**Project Scope**

Development of an SiPM based multichannel array photon detector for the SciFi Tracker upgrade. The detector part includes also a flexible PCB and connectors together with a detector mounting structure that allows for a mechanical unit of typically 4 detector arrays. Attached to this project is also the development of a light injection system that allows to calibrate the gain of the SiPMs in situ.

Link the SciFi Tracker upgrade TDR: http://cds.cern.ch/record/1647400?ln=en

**Goals (SiPM)**

Automated measurement of the detectors for the most important characteristics:

- Breakdown voltage, gain and gain uniformity (multichannel) measurement
- DCR at room temperature and at -40°C for irradiated detectors (multichannel)
- X-talk measurement (multichannel)
- PDE (single channel)
- LED light spectrum recording for super-module
- Functional test (I-V) for series production acceptance test without soldering to flex

Possibility of measurement:

- Temperature coefficient (T vs Gain) (single channel)
- After-pulse (single channel)

**Goals (Light injection system)**

Development of a light injection system for gain calibration of the SiPM. The system needs to be sufficient uniform that the calibration by measuring the photon peaks (via threshold scan) is possible for all channels. Typical amount of light is 4 to 8 photons per pulse.

**Projects**

Optimization of the detectors for the requirements in the SciFi Tracker application includes:

**A. Silicon optimisation**

a) PDE optimization - maximal PDE is the most important requirement, further developments of the two providers Hamamatsu and KETEK need to be driven into this direction, higher fill-factor (FF) (Hamamatsu), green shifted or flat spectral response (KETEK), pixel size optimisation

b) X-talk optimization - trenches between pixels can reduce x-talk but decrease the FF, larger pixels have higher x-talk

**B. Silicon Packaging:**

a) Low dead area between detectors is required to keep an overall high hit detection efficiency, tolerances regarding thermal expansion have to be defined. Thermal cycling of package to qualify resistivity against thermal stress
C. Flex and mounting:

a) Flex PCB needs to be optimized for low thermal conductivity and highest possible immunity for environmental electrical noise (RF) and good signal transmission between detector and FE ASIC.

b) Detector alignment and mounting to the Flex.

D. Detector characterisation:

a) Automated tests for production testing

b) Irradiation studies on latest generation of prototypes and final devices

c) Characterisation of devices in the lab for in depth understanding of certain parameters and characteristics

E. Development of light injection system:

a) Test the leaking fibres with notches or scratch and evaluate different fiber routing options. Evaluate the amount of light required.

b) Electronics for light injection - evaluate rad-hard electronics mezzanine pluggable on the FE card with fast LED driver.

Lab Facilities:

EPFL

- Automated test stand for non-soldered SiPM arrays for acceptance test
- Warm and cold (-60°C to +40°C) characterisation box for arrays and single channel detectors (VATA64, FEMTO single channel amplifier), Gain, PDE (rel.), I-V, X-talk, after-pulse, automated threshold scan setup
- Fiber module test stand with x-y table for laser, LED or e-gun injection tests
- Neutron irradiation facility for irradiation of 2*10^10 neq/cm^2
- Multichannel bias voltage power supply CAEN (32 channels, 10mA, 10mV adj, current monitoring)
- Liquid based circulating chiller for cooling large modules down to -80°C

Testbeam:

The procedure to bring material into the North Area (H8A) by crane:

- Pack all the material on a metalique pallet
- **1-2 days before installation** fill an EDH request for Internal Transport / Handling Request. An example of the document can be seen here. Material is moved from bldg887(EHN1) RC37 buffer zone to H8A. The document should include a picture of the material to transport. One should ask for a "transpalette" to bring the material from the bus to the area.
- !!! Put a copy of the EDH document on the pallet !!!
- Contact person for the crane transport: M. Pierre Sorgues (164765).
- Bring the pallet to the North Area, side RC-37 (buffer zone) and contact Pierre Sorgues (164765) for the crane transport. Specify you will need a transporteur to move the pallet out of the car.

The procedure to bring material back to EPFL from North Area (H8A):

- Pack all the material on a metalique pallet
1-2 days before installation fill an EDH request for Internal Transport / Handling Request. An example of the document can be seen here. Material is moved from H8A to bldg887(EHN1) RC-37 buffer zone. The document should include a picture of the material to transport. One should ask for a "transpalette" to bring the material from the bus to the area.

- Put a copy of the EDH document on the pallet !!!
- The day of transport contact Pierre Sorgues (164765) for the crane transport. He will move the pallet into the buffer zone HC37 for radiation inspection. Specify you will need a transporteur after the radiation check.
- Fill a TREC request on the computer inside the buffer zone RC-37. Follow the instruction, use H for the shipment adress (outside from Cern ...). Use the stickers for the bar code and stick them on the material
- Call the radio protection department (number on the door, can be unavailable) or wait the radio protection control (can last one or two days).
- Once the radiation check is done, you can take the material with you !

In both cases, if troubles happen when trying to passe CERN entrance, use the material transfert sheets in the car and pass by the material entrance from CERN.

A check list for the material can be found here : * Checklist_for_TB.xlsx

Metalic boxes are available for transportation in the mechanical workshop (picture in attachment).

The Nim crate setup used in May 2016 can be found here :

- Nim_crate

Links to Testbeam twiki pages for the SciFi telescope:

- TestbeamNov2015
- TestbeamMay2016
- TestbeamOct2017
- TestbeamJuly2018 (SHiPCharm)
- TestbeamOct2018

**Presentation given in LHCb meetings**

- Scintillating Fibre Tracker meeting, 28 September 2012, SiPM from KETEK
- LHCb Week Davos, September 2012 Status and Outlook
- LHCb Upgrade SciFi Tracker, 9 August 2012, SiPM irradiation tests

-- GuidoHaefeli - 15 Jul 2014

---

This topic: LHCb > SiPM

Presentation given in LHCb meetings