Prototype of the bunch arrival time monitor for SHINE

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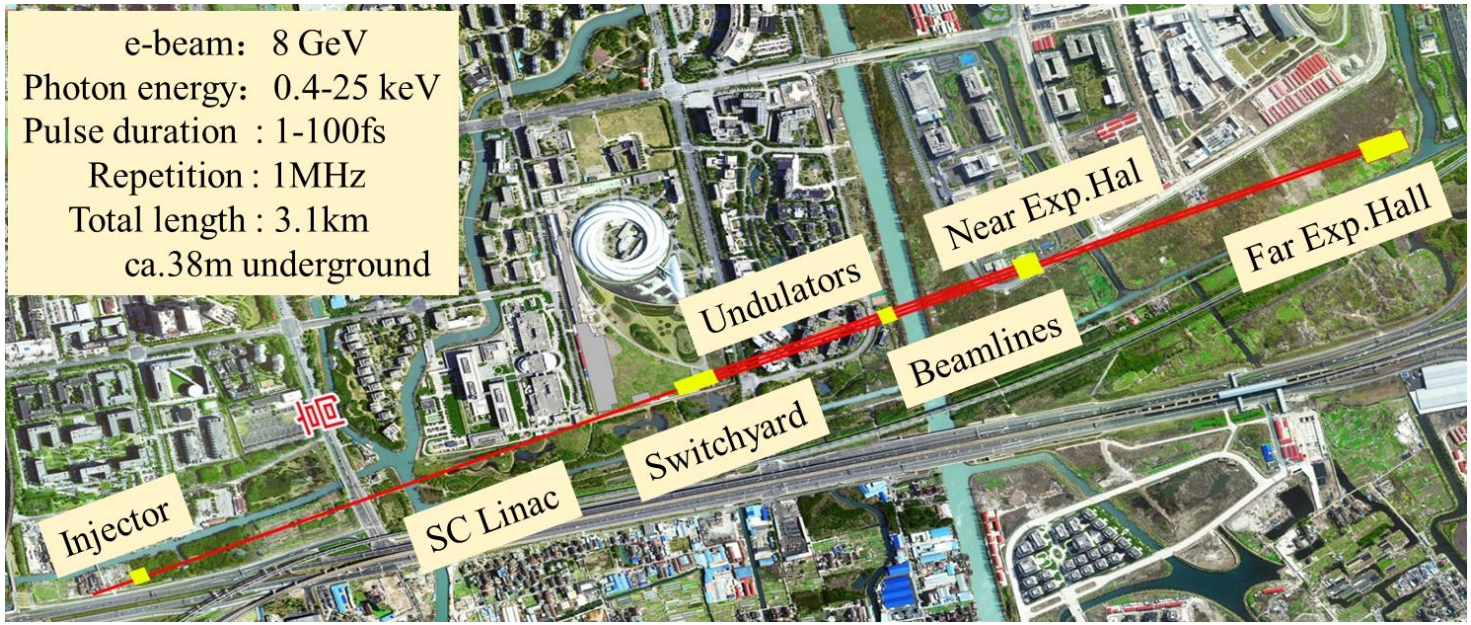
BAM for SHINE



- SHINE is a high rep-rate XFEL facility, based on an 8 GeV CW SCRF Linac, under development in China;
- Two types of BAM are planned for SHINE, BAM based on RF phase detector and BAM based on electro-optica modulation technology.

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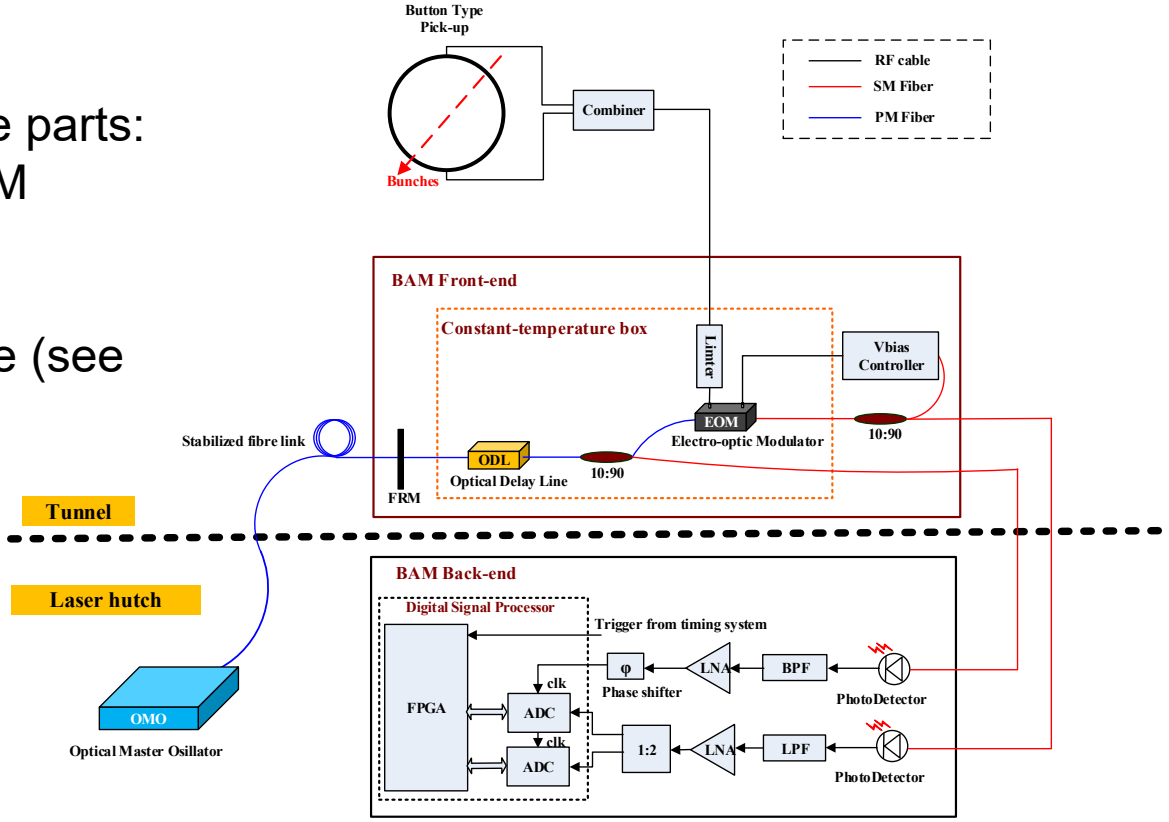
EO-BAM prototype for SHINE

- The bunch arrival time monitor based on the electro-optical modulator is planned for SHINE and will firstly be tested on SXFEL for performance evaluation.

✓ The BAM consists of three parts: the beam pick-up, the BAM frond-end and back-end.

✓ The prototype at this stage (see right figure) is a simplified version of the final BAM.



Schematic diagram of the first BAM prototype

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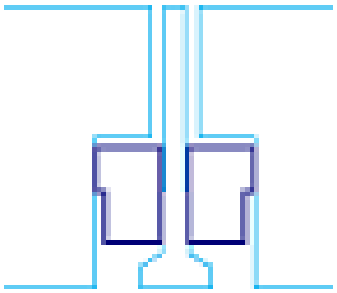
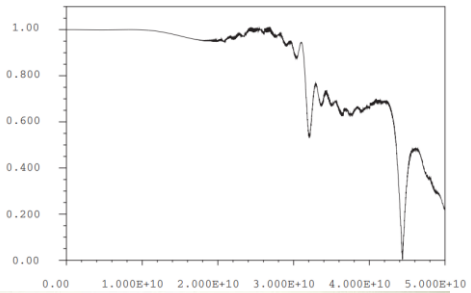
Button type pick-up

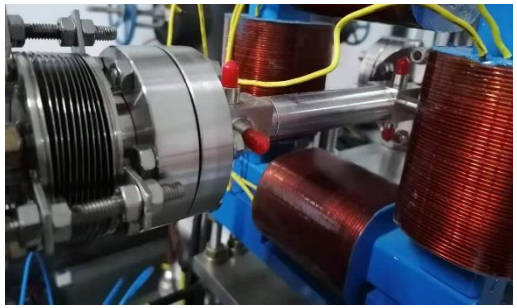
- A 18GHz pick-up has installed on the SXFEL and it will be used for the functional verification of the BAM prototype until the 35GHz pick-up is ready.
- We have finished the development of the electrode for the 35GHz pick-up. The bandwidth of the pick-up electrode can achieve up to 40GHz.

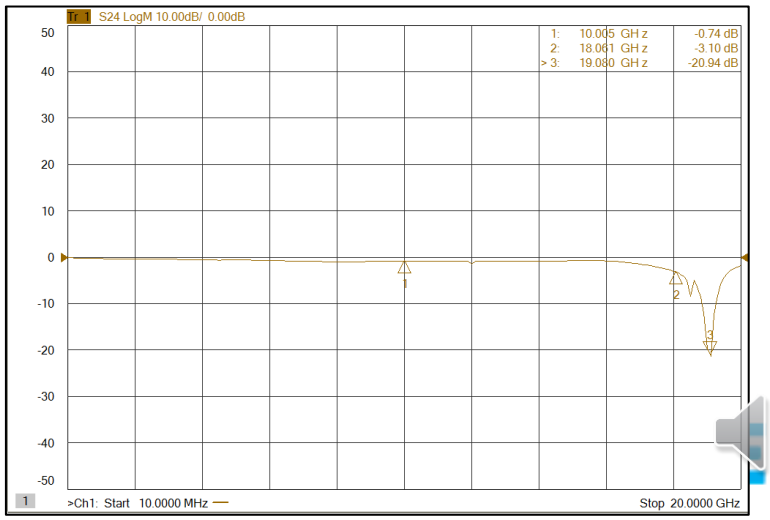
35GHz button type pick-up



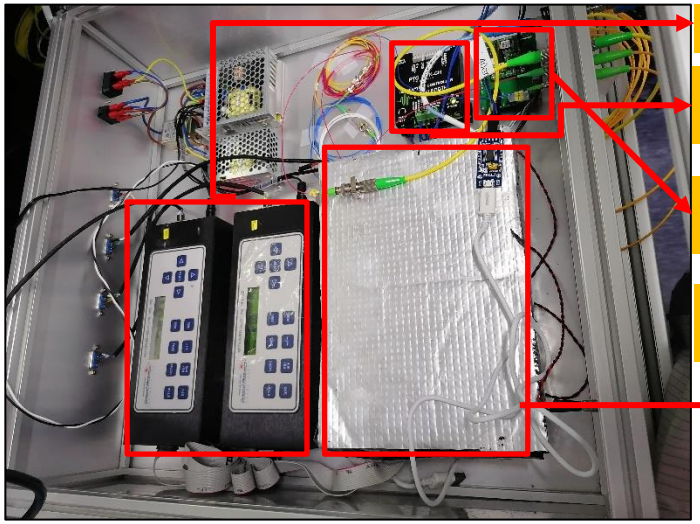


18GHz button type pick-up



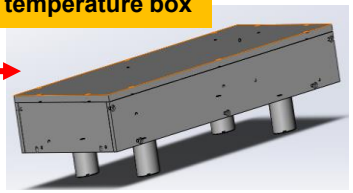


BAM front-end

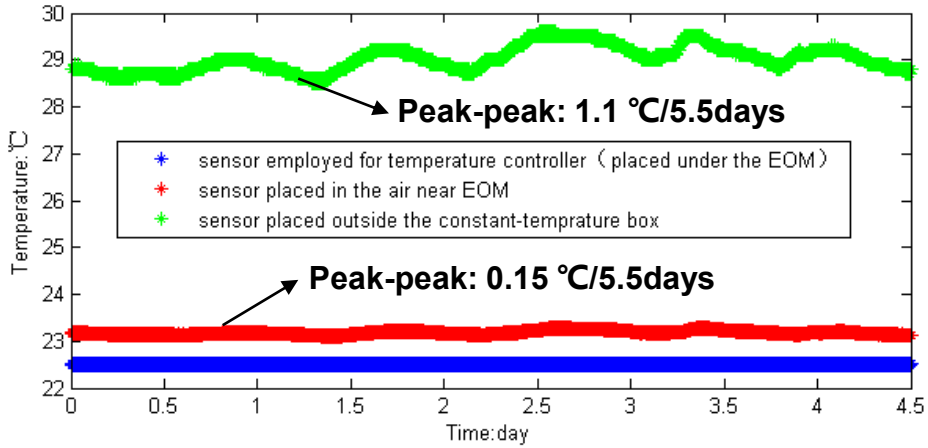


Picture of BAM front-end

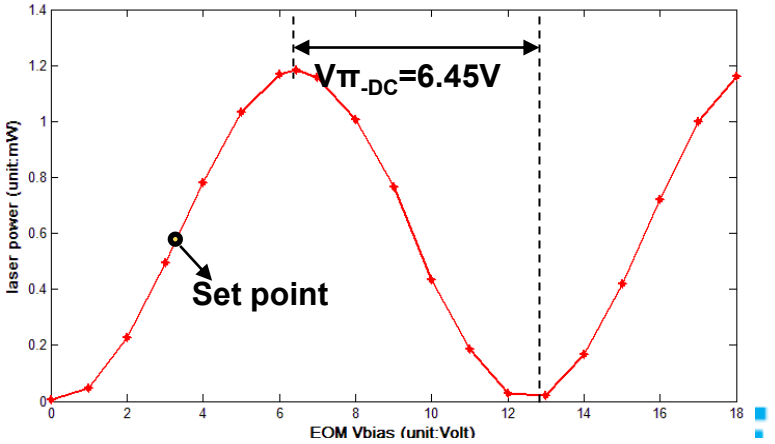
- The BAM optical front-end is all-PM-fiber structure.
- Temperature-sensitive optical components are housed in a constant-temperature box.



3D map of the constant-temperature box

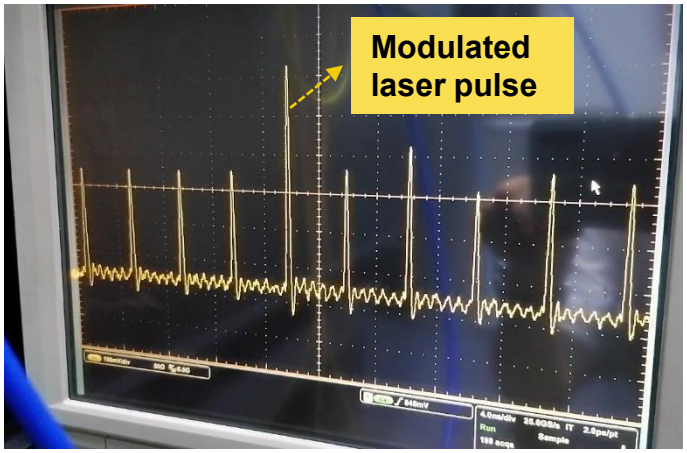


Long term (5.5days) temperature change inside the BAM front-end



Transmission characteristics curve of the EOM

BAM back-end

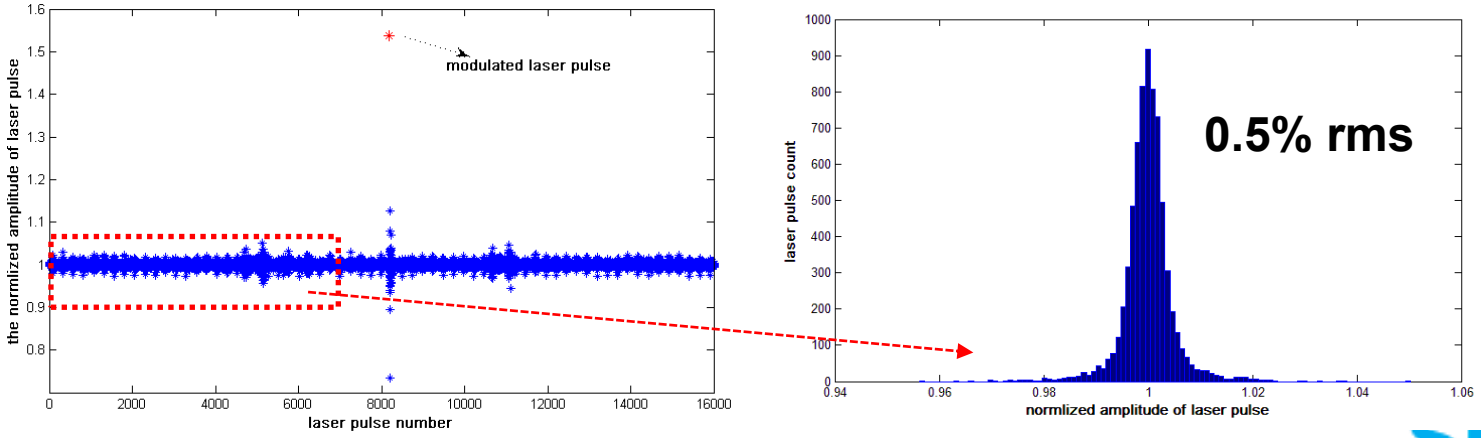


The photodetector signal converted from laser pulse of EOM

Main parameters of high-speed signal processor(two versions)

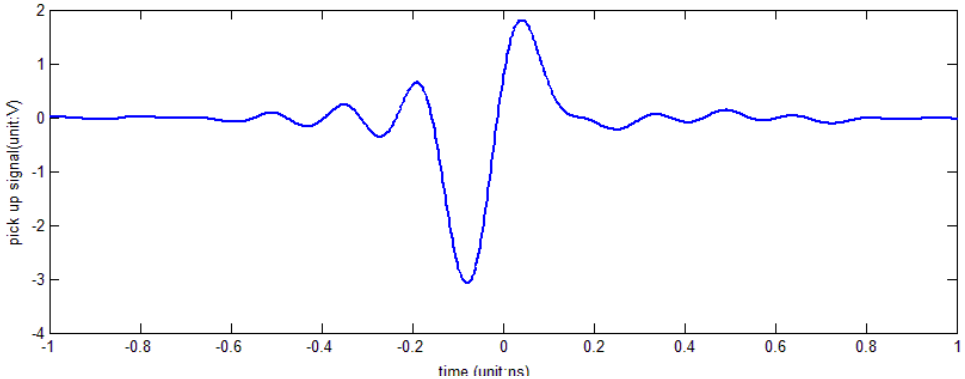
parameter	value
RF channels	2
ADC bits	14
Max ADC rate	250Msps
ADC bandwidth	500 MHz
ADC sampling rate	238MHz

parameter	value
RF channels	4
ADC bits	16
Max ADC rate	1Gsps
ADC bandwidth	1GHz
ADC sampling rate	952MHz



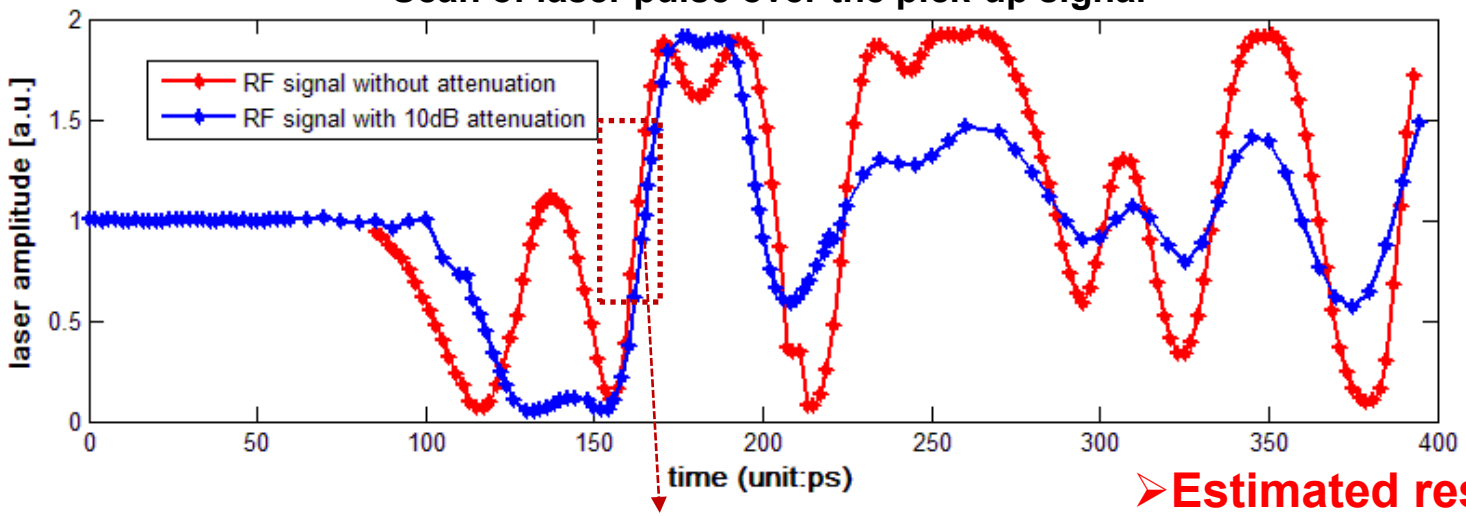
Laser pulse detected by the BAM back-end

The beam test result



- Beam test for BAM prototype is carried out at SXFEL. Electron charge is 500 pC.
- Two oppositely placed 18GHz pick-up electrodes are combined in a RF combiner and be transmitted through a 22 meters RF cable to the BAM front-end.
- Left figure shows that RF signal observed by the 5GHz-bandwidth-oscilloscope.

Scan of laser pulse over the pick-up signal



Slope: ~55fs/(% modulation)

Laser amplitude detection: 0.5% rms

➢Estimated resolution of BAM is ~27.5fs rms.

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Conclusion

- we have finished the development of the 35GHz pick-up electrodes and its measured bandwidth can achieve up to 40GHz.
- The first EO-BAM prototype based on 18GHz button pick-up has installed on SXFEL for beam test.
- The beam test result shows the estimated resolution of the prototype is about 27.5 fs rms.
- Future work:
  - some efforts will be made to improve the resolution of the prototype.
  - Assemble another BAM prototype, and use two BAMs to carry out the resolution verification.
  - …

Thanks for your attention!