

LOLA Manual for FLASH Operators

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June 15, 2017

There are to options available using LOLA

1. **SMATCH** section -> Manual starting page 2

- Tasks / properties:

Measure the longitudinal profile during SASE tuning / **Bunch length**
Kicks one bunch from bunch train
LOLA middle layer server and LOLA slow feedback

2. **SDUMP** section -> Manual starting page 11

- Tasks / properties:

Measure the longitudinal phase space
Only one bunch in the machine is allowed

Switch LOLA off -> Manual starting page 20



This manual is based on Minjie Yan's LOLA manual from 2014.02.28.

> SMATCH section -> Manual starting page

- Tasks / properties:

- Measure the longitudinal profile during SASE tuning / Bunch length

- Kick one bunch from bunch train

- LOLA middle layer server and LOLA slow feedback



Open panels

SMATCH

The image displays the FLASH control interface, which is a complex dashboard for managing the FLASH synchrotron facility. The interface is divided into several main sections:

- Top Bar:** Contains the FLASH logo and various navigation icons including Diagnostics, Tools, Magnets, Vacuum, and Cryo.
- Left Panel:** Displays the SMATCH beamline setup, including components like SFELC, TDS LOLA, Kicker, 8SMATCH, 11SMATCH, and MINI DUMP. It also shows SMATCH and SDUMP setups with parameters like CAM Power Cycle, Filter Wheel, and Mirror Stage.
- Right Panel:** Contains a grid of buttons for various system components, including Bunch Length, ORS, Energy, WireScan, Screens, Miscellaneous, Toroids, Dosimetry, LOLA, SYNC, and Master Oscillator.
- Bottom Panel:** Shows a detailed view of the 13SMATCH camera setup, including exposure, gain, and rate controls. A red box highlights the "Start / Stop" button.

Red arrows indicate the flow of interaction: from the "Diagnostics" icon in the top bar to the "Camera 13SMATCH" button in the left panel, and from the "Start / Stop" button in the bottom panel to the "LOLA Section Overview" button in the right panel.



Open panels

SMATCH

The image displays the FLASH Free-Electron Laser control interface, which is a complex dashboard with multiple panels. The main interface is titled "FLASH Free-Electron Laser FLASH" and includes a "Diagnostics" section on the left. The central area is divided into several functional blocks: "BLMs" (Beam Loss Monitors), "BPMs" (Beam Position Monitors), "Bunch Length", "F Cups", "HOM" (Higher Order Mode), "Toroids", "Dosimetry", "LOLA" (Longitudinal Overlap Laser Acceleration), and "SYNC".

The "LOLA" panel is highlighted with a red box, and a red arrow points to it from the "LOLA Monitor Settings" button in the "LOLA" section. This panel is titled "LOLA Bunch Length Monitor Settings" and contains several sub-sections:

- SMATCH**: Includes "User Bunches" (30), "Set Timing for SMATCH", "Select LOLA repetition rate" (1 Hz), "LOLA Bunch #", "switch everything off", "LOLA bunch", "Kicker Control" (direction, mains, HV switch), "Timing Control (Expert)" (BLM MASK, TPS MASK, Camera Timing), and "Dipole D9SMATCH".
- SDUMP**: Includes "Set Timing for SDUMP" and "LOLA timing expert".
- LOLA**: Includes "LOLA phase FB", "Klystron Voltage", "HV" (OFF), "PFN" (OFF), "HV rbv" (0.0 KV), "LOLA TDS", "Phase" (switch to the other zero-crossing), "Amplitude" (limit 1.25), "Interlocks" (Alarm, Reset, Vacuum P-Width Reflection), and "Tools" (Matlab, Measurement GUI, Phase calculator, Camera Watchdog).
- Calibration**: Includes "Choose camera" (SMATCH), "adjust gain" (auto), "Time calibration" (left, right, do time-calibration), "last calibration" (11-18T060315 Ampl 1.25 Ph 10 at 1st, value: -7.9809 to pixel), and "Refresh".
- Measurement**: Includes "Save & Display Single Measurement" (Do One Measurement), "Save Multiple Images" (Do measurement), "Load old measurements", "Print", "Reconstruction from 2 zero-crossings", and "Expert" (Background method, Background number, Image number, Scan steps, Wait for operator to adjust beam position before continuing time resolution measurement).
- Monitoring**: Includes "Start Monitor" and "Some Tips" (1. Is camera setting correct? 2. Is LOLA timing correct? 3. Is camera server dead?).

The "FLASH" logo is visible in the bottom left corner, and the "DESY" logo is in the bottom right corner.

Kick one bunch

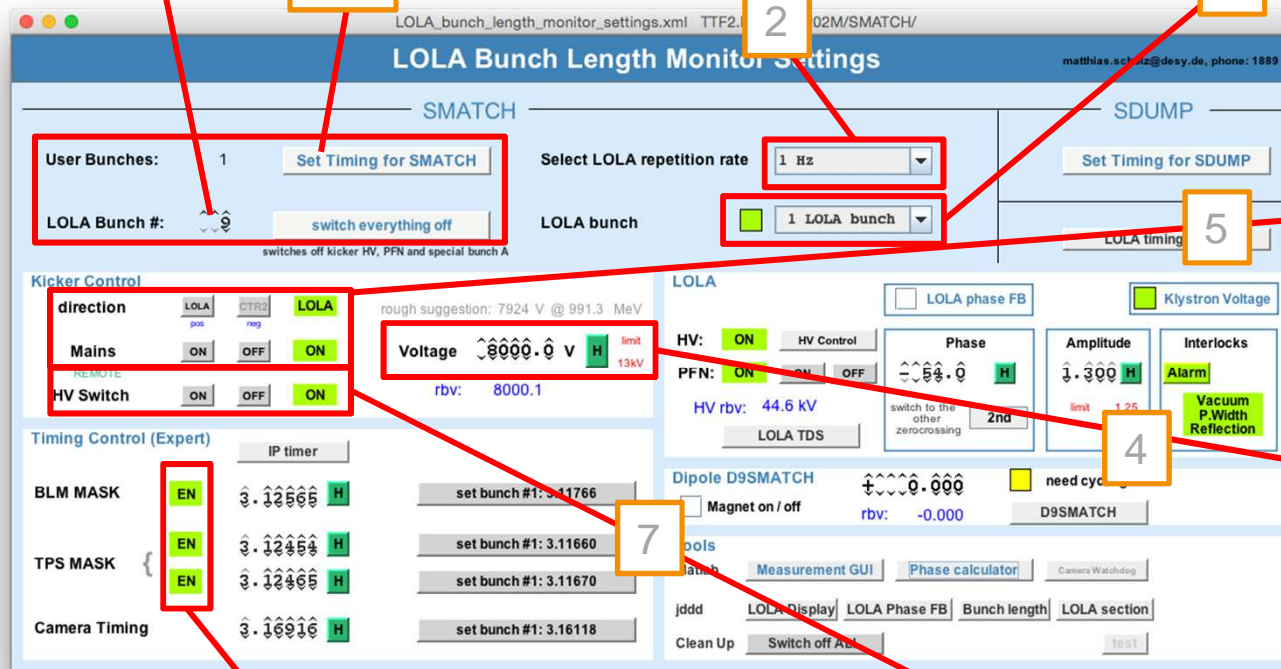
SMATCH

1.1: Select the LOLA bunch (typically user bunches + 1)

1.2: Press 'Set Timing for SMATCH'

2: Select the LOLA repetition rate (typically 10 Hz for setup / single measurement / calibration and 1 Hz for continuous operation).

6: Generate LOLA bunch by selecting '1 LOLA bunch'.



5.1: Make sure direction is set to LOLA

5.2: Make sure HV is switched on

4: Set kicker voltage to the suggested value. Deviations are possible due to variations of e.g. beam orbit at LOLA.
(Can be >2000V, 100V steps see 6.2)

7.1: If you are ready, you can turn on the kicker with 'HV SWITCH' to ON.

7.2: The beam should be visible on the screen. If not you may need to adjust the kicker voltage in steps of +/-100 V (can be >2000V) - It's ok that the beam is in the lower part of the camera (attention if the voltage is too small it goes into F11 beamline)



3.1: Enable BLM MASK

3.2: In long pulse mode, also enable TPS MASK

Streak one bunch with LOLA

SMATCH


- 3.1: Change the phase in 10 degree steps until you see the beam on the camera.
- 3.2: Increase the amplitude in small steps (~ 0.100) and adjust the phase accordingly. Always keep the beam on the camera in sight.
- 3.3: Go to maximum amplitude of 1.250.

Note: if you steer the beam off the screen it might cause BLM alarms in the undulator area. Don't worry, either you continue playing with the phase to find the beam again or start from the beginning with amplitude = 0.100.

The screenshot shows the 'LOLA Bunch Length Monitor Settings' window. Three red arrows with numbered boxes point to specific controls:

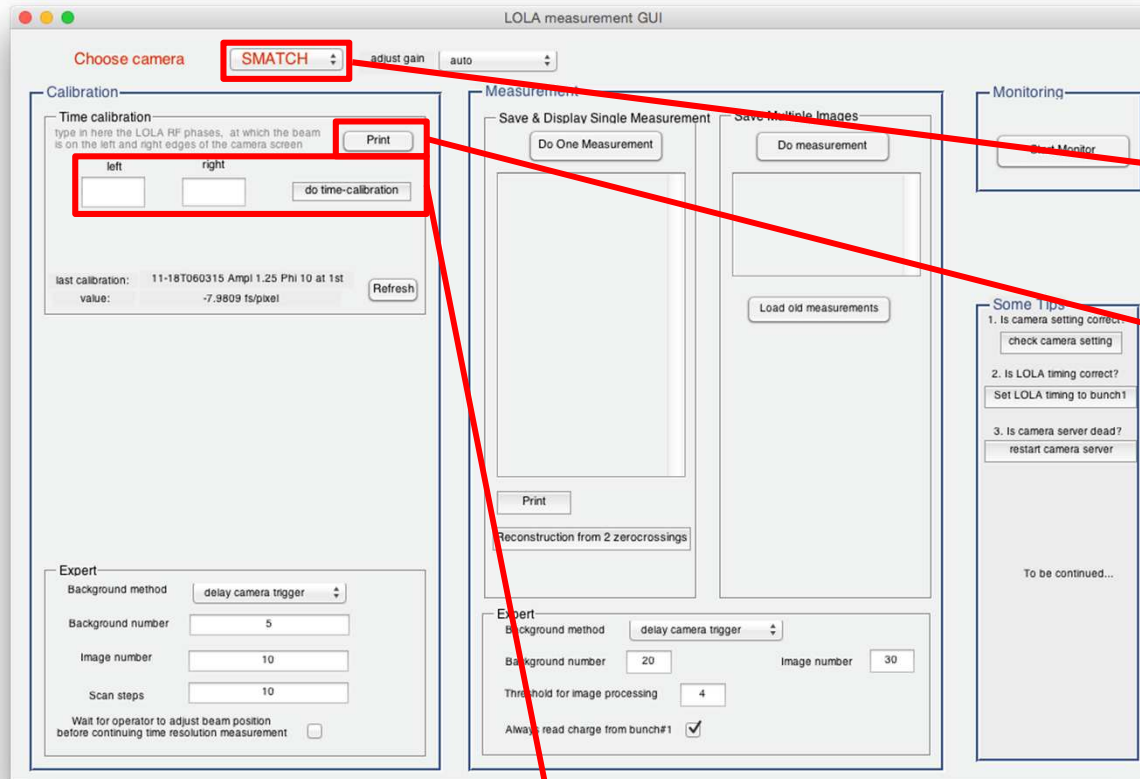
- 1:** Points to the 'Amplitude' control in the 'LOLA' section, which is currently set to 1.300. A text label next to it says: '1: Reduce LOLA amplitude to a small value e.g. 0.100.'
- 2:** Points to the 'LOLA PFN' control in the 'LOLA' section, which is currently set to 'ON'. A text label next to it says: '2: Turn on LOLA PFN'.
- 3:** Points to the 'Phase' control in the 'LOLA' section, which is currently set to 54.0. A text label next to it says: '3: Change the phase in 10 degree steps until you see the beam on the camera.'

The interface also includes sections for 'User Bunches', 'Kicker Control', 'Timing Control (Expert)', 'Dipole D9SMATCH', and 'Tools'.



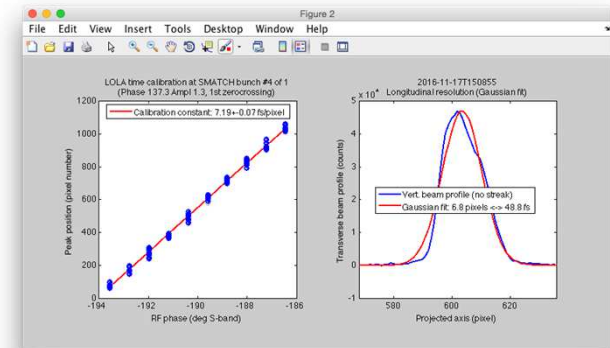
Do time calibration

SMATCH



1: Chose camera SMATCH

3: Print the calibration plot to the logbook.



2

- 2.1: Type in here the LOLA RF phases at which the beam is on the LEFT and RIGHT side of the screen.
- 2.2: Click 'do time calibration'.
- 2.3: During the calibration, you may need to click a continue button in the GUI.

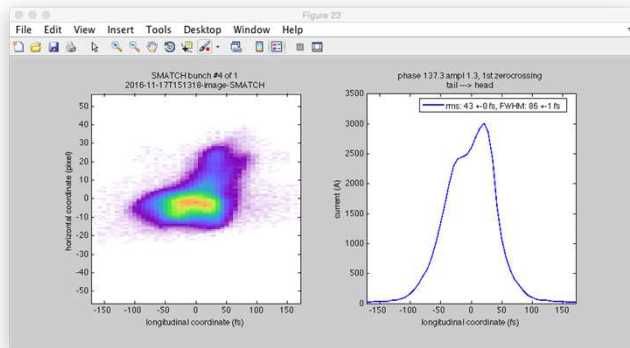


Note: Time calibration needs to be repeated if the machine optics changes, OR the LOLA amplitude changes.

Do measurements

SMATCH

- Save and display one single shot measurement (typically used)
- Don't forget to print to logbook. To do that you can use the print button on the Matlab panel.



The screenshot shows the LOLA measurement GUI. The interface includes sections for Calibration, Measurement, Expert, and Monitoring. Red boxes highlight the 'Do One Measurement' and 'Do measurement' buttons. A red arrow points from the 'Print' button in the Calibration section to the 'Print' button in the Measurement section.

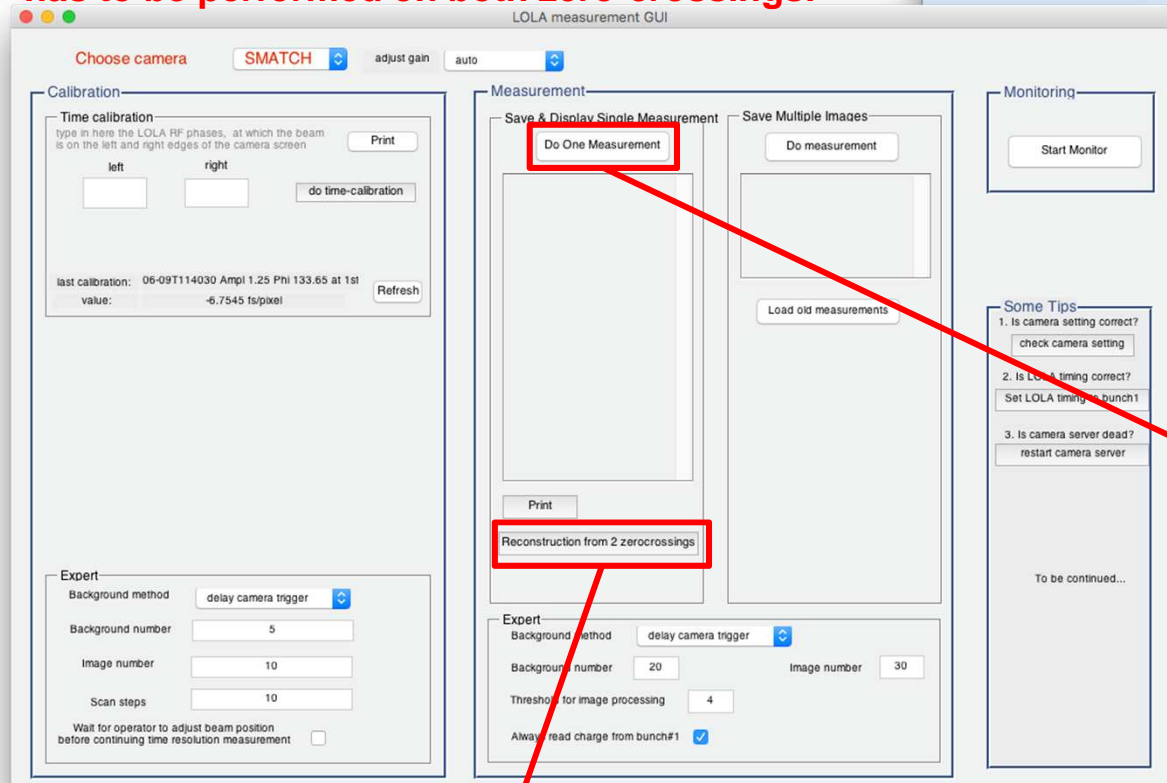
- It is also possible to save multiple raw data for future offline analysis.
- If you are doing some LOLA studies, you may need to save some data using this option.



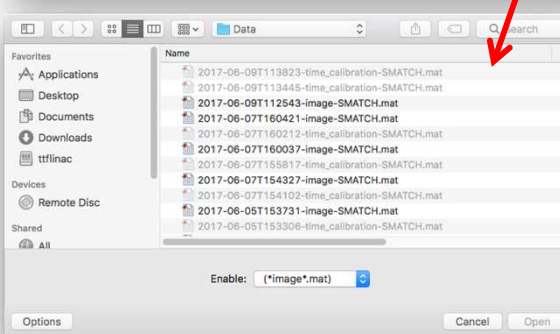
Reconstruct bunch length from two measurements

SMATCH

For a reliable bunch length, the measurement has to be performed on both zero-crossings!

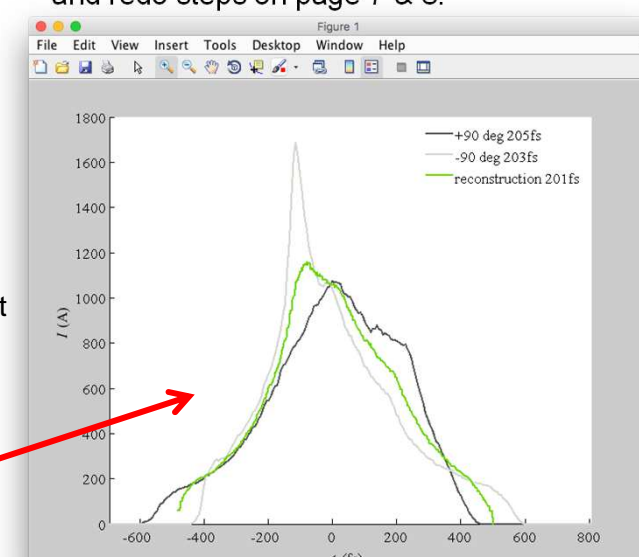


1. Make two measurements of the bunch length, one for each zero crossing of the LOLA RF- means change here zero-crossing and redo steps on page 7 & 8.



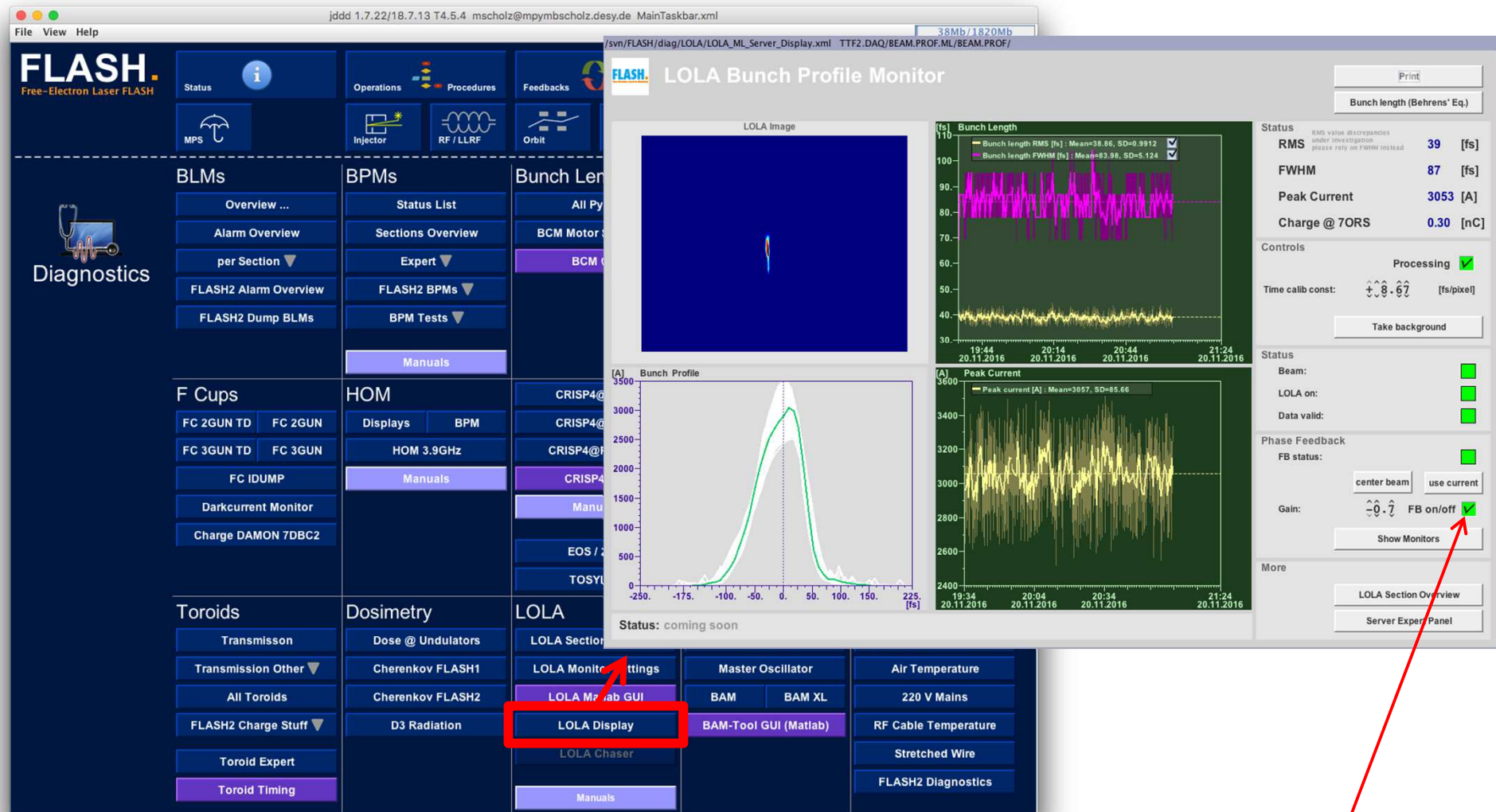
2. This file selection GUI will open two times. Select the last and the second last measurement taken before.

3. A plot showing the results of the bunch length calculation based on the chosen measurements opens.



LOLA middle layer server

SMATCH



- Open LOLA Display **for continually ongoing measurement of the bunch length.**
- The time calibration is automatically **used from the last calibration measurement.**
- Activate the LOLA phase feedback in order to keep the beam (horizontally) centered on the screen. Attention take care that the sign is correct (test it by slightly changing the LOLA phase)!
- **Operate LOLA with 1 Hz (see page 5) to avoid high activation of the screen 13SMATCH!**

> SDUMP section

- Tasks / properties:

Measure the longitudinal phase space

Only one bunch in the machine is allowed



Open panels

SDUMP

The image displays the FLASH control interface, which is a complex dashboard for managing the FLASH facility. The main window is titled "FLASH." and contains a top navigation bar with icons for File, View, Help, and various system components like RF/LLRF, Orbit, Photons, Magnets, Vacuum, and Cryo. The main area is divided into several panels, including "Bunch Length", "ORS", "Energy", "WireScan", "Screens", "Toroids", "Dosimetry", "LOLA", "SYNC", and "Miscellaneous".

Overlaid on the main interface are three sub-panels:

- SMATCH-SDUMP_beamline.xml**: This panel shows a detailed beamline diagram with components like SFELC, TDS LOLA, Kicker, 8SMATCH, 11SMATCH, and UND. It includes controls for SMATCH Setup (Cam 13SMATCH, Screen control, CAM Power Cycle, Filter Wheel, Filter, CAM, Mirror Stage, CAM Stage, Mirror Hor, CAM Zoom, Mirror Vert) and SDUMP Setup (6SDUMP, Screen control, CAM Power Cycle, Filter Wheel, Filter, CAM, Mirror Stage, CAM Stage, Mirror Hor, CAM Zoom, Mirror Vert). It also features a "Camera 6SDUMP" section with "Diode Ring-1" and "Diode Ring-2" LED controls (ON/OFF) and a "MINI DUMP" section.
- Camera.xml**: This panel shows the "6SDUMP" camera controls, including "Exposure" (Manual/Auto), "Gain" (Manual/Auto), "Print", "Images" (Start/Stop), "Rate [Hz]: 20.0", and "Frame: 153".
- FLASHING10**: This panel shows the "FLASHING10" controls, including "MATLAB GUI", "LOLA Display", "LOLA phase FB", "Restart Server", and "PowerCycle".

Red arrows indicate the flow of information and control between the main interface and the sub-panels. One arrow points from the "Diagnostics" icon in the top navigation bar to the "Camera 6SDUMP" section of the SMATCH-SDUMP_beamline.xml panel. Another arrow points from the "Camera 6SDUMP" section to the "Images" section of the Camera.xml panel. A third arrow points from the "Images" section to the "LOLA Section Overview" button in the LOLA panel of the main interface.

The DESY logo is visible in the bottom left corner.

Open panels

SDUMP

The image displays the FLASH Free-Electron Laser control interface, which is a complex web-based system. The main interface is divided into several sections:

- FLASH Free-Electron Laser FLASH**: The top header bar.
- Navigation Bar**: Includes links for Status, Operations, Procedures, Feedbacks, and Auto.
- Diagnosics**: A sidebar on the left with a stethoscope icon, containing links for BLMs, BPMs, Bunch Length, F Cups, HOM, CRISP4, Toroids, Dosimetry, LOLA, and SYNC.
- Main Content Area**: A grid of panels for different components and systems, including:
 - BLMs**: Overview, Alarm Overview, per Section, FLASH2 Alarm Overview, FLASH2 Dump BLMs.
 - BPMs**: Status List, Sections Overview, Expert, FLASH2 BPMs, BPM Tests, Manuals.
 - Bunch Length**: All Pyros, BCM Motor Stages, BCM GUI.
 - F Cups**: FC 2GUN TD, FC 2GUN, FC 3GUN TD, FC 3GUN, FC IDUMP, Darkcurrent Monitor, Charge DAMON 7DBC2.
 - HOM**: Displays, BPM, HOM 3.9GHz, Manuals.
 - CRISP4**: CRISP4@141m, CRISP4@202m, CRISP4@FLASH, CRISP4 GUI, Manuals.
 - Toroids**: Transmission, Transmission Other, All Toroids, FLASH2 Charge Stuff, Toroid Expert, Toroid Timing.
 - Dosimetry**: Dose @ Undulators, Cherenkov FLASH1, Cherenkov FLASH2, D3 Radiation.
 - LOLA**: LOLA Section Overview, LOLA Monitor Settings (highlighted with a red box), LOLA Matlab GUI, LOLA Display, LOLA Chaser, Manuals.
 - SYNC**: LbSync Main, Master Oscillator, BAM, BAM XL, BAM-Tool GUI (M).

Two specific panels are shown in detail:

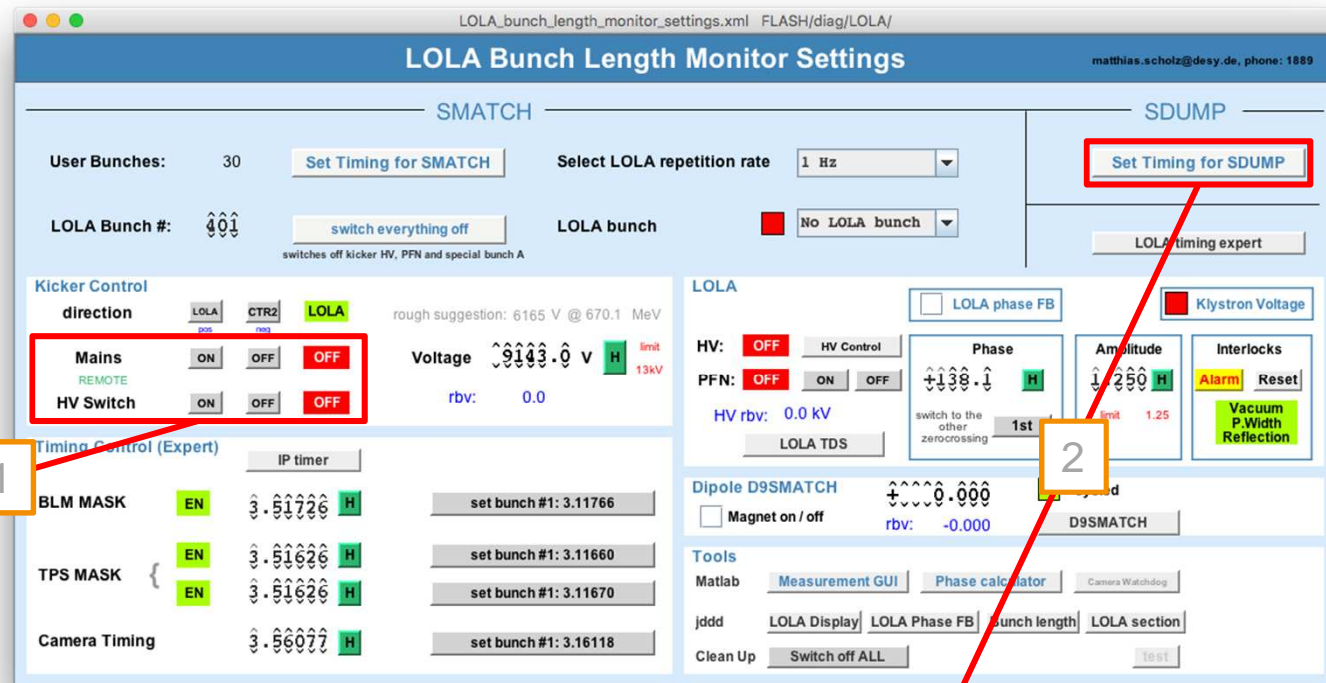
- LOLA Bunch Length Monitor Settings**: This panel allows for configuring the LOLA system. It includes fields for Total Bunches (100), LOLA Bunch # (101), and LOLA repetition rate (1 Hz). It also has sections for Kicker Control (direction, Mains, HV Switch), Timing Control (Expert) (BLM MASK, TPS MASK, Camera Timing, Kicker Timing), and LOLA parameters (HV, PFN, HV rbv, Phase, Amplitude, Interlocks). A red arrow points from the "LOLA Monitor Settings" button in the main interface to this panel.
- LOLA measurement GUI**: This panel is used for measuring the LOLA system. It includes sections for Calibration (Time, Energy), Measurement (Save & Display Single Measurement, Save Multiple Images), and Monitoring. It also has a "Choose camera" dropdown set to "SDUMP".

The DESY logo is visible in the bottom left corner.

Set timing and ensure kickers are off

SDUMP

1: Make sure that at least the HV switch is set to off.



- 2.1: Change the phase in 10 degree steps until you see the beam on the camera.
- 2.2: Increase the amplitude in small steps (~ 0.100) and adjust the phase accordingly. Always keep the beam on the camera in sight.
- 2.3: Go to maximum amplitude of 1.250.

Note: if you steer the beam off the screen it might cause BLM alarms in the undulator area. Don't worry, either you continue playing with the phase to find the beam again or start from the beginning with amplitude = 0.100.



Beam in SDUMP section

SDUMP

The screenshot displays the SDUMP control interface. At the top left, a window titled 'Magnet D9SMATCH' shows the current dipole current as 0.000 A, with a suggested current of -151.6 A at 606.4 MeV. Below this, the 'SMATCH Setup' and 'SDUMP Setup' sections are visible. The 'SDUMP Setup' section includes a 'CAM Power Cycle' button and a 'CAM' button. A red box highlights the 'CAM' button, with a red arrow pointing to it. Another red box highlights the 'Camera 6SDUMP' button, with a red arrow pointing to it. A third red box highlights the 'Start / Stop' button in the 'Camera.xml' window, with a red arrow pointing to it. The 'Camera.xml' window shows the '6SDUMP' camera settings, including exposure, gain, and rate. The 'Start / Stop' button is highlighted with a green checkmark.

1. Switch on the camera 6SDUMP

2. Turn on dipole D9SMATCH

- Set the suggested dipole current for the actual beam energy e.g. for 700 MeV -> current -175 A.
Note: The negative sign of the dipole current!
- Set the number of bunches to one.
- Now you should see the beam on the screen. If not, adjust the current in 0.1 A steps.

Streak with LOLA

SDUMP

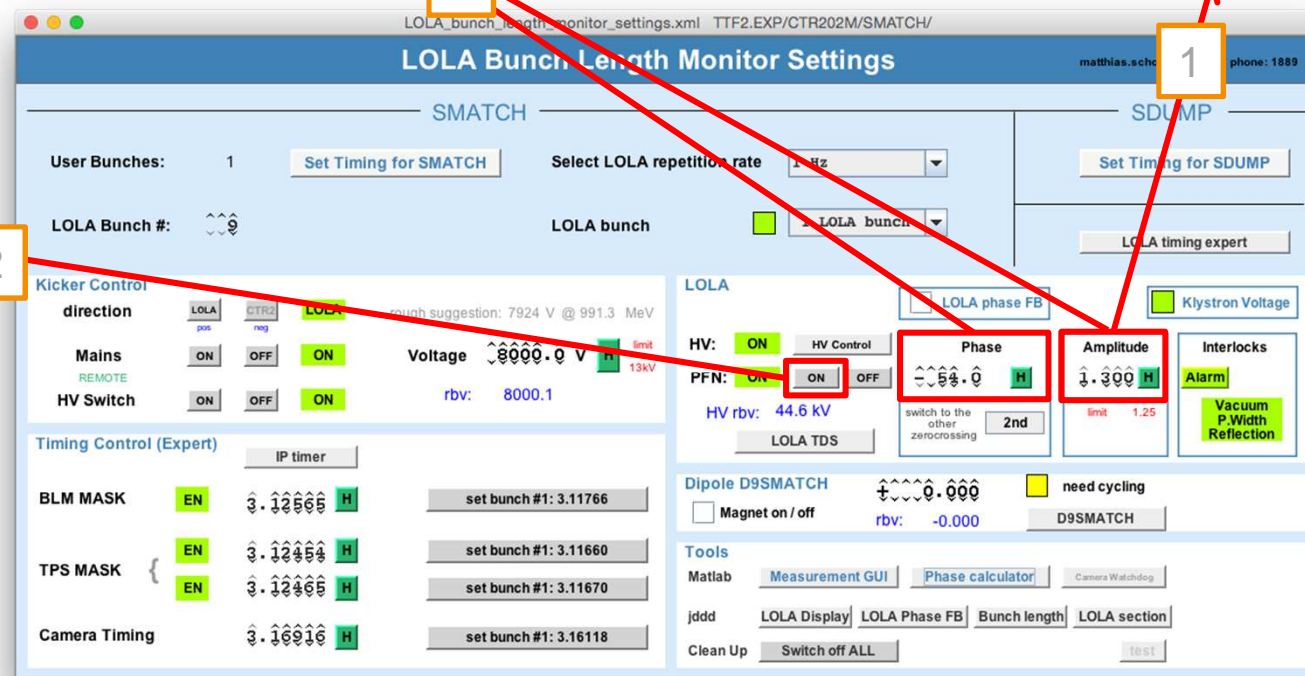
- 3.1: Change the phase in 10 degree steps until you see the beam on the camera.
- 3.2: Increase the amplitude in small steps (~ 0.100) and adjust the phase accordingly. Always keep the beam on the camera in sight.
- 3.3: Go to maximum amplitude of 1.250.

Note: if you steer the beam off the screen it might cause BLM alarms in the undulator area. Don't worry, either you continue playing with the phase to find the beam again or start from the beginning with amplitude = 0.100.

- LOLA measurements in the SDUMP beamline are carried out with 'normal' bunches.
- No 1 Hz operation possible. Reduce the time with beam on the screen to minimize activation.
- Maximum 2 bunches are allowed.

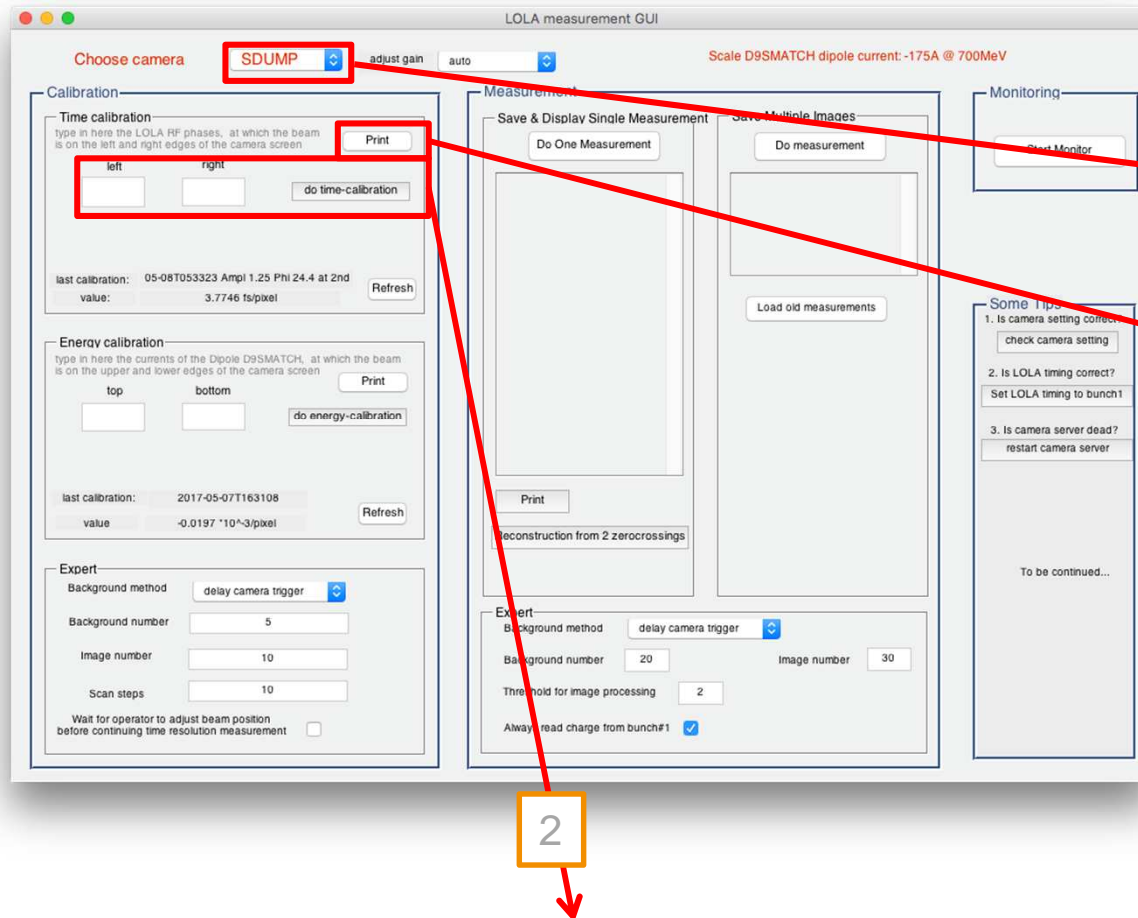
2: Turn on
LOLA PFN

1: Reduce LOLA
amplitude to a small value
e.g. 0.100.



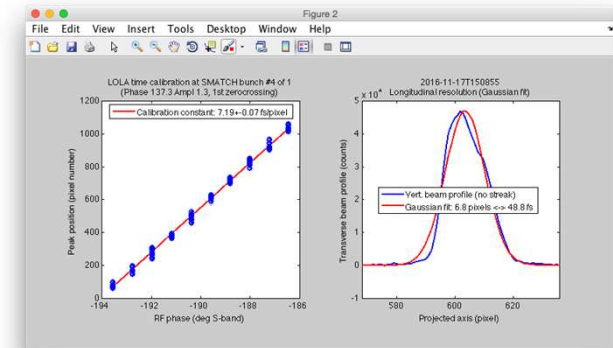
Do time calibration

SDUMP



1: Chose camera SDUMP

3: Print the calibration plot to the logbook.



- 2.1: Type in here the LOLA RF phases at which the beam is on the LEFT and RIGHT side of the screen.
- 2.2: Click 'do time calibration'.
- 2.3: During the calibration, you may need to click a continue button in the GUI.



Note: Time calibration needs to be repeated if the machine optics changes, OR the LOLA amplitude changes.

Do energy calibration

SDUMP

LOLA measurement GUI

Choose camera: SDUMP adjust gain: auto Scale D9SMATCH dipole current: -175A @ 700MeV

Calibration

Time calibration
type in here the LOLA RF phases, at which the beam is on the left and right edges of the camera screen
left: right: do time-calibration
Print
last calibration: 05-08T053323 AmpI 1.25 Phi 24.4 at 2nd
value: 3.7746 fs/pixel Refresh

Energy calibration
type in here the currents of the Dipole D9SMATCH, at which the beam is on the upper and lower edges of the camera screen
top: bottom: do energy-calibration
Print
last calibration: 2017-05-07T163108
value: -0.0197 *10^-3/pixel Refresh

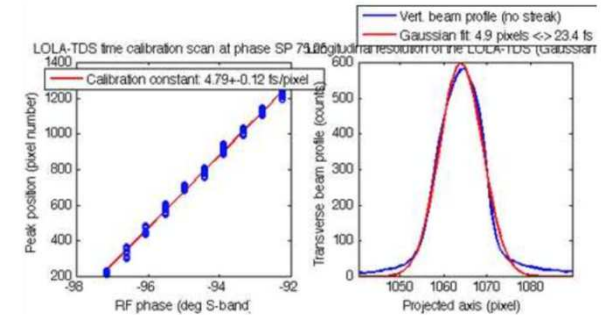
Expert
Background method: delay camera trigger
Background number: 5
Image number: 10
Scan steps: 10
Wait for operator to adjust beam position before continuing time resolution measurement: ☐

Measurement

Save & Display Single Measurement: Do One Measurement
Save Multiple Images: Do measurement
Load old measurements
Print
Reconstruction from 2 zerocrossings

Monitoring
Start Monitor

Some Tips
1. Is camera setting correct?
check camera setting
2. Is LOLA timing correct?
Set LOLA timing to bunch1
3. Is camera server dead?
restart camera server
To be continued...



2.1: Click the print button to print the plot of the calibration to the elog.

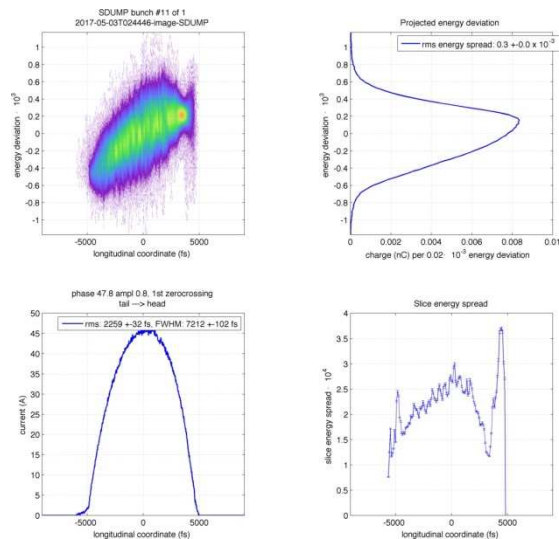
1.1: Type in here the dipole current, at which the beam is on the top and bottom of the screen.
1.2: Click the do energy-calibration button.



Do measurements

SDUMP

- Save and display one single shot measurement
- Don't forget to print to logbook. To do that you can use the print button on the Matlab panel.



LOLA measurement GUI

Choose camera: SDUMP adjust gain: auto Scale D9SMATCH dipole current: -175A @ 700MeV

Calibration

Time calibration
Here is base the LOLA RF phases, at which the beam is on the left and right edges of the camera screen
left: [] right: [] do time-calibration
last calibration: 05-08T053323 Ampl 1.25 Phi 24.4 at 2nd value: 3.7746 fs/pixel Refresh

Energy calibration
type in here the currents of the Dipole D9SMATCH, at which the beam is on the upper and lower edges of the camera screen
top: [] bottom: [] do energy-calibration
last calibration: 2017-05-07T163108 value: -0.0197 $\cdot 10^{-3}$ /pixel Refresh

Expert
Background method: delay camera trigger
Background number: 5
Image number: 10
Scan steps: 10
Wait for operator to adjust beam position before continuing time resolution measurement: ☐

Measurement

Save & Display Single Measurement
Do One Measurement
Print
Reconstruction from 2 zero-crossings

Save Multiple Images
Do measurement
Load old measurements

Monitoring
Start Monitor

Some Tips
1. Is camera setting correct?
check camera setting
2. Is LOLA timing correct?
Set LOLA timing to bunch1
3. Is camera server dead?
restart camera server
To be continued...

- Save multiple raw data for future offline analysis.
- If you are doing some LOLA studies, you may need to save some data using this option.



LOLA Manual for FLASH Operators

Matthias Scholz
June 15, 2017

Switch LOLA off



Switch off

- 1 use this button to switch every thing off
or switch off kicker, PFN, special bunch (typically A is used)

LOLA_bunch_length_monitor_settings.xml TTF2.EXP/CTR202M/SMATCH/ matthias.scholz@desy.de, phone: 1889

LOLA Bunch Length Monitor Settings

SMATCH

User Bunches: 1 [Set Timing for SMATCH](#) Select LOLA repetition rate: 1 Hz

LOLA Bunch #: [switch everything off](#) LOLA bunch: 1 LOLA bunch

switches off kicker HV, PFN and special bunch A

Kicker Control

direction: LOLA rough suggestion: 7924 V @ 991.3 MeV

Mains: ON OFF ON Voltage: 8000.0 V limit 13kV

HV Switch: ON OFF ON rbv: 8000.1

Timing Control (Expert)

IP timer

BLM MASK: EN 3.12565 H set bunch #1: 3.11766

TPS MASK: EN 3.12454 H set bunch #1: 3.11660

EN 3.12466 H set bunch #1: 3.11670

Camera Timing: 3.16016 H set bunch #1: 3.16118

LOLA

☐ LOLA phase FB ☒ Klystron Voltage

HV: ON HV Control Phase: 0.0 H Amplitude: 1.300 H Interlocks: Alarm

PFN: ON ON OFF switch to the other zero-crossing 2nd limit 1.25 Vacuum P.Width Reflection

HV rbv: 44.6 kV LOLA TDS

Dipole D9SMATCH

☐ Magnet on / off rbv: -0.000 need cycling D9SMATCH

Tools

Matlab: [Measurement GUI](#) [Phase calculator](#) [Camera Watchdog](#)

jddd: [LOLA Display](#) [LOLA Phase FB](#) [Bunch length](#) [LOLA section](#)

Clean Up: [Switch off ALL](#) [test](#)

