Collimator alignment in high radiation environment

Remote controlled alignment verification system for LHC collimators at IP7
• Introduction
• Metrology
• Initial alignment
• The train concept
• Measurement concept and references
• Sensors and configuration
• Measurement Results
Betatron cleaning area

- Minimize the time to spend in the zone
- Failsafe automation of measurements
Collimator metrology

- Alignment of Collimator w.r.t. plug in support
- Alignment of fiducials w.r.t. Collimator coordinate system

✓ All collimators are at the same position w.r.t. the plug in
✓ All collimators have equal parameters for the fiducials.
Initial alignment

- 2D alignment using TDA5005
- Vertical alignment using digital level
- Smoothing with neighbour magnets using wire offsets
• The concerned zones are considered to be the most radioactive in the LHC
• The time to spend in these zones has to be minimized

Remote controlled alignment check
Train concept

• Train attached to the monorail (collaboration with TS-IC-IS)
• Wire offset measurements to determine the transversal train position
• Digital photogrammetry to link the position of the train and the collimators / reference magnets
Train concept

Sensor unit
Service unit
Engine unit
• Measurement of the wire position w.r.t. the reference magnets
• Measurement of the different collimators w.r.t. the wire

Train concept

Reference Magnet

Collimator

stretched wire

Monorail
Principle crossection

19/03/2007 Patrick Bestmann TS-SU-A(}
• Normal retroreflecting targets are optimized for contrast and visibility and not radiation hard
• Aluminium targets have to be produced in order to resist under radiation (prototypes ready)
• 5 targets/collimator are needed to represent the position and orientation of the collimators
Photogrammetry Targets

- Fiducials are adjusted to nominal coordinates
- Additional targets will be attached to fiducials
Photogrammetry

- 3 to 4 cameras will deliver synchronized images of the collimator targets
- Using these images the system can calculate 3D coordinates of the collimators in the train coordinate system using triangulation
- But where is the train?
• The train will get its position from the stretched wire.
• The wire sensors are two additional objects to be measured in the same images.
• Self-calibrating system as the sensors are measured in each image.
• Online displacement of the wire sensors to compensate Monorail defaults and train movements
Recapitulation

• Transversal position of the collimator targets and reference magnets w.r.t. the wire.
• The rotation around the wire will be measured using electronic inclination sensors
• The longitudinal position will be measured relative to the reference magnet using a laser distometer
<table>
<thead>
<tr>
<th>Date</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/06</td>
<td>Layout Target prototypes, Wire sensor comparison</td>
</tr>
<tr>
<td>01/07</td>
<td>Finalizing simulations for fixing camera parameters, order of target prototypes</td>
</tr>
<tr>
<td>02/07</td>
<td>Starting of train construction, Order for wire sensors</td>
</tr>
<tr>
<td>03/07</td>
<td>Camera system: call for tender, Layout and construction for instrument frame</td>
</tr>
<tr>
<td>05/07</td>
<td>Software and interfaces for the system</td>
</tr>
<tr>
<td>06/07</td>
<td>Assembling of train and wire sensors, tests for interfaces and software</td>
</tr>
<tr>
<td>08/07</td>
<td>Integration of cameras, Tests and calibrations</td>
</tr>
<tr>
<td>......</td>
<td>Assembling, Tests and modifications</td>
</tr>
<tr>
<td>......</td>
<td>.....</td>
</tr>
<tr>
<td>05/08</td>
<td>Operational system</td>
</tr>
</tbody>
</table>