Establishing a Reference Network for the alignment of Sirius

Authors: Henrique Geraissate, Gustavo Rovigatti and Rodrigo Leão
Metrology Group / CNPEM

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Introduction

Energy: 3 GeV
Emittance: 0.25 nm.rad
Circumference: 518 m
Nº of magnets: 650
Nº of girders: 220

### Storage Ring Alignment Tolerances

<table>
<thead>
<tr>
<th></th>
<th>Between Magnets</th>
<th>Between Girders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerance</td>
<td>0.040 mm</td>
<td>0.080 mm</td>
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Networks installed in this areas
Methodology – Networks Layout

- Representation of radiation shielding into SpatialAnalyzer
- Primary Network Nominal Points
- Secondary Network Nominal Points

- Points materialized with SMR nests
- Embedded into the concrete
- Wall, floors and pillars (Hall)
Methodology – Survey

**Levelling Campaign**
- 8 different campaigns
- Double-levelling procedure
- Level reference for calculation

**Tracker Survey**
- Tripod and Wall Mounts
- Primary Network
  - 241 stations
  - 1220 points
  - 5542 measurements
- Radius Control
- Secondary Network
  - 195 stations
  - 730 points
  - 4107 measurements
Methodology – Connection Technique

- Secondary network internal connections:
  - Exp. Hall ↔ Hutches
  - Exp. Hall ↔ Long Beamlines
  - Made by bridge tracker stations, measuring points in both environments

- Storage Ring and Experimental Hall networks should be connected via the radiation shielding holes, a very restricted line of sight
- Development of a technique for reciprocal orientation between Laser Trackers
Methodology – Calculations

Earth Curvature Compensation

- The Earth isn’t flat!
- Alignment of distant components with respect to the source beam
- The greater the distance, the lower the network

\[ h = \frac{D^2}{2R} \]

Constraints

- Preserve the network shape, measured by reference stations
- Level: absolute max error between the calculated network and the original levelled points
- Radius: average error between the 5-resulting “line of sights” and the original stations mean

Parameter Optimization

- Control Radius Statistics
  - Uncertainty (1σ): 0.034 mm
  - Standard Error: 0.009 mm

- Levelling Campaigns Statistics
  - Uncertainty (1σ): 0.108 mm
  - Standard Error: 0.017 mm
Resulting Networks
Resulting Networks

Avg. Radial Uncertainty: 0.034 mm

Avg. Vertical Uncertainty: 0.083 mm
Network Deformation

Two epochs comparison: January 2020 to May 2018

Monitoring System details:
TUPAB309 – Alignment Verification and Monitoring Strategies for Sirius Light Source – Rodrigo Neto
Crystal of SARS-CoV-2 3CL and structure of the protein, obtained from the first experiment conducted at Manacá Beamline at Sirius.

https://www.lnls.cnpem.br/first-experiments-are-carried-out-on-sirius/

THANK YOU!

Alignment Results details:
THXB06 – Results of the First Alignment Run for Sirius, the new Brazilian Synchrotron – Rodrigo Leão