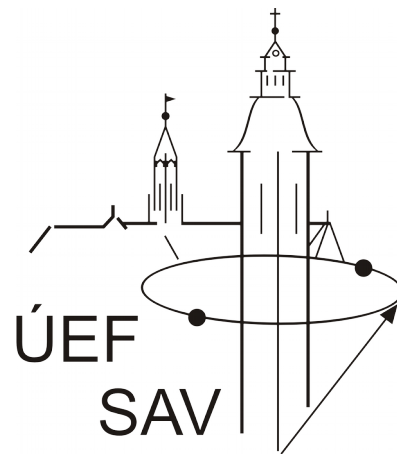


Slovak participation in ALICE

Ivan Králik

Institute of Experimental Physics, Košice



RECFA Meeting Bratislava, Slovakia, 18 May 2018

Outline

- Slovak involvement in ALICE
- Experiment ALICE
- Hardware contributions
- Software contributions
- Physics analysis
- Summary

Slovak involvement in ALICE



Košice cluster

Institute of Experimental Physics, Slovak Academy of Sciences



Bratislava



Faculty of Mathematics,
Physics and Informatics,
Comenius University

Faculty of Science,
P.J.Šafárik University



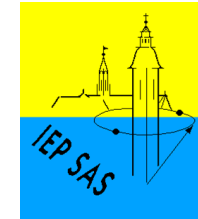
Faculty of Electrical
Engineering and Informatics,
Technical University Košice
(ALICE full member since 2015)

Slovak involvement in ALICE

Bratislava



Kosice cluster



Team leader: B. Sitár

Team leader: I. Králik

Physicists, engineers:

M. Mereš, M. Pikna, P. Strmeň,
I. Szarka

Physicists and engineers:

M. Bombara, A. Kravčáková, J. Vrláková,
J. Jadlovský, A. Jadlovská, S. Jadlovská,
M. Vaľa, P. Kaliňák, M. Krivda, J. Mušínský,
R. Bílek, I. Kuľková, M. Straka, J. Špalek,
L. Šándor

PhD students:

A. Szabo

PhD Students:

M. Šefčík, L. Tropp, Z. Jakubčinová, M. Kopčík,
M. Oravec, J. Čabala, D. Vošček, L. Koska,
J. Socháň

Technician:

E. Hanuska

Students:

L.A. Husová, M. Tkáčik, A. Březina, M. Pánik, E. Hanc

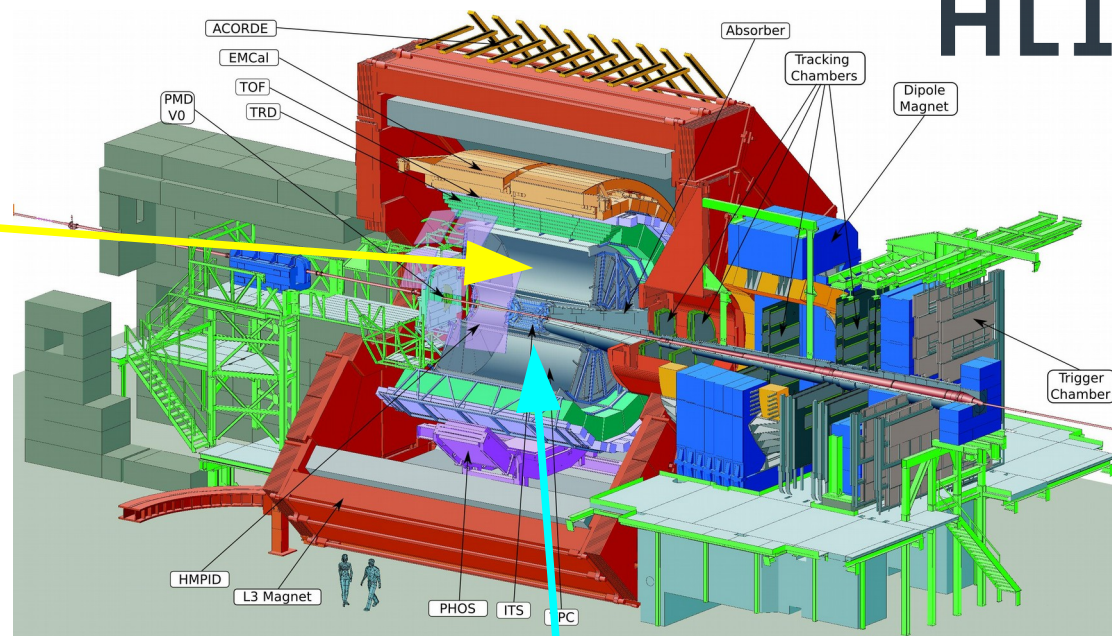
Experiment ALICE



ALICE (A Large Ion Collider Experiment) is a heavy-ion experiment on the LHC designed to study the physics of strongly interacting matter at extreme conditions.

TPC

Time Projection Chamber
- main tracking device in ALICE.
Provides tracking and PID via dE/dx



CTP

Central Trigger Processor
- the heart of the ALICE trigger.

SPD

Silicon Pixel Detector - the most inner tracking detector.
Used for vertex finding, tracking, and triggering.

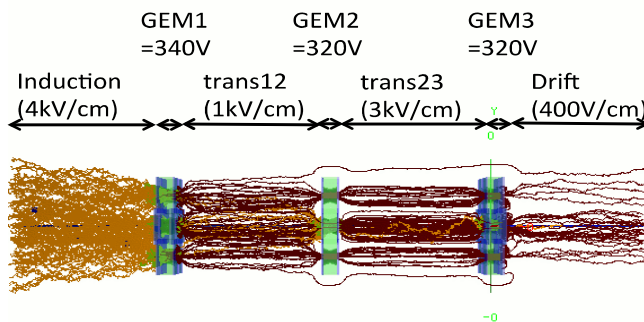
Hardware contributions

Work on the ALICE TPC upgrade

- TPC continuous readout without gating grid
 - minimize ion feedback from amplification region
 - **change MWPC readout to GEM readout**
 - preserving tracking and particle identification capabilities
 - on-line calibration and data reduction in HLT
 - **at 50 kHz of Pb–Pb interaction**: reduction factor of ~ 25 , event rate tape 25 kHz, throughput to mass storage 20 GB/s
 - **3x faster gas mixture with CF_4 – research at Bratislava**

• Event display

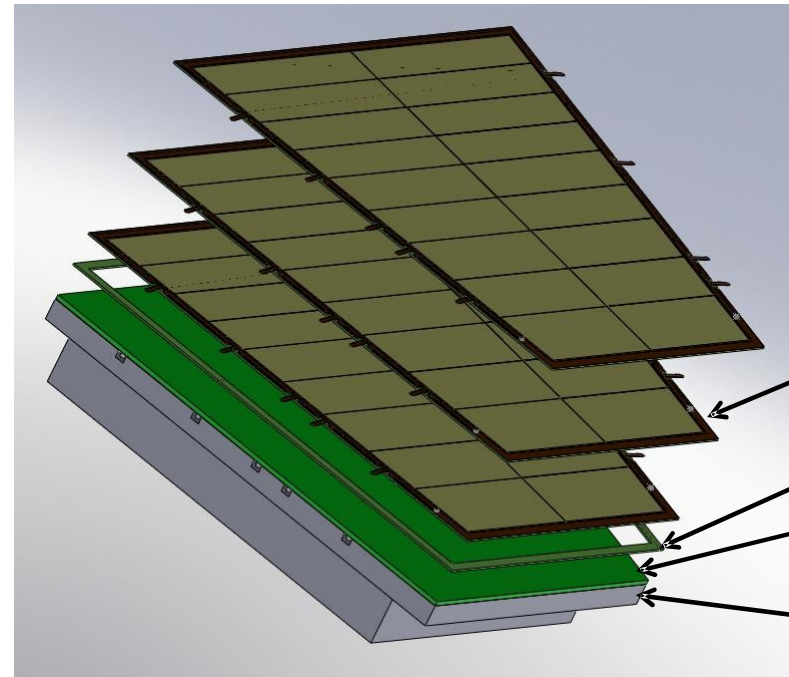
Ar(70%):CO₂(30%)



- 7 holes/layer are drawn for display (TGeoManager).

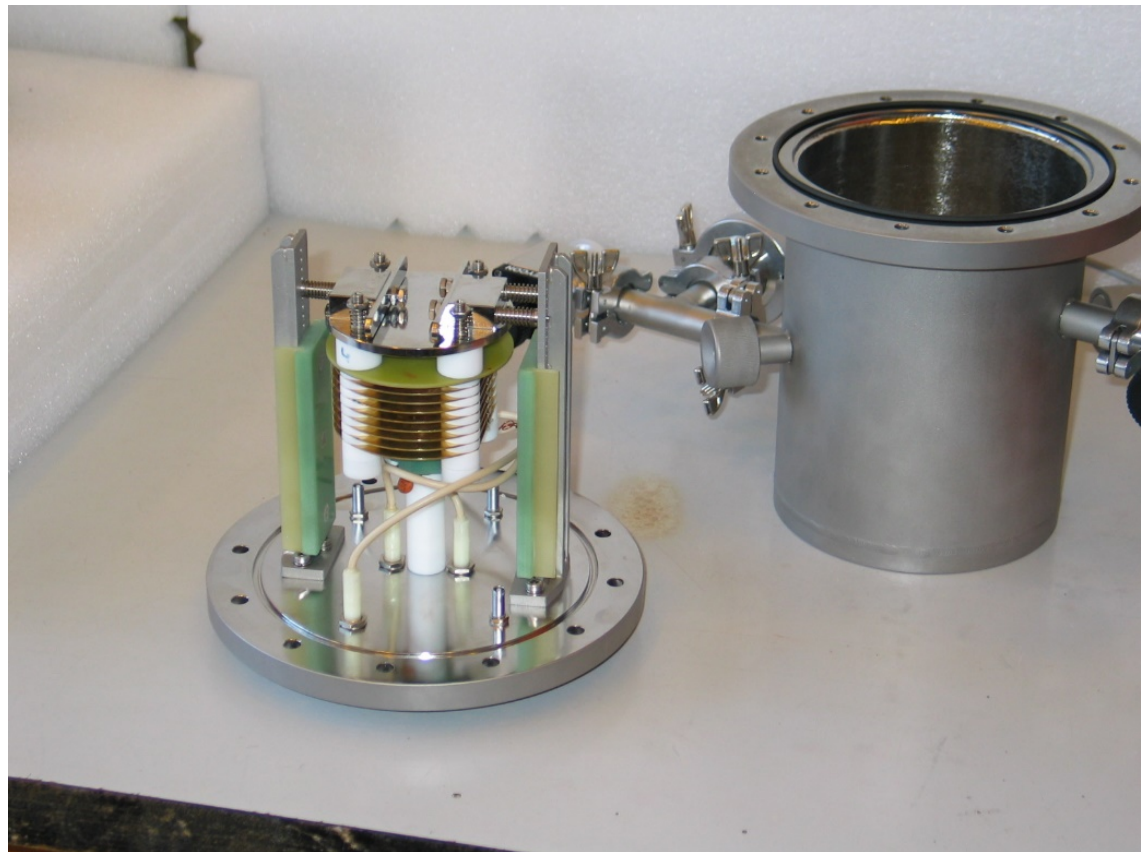
```

----- Event Summary 0 -----
*** ElectronsTotal = 238
**** ElectronsDrift = 0
**** ElectronsGEM3UpperMetal = 0
**** ElectronsGEM3Plastic = 1
**** ElectronsGEM3LowerMetal = 15
**** ElectronsTransfer23 = 0
**** ElectronsGEM2UpperMetal = 0
**** ElectronsGEM2Plastic = 2
**** ElectronsGEM2LowerMetal = 17
**** ElectronsTransfer12 = 0
**** ElectronsGEM1UpperMetal = 0
**** ElectronsGEM1Plastic = 14
**** ElectronsGEM1LowerMetal = 87
**** ElectronsInduction = 102
*** IonsTotal = 238
**** IonsDrift = 33
**** IonsGEM3UpperMetal = 85
**** IonsGEM3Plastic = 9
**** IonsGEM3LowerMetal = 2
**** IonsTransfer23 = 0
**** IonsGEM2UpperMetal = 1
**** IonsGEM2Plastic = 3
**** IonsGEM2LowerMetal = 0
**** IonsTransfer12 = 0
**** IonsGEM1UpperMetal = 76
**** IonsGEM1Plastic = 29
**** IonsGEM1LowerMetal = 0
**** IonsInduction = 0
    
```



Ion mobility and drift measurement in a special TPC chamber

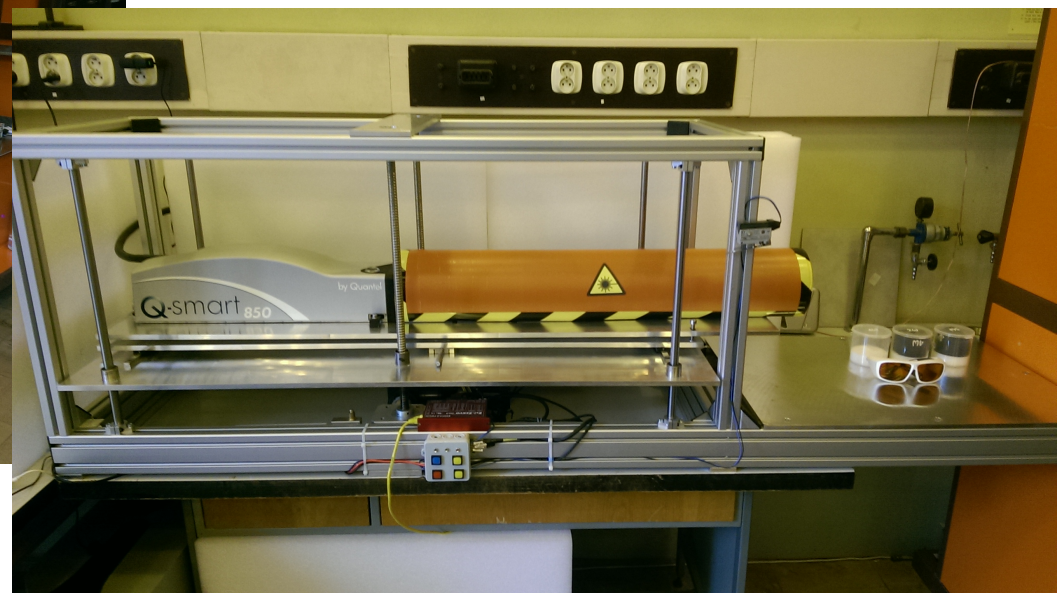
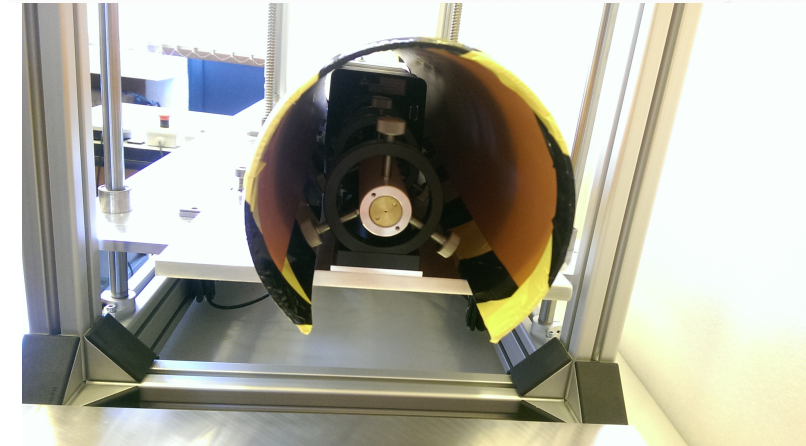
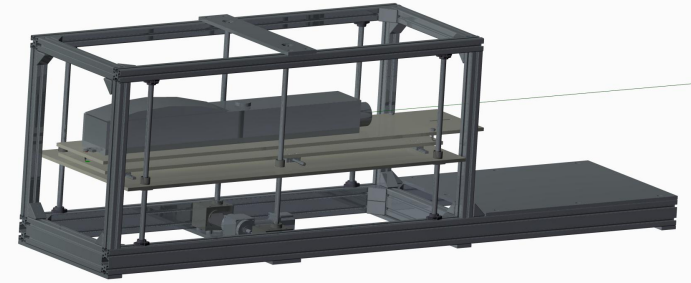
- ❑ Ion drift length can be set in the range 5 – 50 mm.
- ❑ The chamber can handle also mixtures of aggressive gasses like CF-4.
- ❑ The aim of the ion drift measurement is to minimize the backward ion flux in the ALICE TPC.



Laser detector laboratory

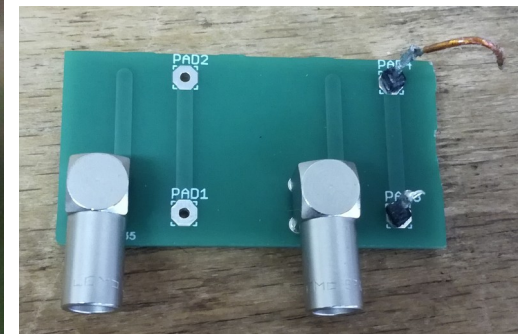
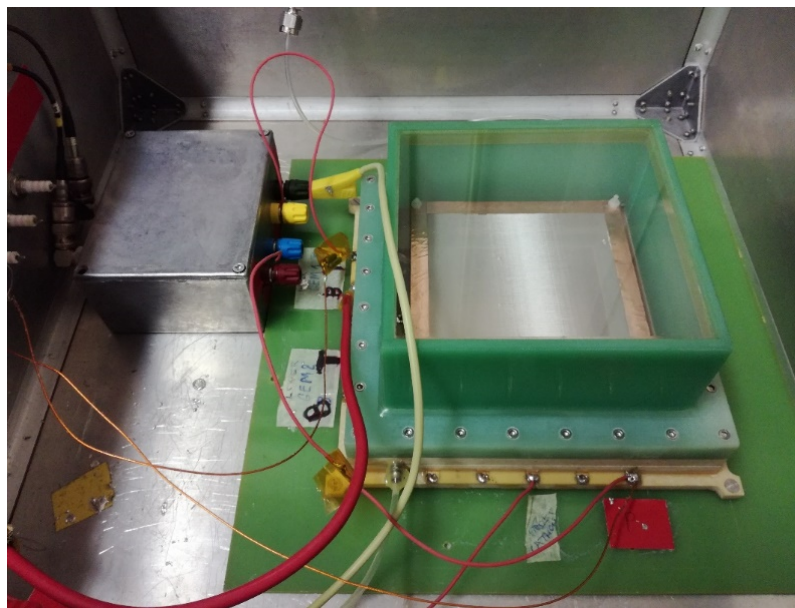
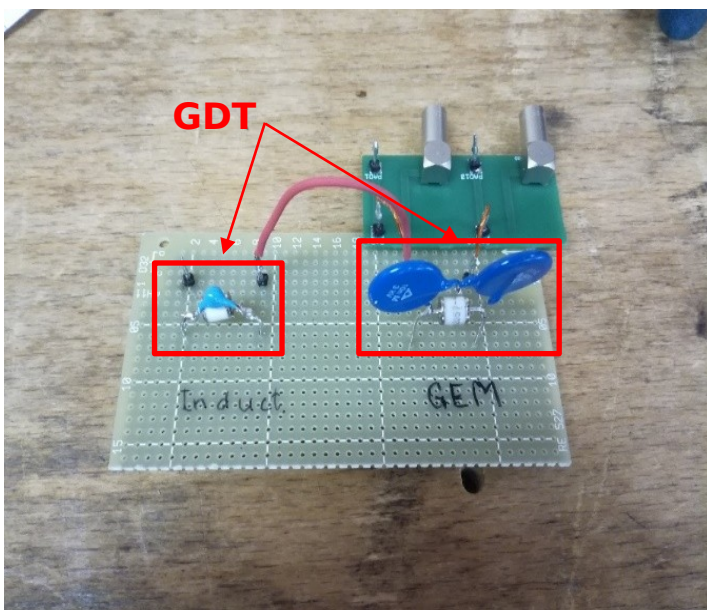
Collimated beam $\phi < 1$ mm of photons with 213 nm wavelength for detector testing is provided by a powerful UV Nd: YAG laser

Optical bench allows to set the beam position w.r.t. detector with the precision ≤ 0.1 mm



Research and development of the GEM TPC for ALICE experiment

- The study of the discharge behaviour in a gas mixture (Ar+CO₂ 90:10) in the configuration GEM + anode
- The mechanism of the propagation of discharges from GEM to the anode is not understood.
- For comparative measurements a GDT (Gas Discharge Tube) is used.



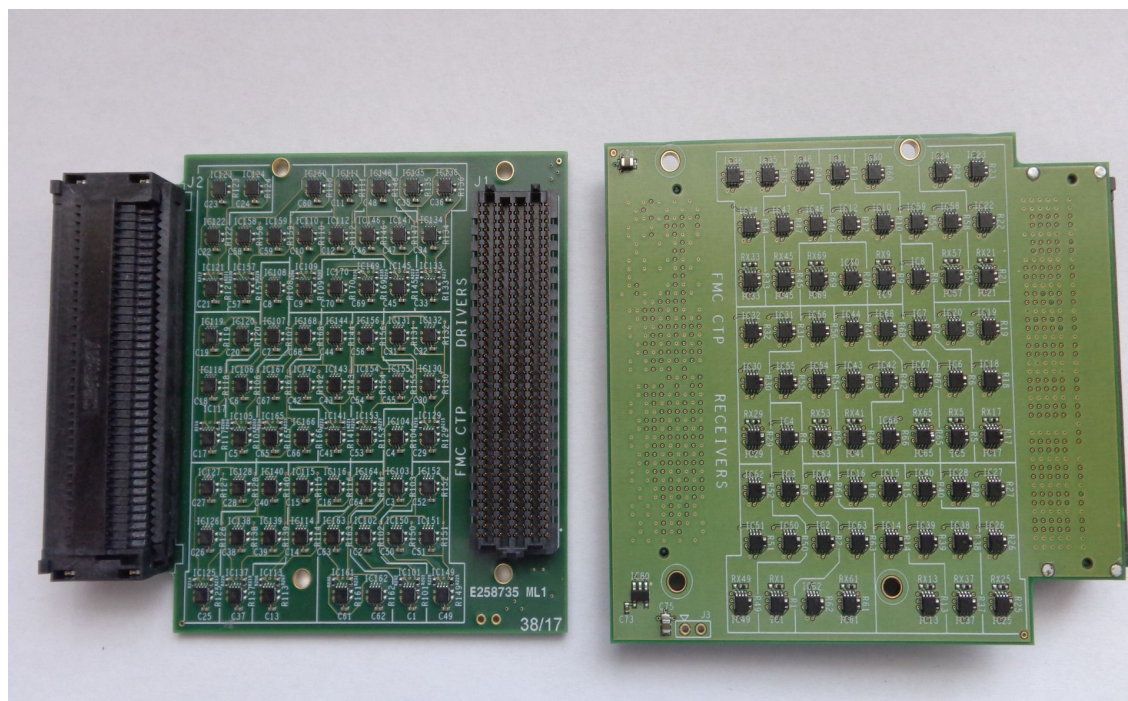
PCB antenna

CTP electronics for the ALICE upgrade

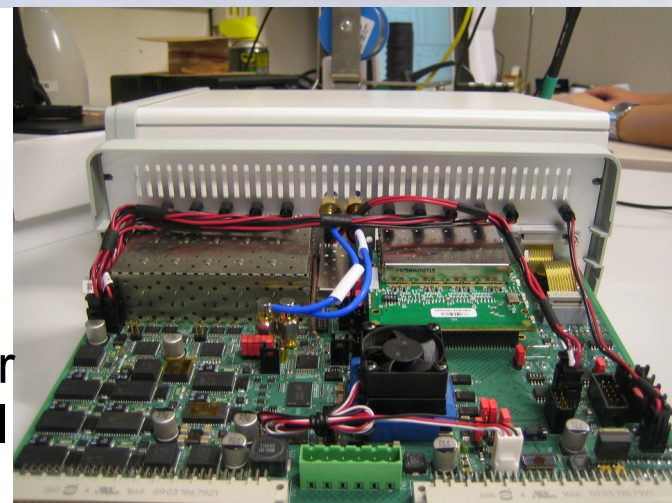
Development, production and testing of the FMC-CTP board (FPGA Mezzanine Card)



Octopus cable production

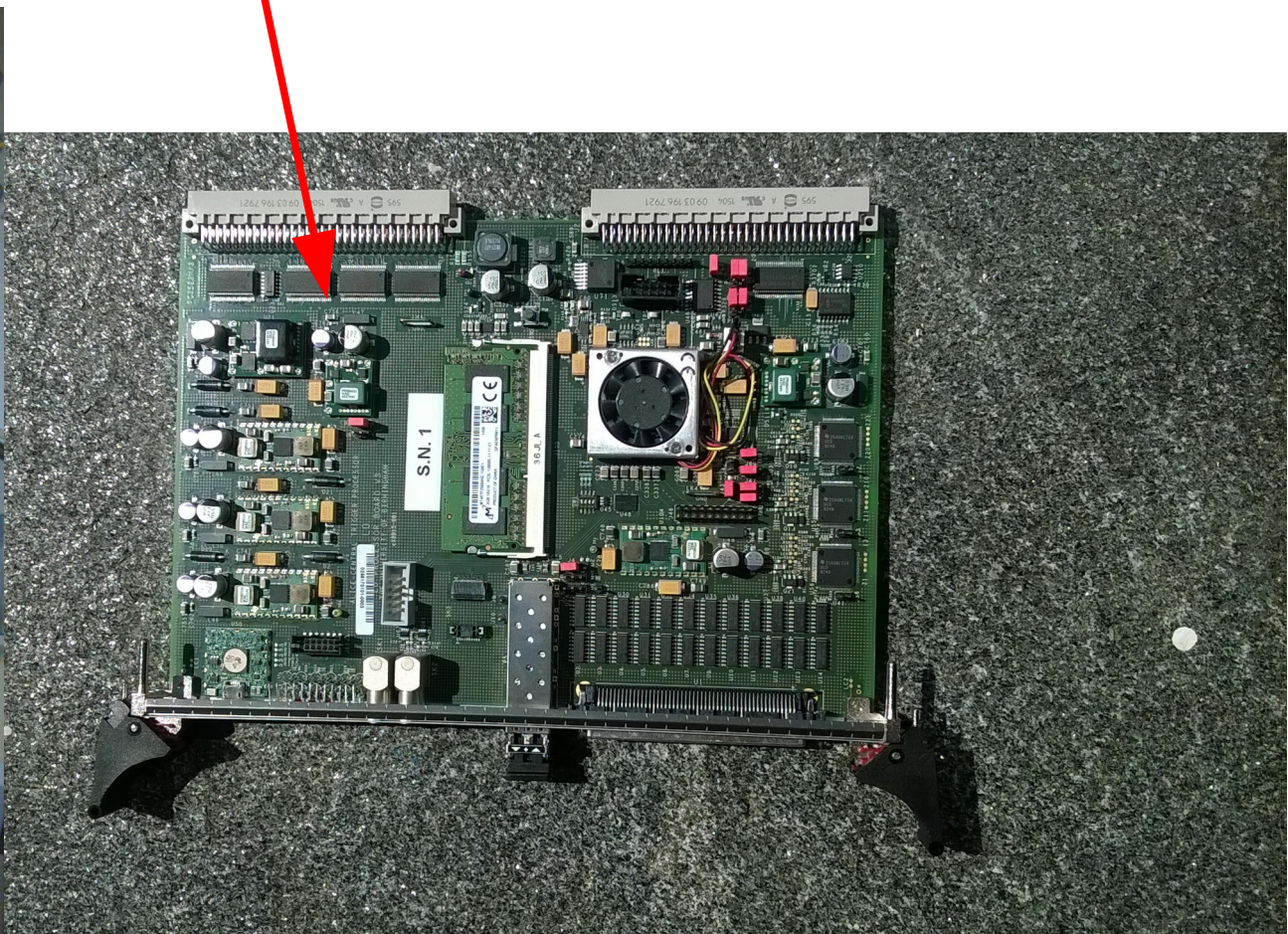
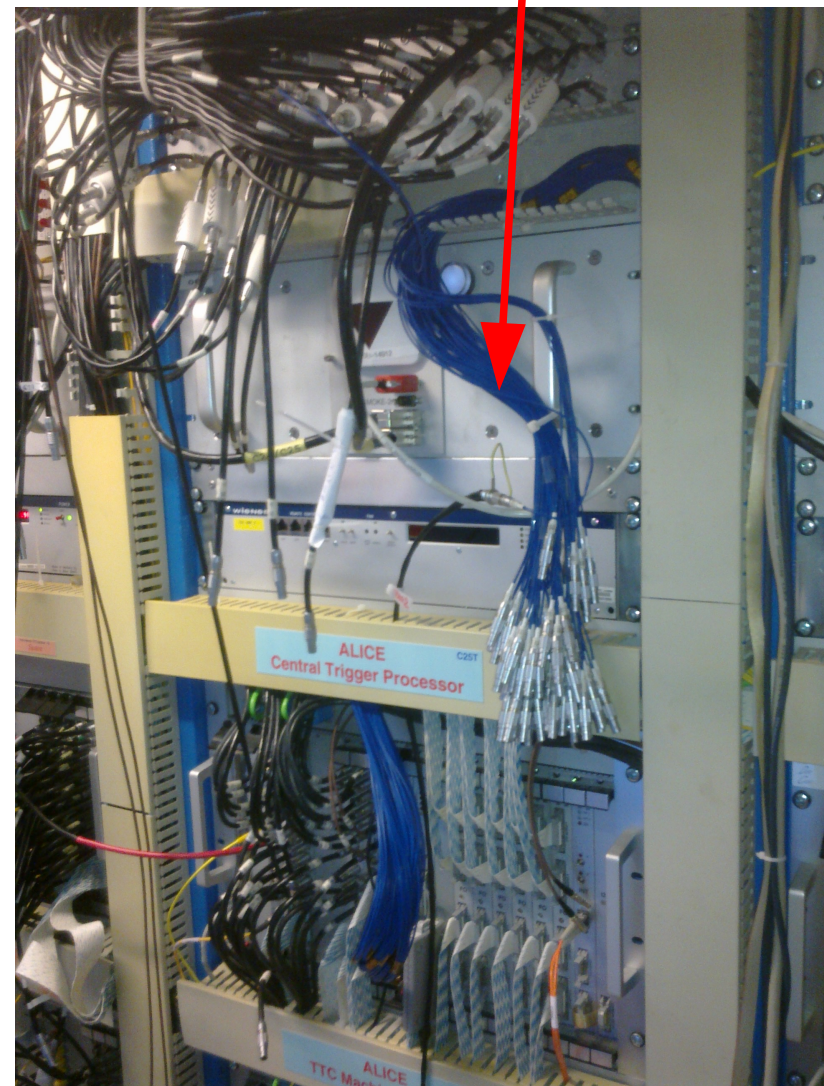


Connection of the Trigger board and the front panel for the VME Elma box



CTP electronics

- Production of a new patch-cable for the CTP
- Debugging of a new L0 board for the CTP

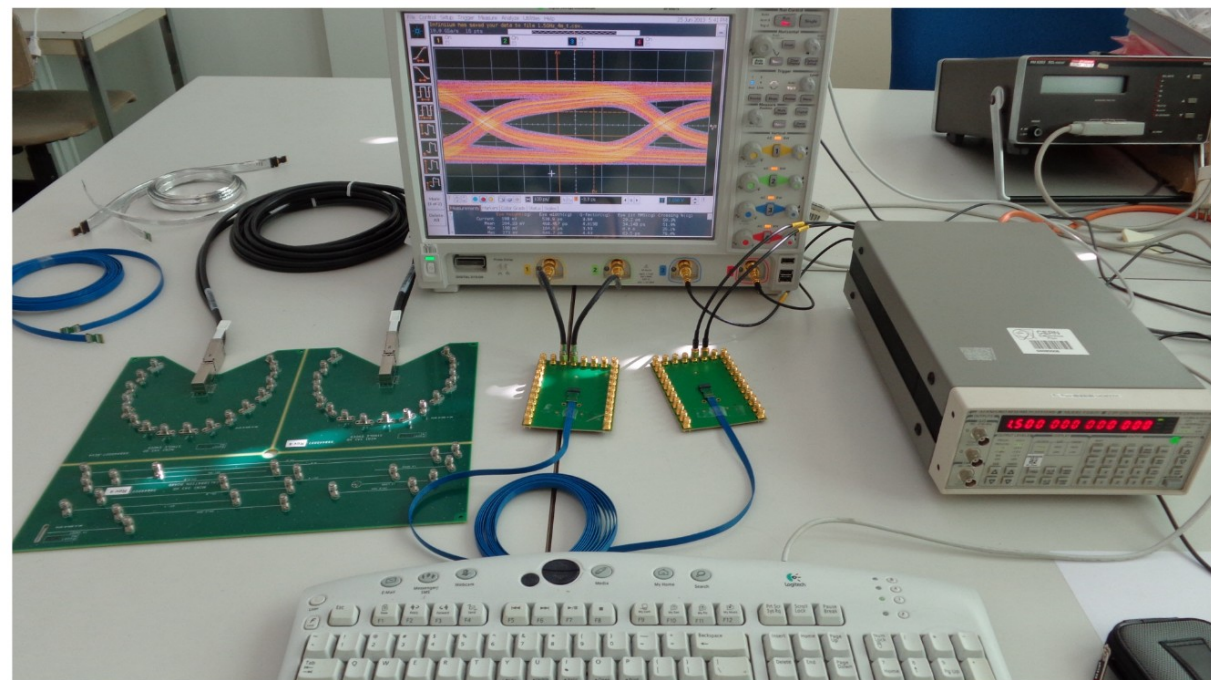


Testing cables for the ALICE ITS upgrade

Proposal and production of an adaptor for measurement of the HF properties of various ITS readout bus prototypes.

Measurements and analysis of HF properties of several flexible buses for the ITS readout before and after their irradiation in the cyclotron at UJV Rez, Czech republic.

Measurements and analysis of HF properties of several high speed cables.



Setup at CERN

Software contributions

External access to ALICE control conditions data - AMANDA 3

Alice **MAN**ager for **D**cs **A**rchives

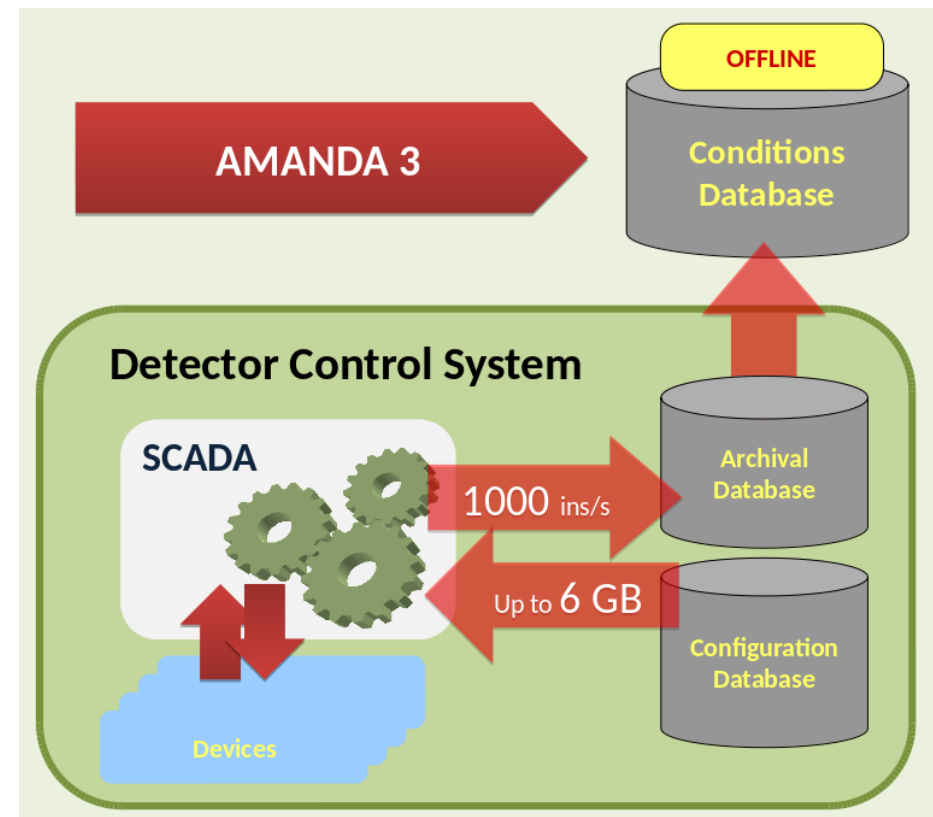
The conditions data exchange between the DCS and ALICE offline.

Specific tasks are scattered among multiple computers, which allows for load balancing and system jam prevention.

The web client removes the dependency on the operating system.

The system is used by ALICE Offline to extract operational conditions after a run is completed.

AMANDA 3 was introduced into CERN infrastructure in 2014



Dcs ARchive MAnager for ALICE conditions data (DARMA)

Updated version of AMANDA 3

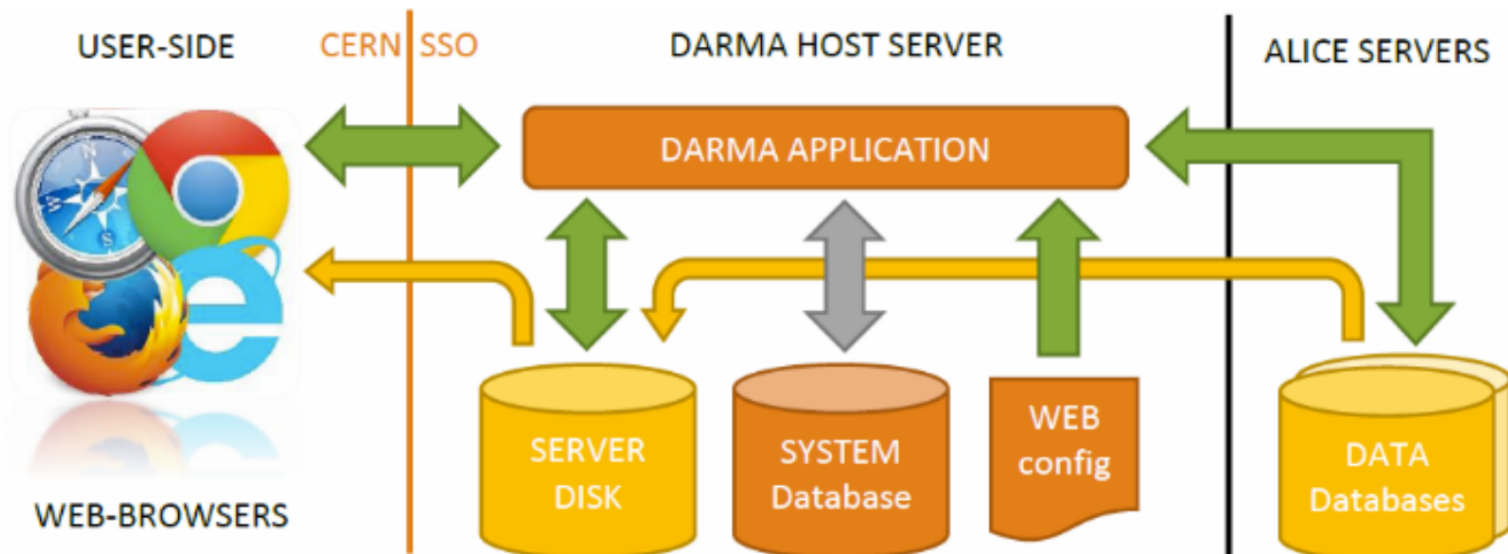
Aim is to simplify the overall complexity of the AMANDA 3

- simpler implementation
- simpler administration
- portability

without sacrificing the functionality

User side:

- classic PC
- mobile phone
- tablet

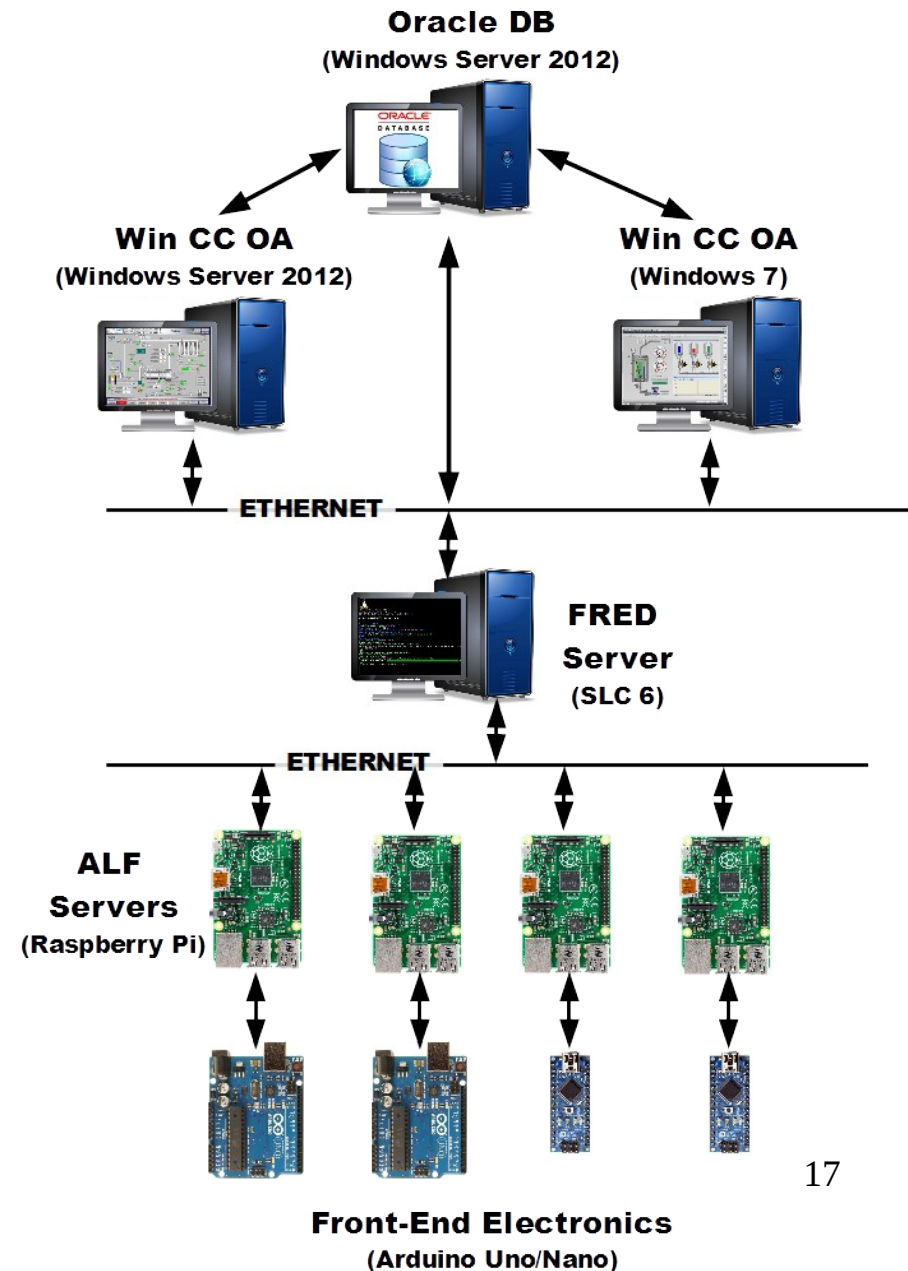


Detector Control System for the Internal Tracking System (RUN 3)

New ITS being built for the RUN 3
needs completely new Detector Control
System

Development and building of a new
control system is under way
- when hardware modules are ready
a software modules debugged and
tested in simulated environment
are installed at CERN

Heavy involvement of PhD students
in the development of the ITS DCS.

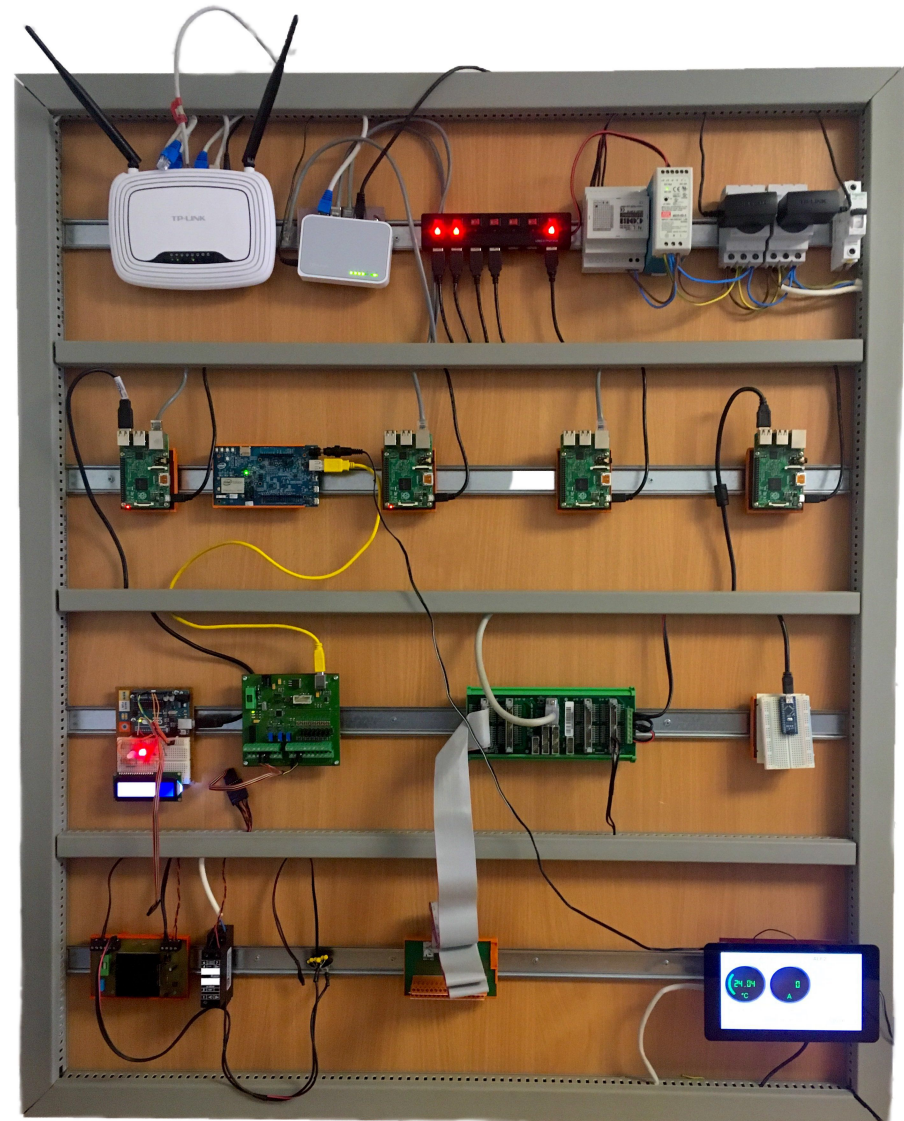


Detector Control System for the Internal Tracking System (RUN 3)

Simulator of sensors and actuators and their integration into the DCS infrastructure

It is a part of the functional copy of the CERN DCS infrastructure used for developing and debugging of individual system components at Technical University Kosice.

With tools like this all development can be done at TUKE and only debugged and tested components of the ITS DCS are installed at CERN.

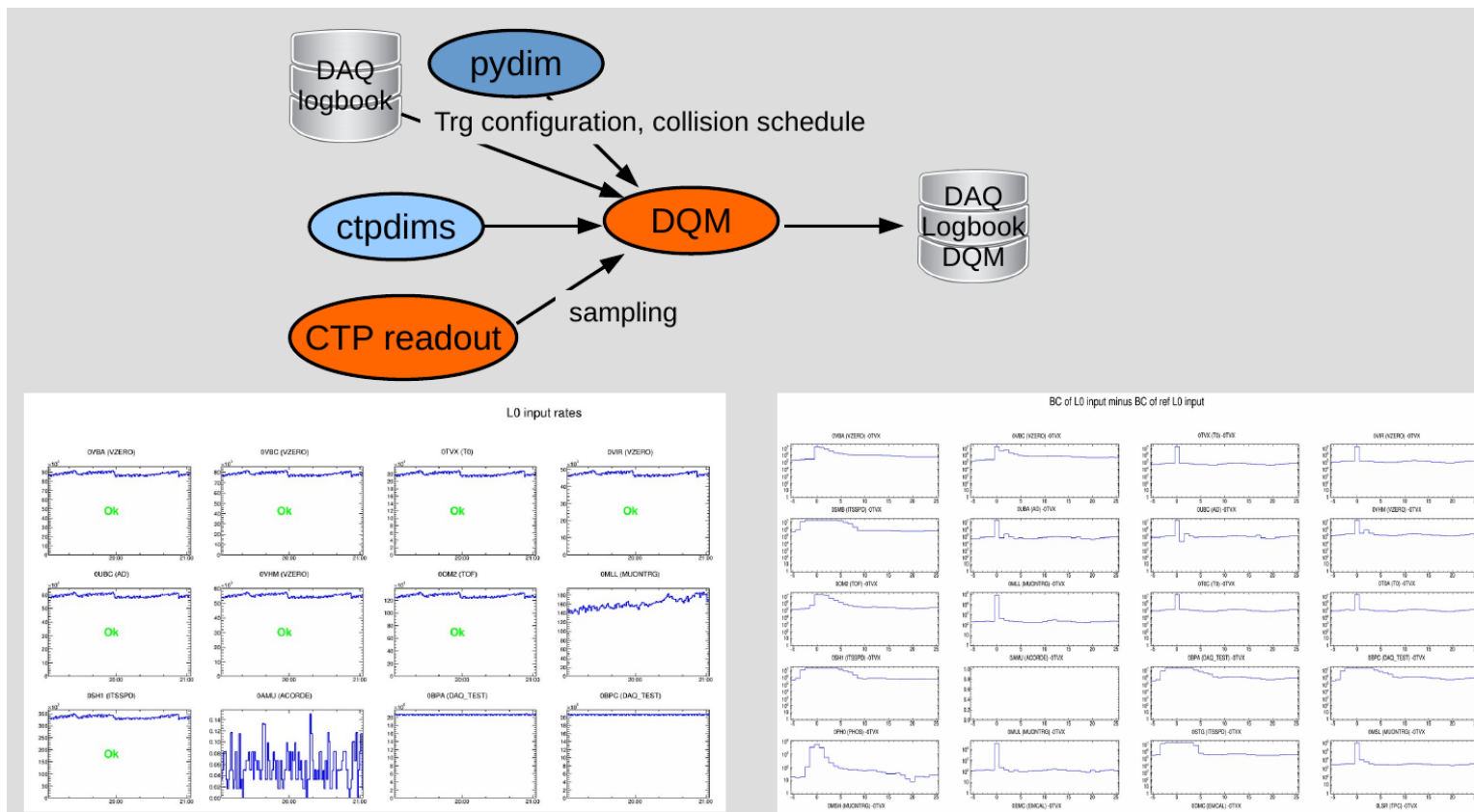


Trigger Data Quality Monitoring for RUN 2

DQM:

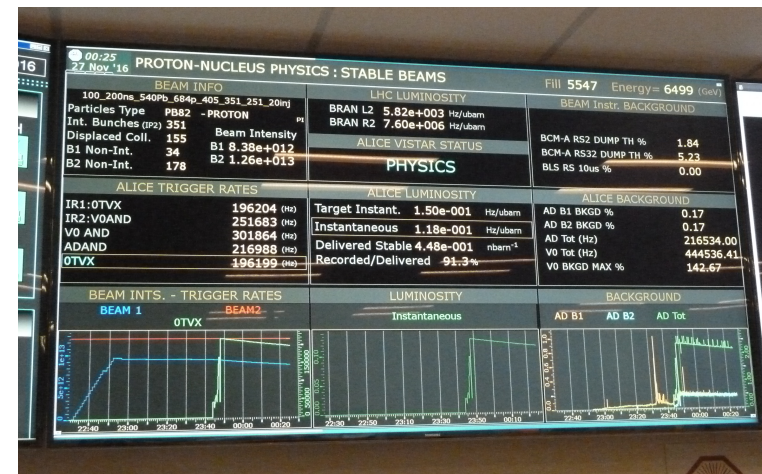
ROOT application supplying many histograms from data acquired by:

- reading CTP counters (1/min, DIM)
- subset of events from the DAQ stream
- histograms, available only during data taking, are stored in DAQ logbook

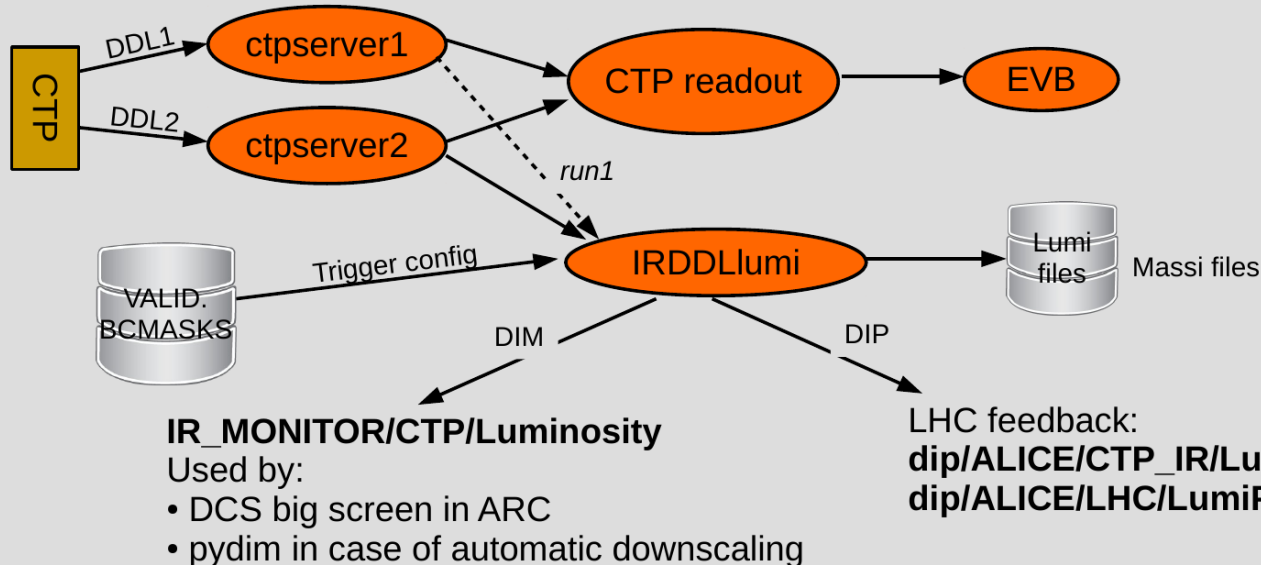


LHC IF : On-line luminosity monitoring

- Provides on-line beam luminosity for each colliding pair of bunches, DIM and DIP publications, simple archivation for off-line processing
- on-line feedback for LHC
 - off-line files for each colliding pair of bunches (LHC)
 - display in ACR
 - data for the VdM scans



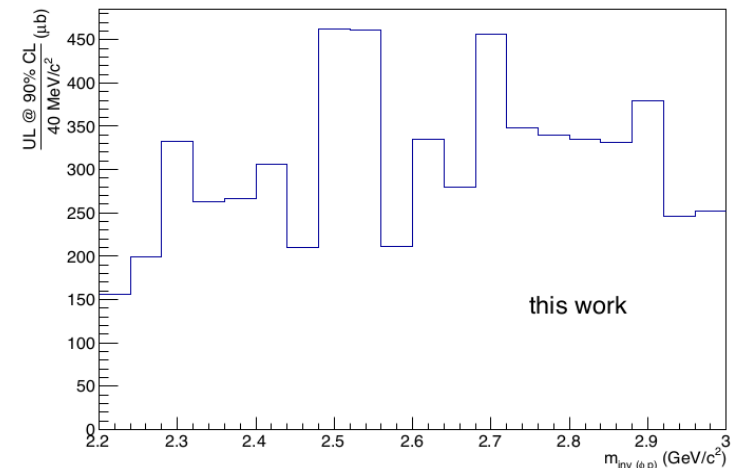
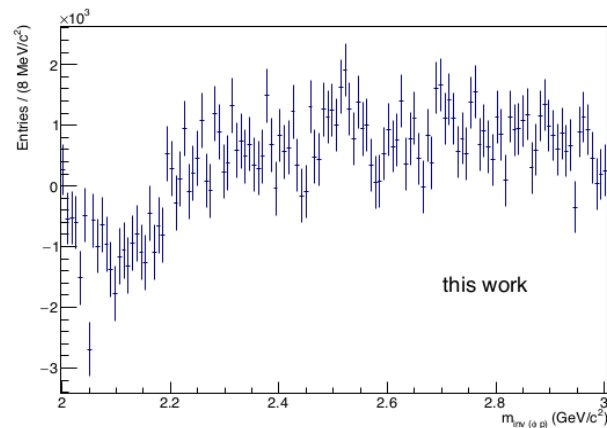
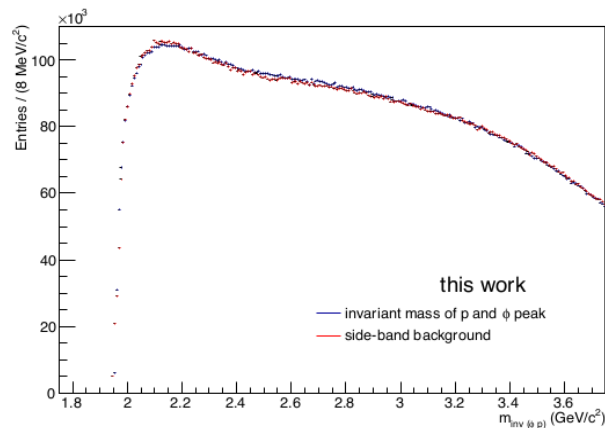
ALICE TRIGGER RATES	
IR1:0TVX	196537 (Hz)
IR2:V0AND	251828 (Hz)
V0 AND	301436 (Hz)
ADAND	215836 (Hz)
0TVX	196928 (Hz)



Physics analysis

Pentaquark search on the ALICE experiment

- For the background estimation, the sideband method was used.
- Since mass of the P_s^+ is a priori unknown - tests for the presence of a signal carried out at a numerous mass hypotheses.
- Investigated spectrum from $2.2 \text{ GeV}/c^2$ to $3.0 \text{ GeV}/c^2$ - scanning of each $40 \text{ MeV}/c^2$ wide window in the sideband-subtracted invariant mass spectrum.



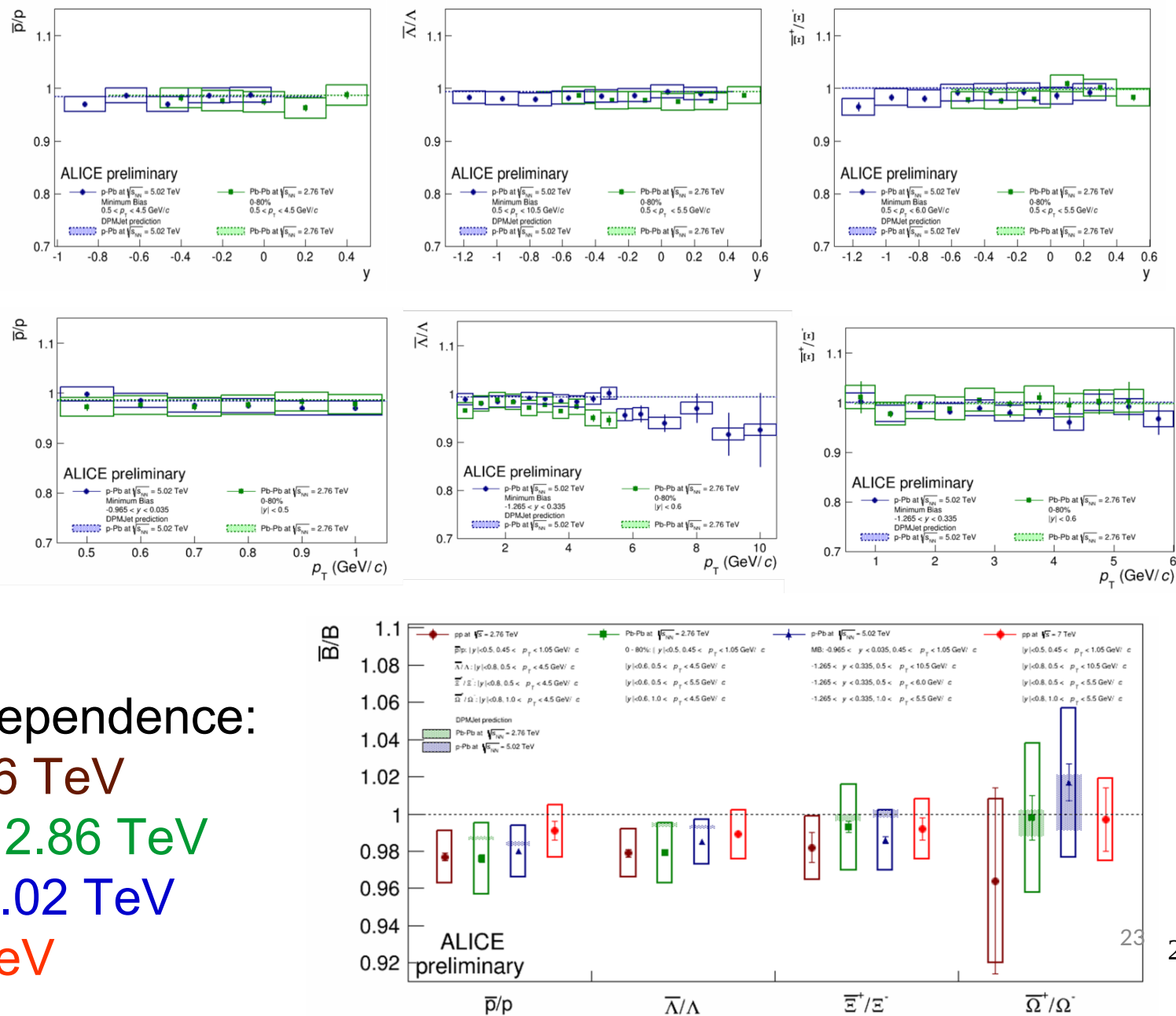
The average value for the upper limit of the P_s^+ production over all tested masses was found to be **$284.4 \pm 3.8 \text{ } \mu\text{b}$**

Midrapidity antibaryon-to-baryon ratios in Pb-Pb and p-Pb collisions measured by the ALICE experiment

Rapidity
dependence
p-Pb @ 5.02 TeV
Pb-Pb @ 2.76 TeV

Transverse
momentum
dependence

System dependence:
pp @ 2.76 TeV
Pb-Pb @ 2.86 TeV
p-Pb @ 5.02 TeV
pp @ 7 TeV



Strange and multi-strange particle production in p-p and Pb-Pb collisions

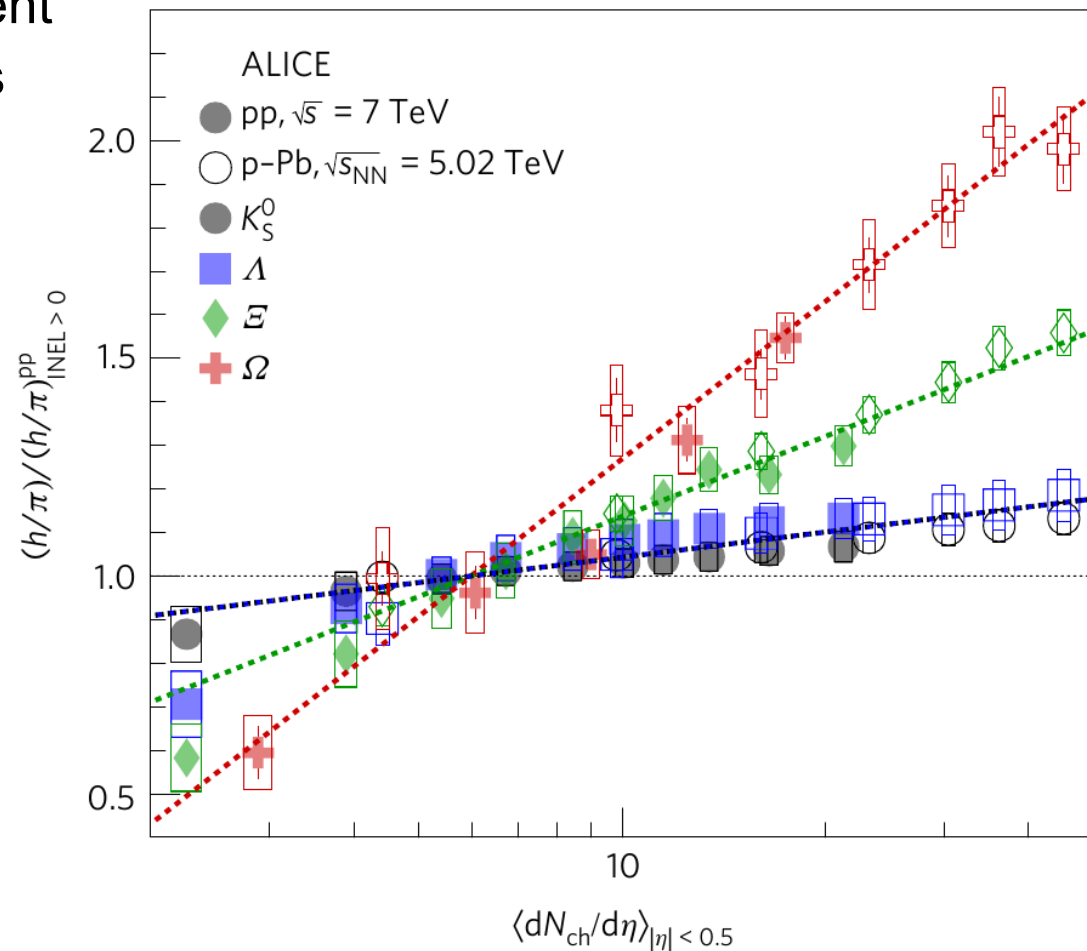
Study of the K_S^0 and Λ in p-p and Pb-Pb collisions at various LHC energies

- physics analysis (selection of signals, systematic errors,)
- systematic studies, method improvement
- testing robustness of analysis methods

Recent observation:

The production of strange and multi-strange particles in the high multiplicity p-p collisions exhibits behaviour observed in Pb-Pb collisions

Main analysis topic in Kosice



Angular correlations between strange and non-strange particles in p-p @ 13 TeV

Trigger particle: Λ or K_S^0 with $p_T > 4$ GeV/c

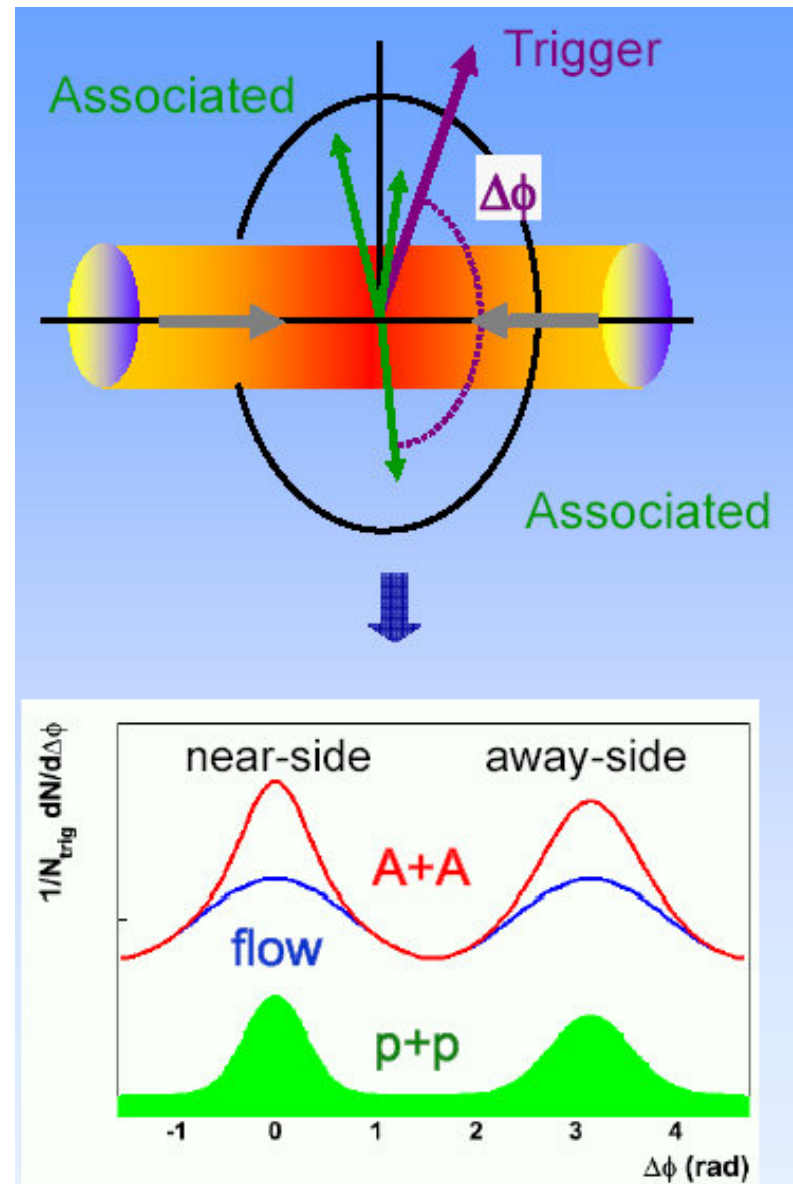
Associated particles: any charged hadrons, with $p_T > 4$ GeV/c

Motivation:

- gluon jets produce more baryons than quark ones
- p-Pb or high-multiplicity p-p events may lead to some phenomena observed in much larger systems (Pb-Pb)

Status:

- one diploma work completed
- the subject may be studied in PhD thesis (not in Kosice)

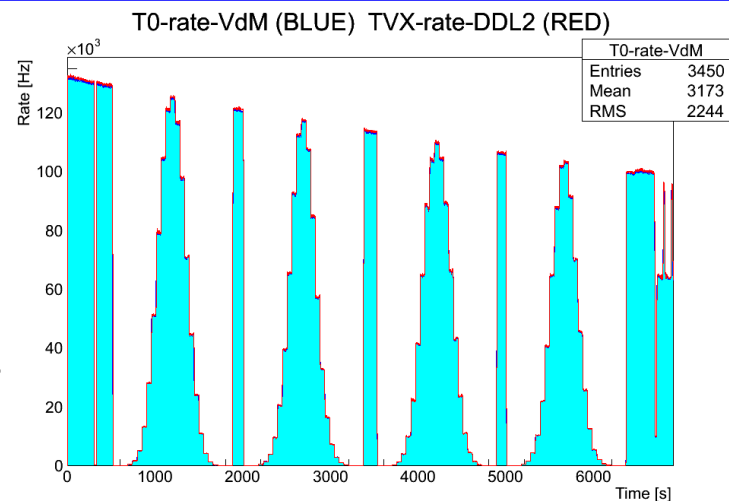


ϕ meson polarization in p-p and Pb-Pb collisions

- New functions needed for the ϕ polarization studies were implemented into the official analysis code AliROOT
- Work in progress ...

Normalization cross section measurement using Van der Meer scans

- Data acquisition from the CTP using LHC IF soft. with extra input channels used only for VdM
- Production of data sets for the analysis
- Calculation of the corrections due to electromagnetic interactions between two beams and corresponding systematic errors



Summary

- Slovak hardware activities and main software contributions are aimed at the ALICE upgrade during LS2. Considerable involvement of PhD students.
- New infrastructure is being built for work on ALICE upgrade in Bratislava as well as in Kosice.
- Physics analysis is driven mainly by the PhD students and postdocs.
- Gaps in age structure in HEP physics.
- One generation of very experienced electronic engineers is retiring with almost zero chance to replace them - we are shifting our main focus from electronics design to detector control systems.
- The ALICE experiment will give us at least another decade of exciting physics and challenging working environment.