Fiber ToF Tracker
Status & Plans

UNIVERSITÉ
DE GENÈVE

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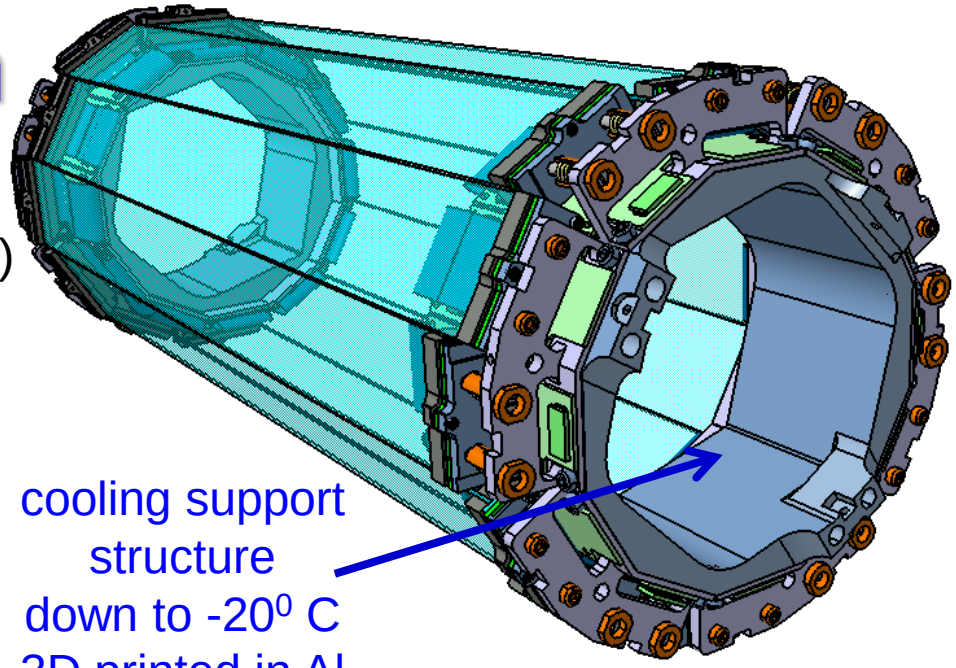
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

SciFi Detector Design

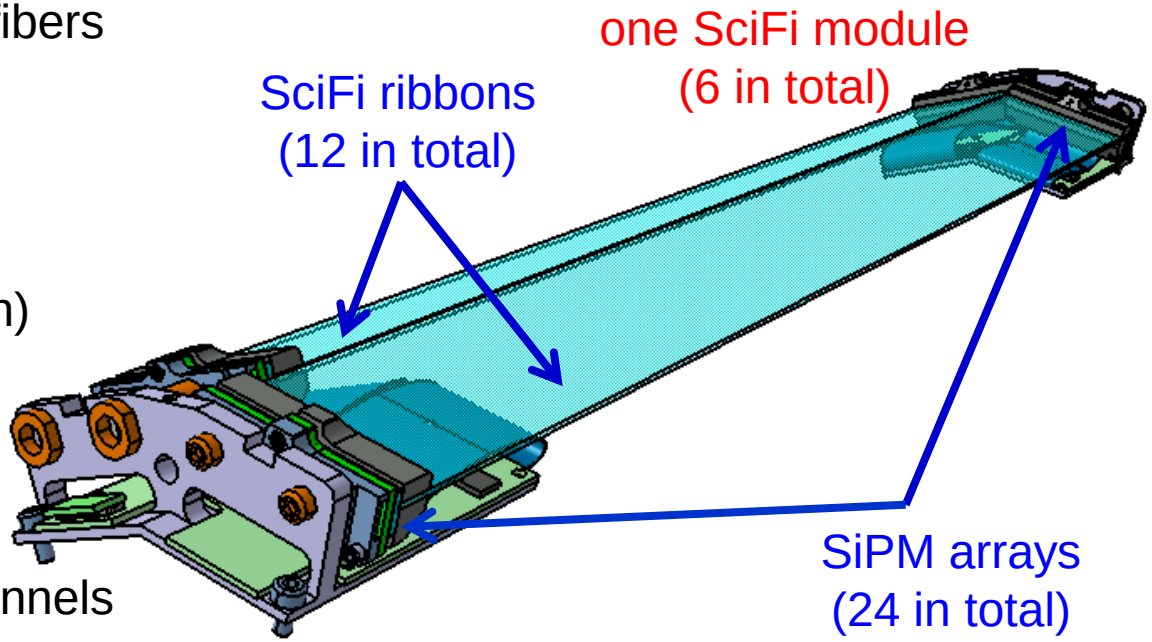


Requirements
- handle very high rates (> 10^8 μ decays / s)
- thickness x/x_0 < 0.3% (<1 mm)
- time resolution ≤ 250 ps
- efficiency > 95%
- very tight space constraints
- high occupancy up to 250 kHz/ch

12 SciFi ribbons at ~ 6 cm radius
- 32.5 mm × 300 mm fiber ribbons
- 3 staggered layers of 250 μm ϕ fibers
- fiber SCSF-78MJ from Kuraray
- very thin ~0.2% x_0

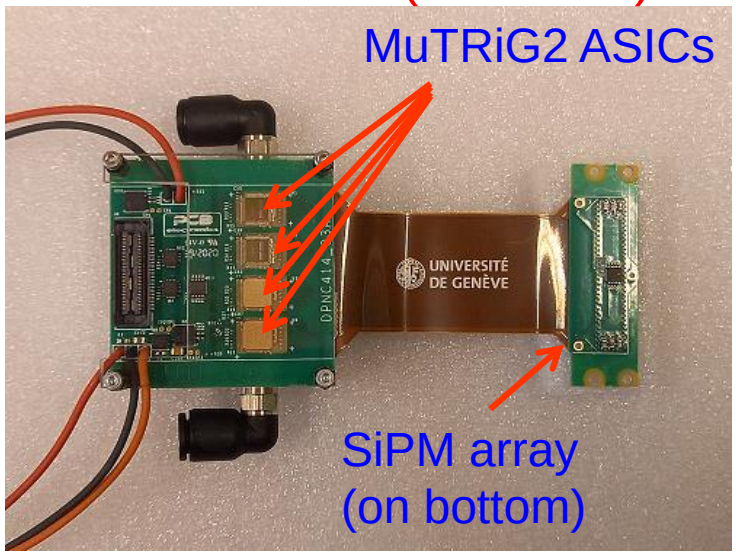
Si-PM readout at both fiber ends
- 128 ch SiPM array (LHCb design)
- 250 μm pitch

Readout
- MuTRiG ASIC
- 96 chips and ~3000 readout channels



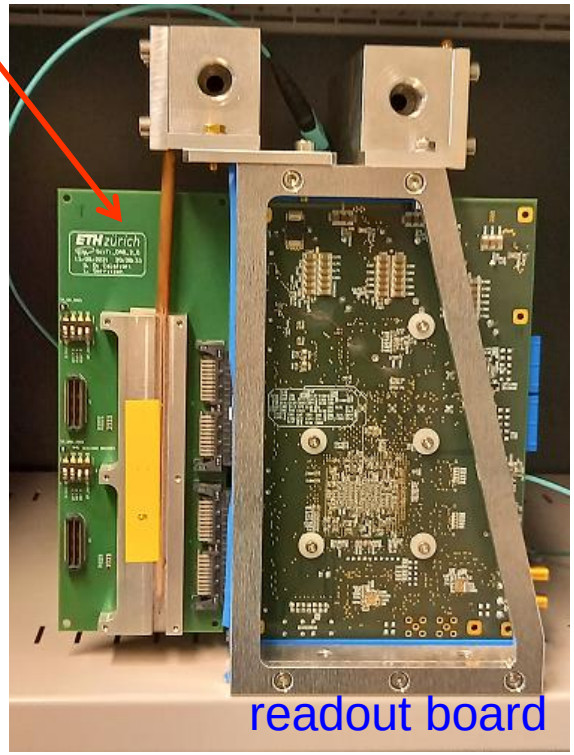
Readout Electronics

SciFi board (version 2)



µtwisted pair cable bundle

SciFi adapter board



Readout based on the MuTRiG ASIC
(Muon Timing Resolver w/ Gigabit link)

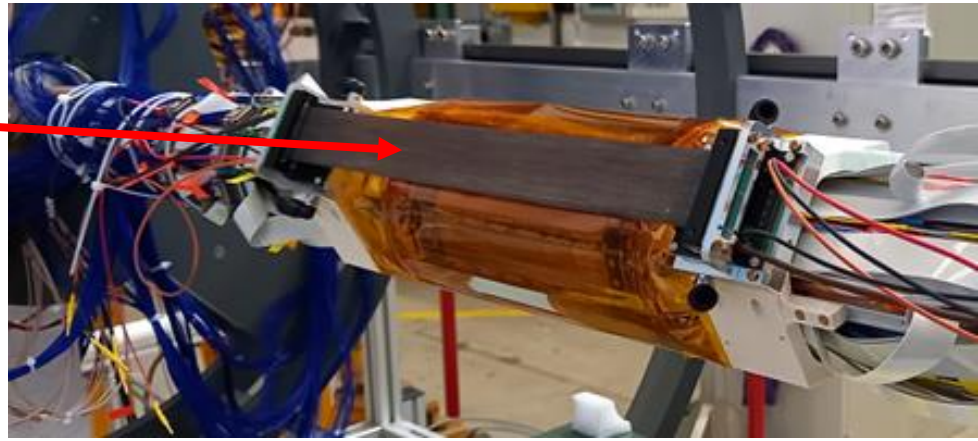
- 32 differential inputs / chip
- individual SiPM bias tuning
- 50 ps time bin
- Gigabit serial data link (1.25 Gbps), up to 1.1 MHz hit rate / channel

4 MuTRiG chips are required to read out one 128 ch. SiPM array
in total 24 SciFi boards with 4 MuTRiG ASICs each (96 MuTRiG ASICs in total)

design of the “final” SciFi board, which meets the tight space constraints (i.e. $\leq$ 26.5 mm width) almost completed (need still to define the connector or interposer for the µtwisted pair cables)

Readout Integration

During the seasonal integration run
two SciFi modules
(2 ribbons, 4 SiPM arrays, 4 SciFi boards)
were installed.

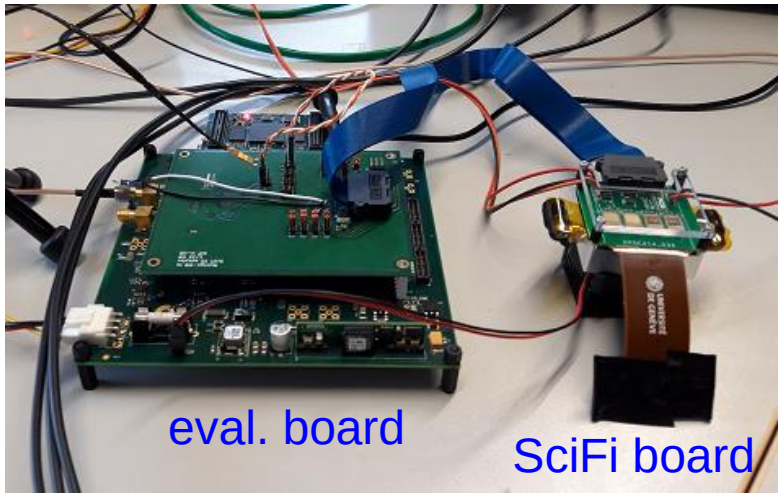


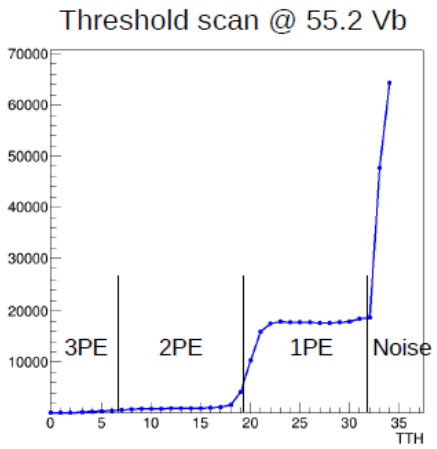
The MUTRiG2 ASICs were operated
through the full Mu3e DAQ chain.

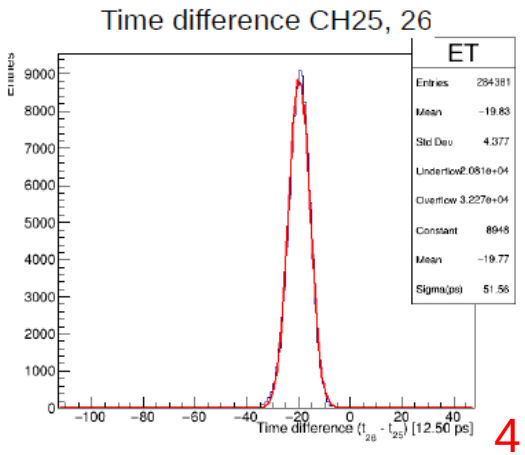
We succeed to talk to the MuTRiG2 ASICs and to configure the ASICs,
however we did not succeed to lock the chips PLLs and read out the ASICs.

More DAQ developments are ongoing.

Earlier in 2021 at KIP (K.B.) the same SciFi board (v2) has been successfully tested
using the MuTRiG evaluation board with USB readout

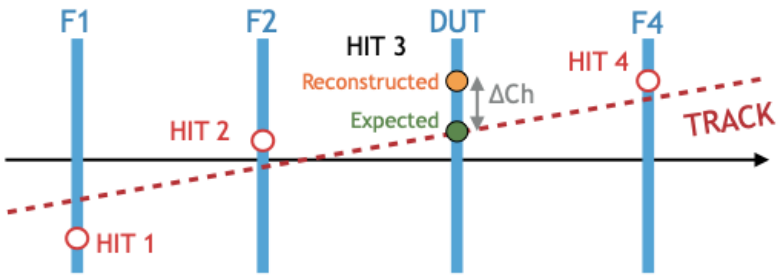


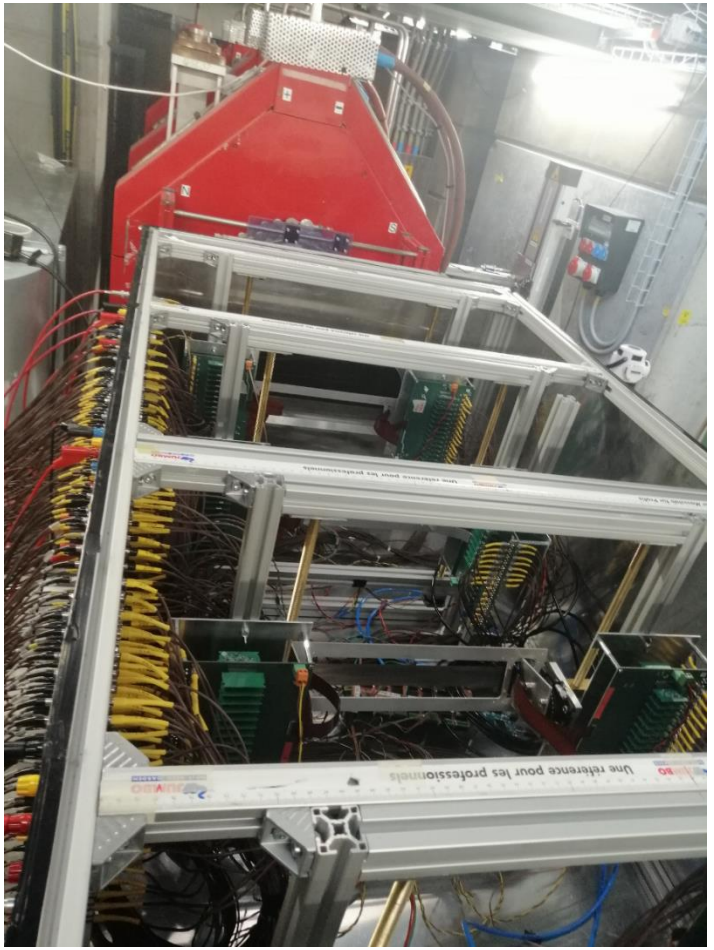




2021 Test Beam Activities

We set up and operated in MPi1 a SciFi “telescope”
consisting of 4 SciFi ribbons
read out at both ends with SiPM arrays
and DRS based electronics (~350 channels)
and external timing triggers





goals:

- validate “black” glue for the SciFi assembly
- study in detail SciFi detection efficiency w/ tracking
- study SciFi timing with an external time reference
- study behavior of irradiated SiPMs and impact of cooling

→ for results see separate talk

Also measured multiple scattering in SciFi ribbons in PiE1.

Overall Status & Plans

(assuming no additional hick ups and delays because of COVID)

Mechanics is being finalized
- the mechanical design and prototypes are available since quite some time, however new issues showed up when integrating with other sub-detectors
- expect to finalize the design soon and proceed to production
- cooling concept well advanced, will start testing soon, in particular cooling power
- production of SciFi ribbons being finalized

SiPM arrays in hand

SciFi readout
- SciFi boards using MuTRiG1 and MuTRiG2 ASICs successfully tested using MuTRiG evaluation board with USB readout
- design of "final" SciFi board, which meets Mu3e space constraints, almost finished ready for Fall test beam activities
  (mainly reduce the board width down to 26.5 mm, connection to μtwisted cables, …)
- new version of MuTRiG ASIC (v3) is under discussion → separate discussion
  chip pinout unchanged → very minor changes to the SciFi board design
- full electronics ready (assembled and tested) ~6 months after we procure the ASICs

SciFi detector integration work ongoing (cabling, cooling, etc.)

DAQ integration work in progress (main test beam activity for 2022)

Test Beam Time Request for 2022

Request ~10 days* in June W24 – W26
test SciFis with MuTRiG electronics
(MuTRiG1 and MuTRiG2 ASICs, SciFi boards version 1 and 2)
using MuTRiG evaluation boards (USB readout) and Stratix IV FPGA board
goal: fully characterize the MuTRiG ASICs with the SiPM arrays

Request ~10 days* in October W38 – W43
test SciFis with full DAQ chain and close to final SciFi boards (version 3)
goal: fully debug MuTRiG DAQ

Cosmic Run in Spring

Mu3e integration run W48 – W50
install and operate two SciFi ribbons (with 4 SiPM arrays and 4 SciFi boards)
fully integrate SciFi in Mu3e framework, in particular in the Mu3e DAQ

*our experience showed that we need a bit more than a week for proficient test beam activities, for instance start after a long machine development break

The Team (as off today)

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