PAUL SCHERRER INSTITUT

# The Bunch-Arrival Time Monitor for SwissFEL

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on behalf of the Timing&Synch Group

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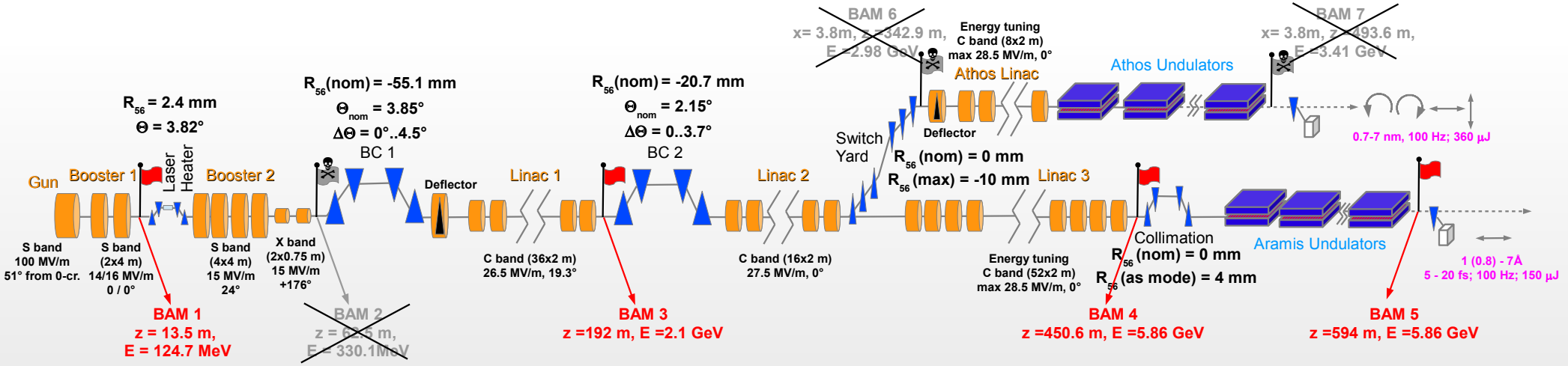
# Purpose, Specifications, Requirements for SwissFEL



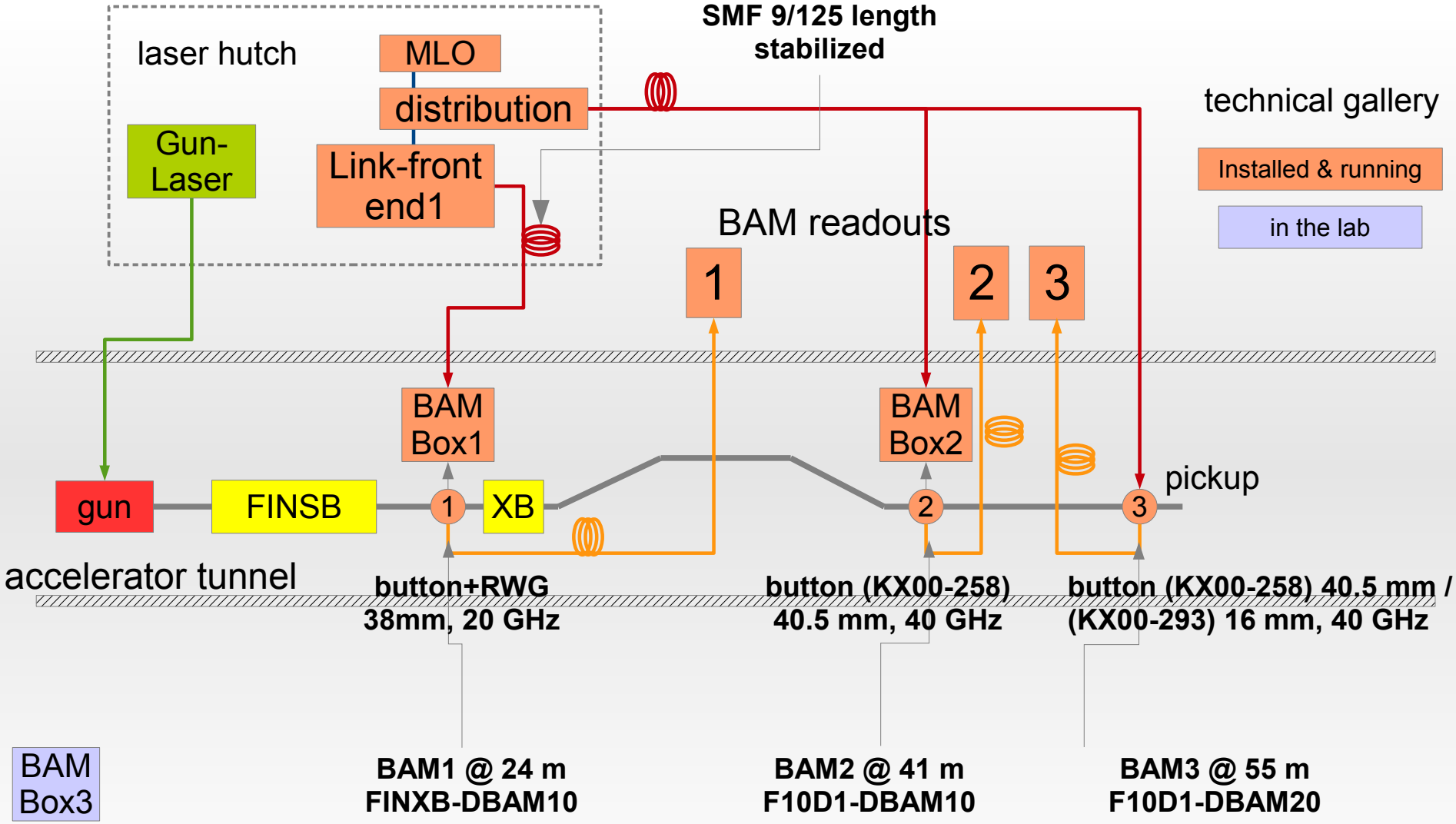

## Purpose

- Precision (<50fs/<10fs) arrival time measurement at selected locations (e.g. Magnetic chicanes/undulators) relative to a highly stable optical reference system (resolution <5 fs; drift 10fs/day)
- Decouple drift sources and phase errors during commissioning and setting of the machine
- Feedback on accelerator cavity phases, tuning of BC, etc.
- Correlation with other events, e.g. Pump-Probe experiments

## Parameters and Specifications

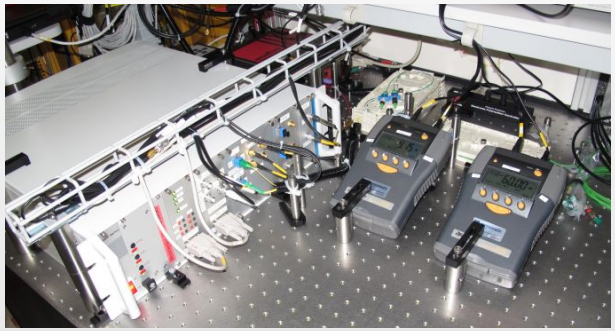
| Parameter | Specification | Remark |
|---|---|---|
| **Dynamic range (time of flight comp.)** | **< 300 ps** | Compensation for changes in BC angles |
| **Dynamic range (arrival time jitter)** | **20 (100) ps** | Slope pickup signal (combination of 2 slopes) |
| **Dynamic range (charge)** | **10-200 pC** | for ps to fs bunches |
| **RMS resolution (S/N) (before/after BC)** | **<50 / <10 fs** | Within the range 10-200 pC, monitored online (slew rate+laser ampl. jitter) |
| **T° Stability** | **0.05 °C** | Active T° stabilization of the optical front-end |
| **calibration** | **dynamic** | Scan of the ref. Laser pulses over the pickup |
| **Measurement mode/rep.rate** | **10 / 100 Hz** | Bunch-synchrone, non-destructive, (2 bunch at 28 ns, Phase 2) |
| **Ref. interface** | **optical** | Client of the pulsed optical reference distribution |
| **CS-Interface** | **Digital output** | Fast ADC+event receiver; shot-to shot arrival time offset and drift (over larger period) with fs precision |
| **Other interfaces** | **Beam based FB** | Comissioning: beam-based Fbs on high level (10Hz)<br>User operation: beam-based Fbs on low level (100Hz) |

# BAM Topology in the Injector Test Facility



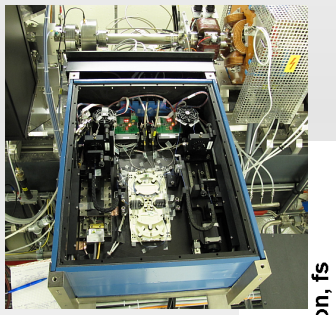
# Status FINXB-DBAM10

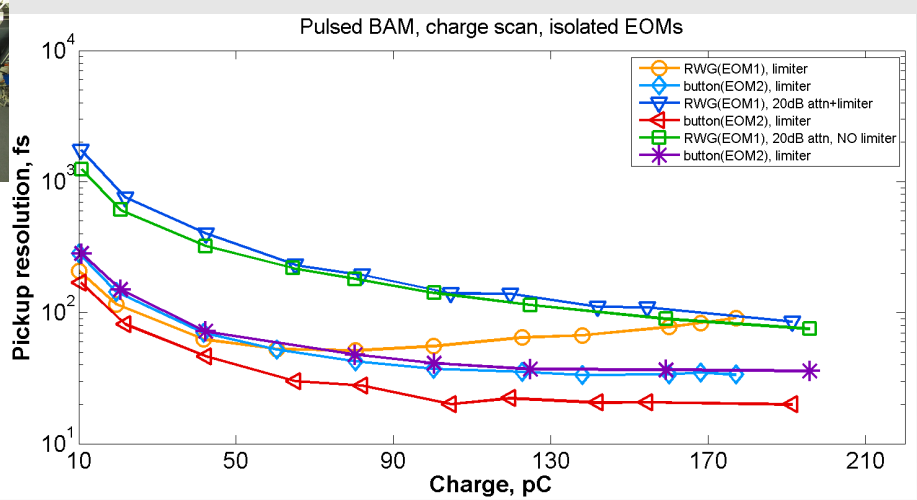
**Completely functional with length-stabilized link**
- 2 bunch operation: no
- Resolution, charge: 200pc-60 pc: 18 fs;
(button pickup) 60 pC – 10 pC: 30-170 fs



**Link 1 Stabilization:**
RF- Phase Detector: - TEC stabilized
- no dispersion compensation necessary
- Amplitude ratio control (FB with EDFA1)
- Phase difference control (FB with a MDL )

**BAM-Box:** - TEC stabilized (12 Peltier)
- 2 EOMs, 10 GHz
- commercial EDFAs






**Pickup:** - button (80GHz) & RWG (~20 GHz)
- BW Limited (< 20 GHz) by feedthrough

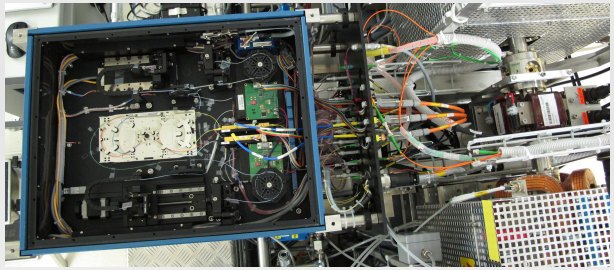
**Readout**: - GPAC 12 FL, 500 MHz, 12 bit,
- Sample length: 400 smp
- AC coupling
- signal conditioning DAC (since recently)
- bunch synchrone (continuous)

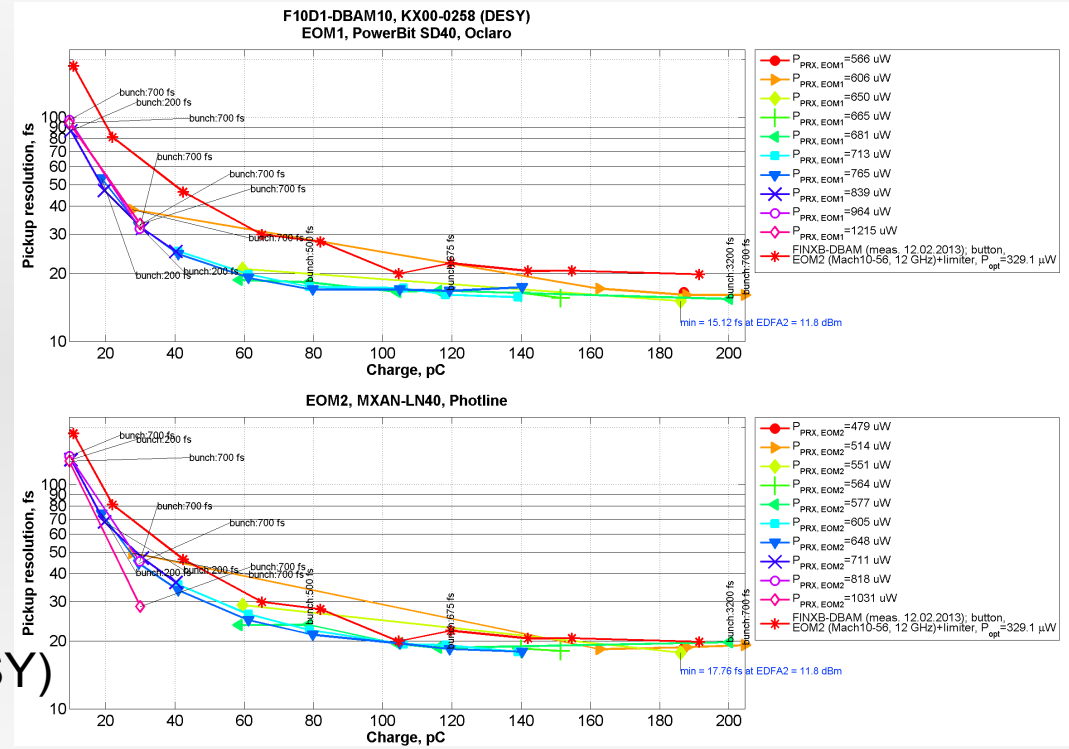
# Status F10D1-DBAM10

**Completely functional**
- 2 bunch operation: no
- Resolution, charge: 200pc-50 pc: 18 - 15 fs (improved a few fs with short ref. pulses);
(button pickup) 40 pC – 10 pC: 25-90 fs (tested with chirped ref. pulses)

**Link 2 Stabilization:**
Breadboard BOC, dispersion compensation

**BAM-Box:** - TEC stabilized (12 Peltier)
- 2 EOMs, 40 Gb/s (~33 GHz)
- commercial EDFAs






**Pickup:** - button KX00-258 (40.5 mm, 40 GHz DESY)
End of August KX00-293 (16 mm, 40 GHz, DESY)

**Readout**: - commissioned with GPAC 12FL (12 bit), offset DAC with high IL and the BAM1 PRX
- any time now: GPAC 16FL (16 bit), low IL offset DAC, PRX with larger dynamic range of the RF amplification
- bunch synchrone (continuous)

# BAM „To-Do List“

**Milestones:** - 2 bunch operation (under discussion whether required for BAM)
- Resolution, charge: 10 pc: <10 fs;

**SwissFEL:** - housing, radiation shielding, pickup support
- independent timing shifter for the optical links (T&S)
- BAM server, FPGA processing/buffering, Matlab with FPGA...
- event receiver on the FPGA
- fast feedback (platform, manpower and concept missing/not supported)...