

# LR BB compensation with wire (MD2202)

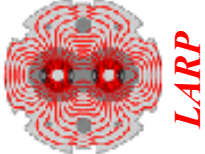
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## preliminary BSRT profile analysis

M. Fitterer , S. Papadopoulou, G. Sterbini

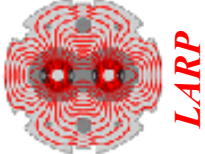
**Acknowledgements:**

**G. Stancari, Y. Papaphilippou, A. Valishev, E. Bravin , G. Trad**



- 1) Introduction to BSRT profiles
- 2) Overview of the MD
- 3) Comparison of BSRT and wire scanner profiles
- 4) Results for MD2202 – LR BB compensation with wire:
  - a) transverse profile changes induced by wire
  - b) evolution of profiles along the fill
  - c) longitudinal profiles

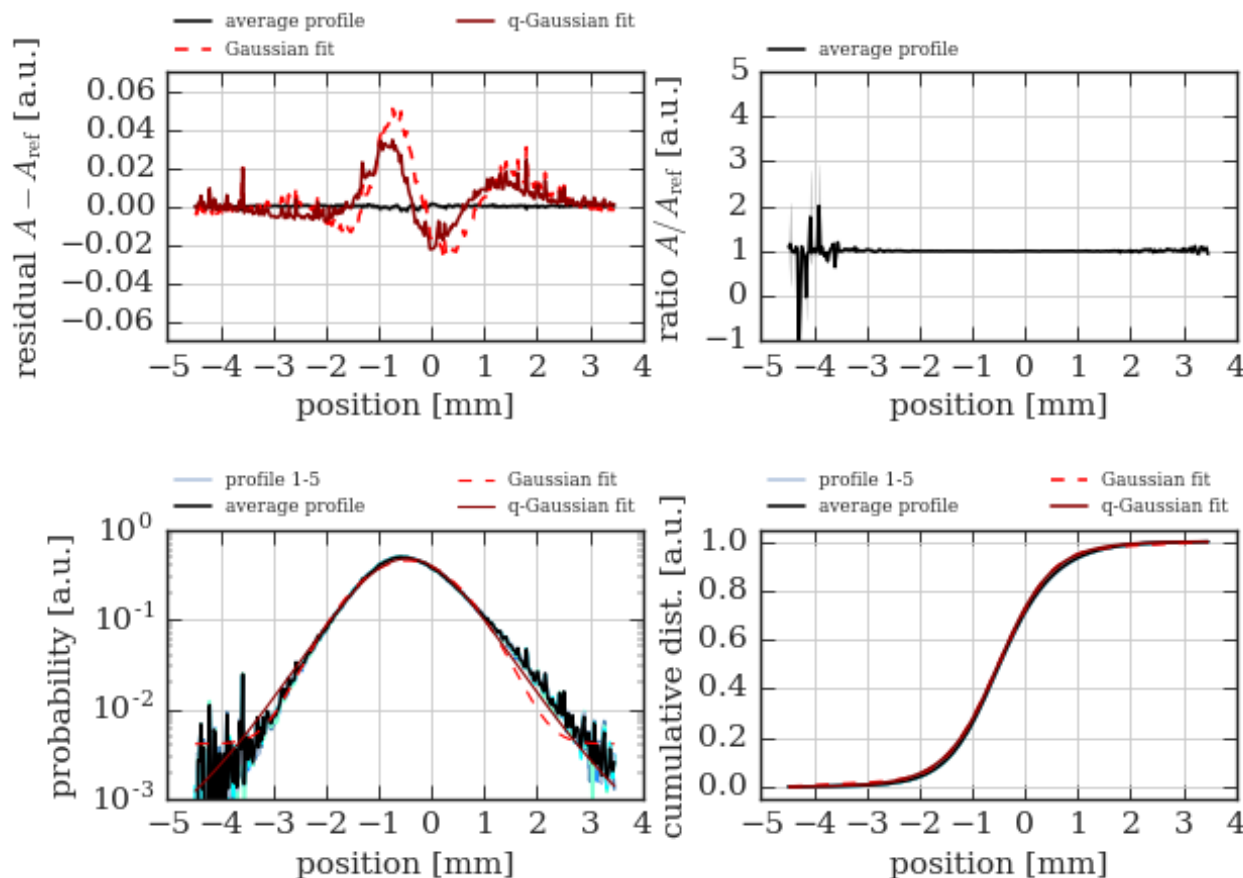
# Intro BSRT profiles



# Intro BSRT profiles - Injection



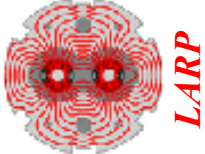
H plane, slot 224 - 2017-07-01 16:09:04, ref slot 224 - 2017-07-01 16:08:49



- profiles in H are slightly asymmetric -> This is instrumental
- profiles in V are symmetric and almost Gaussian
- residual shows changes of the center of the distribution and deviation from Gaussian/q-Gaussian fit
- ratio (would if sensitive enough) show changes in the high amplitude tails

## Analysis steps:

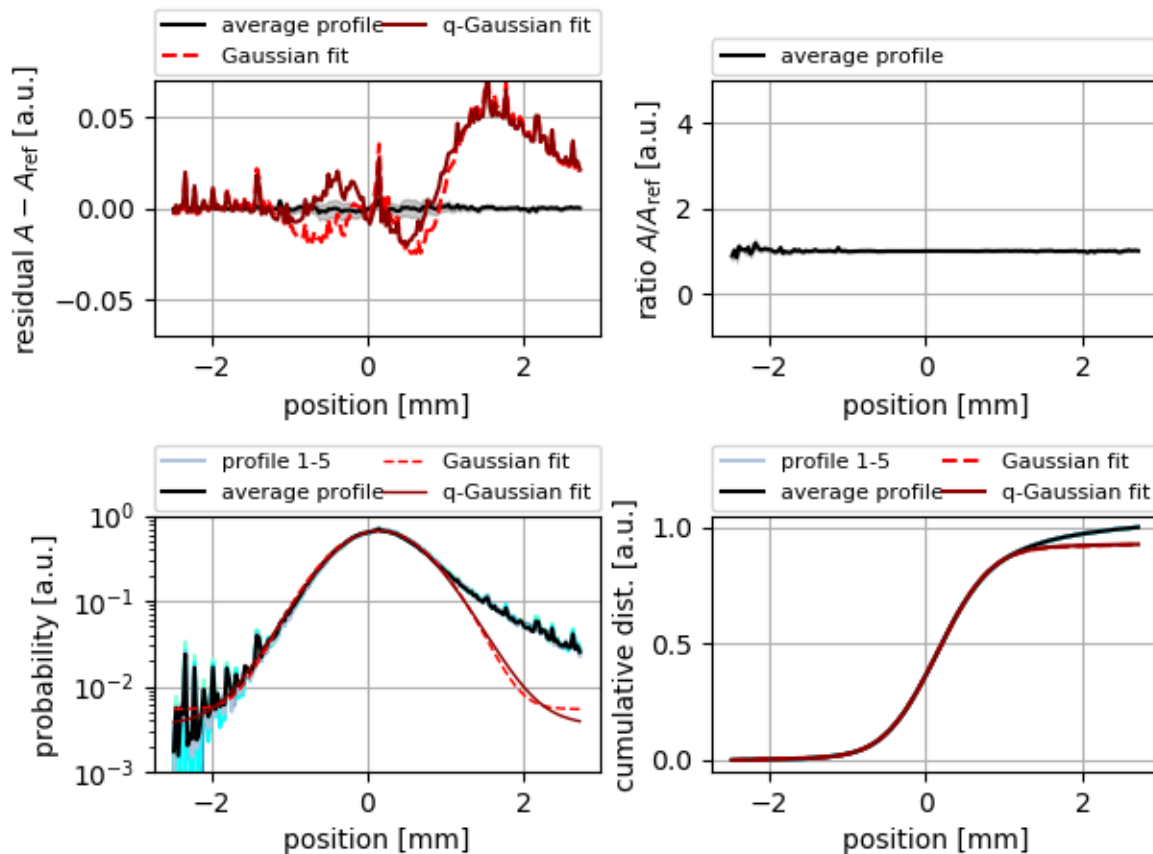
- 1) average over profiles
- 2) fit profiles with Gaussian and q-Gaussian



# Intro BSRT profiles - FT



H plane, slot 20 - 2017-07-01 21:35:21, ref slot 20 - 2017-07-01 21:35:00

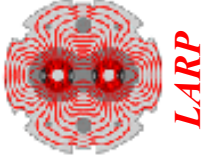


- profiles in H are heavily asymmetric -> this is instrumental
- profiles in V are symmetric

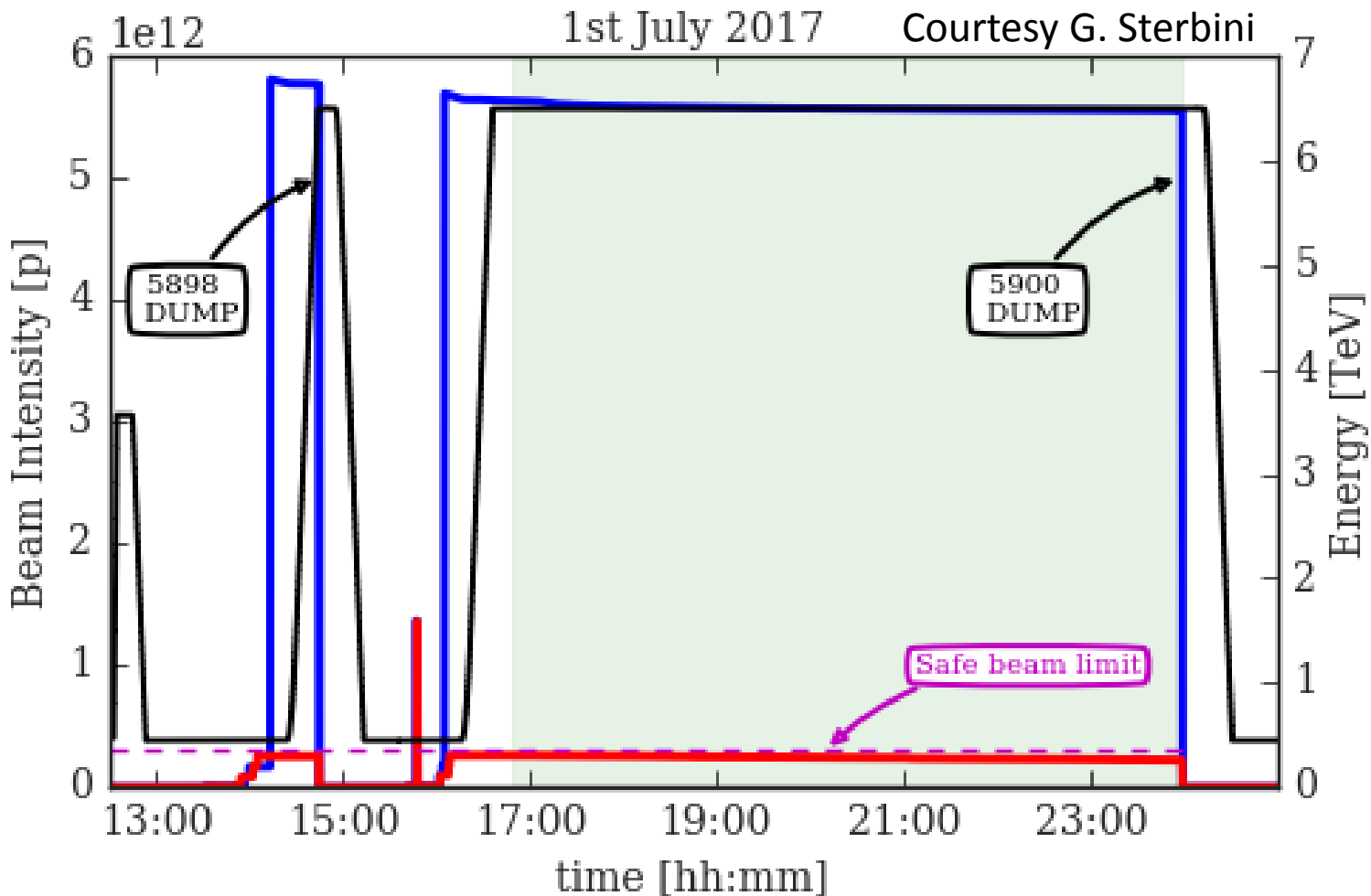
## Analysis steps:

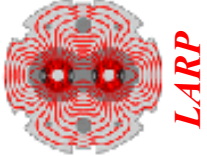
- 1) average over profiles
- 2) fit profiles with Gaussian and q-Gaussian (weighted in H)

# **Overview of MD2202 – LR BB compensation with wire**

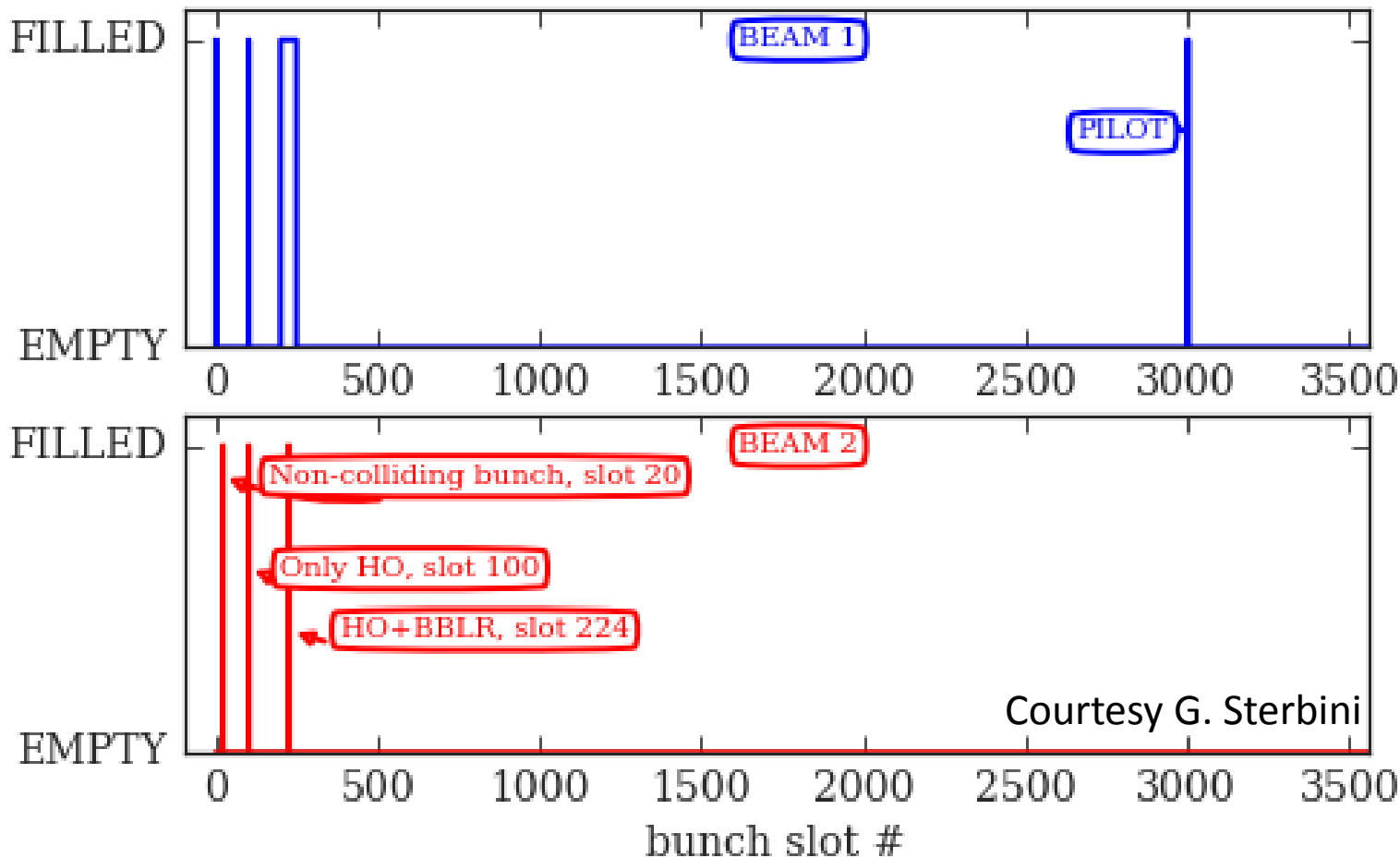


# Overview of MD

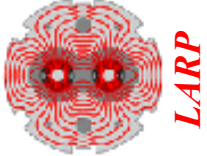




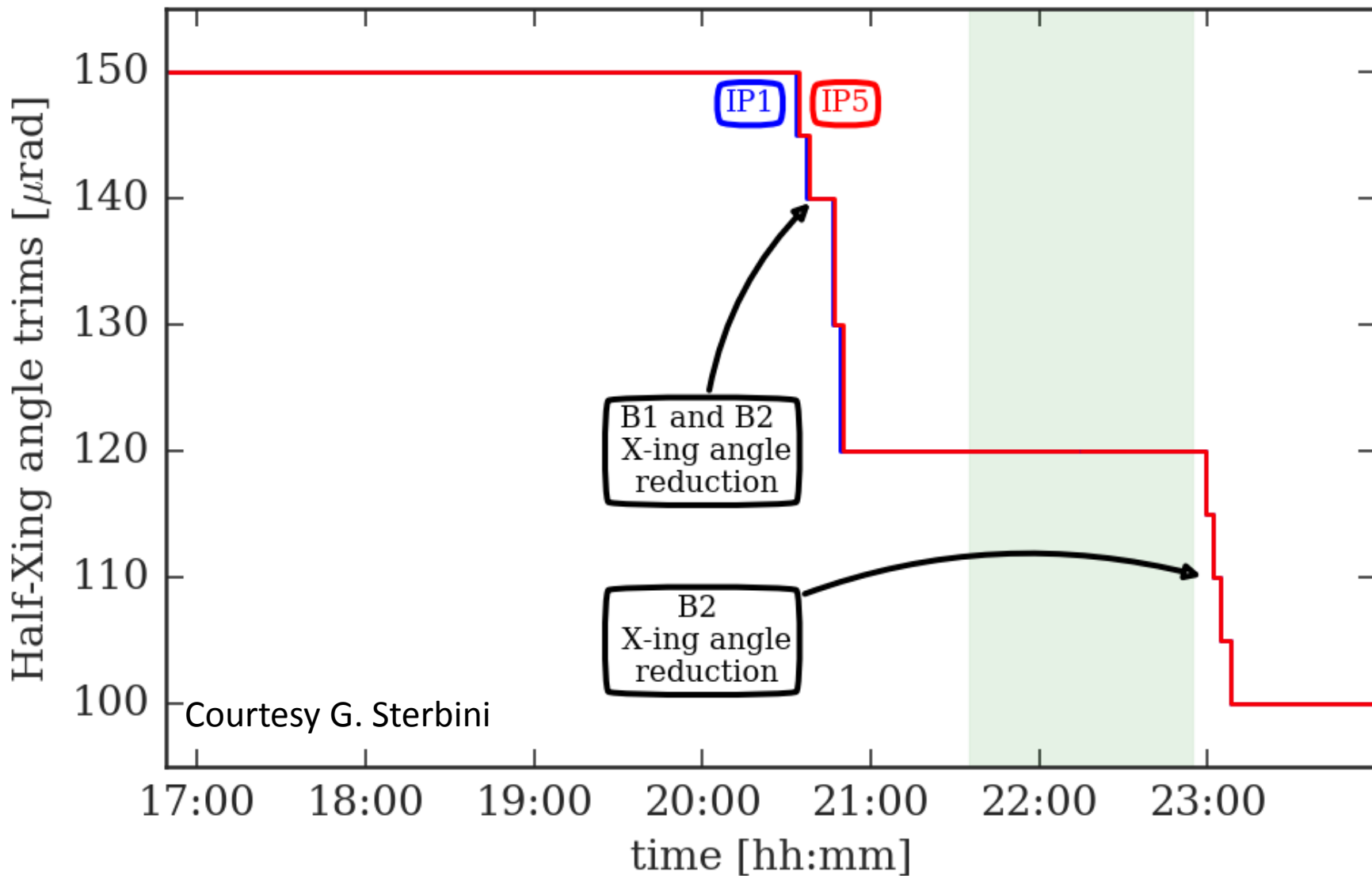
# Filling Scheme

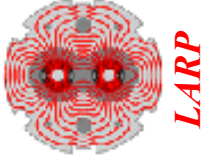




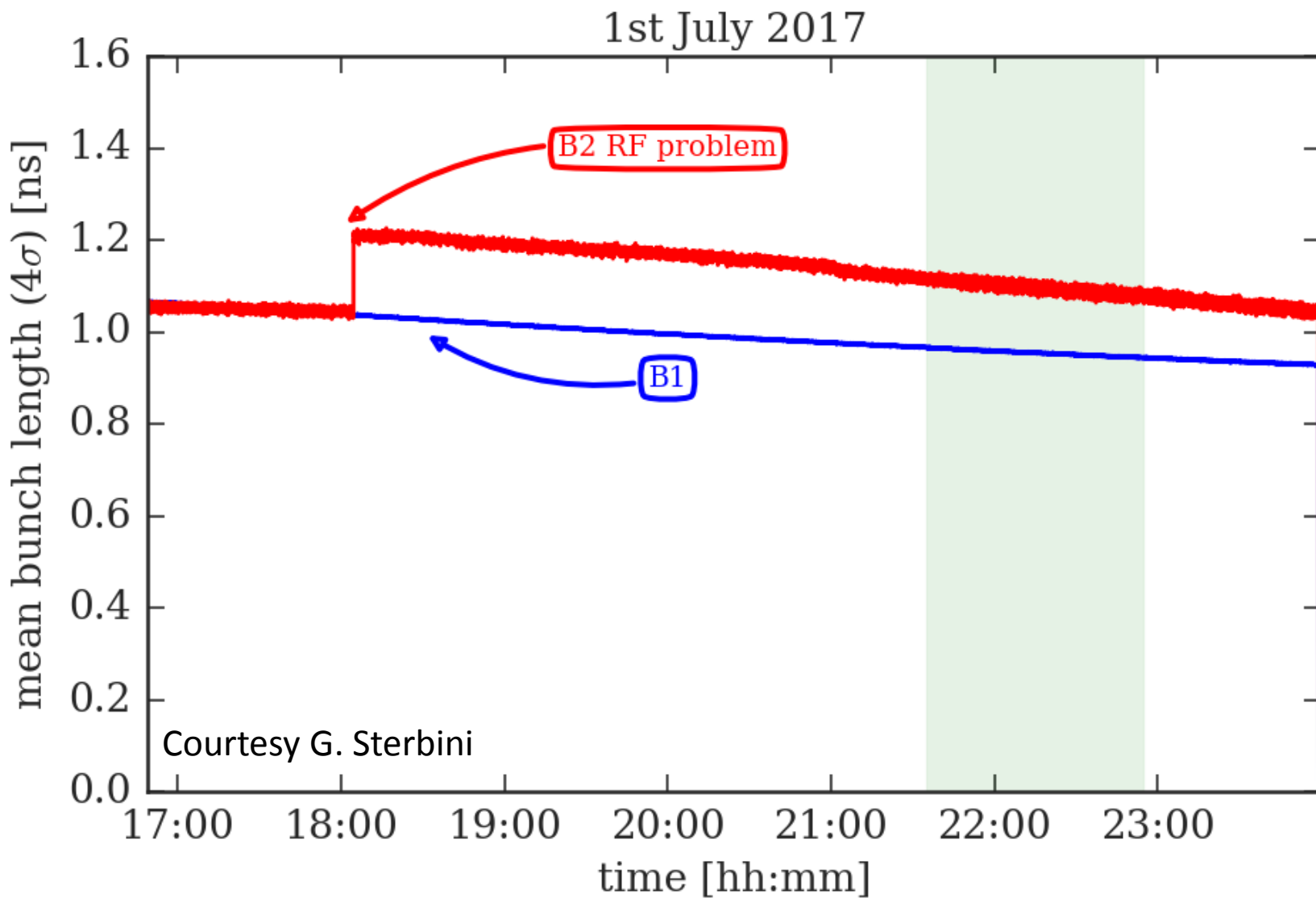


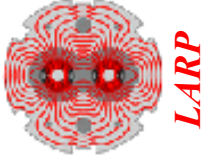
# Crossing Angle Reduction



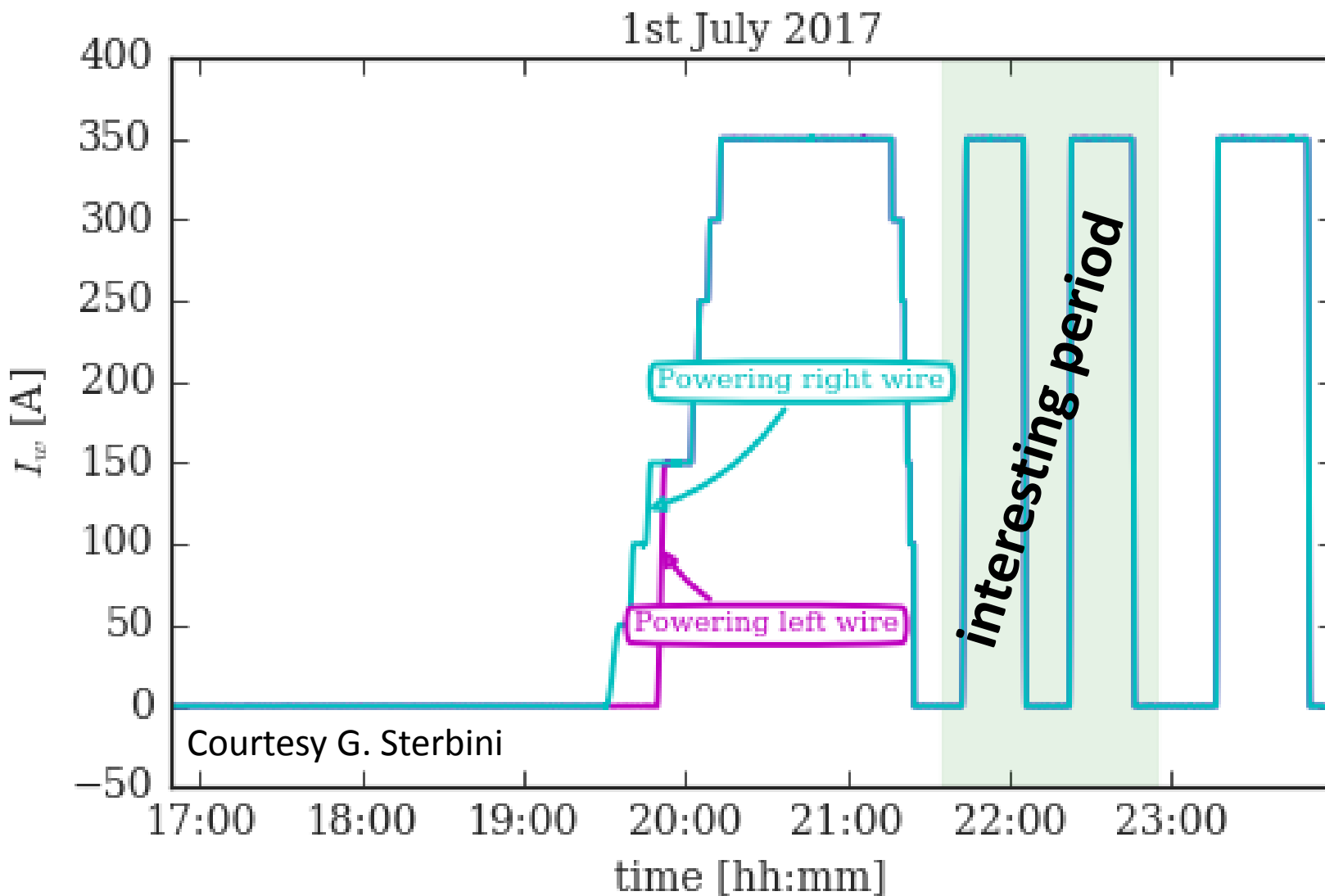


# Crossing Angle Reduction

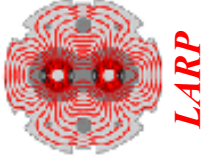




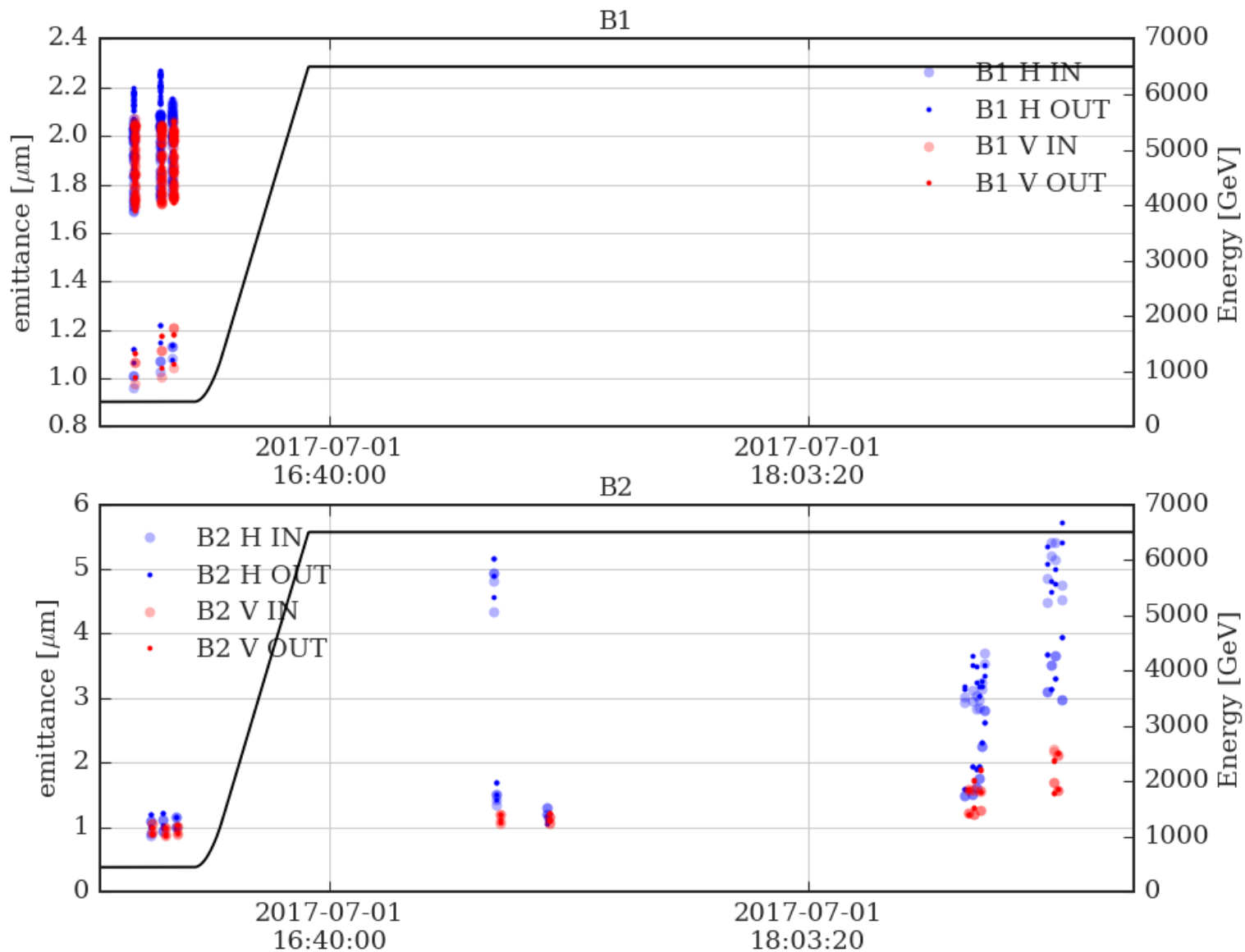
# BSRT profiles for wire on/off

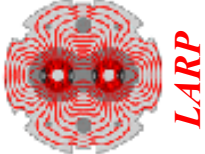


# **Comparison BSRT and BWS at Injection and FT**



# Available BWS data





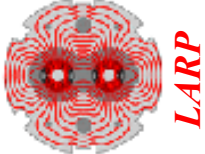
# Updated beta functions



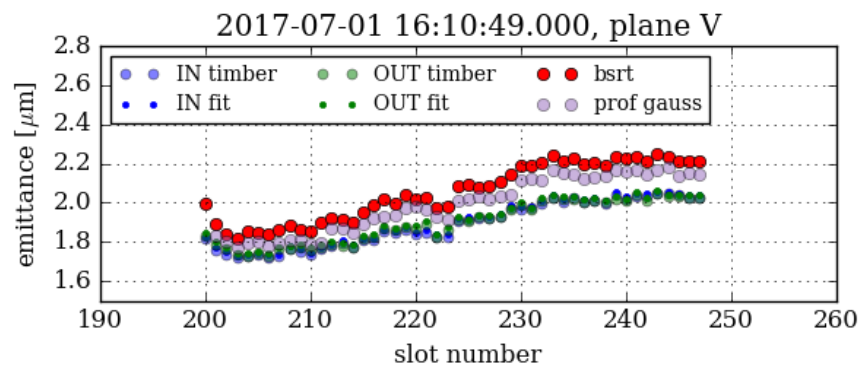
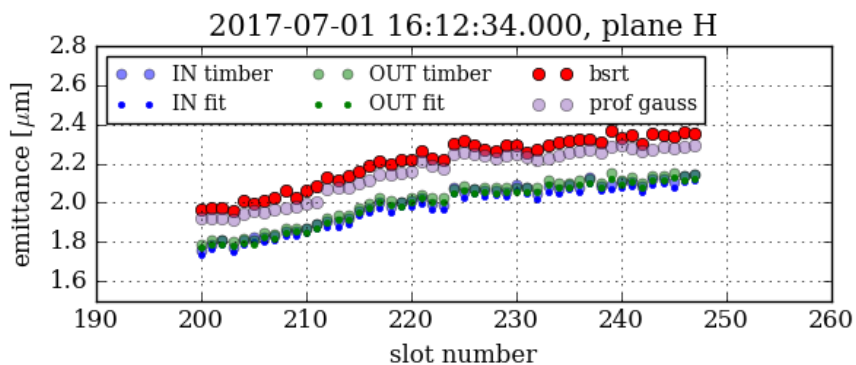
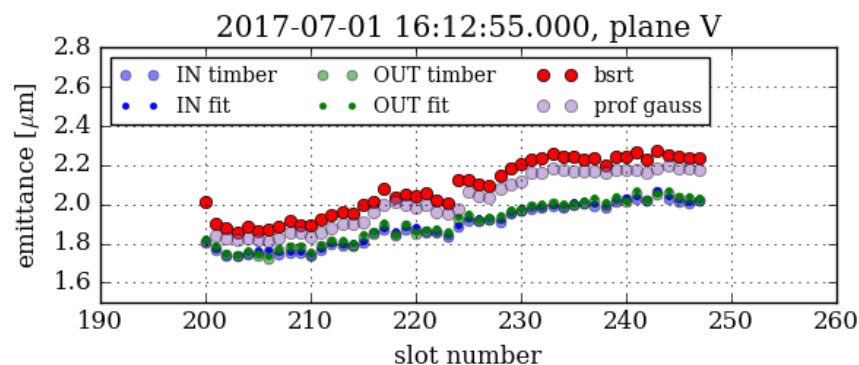
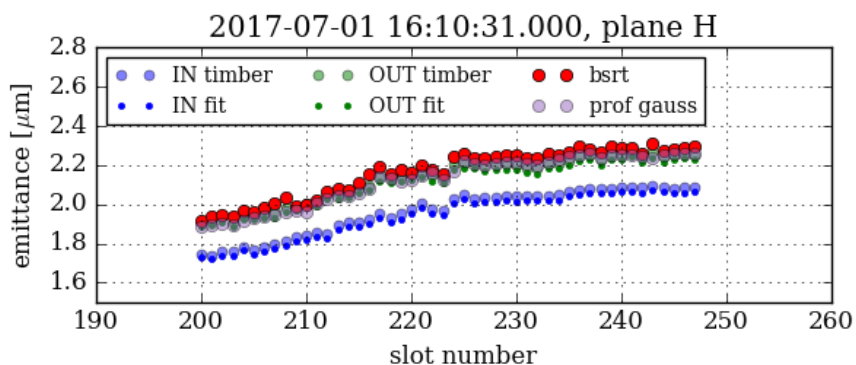
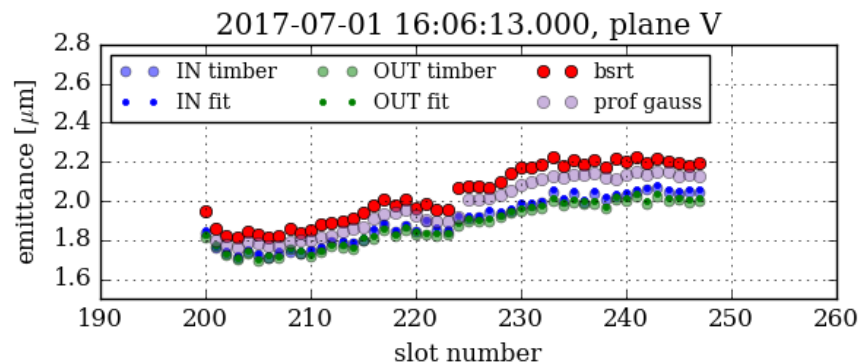
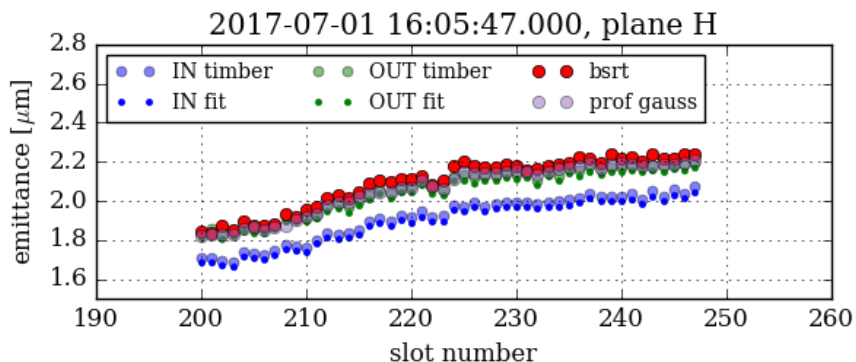
BSRT: Use beta@Undulator (MU.\*) at 450 GeV and beta@dipole (MBRS\*) at 6.5 TeV

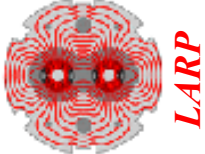
	Beam 1					
	inj		Flattop		40 cm	
	$\beta_x$	$\beta_y$	$\beta_x$	$\beta_y$	$\beta_x$	$\beta_y$
BWS.5R4	195.5 ± 2.5	338.5 ± 4.3	192.5 ± 3.5	344.3 ± 5.8	182.9 ± 2.0	341.7 ± 4.0
MBRS.5R4E	202.1 ± 2.5	299.9 ± 3.9	198.4 ± 3.6	304.6 ± 5.2	188.2 ± 2.2	301.0 ± 3.7
MU.B5R4	206.8 ± 2.6	287.3 ± 3.8	202.8 ± 3.7	291.6 ± 5.0	192.5 ± 2.2	287.6 ± 3.6
	Beam 2					
	inj		Flattop		40 cm	
	$\beta_x$	$\beta_y$	$\beta_x$	$\beta_y$	$\beta_x$	$\beta_y$
BWS.5L4	185.1 ± 2.5	394.4 ± 4.7	193.5 ± 3.3	424.9 ± 7.1	192.1 ± 2.4	398.9 ± 4.5
MBRS.5L4E	192.5 ± 2.6	339.3 ± 4.4	206.2 ± 3.6	366.5 ± 6.2	208.8 ± 2.6	340.3 ± 4.0
MU.B5L4	193.1 ± 2.6	337.6 ± 4.4	206.9 ± 3.6	364.6 ± 6.2	209.7 ± 2.6	338.4 ± 4.0

= changed values

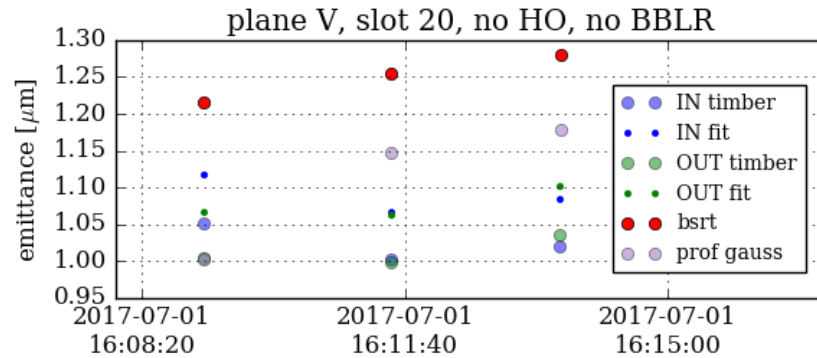
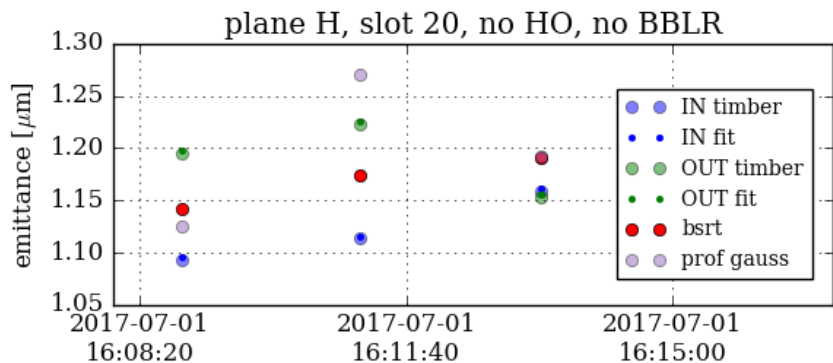
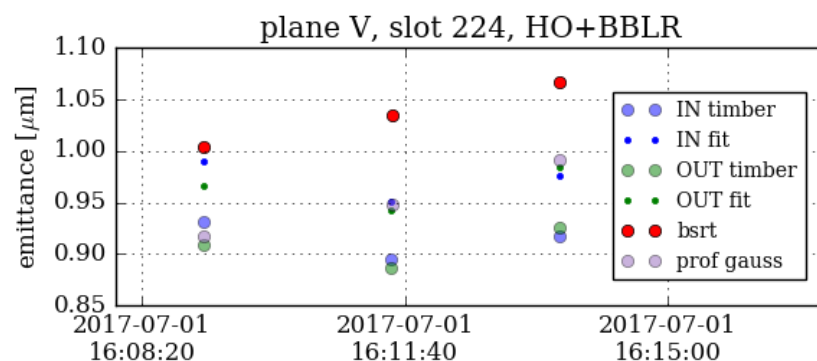
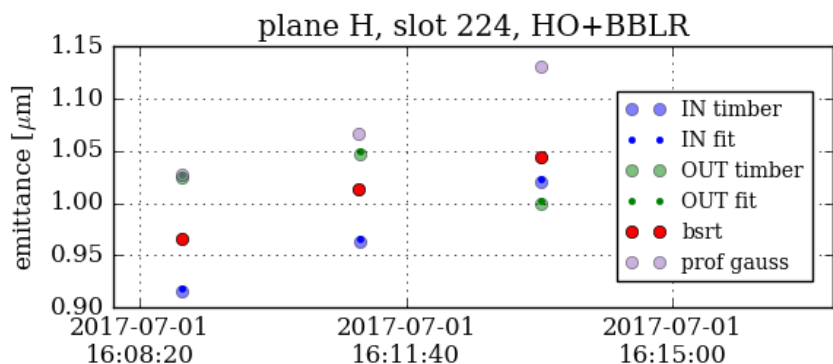
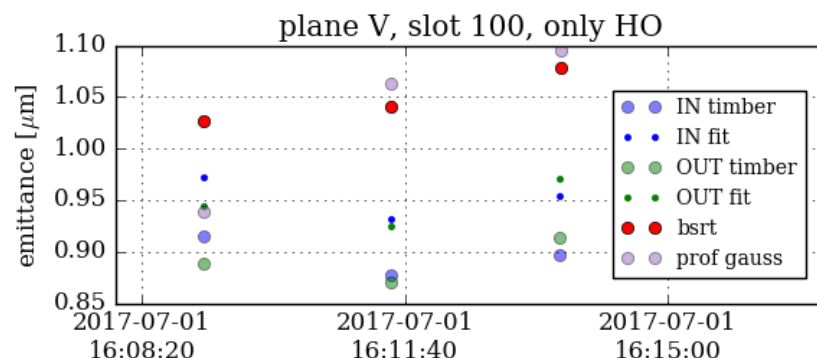
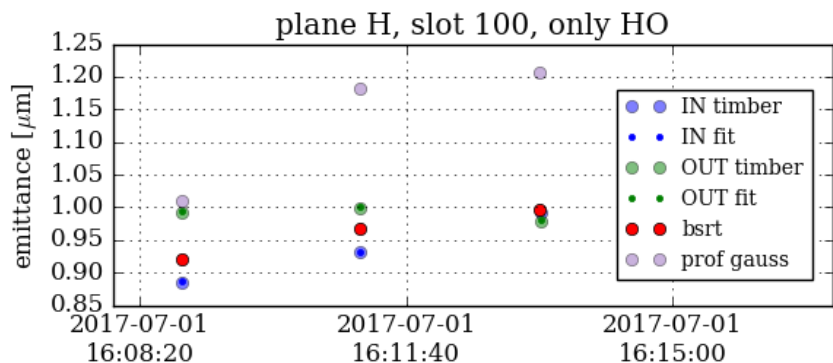


# Beam 1 Injection – train

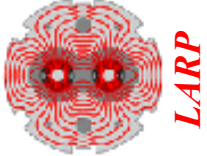




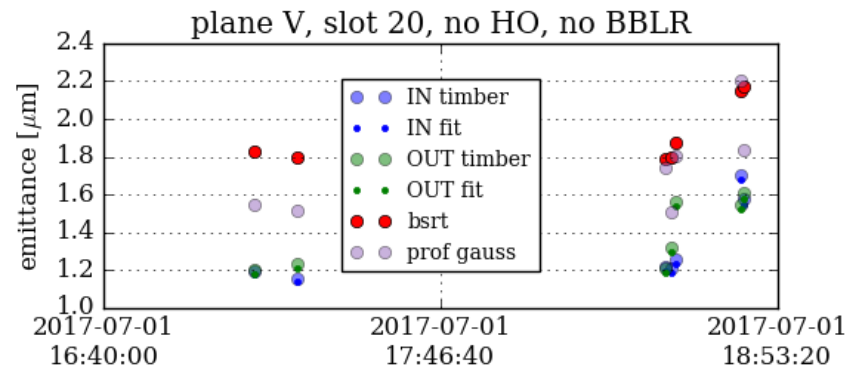
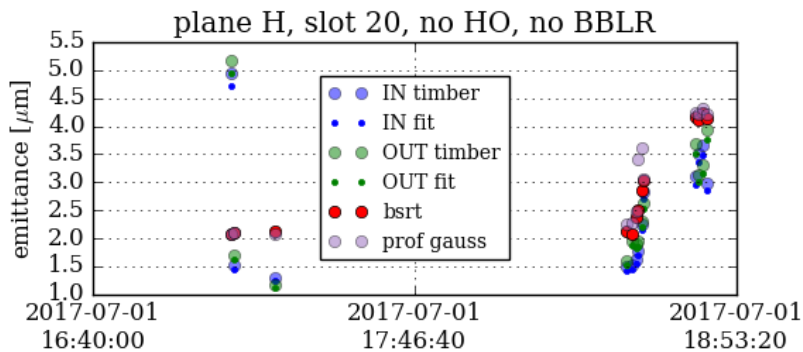
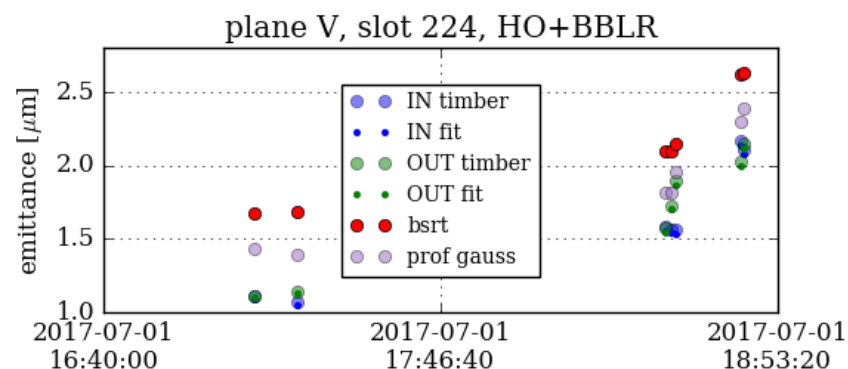
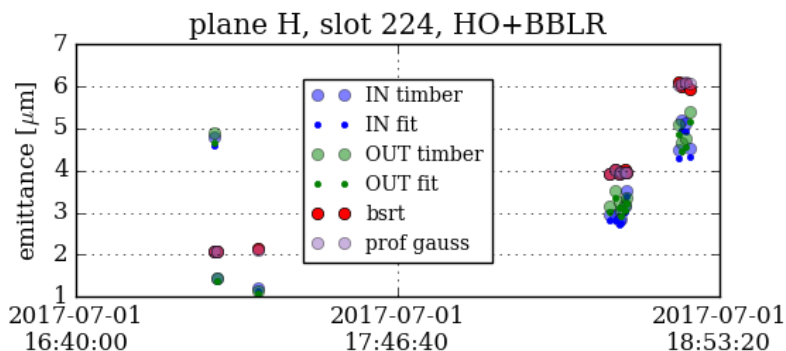
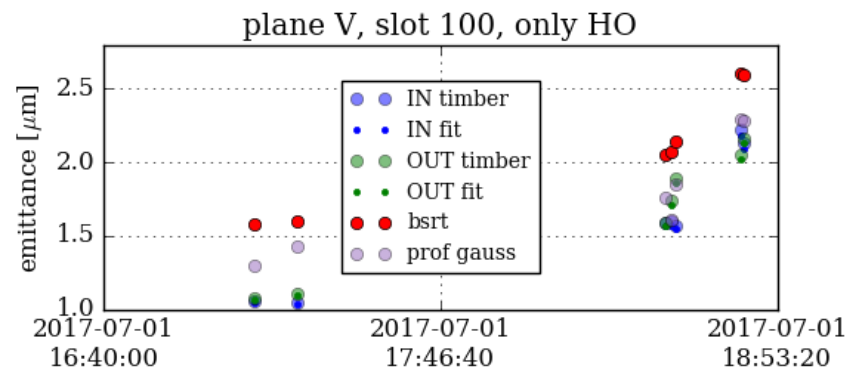
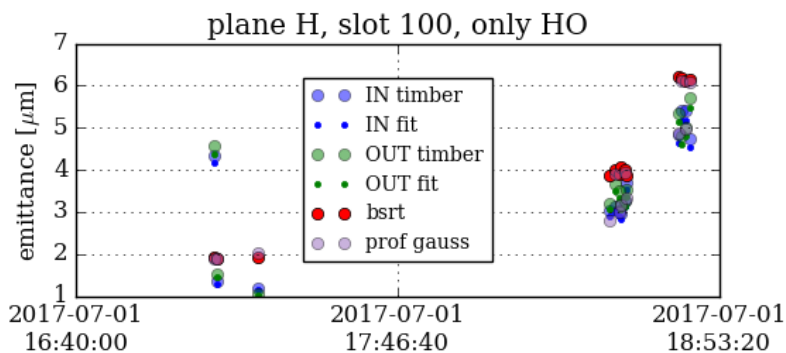
# Beam 2 Injection

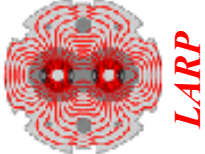




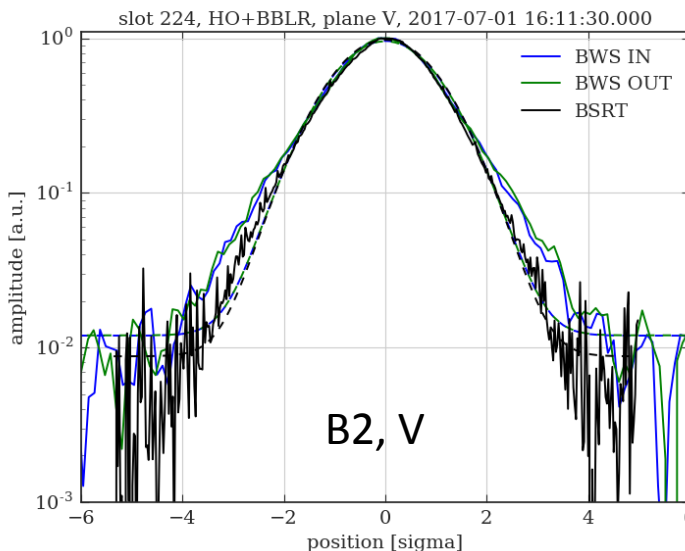
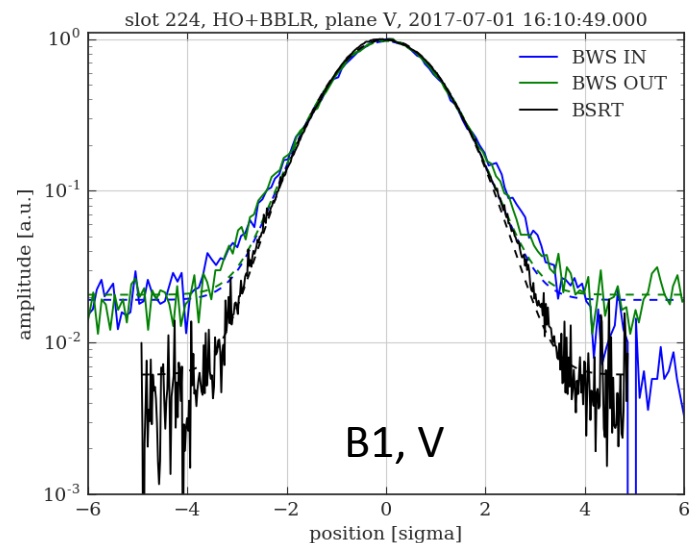
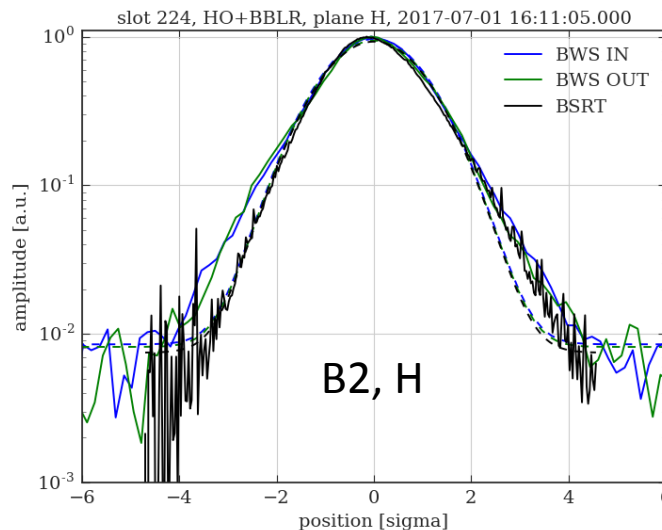
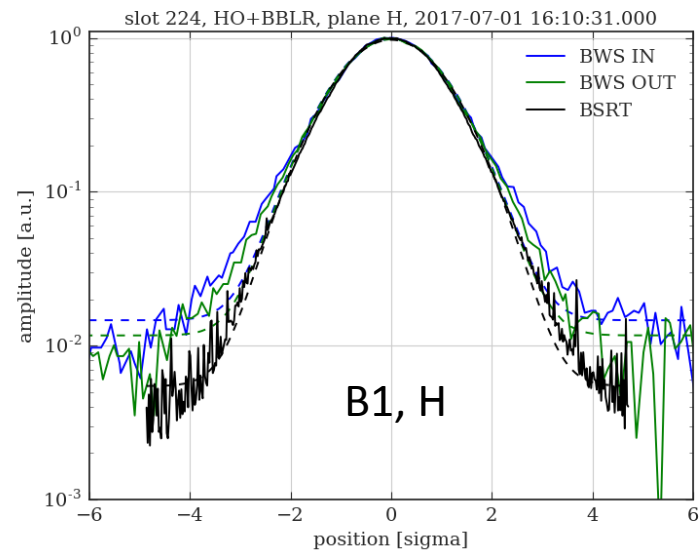


# Beam 2 FT





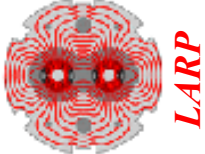
# Profiles Injection



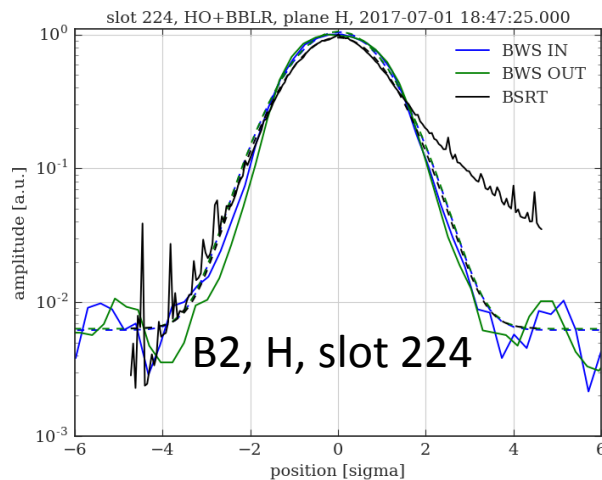
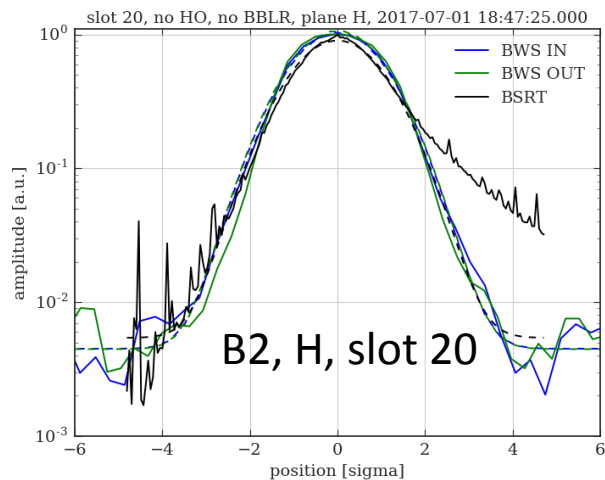
If scaling with beam sigma correct:

- BWS show larger tails than BSRT

other bunches and profiles see: [bws bsrt cernbox](#)

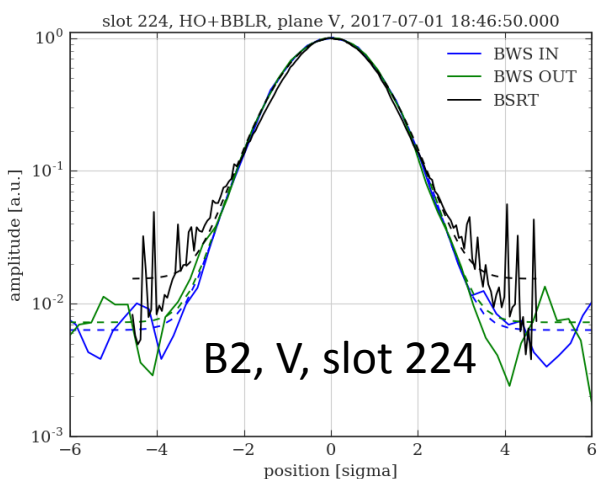
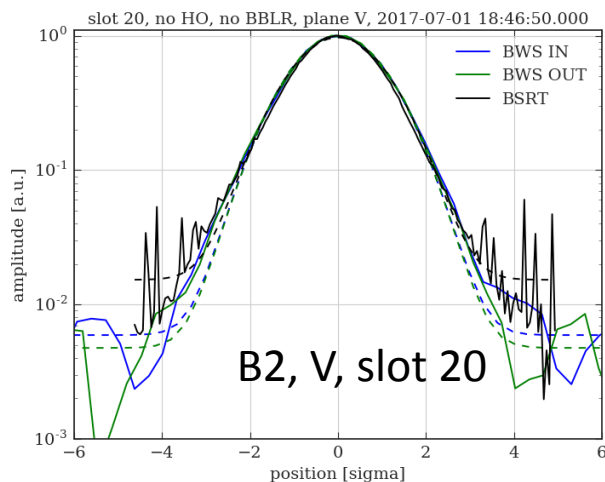


# Profiles FT



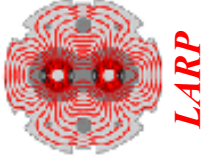
If scaling with beam sigma correct:

- BSRT shows larger tails
- BSRT shows bump on right side (instrumental)

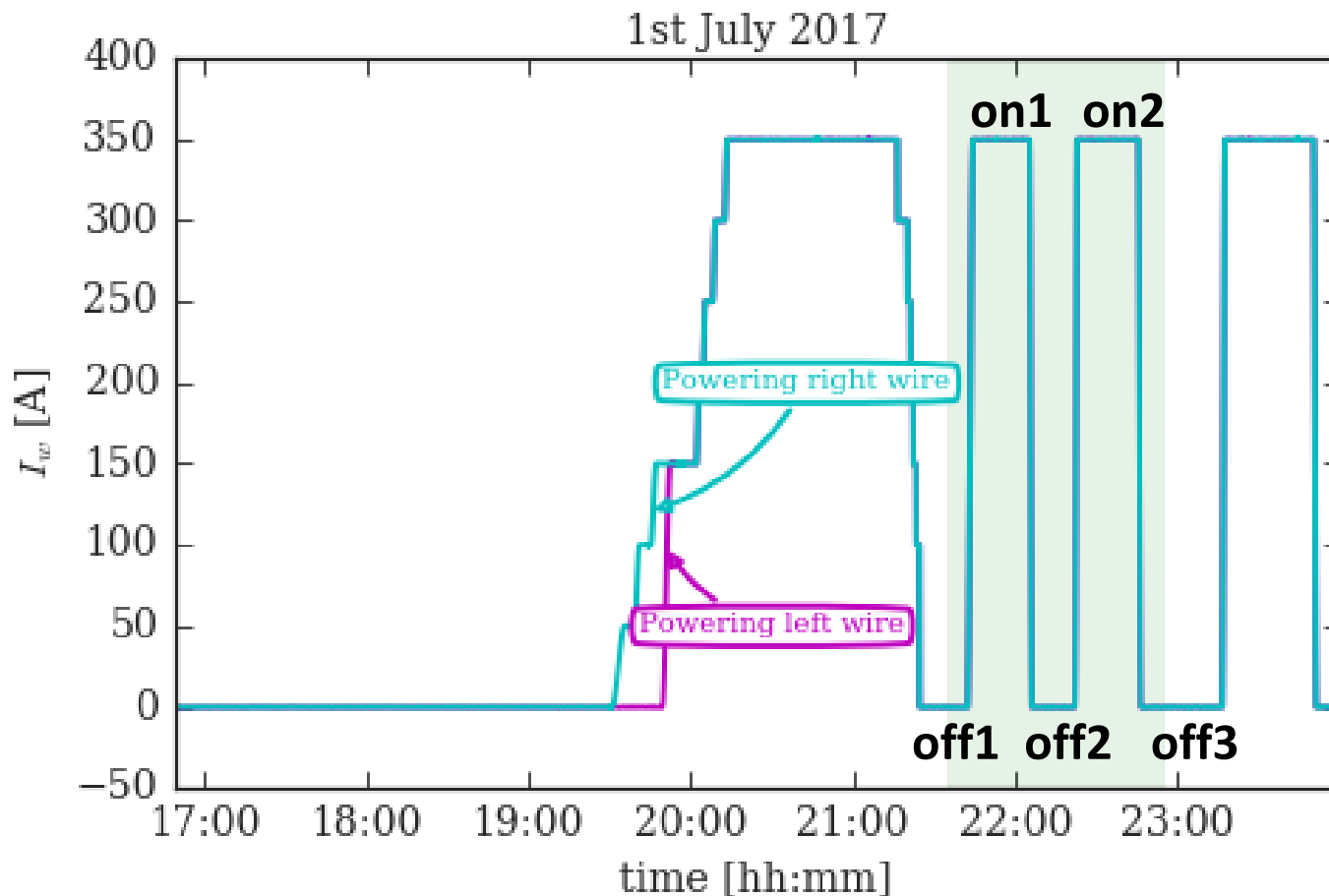


other bunches and profiles see: [bws bsrt cernbox](#)

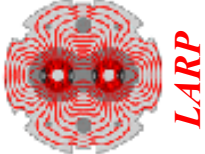
# Results MD2202 – BSRT transverse profiles



# BSRT profiles for wire on/off – B2



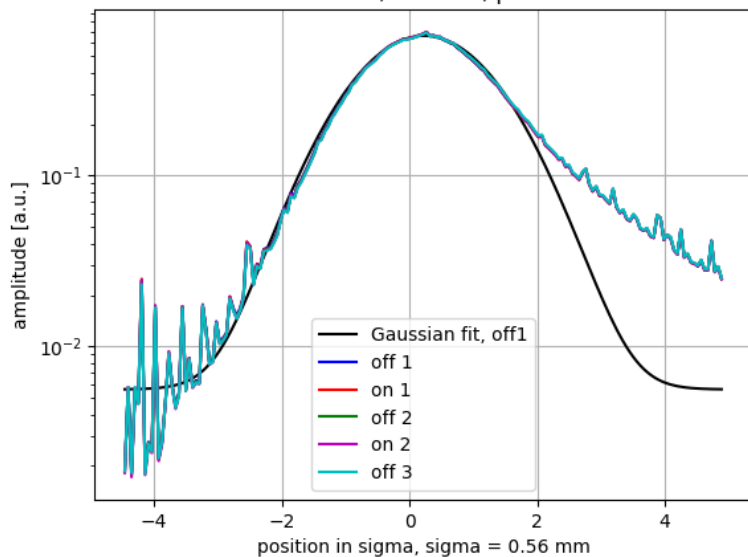
Do we see distribution changes when wire is switched on/off?



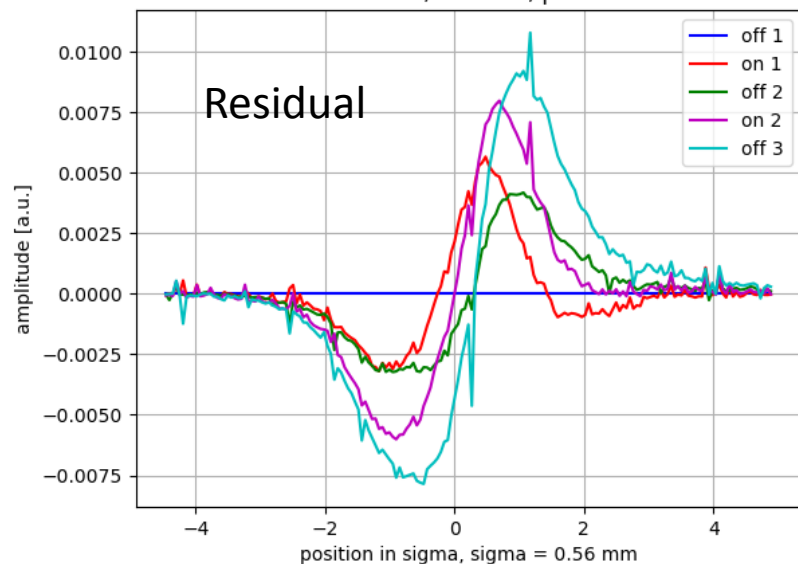
# wire on-off average - H



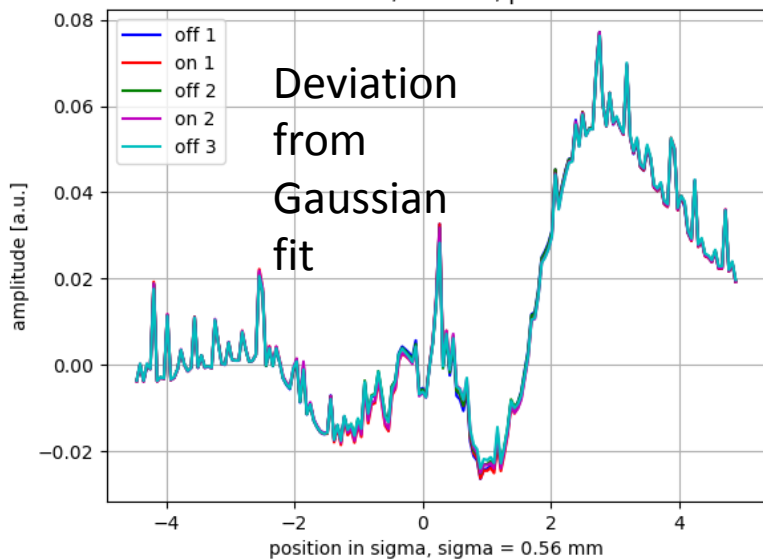
HO+BBLR, slot 224, plane h



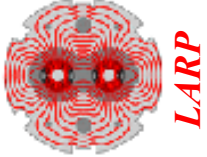
HO+BBLR, slot 224, plane h



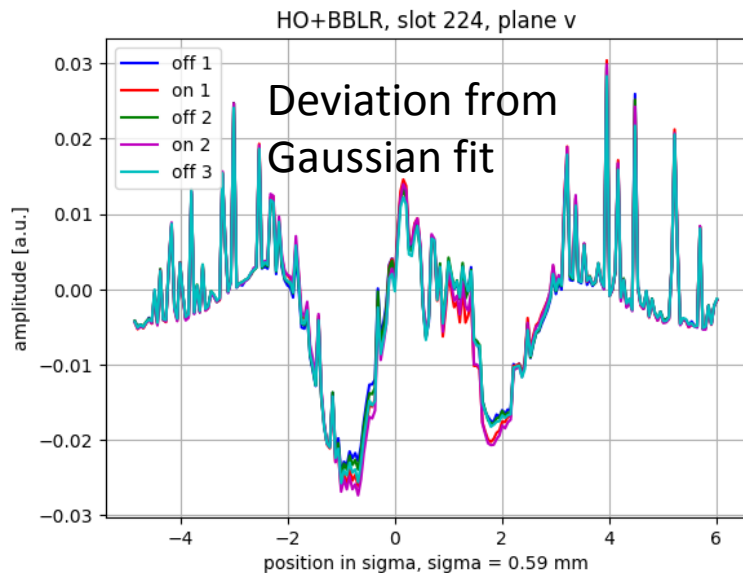
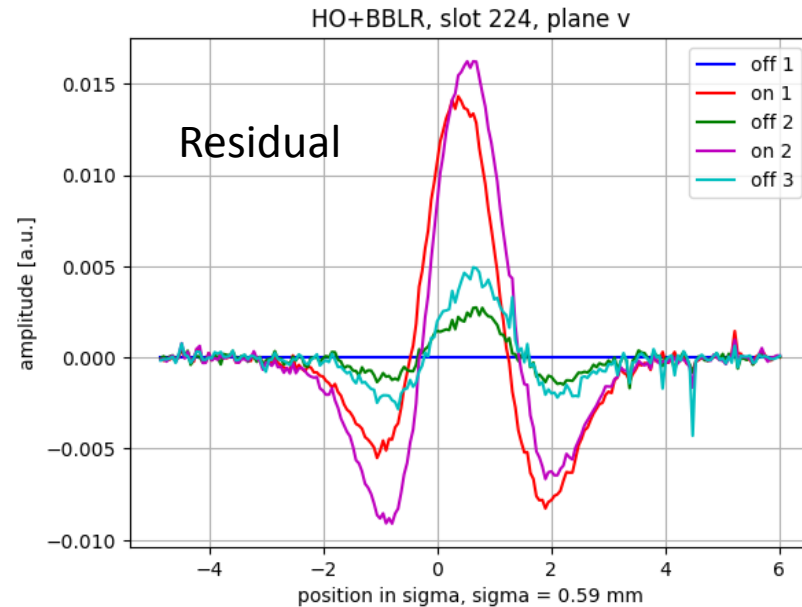
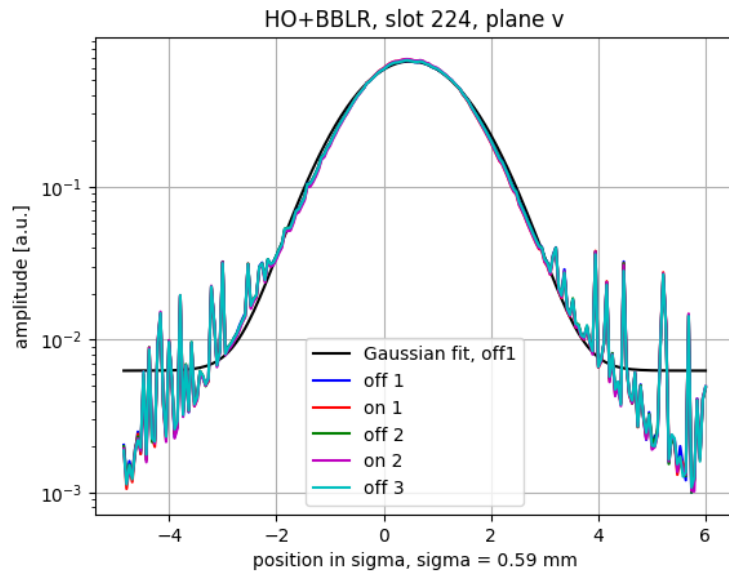
HO+BBLR, slot 224, plane h



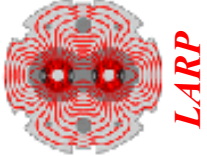
- non-Gaussian distribution
- distribution changes in respect to initial distribution (off1). This change could be due to an **uncompensated orbit shift**
- no difference between bunches (see backup slides)



# wire on-off average - V



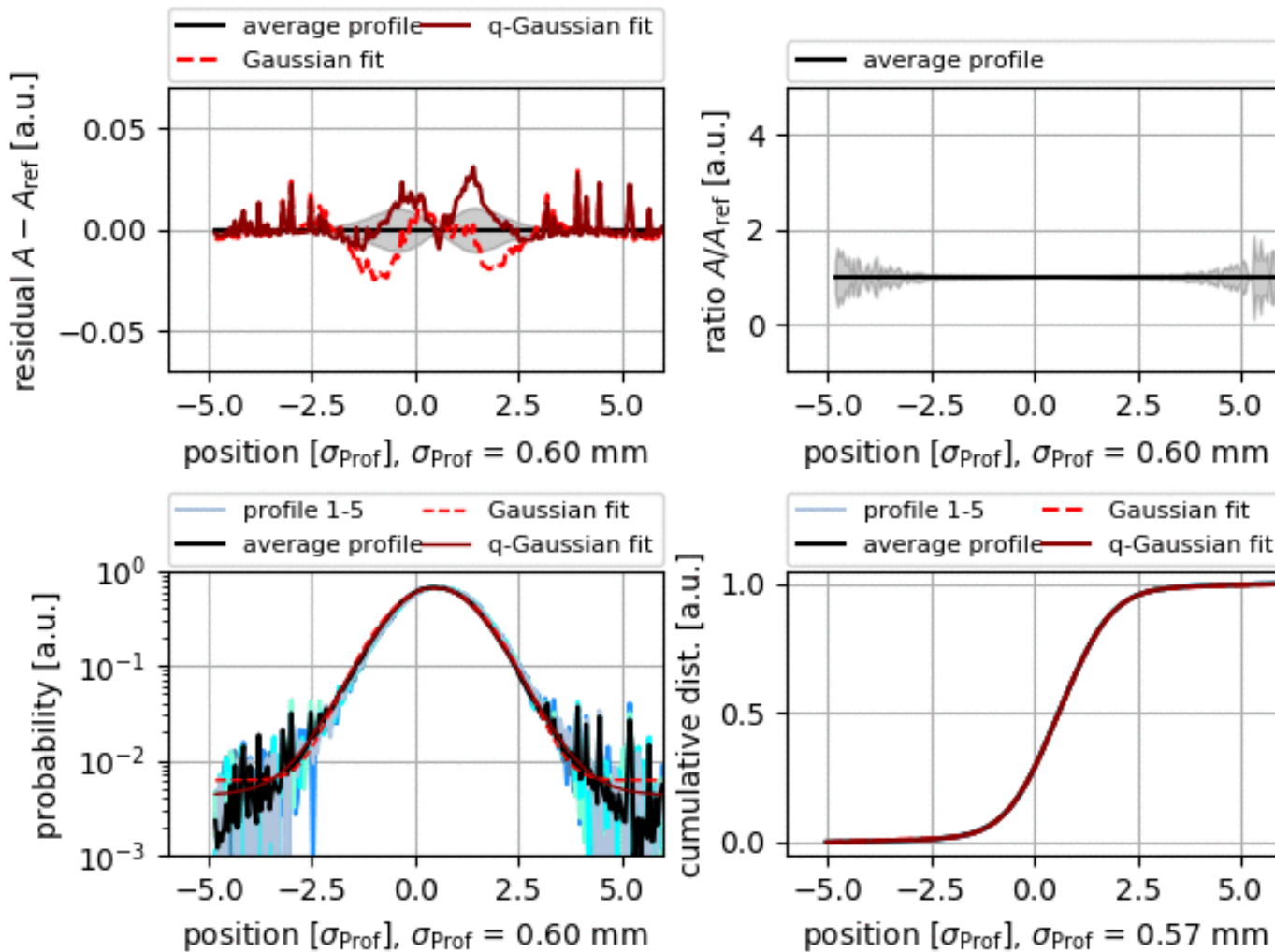
- non-Gaussian distribution
- distribution changes in respect to initial distribution (off1). This change could be due to an **uncompensated beta-beat (decrease of beta)**
- no difference between bunches (see backup slides)



# wire on-off evolution - V

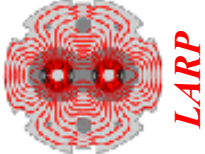


V plane, slot 224 - 2017-07-01 21:35:01, ref slot 224 - 2017-07-01 21:35:01

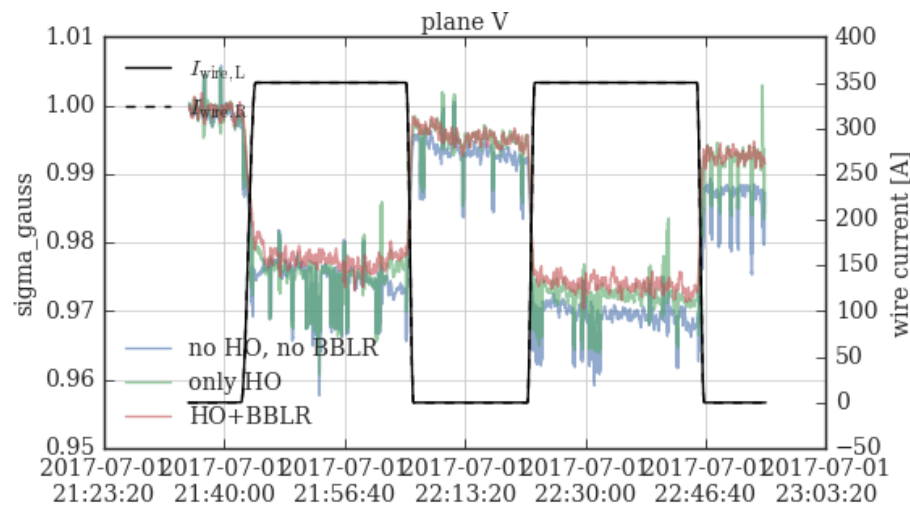
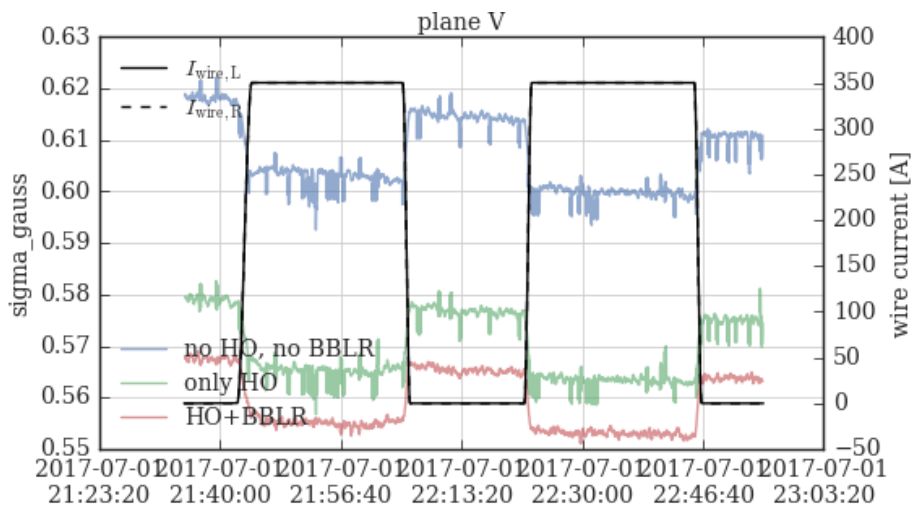
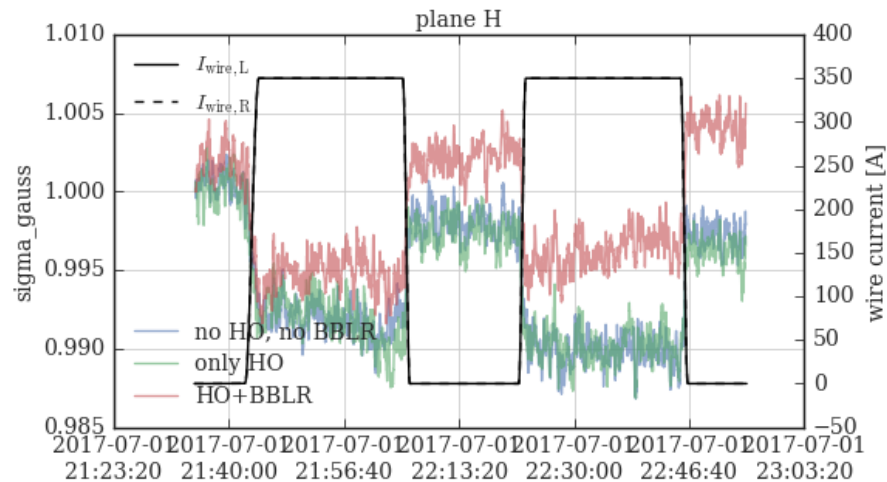
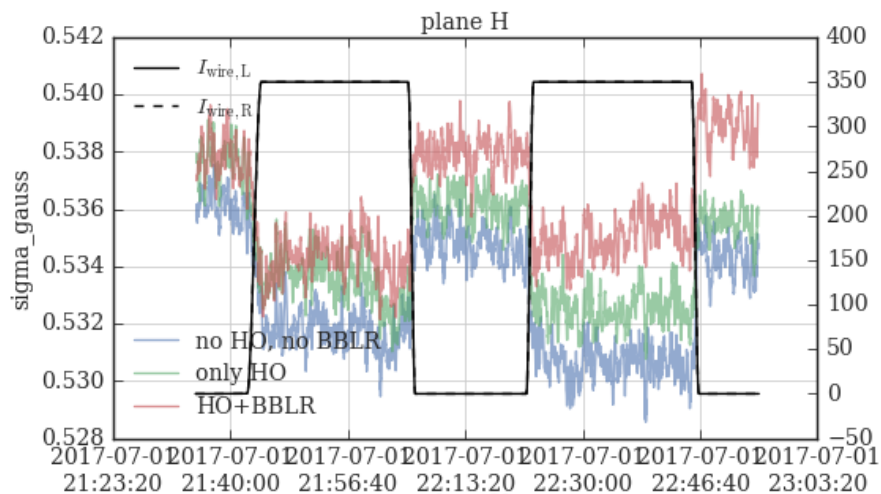


similar profiles for other bunches  
see [bsrt profiles](#)

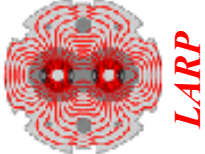




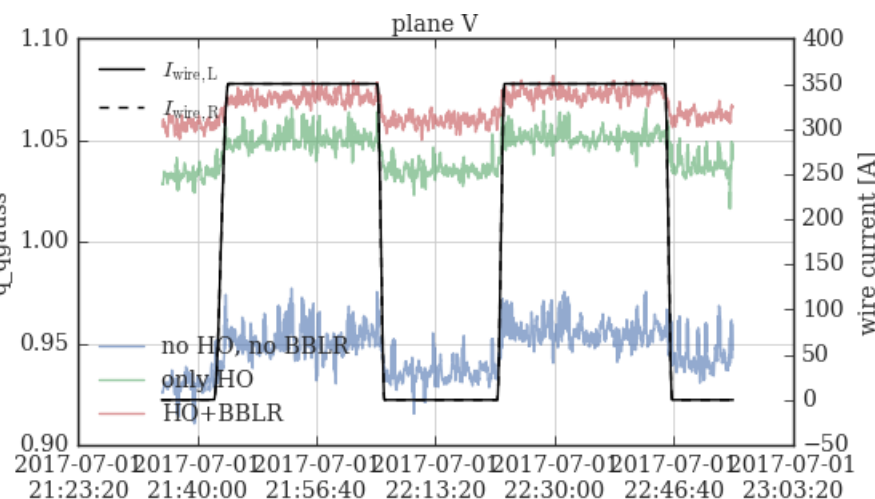
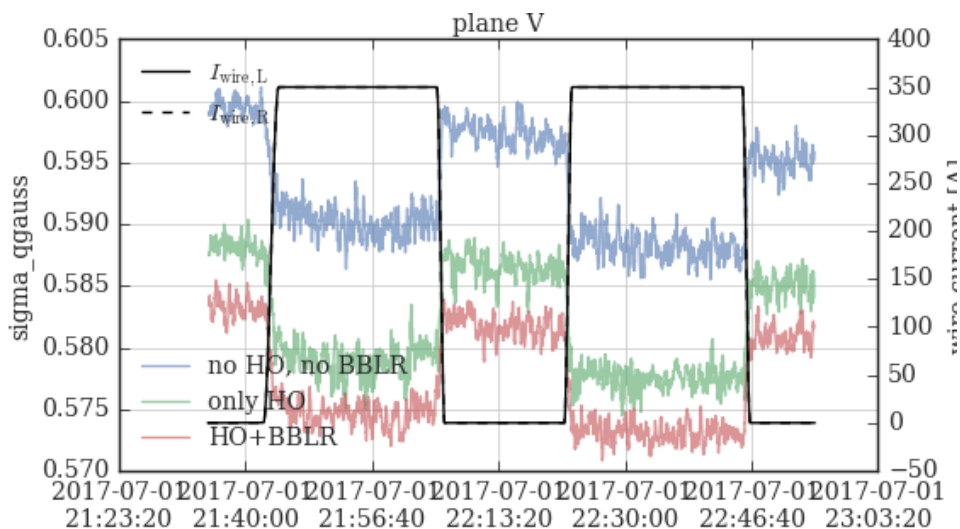
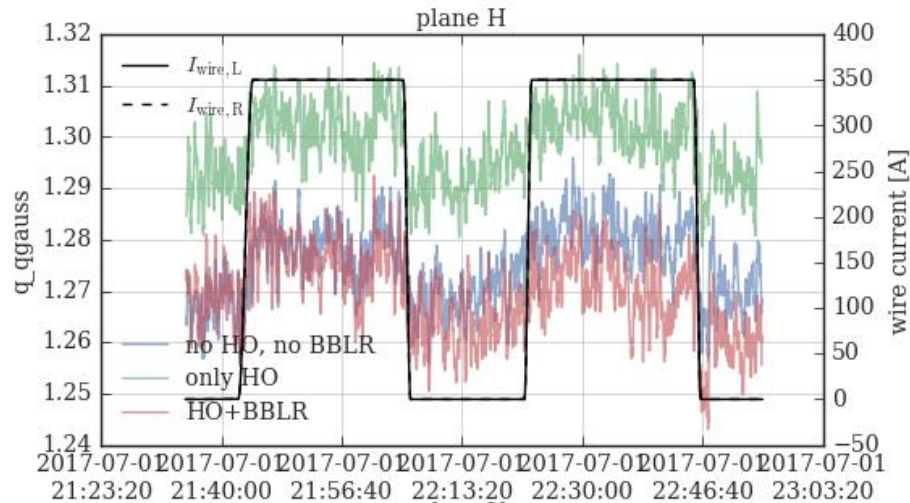
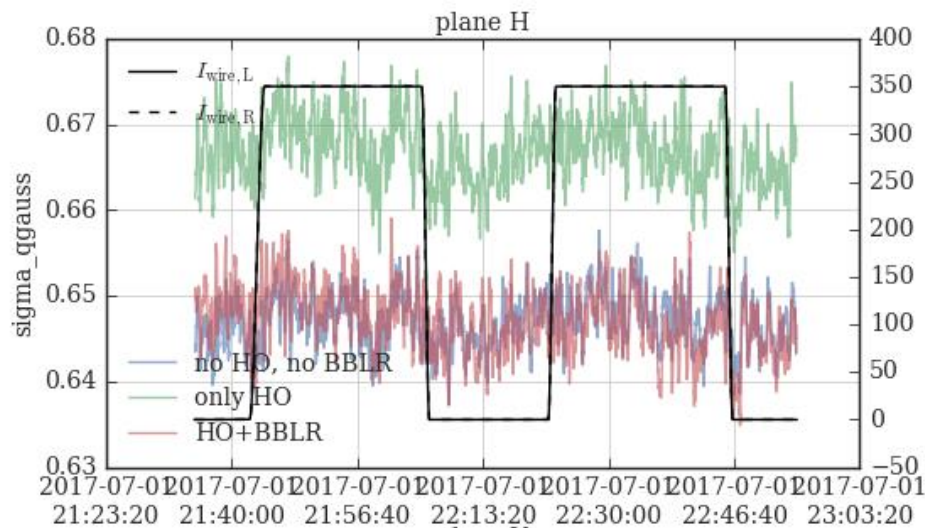
# wire on-off – Gauss



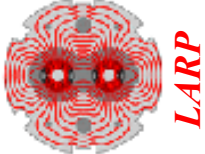
Beam size change is consistent with beta-beat (decrease of beta) + the profile changes observed



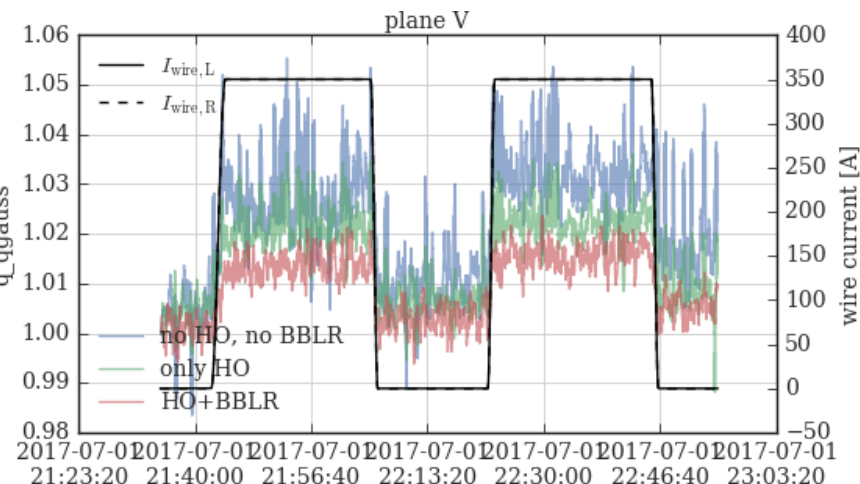
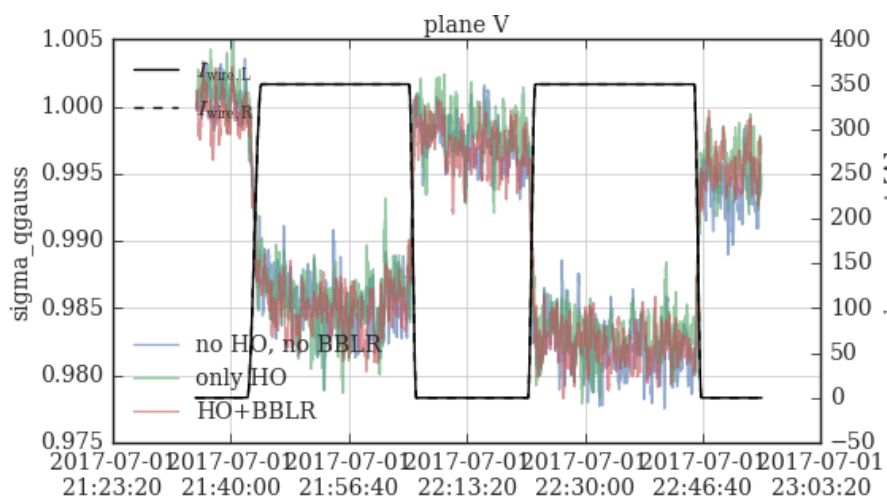
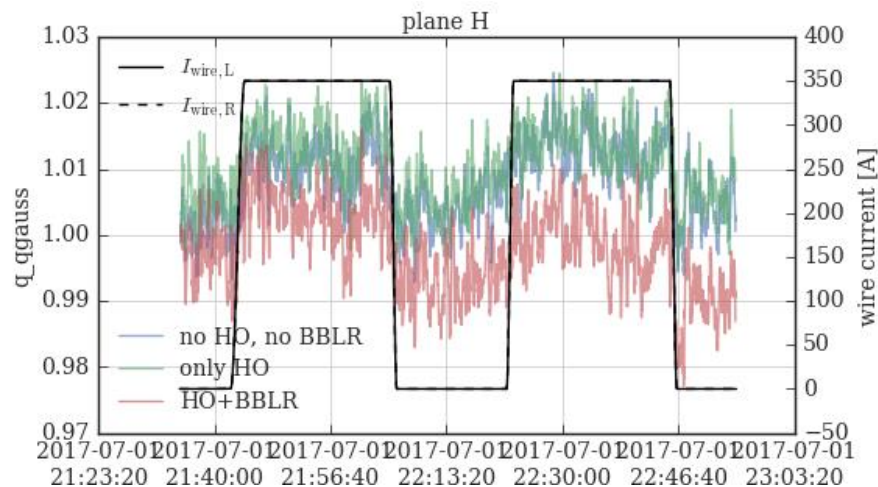
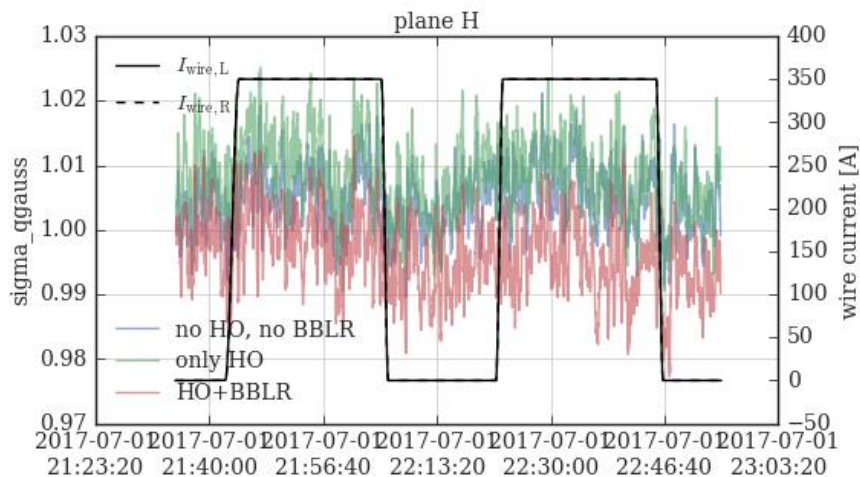
# wire on-off – q-Gauss



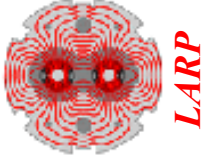
better agreement with observed shift of distribution in H (no increase in sigma)  
 + beta-beat in V (decrease of sigma when wire is switched on)



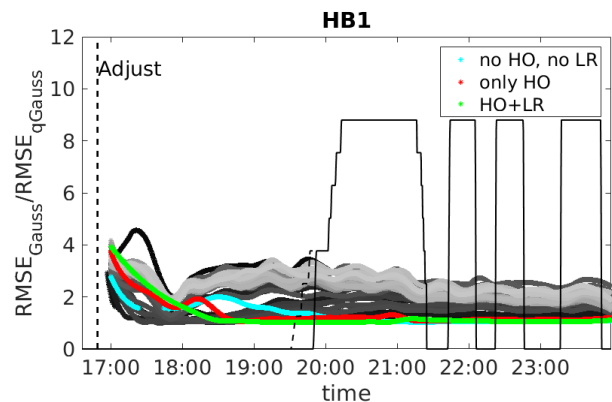
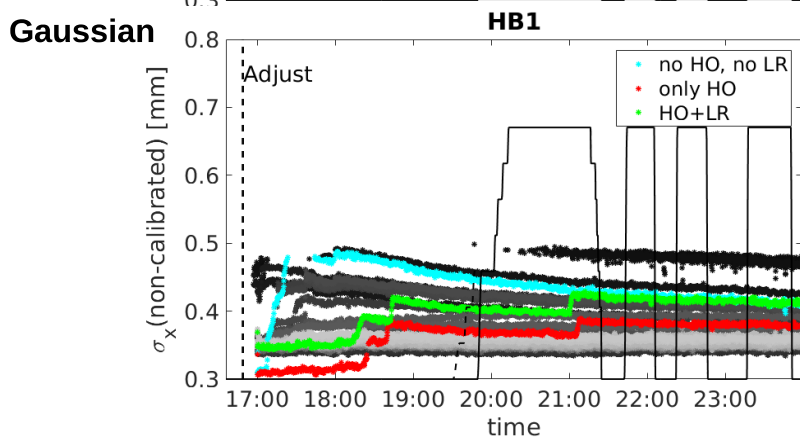
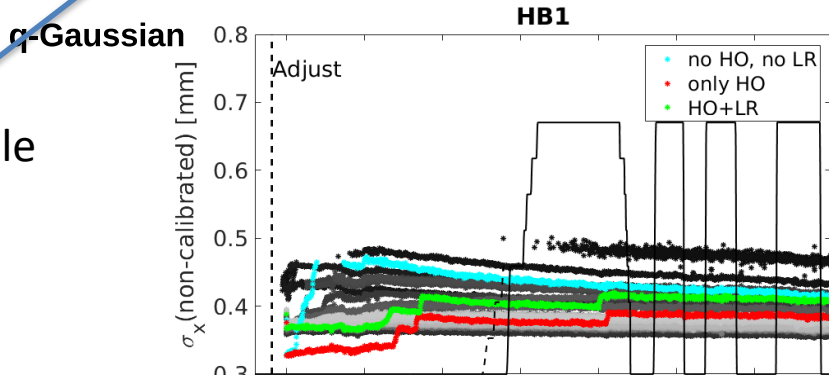
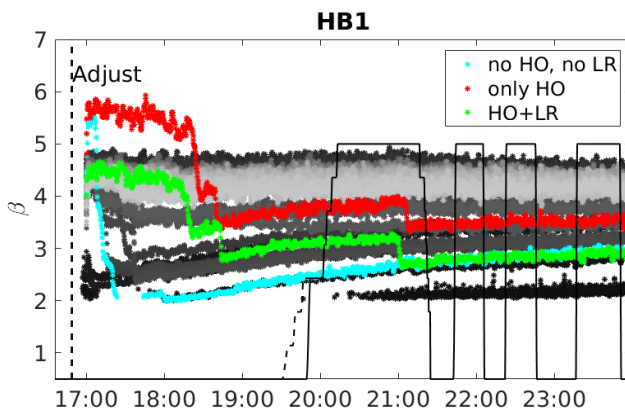
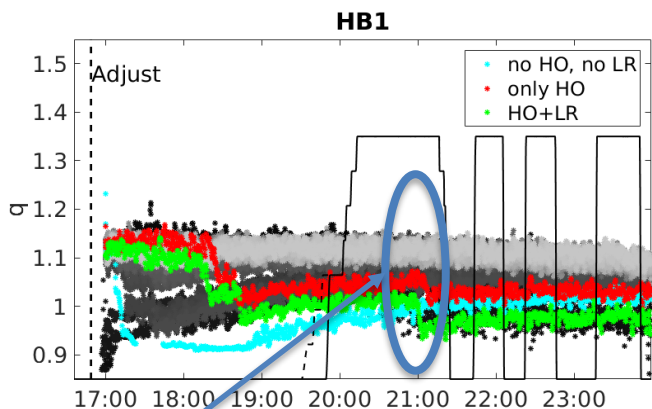
# wire on-off $\beta$ -q-Gauss



q-parameter changes when wire is switched on -> bunch with compensation appears least affected -> are these changes real or instrumental???

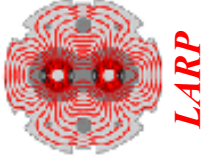


# BSRT profiles fill – B1 H

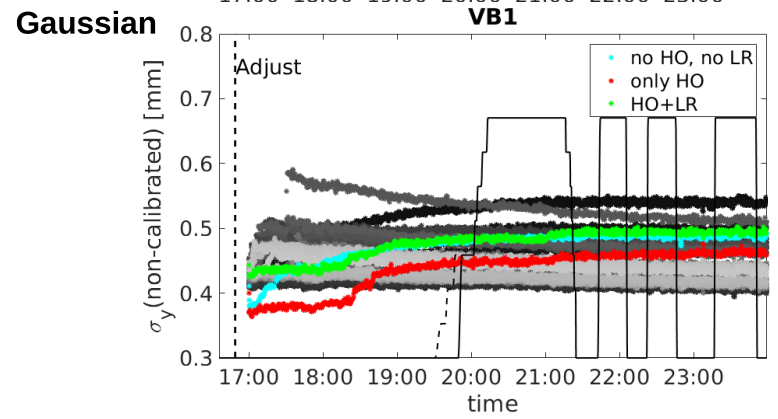
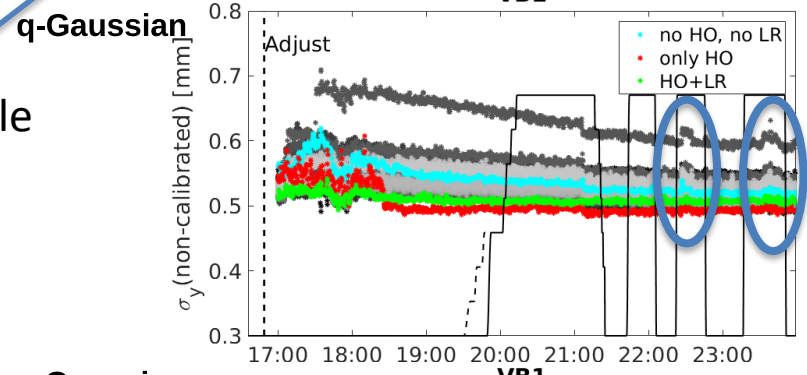
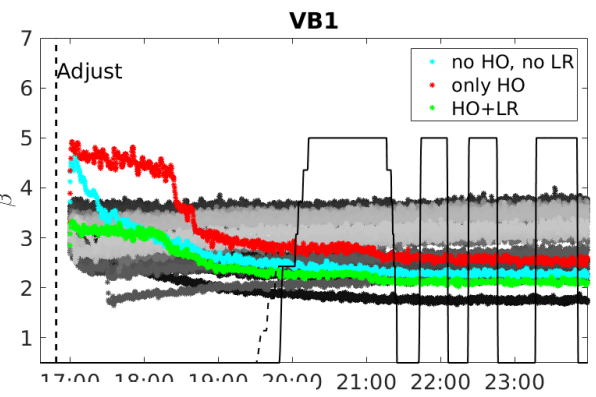
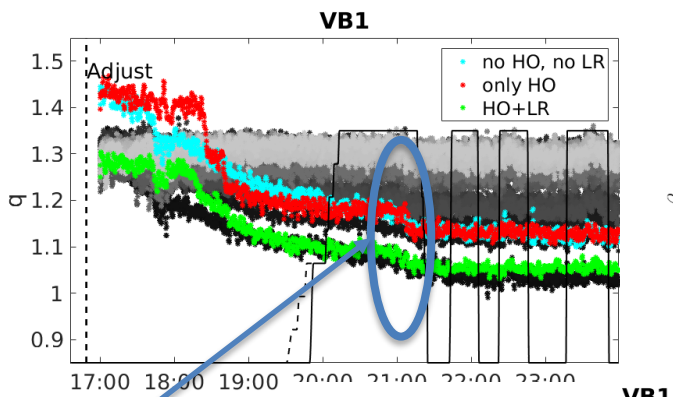


crossing angle reduction?

Courtesy S. Papadopoulou

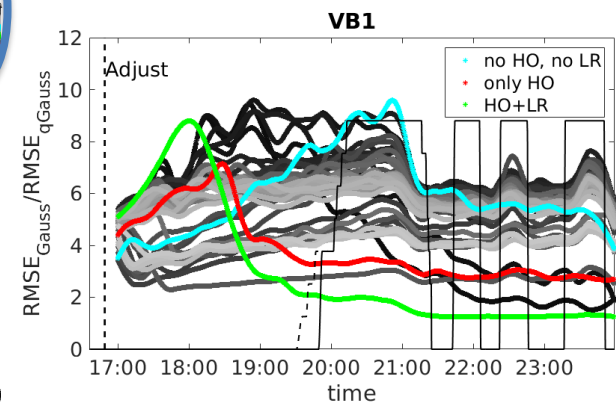


# BSRT profiles fill – B1 V



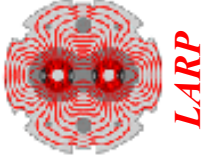
crossing angle reduction?

What is this?



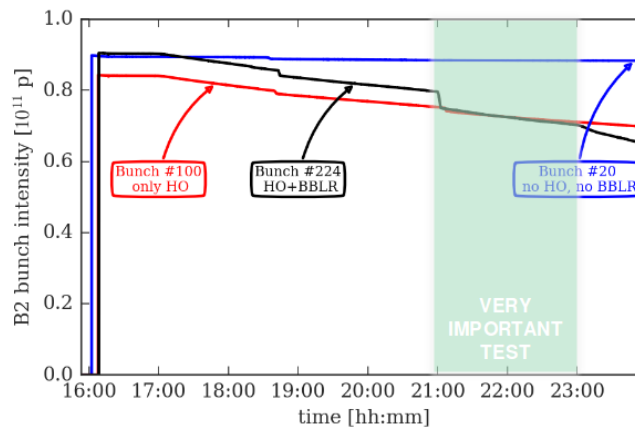
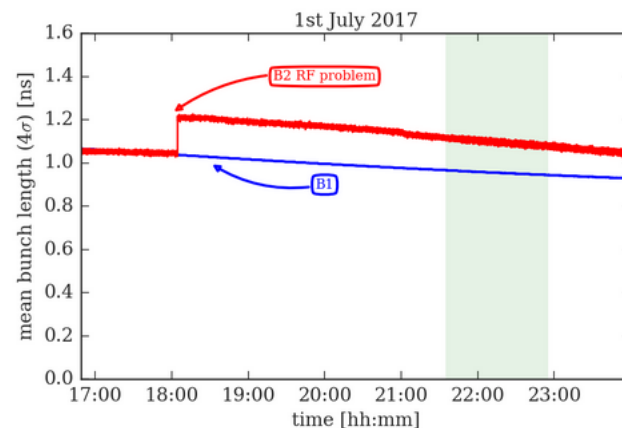
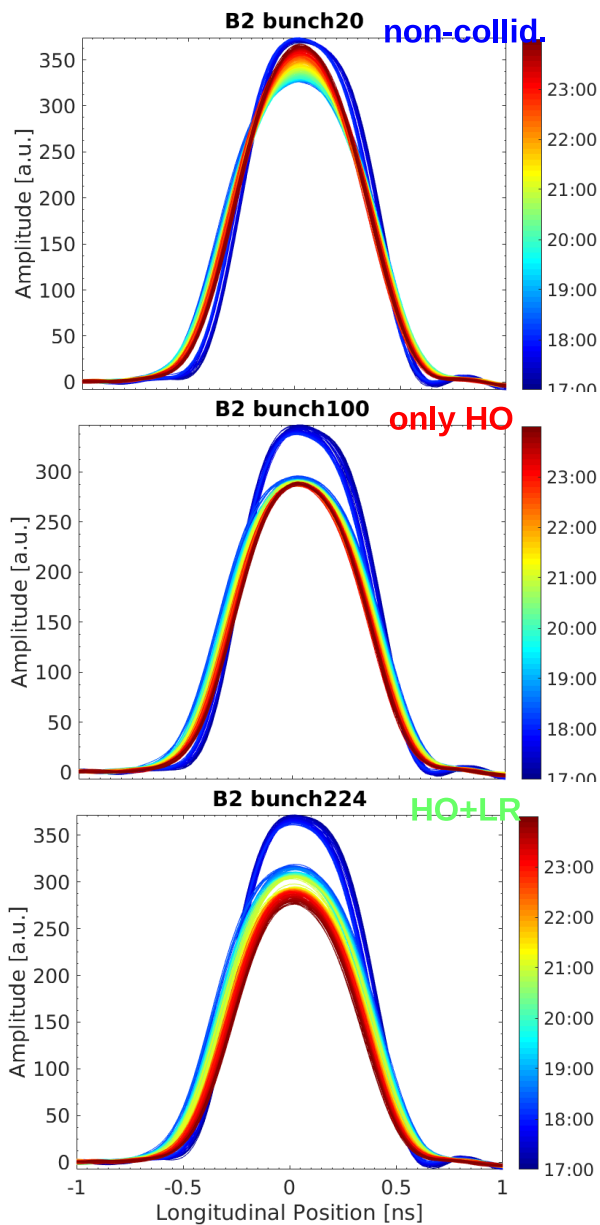
Courtesy S. Papadopoulou

# **Results MD2202 – longitudinal profiles B2 (B1 scope broken)**

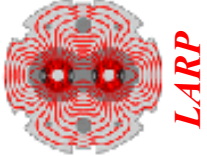


LARP

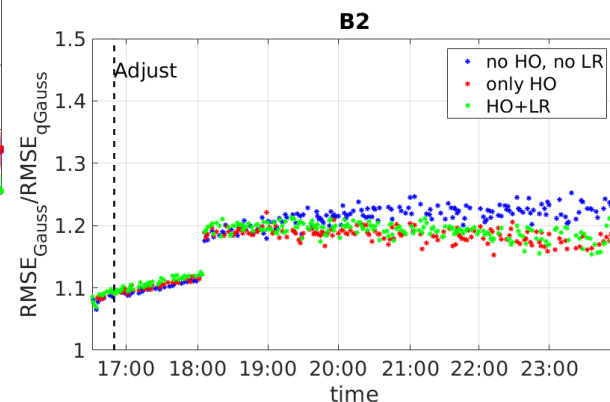
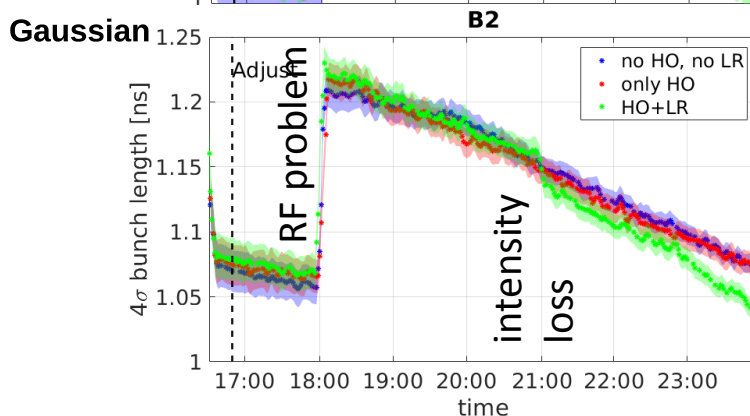
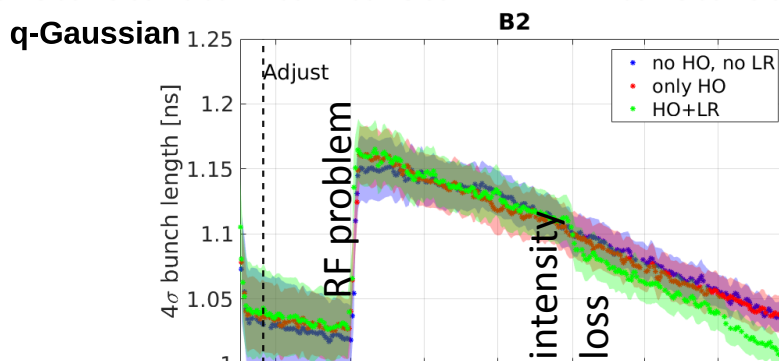
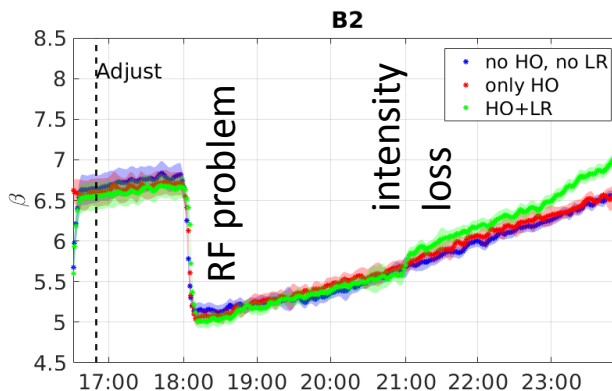
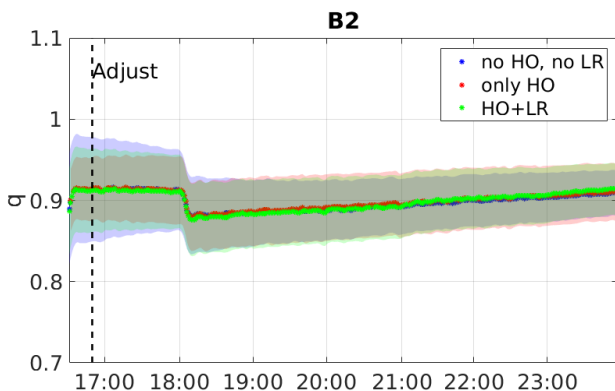
# Evolution of long. prof.



Courtesy  
S. Papadopoulos

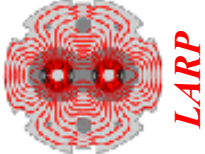


# Evolution of long. prof.



Courtesy  
S. Papadopoulou





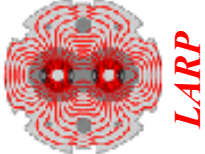
# Conclusion



We need input from BI experts to understand better our results!!!

BSRT compared to BWS (wire scan):

- Injection:
  - BWS profiles show heavier tails than BSRT profiles
  - artificial small bump on right side H in BSRT profiles
  - BSRT profiles rather Gaussian, BWS profiles non-Gaussian with heavier tails
- Flat top:
  - in H left side agrees “fairly” well
  - in V whole profile agrees “fairly” well
  - bunches appear to be quite Gaussian up to 2-3 sigma (very roughly!)

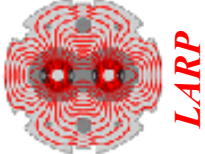


We need input from BI experts to understand better our results!!!

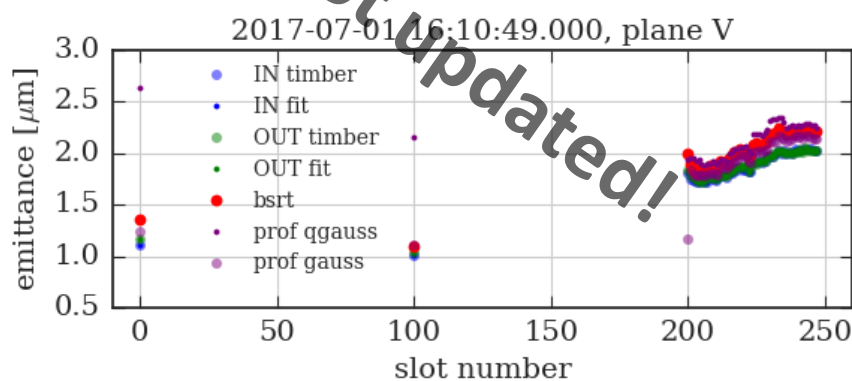
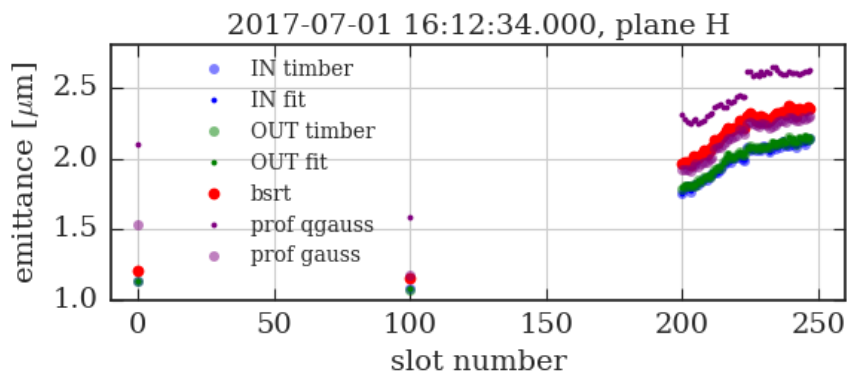
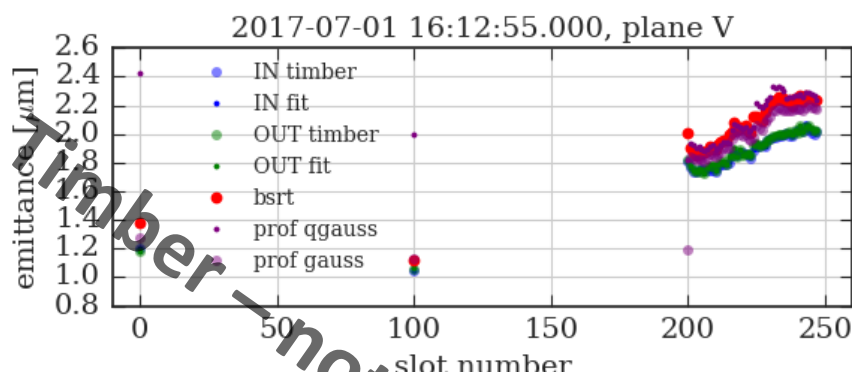
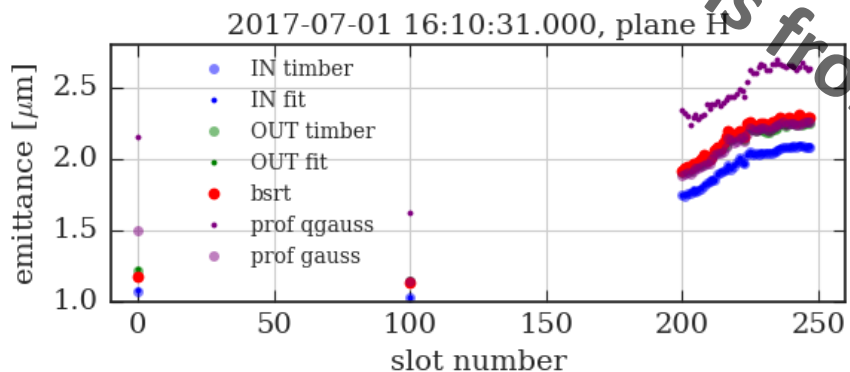
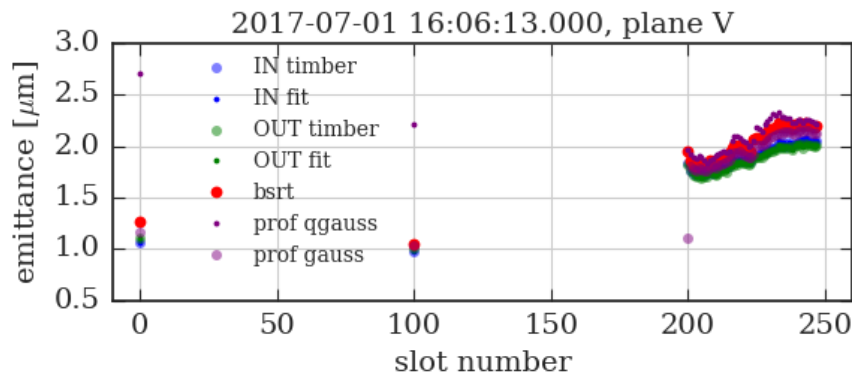
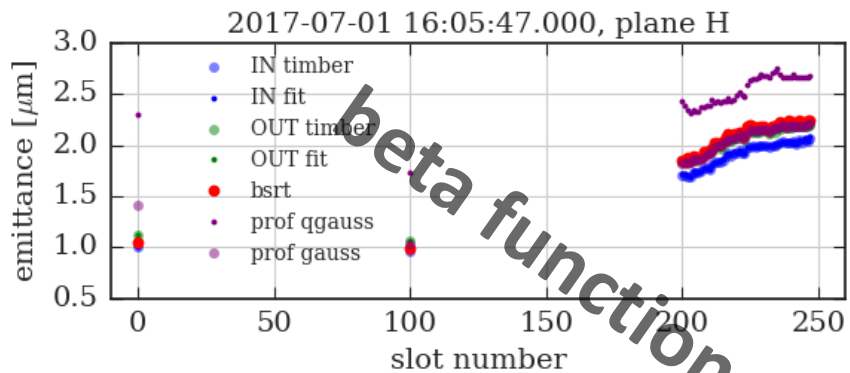
LR BB compensation - change of profile when wire is switched on/off:

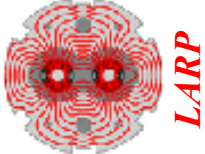
1. change in profile with wire current can be explained by orbit shift in H and beta-beat in V
2. no or only very small differences of distribution change between bunches  
-> is this real or an artifact of our fitting/model?

# Backup Slides

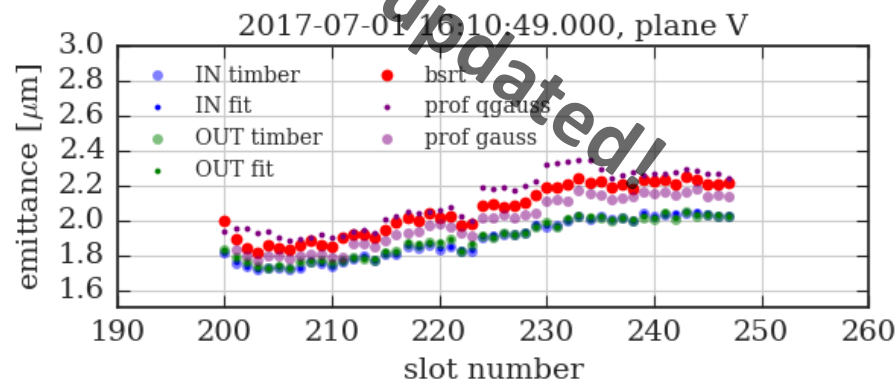
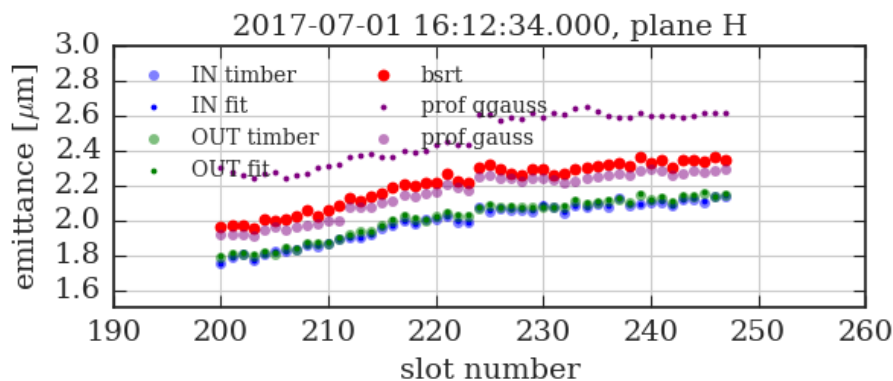
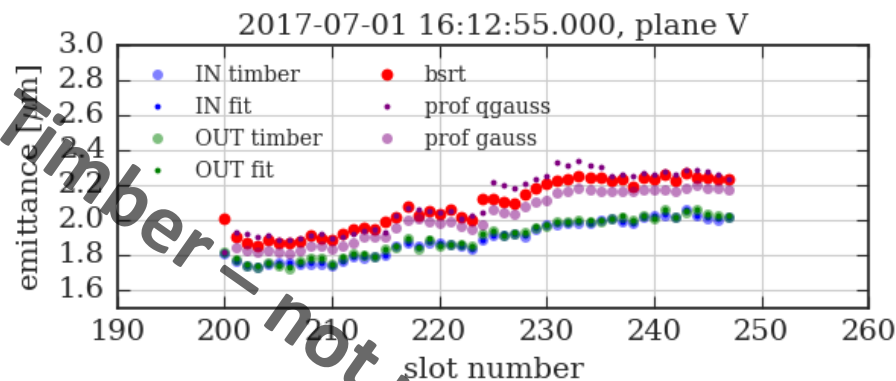
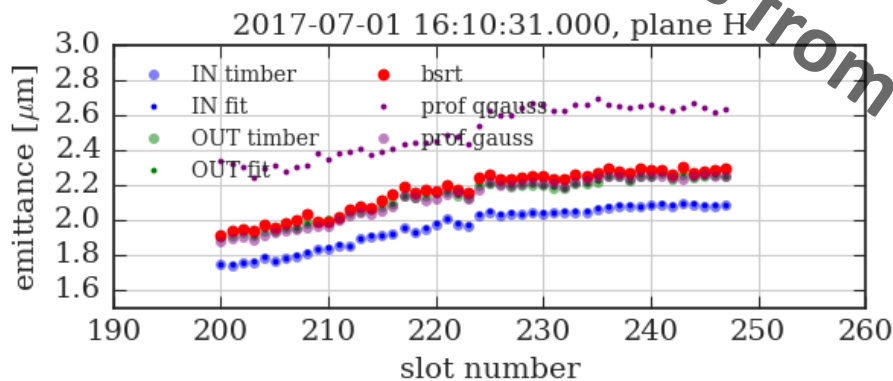
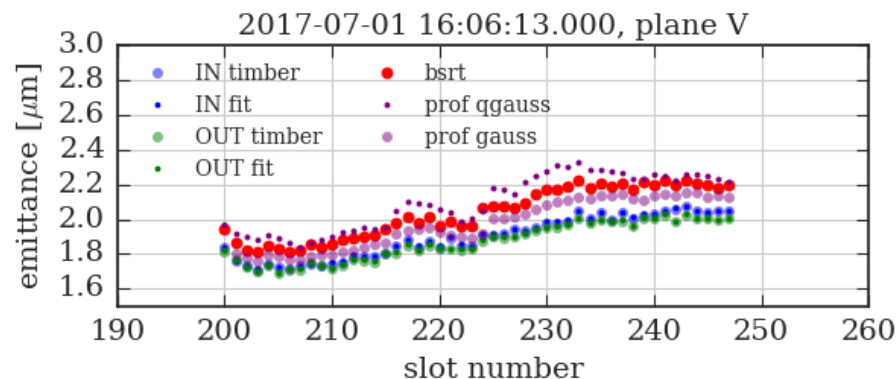
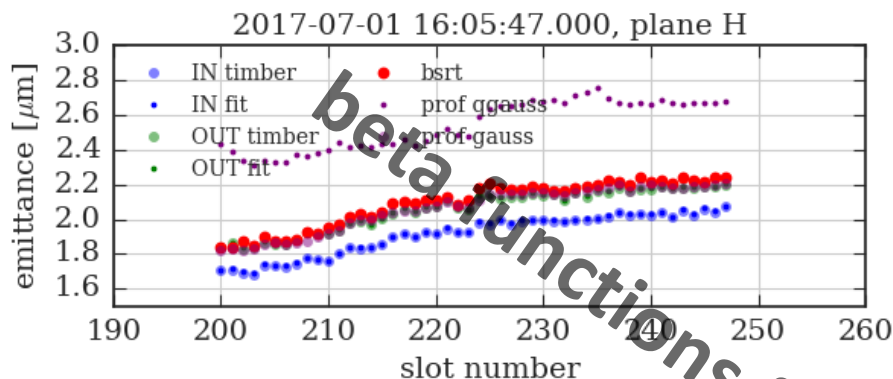


# Beam 1 Injection – all bunches

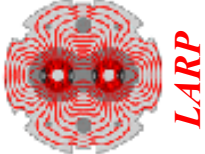




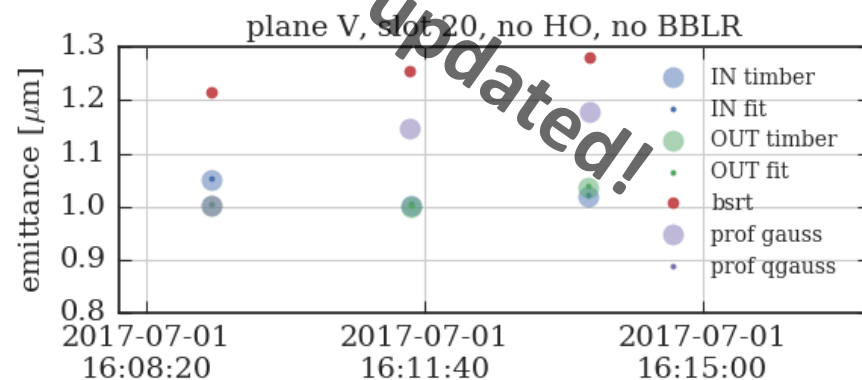
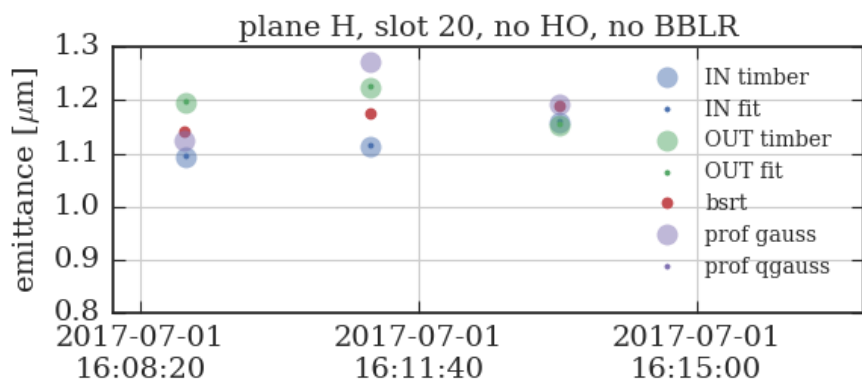
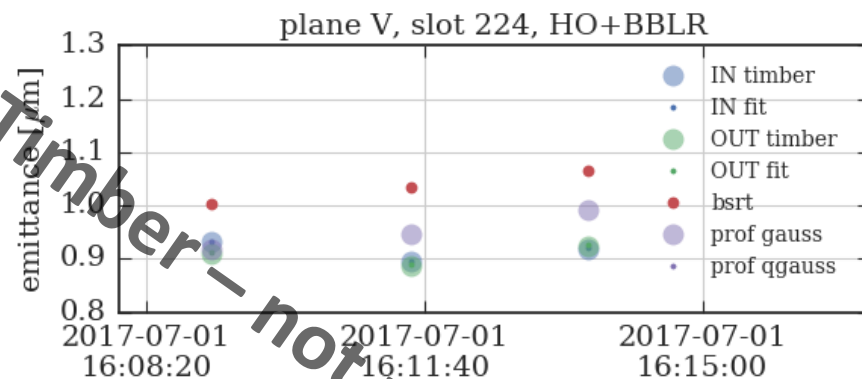
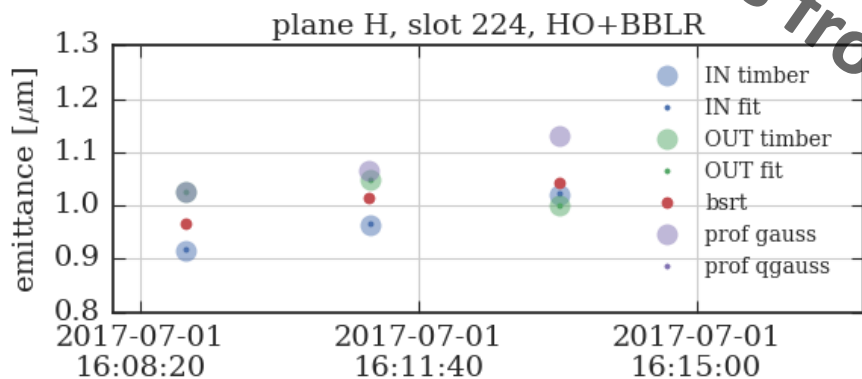
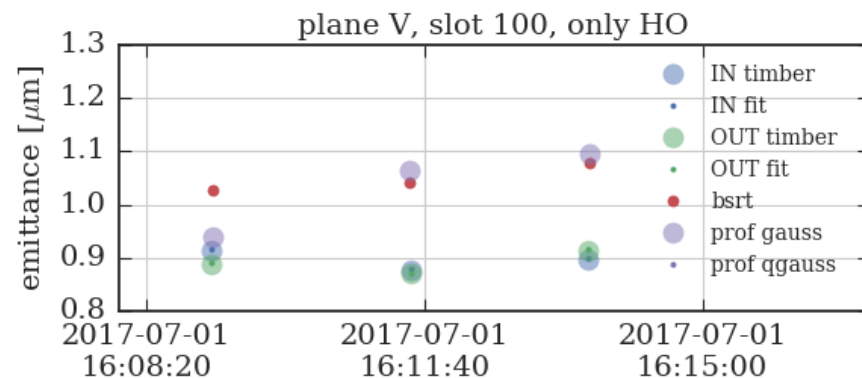
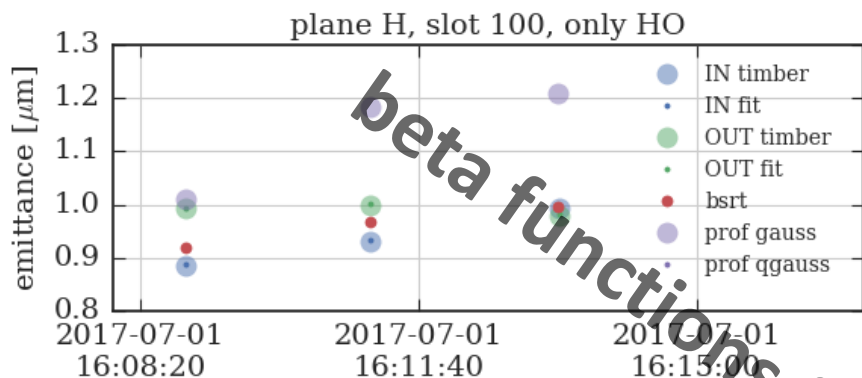
# Beam 1 Injection – train



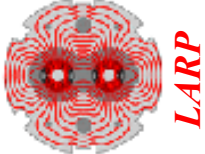
beta functions from timber – not updated!



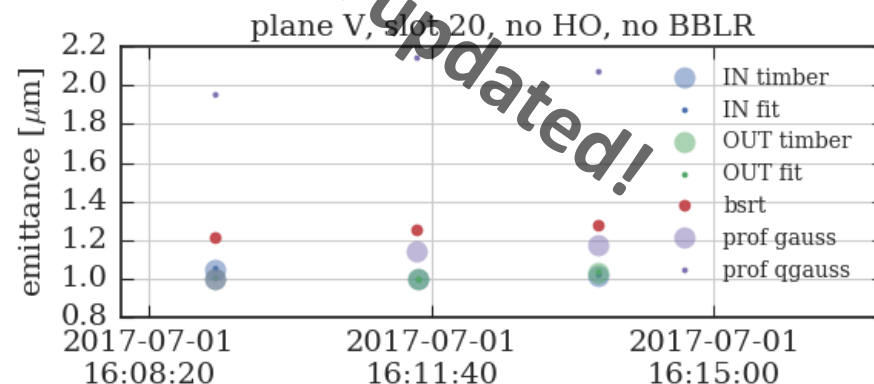
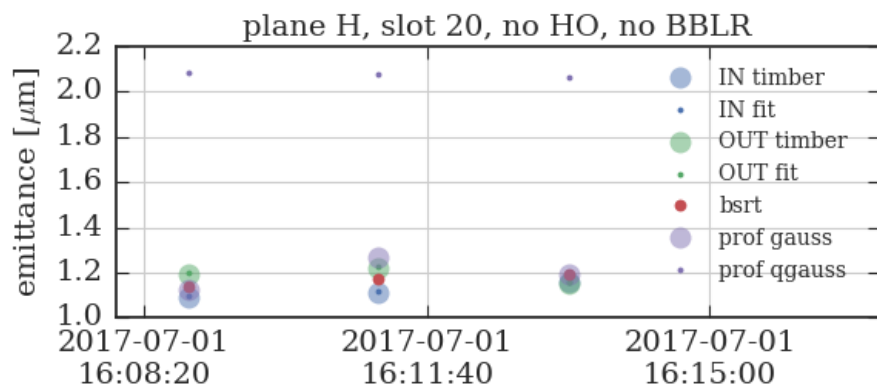
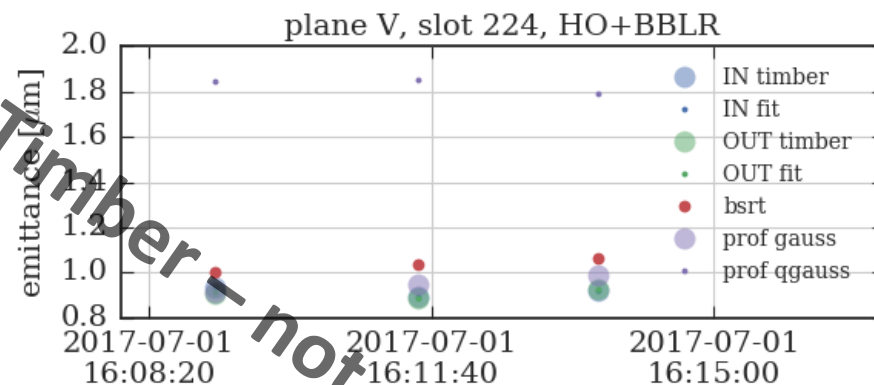
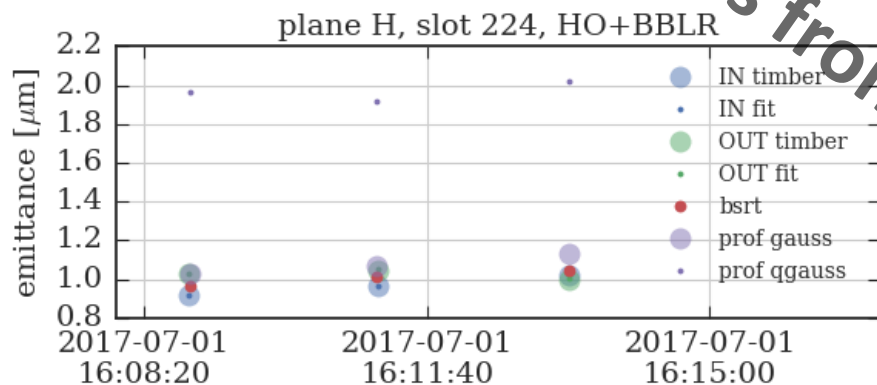
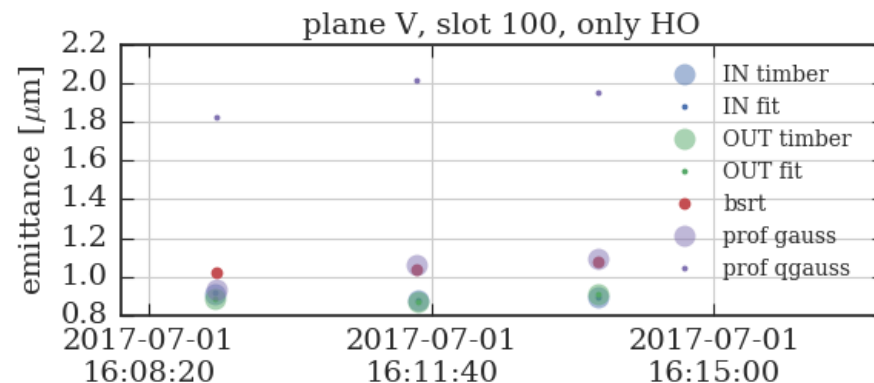
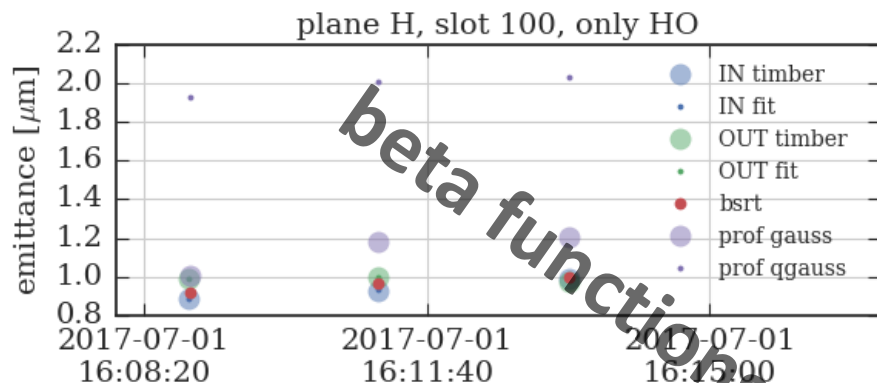
# Beam 2 Injection



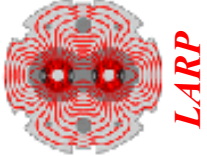
beta functions from Timber - not updated!



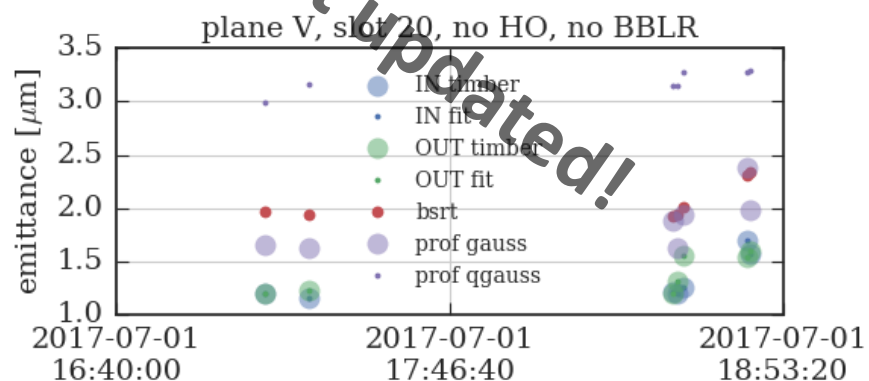
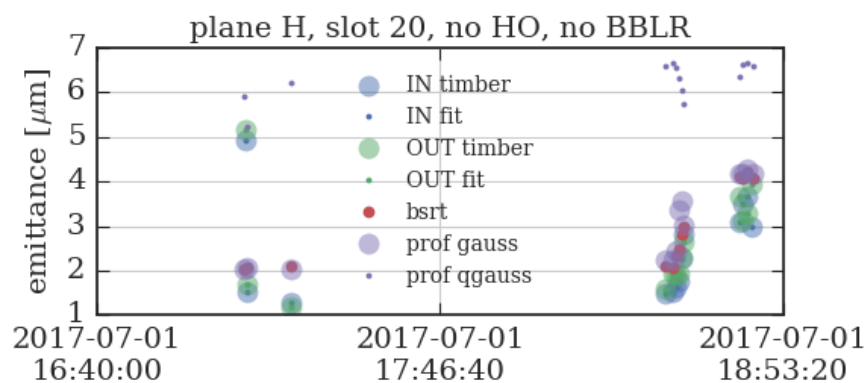
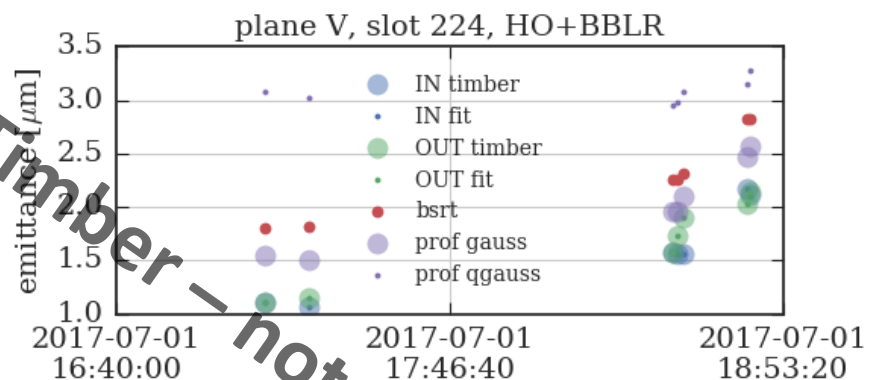
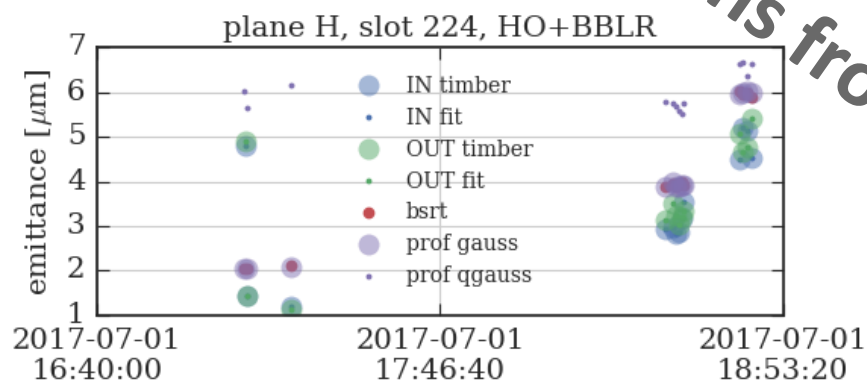
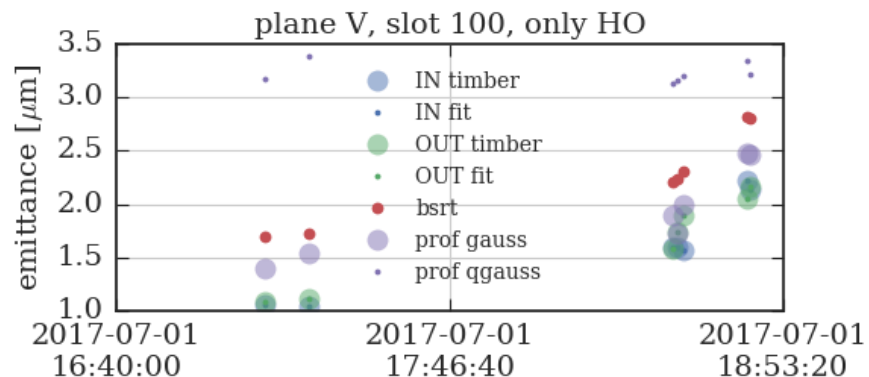
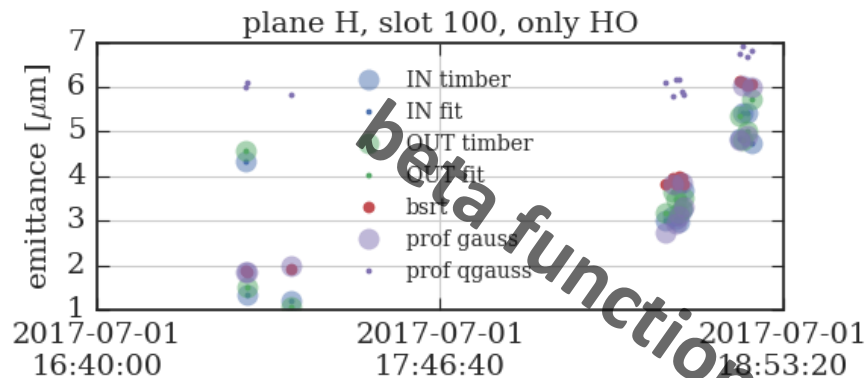
# Beam 2 Injection – with q-Gauss fit



beta functions from Timber – not updated!

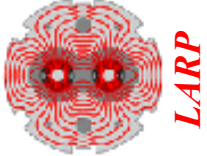


# Beam 2 FT

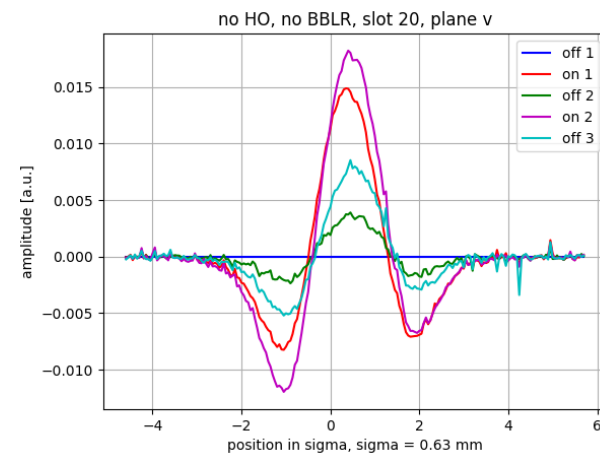
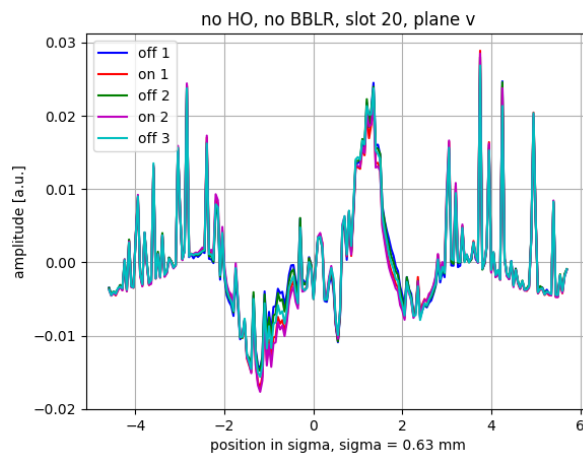
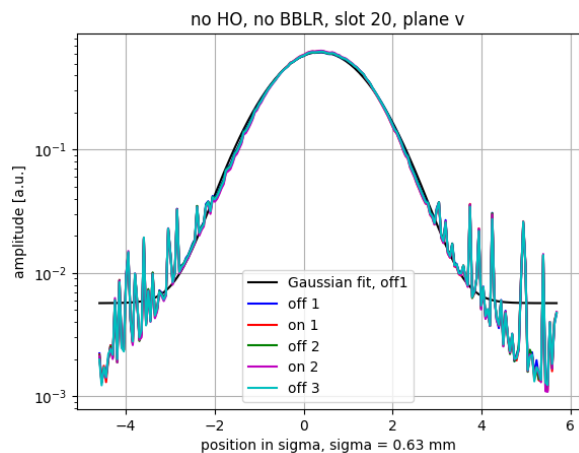
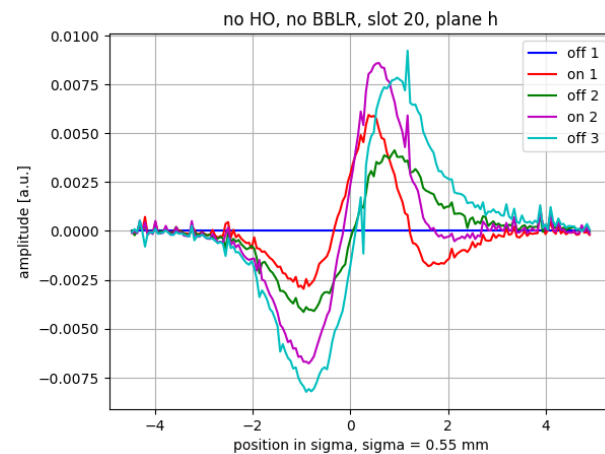
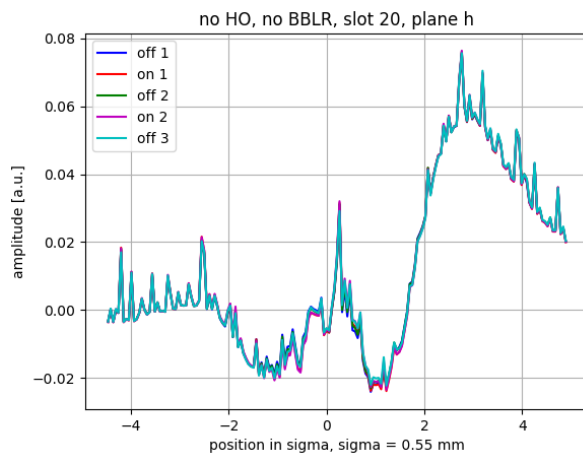
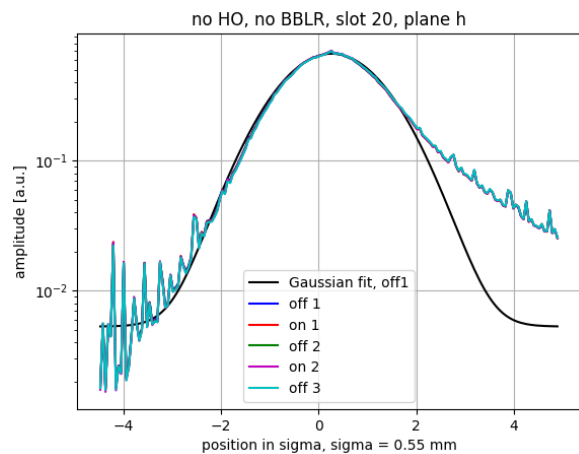


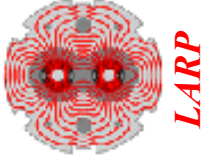
beta functions from Timber - not updated!



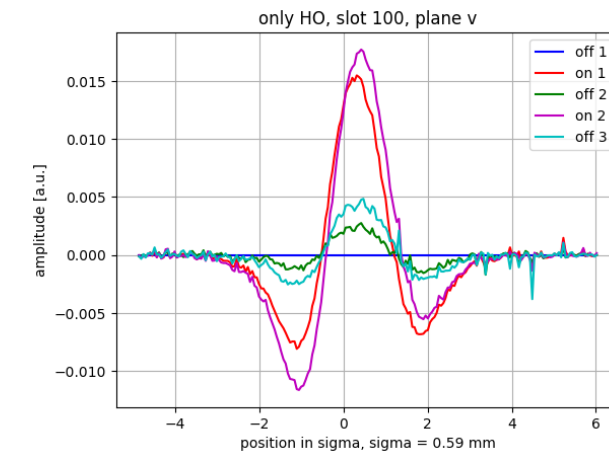
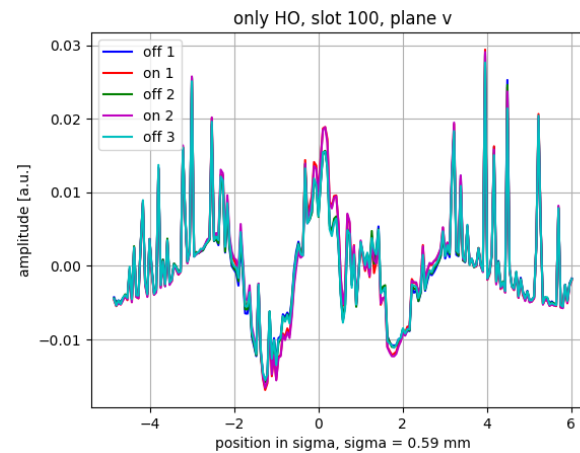
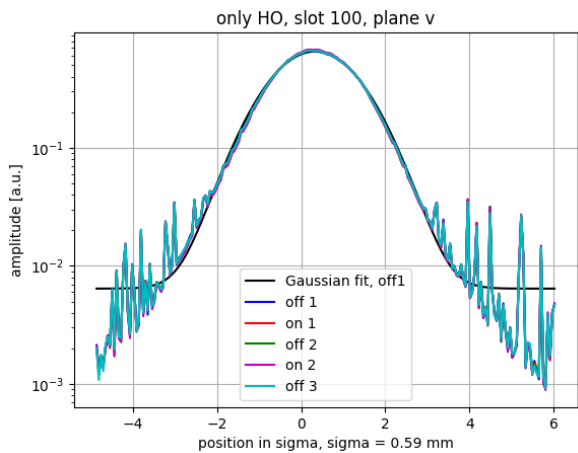
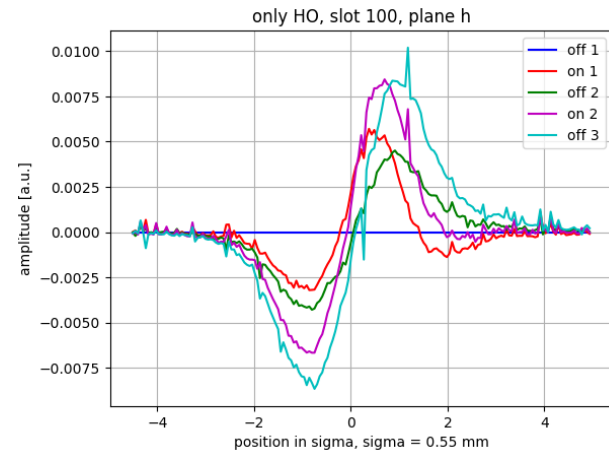
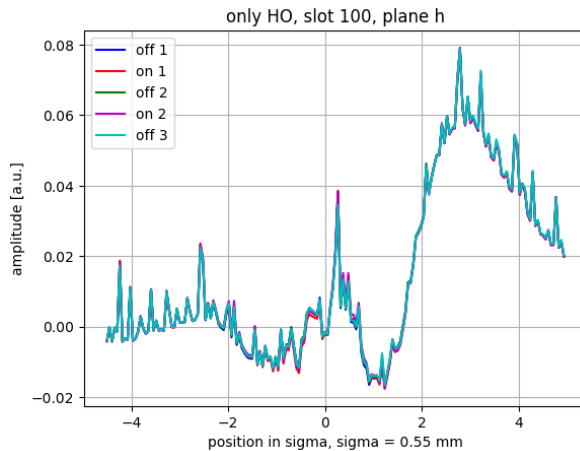
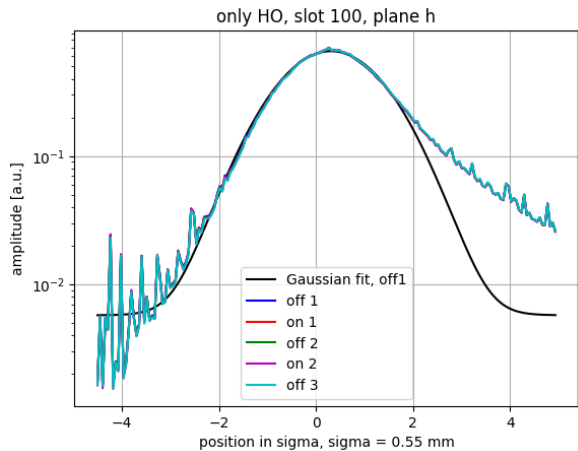


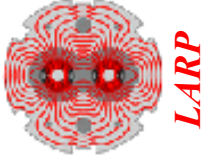
# BSRT profiles wire on/off slot 20



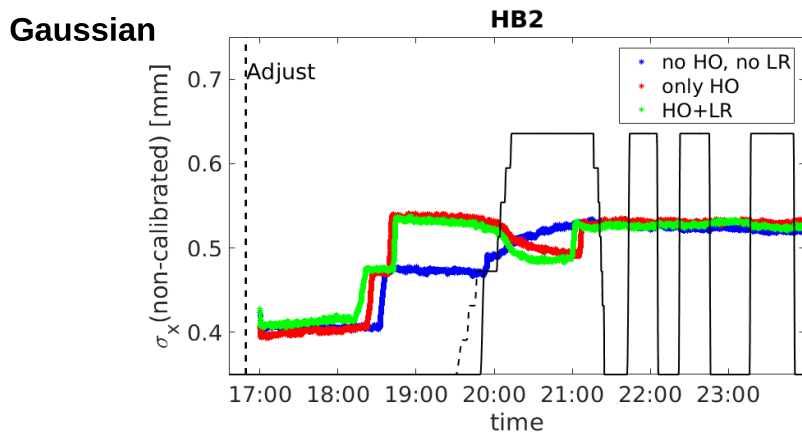
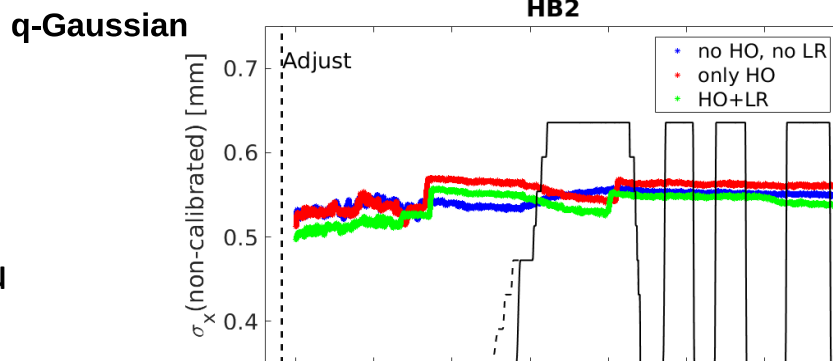
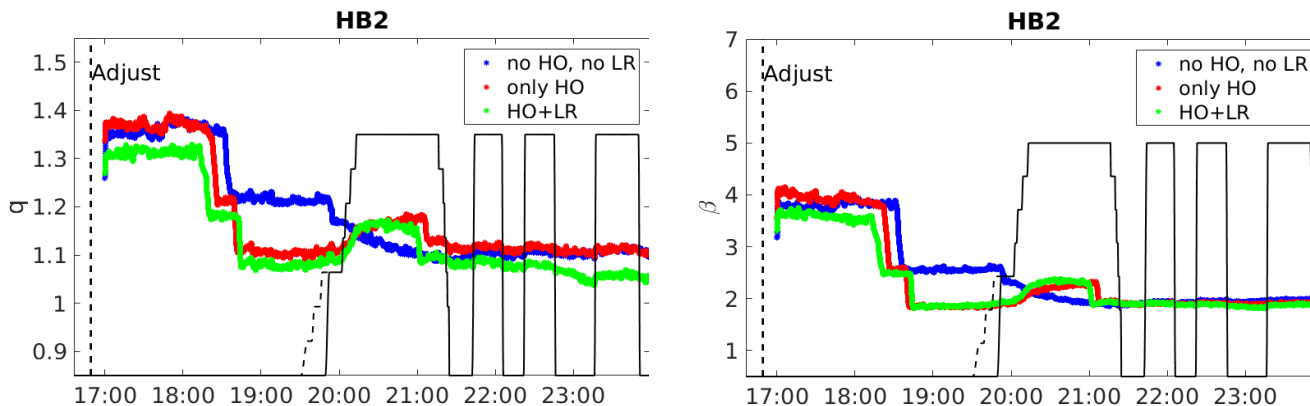


# BSRT profiles wire on/off slot 100

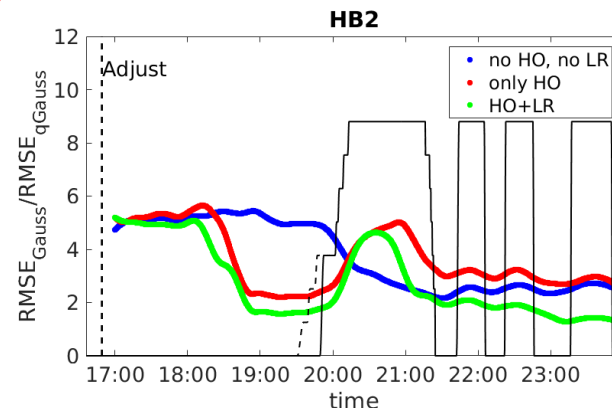




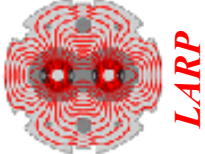
# BSRT profiles fill – B2 H



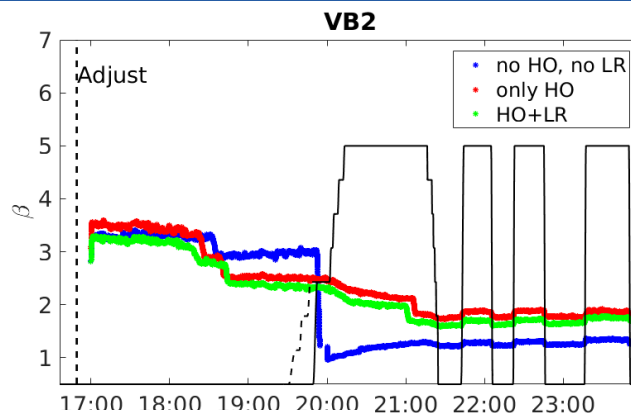
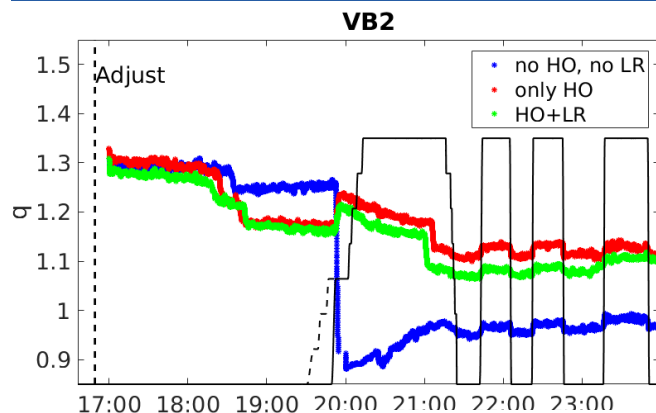
no change with wire on/off



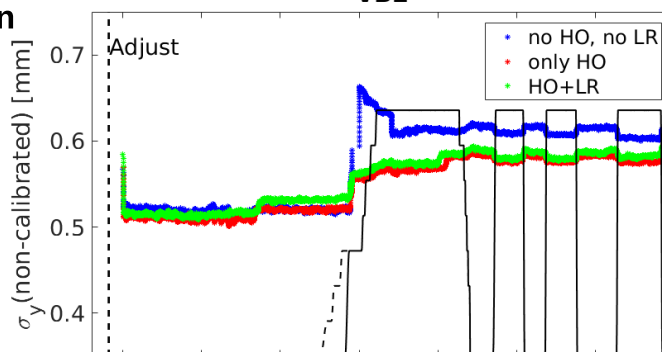
Courtesy  
S. Papadopoulou



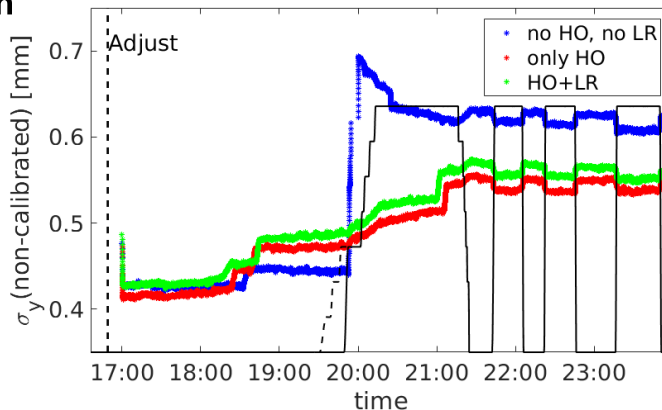
# BSRT profiles fill – B2 V



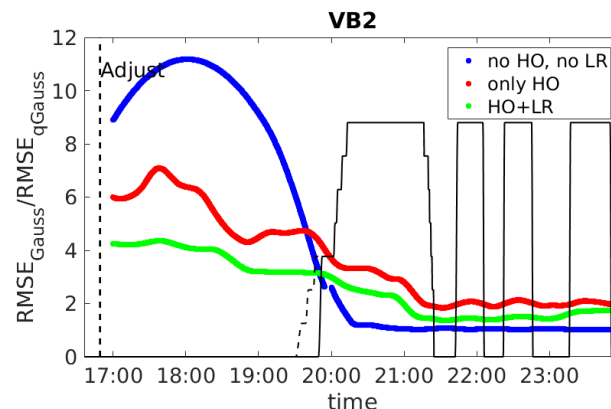
q-Gaussian



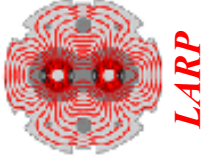
Gaussian



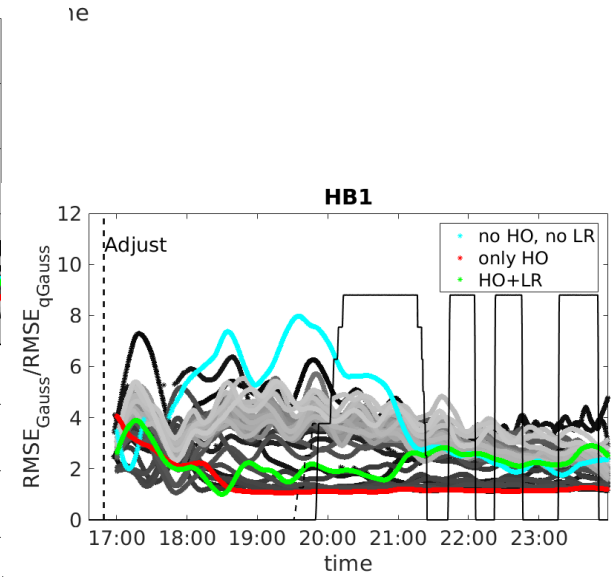
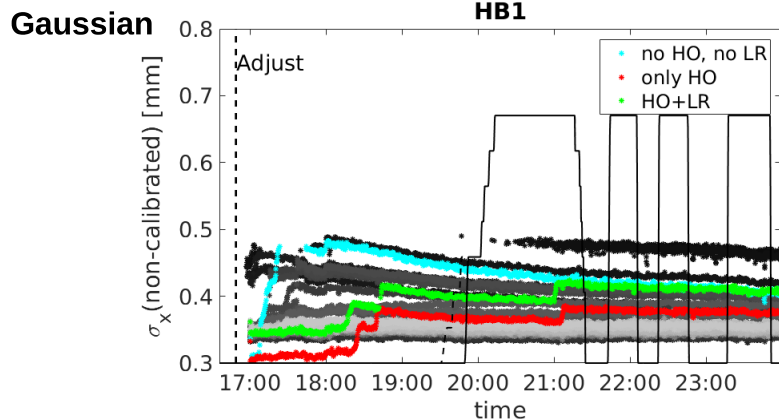
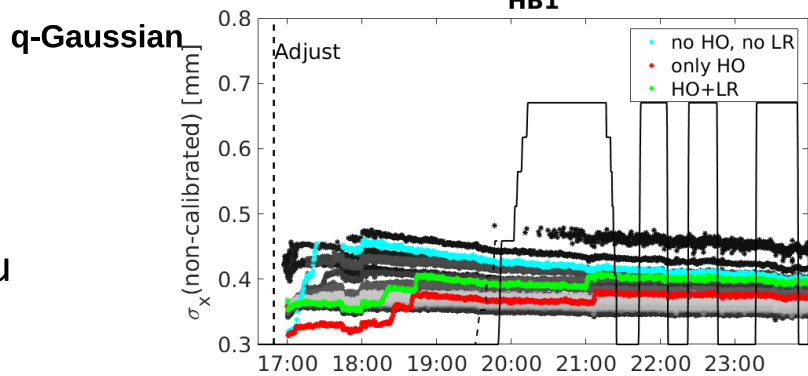
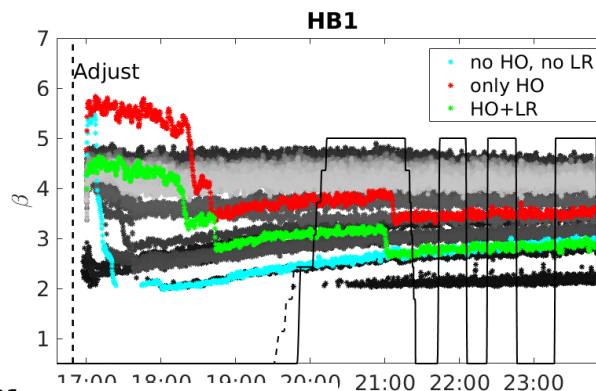
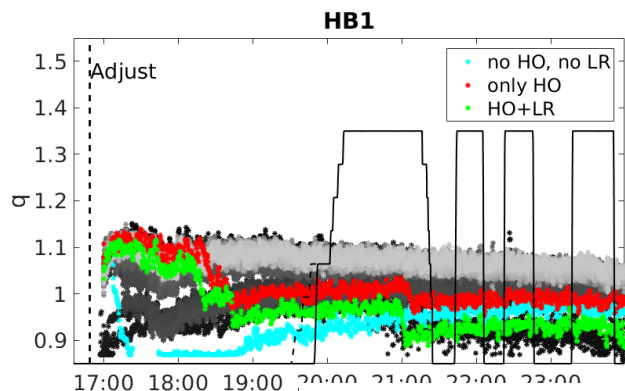
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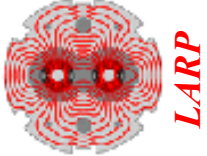
Courtesy  
S. Papadopoulou



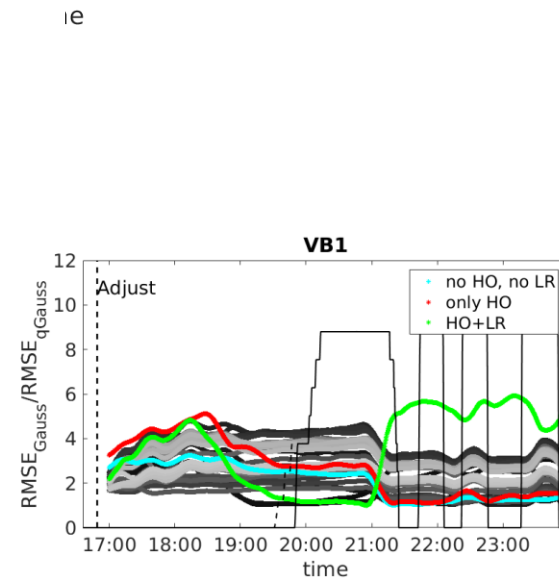
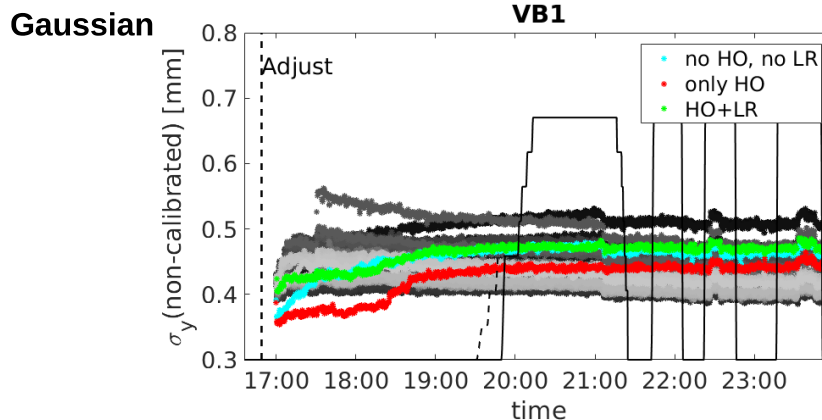
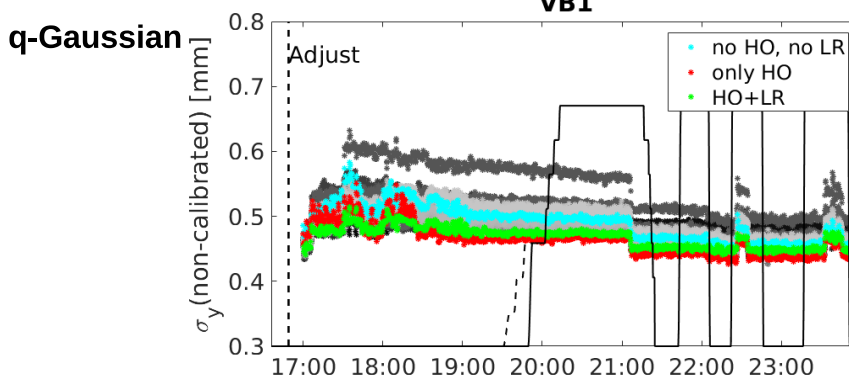
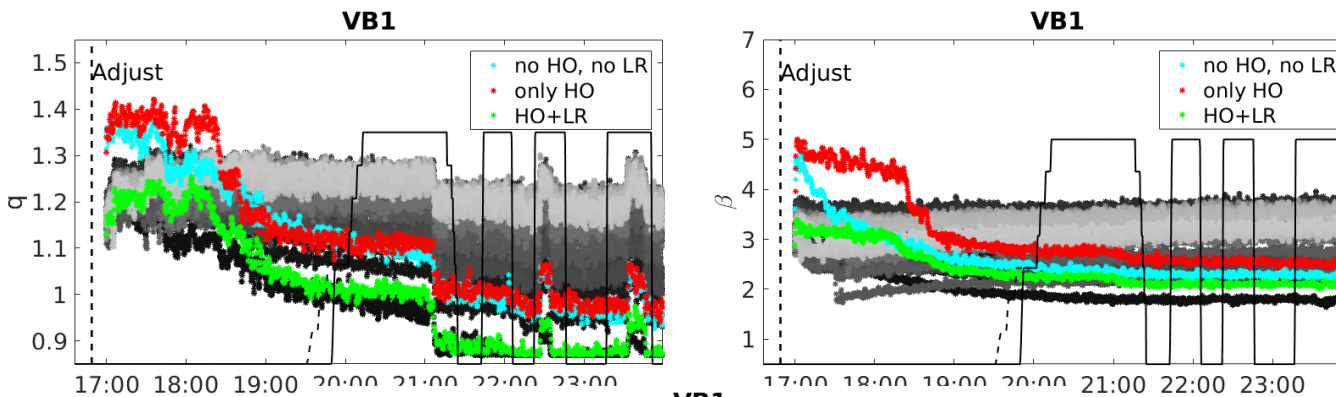
# BSRT profiles fill – B1 H – 2 sig cut



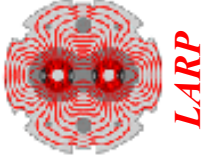
Courtesy  
S. Papadopoulou



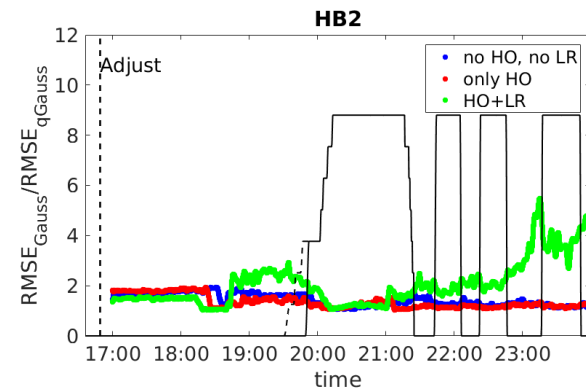
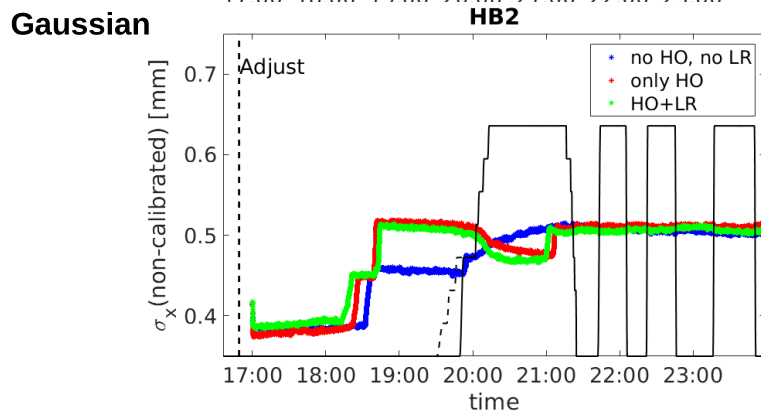
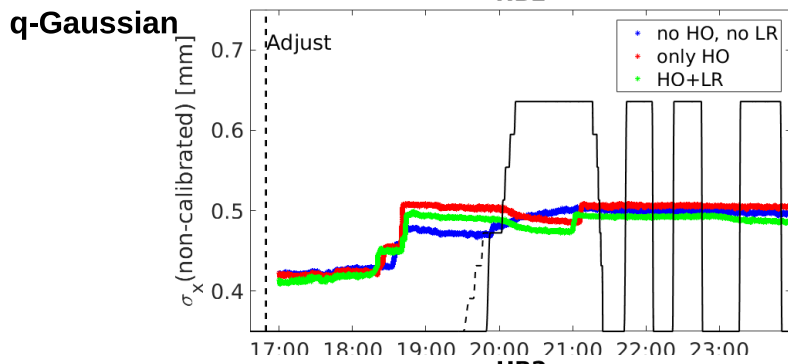
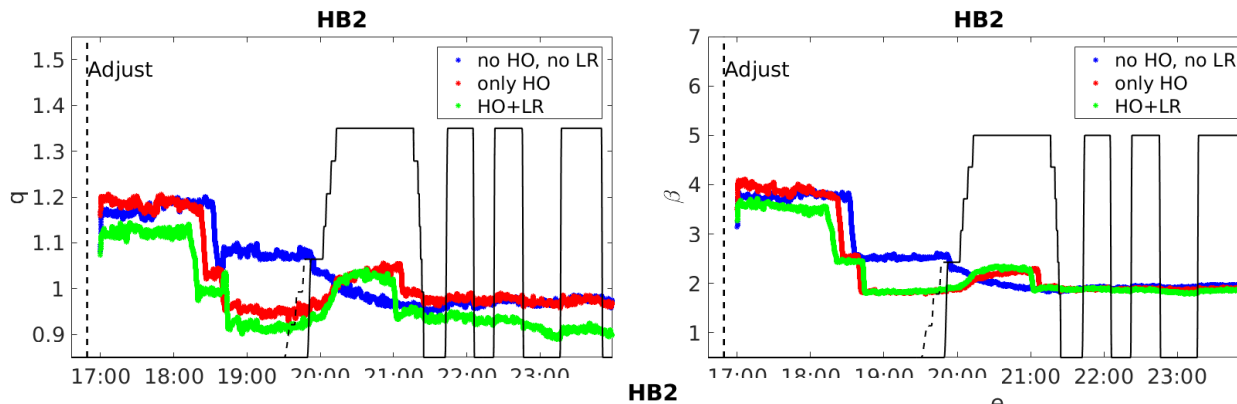
# BSRT profiles fill – B1 V - 2 sig cut



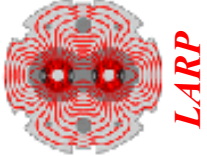
Courtesy  
S. Papadopoulos



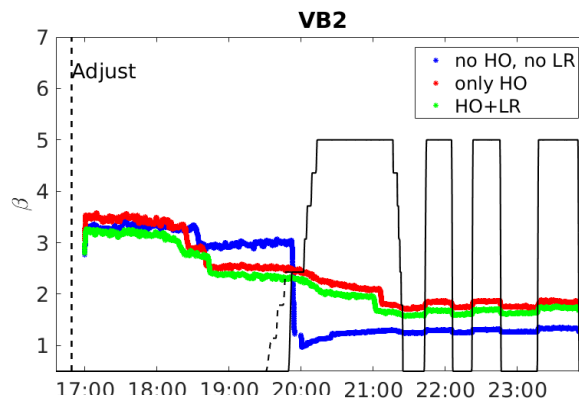
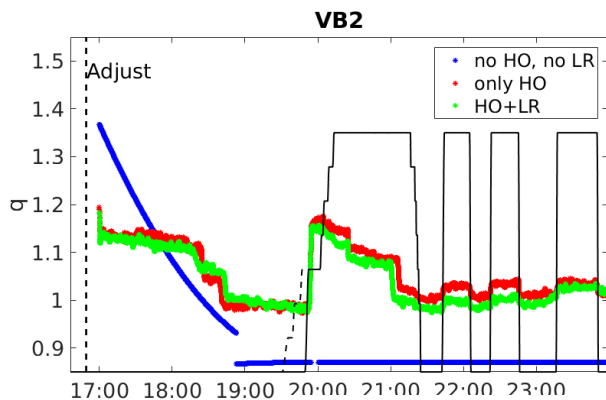
# BSRT profiles fill – B2 H – 2 sig cut



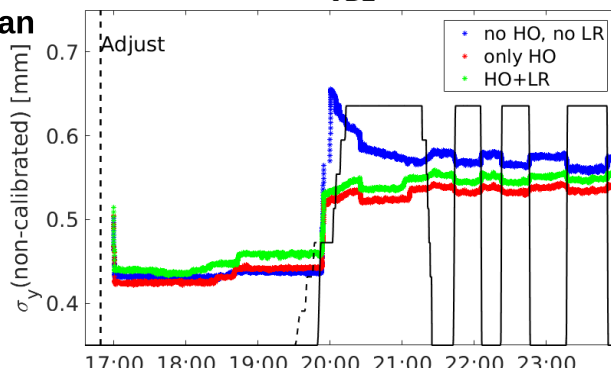
Courtesy  
S. Papadopoulou



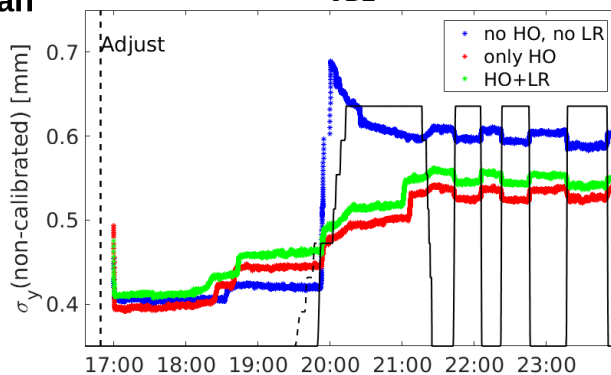
# BSRT profiles fill – B2 V – 2 sig cut



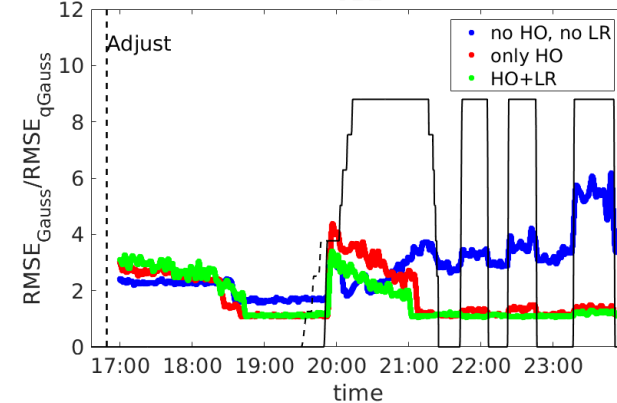
q-Gaussian



Gaussian



VB2



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S. Papadopoulou

VB2

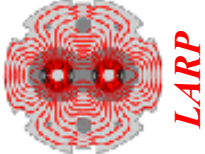
ie

VB2

time

time





## Summary and next steps

### MD2202

Transverse profiles (BSRT):

- Change of VB2 profiles when wire is switched on/off.
- What happens to VB1 around 21:10, 22:30 and 23:45?
- The profile analysis is done for the full transverse profiles and for a 2 sigma cut. Using the 2 sigma cut to avoid the tails (diffraction or other instrument effects), the Gaussian and q-Gaussian results have in general a better agreement ( $q \rightarrow 1$ ) for HB1, HB2 and VB2. This is not the case for VB1, specially during the first 1 h after the Adjust.

Longitudinal profiles (only B2):

- B2 RF problem.
- A drop in the HO+LR bunch length due to losses (at ~21:00).

### Transverse bunch profiles; BSRT and WS

- The LSF factor that is used to calibrate the beam size, is just a value to get the same emittance as for the WS. Even if it assumed to be a Gaussian for simplicity, in reality it is not. The BSRT and the WS profiles should be compared using the same fitting function, this is the only way to get an alternative LSF factor to be used for non-Gaussian distributions.
- The BSRT beams sizes at FT come from profiles that are fitted till the ~50% height of the right side of the distribution. Is that always true?

### Longitudinal bunch profiles

- Discussions with Helga to use updated transfer functions for high intensity bunches.