Longitudinal Bunch Arrival-Time Feedback at FLASH

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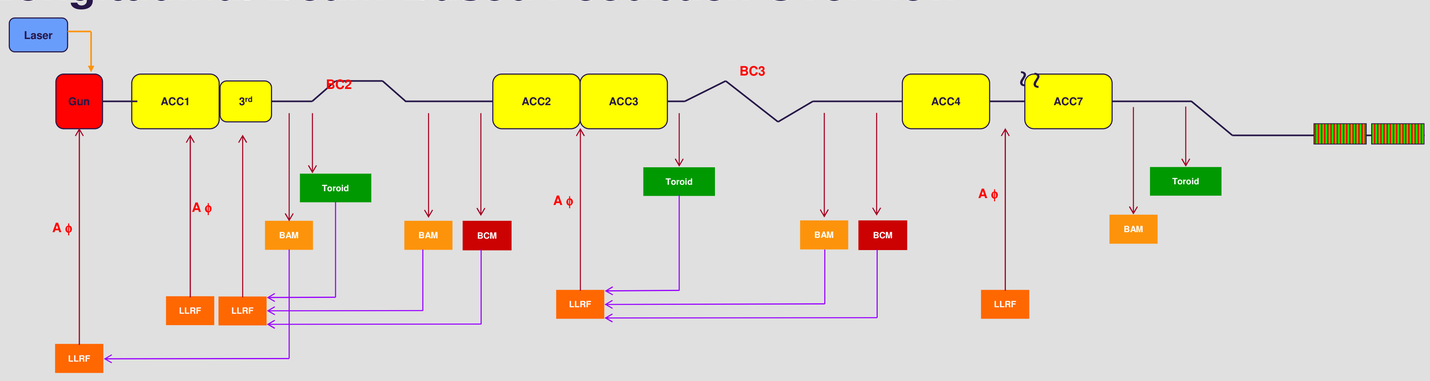
Abstract

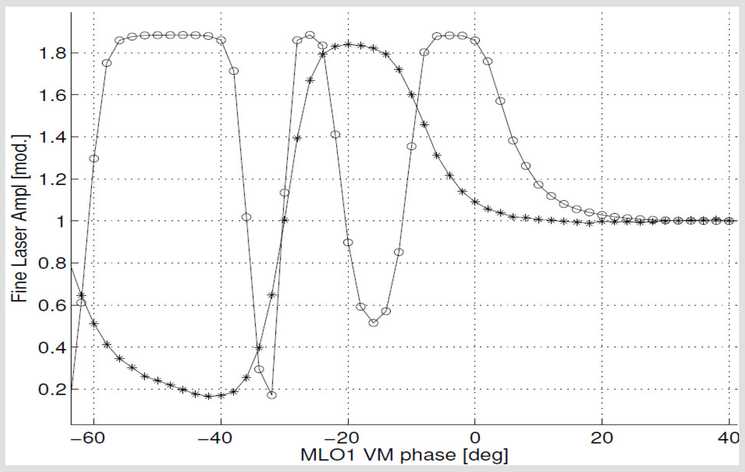
Electron bunches at the free electron laser FLASH at DESY have a duration of 10 fs to 150 fs and an arrival-time jitter of about 150 fs (rms). It is anticipated that the newly installed optical synchronization system will stabilize the seed and pump-probe lasers to within ~10 fs. In order to perform reliable and stable seeding, the electron bunch timing jitter needs to be reduced. Bunch arrival-time monitors measure the arrival-time fluctuations at different locations and are used in a beam-based feedback loop to correct the amplitude of the accelerator RF. In order to provide reliable operation and high availability of the bunch arrival-time feedback, intensive efforts have been undertaken in system automation and exception handling. This will be discussed along with the latest results and limitations on the stability of the arrival-times at FLASH.

Longitudinal Beam-Based Feedback Overview



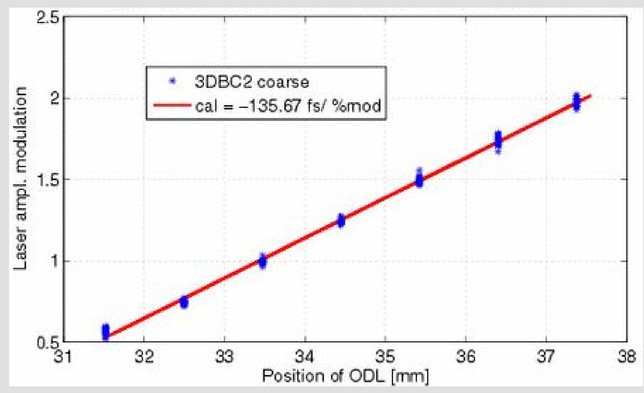
Measurement of the Pick-Up Signal with monitor

- Scan of laser pulse phase
- Line with * is the coarse channel
- Line with o is the fine channel



Calibration

- In order to convert the measured arrival signals into arrival time information a calibration is needed.
- The motorized and calibrated optical delay stage (ODL) will be moved around the working point, the arrival signal difference will be measured and a linear fit has to be calculated.
- Errors in both coordinates has to be taken into account (mainly laser noise and arrival time fluctuations of the bunches)

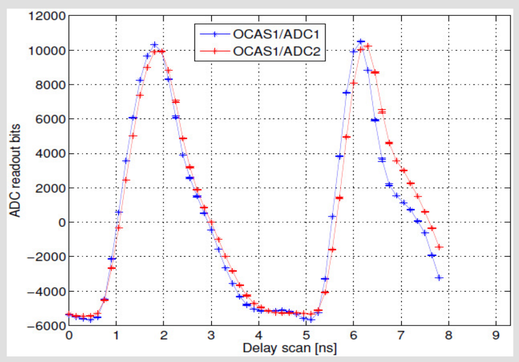


Optical Delay Stage Feedback

- In order to measure the arrival time, the laser pulses need to be shifted in time to set the right working point on the steep slope of the pick-up signal
- A feedback adjusts on optical delay stage automatically to keep the right working point, if once found
- The fine and coarse measurement is used to allow a higher dynamic range as just the fine signal
- Fine and coarse measurement are shift able relative to each other with a second delay stage, which has to be corrected in an additional feedback on a long term basis

Delay Adjustment

- Due to the high repetition rate of the laser pulses (216MHz) only every second peak and base line could be sampled with two ADCs
- It is important, that the peak-sample targets really the peak of the laser pulse and not the edges around it.
- Due to drifts of fibers and electronics a deviation of the right timing is possible
- Therefore adjustable electronic delays have to be corrected automatically to stay at the peak



Electro-Optical Modulator Bias Voltage

- Electro-Optical Modulators used to modulate the laser pulses with the pick-up signal of the bunch depends on the applied bias voltage
- From time to time a change of the bias voltage is needed to keep the desired relation ship of maximum and minimum modulation to unmodulated pulses
- In an automated procedure the delay stage is used to drive the working point to maximum modulation and then the bias voltage is adjusted, that modulation matches the predefined point

Polarization Controller

- Electro-Optical Modulators used to modulate the laser pulses with the pick-up signal of the bunch depends on the polarization of the input laser pulses
- Diverting from the optimal polarization reduces the power of the modulated and unmodulated pulses and thus the input signal at the ADCs. This leads to higher measurement noise and worse resolution
- Therefore the polarization has to be automatically adjusted, by optimizing the output power

Further Information

- Poster THPA06
- Talk THOAI2
- Talk THOA3

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