Real-Time Display System for the Optical Fiber Beam Loss Monitor for the PHIL and ThomX facilities

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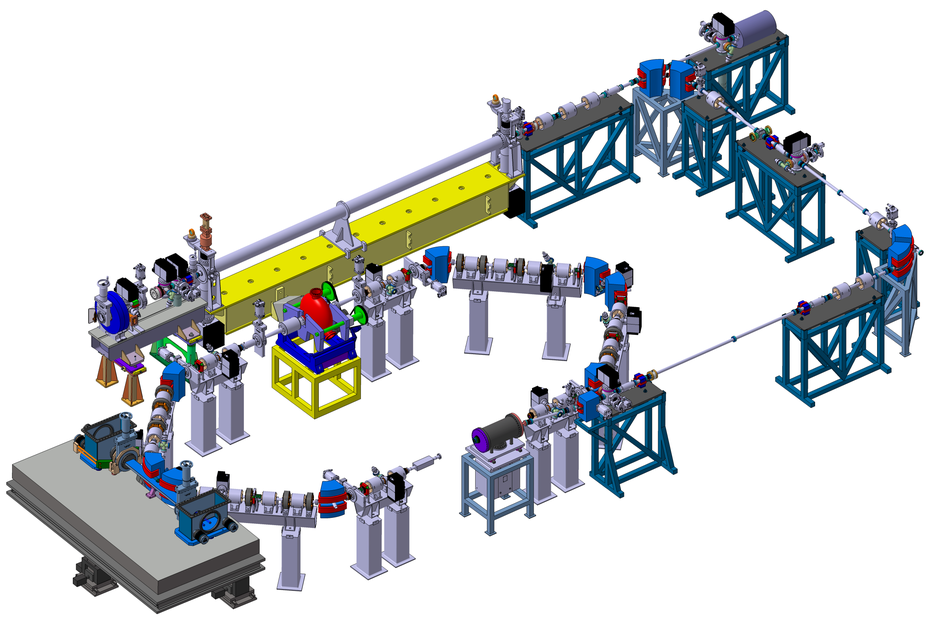
Introduction

ThomX is a project to build an accelerator based compact X-ray source in Orsay (France). At present, the ThomX machine is under construction.



- A reliable beam loss monitor capable to locate the losses will be indispensable for the commissioning.
- Fiber Beam Loss Monitor (FBLM) is installed at PHIL (PHotoinIector at LAL, Orsay) as a prototype for the ThomX machine

Description	PHIL	ThomX	Units
Beam energy	5	50 – 70	MeV
Bunch charge	< 1.5	1	nC
Bunch length (rms)	> 3.5	3.7 (injector) 30 (ring)	ps ps
Beam energy spread (rms)	< 2 – 3	< 1	%
Repetition frequency	5	50	Hz
Machine length	∼ 5	∼ 5 (Injector) ∼ 13 (TL) ∼ 18 (Ring)	m m m

Detection principle

- Production of Cherenkov radiation in the optical fiber attached to the vacuum chamber by the electromagnetic shower generated when the main beam hits the vacuum chamber.

☞ The Cherenkov light is converted to an electrical signal containing the information about the position and intensity of the beam losses.

Experimental set-up

Optical fiber:

- A fiber belongs to the Hard Plastic Clad Silica (HPCS) fibers made by the LEONI Fiber Optics GmbH.
- The fibers used at PHIL have a 600 μm fused silica glass core, 630 μm of optical cladding made from polymer consisting of a fluorinated acrylate and 950 μm Tefzel® jacket.
- Speed of light in the fiber was measured to be 0.63 c (0.19 m/ns).
- Attenuation of the fibers has been estimated to be several tenths of dB/meter at 405 nm.

Detection and Acquisition systems:

- The photosensor modules H10721-01 manufactured by Hamamatsu Photonics.
- The FBLM signal is displayed and recorded by using the LeCroy WavePro 740Zi oscilloscope.
- Remote control of the oscilloscope is used to adjust the display parameters.

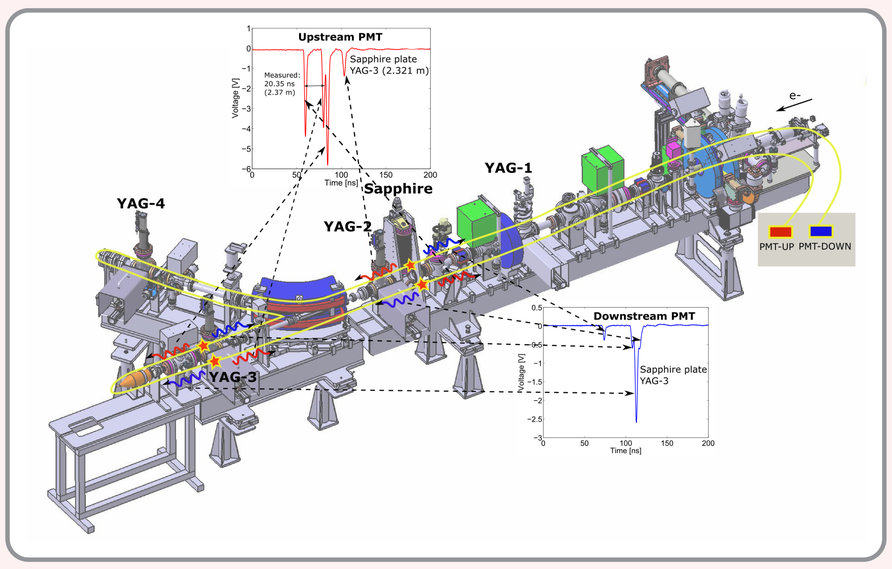
FBLM calibration:

- Every meter along the accelerator is 8.6 ns on the oscilloscope.

Summary and future plans

- The measured position accuracy allows resolving the beam losses occurring as close as 30 – 40 cm with the 25 m fiber along the vacuum chamber.
- Real-time display system for the FBLM is now under development.
- Auxiliary calibration procedure will be envisaged for the ThomX commissioning.

Fiber Beam Loss Monitor at PHIL

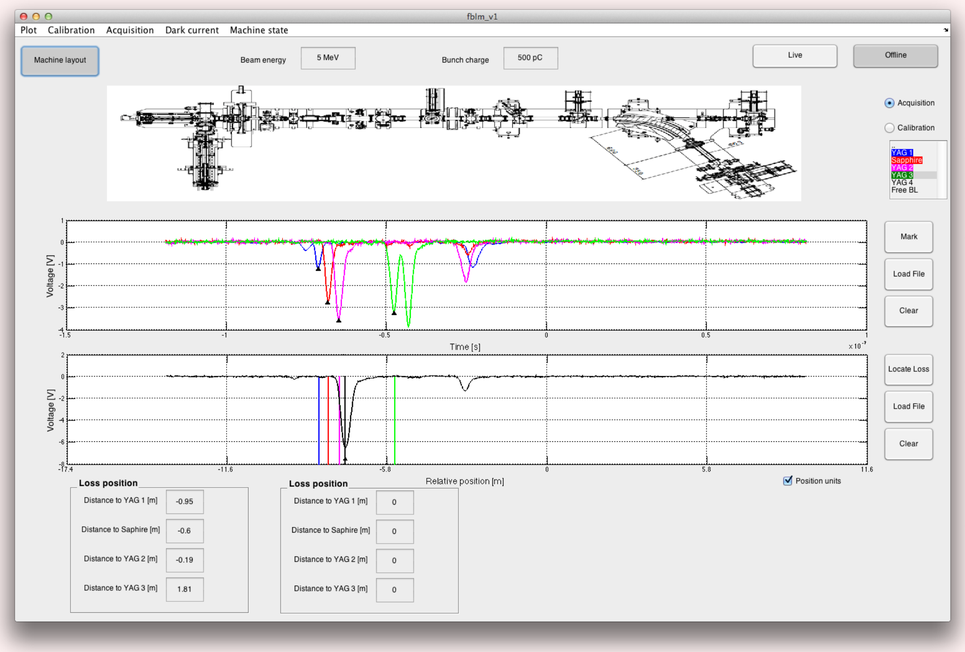


☞ The fiber of 25 meters was installed alongside the vacuum chamber to cover continuously the total length of the photoinjector from both sides.

☞ Four YAG screens and Sapphire plate have been used to calibrate and generate the beam losses at PHIL.

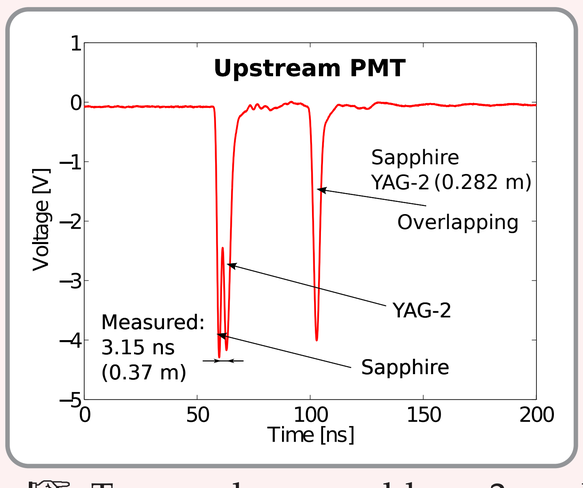
☞ Better time resolution is obtained by using the signal from the upstream PMT.

Real-time display system



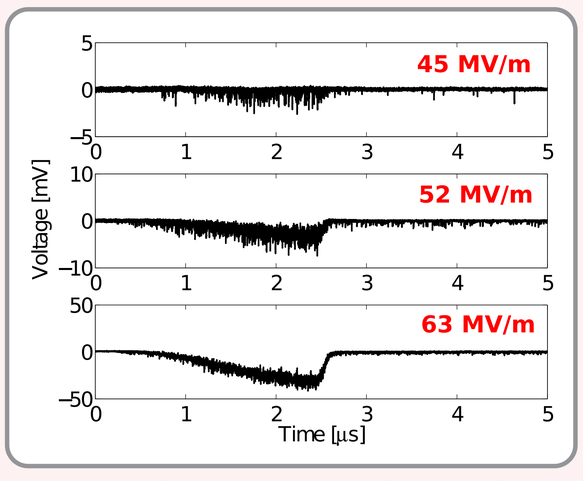
- Acquisition and display of the raw waveforms together with the main machine parameters.
- Performing the FBLM calibration procedure.
- Locating the beam losses and search for their relative position along the accelerator.
- Saving the data and calibration (allows to compare the machine states from run to run).
- Live acquisition as well as the possibility to conduct offline analysis if needed.
- Performing the dark current studies.

The FBLM resolution



☞ Two peaks spaced by ∼3 ns defines time resolution of the FBLM.

Dark current studies



☞ At PHIL, the FBLM can be used to condition the dark current (detection limit below 1 pC).