



# Scans with hybrid prototypes and LIU based electronics during BSRT fill 16.05.2023

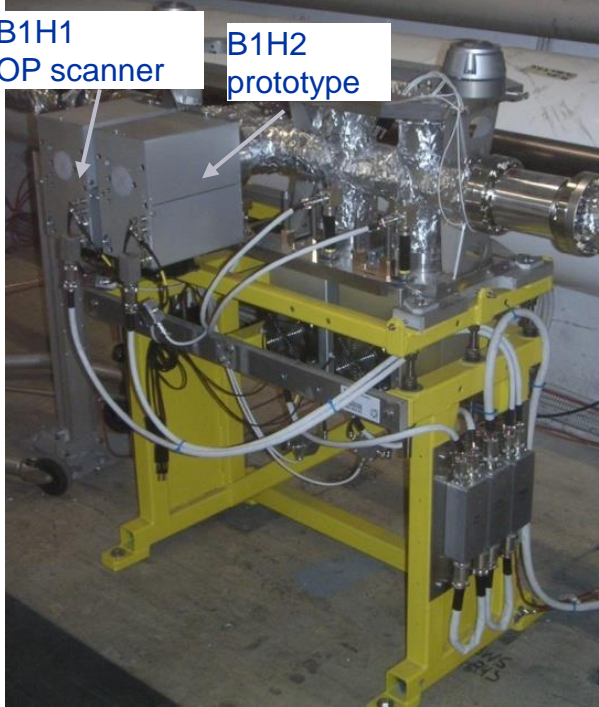
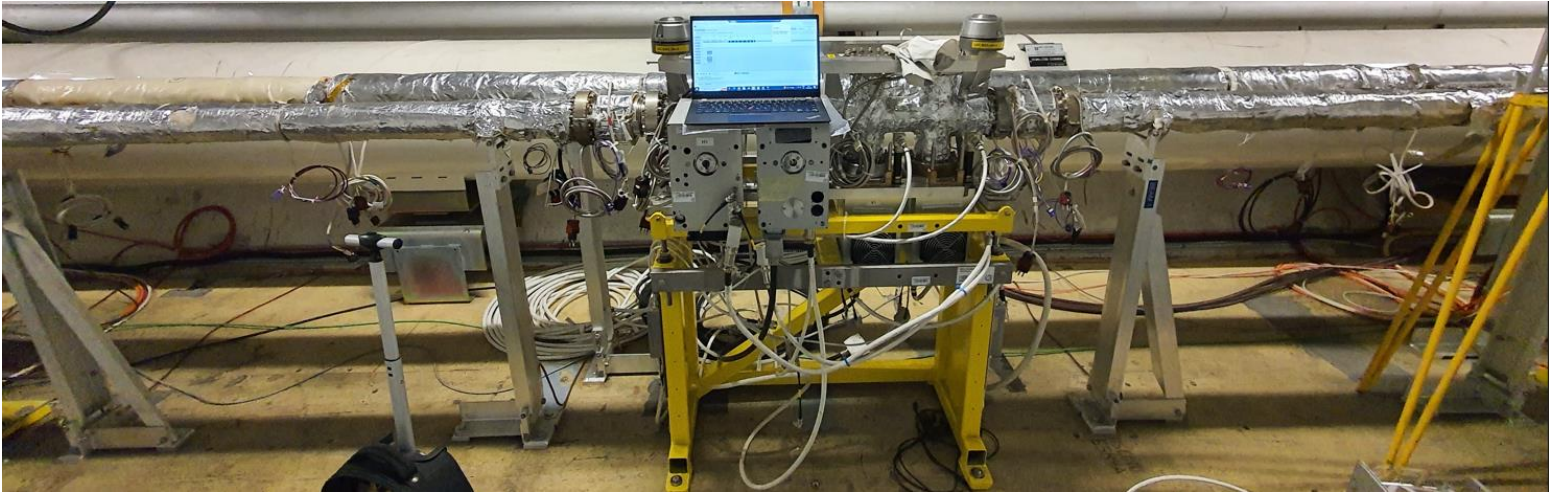
LHC Beam Wire Scanner CONS team meeting #9

J. Emery & A. Guerrero  
30.05.2023

# Hybrid tests during the BSRT fill 16.05.2023

- **Preformed parasitical scans during the BSRT calibration procedure.**
- **BSRT fills are taking place when time in LHC schedule.**
- **This one took place during holidays of Ana (which still helped me almost all day to prepare it!)**
- **Large data sets were taken for Beam 2 at top energy, but due to the short time to setup with beam not usable data for beam 1.**
- **At injection before the beginning (~13:15 - 13h30)**
  - **Grab from the navigator B1 & B2 data, (but not processed yet)**
- **At top energy after calibration & emittance scan by the experiments (~19h30 - 20h15)**
  - **Data to NXCALS for Beam 2, Beam 1 (36 scans, 5 in NXCALS all at 0)**
- **Beam losses are about 6% higher with the prototypes for the running sum in warning (36% of the thresholds for running sum 2.56ms, 10ms, 82ms)**

# B1 Pictures



5m downstream

30m away

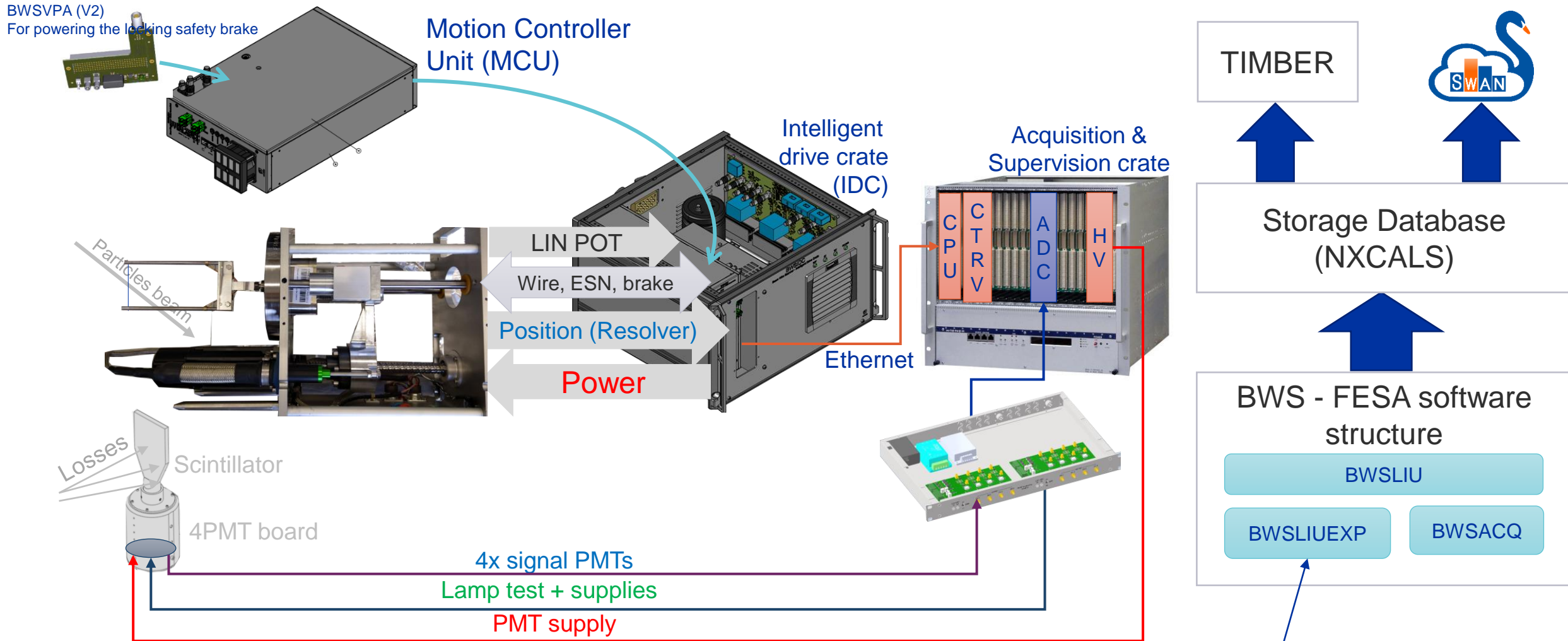


BEAM 1 LIU type crate(UA47)

LHC BWS BEAM 1 PMT PART  
LIU type (right) OP type (left)

LHC BWS BEAM 1 MOTION PART

# LHC hybrid prototype with LIU electronics



The linear wire-scanner hybrid does not have a linear optical encoder, so the BWSLIUEXP FESA class is now simulating it using the resolver data

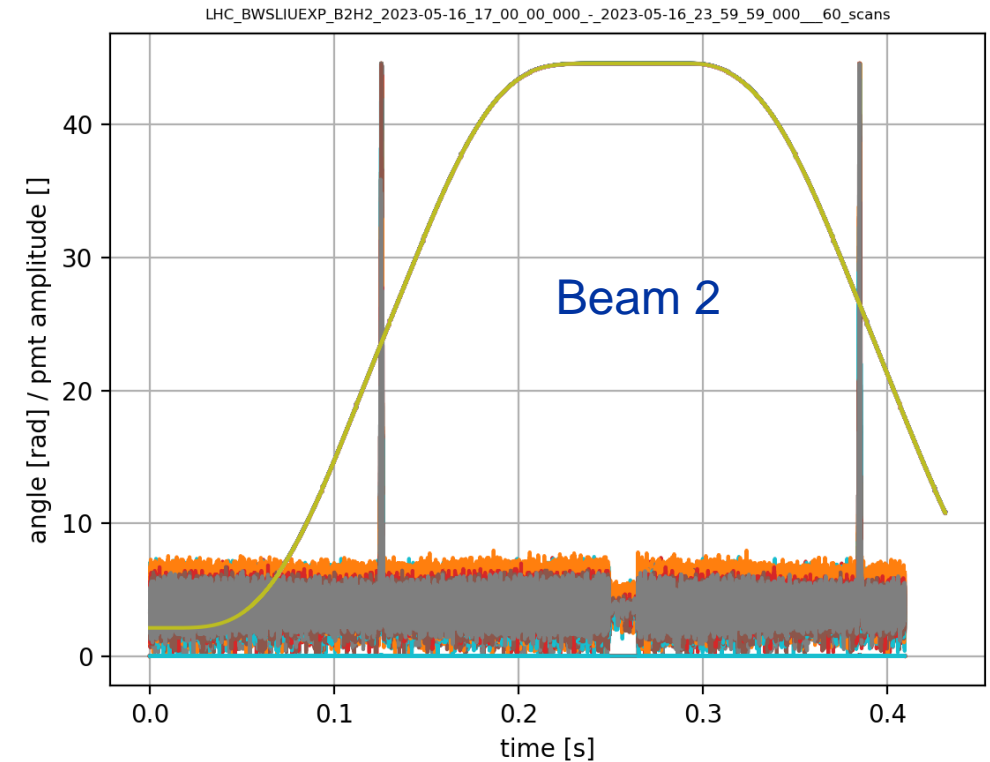
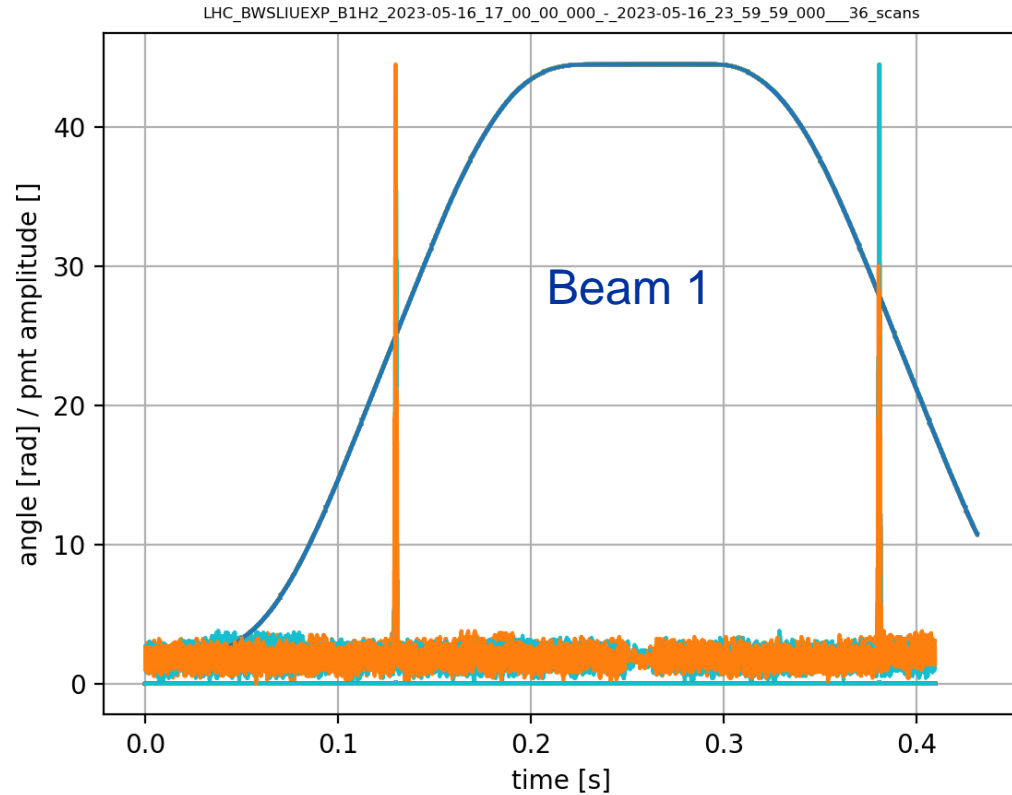


# Data processing as presented

- Only beam 2 large data sets usable
- Phasing was done on both beams and works ok (to integrate exactly one bunch only)
  - crosstalk to be evaluated
- Since bunches were not selected correctly at the BWSLIU level
  - information extracted from BWSACQ class
- In BWSACQ class, all the 3564 bunches are integrated and available
  - filtering of the bunches of interest is done in the script.
- The positions were not generated by BWSLIUEXP from the resolver
  - start and stop angle & assuming a constant speed => position reconstructed
  - IN-OUT slack evaluated using beam center equivalent to 0.9 mm for B2
- Data extraction not so easy with SWAN
  - need to put in place multiple request to reduce data size, otherwise the process crash.
- Will need detailed analysis for:
  - Process the 4 PMT channel, check saturation.
  - Quantitative compare of beam size (IN-OUT, Hybrid-OP) in same condition.

# BWS Hybrid – BSRT fill - Top Energy

## Resolver data and PMT oasis channel

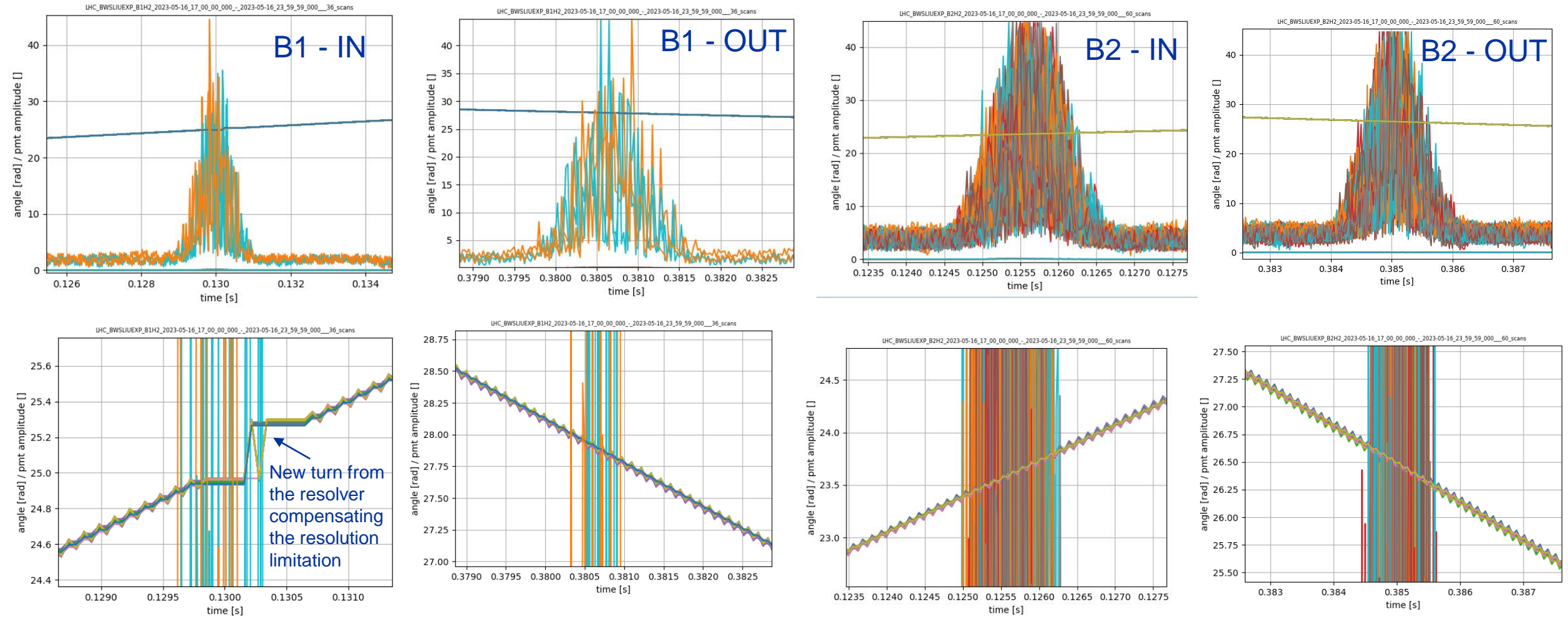


```
18:54:46 Monitoring started...
18:54:46 Apply filter: BLM[QABTEC2M][I]\.((0[1-9])|([12][0-9])|(3[0-4])|LR)[12345678]\.[B][012][EITB][0-9]?[0-9]?_*
18:54:46 Filter applied. 3593 monitors displayed.
19:29:20
19:29:20 Warning on: BLMTI.04L5.B2I10_TCTPH.4L5.B1, integration time: 2560 us, losses = 6.414612E-02, threshold = 1.828963E-01, ratio = 35%
19:29:20 Warning on: BLMTI.04L5.B2I10_TCTPH.4L5.B1, integration time: 10 ms, losses = 1.611854E-02, threshold = 4.572548E-02, ratio = 35%
19:29:20 Warning on: BLMTI.04L5.B2I10_TCTPH.4L5.B1, integration time: 82 ms, losses = 2.015304E-03, threshold = 5.717055E-03, ratio = 35%
19:32:38
19:32:38 Warning on: BLMTI.04R1.B2I10_TCTPV.4R1.B2, integration time: 2560 us, losses = 6.555311E-02, threshold = 1.828963E-01, ratio = 36%
19:32:38 Warning on: BLMTI.04R1.B2I10_TCTPV.4R1.B2, integration time: 10 ms, losses = 1.643706E-02, threshold = 4.572548E-02, ratio = 36%
19:32:38 Warning on: BLMTI.04R1.B2I10_TCTPV.4R1.B2, integration time: 82 ms, losses = 2.056003E-03, threshold = 5.717055E-03, ratio = 36%
19:32:38 Warning on: BLMTI.04R1.B2I10_TCTPV.4R1.B2, integration time: 82 ms, losses = 2.056003E-03, threshold = 5.717055E-03, ratio = 36%
```

BLM fixed display warnings  
after BWS Hybrid scans (B1&B2)

# BWS Hybrid – BSRT fill - Top Energy

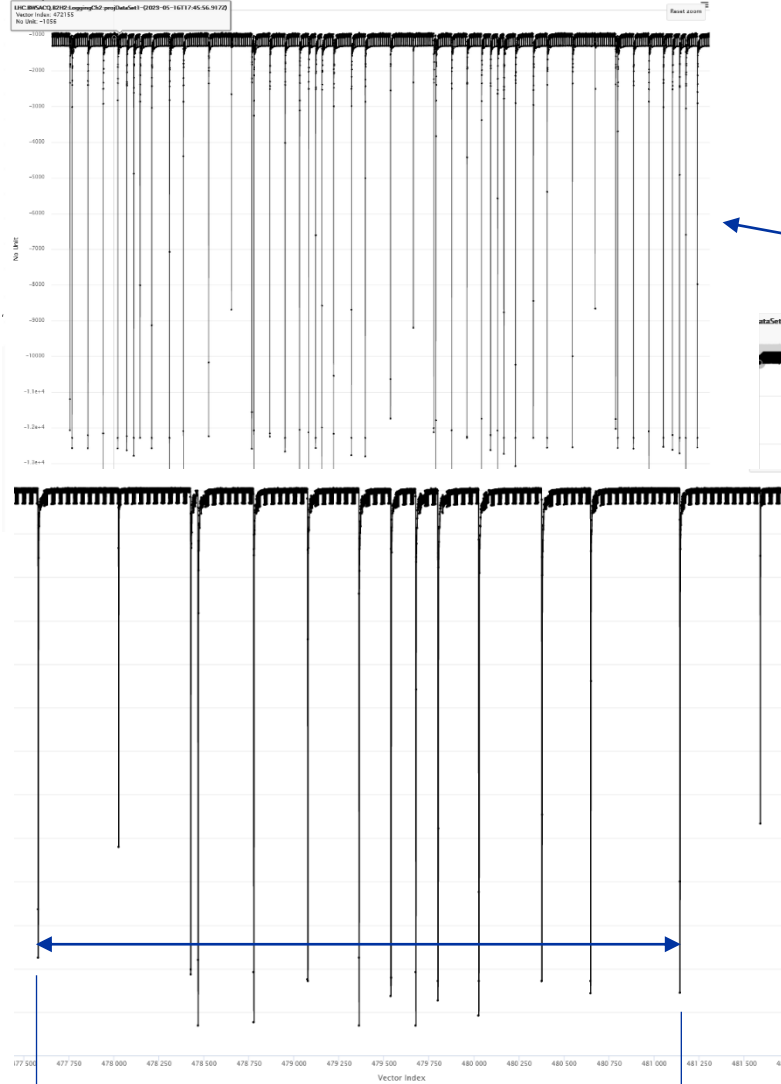
## Resolver data and PMT (slow) oasis channel - ZOOM



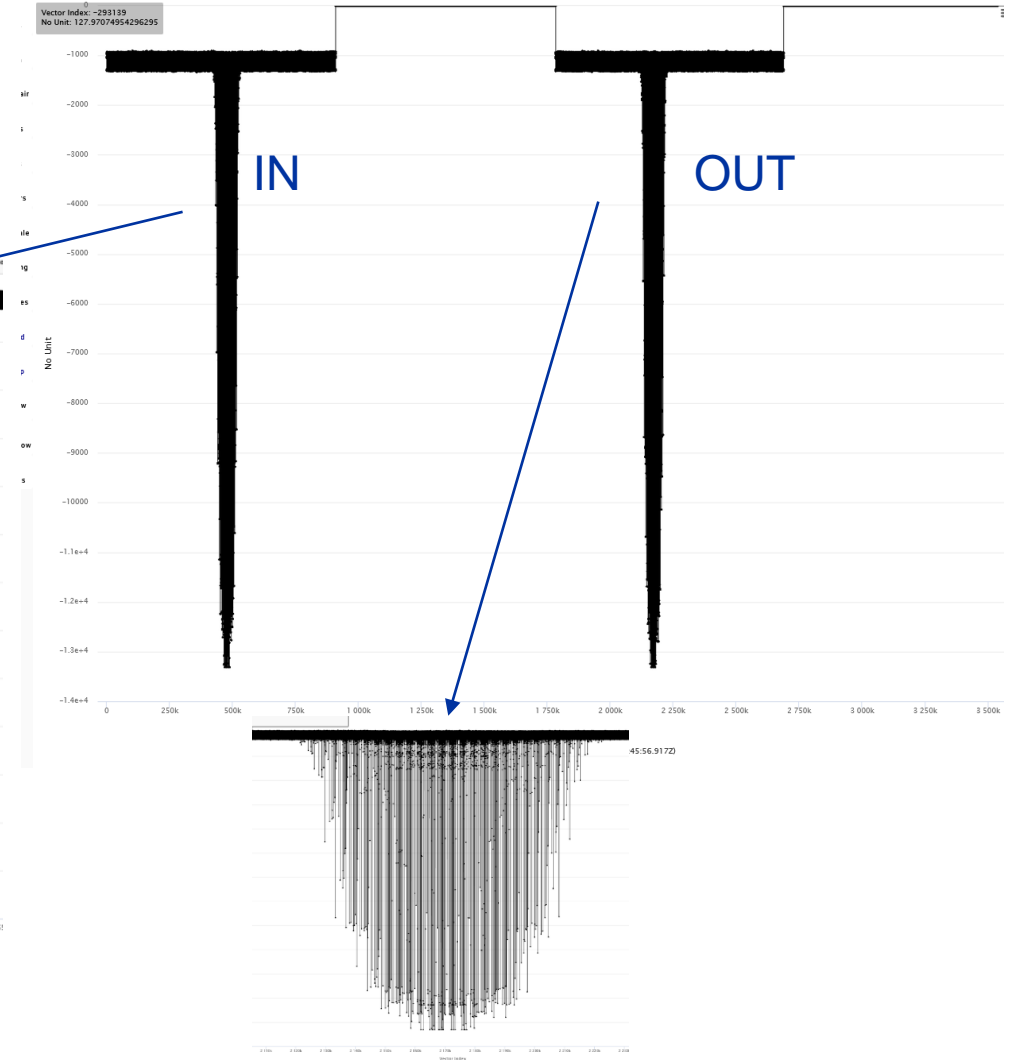
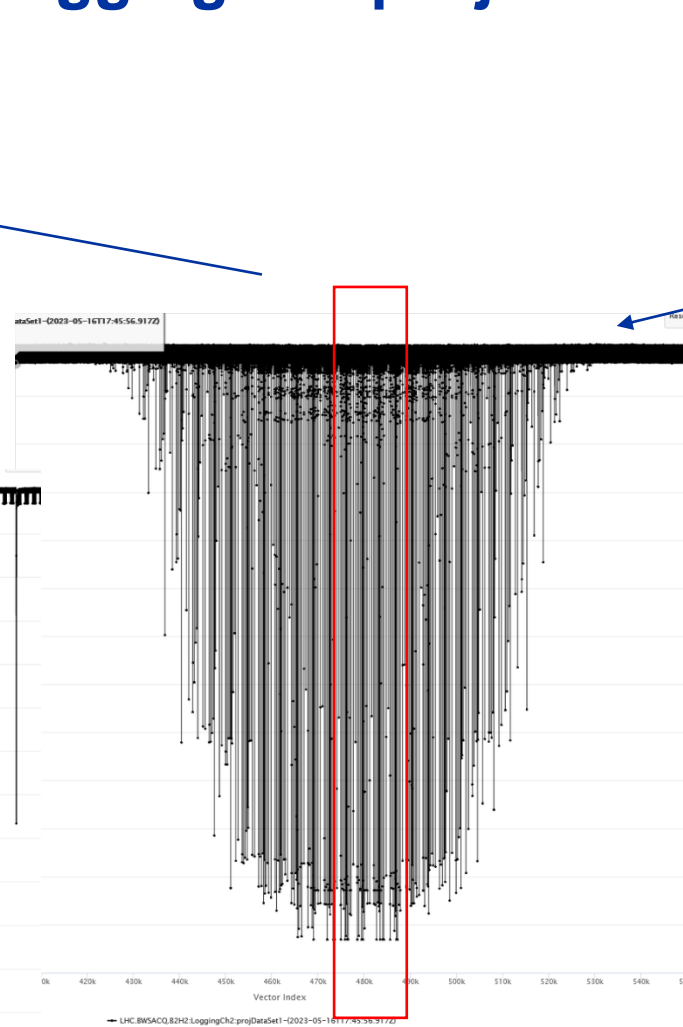
=> New linear design would certainly profit from an optical rule as in the LIU rotational design

# BWS Hybrid – BSRT fill - Top Energy

## LHC.BWSACQ. B2H2:LoggingCh2:projDataSet1 19:45:56.917



477579 481143  
1 turn – 3564 bunches



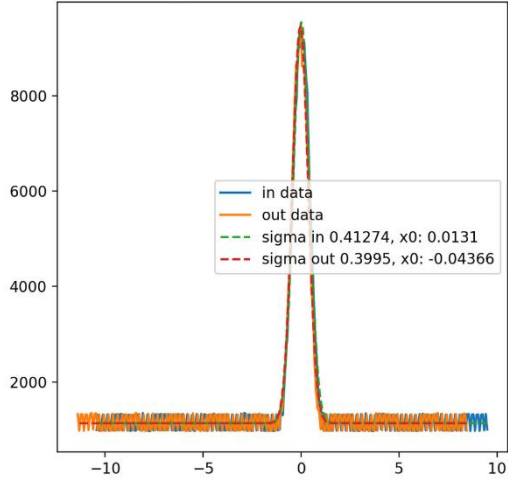
Bunches (beam2) = [3, 450, 850, 891, 1200, 1500, 1785, 1962, 2100, 2223, 2450, 2800, 3071]



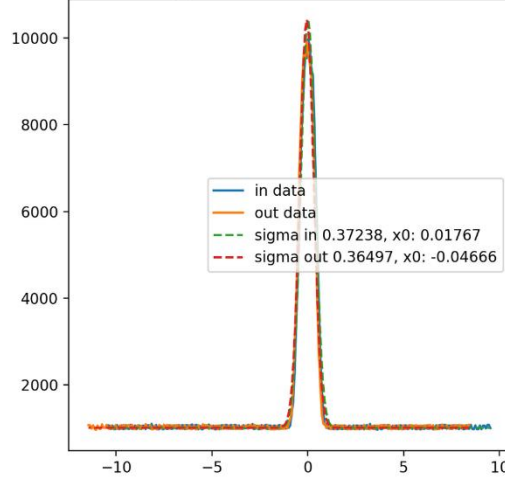


# Some fit illustration – top of the Gaussian not always good – saturation / need of 2 Gaussian fit to be evaluated

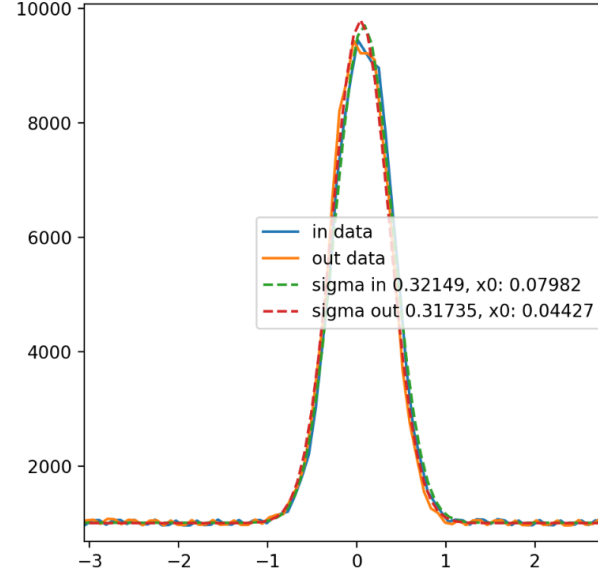
HCTEST.BWSLIU.LIN\_B2 2023-05-16 20:08:30.613246 bunc



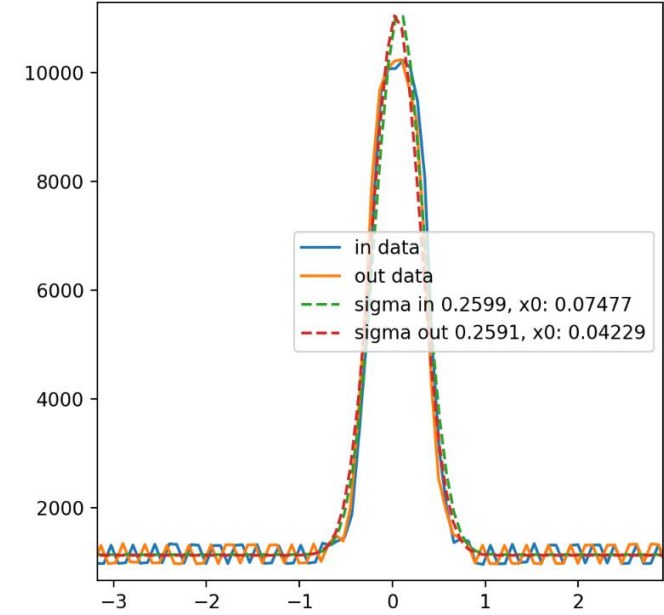
.HCTEST.BWSLIU.LIN\_B2 2023-05-16 20:08:30.613246 bun



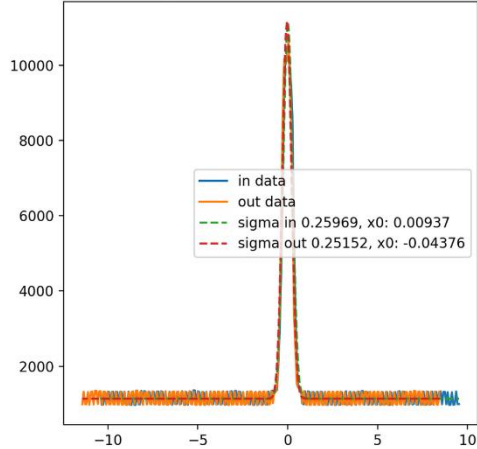
.HCTEST.BWSLIU.LIN\_B2 2023-05-16 19:58:13.893466 bun



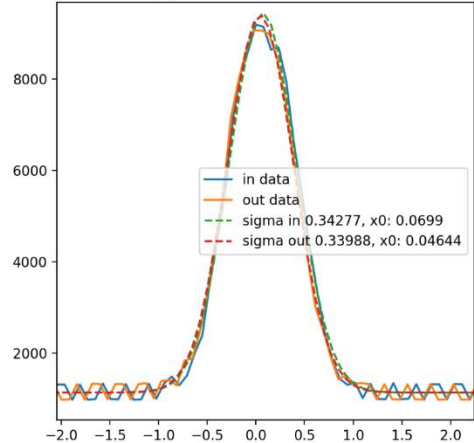
.HCTEST.BWSLIU.LIN\_B2 2023-05-16 19:56:43.460462 bunc



.HCTEST.BWSLIU.LIN\_B2 2023-05-16 20:08:30.613246 bunc

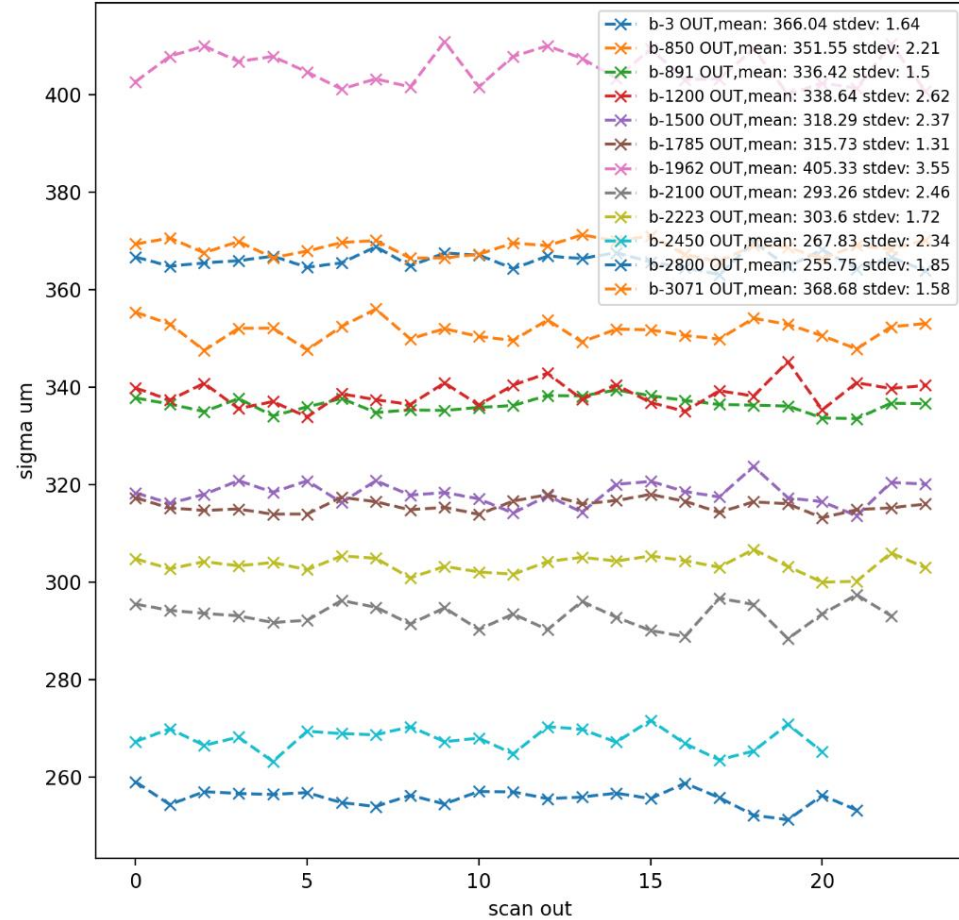
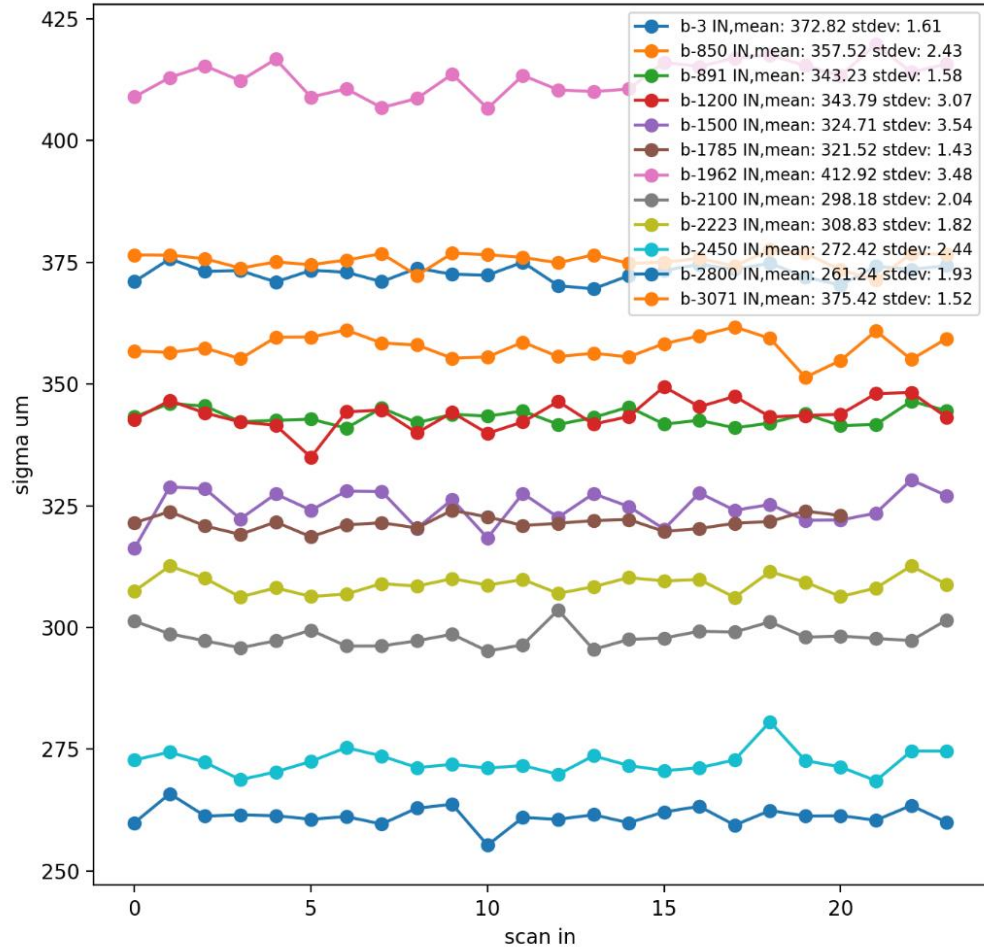


HCTEST.BWSLIU.LIN\_B2 2023-05-16 19:53:19.642479 bunc



# BWS Hybrid – BSRT fill - Top Energy Sigma for the ~first 23 scans

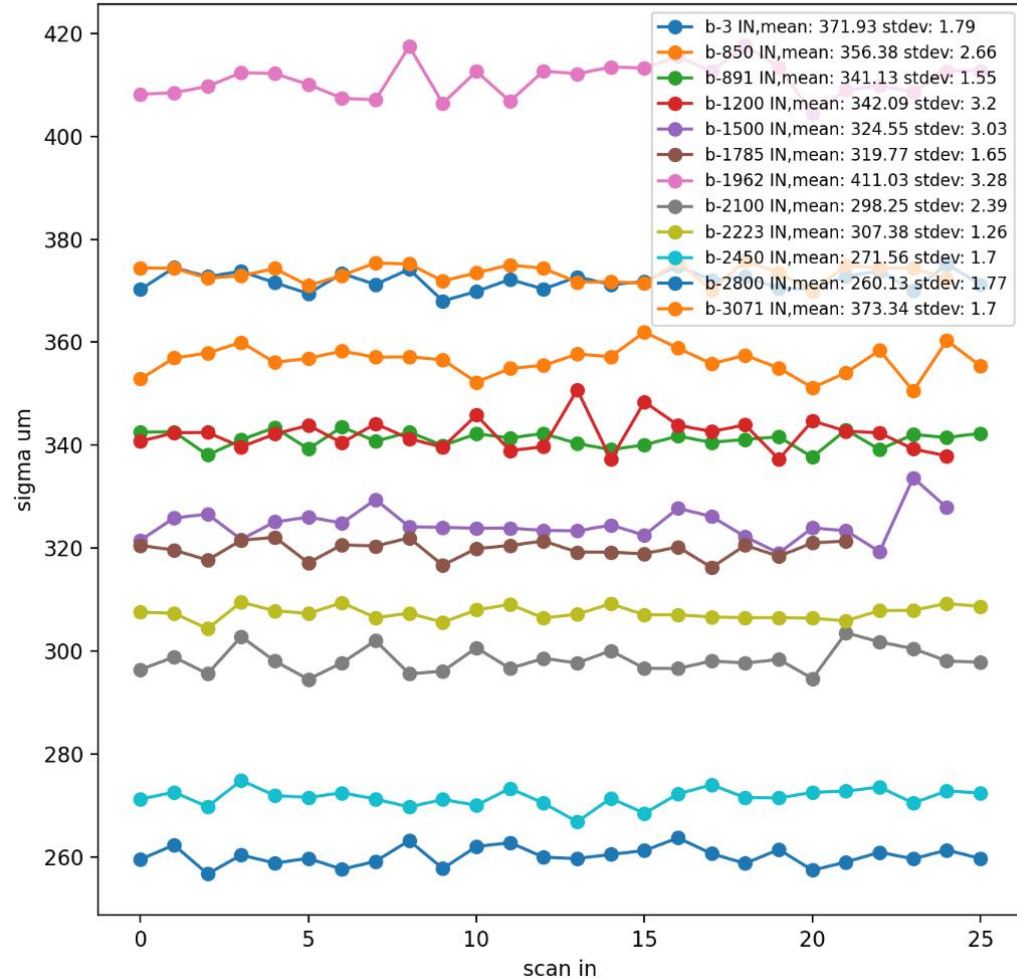
CTEST\_BWLIU\_LIN\_B2\_2023-05-16\_17\_45\_00\_000 - 2023-05-16\_17\_59\_59\_000 CTEST\_BWLIU\_LIN\_B2\_2023-05-16\_17\_45\_00\_000 - 2023-05-16\_17\_59\_59\_000



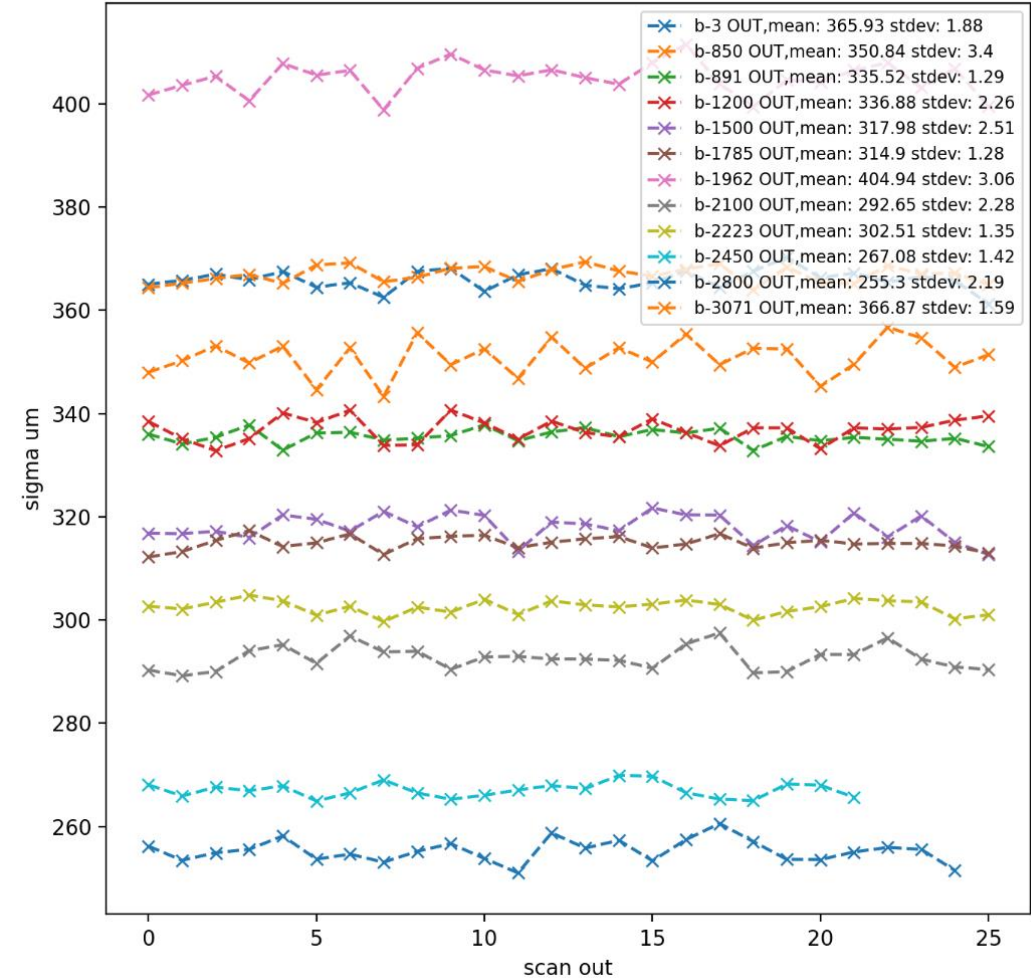
IN	OUT	diff
372.82 std 0.43%	366.04 std 0.45%	6.78 (1.8%)
357.52 std 0.68%	351.55 std 0.63%	5.97 (1.7%)
...	...	...

# BWS Hybrid – BSRT fill - Top Energy Sigma for the ~last 25 scans

CTEST\_BWSLIU\_LIN\_B2\_2023-05-16\_17\_59\_00\_000 - 2023-05-16\_18\_14\_59\_000



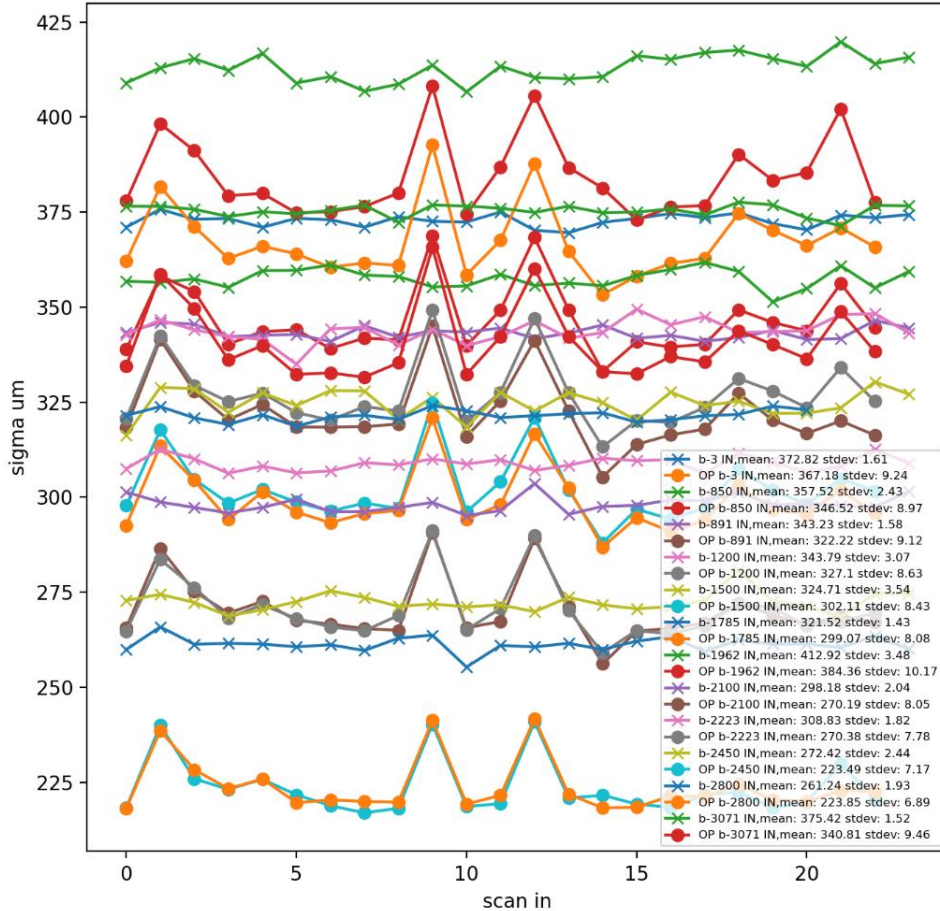
CTEST\_BWSLIU\_LIN\_B2\_2023-05-16\_17\_59\_00\_000 - 2023-05-16\_18\_14\_59\_000



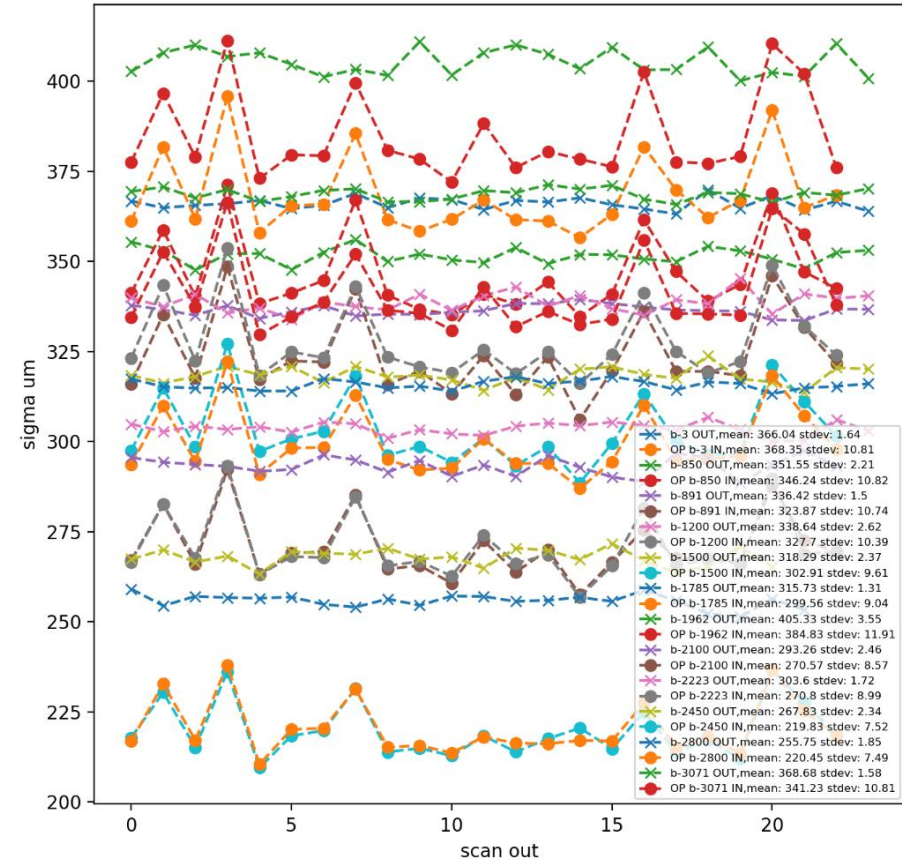


# Plot with OP scans (not the same time scale!)

CTEST\_BWSLIU\_LIN\_B2\_2023-05-16\_17\_45\_00\_000 - 2023-05-16\_17\_59\_59\_000



CTEST\_BWSLIU\_LIN\_B2\_2023-05-16\_17\_45\_00\_000 - 2023-05-16\_17\_59\_59\_000



OP start = "2023-05-16 15:30:00.000" to stop = "2023-05-16 18:29:59.000"

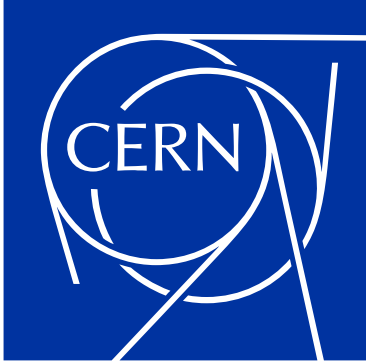
Recalculate OP sigma with reconstructed positions at cst speed (as now used for BSRT calibration)

Check bunch selection - why proto has a larger bunch and the OP has 2 smaller bunches?



# Summary

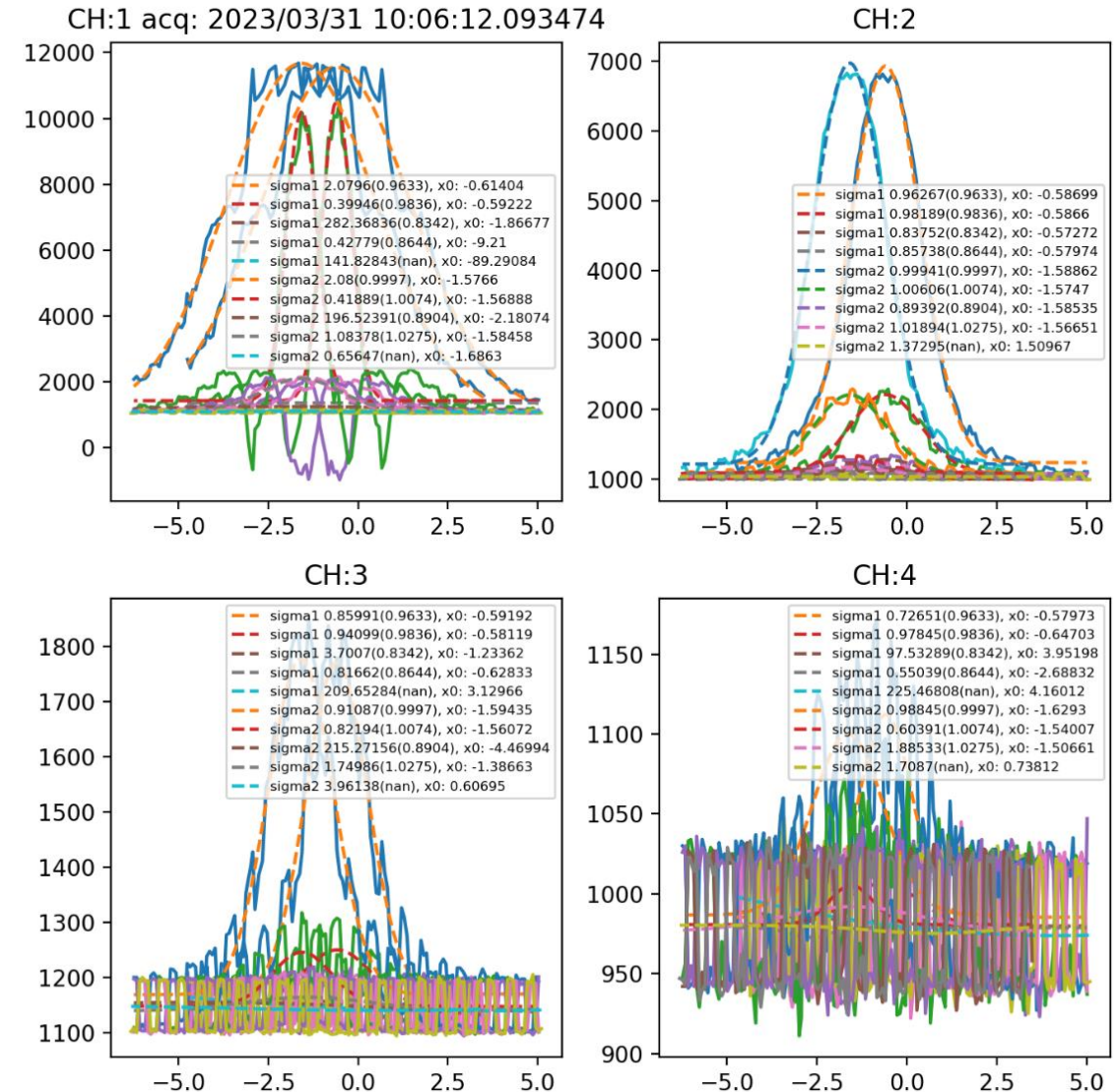
- **BSRT calibration of the 16.05.2023 was the occasion to test the Hybrids**
- **Multiple difficulties due to:**
  - **short among of time allowed for Hybrid at injection and top energy.**  
=> **we will have more time in the dedicated MD (14-18 June)**
  - **too large data handling for the navigator when it comes to display data for bunch selection and phasing.**  
=> **Ana is working on disk storage (.hdf5) to use specific viewer to handle large dataset**
  - **NXCALS was not accepting all the integrated bunches (now ok, limit increased to 30Mbytes)**
- **Quantitative data on Beam 2 at top energy & preliminary analysis preformed**
- **Beam was not dumped after 60 scans B2 and 36 B1 (only 6% more losses due to lower speed probably)**
- **Multichannel PMT provided one good channel and other saturated or too low, as expected**
- **60 scans analyzed showing <1% std dev and <2% IN-OUT difference, comparison to OP scanner is encouraging**
- **Detailed analysis is required to get quantitative numbers for beam size measurement repeatability, optimum comparison with OP scanners, analysis of the other PMT channels, etc.**



[home.cern](http://home.cern)

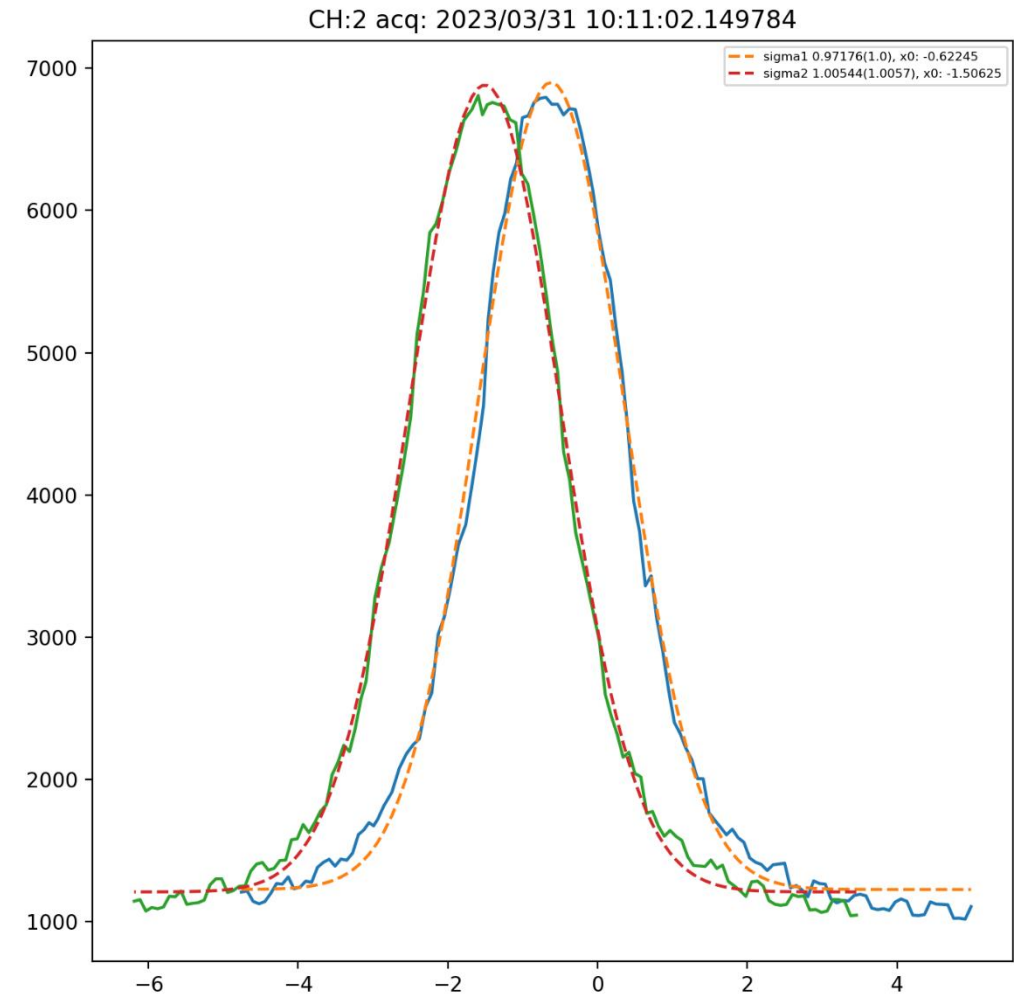
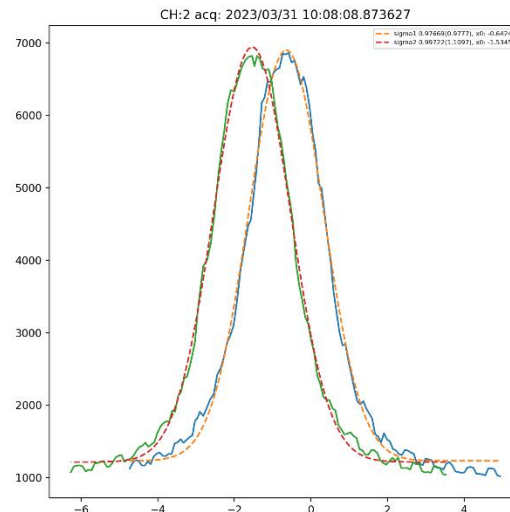
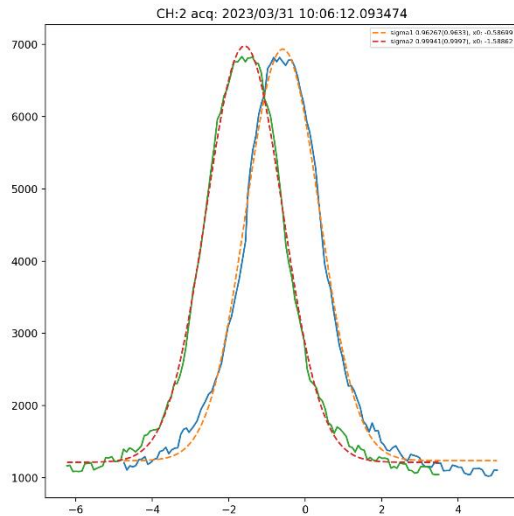
# BWS LHC B1 - first scans with the hybrid and LIU based electronics

- Few scans performed with one bunch during commissioning time
- We found the beam quickly by checking the raw PMT data
- After setting up few parameters with beam, we obtained 3 meaningful scans
- Electronics/software worked well and found the optimum channel (CH2)
- With HV=400V CH1 is saturated, CH3 is a little to low and CH4 is the lowest



# BWS LHC B1 - first scans with the hybrid and LIU based electronics

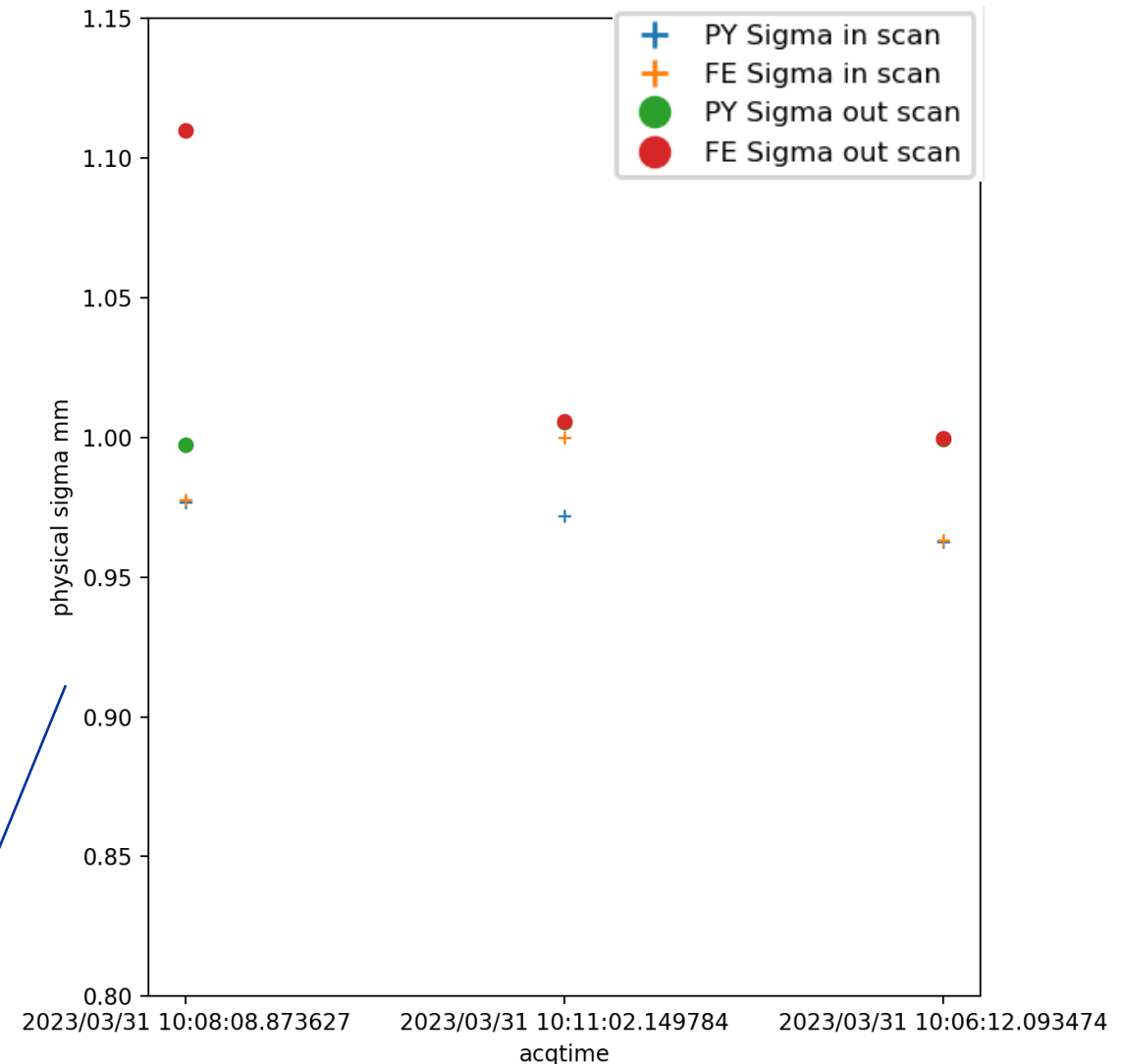
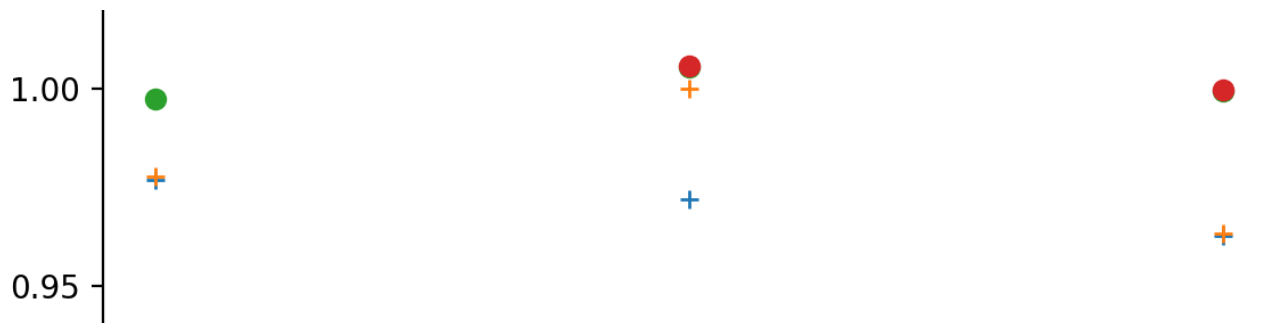
- Position offset between IN and OUT signal, most probably due to the slack introduced by resolver processing (tbc).
- If found to be the source, this can be fixed by configuration at the FESA software level
- Absolute position already very good considering we only based it on scanner geometry (no laser calibration)



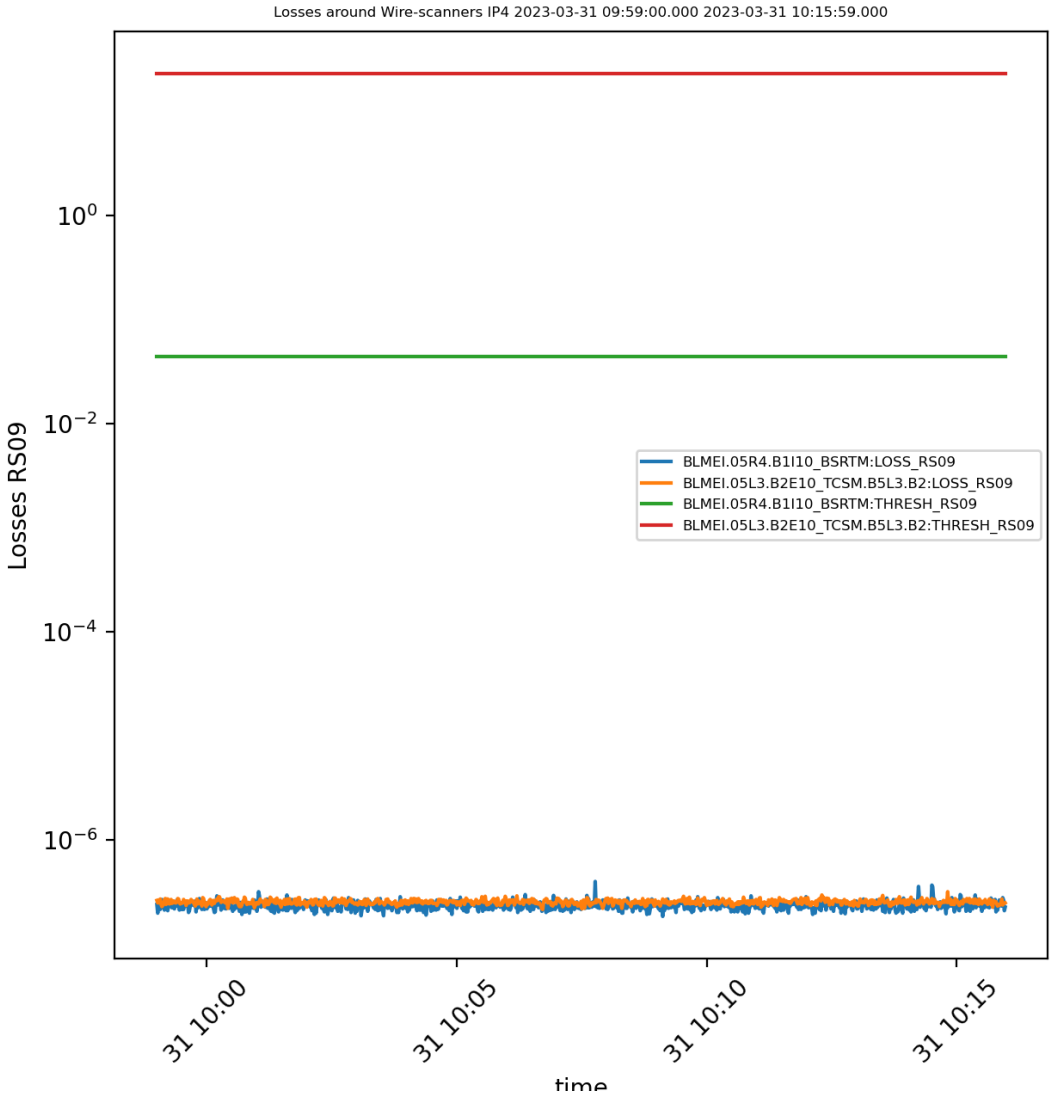
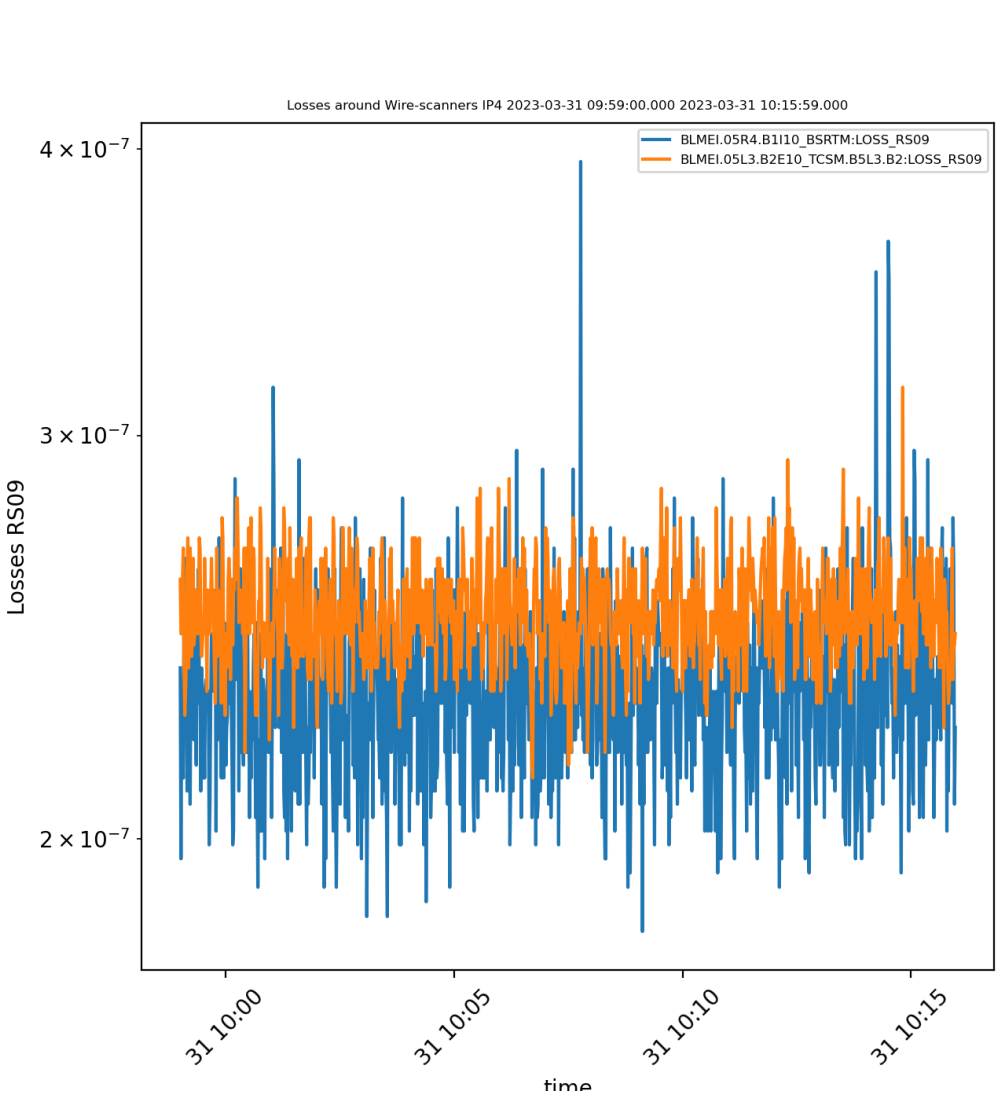


# Beam size results summary

- The 3 scans giving very similar beam size
- IN scan always smaller than OUT scan
- Front-End (FE) fit and SWAN python (PY) do not always agree
- 10mm window is probably a bit challenging for the gaussian fit with 5 parameters (baseline).
- to check if it is possible to increase the data range or going faster with the wire...



# Beam losses react with a small loss (RS09->1.2s)



# Summary

- **Few successful scans were performed on B1.  
We have encouraging results with the LIU electronics**
- **B2 will be tested as soon as we have an opportunity**
- **Comparative scans with operational systems planned possibly at the end of the BSRT calibration.  
No defined date that I know, it depend on the LHC operation planning.**
- **If not done by the MD bloc 1 (14-18 June), we have requested 2x 4h MD for:**
  - 1) small number of bunch with ramp**
  - 2) large number of bunch at flat bottom to test the PMT system**

**<https://indico.cern.ch/event/1278851/>**
- **Apart from beam test, we should work in the lab on:**
  - increasing the minimal speed from 0.92 to 1.1 or more  
=> PROTO#3 need to be fixed to behave as the ones in the LHC!**
  - Qualify this mechanism with the new laser calibration bench  
=> Do we miss any mechanical pieces?  
=> Should we start with this one instead of the operational system?**