Bunch Arrival Time Monitors

Function & Applications

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BAM System Overview

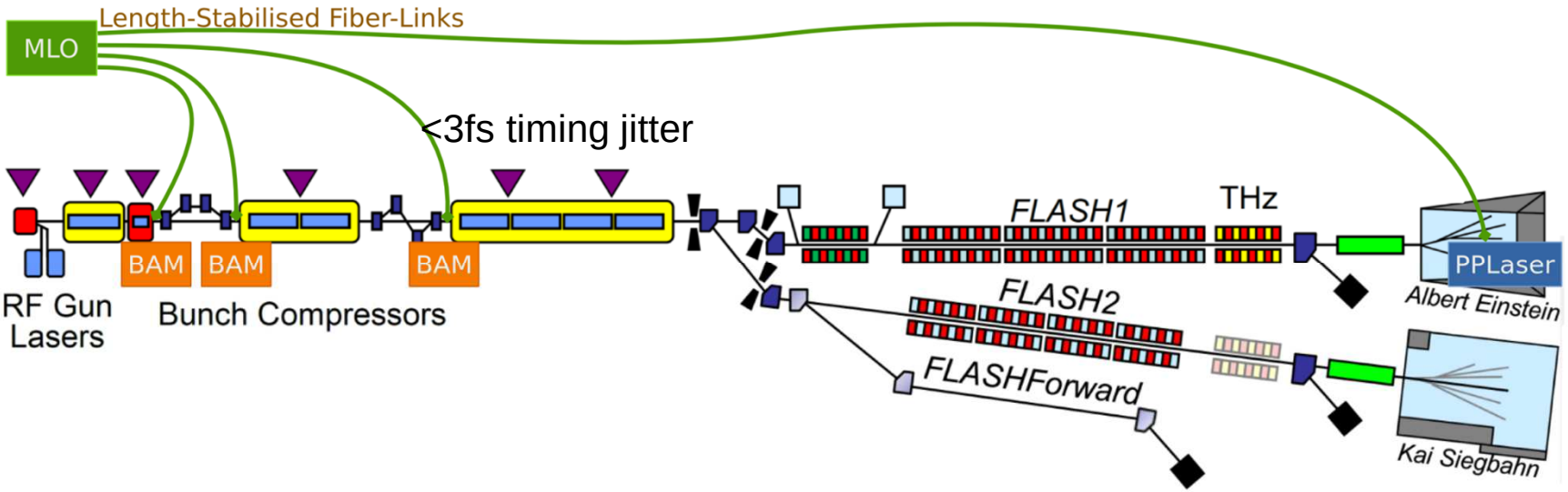
How do the BAMs work

& How can I know whether I can trust their measurement.

BAM Installations at FLASH

Customer of the Optical Synchronisation System.

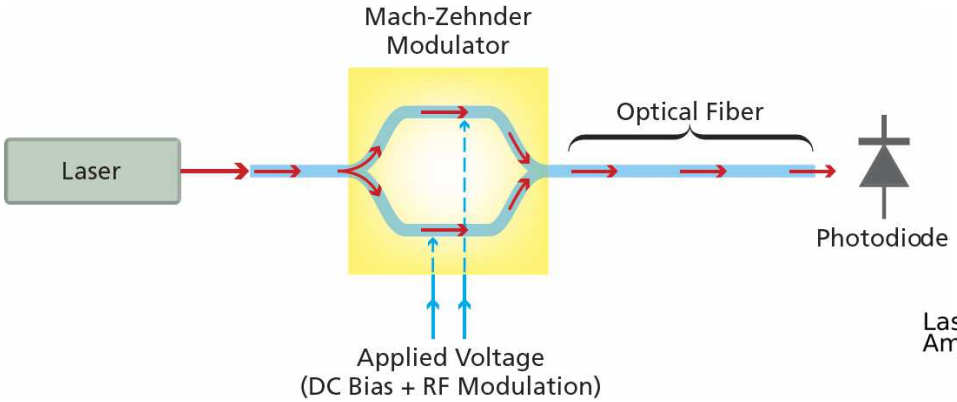
Optical reference
Laser Oscillator, 216MHz



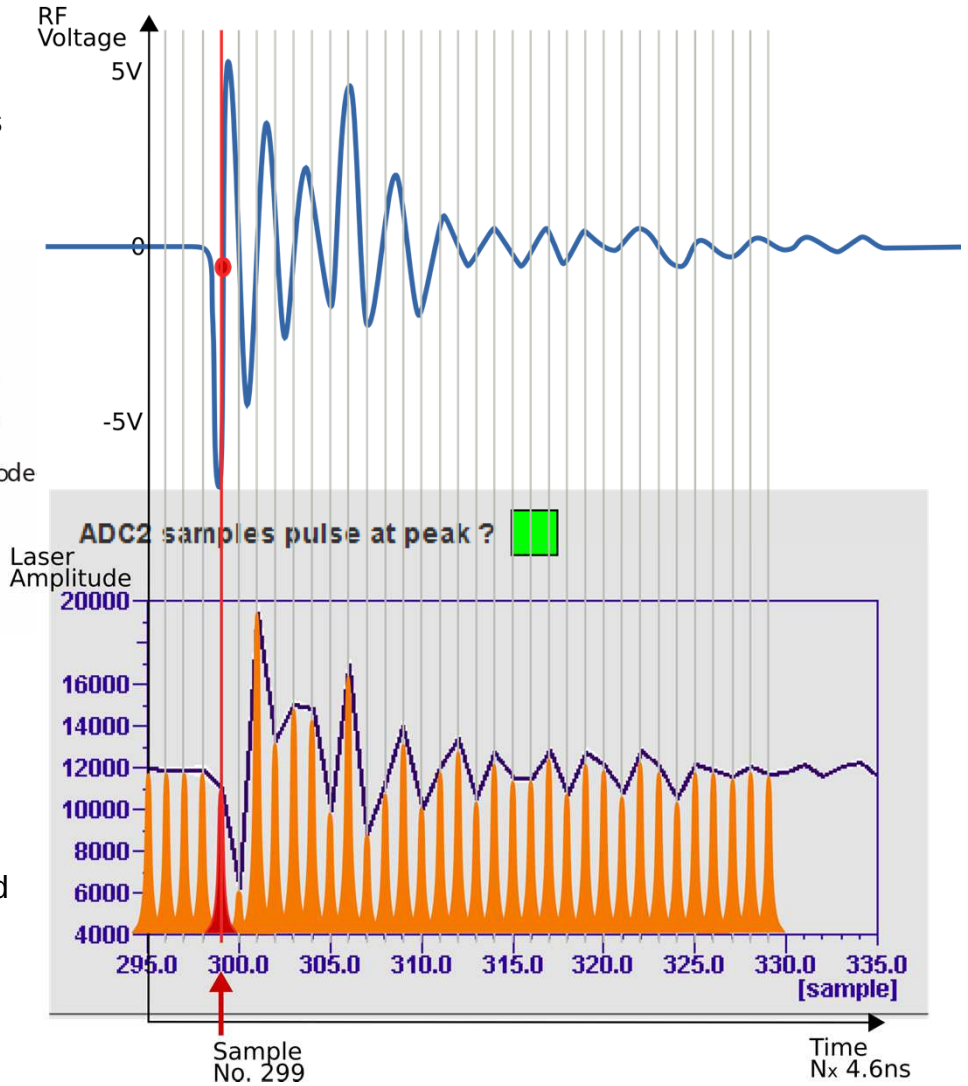
Operation Principle of the BAM

And why isn't the system more robust.

Timing jitter of the electron bunches is
translated into an intensity jitter of timing-stabilised laser pulses



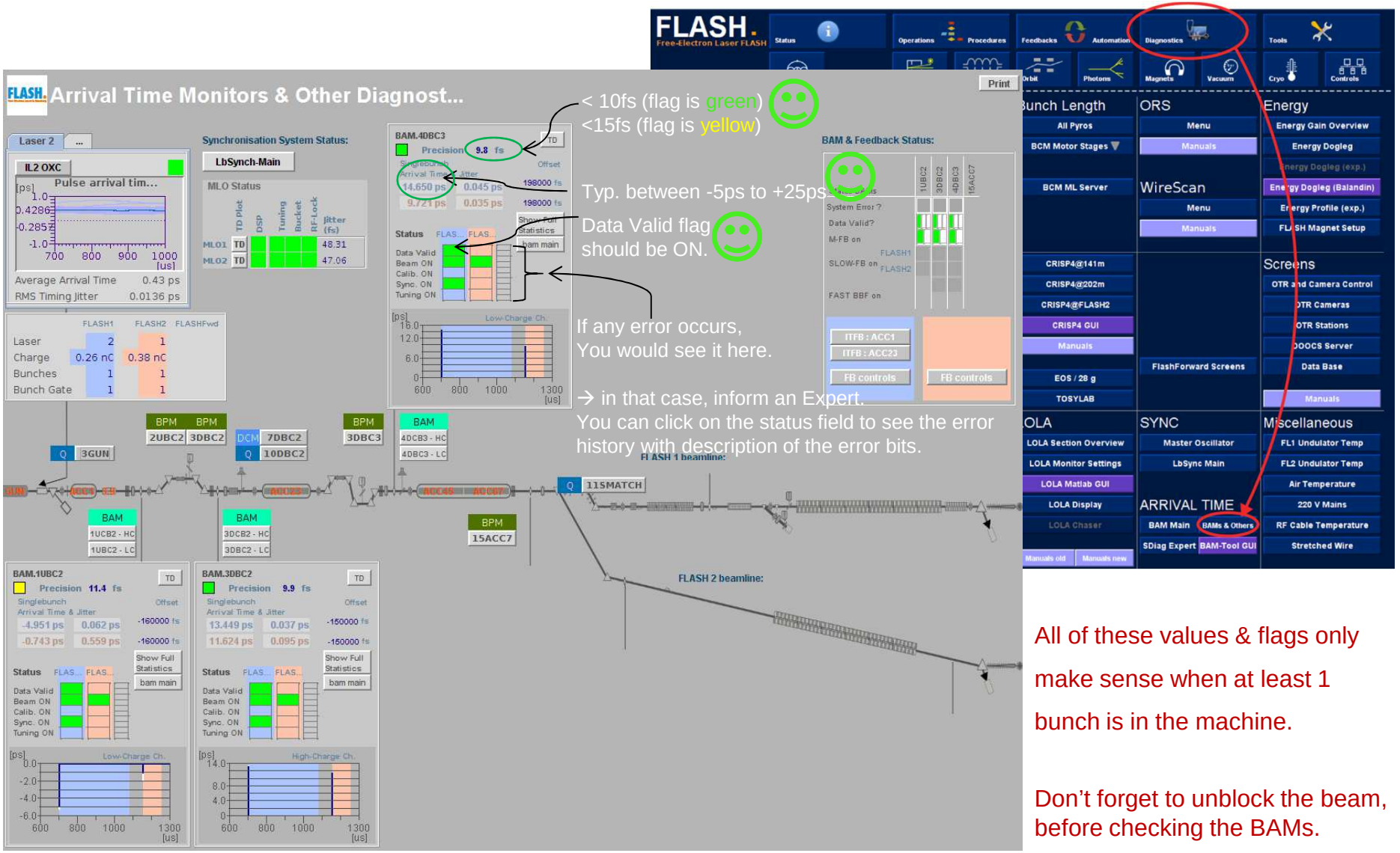
(image https://www.aerodefensetech.com/component/content/article/adt/tech-briefs/photonics/4855)



- Useful BAM signal slope width : 4-8ps
- Laser pulse width : <1ps
- Laser pulse separation : 4.6ns
- Requires an internal feedback to keep the laser pulse around the 1st zero crossing of the RF signal:
  - Feedback is slow (motorised optical delay)
  - BAM could jump on wrong signal slope losing measurement precision.
  - RF Signal height is dependent on e- bunch charge.

Overview Panel of BAMs

How to know whether the BAMs are OK.



All of these values & flags only make sense when at least 1 bunch is in the machine.

Don't forget to unblock the beam, before checking the BAMs.

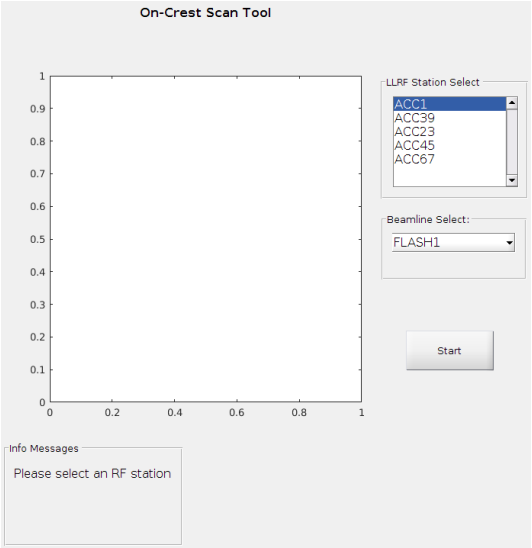
On-Crest Phase Measurement

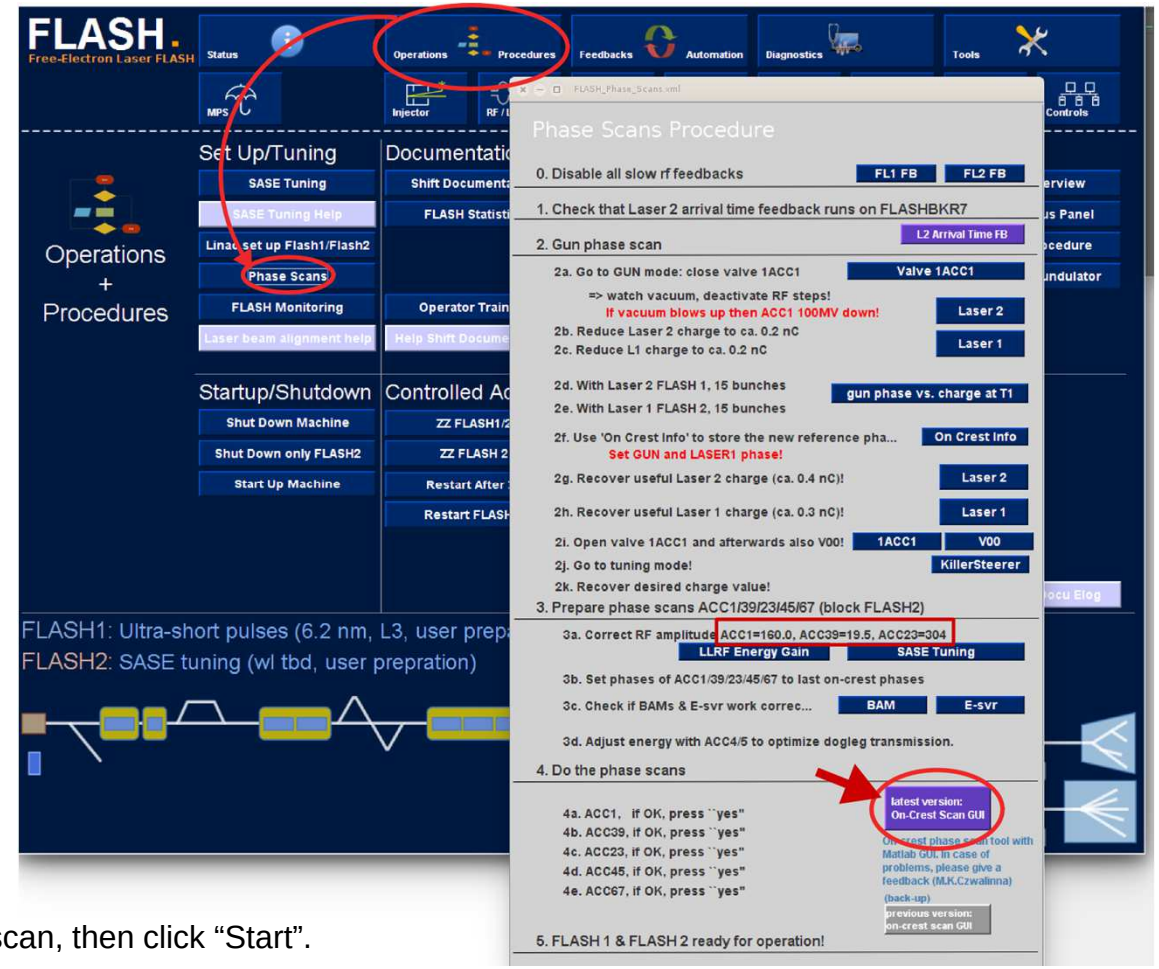
How to evaluate whether or not the scan does make sense.

On-Crest Phase Tool

Where to find it & how to use it

Matlab Script
used for the scans of the RF modules



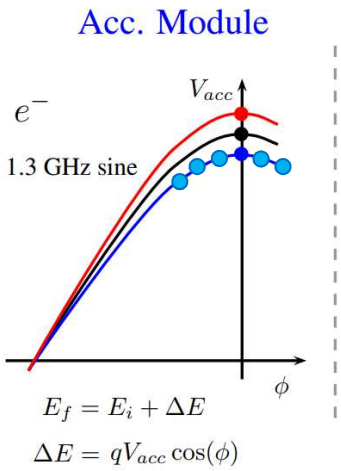


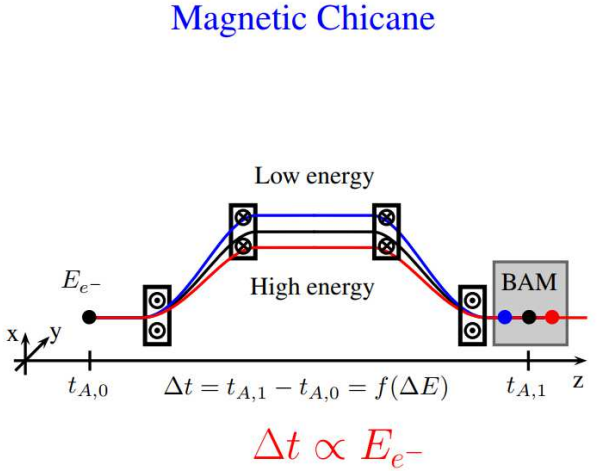
1. Select the RF station you would like to scan, then click “Start”.
2. Be patient, the tool is taking data and evaluates the fit to the data points. Then check whether the fit curve looks OK (see next slide); if so, press the button “Yes” (not visible in this screenshot)
3. Wait for the tool to set the new reference phase. The tool will tell you, when it is ready for a new scan.
4. Then repeat with the next station.

On-Crest Phase Measurements

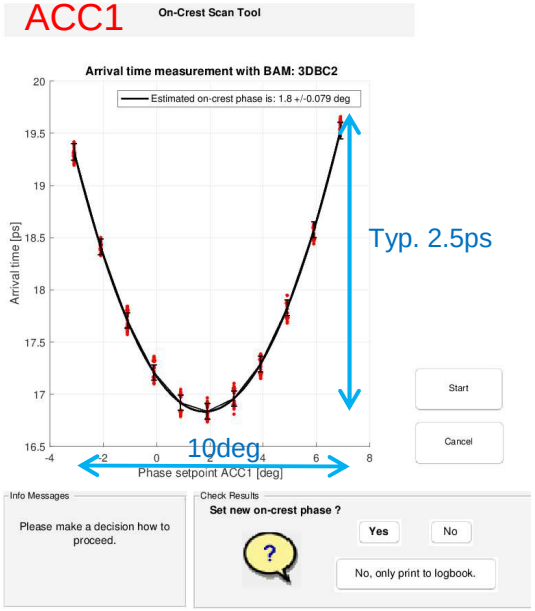
& how the BAMs can be used for it.

For On-Crest Scan:
RF Amplitude is kept constant,
But a change in energy is introduced
from the change in RF phase.

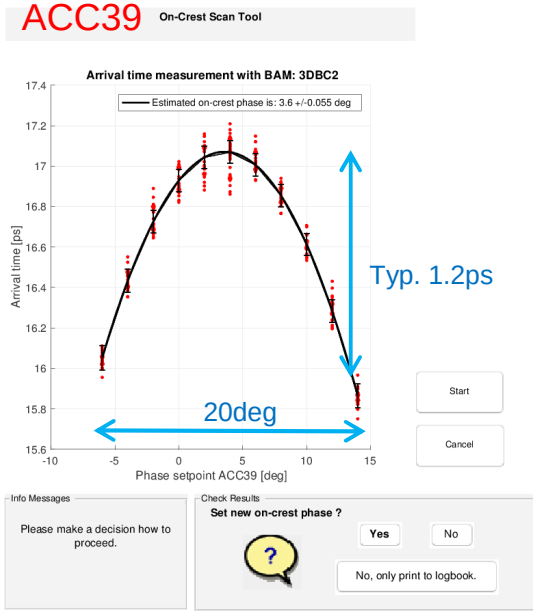




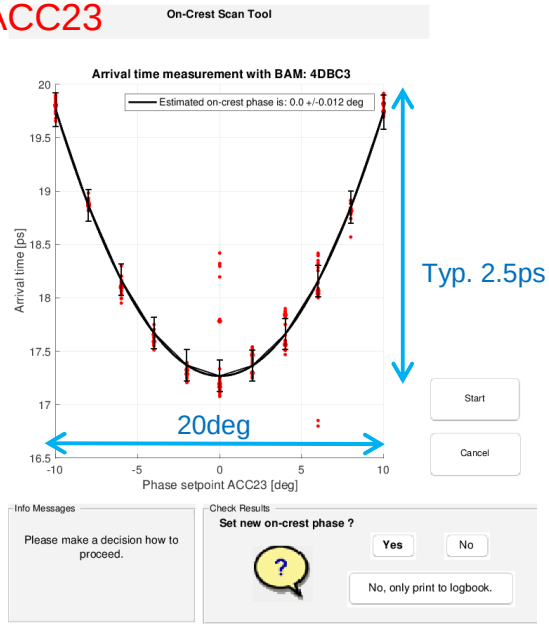
ACC1



ACC39

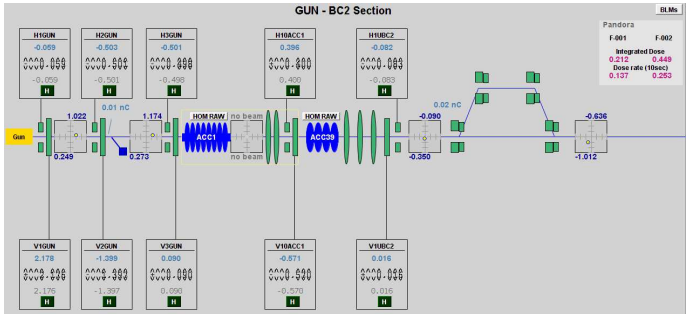


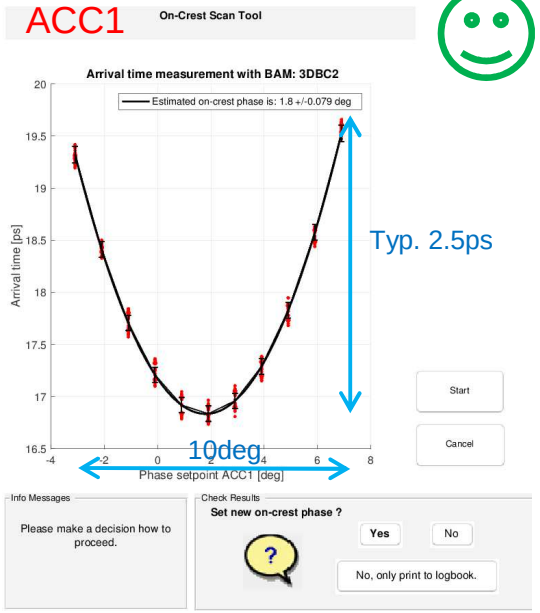
ACC23

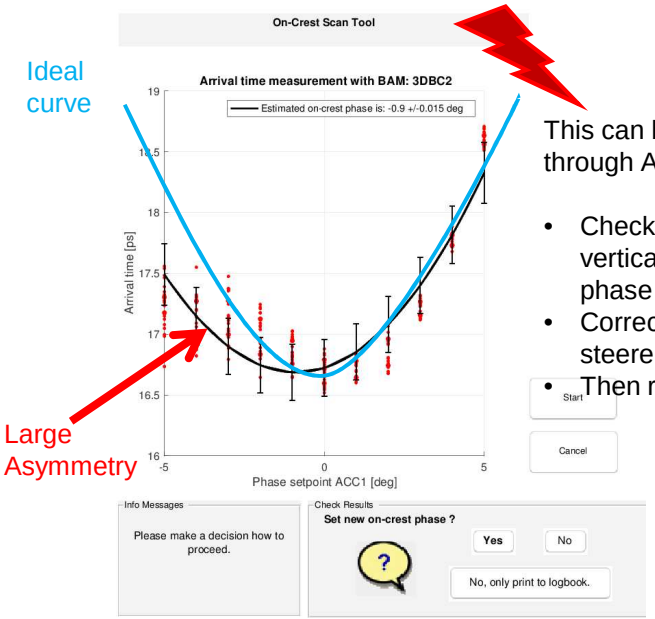


On-Crest Phase Measurement

What can possibly go wrong.

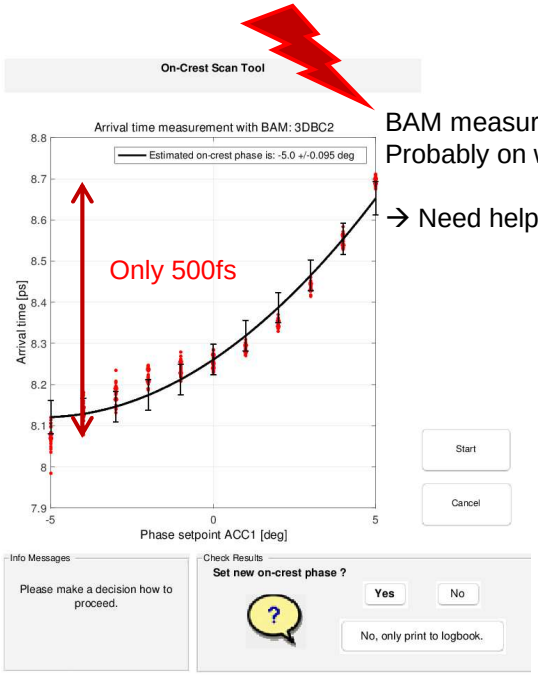






This can be a problem of orbit through ACC1/BC2:

- Check whether (especially vertical) orbit changes during the phase scan
- Correct orbit with (vertical) GUN steerers
- Then repeat the phase scan.



BAM measurement is not correct! Probably on wrong signal slope.

→ Need help from Expert.

Intra-Train Feedback

(longitudinal) (arrival time)

or simply:

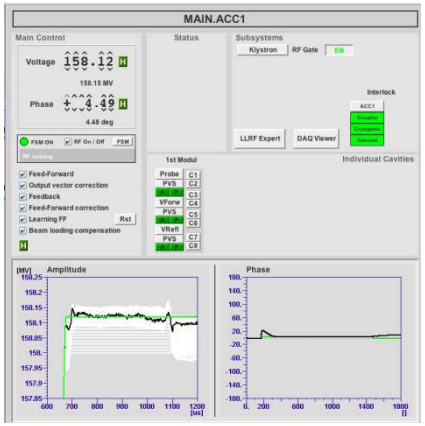
Fast BAM Feedback.

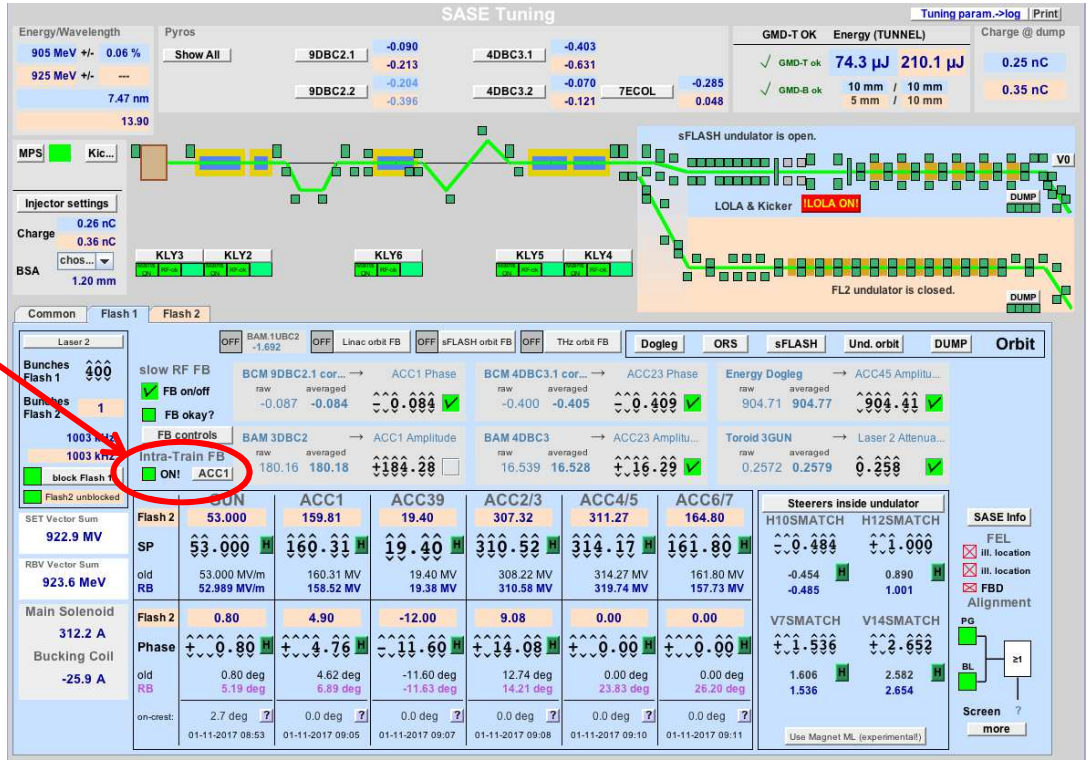
How to check whether the feedback operates as intended.

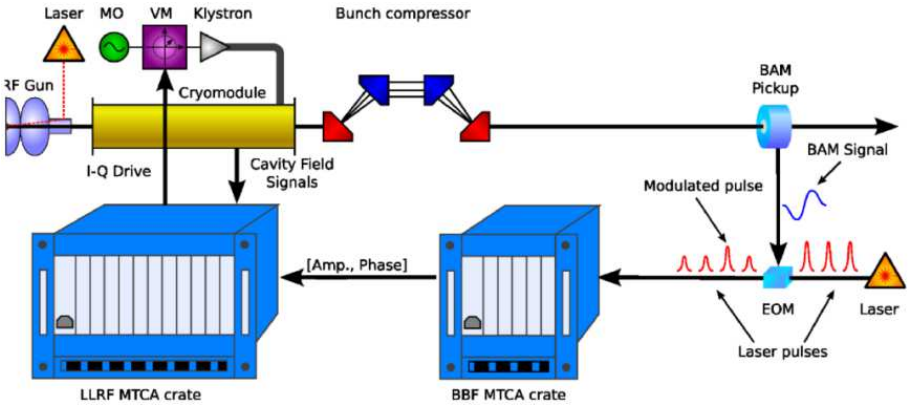
Fast BAM Feedback on ACC1 Amplitude

How to get to the controls panel

PLEASE make sure, that this Feedback is OFF when loading a new file OR during SASE Tuning !







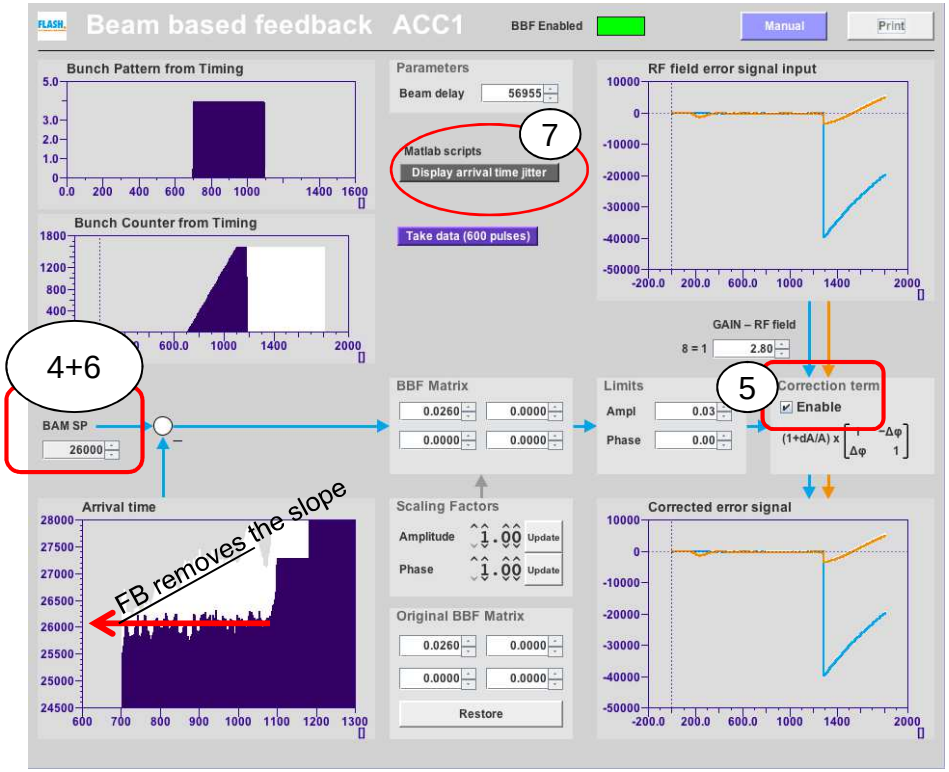
(Still) Only available for FLASH1 bunch trains.

Normally, FL2 bunches should not be influenced from FB action on FL1.

Fast BAM Feedback on ACC1 Amplitude

Controls panel and How to use it.

1. Be sure that at least the BAM.3DBC2 is OK.
2. **This FB is switched on last**, after RF settings had been tuned to final values & shortly before handing the machine over to the users.
3. Open this controls panel.
4. **Adjust the BAM SP** (set-point) value (see example)
   Usually between 25'000 and 35'000
   start with center value of the bunch-train data
5. **Click on Enable** Checkbox.
6. If SASE drops a little, try to **fine-tune the BAM SP** on the hundreds digit.
7. **Open** the "*Arrival Time Jitter Display*" (Matlab tool) : *select BAM.4DBC3*.
8. Arrival Time Jitter displayed should be around 20fs. (see next slide)



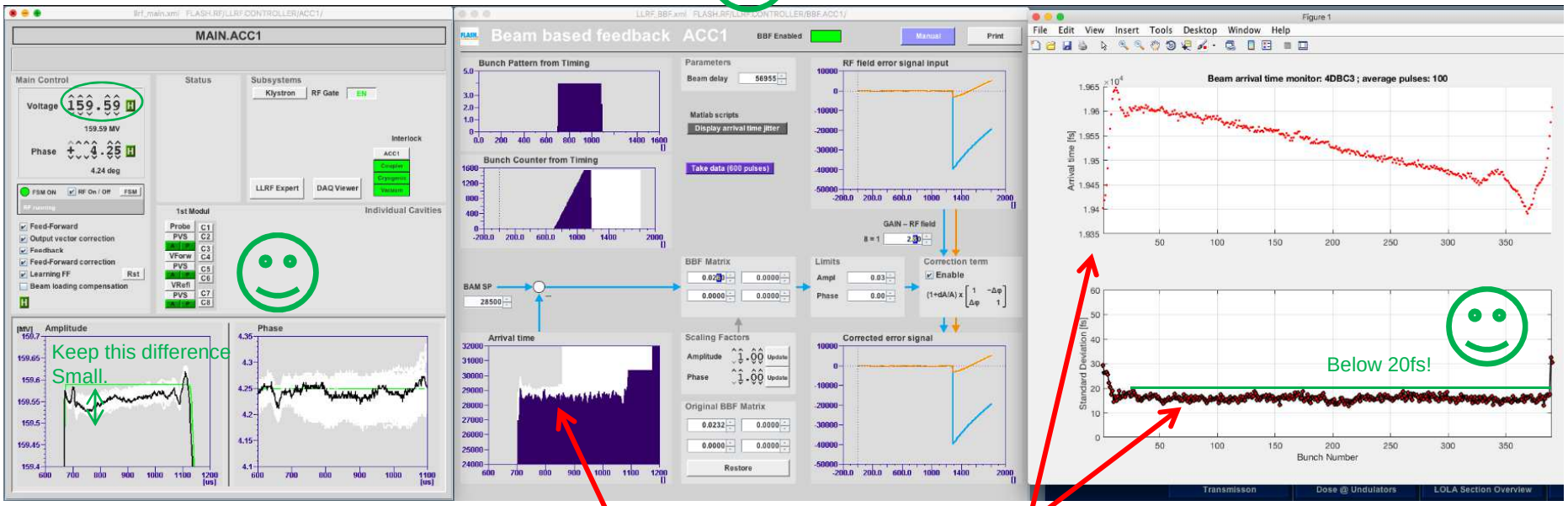
Also, FB reduces the arrival time jitter.

→ Check with BAM.4DBC3!

Fast BAM Feedback on ACC1 Amplitude

How to check the feedback operation.

Keep these 3 panels opened & print to logbook from time to time.



ACC1 :
Might want to adjust the FL1
Amplitude Set-point,
To shift the green set-point curve
Onto the black measurement curve.

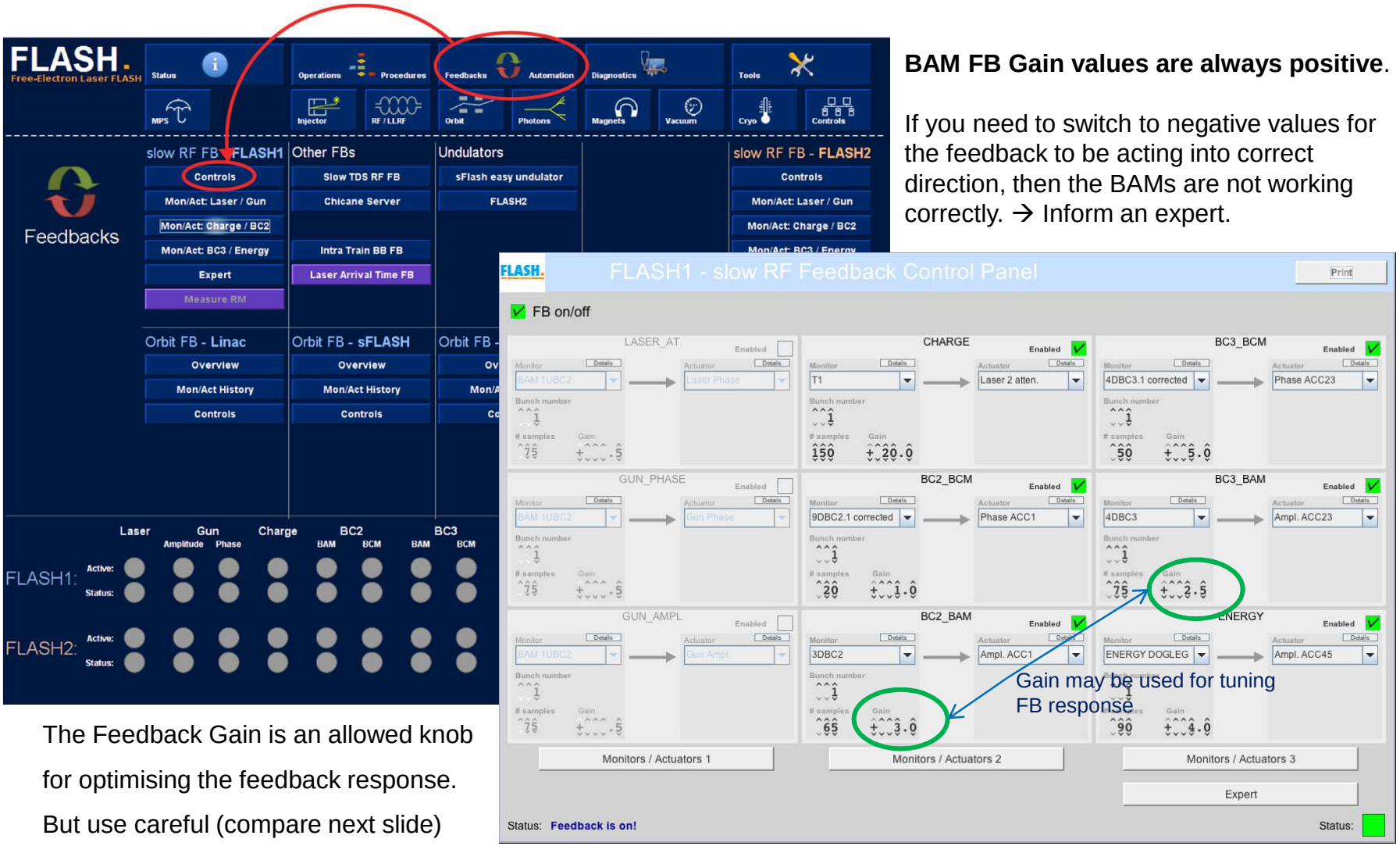
In case you see here rather big oscillations,
Better switch the feedback OFF,
And inform an Expert.

Slow Arrival Time Feedback

Ways to optimise the feedback operation.

Slow RF Feedback(s)

Comment on the slow BAM Feedback.



BAM FB Gain values are always positive.

If you need to switch to negative values for the feedback to be acting into correct direction, then the BAMs are not working correctly. → Inform an expert.

The Feedback Gain is an allowed knob for optimising the feedback response. But use careful (compare next slide)

Slow RF Feedback(s)

BAMs are stabilising the energy in parallel to the compression FBs.

Example:

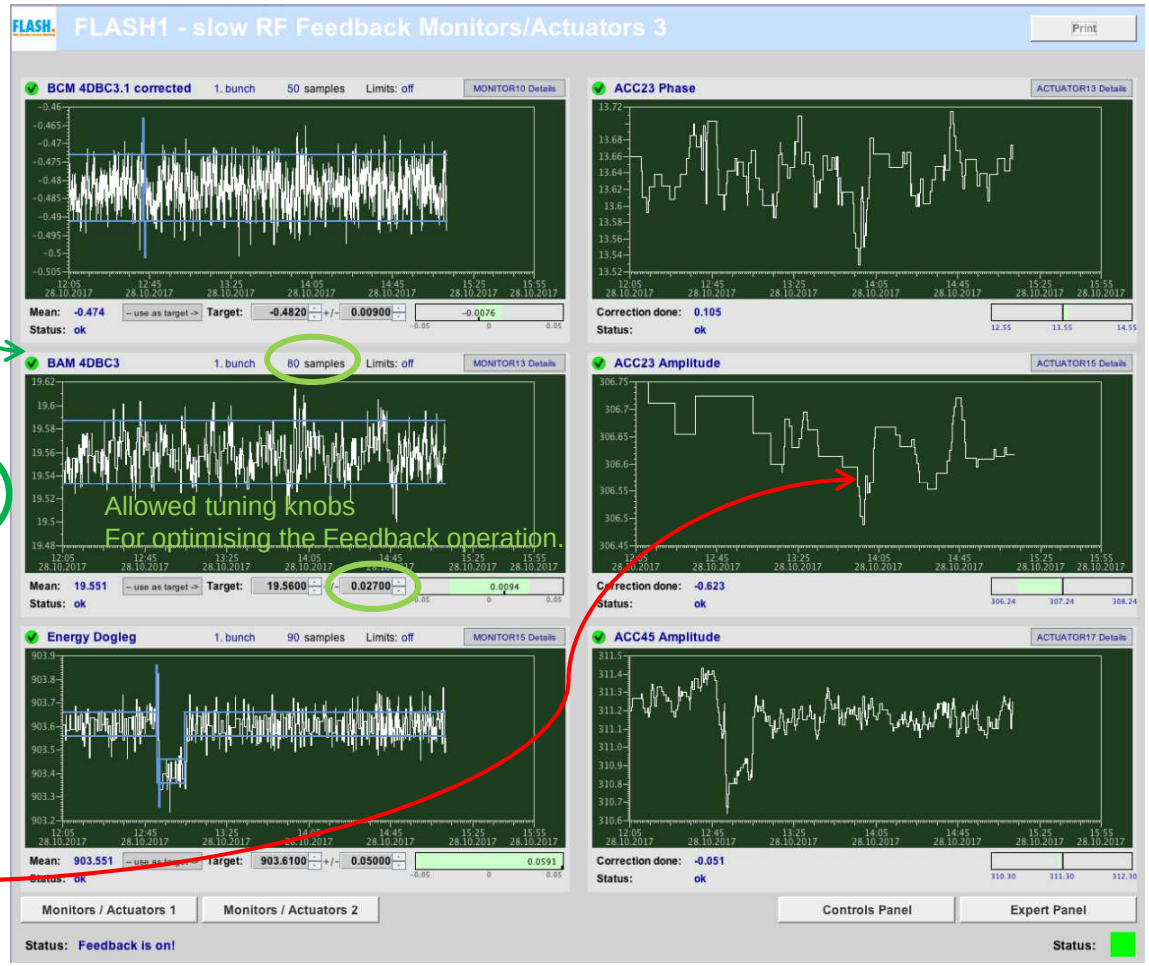
BAM.4DBC3 on ACC23 amplitude.

Optimisation possible via following knobs:

- FB Gain (see slide before)
- No. of Samples used for Averaging:
  Usually, the BC2 feedbacks average less (= react more often) than the BC3/energy FB loops.
- Limits around the Target Value.

As shown here, the FB is acting fine!

But possible problem: If the corrections applied are jumping in single & big steps up and down, the gain of this feedback loop is too large.



Some more or less useful information

Whom to inform, if problems appear.

Experts to call in case of questions…

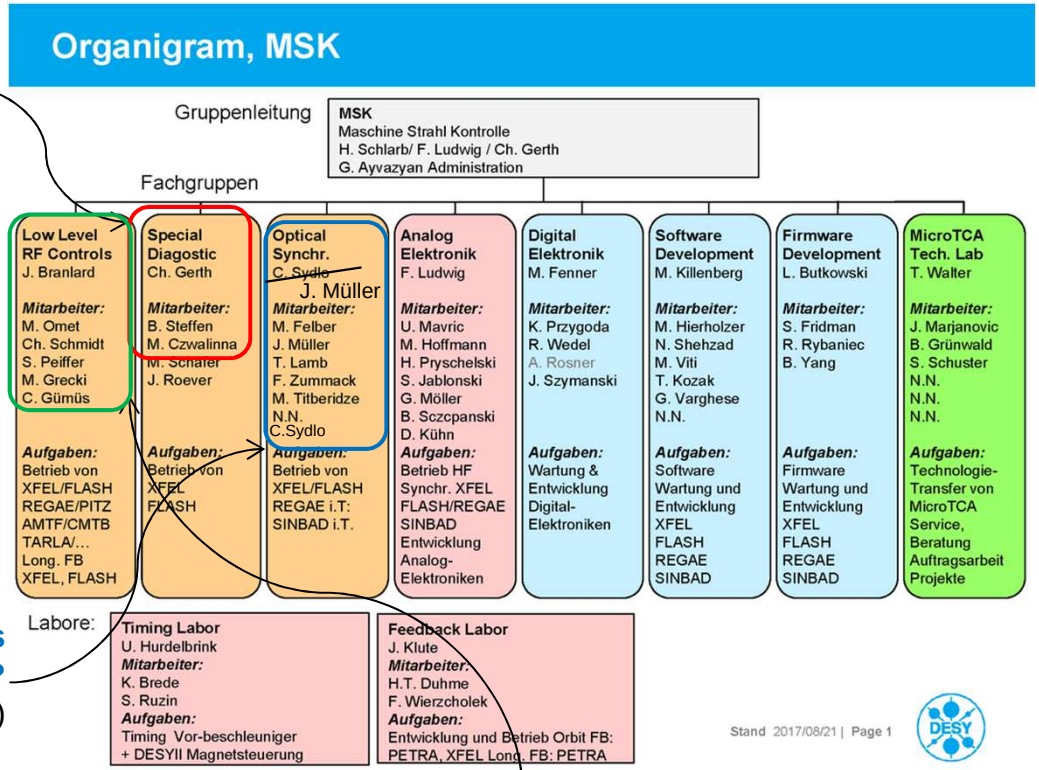
At MSK:

version: 21.08.2017
Sorry, is already outdated.

Any problems with the BAMs ?
(hardware & operation)

Marie K.Czwalinna
Christopher Gerth
Bernd Steffen

Expert-mailing list:
sdiag@desy.de



Any problems with OR questions about the optical synchronisation ?
(maybe on user request)

Jost Müller
Matthias Felber
Thorsten Lamb
Cezary Sydlo

Expert-mailing list:
LbSync@desy.de

Any questions about LLRF or fast Feedback(s)

Specifically about the On-crest Scanning Tool**:**

Marie K. Czwalinna
Christian Schmidt

Julien Branlard
Christian Schmidt
Sven Pfeiffer

Expert-mailing list:
llrf-operations@desy.de