BIS 1.23
Backup solution for BIS optical loops

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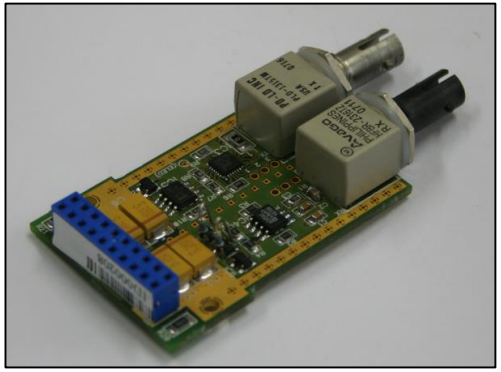
Outline

- Upgrade of optical transceivers: **CIBO** vs **CIBSFP**
- Setup of the **BIS-SFP** test loop
- Data Analysis Results 2017-2018 of BIS-SFP
- Conclusions

Current optical Transceivers

CIBO Daughter board

ELED transceiver



Limitations

- **Low power margin**:
  - Low typical output power: -19 dBm (~13 µW)
  - Low typical sensitivity: -28 dBm (~1.6 µW)
  - LHC fibers attenuation: up to 6 dB.
- **Temperature drift** -0.16 dB/°C
- **No monitoring** of transceiver and link status (except for glitches)
- **Custom built**

SFP optical Transceivers

Small Form-factor Pluggable (**SFP**)

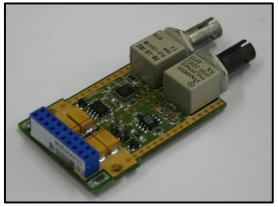
MRV SFP-GD-LX

Advantages

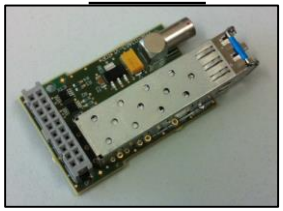
- **High power margin**:
  - High output power: up to -3 dBm (~500 µW)
  - Good sensitivity: -20 dBm (~10 µW)
- **Low gain drift**: Internal compensation
- **Off-the-shelf** industry-standard transceivers
- **Hot plug**
- **Monitoring** functions over I2C:
  - RX Power
  - TX Power
  - Temperature
  - Etc…

BIS 1.23 – Upgrade of Optical Transceivers

CIBO

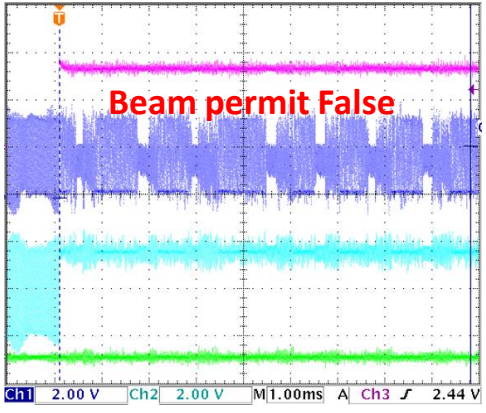


CIB-SFP



100% pin compatible with CIBO

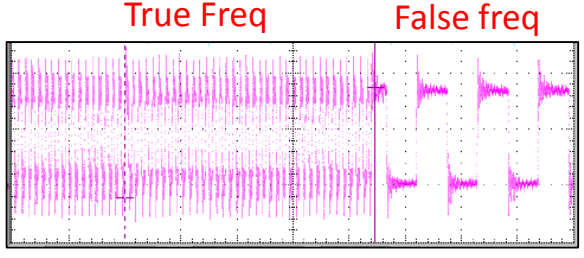
- **BOTH SFP and CIBO do not work properly with DC values → DC level = Ringing**
  - Introduced a **FALSE** frequency of **920 KHz** for the **SFP**
    - **No ringing** → clean signal.
    - BEAM PERMIT: True/False/**Undefined**



CIBM Local Permit

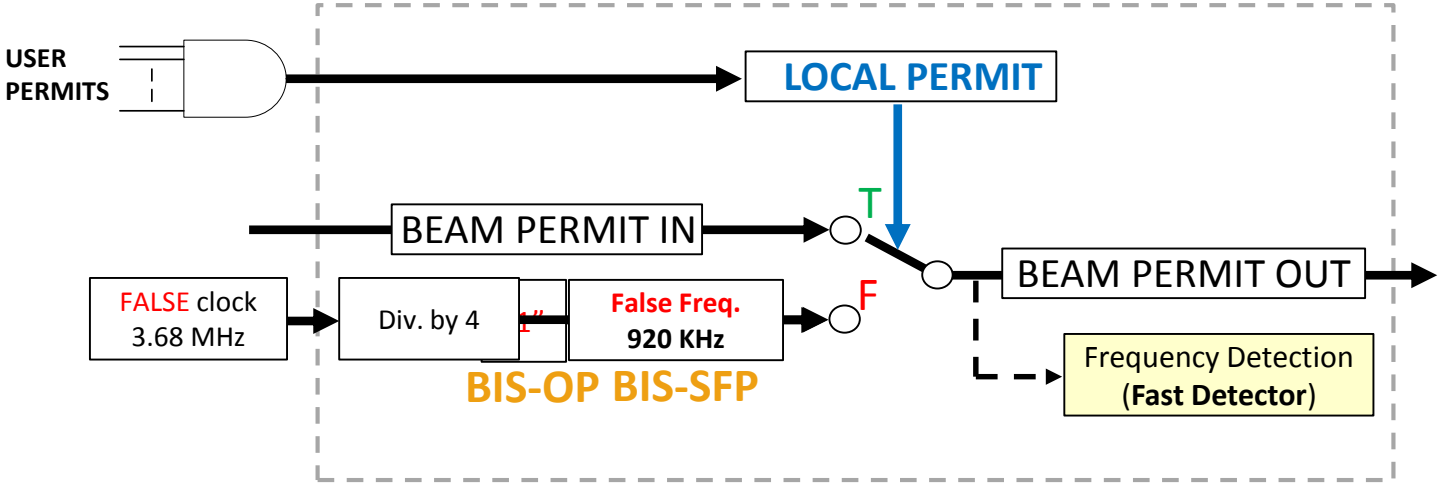
Output signal

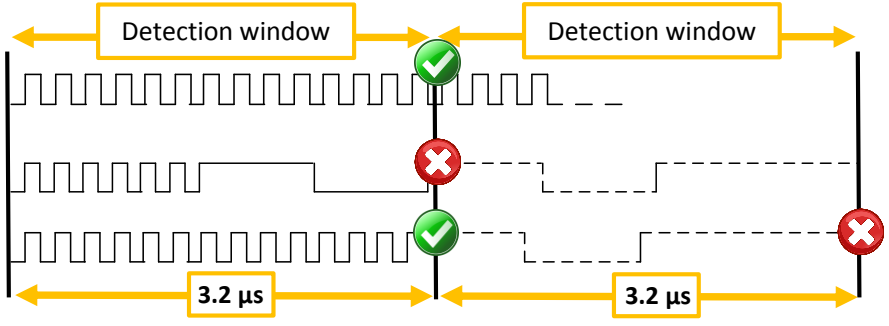
Input signal



SFP output signal

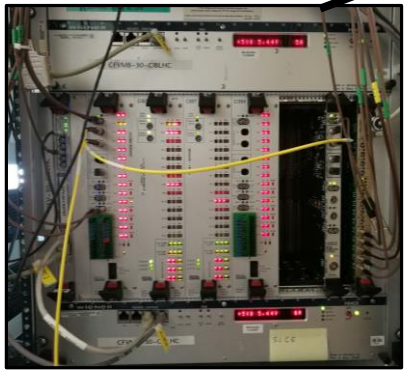
CIBM **BIS-OP** vs CIBM **BIS-SFP**

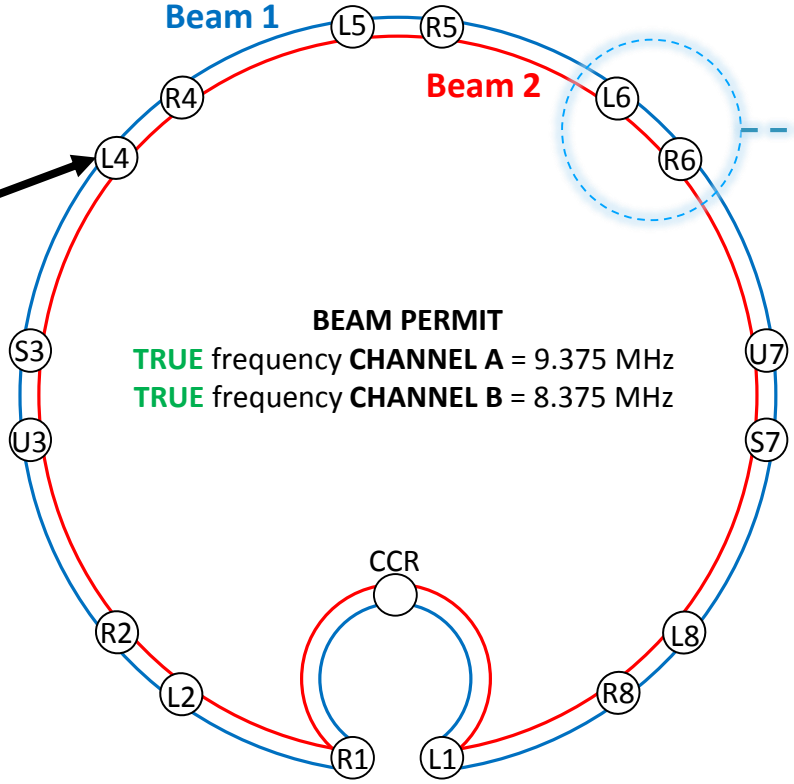




Current Operational BIS (BIS-OP)

17x BICs





CIBGenerator

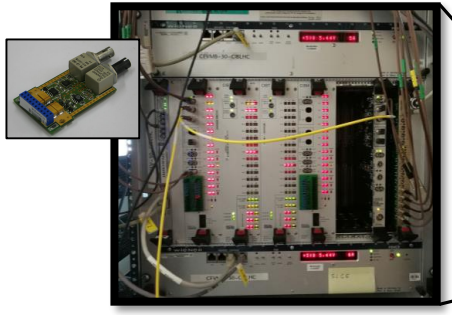
Trigger Synchronization Unit

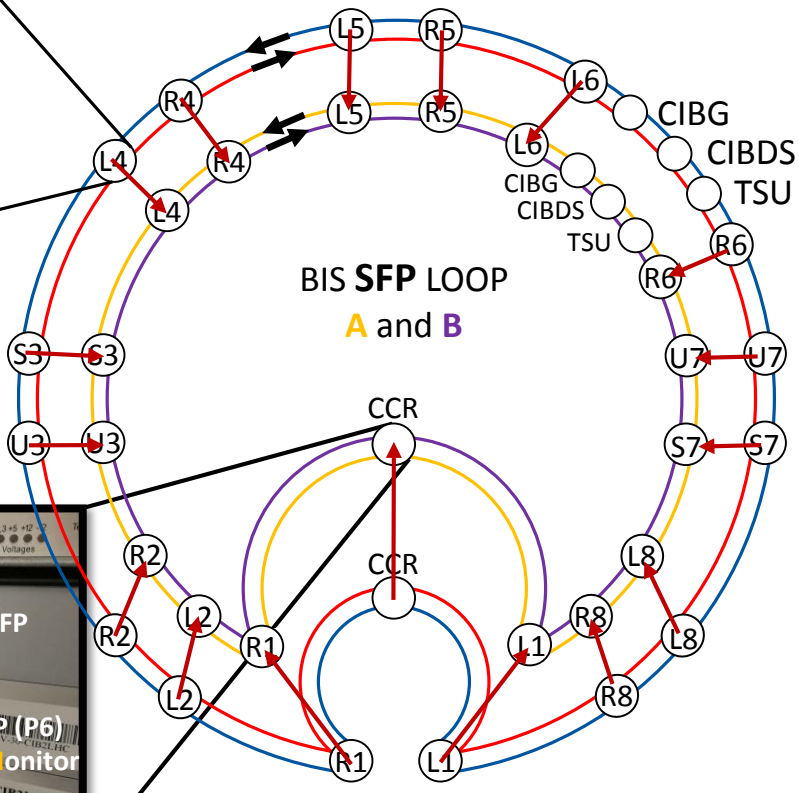
TSU → LHC Beam Dump

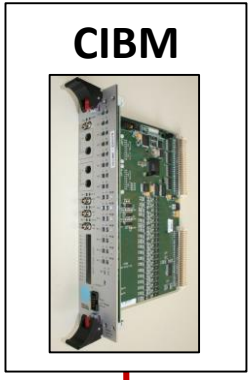
CIBDS

CIBDumping System

BIS Loop LHC - **BEAM 1 A and B**





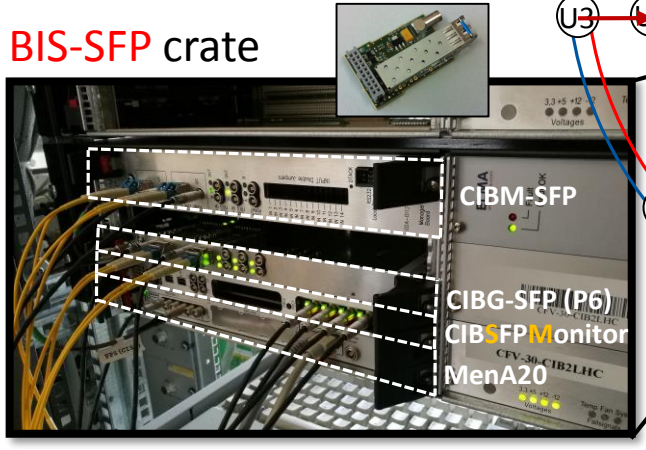


LOCAL PERMIT

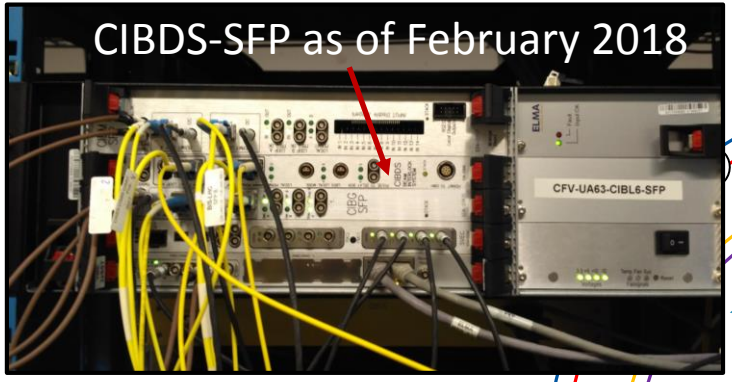
One-way connection

CIBM-SFP

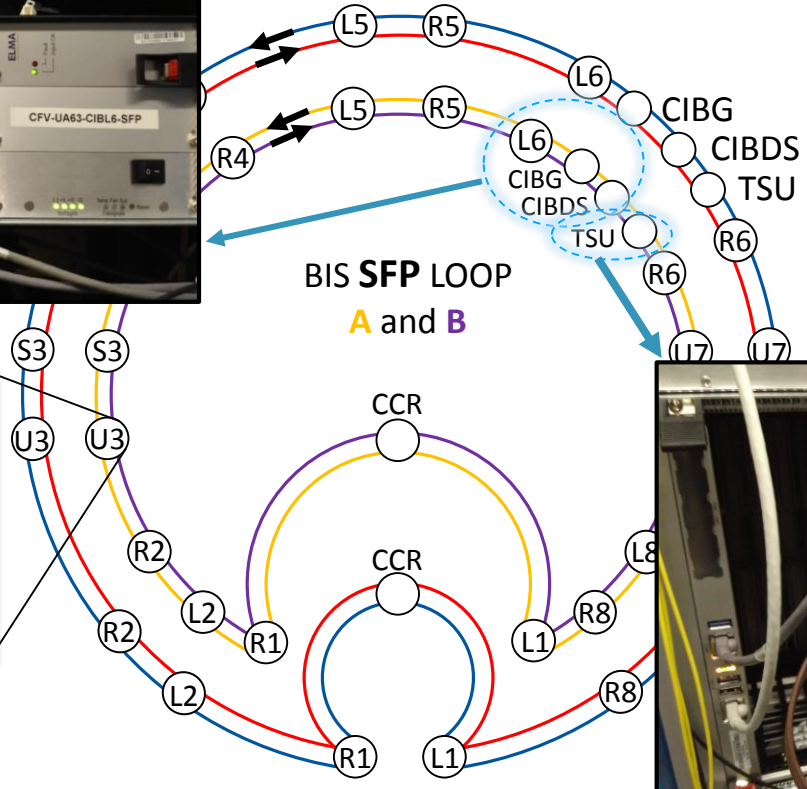
BIS-SFP crate

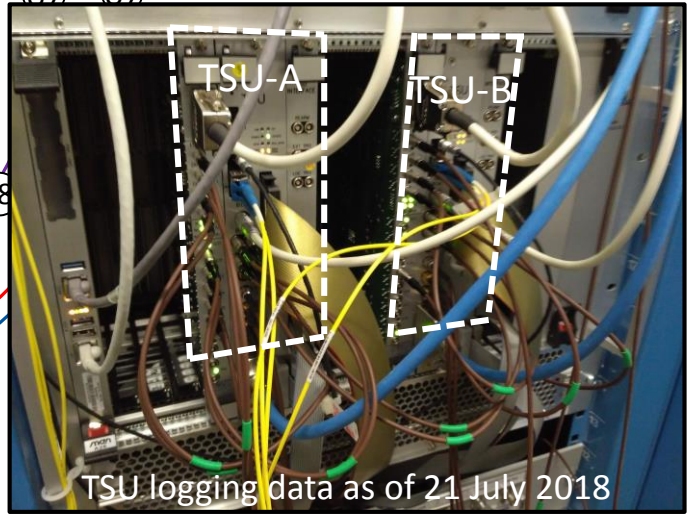


BIS-SFP in Point 6



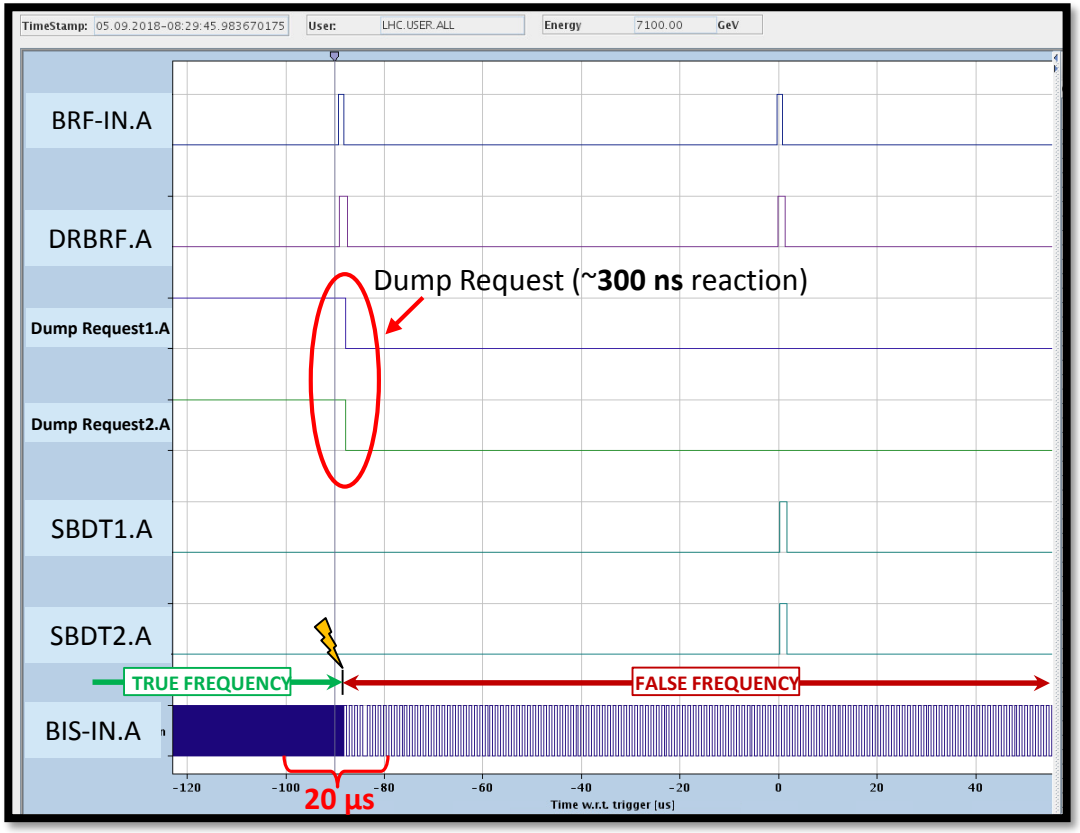
BIS-SFP crate



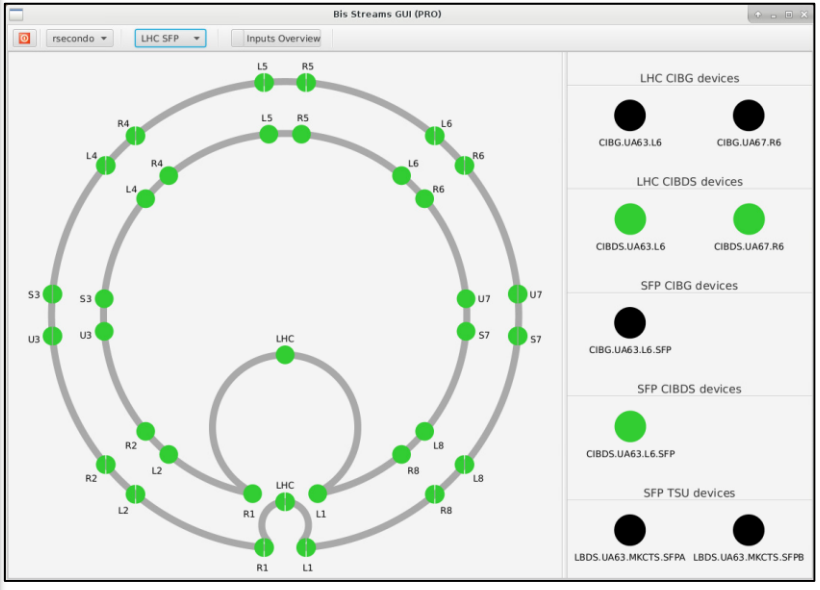


Monitoring Tools

TSU-SFP IPOC Viewer



BIS-SFP GUI



GOALS of the Data Analysis

- NO missed dumps
  - Consistency of **time delay** between (BIS.OP – BIS.SFP) @ BeamPermit T→F for each dump
  - **Beam Permit Propagation Delay** from first opening BIC until the **TSU**
- NO spurious dumps: Analysis of all Beam Permit Transitions.

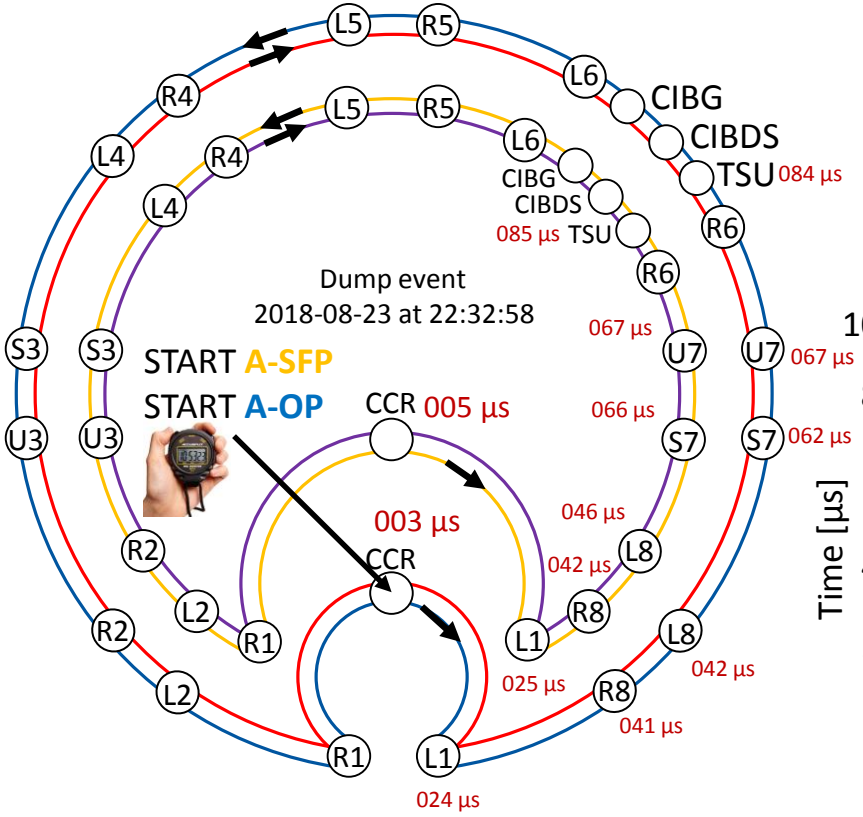
- SFP delay is affected by:
  - BIS-OP Local Permit → 1.7µs - 2µs
  - Detection window of both BIC → 300ns - 3.41us
  - Phase of the Beam Permit Signal → 0 ns – 100 ns
  - Difference in the length of optical fibres → ± 1µs

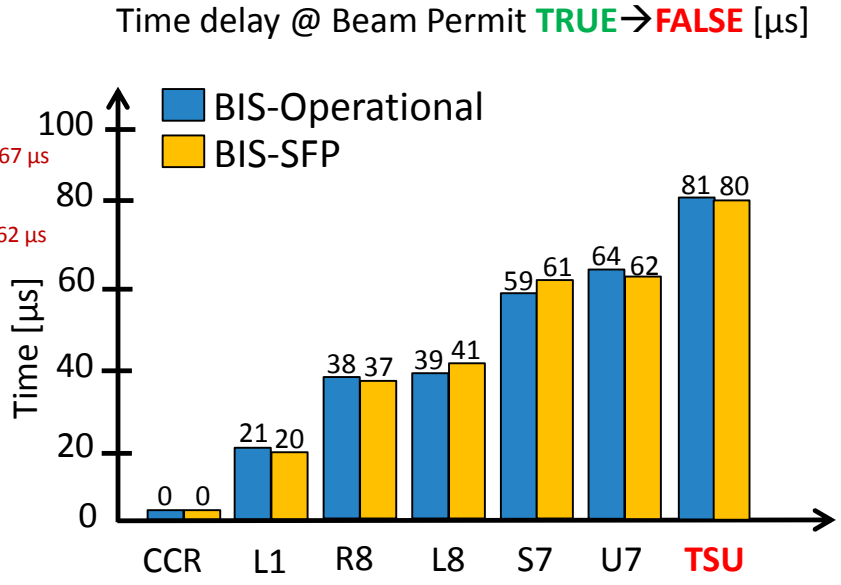
  Error introduced by **data logging** (before Aug 2018) → ± 2 µs

Expected **Range of Time Delay**

(BIS.OP – BIS.SFP) @ BeamPermit T→F ≈ **-8.5 µs to 4.8 µs**

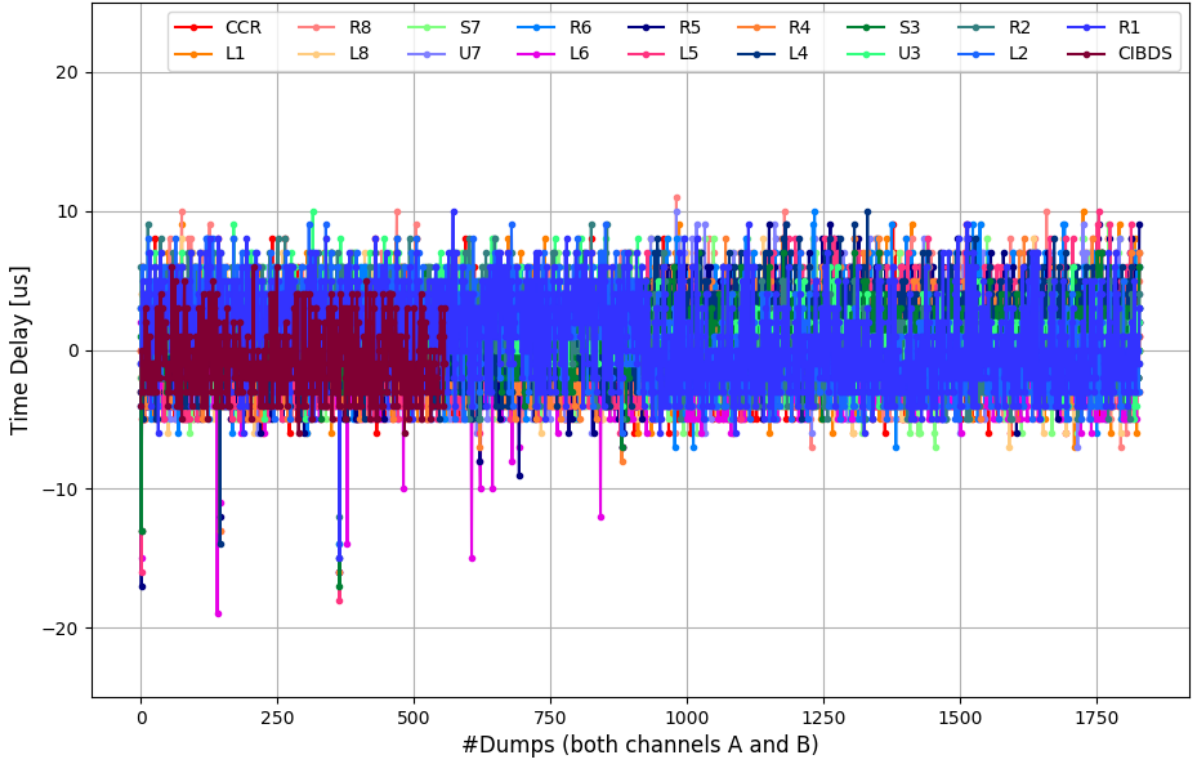
Case Example: Beam Permit Timestamp @ True→False





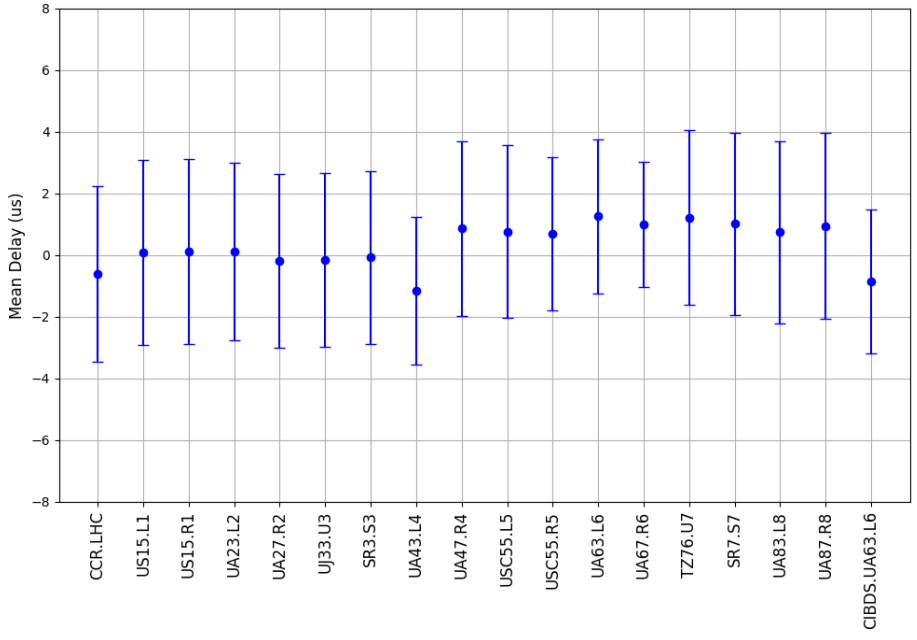
Analysis of Missed Dumps - I

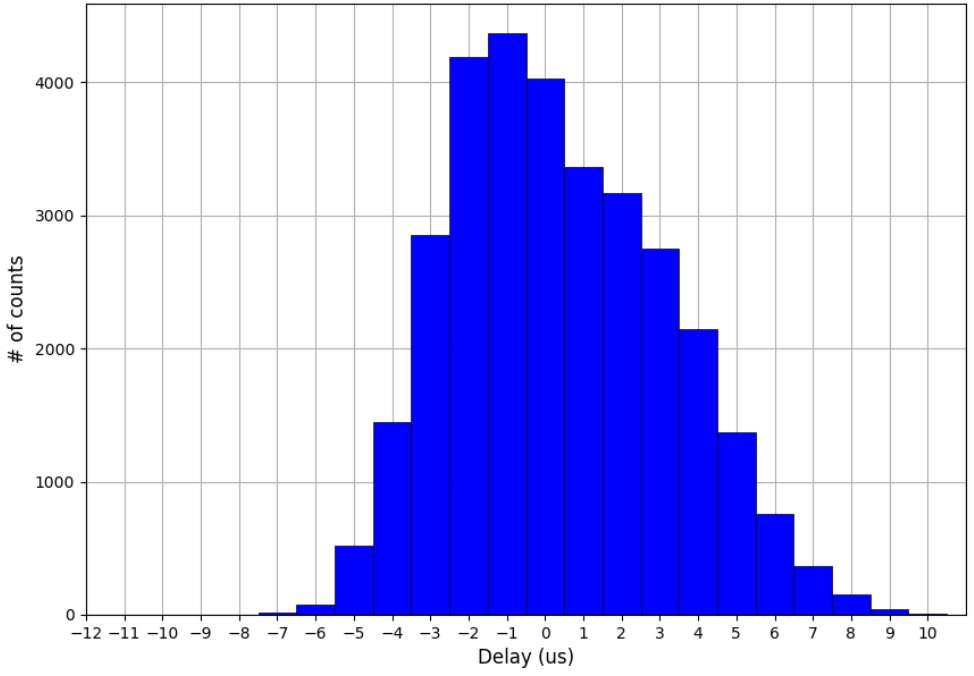
(BIS.OP – BIS.SFP) @ BeamPermit T→F



- 19 July 2017 to 28 October 2018 → 1 year and 101 days
- **1832** dump events (**Beam 1**) x 2 channels A and B
- ~32000 Beam Permit **True** → **False** transitions considering all BICs.
- Data retrieved using **NXCALS**
  - **Faster** data recovery compared to CALS.
  - **1 µs resolution**

Analysis of Missed Dumps - II





- **Mean Delay** = 0.363 µs
- **1σ** = 2.85 µs (The detection window is 3.2 µs)

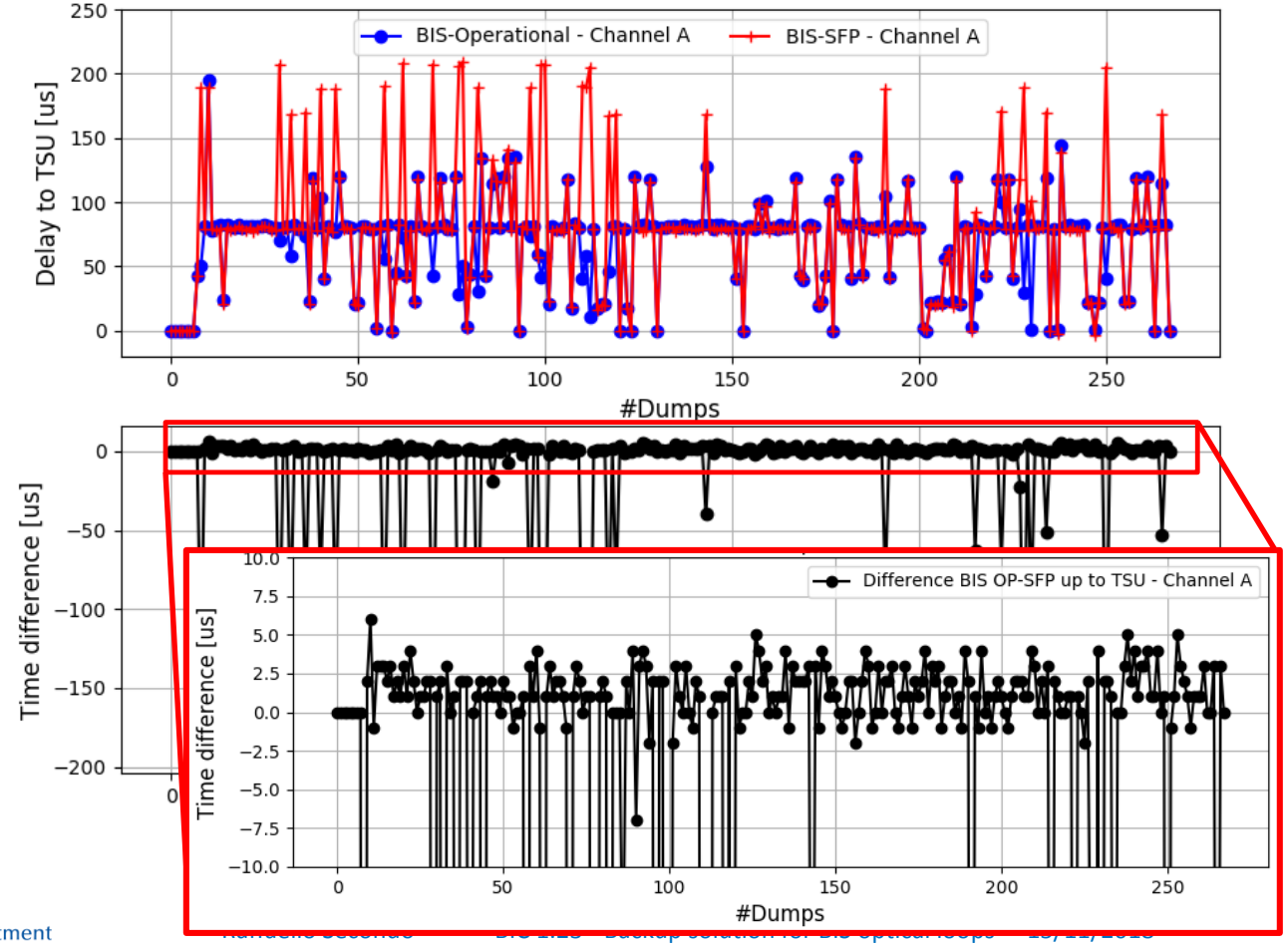
Analysis of Missed Dumps - III

Other events which required a **deeper investigation**:

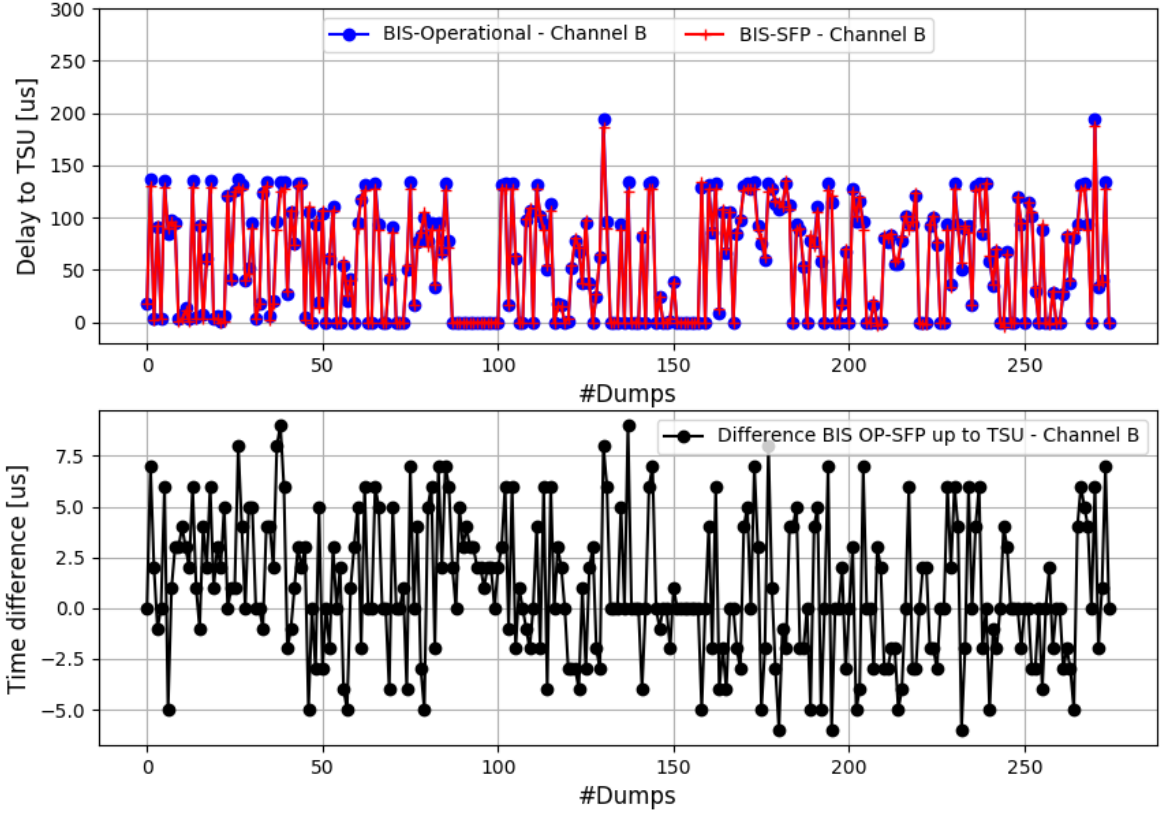
- **4 events** where **data is not present in NXCALS**, but it is accessed via the BIS SFP GUI, (CALS).
- **14 events** with large time delays, all understood (during TS2 2017).
- **2 events** due to CIBG behaviour.
- **19 events** where data is missing for the **TSU**:
  - In these cases the TSU was **not correctly armed** (**16 events** occur in the first week of Sept. 2018 when the arming sequencer experienced an error).
  - TSU arming state added to logging as of Oct 2018.
- **1 event** with a TSU logging issue → understood.
- **3 events** to be still investigated.

Beam Permit Propagation up to the TSU - A

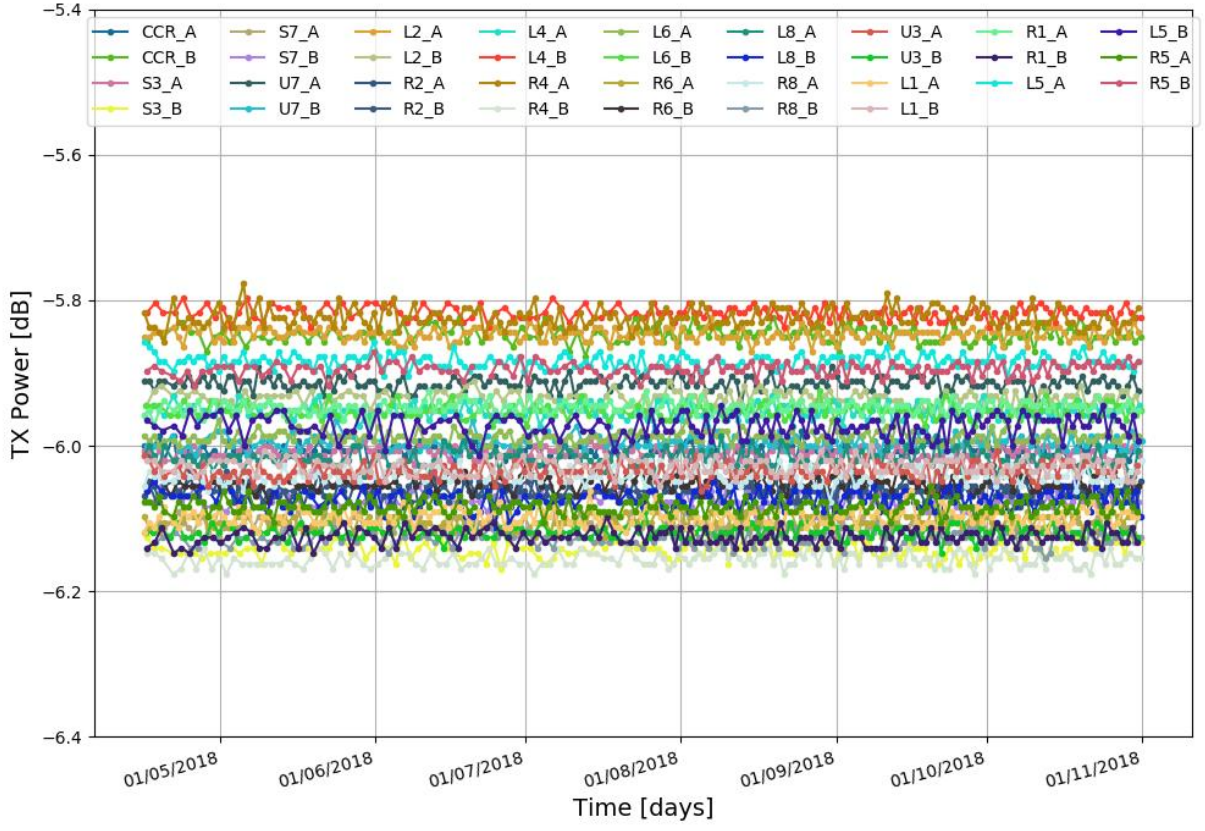
- TSU Data as of **23 July 2018**
- ~275 dumps



Beam Permit Propagation up to the TSU - B

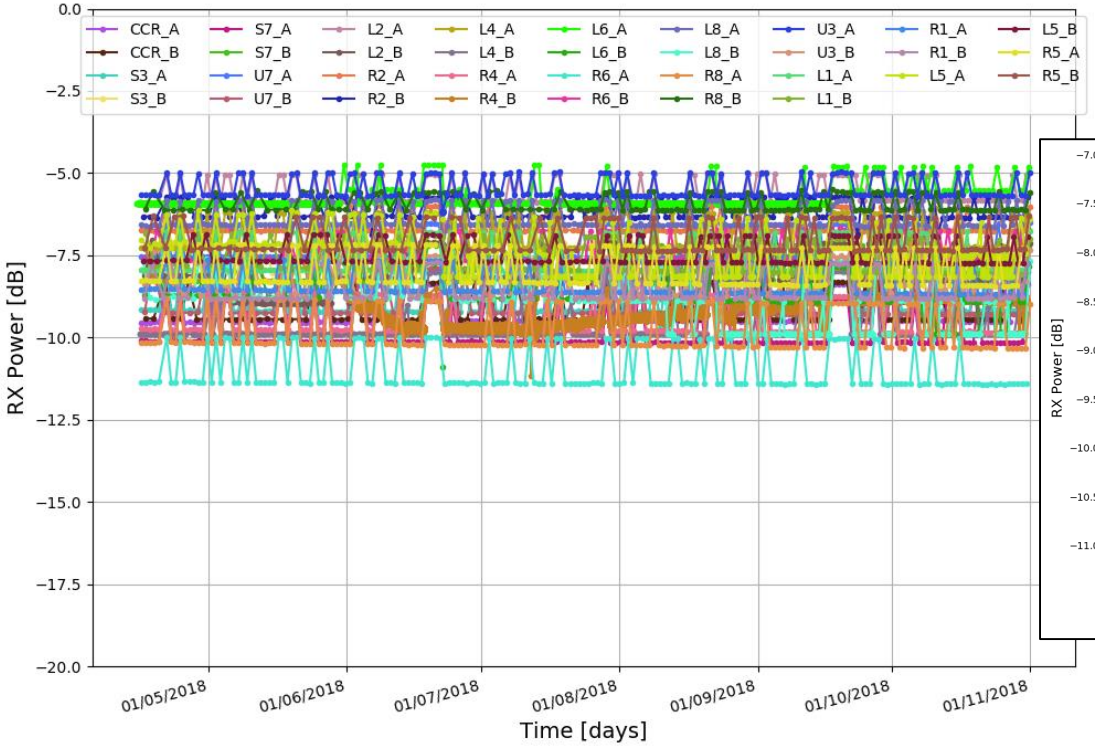


Power Transmitted



- 17x 2 channels A and B on **CIBM-SFP**
- TX power stable at ~-6 dB

Received Power



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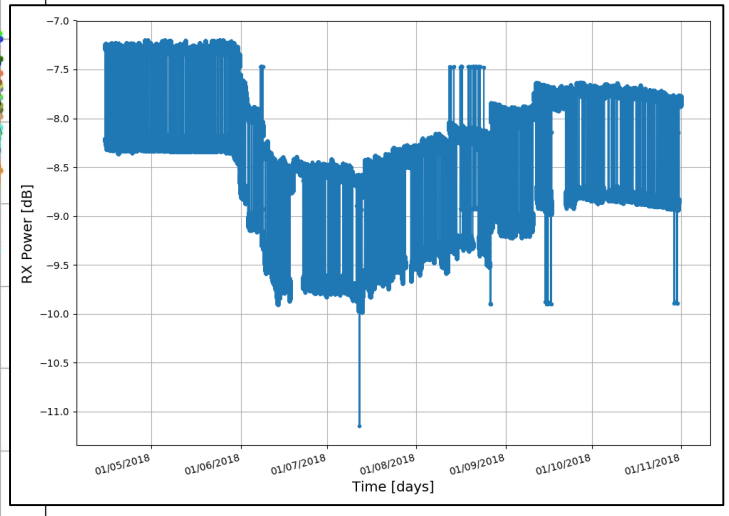

Conclusions

- **No missed dumps** on the SFP loop were observed. In 19 cases the TSU-SFP was not armed and data is missing (in these cases the CIBDS always triggered), analysis to be completed.
- **Data Analysis still ongoing**, to be completed for 2018, including **analysis of spurious dumps**.
- **Reliability Demonstration Test** run to investigate BIS-SFP reliability with a given confidence interval (M. Blumenschein). To achieve 0 failures of the kind "missed dump" over 1000 LHC years with 90% Confidence Level → at least 4000 more dumps are required.
- Values of **Beam Permit delay** at each transition True to False between the two loops (OP- SFP) loops are **consistent** with the expected time range values.
- **Transmitted and Received power** are stable within the expected range. The SFP built-in diagnostic **can improve availability** by early recognition of faults.
- **SFP transceivers** are a good candidate for BIS v2 signal transmission via fiber optics.


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