Diagnostics Tools to Optimize the Injection Efficiency

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OUTLINE

• Introduction
• Project description
• Applications in routine operation
• Conclusion
ALBA Synchrotron:

- 3rd Generation Synchrotron Light Source
- 3 GeV Storage Ring of 270m
- Operating since 2012
- 8 BLs fully operative + 4 in construction
- Location: Barcelona (Spain)
Diagnostics Tools to Optimize the Injection

- LINAC 100 MeV
- Booster To Storage Ring Transfer Line (BTS)
- Booster 100 - 3000 MeV
- Storage Ring 3 GeV
- Linac To Booster Transfer Line (LTB)
- Beam Lines
SYNCHROTRON LIGHT SOURCES

- Designed to deliver stable photon beams for users
- Typical operation mode: TOP-UP
- Some BLs cannot use the data collected during injections

It is desirable to shorten the injections

The operators try to keep the injection efficiency up
Main issue since top-up operation: BTS Transmission

- Presented large oscillations
- BTS Optimized by trial-and-error
- Time consuming for the operators
- Drifts of the settings along a run
Operations Section started a new project

**Goals**

- Define a standard procedure to optimize the BTS transmission in operation
- Improve the BTS transmission

**Tasks**

1. Improve the Beam Instrumentation performance  
   - Beam Diagnostics group
2. Define a “golden trajectory” along the BTS  
   - Beam Dynamics group
3. Monitor the pulsed magnets  
   - Pulsed Magnets Expert
4. Develop a high level software to monitor the BTS  
   - Operations Section
Booster To Storage Ring Transfer Line

Source point BT/SRM-01

Source point BT/SRM-02

Source point BO/SRM

SR injection

BO extraction

BO

SR
1. DIAGNOSTICS IMPROVEMENTS

- BPMs upgrade:
  - Replacement of the Libera Brilliance (multi-turn) electronics by Libera Spark units designed for single pass beams

- SRMs upgrade:
  - Design of a new mechanical support of the optical system
2.- BTS GOLDEN TRAJECTORY

→ Defined performing manual BBAs at the BTS

→ Reproducible by using the non-destructive diagnostics

<table>
<thead>
<tr>
<th>Design.</th>
<th>11/9/16</th>
<th>5/6/17 start</th>
<th>5/6/17 end</th>
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<tbody>
<tr>
<td>Kiest (V)</td>
<td>-</td>
<td>25250</td>
<td>26350</td>
</tr>
<tr>
<td>SRM xpos (mm)</td>
<td>8.1</td>
<td>7.8</td>
<td>8.0</td>
</tr>
<tr>
<td>FSH xpos (mm)</td>
<td>17.8</td>
<td>17.5</td>
<td>18.2</td>
</tr>
<tr>
<td>Septum (V)</td>
<td>-</td>
<td>426.4</td>
<td>425.3</td>
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</table>
3.- PULSED MAGNETS MONITORING

- Amplitude and timing monitored using a scope and ADCs cards
- BO extr and SR inj pulsed magnets readback become very useful in the control room
A) A python script is continuously running during BL operation

- It provides:
  - Control of the BTS SRMs ccds
  - Shot-to-shot data from the injections archived in daily hdf5 files
  - On-line post-processing of the injection data available as Tango Dynamic Attributes
4.- HIGH LEVEL SOFTWARE TOOLS

B) 2 other scripts provide read backs from the pulsed elements asTango Dynamic Attributes

C) A GUI developed in python (based on QT and Taurus) integrates all the information to operate the injector
4.- HIGH LEVEL SOFTWARE TOOLS

BO-SRM

BO current ramp

acopinjectorGUI.py

LTB trends

BTS trends

BT-SRM-1
1. **BTS horizontal alignment** during machine start-ups following the new standard procedure which is available in the *opwiki*

- **Booster extraction adjustment** scanning the kicker and septum to reproduce the “golden positions” at the BO/SRM and BT-SRM-1

- **Injection efficiency optimization** by scanning the SRseij, BO-RF extraction phase.

- **If needed**, scan:
  - The horizontal position at SRseij with the last 2 correctors
  - The injection angle with the SRseij
2. **Transmission recovery** during operation

- **Bad Inj Eff**
  - **BO04-SRM xpos jumped?**
    - Yes: Compensate BO-kiext setpoint
    - No: Continue Investigation
  - **BT-SRM1 xpos jumped?**
    - Yes: Compensate BO-seext setpoint
    - No: Compensate SR-seinj setpoint
  - **SR-seinj readback jumped?**
    - Yes: Compensate SR-seinj setpoint
    - No: Wait Next Injection
Injection efficiency vs. beam position at BO extraction and BTS during 6h of top-up operation.

The efficiency drop is recovered by changing the setpoint of the extraction septum.
<table>
<thead>
<tr>
<th>Date</th>
<th>Time 16h53</th>
<th>Time 17h13</th>
<th>Time 17h53</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bo2Sr eff</td>
<td>88 %</td>
<td>64 %</td>
<td>87 %</td>
</tr>
<tr>
<td>BO-seext</td>
<td>425 Vsp</td>
<td>425 Vsp</td>
<td>424 Vsp</td>
</tr>
<tr>
<td>BT-SRM-1 Xpos</td>
<td>10.9 mm</td>
<td>9.0 mm</td>
<td>10.7 mm</td>
</tr>
</tbody>
</table>

This table was elaborated from our archived data and corresponds to the same example than the previous plot.
CONCLUSION

✔ We found a stable and reproducible BTS horizon trajectory

✔ BTS transmission improved

✔ The operators have now improved tools to optimize and keep the injection efficiency up

✔ The operators have increased our understanding of the BTS dynamics and instrumentation
ACKNOWLEDGEMENTS

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✓ **Pulsed Magnets Experts:** M. Pont and N. Ayala

✓ **Controls and Computing Section**

✓ **Operators Group**
MANY THANKS FOR YOUR ATTENTION!

QUESTIONS?