Remote handling applied to a facility upgrade at CERN during long shutdown 1 in 2013-2014

Sven De Man
CERN EN department
Contents

• Introduction to CERN
• The SPS LSS1 cabling project
  • Scope
  • Remote handling
    • Cabling
    • Transport
    • Mobile robots
• Other robots in operation + developments
Work conditions

- The dose rates are usually low but there are exceptions
- Concerned LSS1 area has an average 1 mSv/h
- Geometry and complexity of the installation are a challenge: replace one cable at 1 mSv/h is no issue but 200 km of cables takes 3000 hours
- Interventions happen in 50 km of tunnels, with an enormous variety of environments and objects to manage. -> adapted heavy handling
- Internal transports also use public roads crossing CH-F borderer adding legal constraints
Access – coordination – dose monitoring

The access control has been highly automated to manage hundreds of accesses a day.
Planning, access location and dose management are integrated in a single interface called IMPACT.
The SPS LSS1 cabling project

- June 2013 – March 2014
In order to increase the SPS reliability, it has been decided to remove 1200 irradiated cables and install 1100 cables situated between BA1 access point and SPS Sector 1+:

- Control cables and HV cables for Kickers.
- Similar campaign was performed in LSS2- during 2008

Cabling work is set as late as possible: 8/10 to 17/03/14 ➔ reduced dose rate
Remote handling

• Cabling work
• Transport and handling of heavy objects
• Inspection and light work by robot vehicle
• Tackling unforeseen job: repair dump
Optimization 1: removal of accelerator
Cabling optimization 1/2

Use of the comb adapters

Replaces cables ties and **speeds up** the cable fixing in the hot area

Number of combs: 50
Installation time: ~2 hours/2 operators

- For kicker cable fixing

  - Quicker (less exposure)
  - No waste
  - Can be used in other areas
1. **Use of the cable winch**

   It allows operating the cable **removal** and **installation** from the cable ends, avoiding the workers to stay long time in the middle hot area

   - **For kicker cable removal**
     - Old cables are cut only at the two LSS1+ ends
     - Full length cables are put on wheels and **pulled** by the winch

   - **For new kicker cable re-installation**
     - New cables are put on wheels and **pushed** by the winch
     - A cable guide rope assures the straight cable routing
Transport and Handling

Installation of internal dump TIDVG 3

Transfer of the 2 TIDVG
Transport and Handling

Handling in storage / accelerator

Installation of TIDVG 2
Mobile Robot operation

- Focus on high work doses for objects under 50 kg
- Successful examples:
  - Opening vacuum clamps.
  - Cutting cables/wires.
  - Removal of safety barriers and supports.
  - Installation of Taylor-Hobson spheres.
  - Handling of vacuum chambers.
  - Unbolting and removing small objects.
Use of ‘EOD’ mobile robots
Mock-up training

disconnection of vacuum and hydraulics on dumps with Robot(s)

Feasibility study – test successful
Tool interface supplied by Telerob
Tools in-house developed
Vacuum leak detection
Repair of SPS internal beam dump

• 25 tonne dump to be disconnected: water, controls and vacuum
• Transport
• Fitting new water connections
• Core (50 mSv/h) extracted
• New core with extra temperature sensors mounted
• Transport and installation
• Alignment (0.1 mm) by means of motorized jacks
• Vacuum connection and leak detection + firing
Telemax® installs cap on the dump
Other robots operated at CERN
Other Robot Operations 1/2
credits: Mario di Castro

- One of the last interventions: handling, RP measurements, manipulation and safe storage of 6 radioactive sources in the old RP calibration hall (172) using 2 teleoperated robots (Telemax and Teodor). Not feasible by human
- Hot source: ~400 mSv/h at 40 cm

- TIM operation: several RP missions performed in the last months (positive feedbacks from OP)

- ISOLDE and future MEDICIS Target Handling: Fully autonomous thanks to a novel fail safe control supervision based on low level failsafe PLC.
  Rad-hard Kuka robot with offset encoder electronics
Other Robots Operations 2/2

- SPS RP monitoring
- SPS MKP oilers inspections and maintenance using robots

Several novel procedures and tools implemented

<table>
<thead>
<tr>
<th>Nr. of Interventions in the last 22 months</th>
<th>Robot operation time [h]</th>
<th>Dose Saved [mSv]</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>~ 53</td>
<td>~ 45</td>
</tr>
</tbody>
</table>
Remaining difficulties

Vacuum and survey interventions are time consuming, force workers to stay close to the equipment and rely on a small pool of specialists: little dose spreading.

- alignment corrections - motorizations are rare and fragile
- leak detection - robot is too slow
- interconnection of equipment by means of conical vacuum flanges - requires feeling

We have high expectations from force reflecting manipulators on mobile platforms. All feedback is most welcome.
Thank you
Questions?
CERN

- [http://home.cern/about](http://home.cern/about)
- CERN, the European Organization for Nuclear Research
- The instruments used at CERN are particle accelerators and detectors. Accelerators boost beams of particles to high energies before the beams are made to collide with each other or with stationary targets. Detectors observe and record the results of these collisions.
Radiation

• During operation = no access to accelerator
• Losses of the beams activate the machine
  • Unwanted losses, typically at switch points +
  • Collimation ++
  • Targets +++ (+ contamination risks)
  • Dumps +++

Dumps are often massive (>20t, lengths of 5 m) and very radioactive. The most stringent requirements come from the need of vacuum of 10E-12 for internal dumps.
## Cabling project phases

<table>
<thead>
<tr>
<th>Task</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work dose calculations and optimization of work methods</td>
<td>April 2013</td>
</tr>
<tr>
<td>ALARA committee agreement</td>
<td>15 Jun 2013</td>
</tr>
<tr>
<td>Remove Accelerator and prepare area</td>
<td>08 Jul 2013</td>
</tr>
<tr>
<td>Optic fibre installation</td>
<td>10 Sep 2013</td>
</tr>
<tr>
<td>Cable exchange</td>
<td>08 Oct 2014</td>
</tr>
<tr>
<td>Connections and other work</td>
<td>Feb 2014</td>
</tr>
<tr>
<td>Reinstallation of hot elements AND UNFORSEEN REPAIR OF TIDVG</td>
<td>Mar 2014</td>
</tr>
<tr>
<td>Vacuum and Geodesy work</td>
<td>Apr 2014</td>
</tr>
</tbody>
</table>