THE ESS IRRADIATED TARGET WHEEL HOT CELL OPERATIONS FOR HANDLING, DISMANTLING, SEPARATION AND PREPARATION FOR FINAL DISPOSAL

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Remote handling systems work package status

Active cells:
• Confinement
• Handling
• Equipment

Achievements so far:
• Preliminary design of the active cells and overall configuration of the confinement.
• Studies of material handling concepts and logistics
• Start of the waste handling study

Focus on:
• *Baseline Design Review in December for the confinement.*
  Requirements: safety, functional, code compliance.

Preconditions:
• Handling and equipment
• Radiation calculations
The active cells consist of a series of different areas having the main purpose of:

- receiving
- processing
- interim storage
- preparation for shipping

The main elements of the active cells are:

- process cell
- maintenance cell
- post irradiated experimental (PIE) cells
- storage pits
- technical galleries
- transfer zone
ESS Target Station Active Cells Layout

- Maintenance cell
- Process cell
- Storage pits
- Transfer area
- PIE cells
- Technical galleries
The process cell
Components from the monolith to be processed in the active cells

There are three main components placed within the shielding monolith that have to be periodically processed in the active cells. These are:

- **Target Wheel including the shaft**,  
- **Moderator and Reflector (MR) plug**  
- **Proton Beam Window (PBW)**

The degrading processes caused by irradiation and thermal environment determine the lifetime of those components.
Design of Target wheel

Short wheel data:

- Diameter: 2.5 m
- Shaft diameter approx. 700, 500 t=30 mm
- Total height of the assembly: 5.3 m
- Total weight: 14.5 tons
- Tungsten core which constitutes the spallation material
- Stainless steel shroud, encloses the tungsten.
- Shroud connected to shaft via a central hub.
- Integrated Helium coolant channels
- Helical shielding inside shaft
- 25.5 rpm
The target is split in 33 segment sectors. Each segment consists of 13 tungsten slabs.

Tungsten slabs

Segment structure
Flow of the irradiated monolith parts

- Maintenance cell
- Process cell
- Transfer area
- Storage pits
Operational mode

- Unloading from monolith
- Transport in high bay
- Startup
- Docking of cask, transport through floor valves
- Transport casks
- Transport to process cell
- Access through intrabay door
- Transport to maintenance cell
- Transport to storage pits
- Storage mode
- Transport to transport cask
- Ready for off-site transport
- Decontamination/monitoring
- Temporary storage

Active cells Operational mode
- Ventilation system in normal operation
- Transport
- Processing
- Ventilation system in forced operation
- PROCESS MODE
Process mode

- Determination of activity level for waste type sorting
- Fixation
- Target wheel

- Cutting of shaft
- Opening of shroud
- Cutting of shroud
- Removal of tungsten elements

- Loading to basket

- Record and mark of basket
- Preparing plastic wrapping of baskets
- Capping/sealing of basket
- Inspection of seals
- Record of content
- Removal of plastic wrapping
Possible dismantling techniques

Mechanical or thermal dismantling?

Thermal:
• oxi-fuel
• plasma
• laser
• water jet

Mechanical:
• shear cutting
  blade cutting
  tearing
• breaking
• end milling

Important parameters for the choice of the cutting methods are:
• cutting speed
• maintenance frequency
• maintainability
• emissions and secondary waste

Conclusion of the pre-study:
Combination of two mechanical processing techniques, circular sawing and end milling for the dismantling of the wheel and shaft.
Circular saw
Circular saw – Dry, high speed
Collection of chips

- The relatively large chips from sawing shall be collected by guiding plates (hoods) connected to a vacuum system which in turn is connected to a waste drum.

- The cutting process shall as far as it is possible be covered by a temporary single layer plastic tent structure to limit the spread of chips and minimize decontamination to a smaller surface.
Remote handling concept

- High degree of modularity - easily replaceable.
- Maintenance and handling - performed remotely.
- The processes of remote handling reversible.
- HMI central outside the confinement including visual surveillance by camera systems and with overlay VR possibilities.
- Manual operation possibilities with through wall manipulators.

Dual power manipulator
Circular saw/end mill
Rotating table
MSM
Dismantling of target wheel shaft

• Cutting of the shaft shall be performed from the top to the bottom.

• The circular saw is remotely operated and driven by a fully automatic output regulated high frequency motor. Servo motors runs the linear rail system and all rotations of the saw assembly.
Removal of segments

- Precise cutting of beam entrance window
- Cassette of tungsten slabs can be pulled out from the wheel structure
Optional solution for removal of slabs
Dismantling sequence: Target Wheel
Tank for radioactive waste

<table>
<thead>
<tr>
<th>Tank wall thickness (mm)</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
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</thead>
<tbody>
<tr>
<td>Empty waste tank weight (tons)</td>
<td>10</td>
<td>18,5</td>
<td>25,5</td>
<td>33</td>
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<tr>
<td>Basket/internal casings weight (tons)</td>
<td>3</td>
<td>3,5</td>
<td>5,5</td>
<td>6</td>
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<tr>
<td>Waste load, max. (tons)</td>
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<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Total waste tank weight, max (tons) Sum of the above.</td>
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<td>34</td>
<td>43</td>
<td>51</td>
</tr>
</tbody>
</table>
Transfer area, tank for radioactive waste & baskets. Interface to waste management.