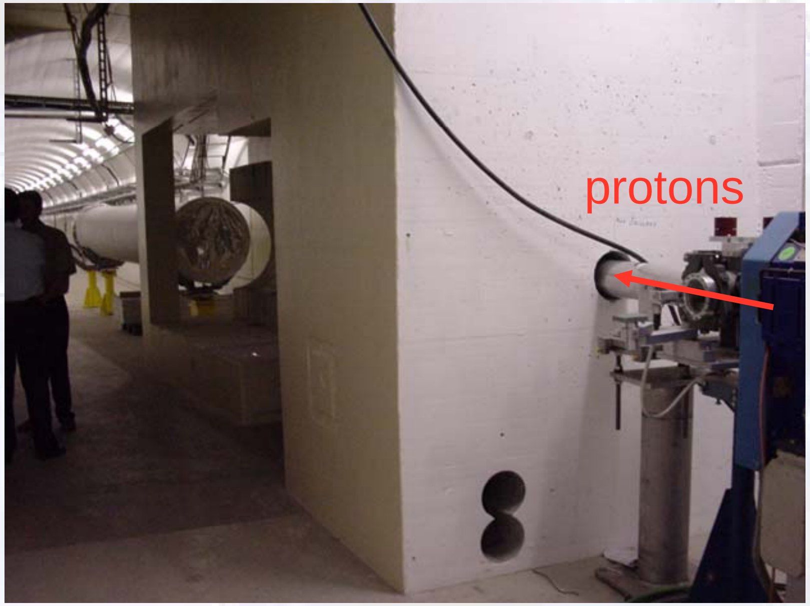
Present status: partially modified to host the MERIT Experiment

What need to be done: re-installation of the beam line
(resources and budget already allocated)

Main components of the Facility:
The Target Area

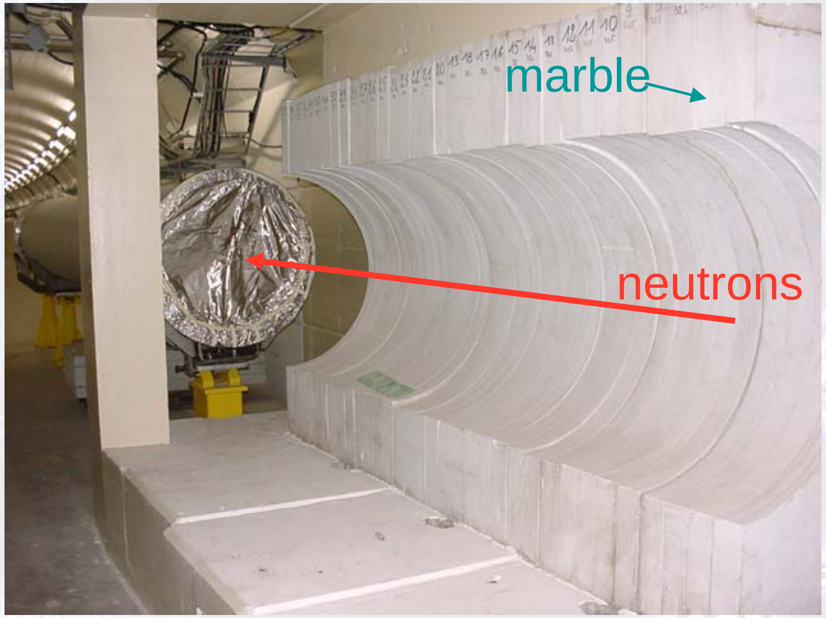


Main components of the Facility:
The Target Area



Present status: inaccessible

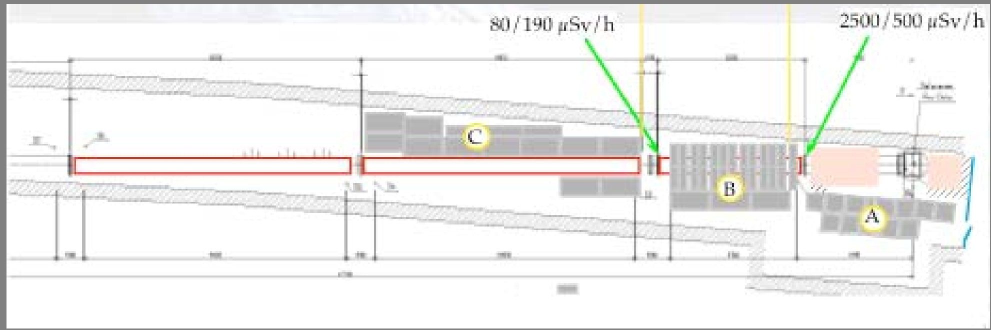
Main components of the Facility:
The Target Area

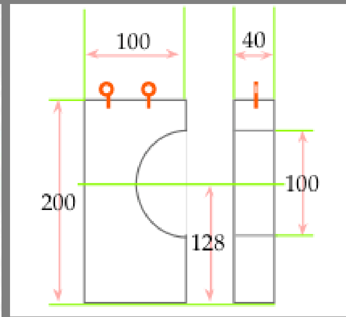


Present status: inaccessible

Main components of the Facility:
Air Ventilation in the Target Area

History:





After the 2001 run an additional shielding (B+C) has been put around the TOF tube to reduce the air activation. Following this actions the reduction expected by the FLUKA simulation (~ factor 10 for ^{7}Be) has been achieved.

A forced ventilation with filters and a system to monitor the release in the atmosphere has been requested by SC-RP. (see T. Otto presentation)

Present status: Simulations done (see M. Brugger presentation)
Design study done (J. Inigo-Golfin presentation)

What need to be done: installation of the ventilation system with the monitoring of emissions in the atmosphere.




The Target Area
What need to be done

Remote Inspection of the pool through the shaft

- **Depending on the results of this intervention two scenarios are envisaged:**
  - No signs of deep corrosion of the cooling circuit are detected.
    In this case the use of the existing cooling circuit could be envisaged and no actions are needed in this area.
  - The inspections are revealing a deep corrosion of the pool or other problems.
    In this case the dismantling of the shielding around the target and in the first 20 m of the TOF tube is needed.
    Taking in account the ambient radioactivity and activation, this operation, requiring the direct handling of the shielding elements, should be carefully evaluated in terms of received doses.

Main components of the Facility:
The Target

- Dimensions:
  $80 \times 80 \times 60$ cm^3
- Pure Lead: 4 t
- Stainless steal supporting structure

Present status: the target is in the Pool at the bottom of the shaft

What need to be done: target replacement

The New Target Design
Motivation & Design Options

- **Why a new Target for n_TOF?** (see T. Otto presentation)
  To avoid the water cooling contamination due to the direct contact between the lead and the cooling water.

- Two lines could be investigated:
1. **Cladded Target** cooled with the existing cooling system
2. **Completely New design** (tungsten, tantalum, air cooling, …)
   This approach eventually needs the dismantling of the shielding in then_TOF tunnel

- Considering:
  - ✓ The **activation** of the shielding around the Target Area.
  - ✓ The **time** needed to remove and reinstall the shielding (6 months).
  - ✓ The “cost” of the received dose to do this operation **(ALARA).**
  - ✓ The **“Gained Experience”** with the old lead Target

The solution of a cladded target has been investigated first.

The decision on the solution to be adopted strongly depends on the status of the irradiated target and the corrosion or contamination of the cooling circuit.

Design Options (investigated up to now)
Cladded lead Target

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- Neutron Flux: unchanged
- Target material: lead
- Target cladding: aluminum alloy, stainless steal or zircalloy.
- Target cooling: water (existing system)
- Target dimension: ~ 100 liters, ~1.3 tons (cylindrical shape)
- Moderation: water / heavy water / borated water (exchangeable)
- Useful n-beam diameter at the exit of the target: 40 cm
- Orthogonal flight-path: foreseen
- 2.2 MeV γ flash: optimized (10 %), by Moderator replacement.
- Target permanent Disposal: this aspect is integral part of the design.

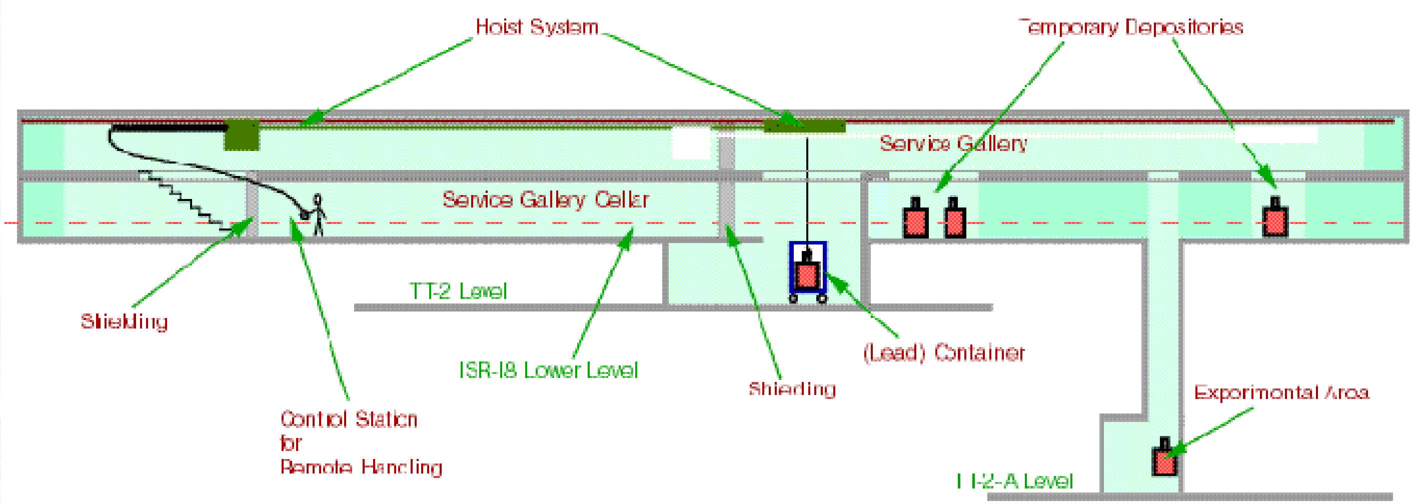
The New Target:
What need to be done

- Verification of the design options based on lead by making the visual inspection of the old target and the analysis of a sample to learn from the gained experience after 5 years of run (~ 6 x10^{19} protons on target).
- Finalization of the Design Study. Several solutions have been investigated in the framework of a new target similar to the old one water cooled by the existing system.

  (see Y. Kadi presentation)
- Conclude the Simulations: neutron flux, energy deposition, decommissioning .
- Write-up of the Safety File
- Activation and Dose-rate Simulations in view of the Permanent Disposal

  (in progress, see M. Brugger presentation)

Main components of the Facility: Target Handling Structure

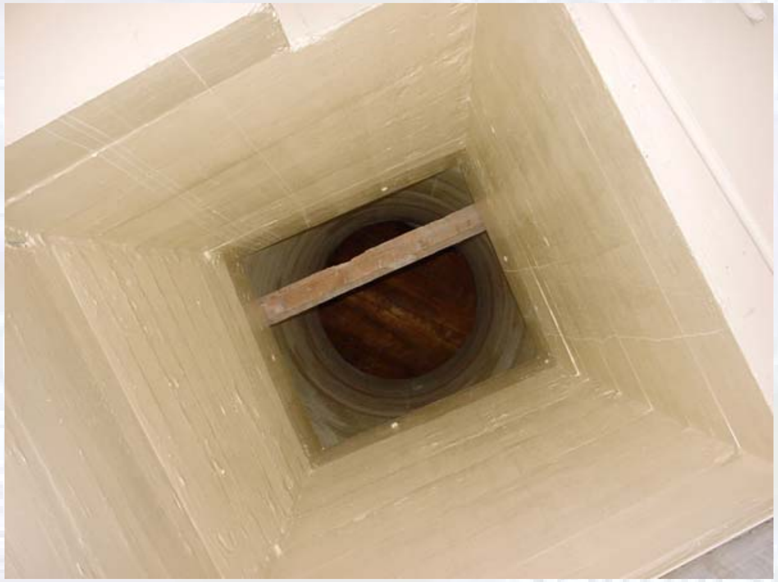


- The Target must be moved from TT2-A to the Depository in the Service Gallery.
- This operation is done through the Shaft by using the Hoist System.
- A system using several video cameras is used for the remote control.

Present status: Hoist system certified for the handling of loads up to 5 tons.

Main components of the Facility:
Access to the Target

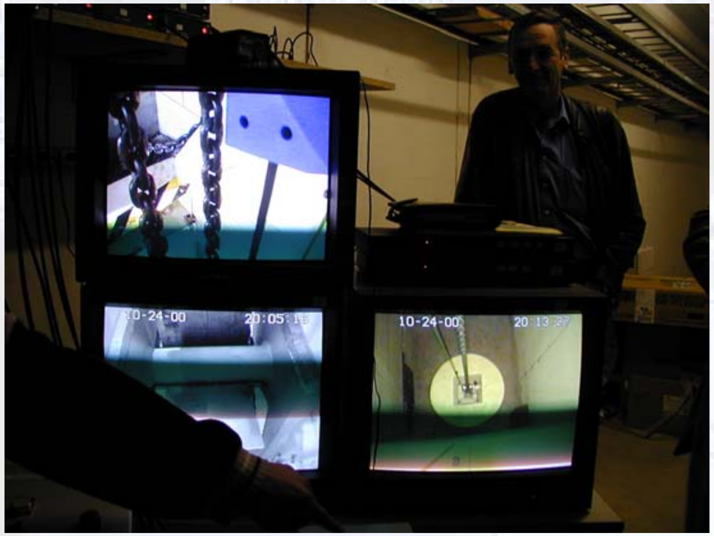
Seen from the bottom



Seen from the top

Present status: shaft activated and eventually contaminated (bottom part).

Main components of the Facility:
Target Handling



Target Handling
Status

- Shielding in the Shaft: removed
- Direct measurement of the dose rate: done (~15 mSv/h max)
- Simulations of the Target activation and dose mapping: done
(results in agreement with the measurement see M. Brugger presentation)
- Risk analysis for the Target removal (EDMS 771843): done
- Target removal Operating Procedure (EDMS 774982): done
- Target removal dose rate estimation (EDMS 774982): done
- "Un-sticking" test to verify the possibility to remove the target : done
- Exceptional procedure for the target recovery in case of jamming of the hoist system (EDMS 787079): proposal accepted by AB, under discussion with TS

(see I. Ruehl presentation)

Target Handling
What need to be done

The main problem concerning the Target removal is the risk of jamming of the Hoist System during the operation

- Envisaged Solutions:
  - Use of the existing Hoist System implementing the required safety measures to recovery the target in case of jamming of the crane.
  - Installation of a new Crane with improved reliability (double motorization).
    This solution has been already investigated. An offer in the framework of the "Contrat de maintenance Equipement de Levage et de Transport" is available.
    Expected budget: 350 kCHF
    Expected time for the delivery and installation: 5 months + 4 months for the market survey. (see I. Ruehl presentation)

Due to the target activation and contamination , the infrastructure and the procedure for the Target recovering in case of jamming of the Hoist System must be envisaged also for a system equipped with double motorization.

Main components of the Facility:
Cooling Circuit

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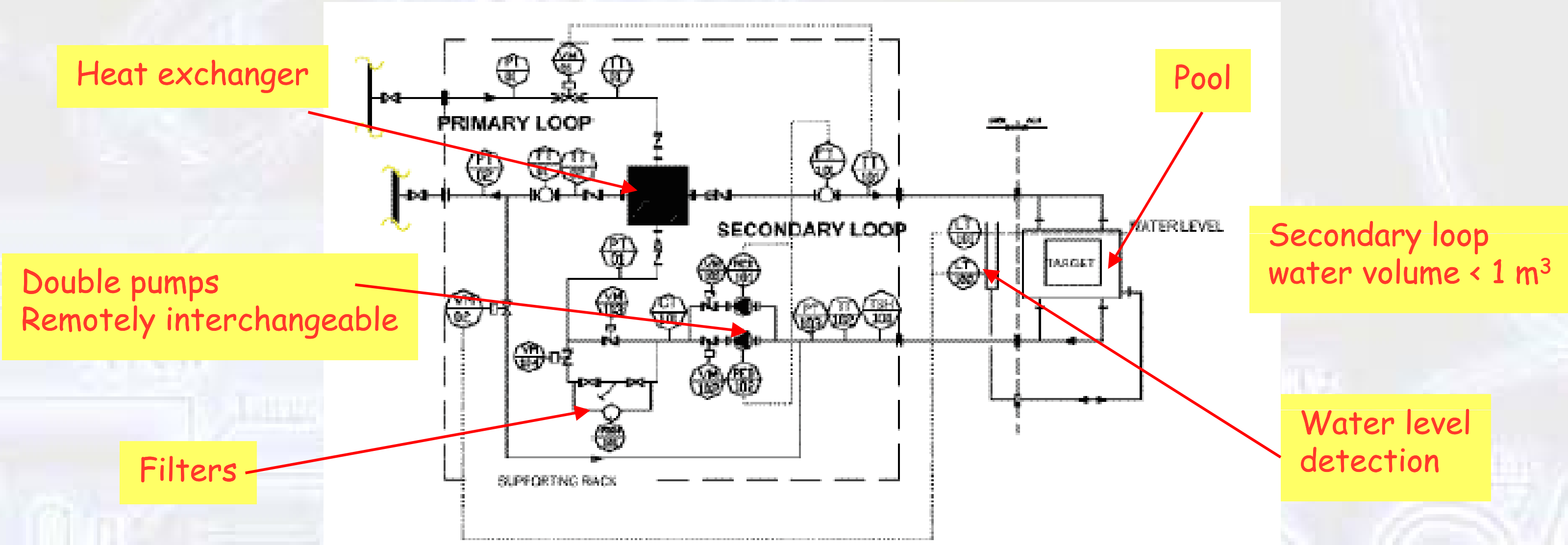

Hydraulic circuit constituted of a heat exchanger and two independent loops:

- Primary loop connected to the PS demineralized water cooling circuit
- Secondary loop connected to the target "pool". **This loop is not pressurized.**
- Continuous water demineralization and filtering
- Remote monitoring of all the parameters via SCADA.

Safety measures

- Water level detection in the pool connected to the interlock chain
- Water retention measures implemented under the pool and the pumping station.
- Water detection in the retention vessel under the pool
- Radiation monitoring near the filtering system.

Main components of the Facility:
Cooling Circuit- The Water Tank

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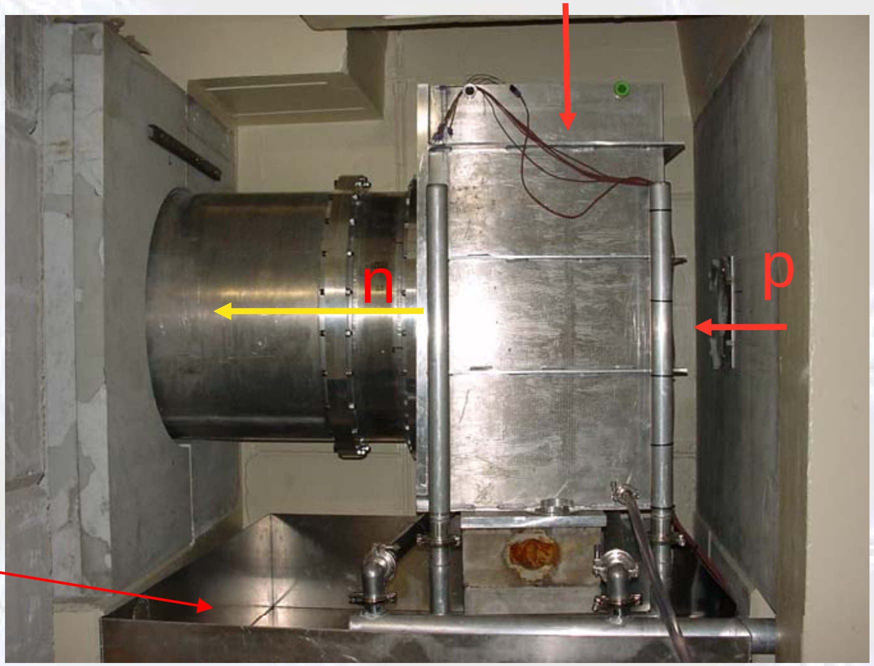
2006

- Volume: ~140 l
- Material: Aluminum alloy
- Wall Thickness: 10 mm
- Water circulating at atmospheric pressure



Present status: inaccessible

Main components of the Facility:
Cooling Circuit- The Window

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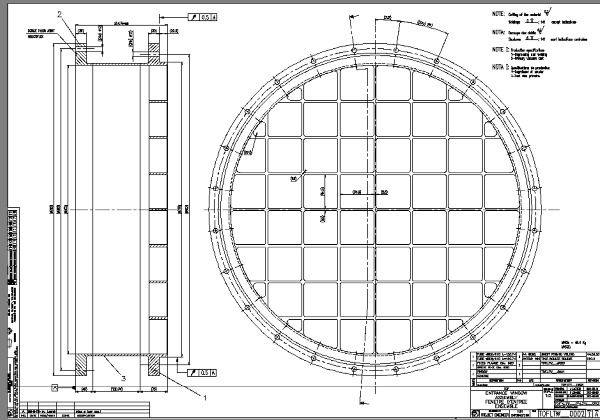
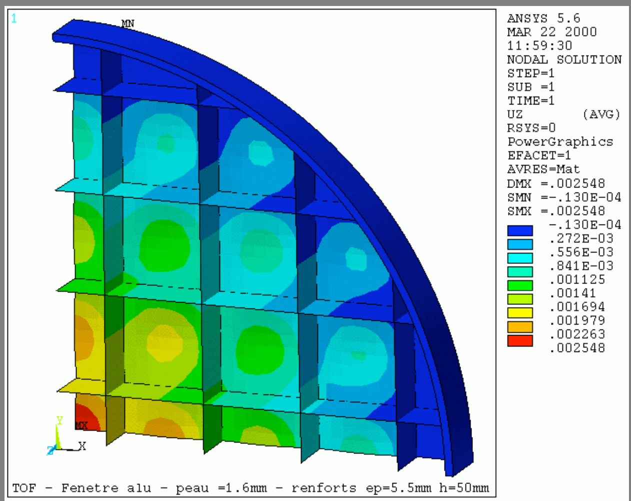
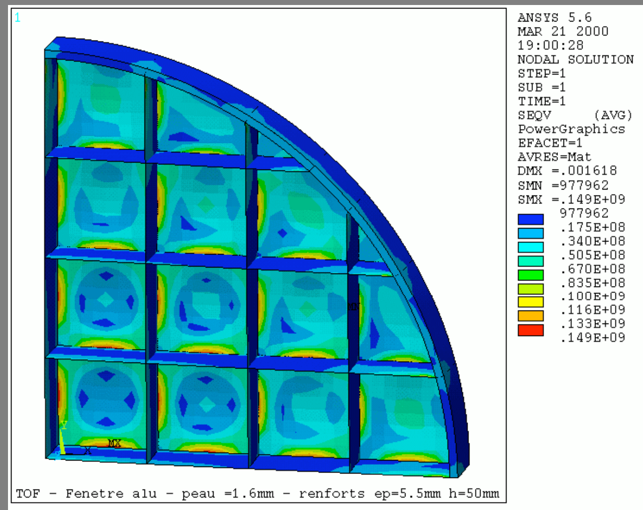
2006

- Useful diameter: 80 cm
- Material: Aluminum alloy
- Thickness: 1.6 mm
- Reinforced
- Monolithic construction
- Aluminum seal







Main components of the Facility:
Cooling Circuit

Draining pump

Cooling Station

Water Retention Vessel

Cooling Circuit
History and Present Status

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History:

- The circuit was working without any problem during the four years runs.
- Normal maintenance performed during the shut-downs.
- Before the 2004 run, the filter was replaced (normal maintenance)
- During the 2004 run, the circuit was dried after removal of the water injecting compressed air during several days. This operation was intended to prepare the filling with heavy water (solution abandoned).
- After restarting an abnormal radioactivity in the filter was detected (see T. Otto presentation)
- In September 2005, the filtering elements have been replaced and a system for a quick exchange has been implemented (ODM 1120935). During this intervention the filter saturation was observed.
- Recently an inquiry to determine the contamination of the cooling circuit piping is in progress.

Present Status: The secondary loop is empty since more than one year

Cooling Circuit
What need to be done

Open question: could the existing cooling circuit be used for the cooling of the new target?

Concerning the specifications of the system the answer is YES, but

- The status of the Cooling basin and the connection piping to the Heat Exchanger must be evaluated after the removal of the old target.
  (see M. Brugger presentation)

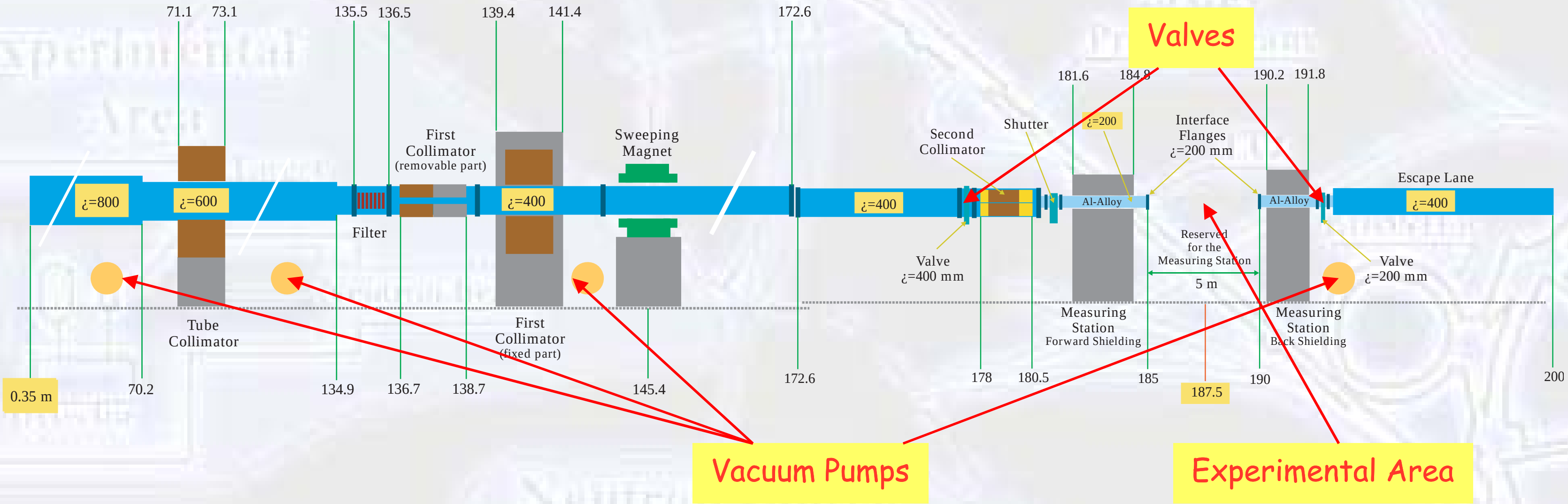
Two scenario are possible:

- Cleaning of the system by using standard procedures available at CERN (see J. Inigo-Golfin presentation)

- Replacement of the system. In this case the removal of the shielding around the target and in the tunnel must be envisaged. According with the information from TS, this solution is demanding a budget of ~ 100 kCHF, 6 months work and 1.5 FTEs.
  The expected received dose rate for this intervention is ~3 mSv
  (see M. Brugger presentation)

Main components of the Facility: The Vacuum Tube

- Four primary pumps are providing a vacuum < 1mbar
- Two pumps are in the primary area
- All the seals are metallic



Safety: the Access Door to the Experimental Area is in the interlock chain. Accessing the area the Valves are automatically closed.

Present Status: Vacuum ready to be restarted (normal maintenance)

Main components of the Facility:
The Collimation

The neutron beam size can be optimized for capture or fission measurement

The collimation is done by two elements:

- Collimator 1 with fixed dimension at a distance of ~ 140 m from the target
- Collimator 2 with two possible openings located at ~ 5 m before the Experimental Area

The nominal beam sizes are: Ø = 2.5 cm for capture, Ø = 8 cm for fission

Present Status: Ready

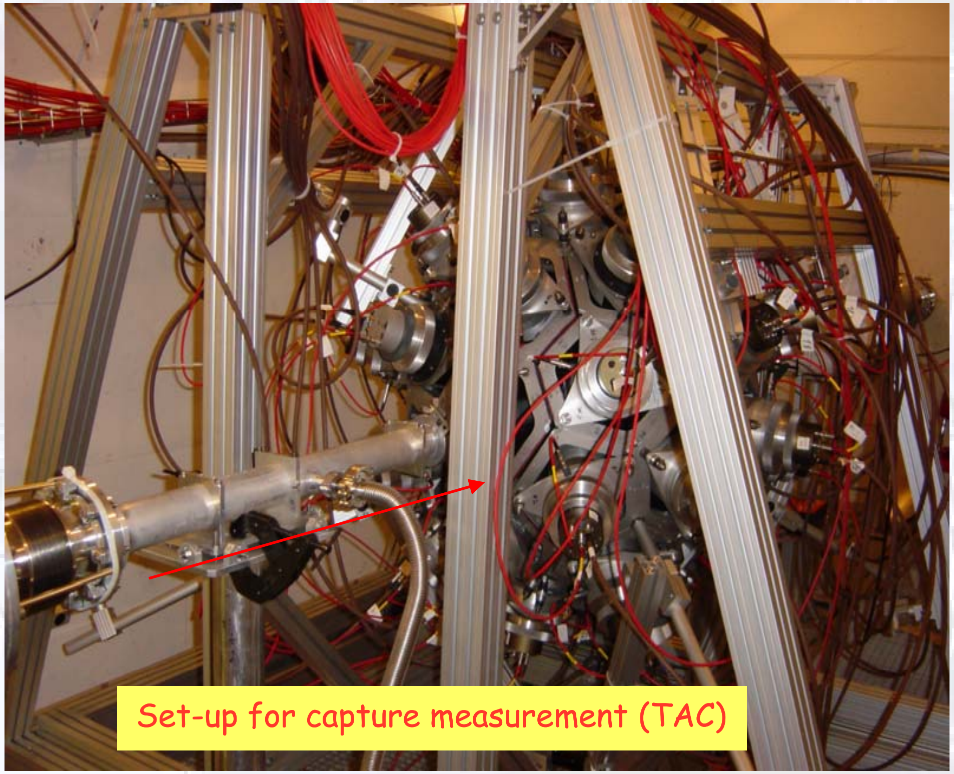
Main components of the Facility:
The Experimental Area EXA

The EXA could be configured for two different measurement:

- Measurement of fission reactions by using various detectors (Ionization chambers FIC or PPAC)
- Measurement of capture reactions by using the Total Absorption Calorimeter or C_6D_6 scintillators.

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

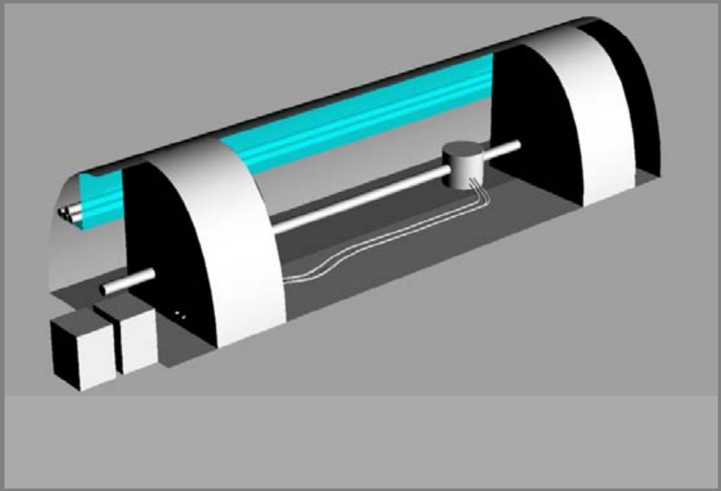
Set-up for fission measurement

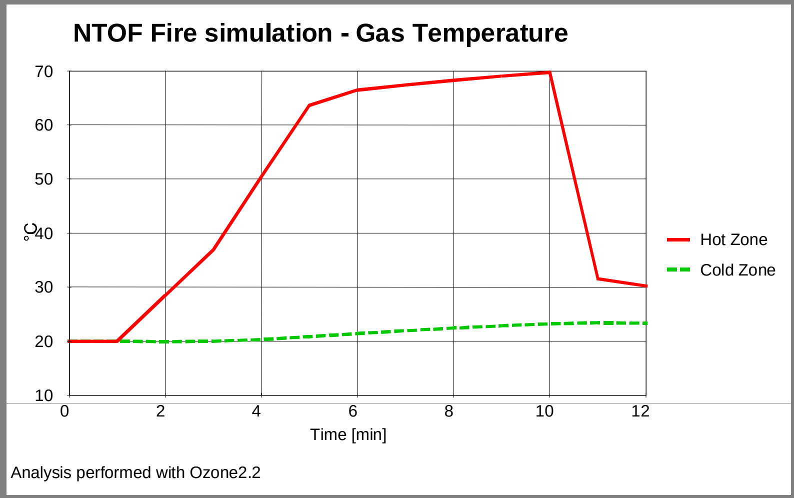


Set-up for capture measurement (TAC)

Experimental Area
History and Status

- After the 2001, 2002 and 2003 runs, following a detailed simulation, the upgrade of the EXA has been done to minimize the risk of fire.





- Implemented measures: removal of the gas system for PPACS, removal of the DAQ modules, installation of a protective fire wall.

Present Status: The Total Absorption Calorimeter is installed

Experimental Area
Constraints

- **The measurement of radioactive samples in the Experimental Area is subjected to the following restriction:**
  (see T. Otto presentation)

> Radioactive targets with activities exceeding 1 LA must be housed in a container certified ISO2919.

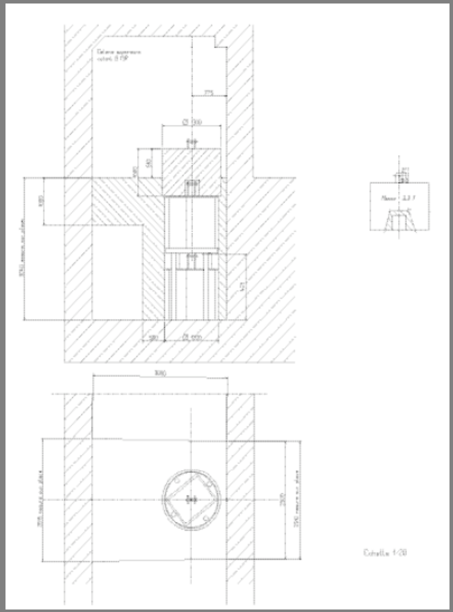
- **This rule is not presenting a serious limitation in case of capture measurement with the Total Absorption Calorimeter.**
- **For fission measurements, requiring the use of unsealed targets (PPAC and FICs), the detectors should be housed in a "class A-like" container.**
  This infrastructure is provided by the laboratory installing the equipment.

What need to be done: no actions expected for the Facility restart.

Main components of the Facility:
The Temporary Target Depository

- The Temporary Target Depository, located at the end of the Service Gallery, is accessible with the existing Hoist System.
- The old target will be stored in this place waiting the agreement with PSI for the final disposal.

(see T. Otto presentation)



Present Status: Ready to receive the activated target

What need to be done: no actions expected for the Facility restart.

Summary

Actions needed for the restart of the Facility:

- **Finalization of the design for the Ventilation System**
- **Removal of the old target**
- **Analysis of the samples taken on the old target (bulk, support)**
- **Visual inspection and sample analysis to define the level of contamination and corrosion of the pool and the cooling circuit pipes.**

Depending on the analysis results and inspections:

- **Finalization of the new target design including the Cooling System (physics simulations, thermal and fatigue simulations, decommissioning)**
- **Preparation of the Safety File for the Facility Description.**

Operation resources after restarting:

- **Technical coordination, engineering support to the institutions, vacuum maintenance, cooling system maintenance: 1 FTE/year**

Operation budget after restarting: 30 kCHF/year