Diagnostics Tools to Optimize the Injection Efficiency

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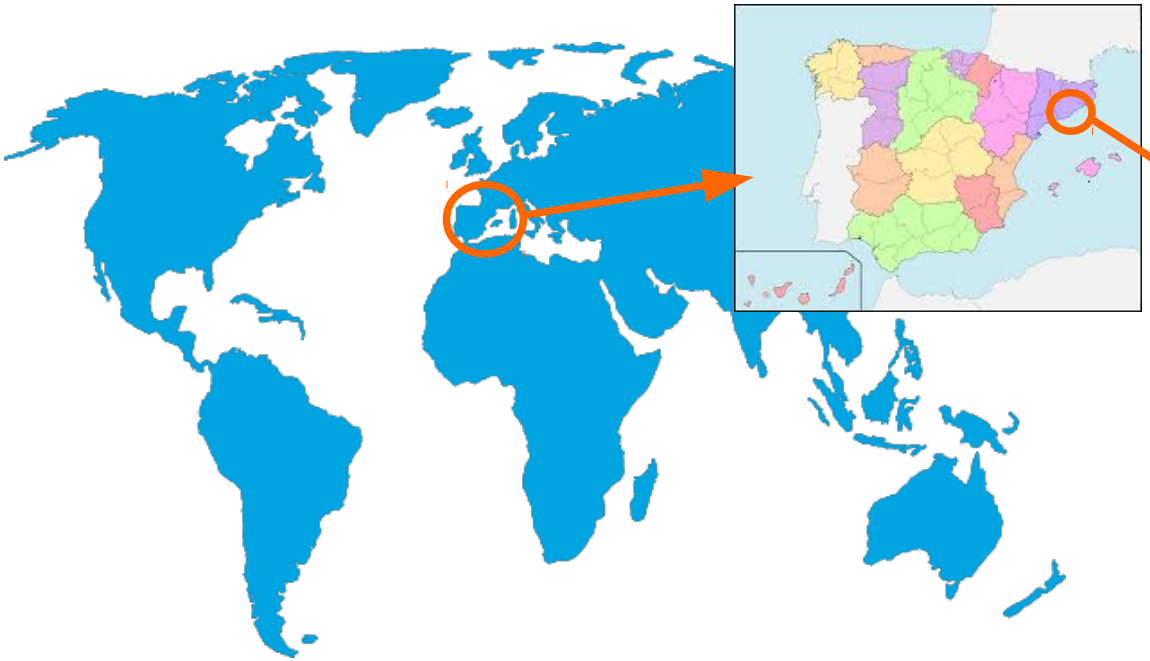
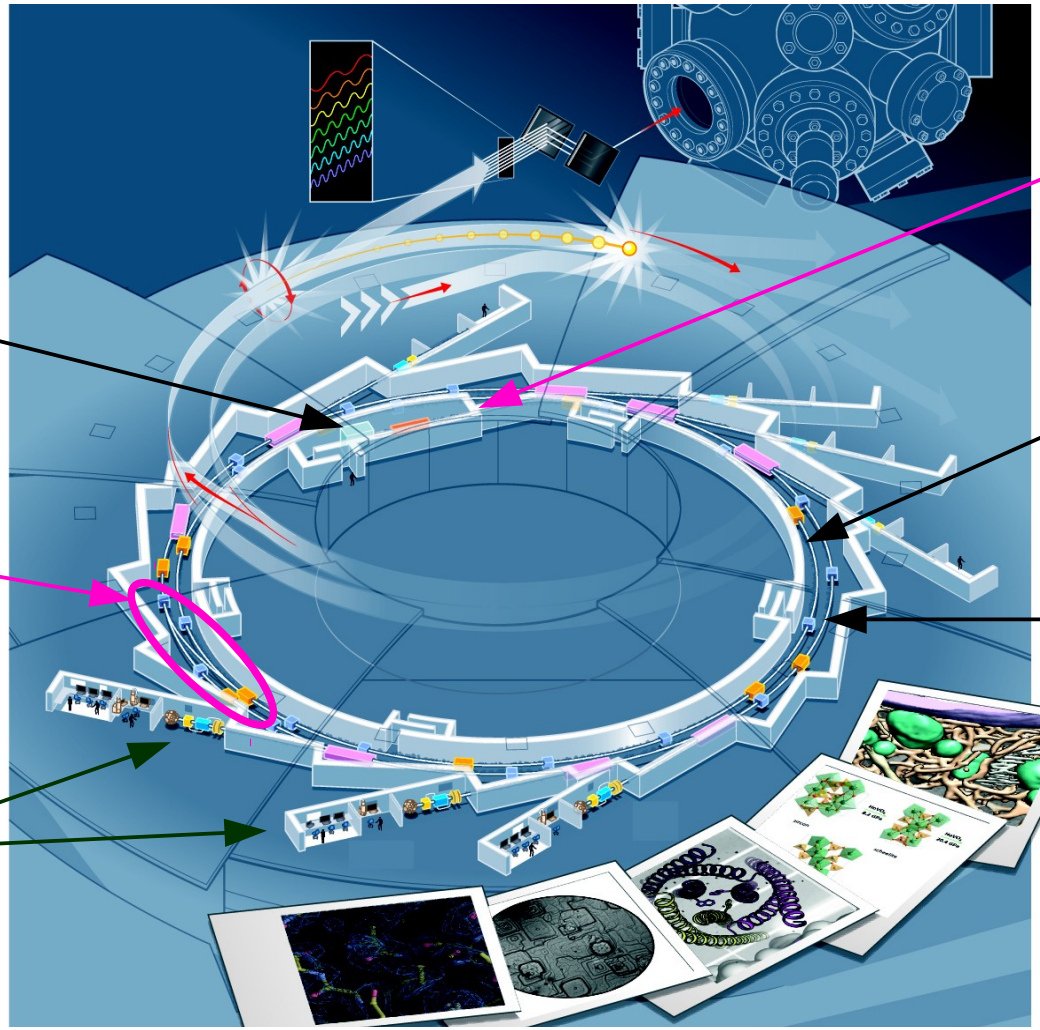
OUTLINE

- 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)




Linac To Booster Transfer Line (LTB)
LINAC
100 MeV
Booster
100 - 3000 MeV
Booster To Storage Ring Transfer Line (BTS)
Storage Ring
3 GeV
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

INJECTION EFFICIENCY

- **Main issue since top-up operation**: **BTS Transmission**

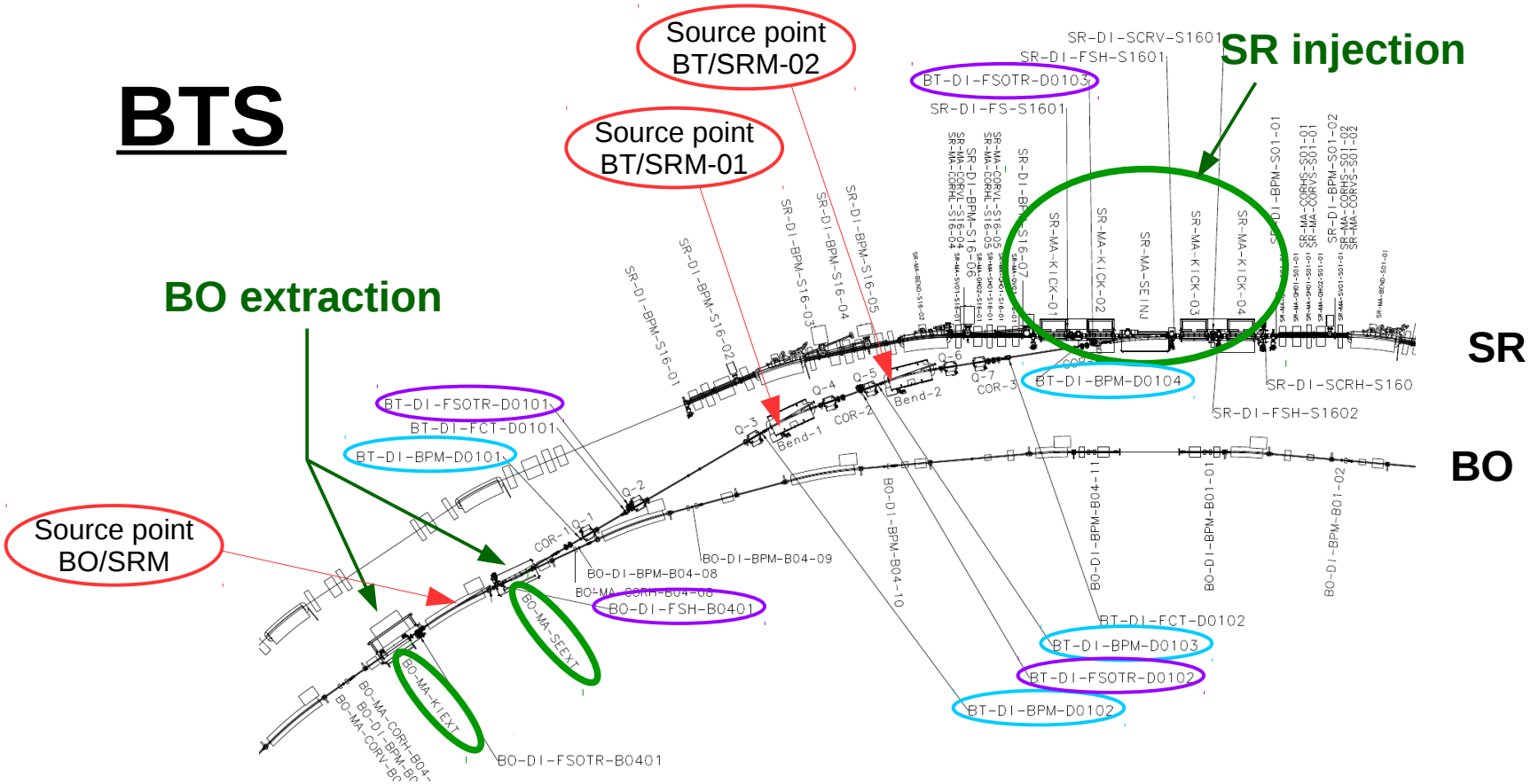
- Presented large oscillations
- BTS Optimized by *trial-and-error*
- Time consuming for the operators
- Drifts of the settings along a run

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

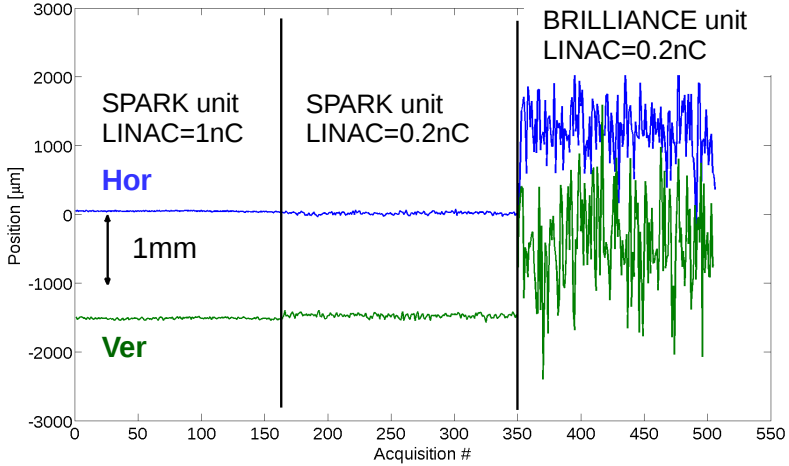
Booster To Storage Ring Transfer Line

BTS

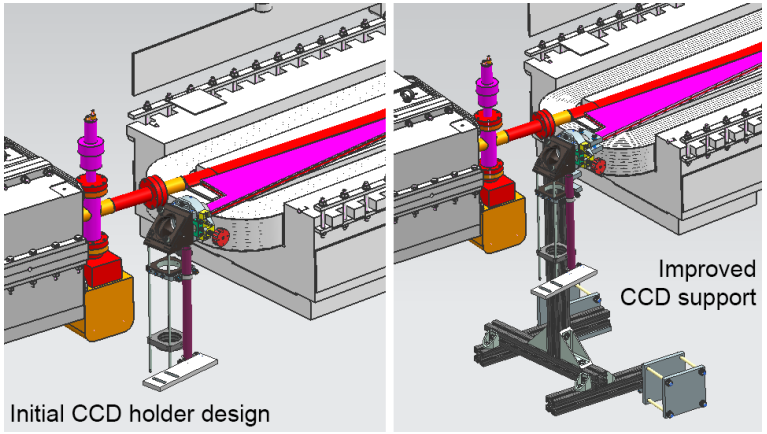


1.- DIAGNOSTICS IMPROVEMENTS

- **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

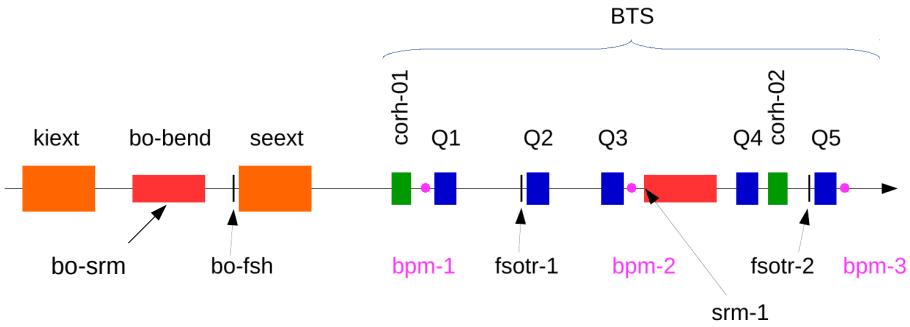


2.- BTS GOLDEN TRAJECTORY

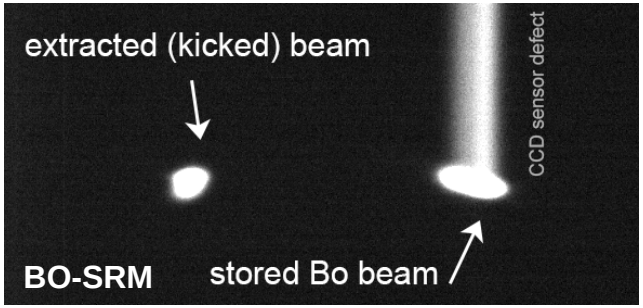
- Defined performing manual BBAs at the BTS

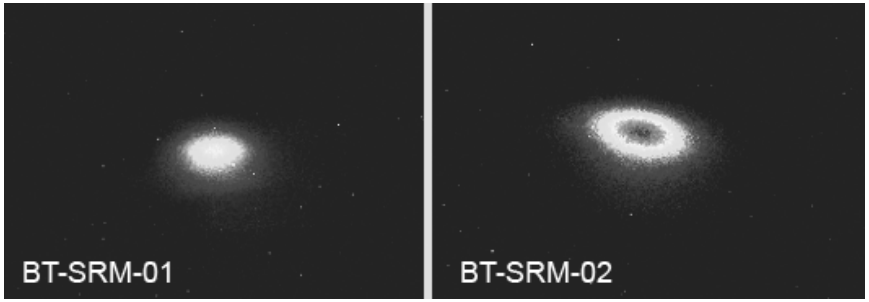
- Reproducible by using the non-destructive diagnostics

- **Manual BBA**



	Design.	11/9/16	5/6/17 start	5/6/17 end
Kiext (V)	-	25250	26350	25600
SRM xpos (mm)	8.1	7.8	8.0	7.8
FSH xpos (mm)	17.8	17.5	18.2	17.8
Septum (V)	-	426.4	425.3	425.0





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

4.- HIGH LEVEL SOFTWARE TOOLS DEVELOPED BY THE OPERATORS

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

acopInjectorGUI.py

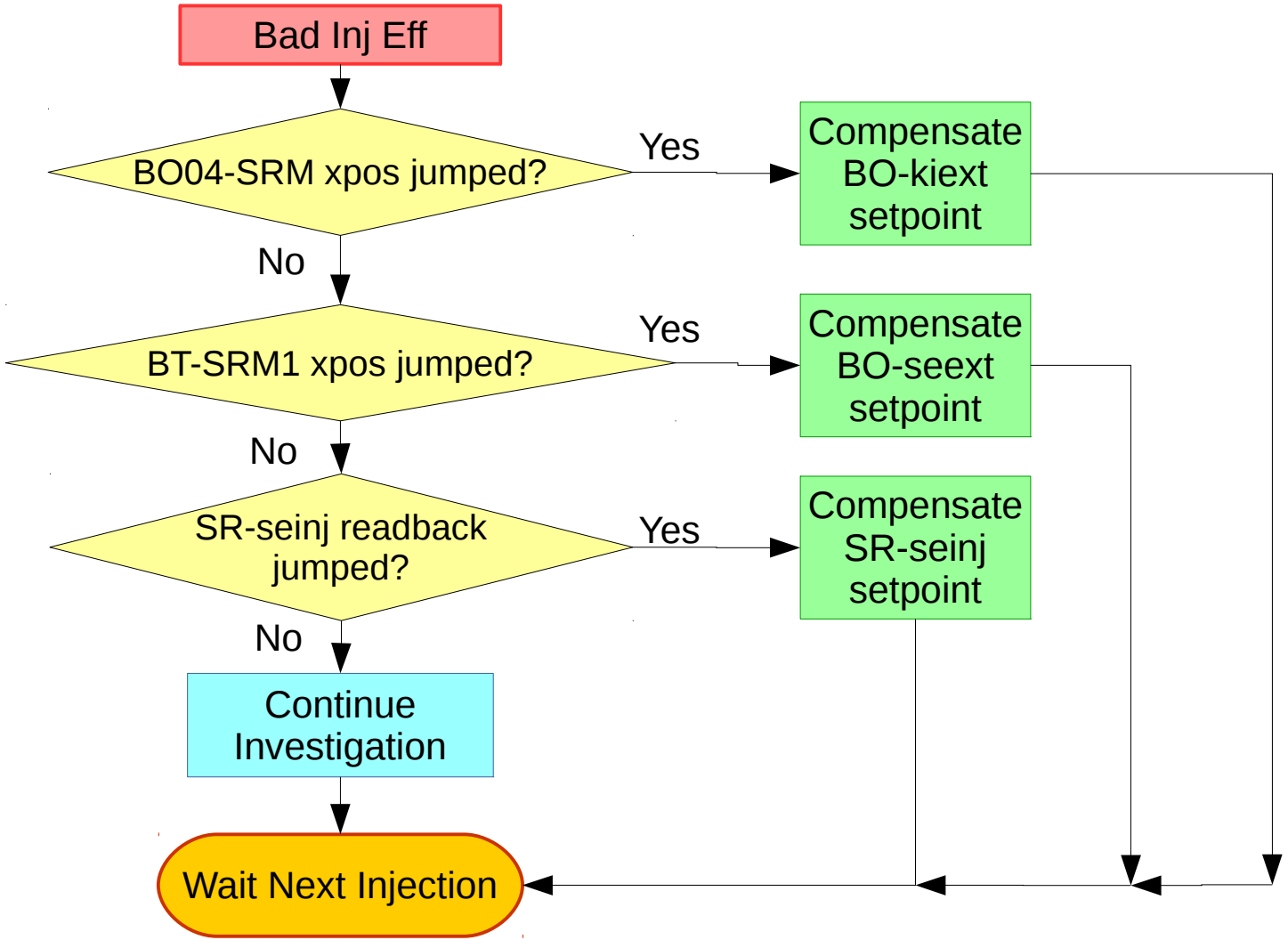
LTB trends

APPLICATIONS IN ROUTINE OPERATION

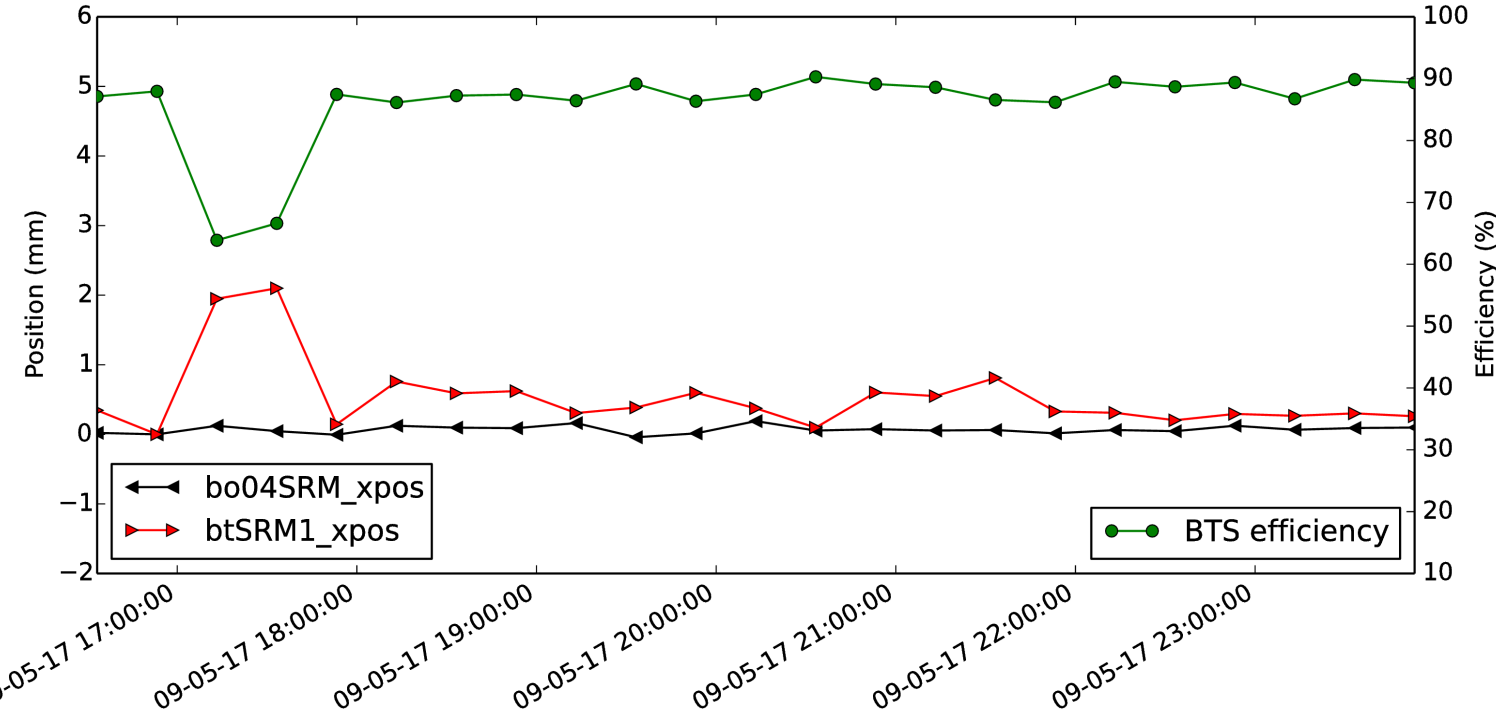
1. **BTS horizontal alignment** during machine start-ups following the new standard procedure which is available in the *opwiki*

- ✔ **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 SRseinj, BO-RF extraction phase.
- ✔ **If needed**, scan:
  - The horizontal position at SRseinj with the last 2 correctors
  - The injection angle with the SRseinj

2. **Transmission recovery** during operation

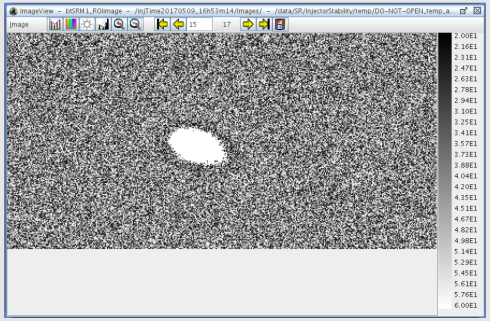
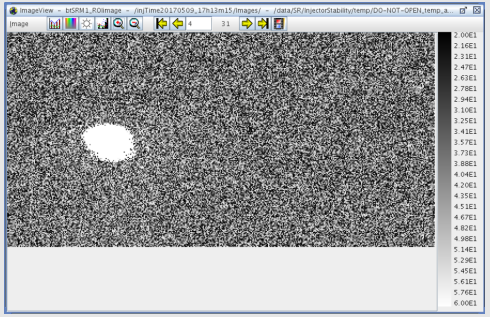
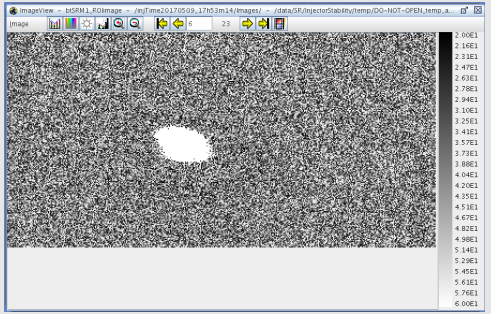


Transmission recovery example



- 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.

09/05/2017	16h53	17h13	17h53
Bo2Sr eff	88 %	64 %	87 %
BO-seext	425 Vsp	425 Vsp	424 Vsp
BT-SRM-1 Xpos	10.9 mm	9.0 mm	10.7 mm
BT-SRM-1 ROI img			

➔ 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 hor 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

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- ✔ **Controls and Computing Section**
- ✔ **Operators Group**

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