

# Availability of Optical Fiber Based Beam Loss Monitor at SACLA XFEL Facility

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## Motivation of beam loss monitor



The limitation of the beam loss in undulator section @ SACLA

- Structural limitation of the shielding thickness of undulator hall (1.5m thick)
- Criterion of the radiation safety at site boundary
- Beam loss per pulse was limited 1 pC on average (0.1% of the beam charge)



The causes and prevention of unwanted beam loss in undulator section

- 1. Fault of accelerator, miss operation Possible to find immediately
- 2. Dark current from the accelerating structure
- Enough conditioning
  - Energy filter chicane
- 3. Beam halo Difficult to find (when, where, how?)

Important to monitor the beam loss over a wide range.

## Optical fiber based beam loss monitor



### Target specifications of beam loss monitor for SACLA

- Sensitivity: ≈1 pC
- Cover a wide range continuously (~120 m) Fiber based beam loss monitor.
- Measure their position
- Evaluate their amount
- Real time

#### Cherenkov or scintillation

(method using radiation damage are unsuitable)

### Principle of fiber based beam loss monitor



Measure the beam loss position from time difference between

- · the signals from both side of detectors or
- master trigger (beam arrival time) and detector signal.

Possibility of evaluation of their amount from amplitude of the detector signal.

## Fiber selection



### Requirements for the fiber



- Core diameter: 400 um
- Radiation induced loss: below a few dB/km/Gy (expected)
- Attenuation of Cherenkov: 6.8 dB/km (measured)

## Specification: Sensitivity



### Evaluation of sensitivity @ SCSS (250 MeV, prototype of SACLA)



### Dark current

- · Generated in the C-band accelerating structure
- Charge ≈ 10 pC (by CT monitor)
- Amplitude of beam loss monitor: ≈40 mV @ 120 m upstream from loss point.
- Number of secondary electron: SCSS < XFEL

 $\Rightarrow$  We achieved the target specifications ( $\approx$ 1pC/pulse, 120m)

## Installation in SACLA





PMT: Hamamatsu H6780-02 with FC connector

ADC: CAEN V1729A Switched-Capacitor Digitizer 4 Channel, 14 bit, 2 GS/s (300 MHz bandwidth)

- The fibers are set along the each beam line.
- PMTs are connect at the upstream end of the fiber.
- The wave form data are store in D.B. at 1 Hz (hundreds of Hz maximum).
- Position calibration was carried out using halo monitor signals.

# Operation in beam commissioning of SACLA



#### Graphical user interface on console at control room.





Useful to transfer electron into undulator section in beam commissioning of SACLA.

# Calibration of beam loss monitor (preliminary)



- Dosimeter (TLD-100, gamma dose) set along the beam loss monitor at BL3.
- The data of beam loss monitor was integrated and corrected about optical attenuation.



## Summary



### Fiber based Cherenkov beam loss monitor

- Possible to detect the beam loss
  - Sensitivity: 1 pC (0.1% of the beam charge)
  - Cover a wide range continuously (≈120 m)
  - Measure their position
  - Real time
- Possibility for real time dose meter.
- Useful tool for beam transfer.