

TOTEM GEM tracker readout & new SRS developments

RD51 mini-week

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TOTEM-PPS Collaboration in need for a **telescope** for its **R&D programme**:

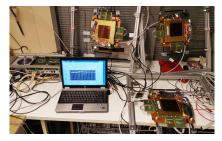
- characterisation of detectors efficiency and uniformity (+ timing precision) at CERN SPS-H8
- wide range of DUT technologies: scintillator tiles, scCVD sensors, LGADs, ...

Basic requirements

- ~1 kHz counting rate
- **②** Spatial resolution from 10 μ m 100 μ m
- S Flexibility for improvements/additions
 - e.g. event builder integration of MCP-PMT for timing applications
- O Portability
- Ise of already developed DAQ
- O Use of already existing tracking reconstruction
- Reasonable cost

TOTEM-Helsinki triple-GEM detector





Pros

Cons

- $10 \times 10 \text{ cm}^2$ area coverage
- Spatial resolution ~60 µm
- DAQ/tracking reconstruction exist
 - X DATE/AMORE software chain **not maintained anymore**
- Hardware available at CERN store, APV25 hybrids, plenty of support from RD51

- Requires gas ArCO₂ (70/30)
- Not easy to transport
 - ✓ for "permanent" installation in TOTEM-PPS experimental area at SPS-H8

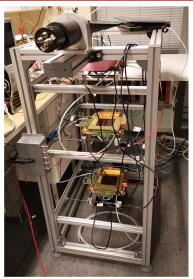
Low cost



Built in Helsinki, ready to be shipped to CERN

- mechanical integration of XY planes, muon counters, and overall frame ready
- SRS FEC and APV25 hybrids electronics tests successfully passed

Timeline for first operations: mid-March



F. Garcia

SRS driver



Given the retirement of ALICE's DATE, developed a library handling all parts of UDP communication with SRS module, and object-oriented definition of all registers.

- "Standard stack", C++14 & CMake, designed for portability
 - core code relies on UNIX socket API and requires no external dependency
 - single shared object + headers library, easily imported elsewhere, heavily documented
- Own implementation of the slow_control executable with more debugging tools, dry-run mode, ...
 - library has full parsing/writing control over .txt configuration files, can write its own (e.g. to store per-run configuration)
- (Boost) Python binding for quick scripting
 - slow control implemented, readout to follow

```
import pysrsdriver as srs
sc = srs.SlowControl('10.0.0.2')
apvapp = sc.readApvAppRegister()
apvapp.triggerDelay = 0x100 # BCKL_TRGDELAY
apvapp.triggerSeqPeriod = 40000 # BCKL_FREQ
# (...)
```

- Currently supported readout mode: APV25, zero-suppressed mode development ongoing
 - unpacking part factorised from slow control, framework to define other data formats
- Released under GPLv3, currently accessible with a CERN NICE account:
 - /lforthom/srsdriver

SRS control



Qt5 graphical user interface with the SRS driver

- developed for the testing and validation of this latter
- all communication/readout is operated through the driver, only Qt as external requirement
- potential candidate for the slow control operations in TOTEM test beam control room

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DAQ connected; all registers updated.								

■ ₩/Iforthom/srscontrol (users with CERN NICE account)



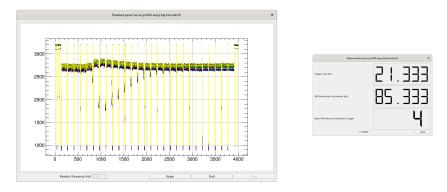
Trivial editor developed to load/edit/upload external .txt configuration files

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sequential storage for later usage to be implemented (.tar?)



Easy debugging of configuration through monitoring of full frames and rates



- earlier is **ROOT-based**, can be easily extended with more advanced online features (fits, pedestal subtraction, ...)
- many more rate monitors to be added, when more unpacking modes are handled



Slow control and data acquisition

SRS driver flexibility, one single library required for slow control and readout components

- already integrated readout part into a producer for EUDAQ2
 - optionally steer slow control through input of sequenced .txt configuration files, or rely on SRS control GUI for prior configuration
 - currently limited monitoring tool, access to full frame, coarse APV unpacking, still a work in progress
- possibly write a wrapper for CMS' XDAQ, or others
 - again, full documentation of API is available for users applications

Tracking and event reconstruction

- given its ongoing development effort, Corryvreckan is a good candidate:
 - EUDAQ2 unpacking already validated,
 - only requires to define APV25 data format and GEMXY + DUT geometries
 - alignment/clustering/tracking (incl. GBL) algorithms already implemented, steering configurations to be implemented



Parallel effort ongoing for the construction, characterisation, and operation of a new triple-GEM tracker for TOTEM test beam area at H8

- sensors already characterised, full readout chain to be tested with SRS
- new implementation of a software toolbox to ease communication with SRS motherboard (slow control and fast readout)
- new graphical tool to help setting up a run configuration
- implementation of the readout part into e.g. EUDAQ2 as a proof of concept for operations at H8
- future developments foreseen for the reconstruction package and commissionning tools (alignment/efficiency mapping/...)



Backup



Pedestal run, APV25 @ HDMI 1-4 Pedestal run, APV25 @ HDMI 1-4 Channel 0 - Channel 1 Channel 2 Channel 3 Channel 0 — Channel 1 Channel 2 Channel 3 ADC) £ 3000 9 3000 -ALC: No OF TAXABLE PARTY. 2500 2000 2000 1500 1500 1000 1000 Time slice 4000 Time slice Pedestal run, APV25 @ HDMI 1-4 Pedestal run, APV25 @ HDMI 1-4 Channel 0 Channel 1 Channel 2 Channel 3 Channel 1 Channel 2 Channel 3 (ADC) £ 3000 £ 3000 OR DO IN THE OWNER. 2500 2500 2000 2000 1500 1500 1000 1000 Time slice ne slice

Calibration Pulse:

Injection of four different charge amplitude to four different APV25.