



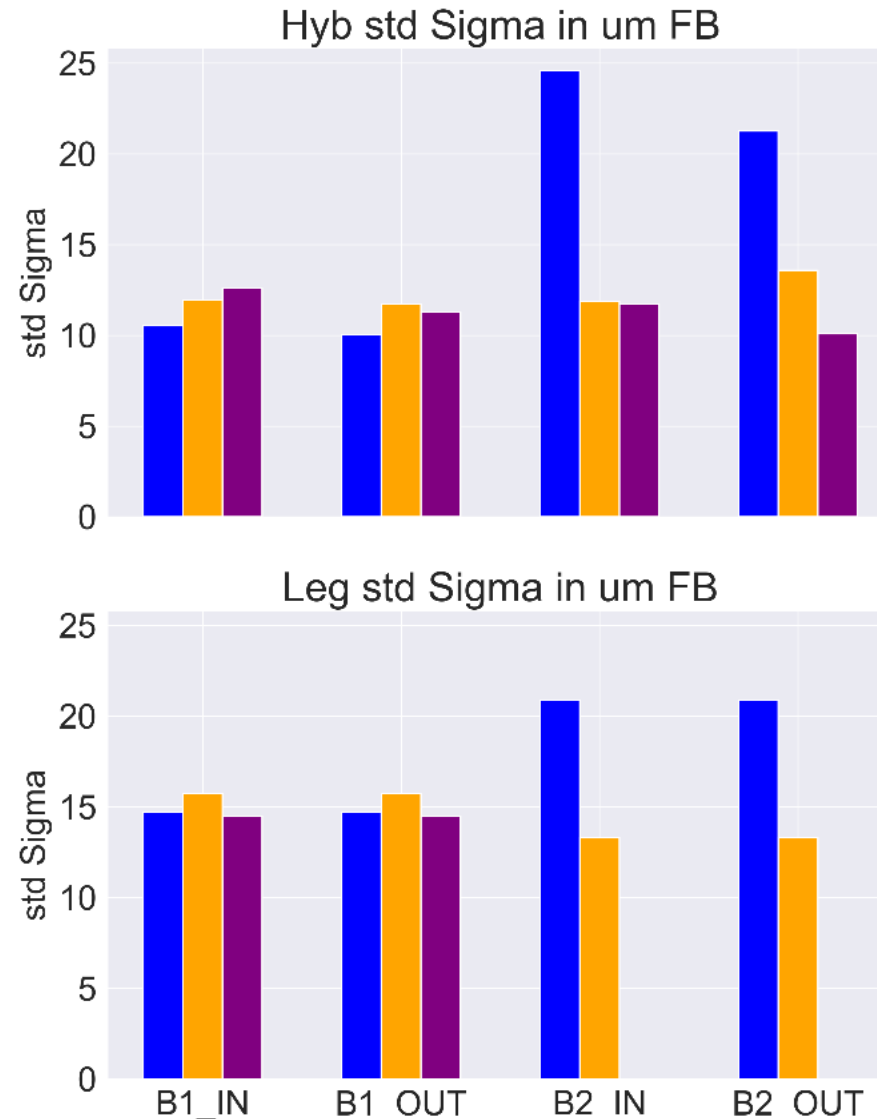
# MD # 9545 results 16.06.2023

Nabil El-Kassem

13.05.2024

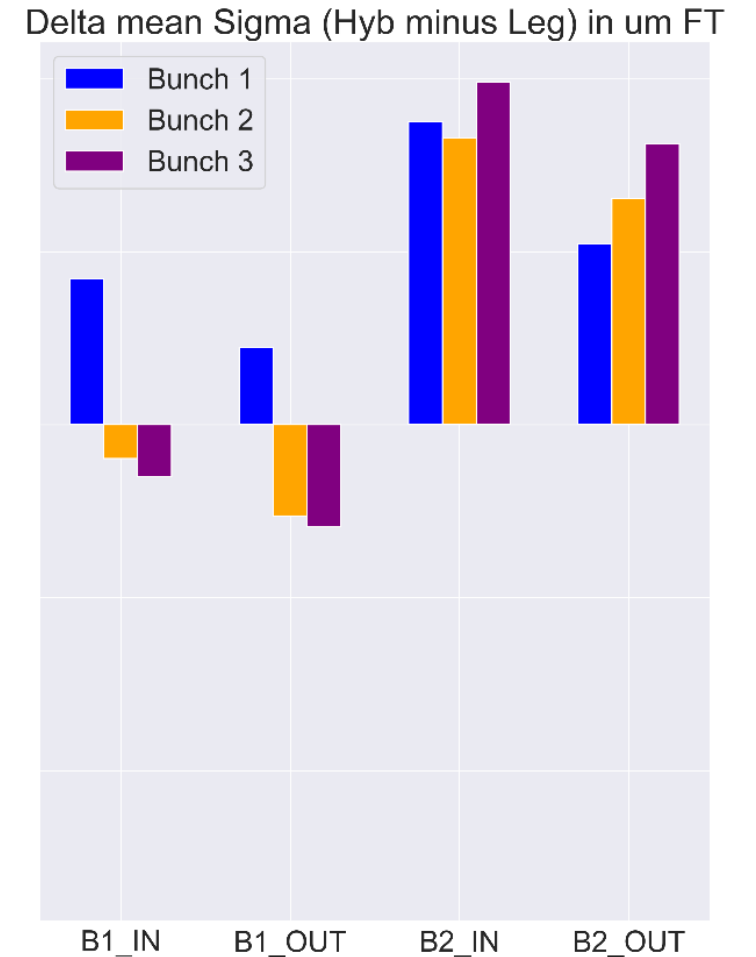
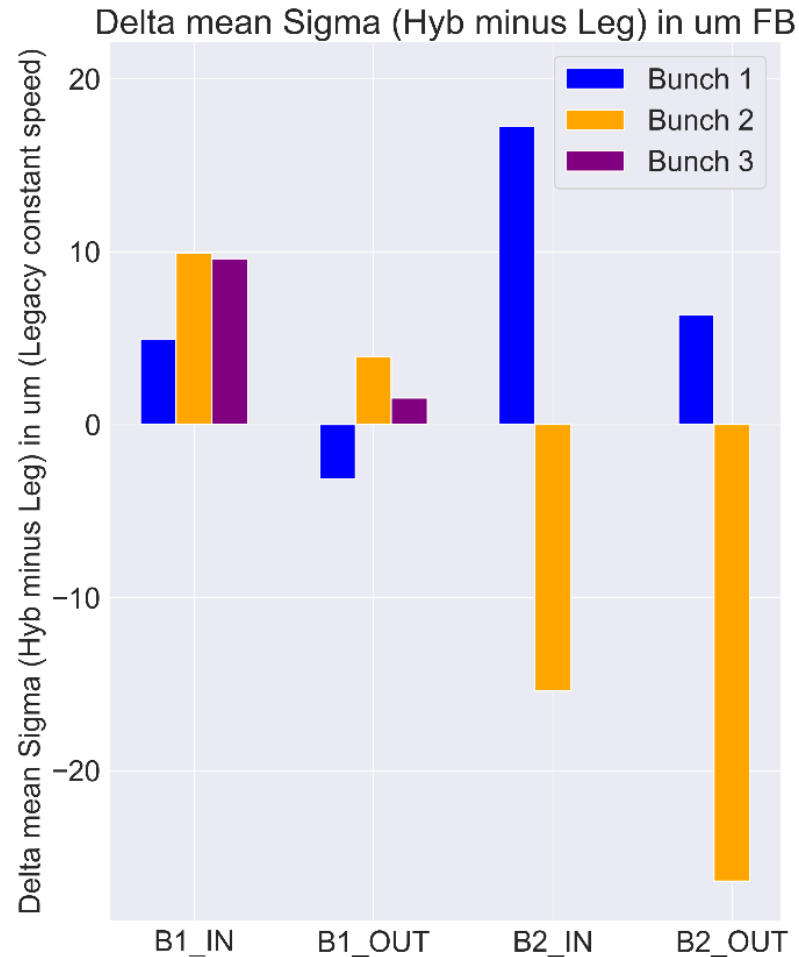
# Std of Sigma at FB and FT Hybrid vs Legacy

- At FB, the standard deviation in the Hyb is smaller than the legacy for B1
- For B2, only bunch 1 std is higher in Hyb
- At FT, the measurements are overall marginally better in the Legacy



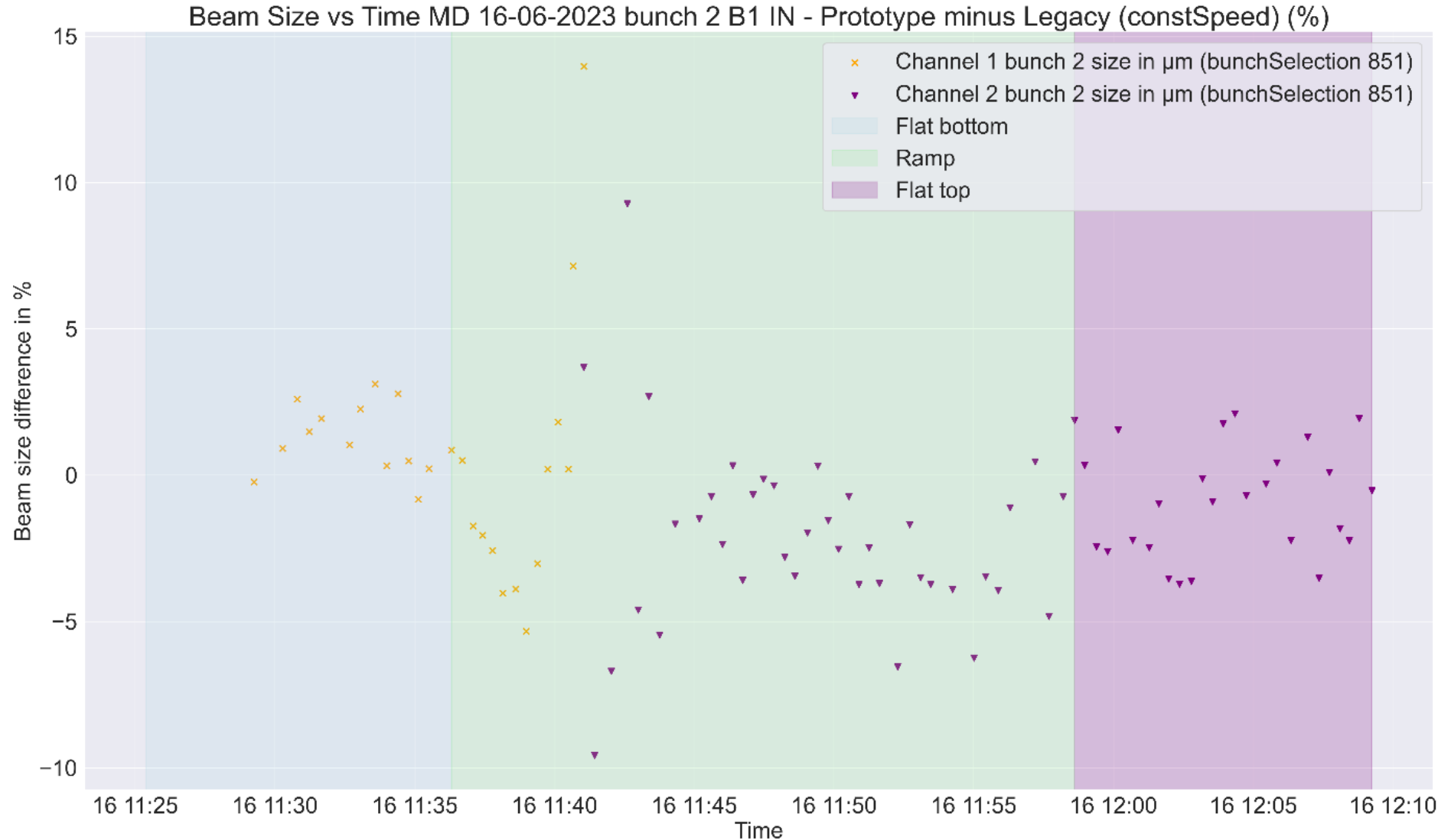
# Delta mean Sigma Hybrid minus Legacy

- **B2 shows bigger differences between Hybrid and Legacy constantly**
- **Differences vary across the different bunches**



# Prototype minus Legacy beam size over time

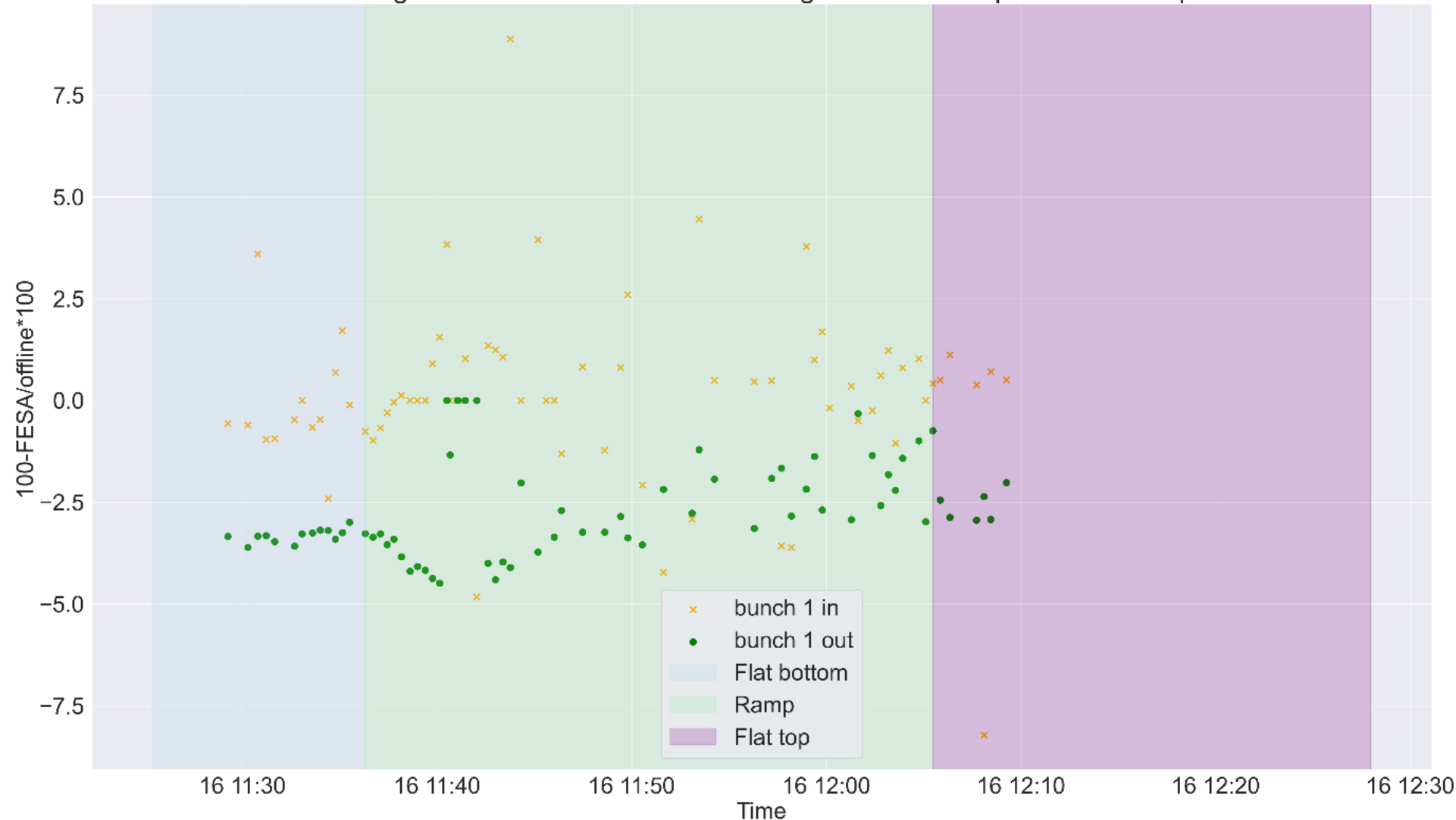
- When directly comparing the beam size provided by the legacy systems and Hybrid systems in percentage. Beam size measurements are very close
- Difference ranges between -5% and 5%



# Offline Fitting vs FESA - Hybrid (1/4)

Percentage difference between offline fitting and FESA B1 proto w const speed

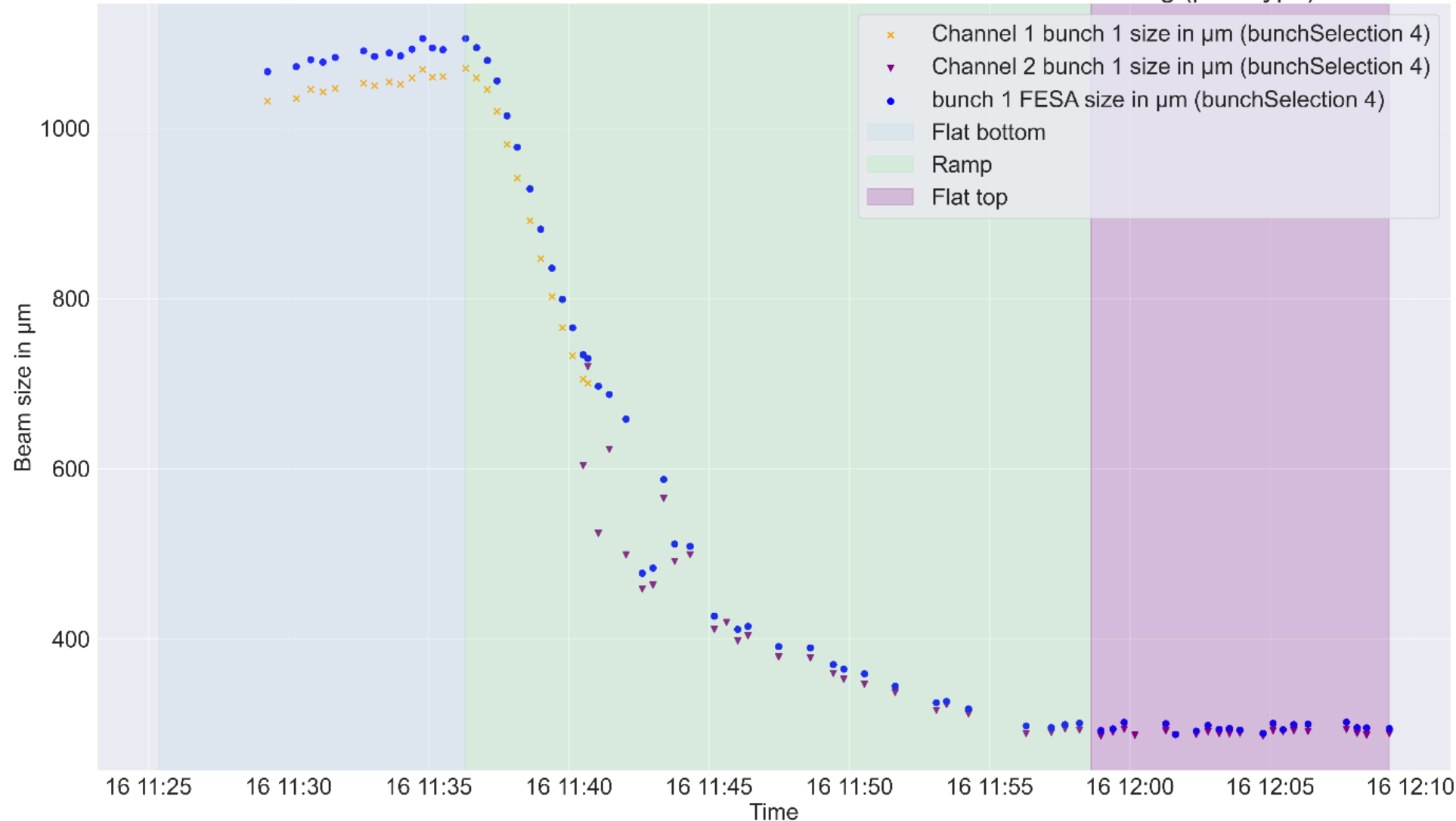
- **B1 Out bunch 1 FESA sigma is higher than the Sigma obtained through offline fitting**



# Offline Fitting vs FESA – Hybrid (2/4)

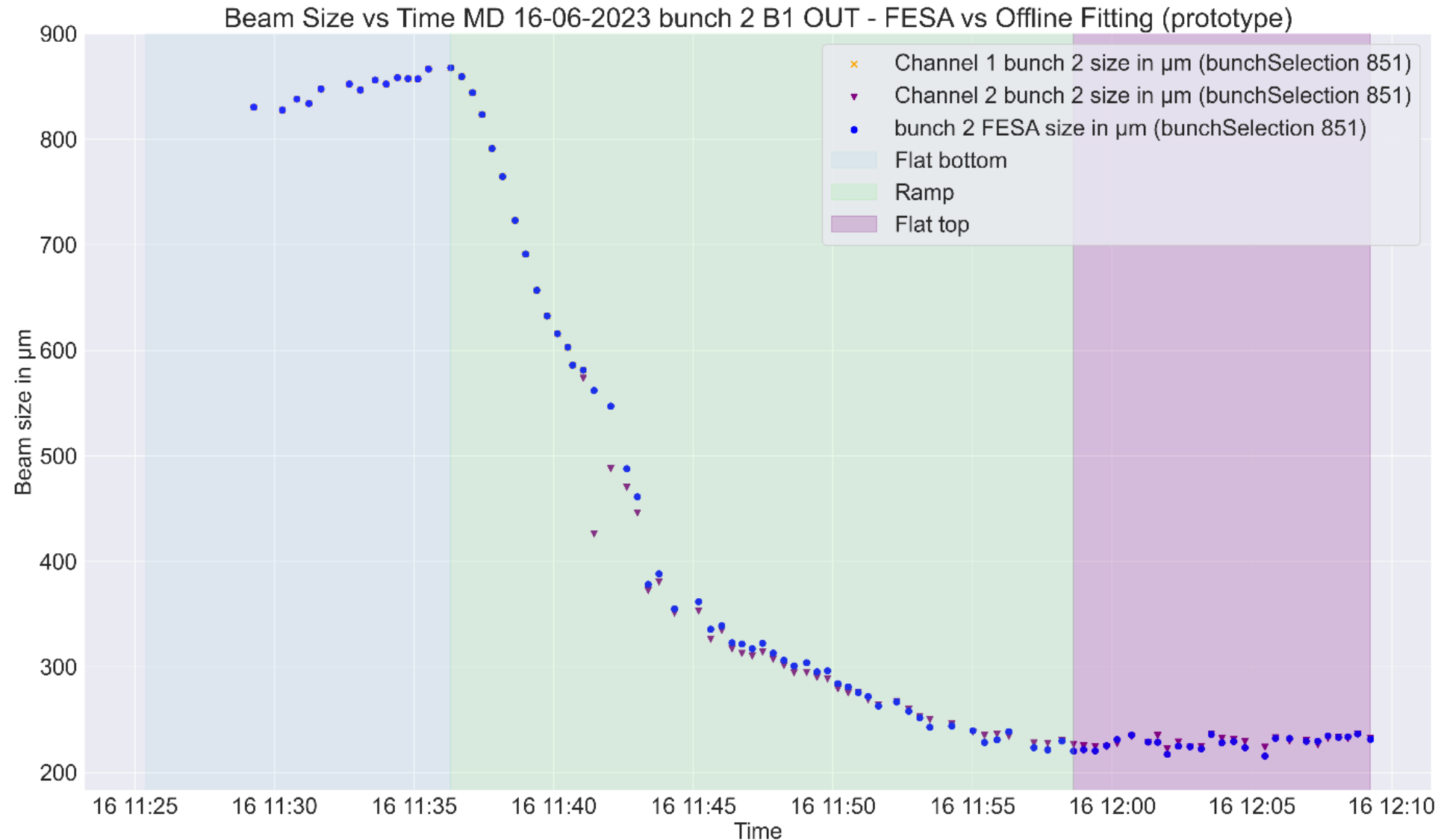
Beam Size vs Time MD 16-06-2023 bunch 1 B1 OUT - FESA vs Offline Fitting (prototype)

- **Difference decreases as the beam size gets smaller**



# Offline Fitting vs FESA – Hybrid (3/4)

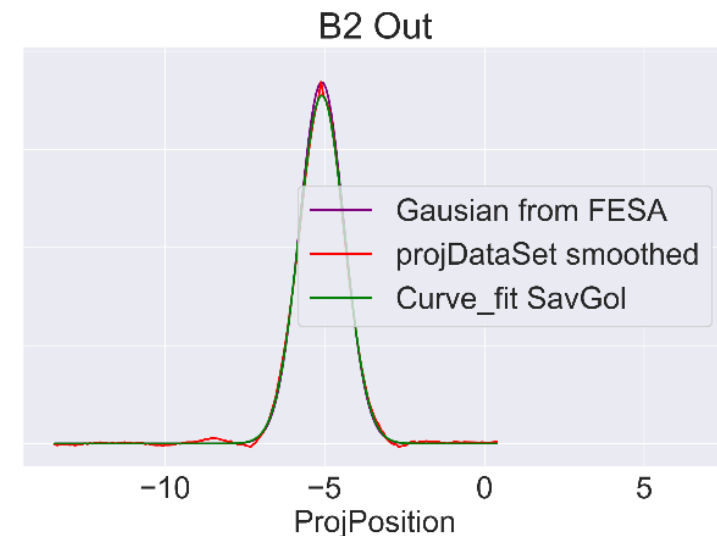
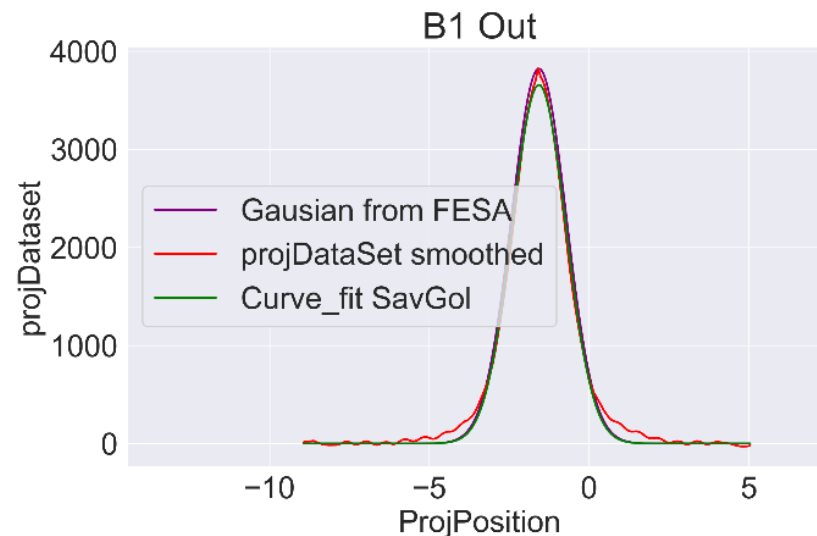
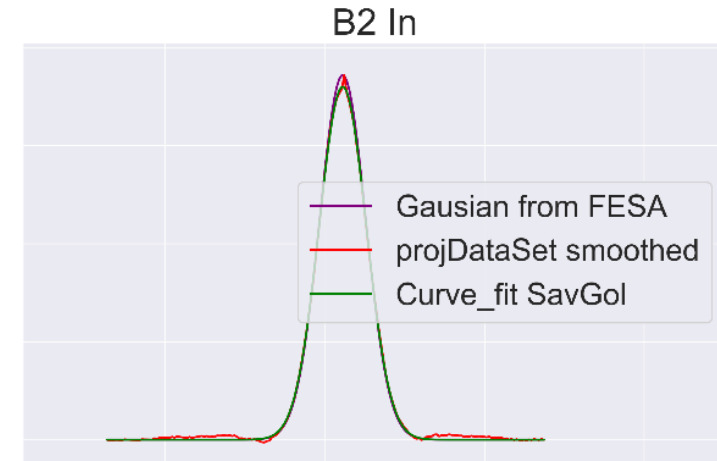
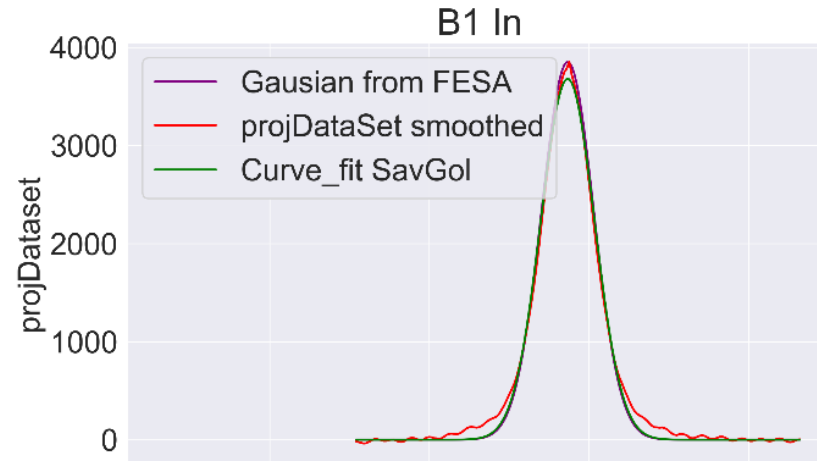
- **Difference is only clearly observable in B1 Out bunch 1 and 3**
- **Smaller and less observable differences in other measurements**



# Offline Fitting vs FESA – Hybrid (4/4)

Offline fit vs Gaussian derived from Sigma (index 10) FB

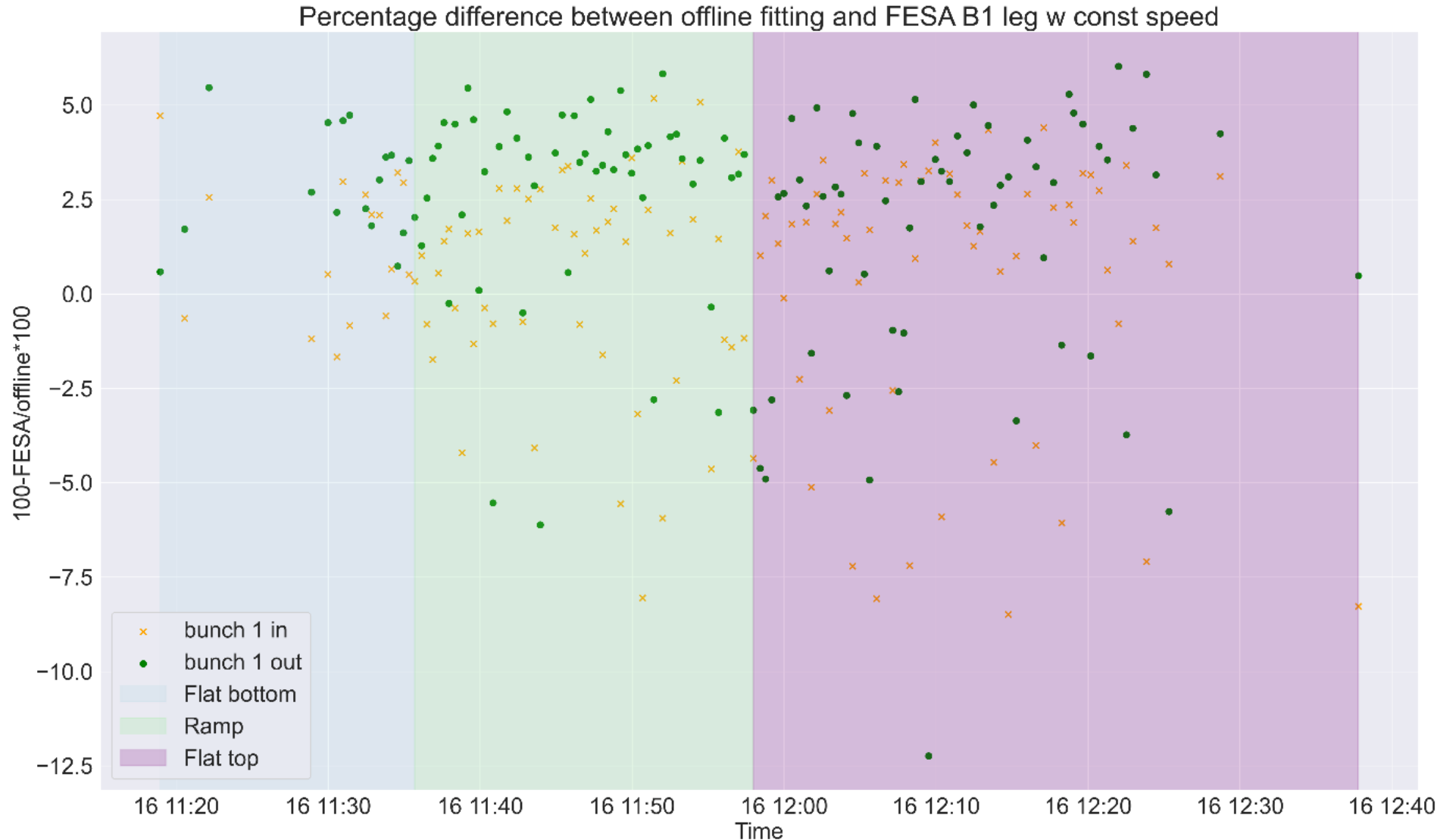
- **Difference not clearly observed when fitting the Gaussian from FESA on top of the Gaussian from the offline fit**
- **For now, there is no definite hypothesis for this behavior**
- **From experience though we can assume that the sigma retrieved from the offline fitting is the more accurate/reliable one**





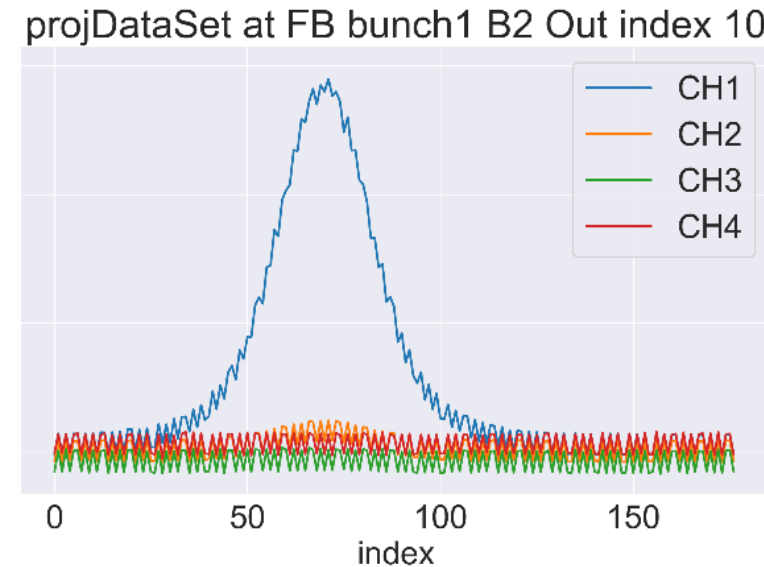
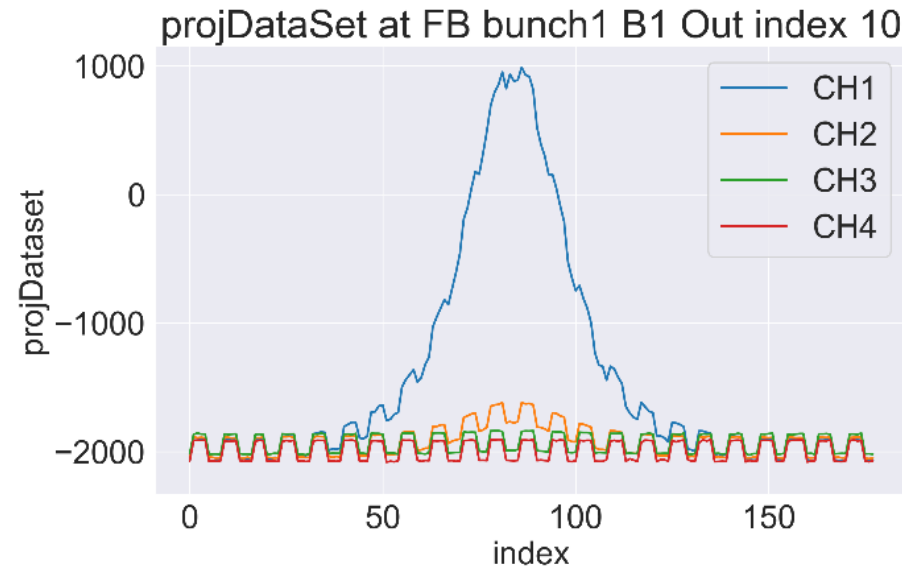
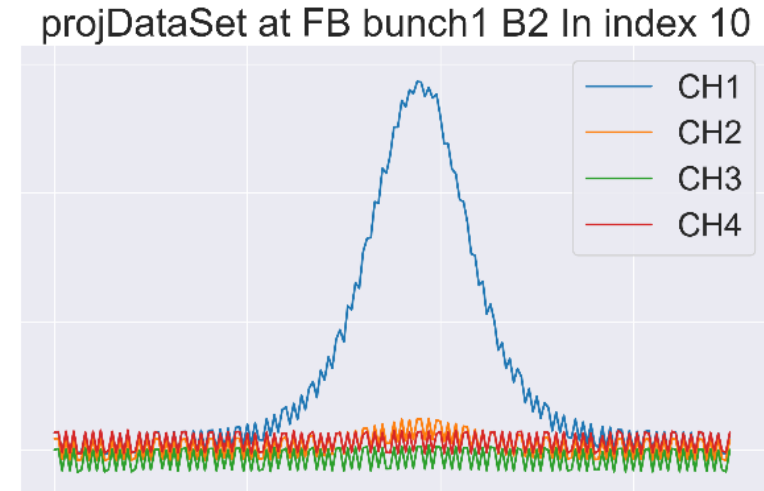
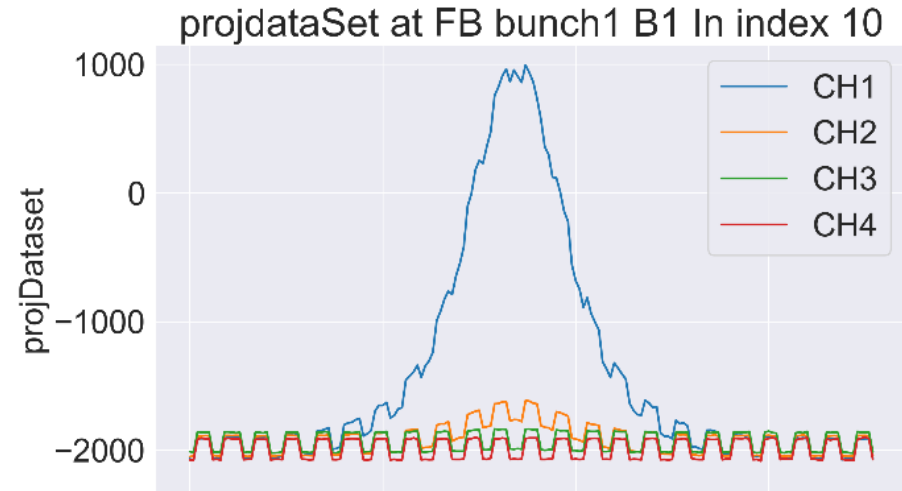
# Offline Fitting vs FESA - Legacy

- For the legacy we can observe that the distribution of the difference is more random, which confirms what we already know from experience
- Constant speed fitting corrects for partially false measurements from the resolver



# ProjDataSet Hybrid B1 vs B2 (1/2)

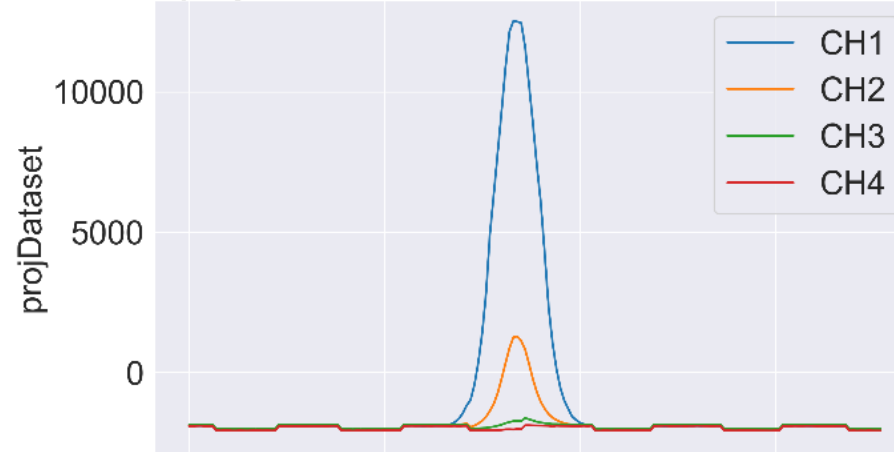
- When plotting the raw projDataSet from the 4 channels the ADC conversion noise has a different profile between B1 and B2 for the Hybrid



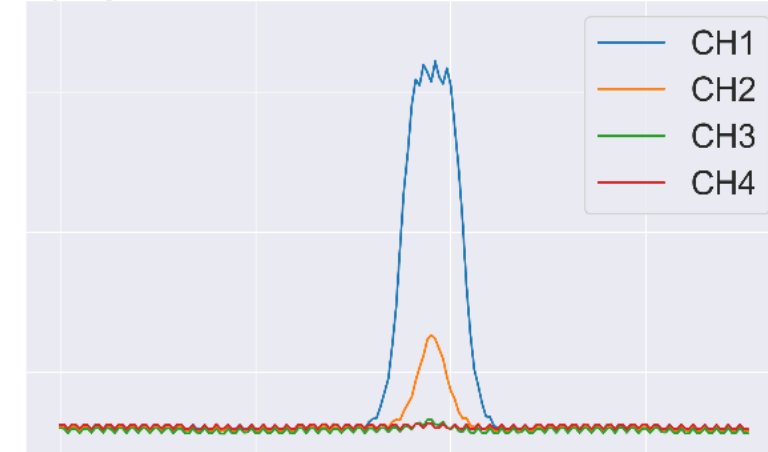
# ProjdataSet Hybrid B1 vs B2 (2/2)

- ProjdataSet saturation is also different at FT between B1 and B2
- The optimal Voltage for the Gain will be derived in the next step of the analysis, which will lead to more usable data from CH3 and CH4

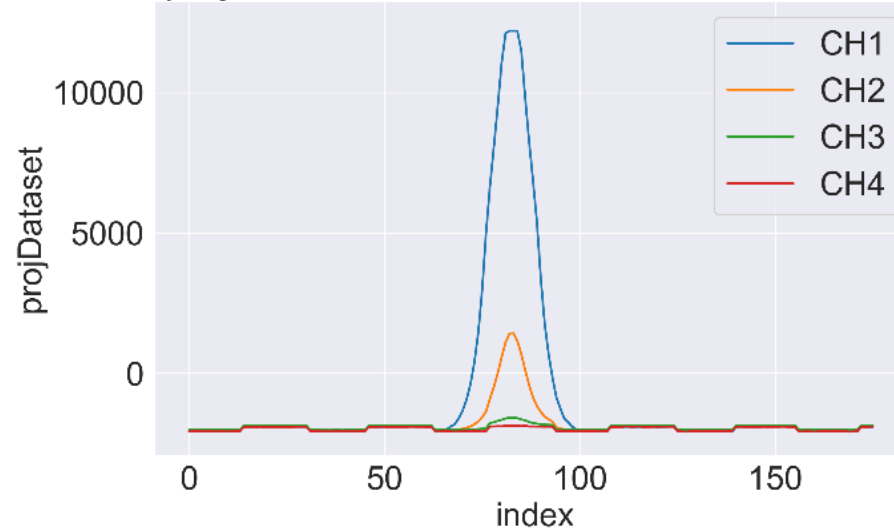
projdataSet at FT bunch1 B1 In index 84



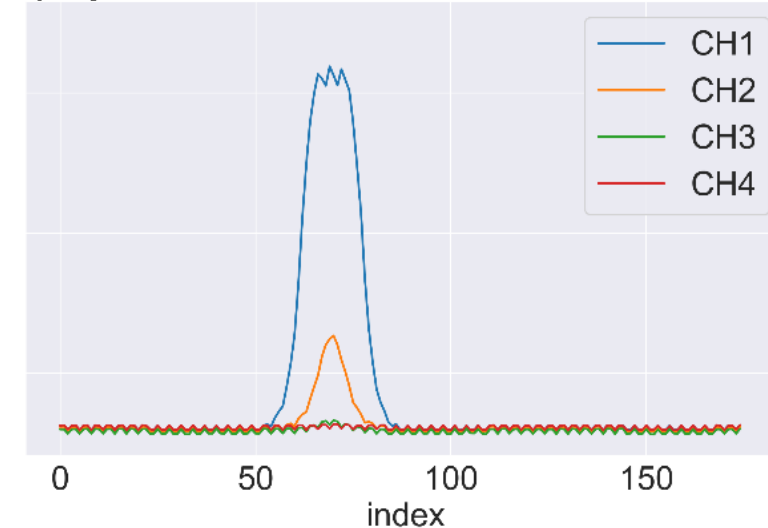
projdataSet at FT bunch1 B2 In index 84



projdataSet at FT bunch1 B1 Out index 84



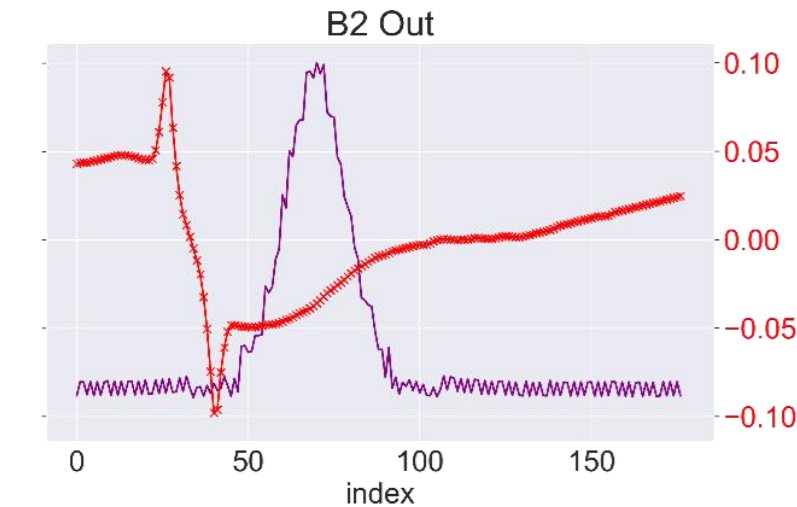
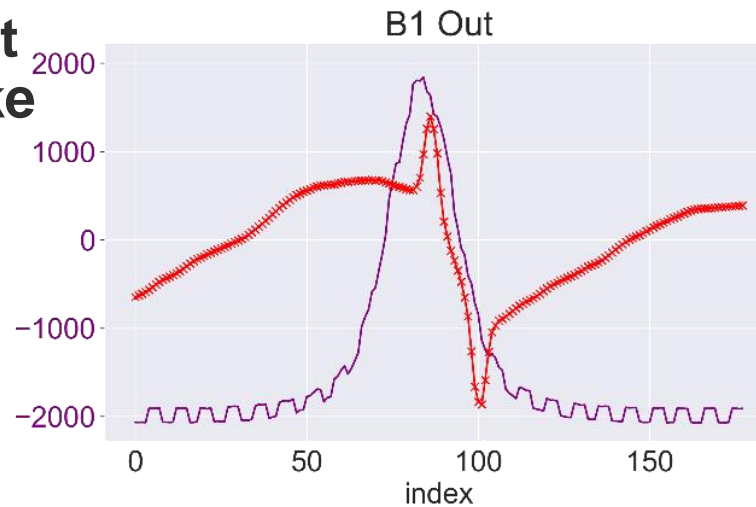
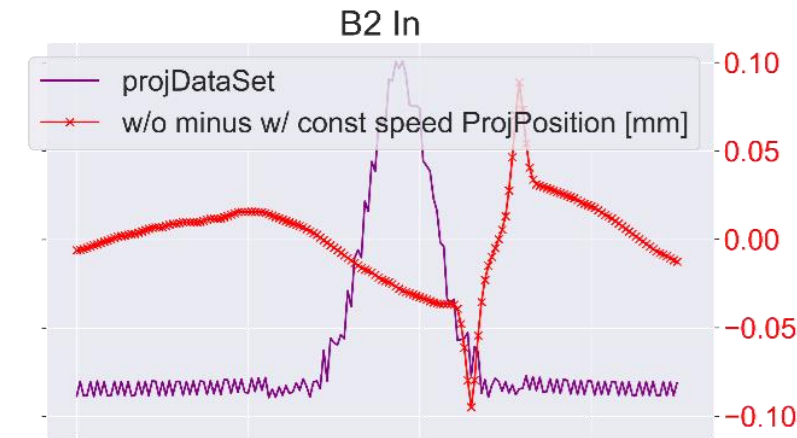
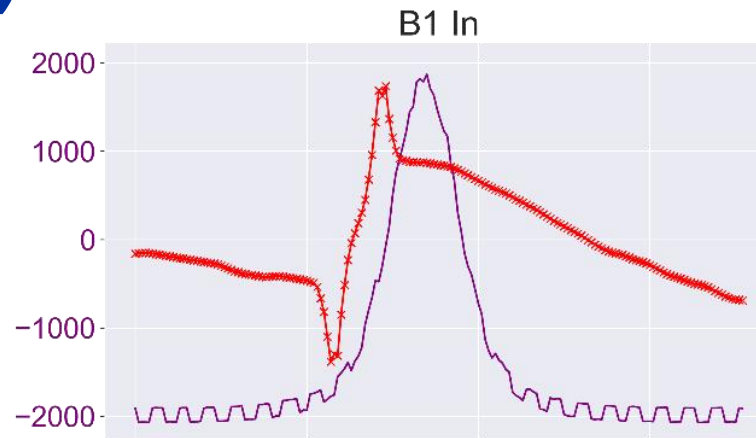
projdataSet at FT bunch1 B2 Out index 84



# ProjDataSet wrt. projPosition w/ and w/o constant speed Hybrid (1/2)

- When plotting projDataSet and delta ProjPosition w/o minus w/ constant speed fitting, we always see a difference in the shape of the profile
- This difference is consistent with the position of the spike of delta ProjPosition
- This may explain the difference we saw earlier between FESA sigma and fitting sigma in B1 bunch 1 out

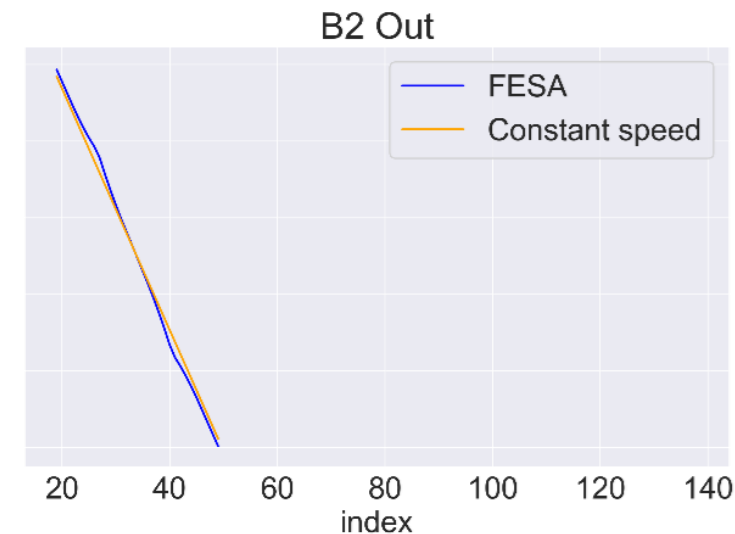
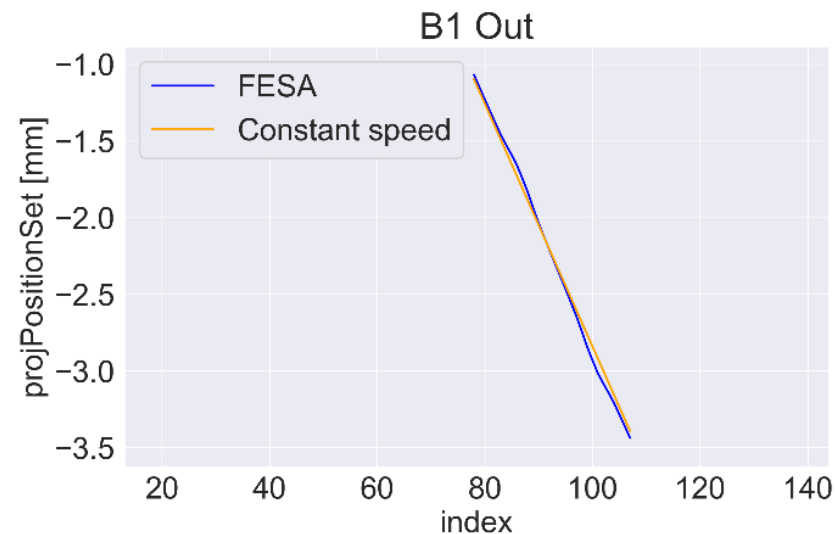
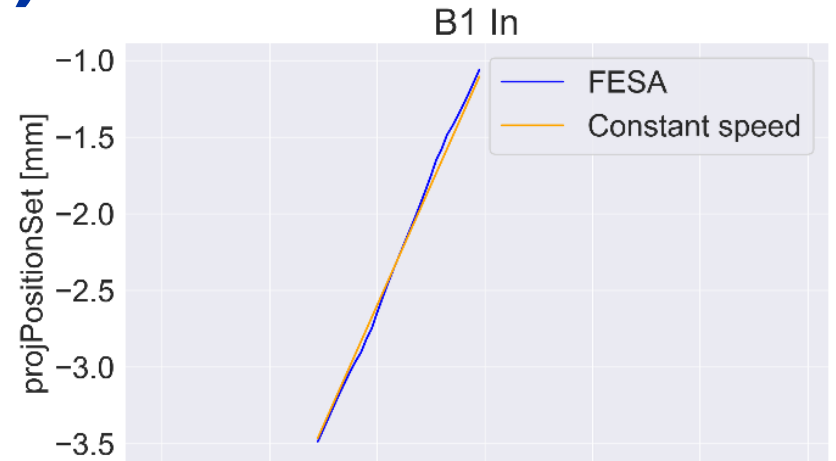
ProjDataSet and delta ProjPosition (index 10) FB proto



# ProjDataSet wrt. projPosition w/ and w/o constant speed Hybrid (2/2)

- Consistent difference around the same position across measurements (-1mm to -3.5mm)

ProjPosition w and wo constant speed (index 10) bunch 1 FB



# ProjPosition w/ and w/o constant speed Legacy

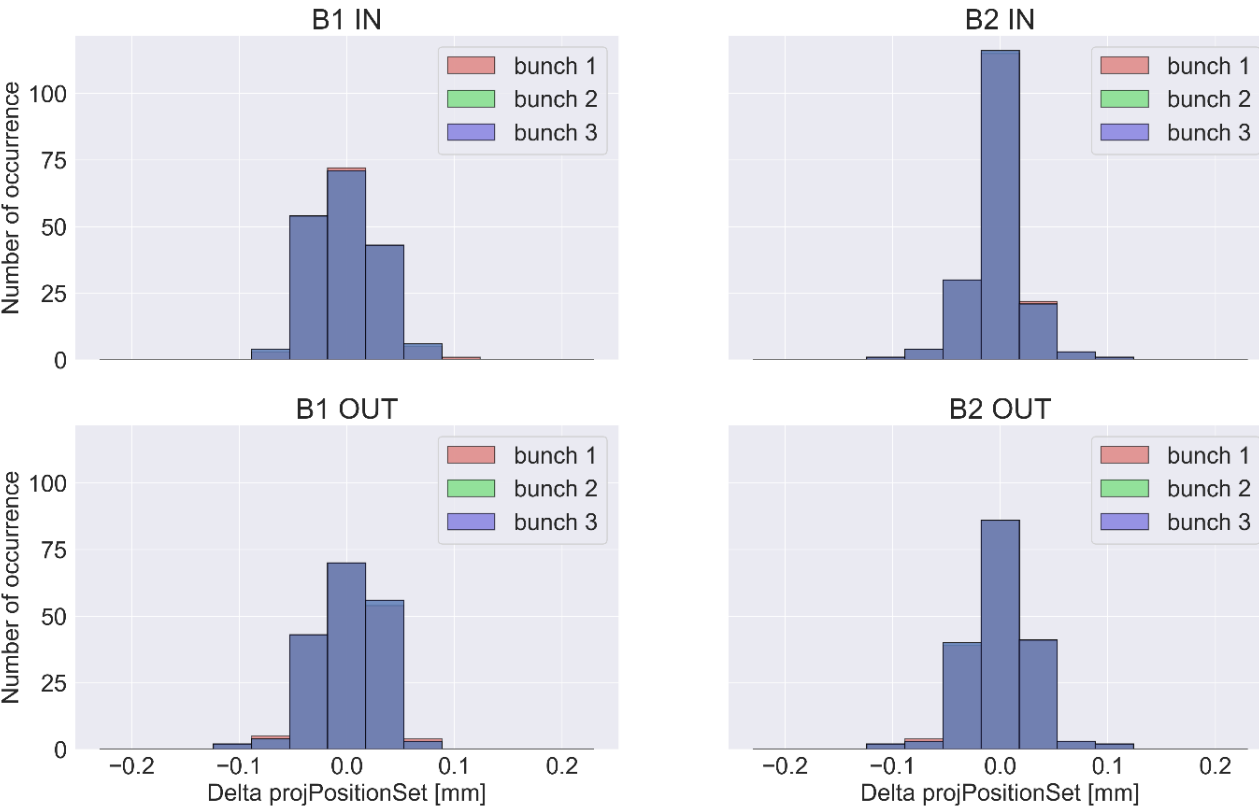
Leg ProjPosition wo minus w constant speed (index 10) bunch 1 FB

- Compared to the Hybrid the shape of the curve w/o minus w/ const speed is more random
- Consistent randomness across all measurements

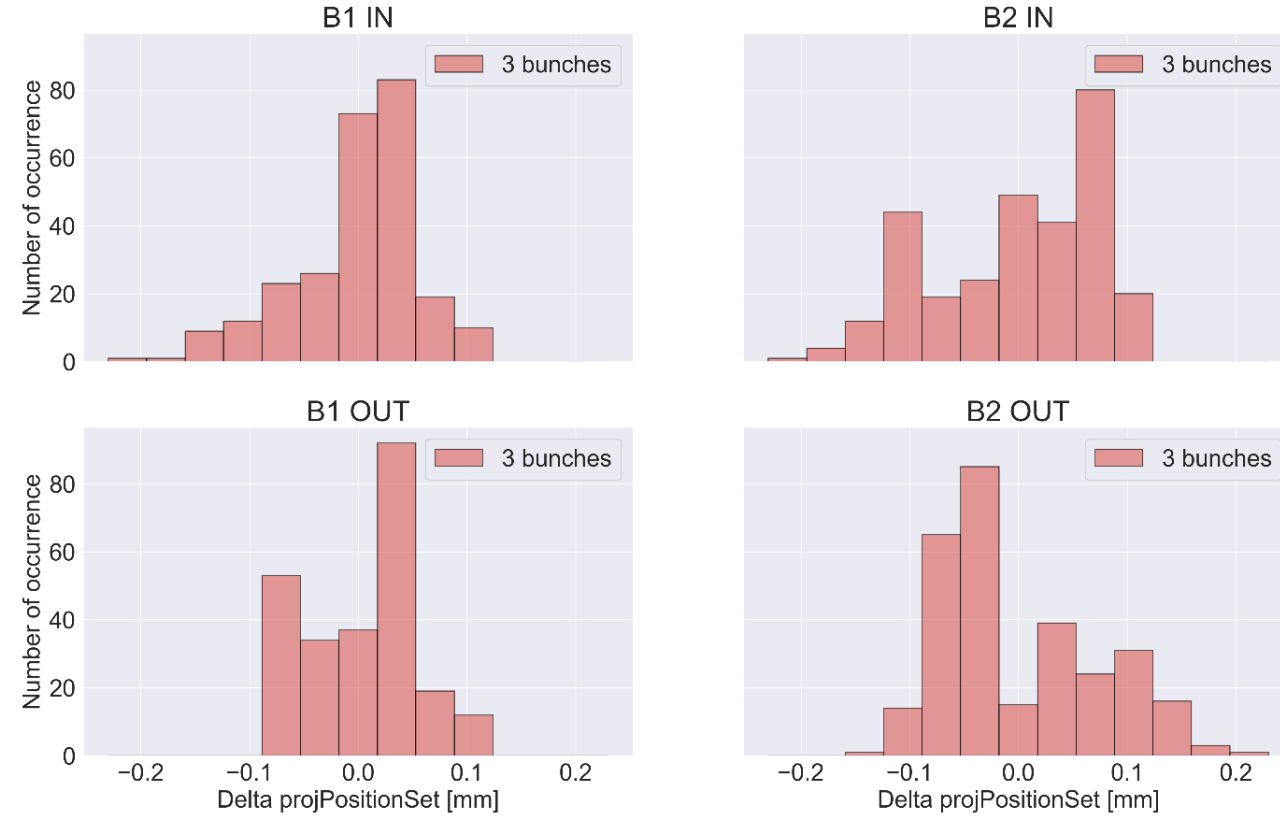


# Distribution projPosition w/ minus w/o const speed

Distribution ProjPosition wo minus w constant speed (index 10) Hyb



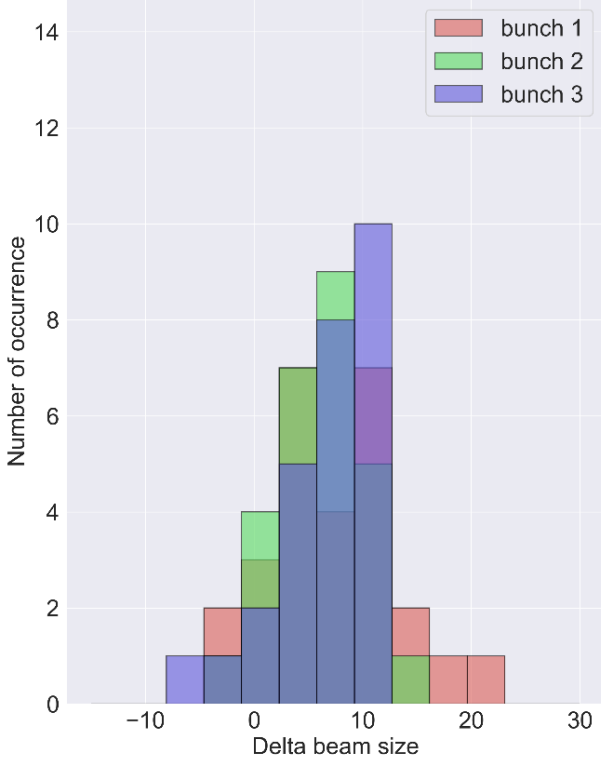
Leg Distribution ProjPosition wo minus w constant speed (index 10)



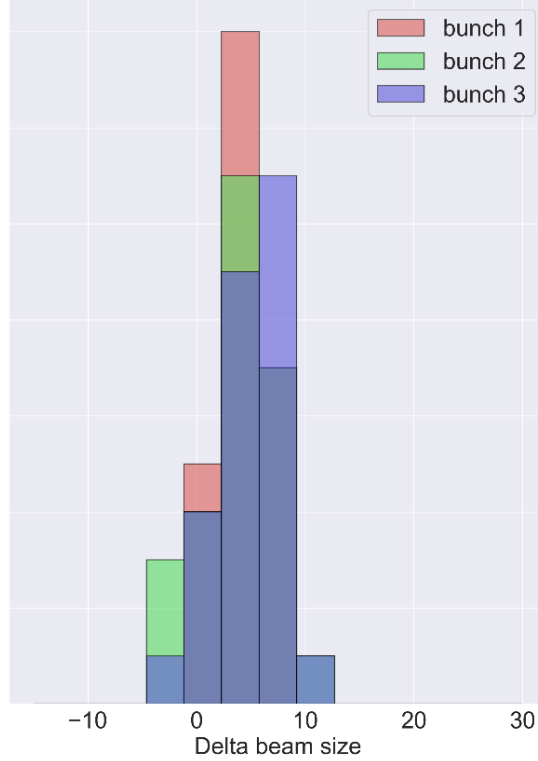
- **More occurrences around zero for Hybrid than Legacy**
- **Non-gaussian distribution for Legacy, making measurements less reliable**

# IN minus OUT distribution prototype vs Legacy B1

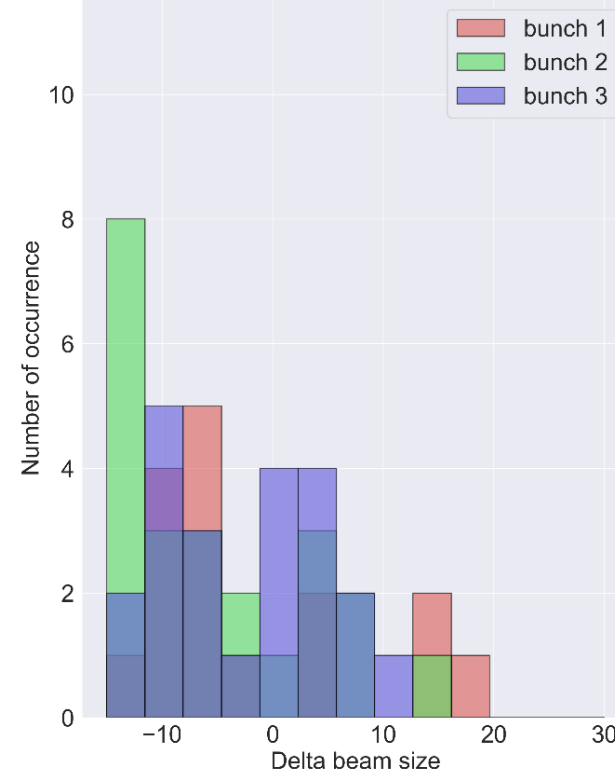
Distribution of B1 IN minus OUT (prototype) FB



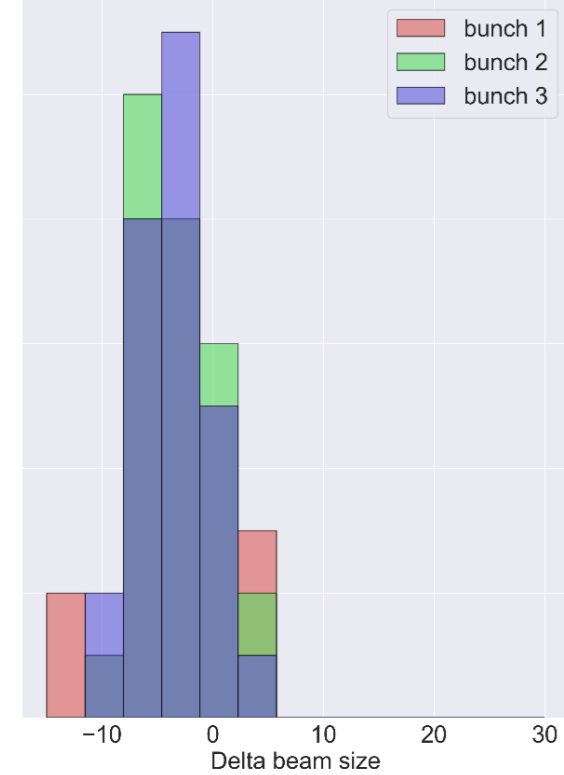
Distribution of B1 IN minus OUT (prototype) FT



Distribution of B1 IN minus OUT (Leg) FB



Distribution of B1 IN minus OUT (Legacy) FT

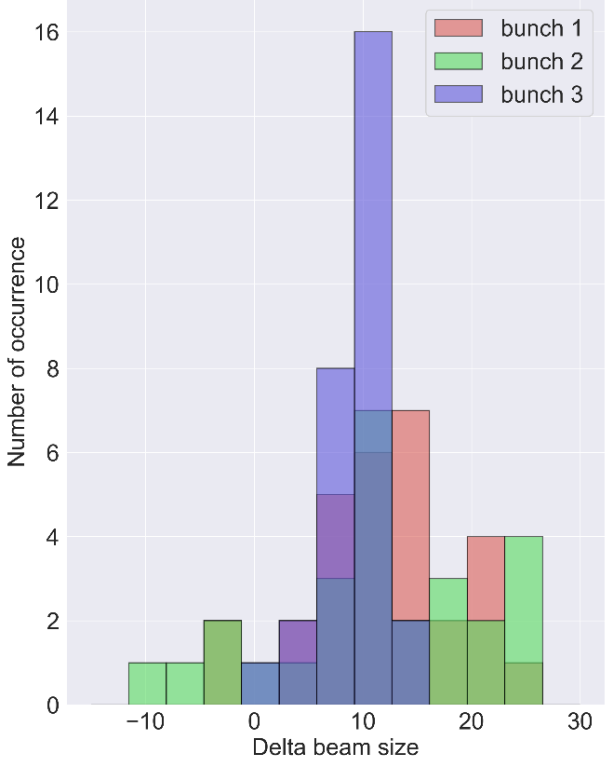


- **Prototype distribution is more gaussian with highest occurrences when IN is bigger than OUT**
- **Legacy distribution shows OUT bigger than IN and is non-gaussian at FB**

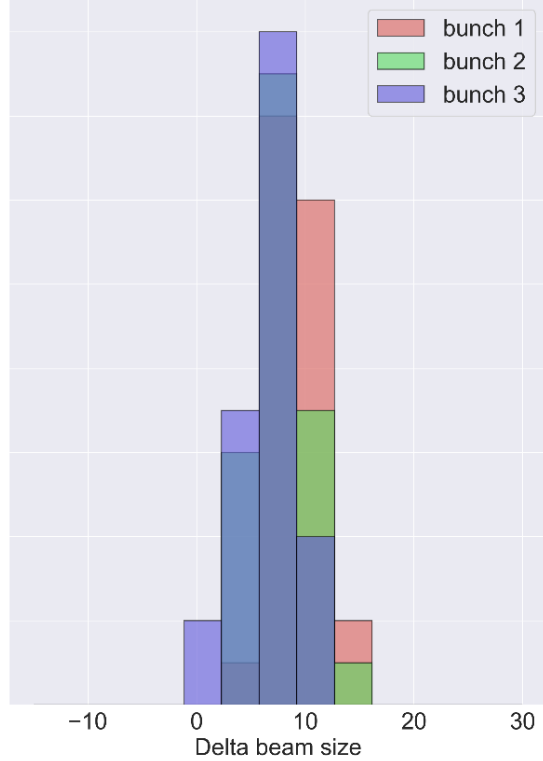


# IN minus OUT distribution prototype vs Legacy B2

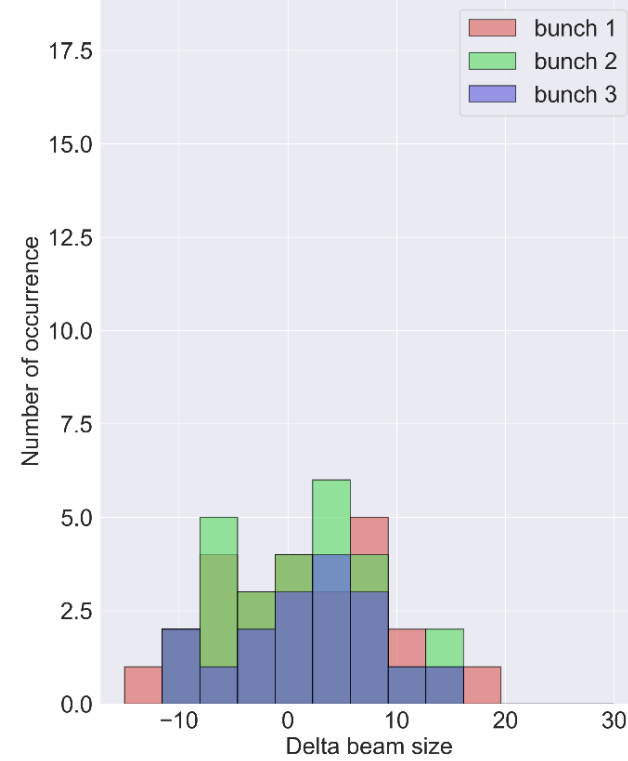
Distribution of B2 IN minus OUT (prototype) FB



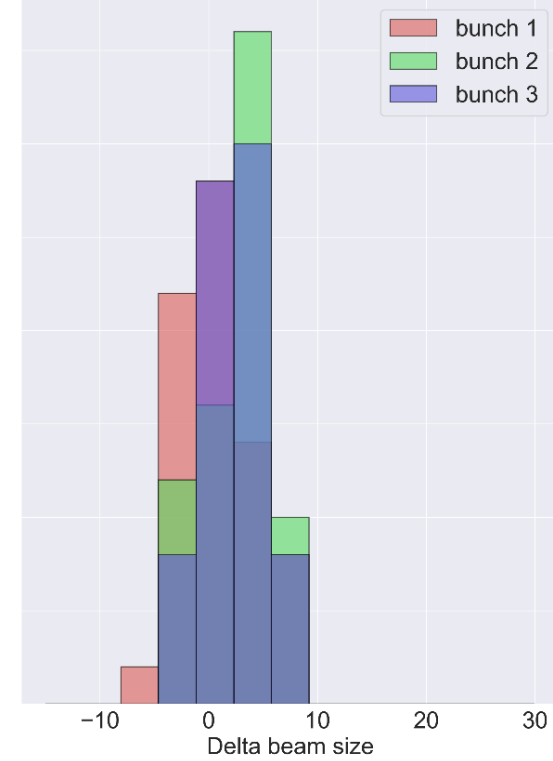
Distribution of B2 IN minus OUT (prototype) FT



Distribution of B2 IN minus OUT (Leg) FB



Distribution of B2 IN minus OUT (Leg) FT



- **Similar results for Hybrid in B2**
- **Legacy shows IN is bigger than OUT, with a more gaussian distribution**

# Next Steps

- **Publish the MD note**
- **Derive the best high voltage setting for the PMT to get usable data from CH3 and CH4**
- **Request a new MD if possible**

# Conclusion

- **Hybrid position measurements are more reliable**
- **Offline fitting with linearity assumption of movement profile highly recommended**
- **Beam size measurements from the Hybrid are more consistent**
- **Hybrid system shows better reading for IN vs OUT measurements**
- **After the best high voltage setting for the PMT is derived, we'll get usable data from CH3 and CH4, which will lead to better measurements in the Hybrid.**
- **Redundancy in hybrid system expected during ramp with overlapping sigma measurements once the best high voltage setting for the PMT is derived**



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