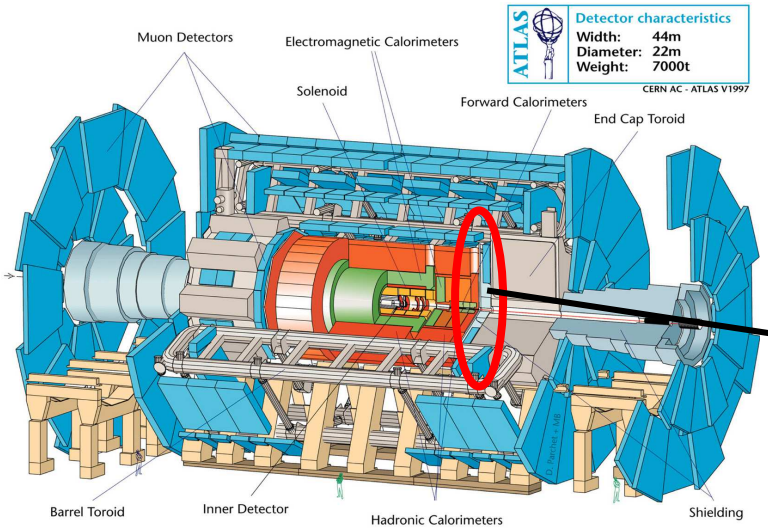
Update on the integration of SRS into the ATLAS DAQ environment

A. Zibell
Ludwig-Maximilians-Universität München

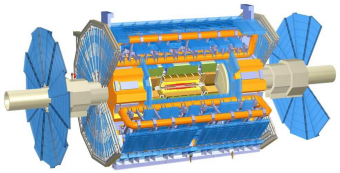
RD51 mini week
23.4.2013

Installation of prototype chambers in ATLAS



- 2012:4 chambers 9x9 cm²
  @Small Wheel, r ~ 1,7 – 1,8 m
- Goals: - general analysis and validation of SRS readout system
  - compare MM tracks with ATLAS data,
  - particle Identification

ATLAS data acquisition chain



Level 1 trigger → Read Out Driver (ROD) — SLINK Link Source Card

Optical ↓ ~ 70 – 100 kHz

Level 2 trigger → Read Out System (ROS) — SLINK Link Destination Card

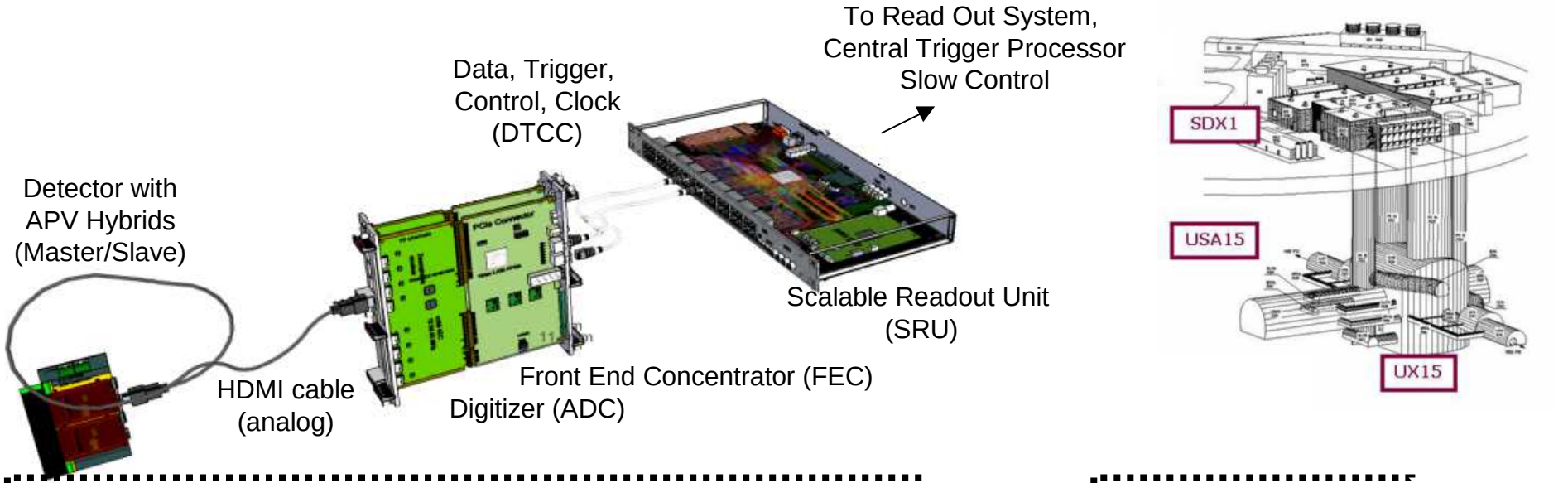
Ethernet ↓ ~ 3 kHz

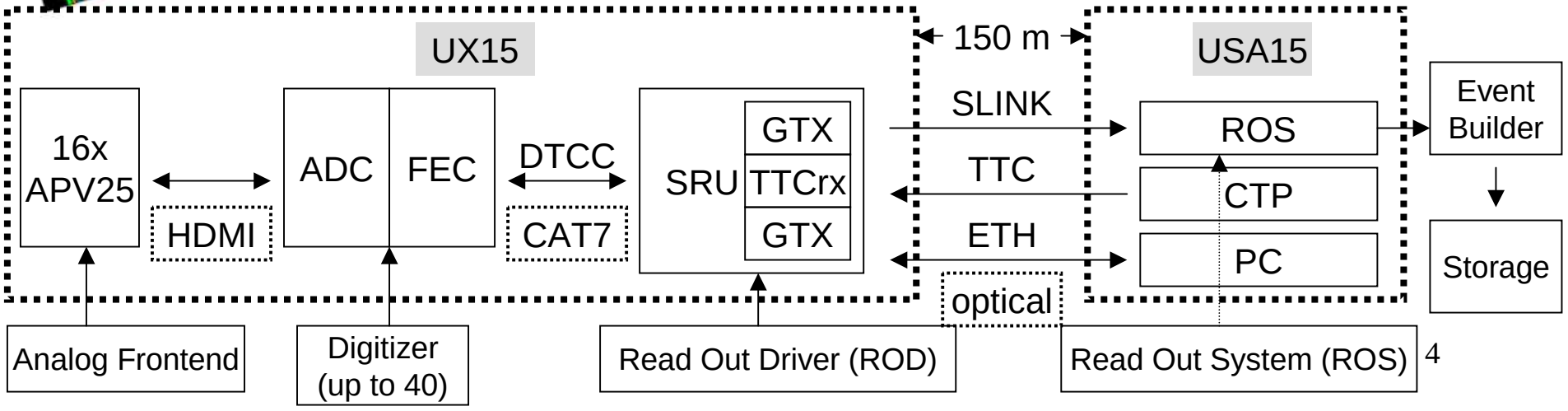
Event filter → Event Builder — O(1000) CPU cores

↓ ~ 200 Hz

Data storage

SRS (Scalable Readout System, RD51 Development)





SRU (Scalable Readout Unit)

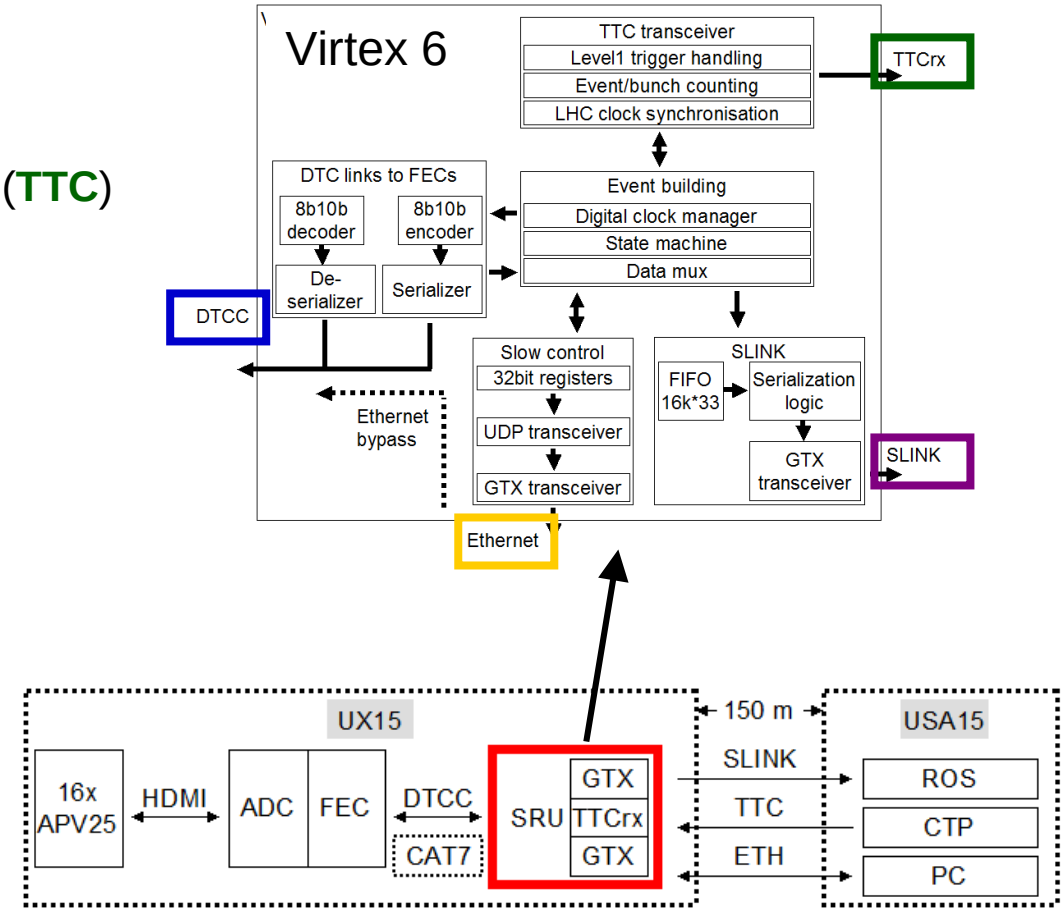
Main tasks:

• Reception and distribution of Level1 triggers, LHC synchronization (**TTC**)
- Event Counter
- Bunch Counter
- Clock Phase
- Bunch Counter reset
- Event Counter reset

• Detector data collection and event building (**DTCC**)
(BCID, EVID, ... , Data)

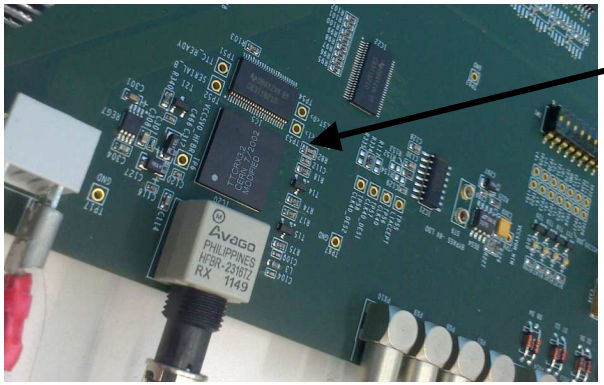
• Data transmission to ROS PC via **SLINK**

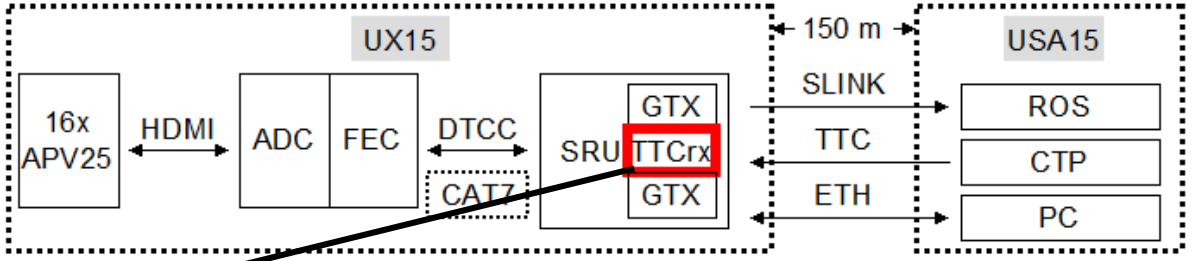
• Slow control / DCS / Data preview via **Ethernet**:
Register setting on APV, FEC, SRU, ...



TTC interface (Trigger, Timing, Control)

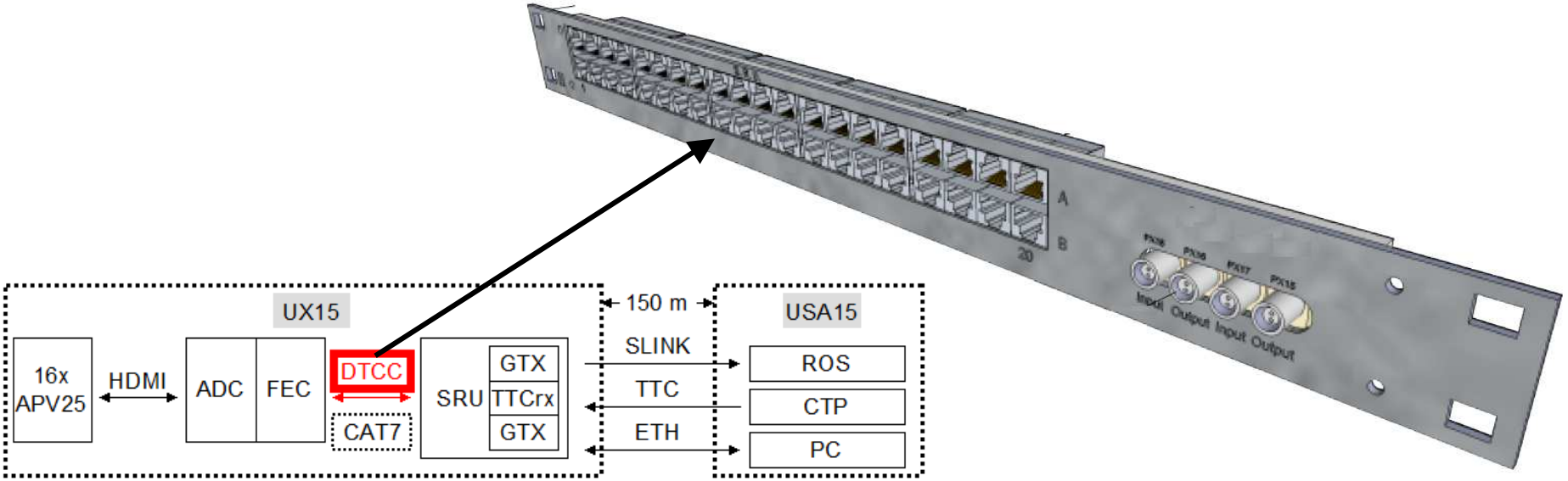
- Communication with standard ATLAS trigger electronics („TTC-Crate“, ...)
- Receives L1A (Level 1 Accept) trigger, Bunch clock, triggertype, resets of eventcounter and bunchcounter as well as directed or broadcast configuration data





DTCC Link

(A. Martinez)



- Connects FEC Card(s) and SRU to transmit:

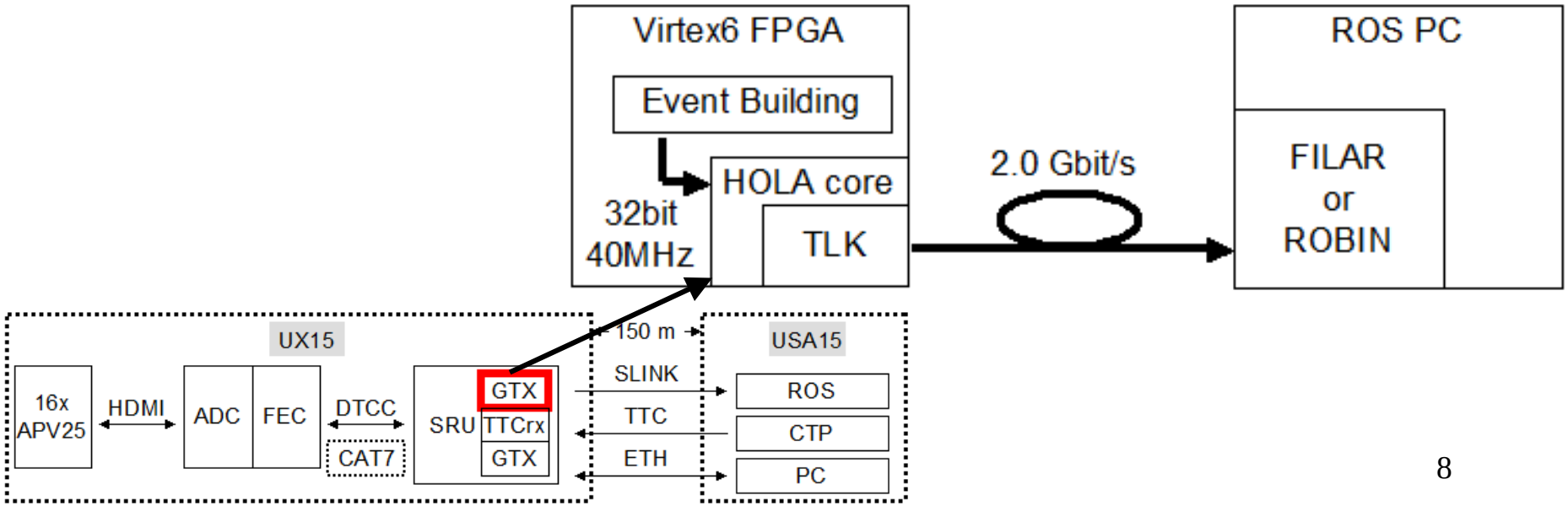
  <= LHC Clock, L1 Triggers and configuration commands from SRU to FEC

  => Detector- and configuration data at 640 Mbit/s from FEC to SRU
- Hot plug ability and automatic resynchronisation
- Support for 40 FEC cards (~82k channels with APV25 Hybrids)
- Conventional CAT cable with RJ45 plugs

SLINK implementation

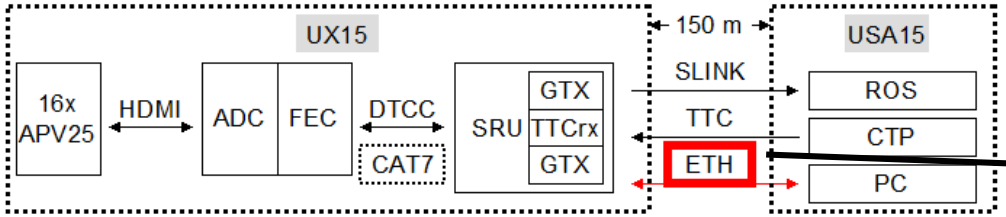
(M. Della Volpe, R. Giordano, V. Izzo, S. Perrella)

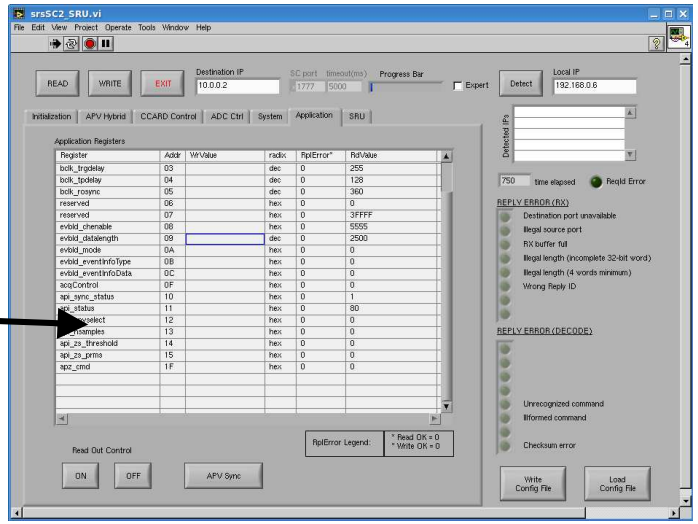
- ATLAS transmits event data from ROD to ROS using **SLINK**
- Now: No longer need of a seperate HOLA daughter card (as used widely in ATLAS), due to implementation of the SLINK serialisation logic IP core in the Virtex6 FPGA (uses one of the FPGA‘s GTX transceivers)
- Successfully tested data transfer to a standard ROS PC.
Valid ATLAS data frames are received.



DCS / Slow control

- Slow control via optical Gbit ethernet connection to the SRU
- SRU DCS requests are handled directly, packets for FEC and APV are forewarded via DTC links (ethernet switch functionality within SRU)
- Online access to parameters like run control, error conditions, ...
- Fine tuning of TTCrx, APVs, etc...
- Online results of calibration, data preview, ...



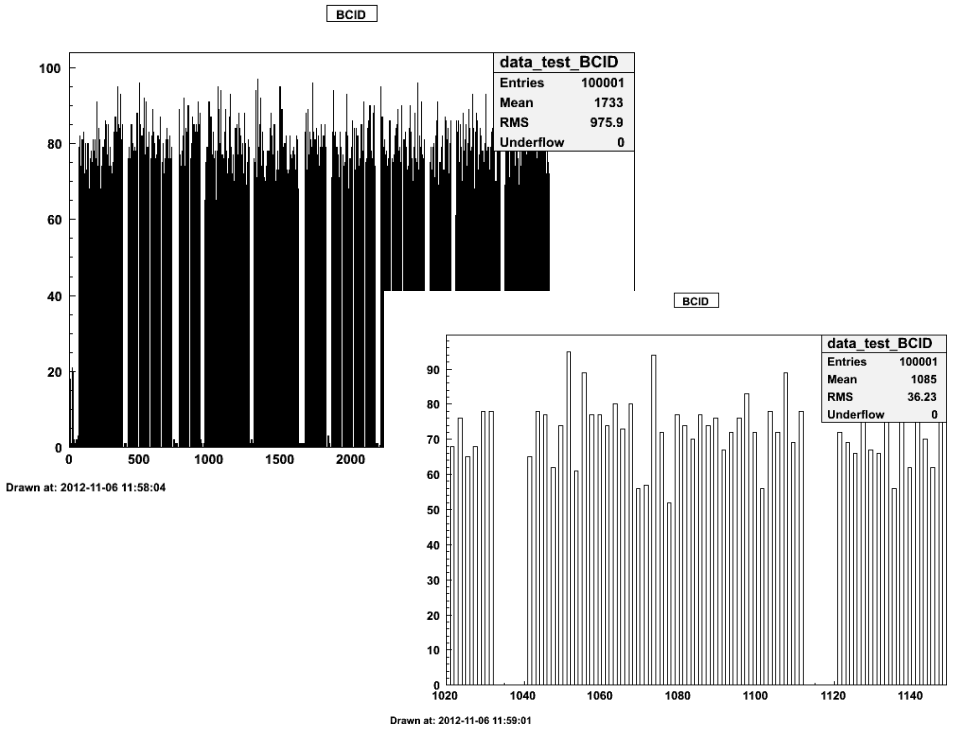


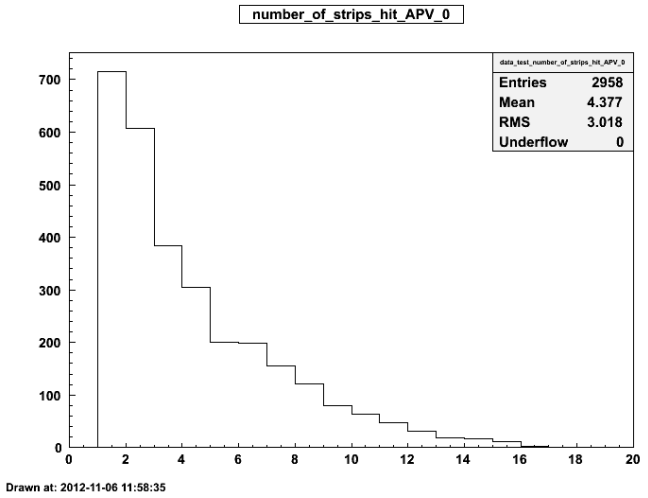
First data in ATLAS

- First run taken with ATLAS triggers (L1A 70 kHz)
- LHC bunch structure visible in data -> TTC and DAQ integration works
- Micromegas not included in general ATLAS DAQ („standalone mode“)

  => no Level 2 trigger information

  => no Synchronization with ATLAS muon tracks





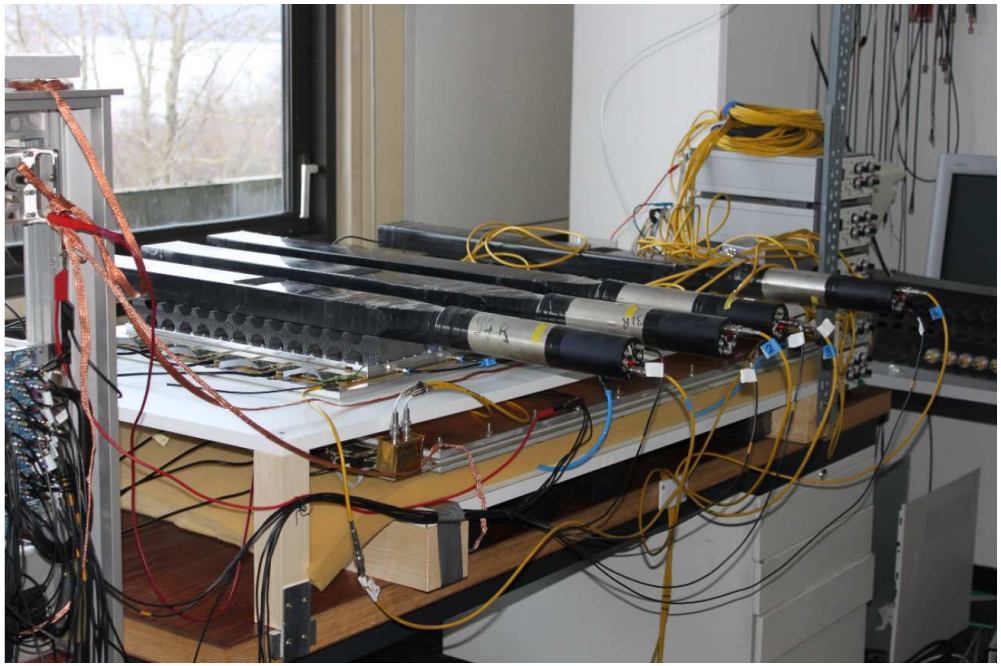
Status and outlook

- Event building firmware on SRU is running and generates valid ATLAS ROD fragments from APV data
- Successful run-taking in standalone DAQ mode within ATLAS infrastructure
- LHC run period ended on 14.2.2013

  => Setup complete aquisition chain at LMU/Garching cosmic ray facility

  => Readout of large (O(m^2)) Micromegas in ATLAS,
  once LHC restarts after 2014

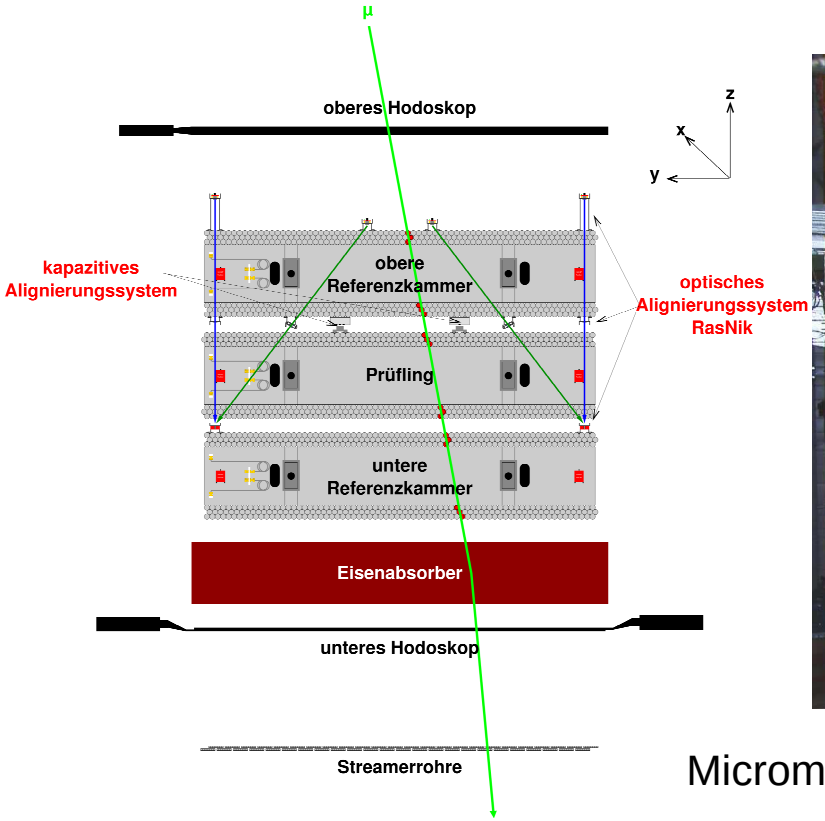
L1 Micromegas chamber

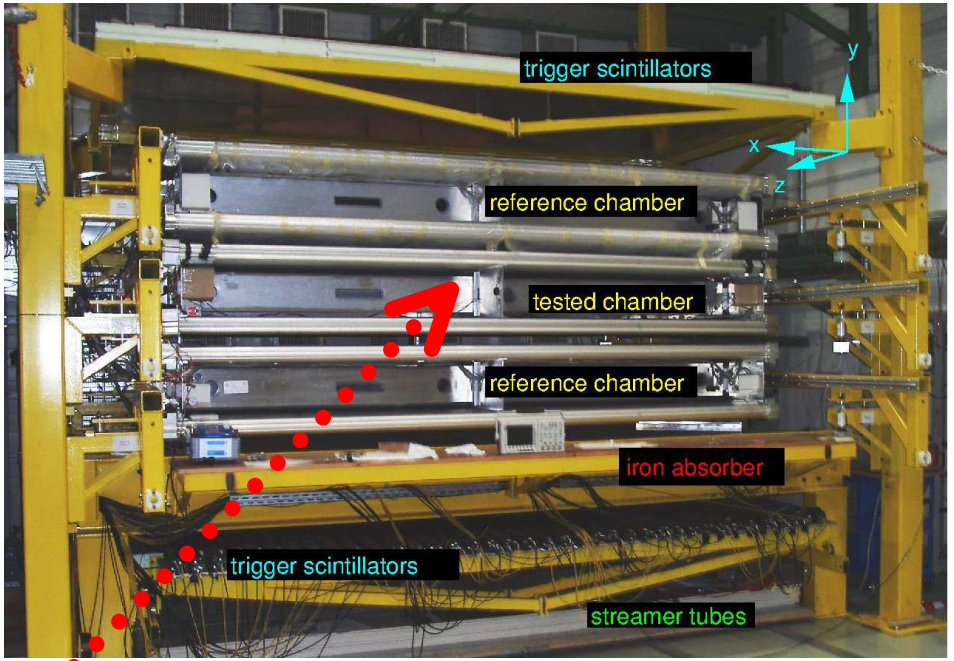


- MAMMA L1 chamber arrived in Munich
- Active area: 0.92 x 1.02 m², 2048 channels
- Several successfull lab-runs with cosmics, reading FEC card via Ethernet

Garching cosmic ray facility

- Two full sized ATLAS BOS MDT muon chambers
- 10cm broad Trigger scintillators cover the full area of 4 x 2.2 m², segmentation along tubes as second coordinate
- Irion absorber and streamer tubes to allow energy cut via multiple scattering angle





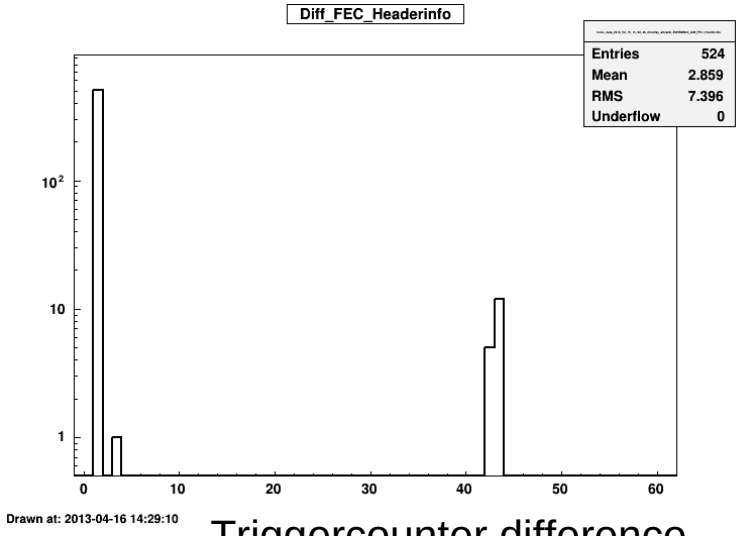
Micromegas

Cosmic ray facility DAQ

- Measurement
  - Tracking of cosmic muons with Micromegas (SRU) and calibrated reference MDTs (Filar)
  - Trigger time and trigger pattern recorded using VME
- Goals
  - comparison of Micromegas tracks with MDT tracks
  - Analysis of residuals and determine position of strips as function of x
  - Analysis of Micromegas angular resolution (microTPC mode)
  - Check of the homogenity of the Micromegas chamber‘s efficiency and mechanical precision
- Three data streams have to be aligned:
  - VME crate data for trigger, trigger timing and trigger hit pattern
  - FILAR card data from the MDT tubes
  - ROBIN card data from the Micromegas/SRS
- All neccessary drivers and software, including ATLAS tdaq, installed on a 4-core machine, running scientific linux 5
- Estimated time for measurements: 2 – 4 weeks

Current issues

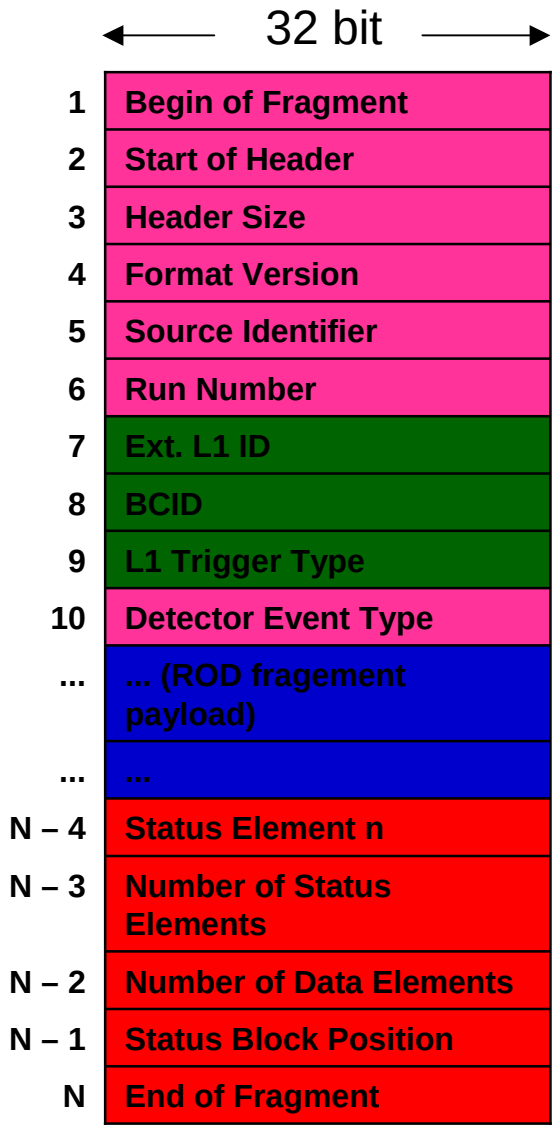
- Non-zero suppression firmware with DTC support works flawless
- Zero-suppression firmware without DTC support (direct ethernet connetion) works
- Zero suppression firmware with support for DTC links shows „bunches“ of missing events in the raw data stream.
- Analysis of raw binary data shows a repeating sequence of ~25 good events, ~40 missing, ~25 good events, ~40 missing, etc...
- Under investigation together with FEC firmware developers



Triggercounter difference

Standard ATLAS Event Data

- L1A trigger (from **TTCrx** (ATLAS), NIM input (Lab) or slow control (debug)) stored in FIFO memory
- ATLAS Event fragment generated for each trigger
- **Header** and **Trailer** information to identify Detector, Run and Event metadata
- **Converted data** from the APV chips will be zero-suppressed by the FEC and then written (via DTC link) to FIFO memorys in the SRU FPGA
- Full event fragment is formed and sent out via SLINK to the ROS PC



Upcoming plans

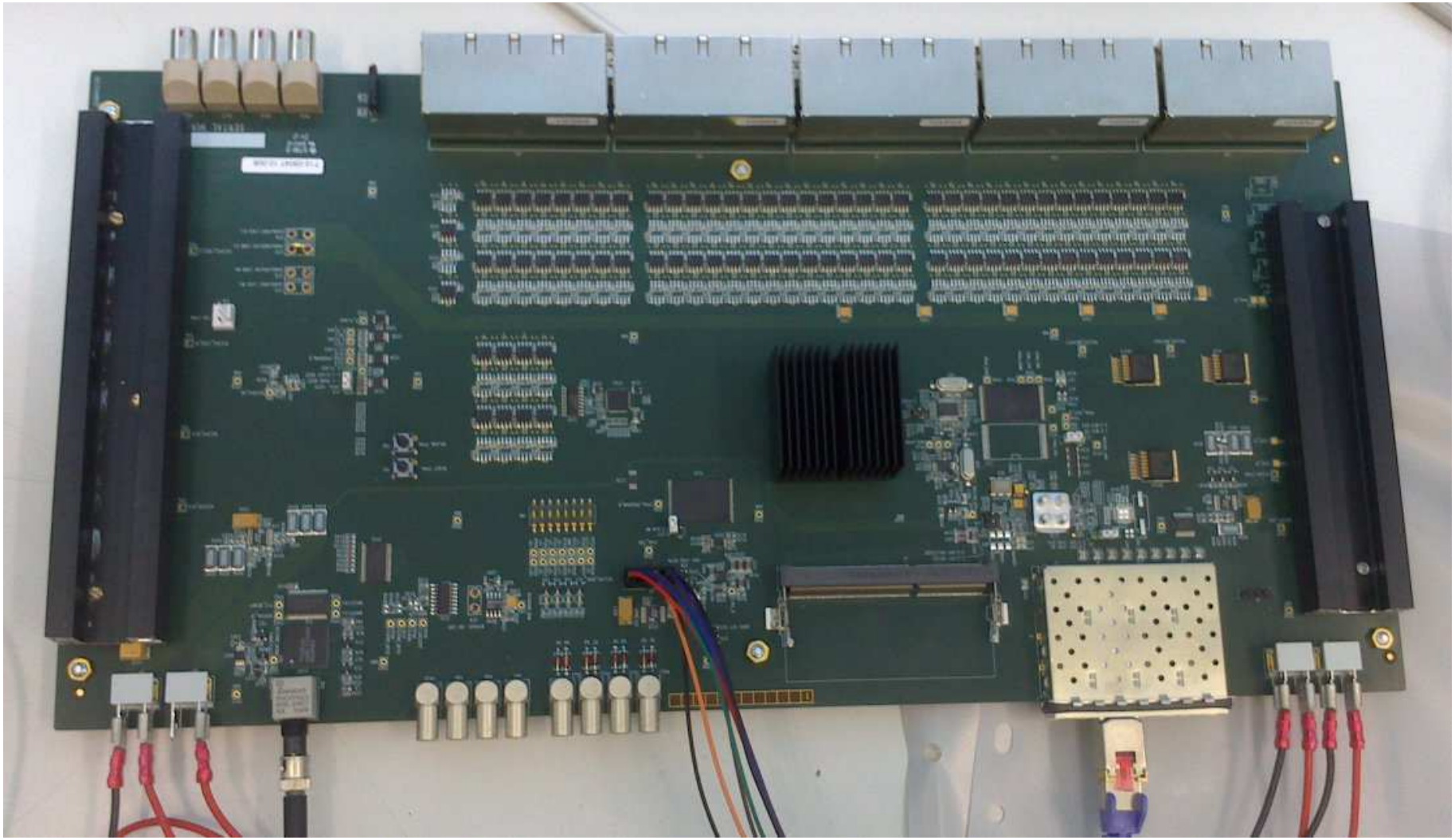
- Mechanical:
  - Mechanical structure to integrate the L1 chamber into the Garching/Munich cosmic ray test stand is ready
  - Installation in week 17 - 18

DAQ:

  - FEC card standalone (Ethernet without SRU) (mmdaq1, mmdaq3)
  - Synchronized setup with MDTs and full data from SRS (~20 Tbytes/month)
  - Synchronized setup with MDTs and zero-suppressed data (O(Gbytes)/month)

Analysis:

  - Integration of the ATLAS event format into Micromegas Analysis framework completed
  - Comparison of Micromegas tracks with MDT track predictions for several Micromegas operational parameters (mmdaq1, mmdaq3, ATLAS DAQ) and measurement of efficiency, residuals, angular resolution, ...

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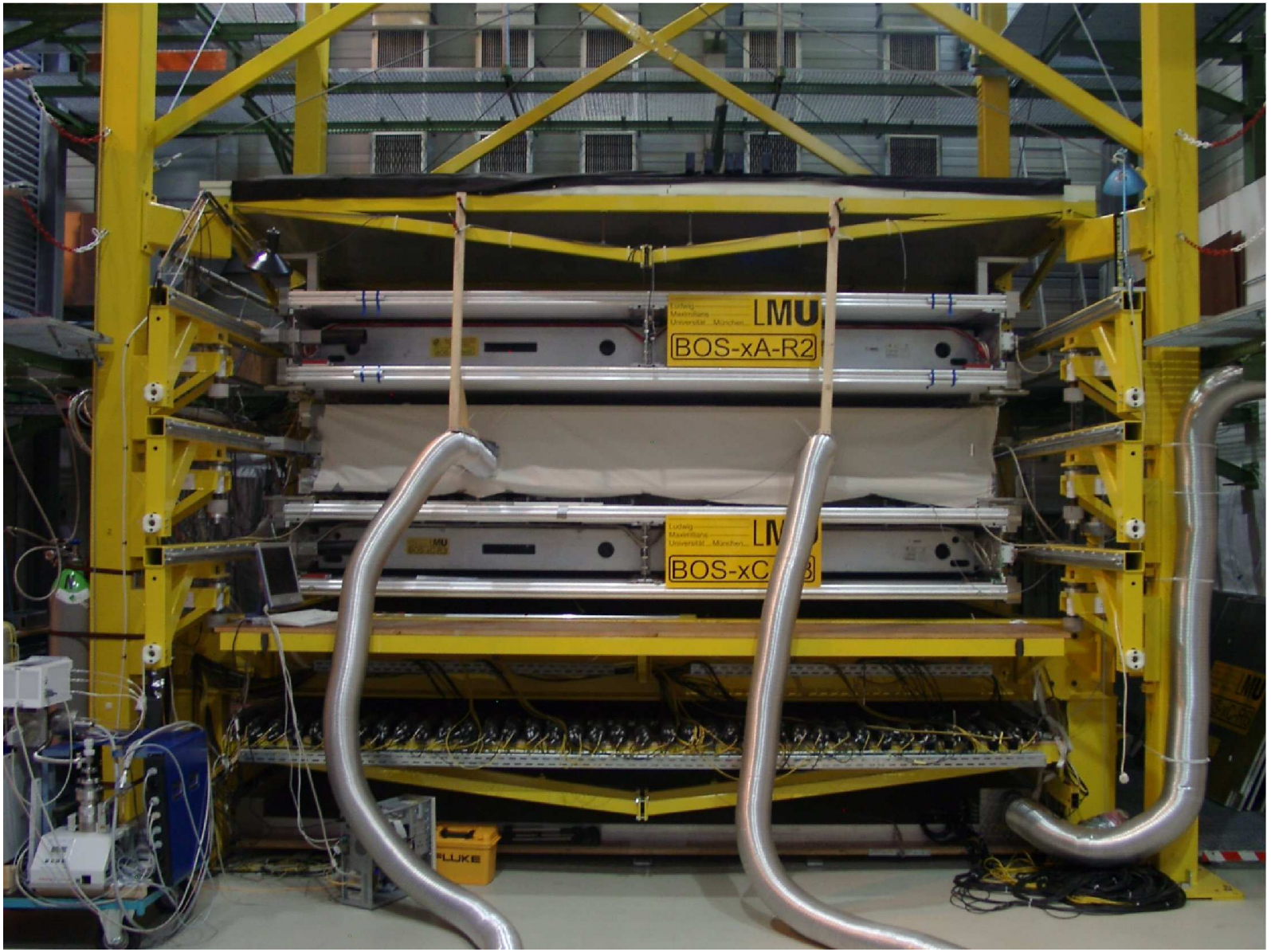
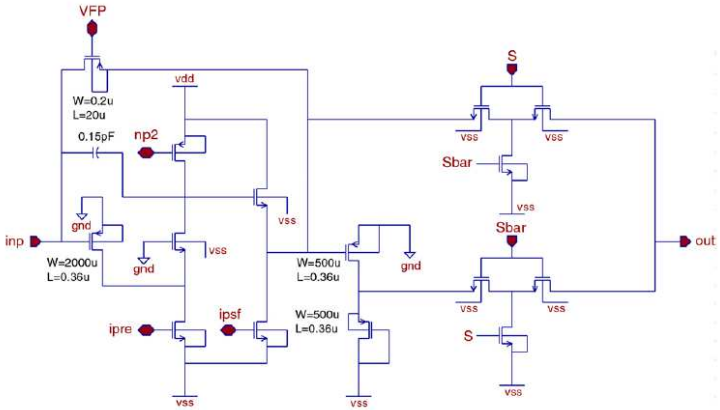
Garching cosmic ray facility

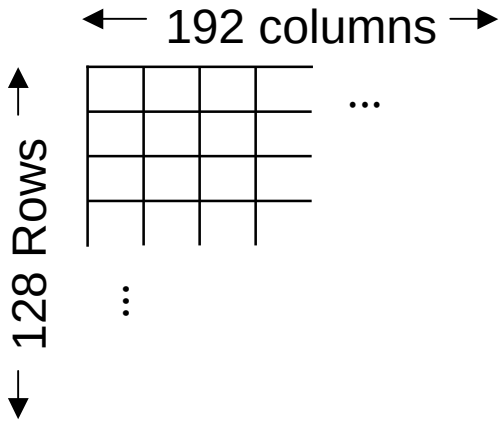


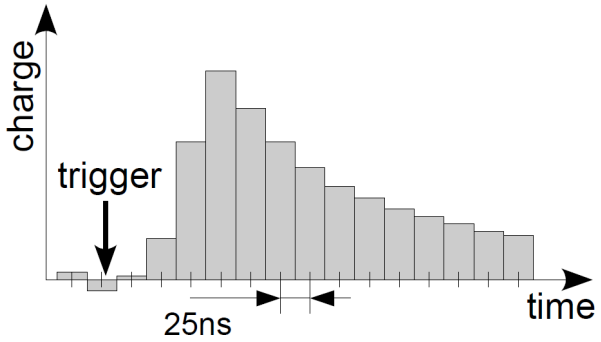
APV25 Charge Sensitive Analog Frontend

- Analogue pipeline ASIC used for read-out of silicon strip detectors in the CMS tracker
- 128 charge sensitive amplifier channels
- Pipeline buffer of 192 cells depth for each input channel, filled consecutively with every clock cycle (40.08 MHz @LHC)
- Blocks of one or more pipeline columns can be read out for each trigger
- => Time evolution of integrated charge signal for each detector channel in steps of ~25 ns

128 preamplifier channels → Analogue pipeline buffer → Selected columns output



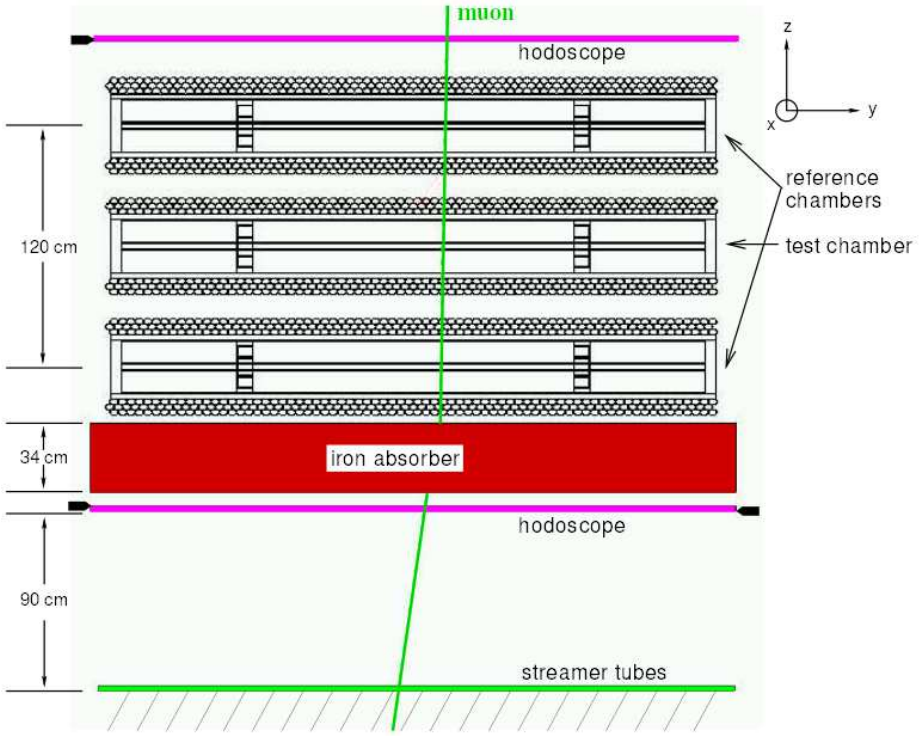


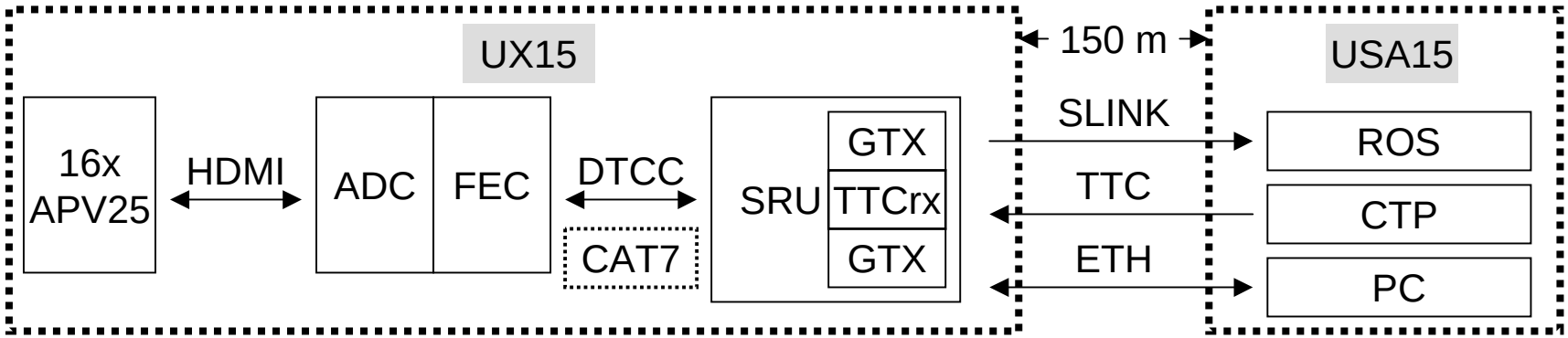


L1A rate vs. APV readout time

- APV readout: 140 clock cycles @40.08 MHz LHC clock frequency
(128 channels + 12 overhead)
- MicroMegas detectors require 10 – 20 time bins to sample signal shape
(1400 – 2800 clock cycles)
- => Mean time difference between Level 1 triggers:
~600 clock cycles @70 kHz trigger rate
- Implementation of busy-logic to decide, which event to process fully
(trigger to APV chips), and which not
- Skipped events also generate ATLAS event frame with no data content
in FIFO buffer to satisfy ROS requirements
- Tested and working with up to 100 kHz random trigger rate

Garching/LMU Cosmic Ray Facility




UX15
150 m
USA15
16x
APV25
HDMI
ADC
FEC
DTCC
CAT7
SRU
GTX
TTCrx
GTX
SLINK
TTC
ETH
ROS
CTP
PC