ECFA MIDTERM REPORT FROM SLOVAK REPUBLIC
CERN, GENEVA, NOVEMBER 2008

Slovak Republic in Numbers

Population: 5 500 000
Capital: Bratislava
Area: 48 845km²
EU member since May 2004

Education:

29 Universities, 8 with Physics education
217342 students (Ba+Ma+Phd)
59110 natural science and technology students (Ba+Ma+Phd)
577 physics students (Ba+Ma)

HEP facts:

HEP research focused in 6 centres (4 cities): Bratislava, Žilina, Banská Bystrica, Košice

Currently ~ 49 physicists and engineers , 16 PhD. students

Participation in HEP experiments: CDF, H1, at CERN

HEP Theory and Phenomenology

~25 physicists and PhD students

Institute of Exp. Physics SAS,
P.J. Šafárik University Košice,

SAS Bratislava

Comenius University
Bratislava

Matej Bel University
Banská Bystrica

University Žilina

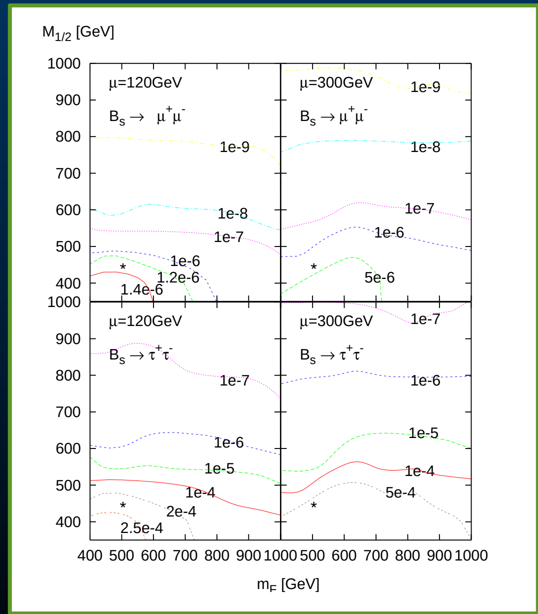
Comenius University, Bratislava

- Global Analysis of the Minimal Supersymmetric Standard Model (MSSM) Constrained by Unification at 10^{16} GeV and Its Implications for LHC Physics. Phenomenology of the MSSM below 1 TeV:

- Chiral perturbation theory and πN interactions

- Development and investigation of the unitary and analytic model of the electromagnetic and weak structure of hadrons. Sum rules for hadron charge radii and cross sections

- Field theory and non-commutative geometry



The $B_s \to l^+ l^-$ Decay Rate Predictions

Institute of Physics of the Slovak Academy of Sciences in Bratislava

- Main activities:
  - Phenomenology:
    - Development and investigation of the unitary and analytic model of the electromagnetic and weak structure of hadrons.
    - Phenomenology of heavy-ion collisions.
    - Meson spectroscopy.
  - Theoretical problems of the Standard Model:
    - Investigation of the mechanism of colour confinement in numerical simulations of lattice QCD.
    - Analysis of symmetry breaking and vacuum structure in light-front field theory models.

Institute of Experimental Physics, SAS Košice

- **Nuclear effects in e+A, p(d)+A and A+B collisions**

- **Nuclear suppression at large x**
  (high-pT hadrons, Drell-Yan, direct photons, heavy flavors,...)

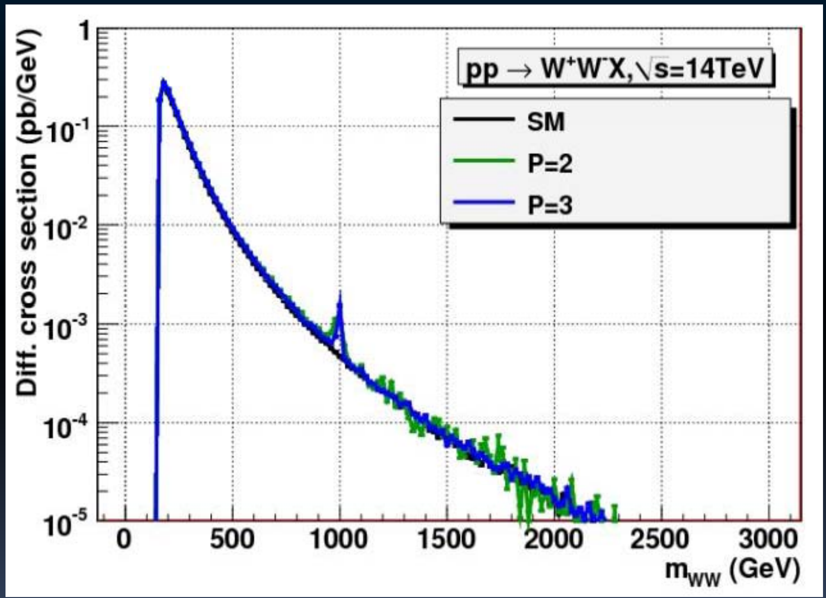
- **Nuclear shadowing at small x**
  (gluon shadowing, DIS off nuclei,...)

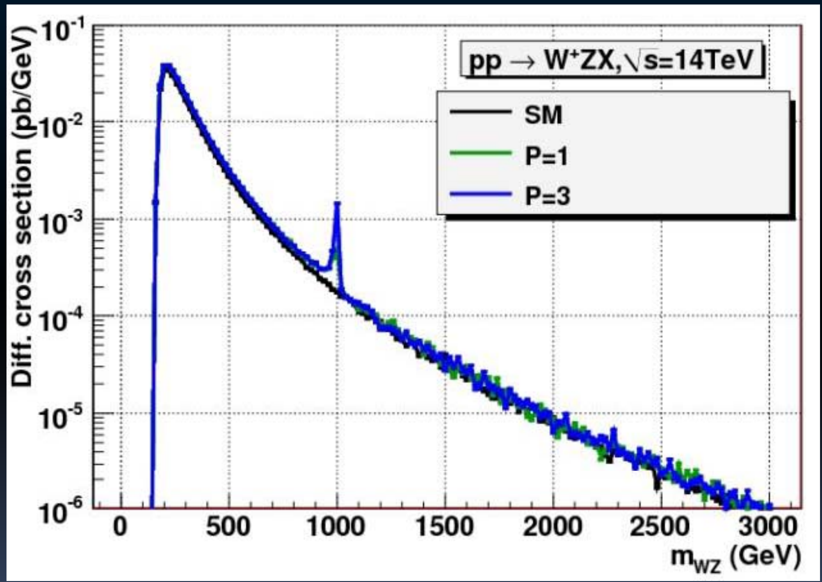
- **Hadronization in nuclear matter**
  (hadrons in DIS off nuclei, nucl. broadening, jet quenching,...)

- **Color transparency**
  (coherent & incoherent production of vector mesons,...)

Physics Dept., University of Žilina

- theory – phenomenology
- electroweak symmetry breaking – alternative nonSUSY scenarios
- effective Lagrangian
- sensitivity of LHC and ILC processes





Signatures of a new vector resonance coupled to the ESB sector

Matej Bel University in Banská Bystrica

- new high-energy theoretical group founded 2006
- 2 full time high-energy physicists, 1 diploma student

- nucleus-nucleus collisions
  (hadro-chemistry, femtoscopy, e-by-e fluctuations, …)
- structure of hadrons and elementary hadronic interactions
  (interactions of strange and charm particles, hadronic resonances,…)
- hadrons in dense matter
  (impact on particle production in nucleus-nucleus reactions …)

Slovakia in Fermilab (CDF)

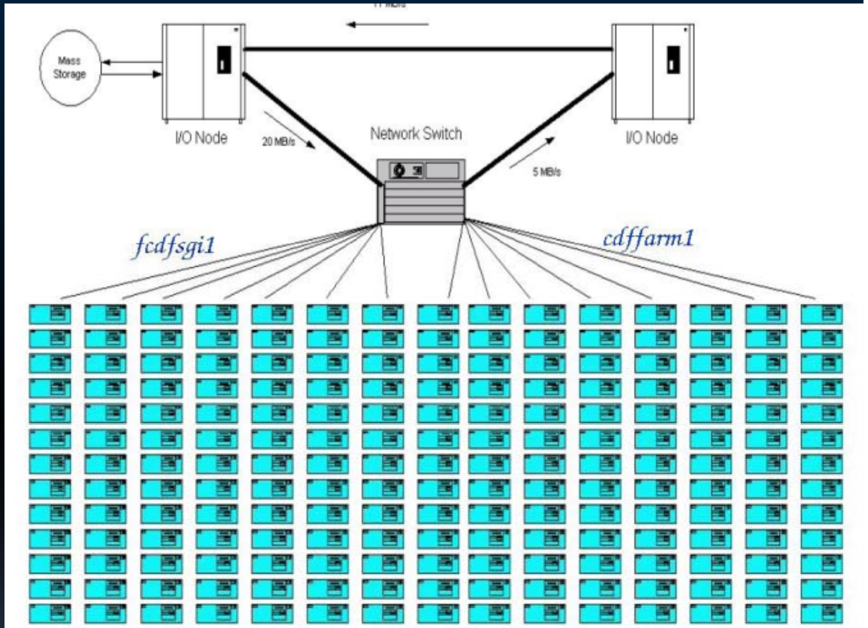
~6 physicists and PhD students

Institute of Exp. Physics SAS,
P.J. Šafárik University Košice,

SAS Bratislava
Comenius University Bratislava

Pioneering work on PC farm application for data processing

- Design and realization of control system for data processing on PC farm
- All CDF data have been processed by this system in years 2001-2003
- Farm based on this design provides services for physics community in Košice



Run II (2001 - 2009)

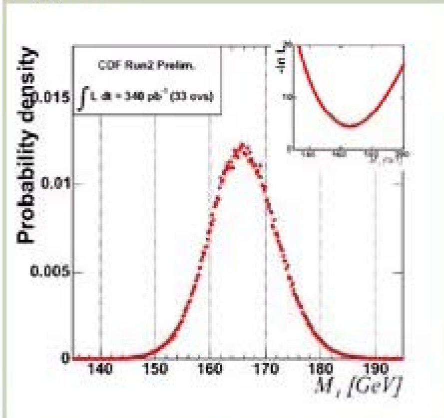
- Main physics topic - Measurements of top quark parameters:
  – Top quark mass – 2x awarded Result of the week in Fermilab Today
  – Top quark charge – Result of the week award
  – W helicity fractions in tWb decay
  – Spin-spin correlations

2006 – Slovakia officially accepted to the CDF collaboration (IEP and Comenius Univ. groups)

Thursday, July 28, 2005

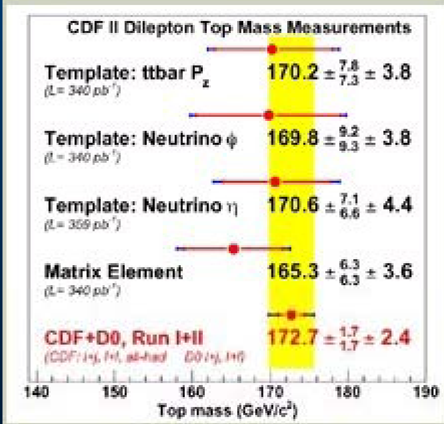
Fermilab Result of the Week

Top Dileptons Have Mass Appeal



Measured probability for top dilepton mass. (Click on image for larger version.)

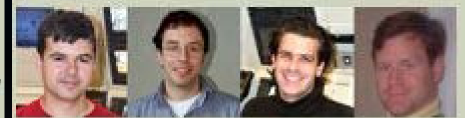
The top quark mass, a fundamental parameter of the Standard Model that must be measured experimentally, is of great interest because of its large value and the constraints it places on the Higgs boson mass. At the Tevatron, top quarks are primarily produced in pairs and decay to a W boson and b quark. The "dilepton" channel includes events where both W bosons decay leptonically; it has low statistics but little background contamination. The mass measurement in this channel provides direct confirmation that the observed excess of events is due to the Standard Model top quark; a significant discrepancy compared to measurements in other channels could indicate contributions from new sources.



Summary of CDF top dilepton mass measurement and CDF/D0 combination of best measurements in each channel. (Click on image for larger version.)

Teams of researchers from the US, Canada, Russia, Finland, Taiwan and Slovakia working at CDF have recently completed four new precision top mass measurements in dilepton events. The reconstruction of the top mass in these events poses a particular challenge, as much kinematic information is lost along with the two undetected neutrinos from W decay. Three of the techniques used were developed during Run1 and enhanced for Run II; values for the missing information are chosen from distributions in simulated events and used to calculate a most likely top mass for each event. The fourth measurement represents the first application in dilepton events of matrix element techniques pioneered in the single-lepton channel. This technique assigns a probability for each top mass by combining the probability that the event comes from top pair decay of a given top mass with the probability that the event was produced by known background sources. The result is the most precise measurement of the top quark mass in dilepton events.

Top (Left to Right): Bo Jayatilaka (U. Michigan), Brig Williams, Daniel Whiteson (U. Pennsylvania), Bottom: Dave Gerdes, Monica Tecchio (U. Michigan), Andrew Kovalev (U. Pennsylvania) (Click on image for larger version.)



(Left to Right) Simon Sabik, Pierre Savard, Kostas Kordas (University of Toronto), David Ambrose (Fermilab) (Click on image for larger version.)

Top (Left to right) Jaroslav Antos, Roman Lysak (Institute of Experimental Physics Slovak Academy of Sciences), Tuula Maki (University of Helsinki and Helsinki Institute of Physics), Bottom: Yen-Chu Chen (Academia Sinica), Andy Beretvas, G.P. Yeh (Fermilab) (Click on image for larger version.)

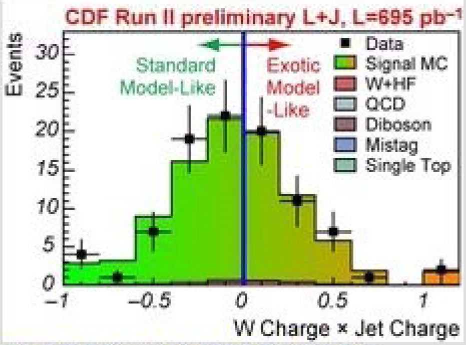
Top: Julian Budagov, Guram Chlachidze, Vladimir Glagolev, Fiodar Prakoshyn (JINR), Bottom: Alexei Sissakian, Igor Suslov (JINR), George Velev (Fermilab), Giorgio Bellettini (INFN and University of Pisa) (Click on image for larger version.)

Result of the Week Archive

Fermilab Result of the Week
July 2005

Fermilab Result of the Week

Charged on Top



To a "b," or not to a "b:" That is the question for the top quark. Shown is the product of the charge of the W and the associated b quark jet for candidate top quark decays. An excess of data in the exotic-like right-hand side could indicate that the top is not what we think it is. More details below(*).

Determining whether a jet of particles came from a b quark or an oppositely charged anti-b quark is at the heart of an existential question related to quarks: what is the true nature of the top quark? Since the top's discovery at the Tevatron more than 10 years ago, physicists have been asking themselves: Is this elusive particle really the top quark predicted by the Standard Model? Measuring its electric charge would help answer that question. According to the Standard Model, the top quark should have a charge of +2/3 and should decay to a W+ (charge +1) and a b quark (charge -1/3), while the anti-top should decay to a W- (charge -1) and an anti-b quark (charge +1/3).

The charge of the W can be obtained from the charge of the electron or muon it decays into, but what about distinguishing between a b quark and an anti-b quark? A team of CDF physicists answer this question by summing the charges of all the tracks inside a b jet. If the sum comes out positive, they assign the jet to an anti-b quark, and if it is negative, to a b quark. Using this algorithm, they estimate that they make the correct assignment about 60% of the time. This is a tough business!

The CDF physicists find that with about 1 inverse femtobarn of data, the Standard Model hypothesis for the top quark is strongly supported. This seems to indicate that this particle thought to be the top quark might indeed be the top quark...electrically speaking

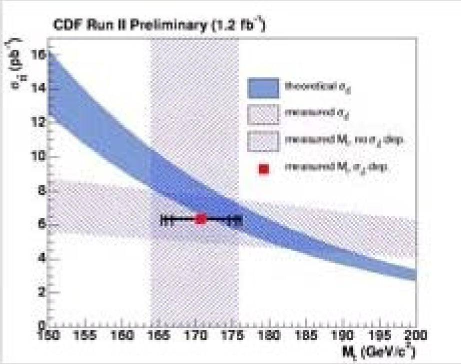
(*)Continued from above: A perfectly reconstructed top or antitop quark would always have a negative value. Due to misreconstruction, about 60% of the time a correct assignment is expected to be made. In approximately 1fb-1 of data, CDF observed 62 negative and 48 positive events.

Fermilab Result of the Week April 2007

From left, top row: Stanislav Tokar (Comenius University, Bratislava), Kevin McFarland (University of Rochester), Jaroslav Antos (Slovak Academy of Science), and Kirsten Tollefson (Michigan State). Second and third rows, from left: Yen-Chu Chen (Academia Sinica), and Andy Beretvas (Fermilab); Zeynep Gunay Unalan (Michigan State University), and Peter Bednar (Comenius University, Bratislava). Bottom row, from left: Veronique Boisvert (University of Rochester), and Veronica Sorin (Michigan State University).

Fermilab Result of the Week

Does the top quark have a weight problem?



A measured cross-section of constrained top mass in a top mass - cross-section plane. The hatched areas mark the separate top mass and cross-section measurements. The blue area marks the theoretical cross-section. The CDF physisicts measure a top mass of 170.7+4.2-3.9(stat)± 2.6(syst) ± 2.4(theory) GeV/c^2 using 1.2 fb^{-1} of data collected by the CDF detector.

The top quark is possibly the most fascinating particle. It is the heaviest elementary particle and its mass places constraints on the standard model Higgs boson. This correlation between the two particles prompts us to measure the mass of (or weigh) the top quark as precisely as possible.

The best way to pin something down is to look at it from as many different angles as possible and see if all measurements agree. If they don't then we know our model has a flaw.

Most current methods attack the problem of measuring the top quark mass by fitting distributions and seeing which mass fits the data best. A novel approach by CDF physicists incorporates the additional information that the lighter the mass of the top quark, the more top quarks produced. Therefore, counting the number of top quark candidates provides a constraint on the top quark mass itself.

But they did not stop here. The physicists also looked into one of the hardest channels to understand, the one that results in neutrinos in the final state. Neutrinos fly through our detectors without being noticed, leaving the "signal" of such a top decay consisting of a large amount of missing information.

The relationship predicted by theory matches the measured top mass and cross-section. The top mass is consistent with all other measurements from CDF, but more importantly the technique provides a more precise measurement than the traditional approach of using a fitting procedure alone.

learn more

Clockwise from upper left: Tuula Maki, University of Helsinki and Helsinki Institute of Physics; Jaroslav Antos, Slovak Academy of Science; Roman Lysak, Slovak Academy of Science; Andy Beretvas, Fermilab; and Yen-Chu Chen, Academia Sinica.

Fermilab Result of the Week
September 2007

Slovakia in DESY (H1)

~5 physicists and 3 engineers

Institute of Exp. Physics SAS,
P.J. Šafárik University Košice,

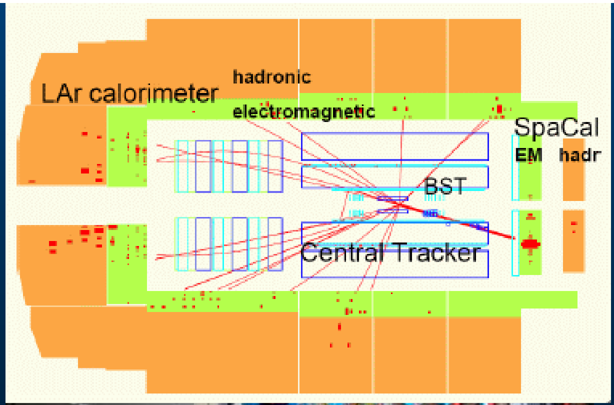
H1 contribution

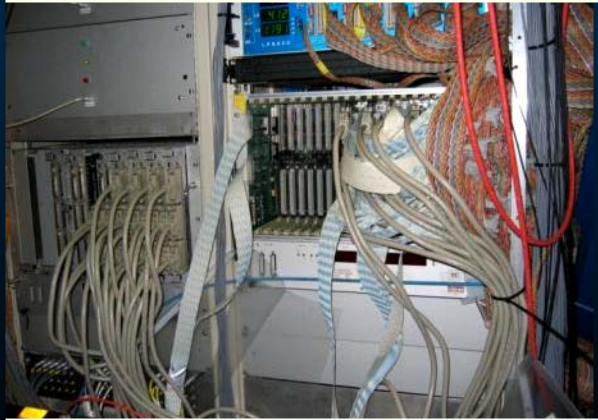
- **FPGA based SpaCal Topological Trigger**
  - using detailed granularity of three backward subdetectors to enhance the scattered electron sensitivity for 1-st level trigger. Used during HERA low energy run for direct proton longitudinal structure function measurement.

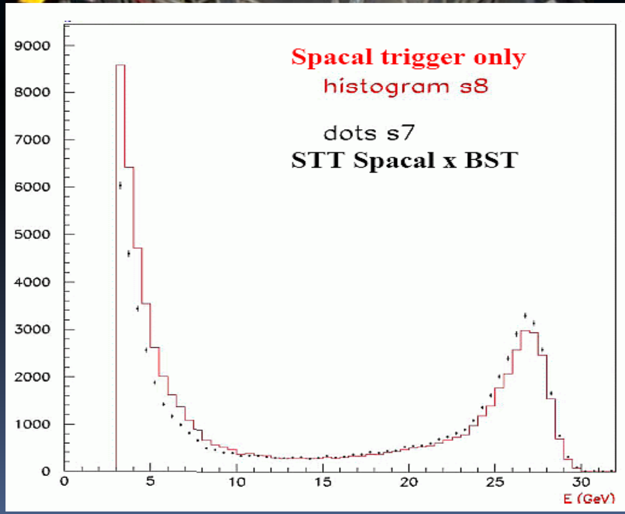
- H1 calorimetry slow control
  - including LAr Calo and SpaCal HV control and monitoring, calorimeter trigger rate monitoring.

- Calibration of LAr calorimeter and SpaCal
  - in HERA II period including software development .

- More than 10 years of daily maintenance of full H1 calorimetry.



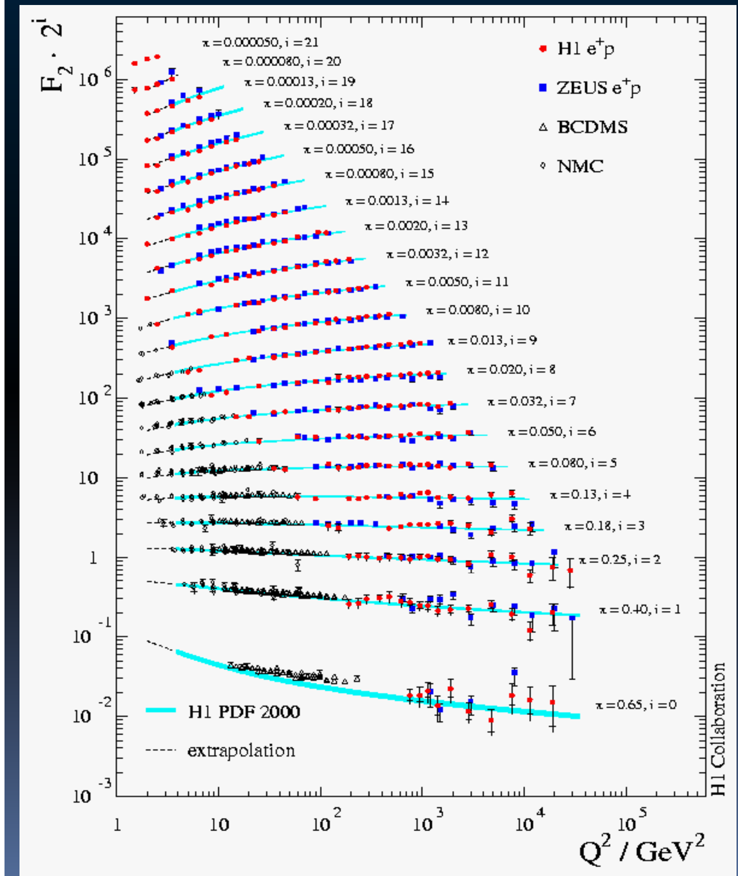




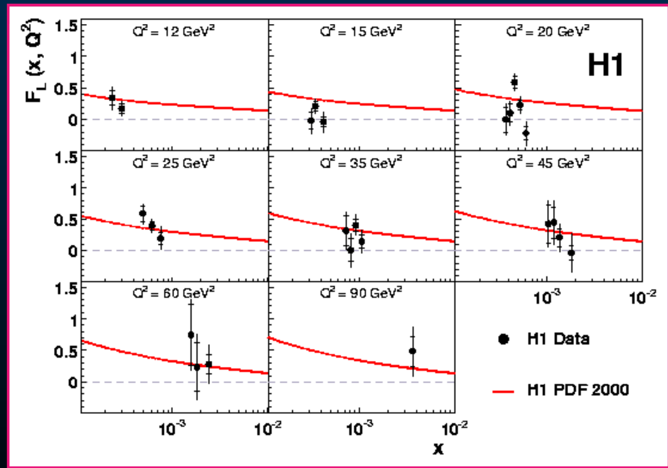
Relative scattered electron trigger rate improvement in high *y* (low E_e) region.

H1 physics

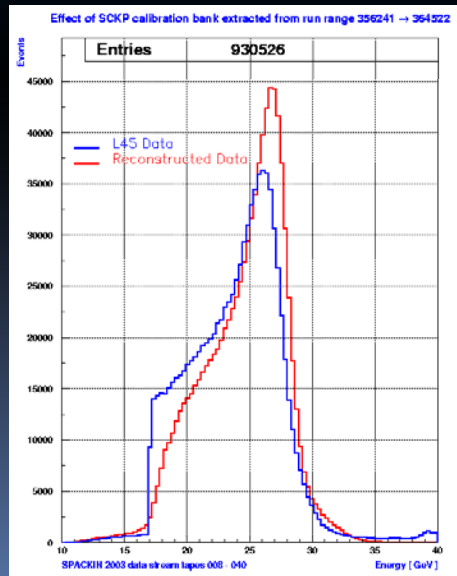
Participation in proton structure function $F_2(x,Q^2)$ and $F_L(x,Q^2)$ analysis with dominant contributions in: calorimeter energy scale adjustment, trigger efficiencies, luminosity cross-checks and acceptance.



First direct measurement $F_L(x,Q^2)$ at low x at HERA:



Typical regular backward SpaCal calorimeter energy scale improvement: combination of hardware (PMT HV) and software adjustments (kinematical peak, cosmics and double angle methods) →



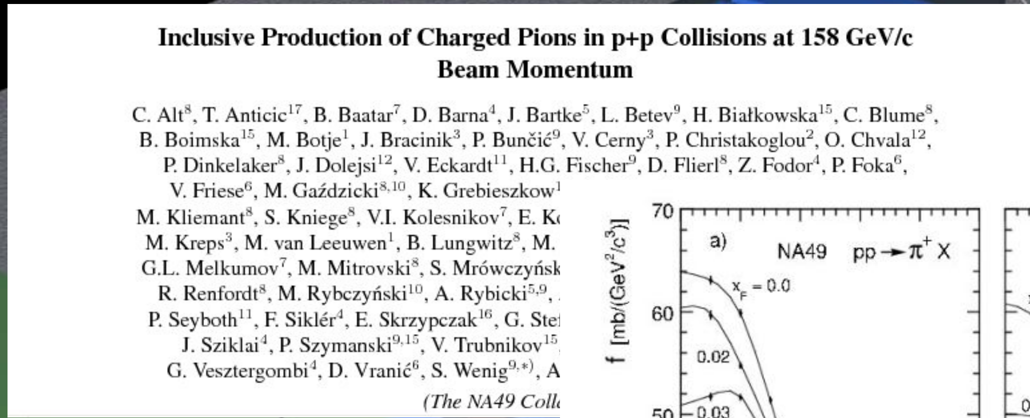
Slovakia in CERN fixed target experiments (NA49, NA57)

~20 physicists and engineers

Comenius University Bratislava, NA49, NA57

Institute of Exp. Physics SAS, P.J. Šafárik University Košice, NA57

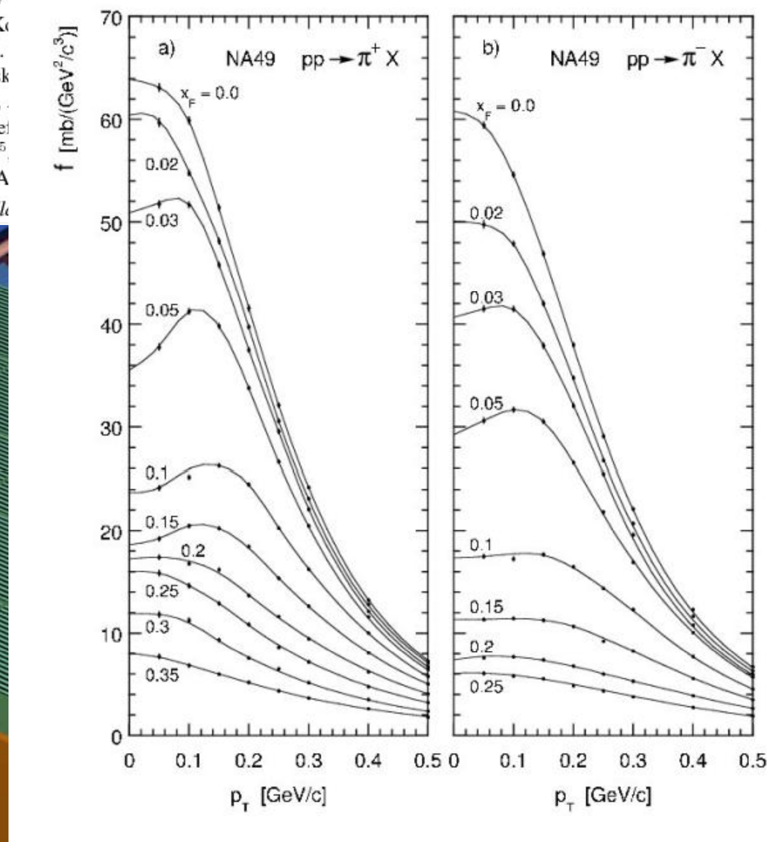
NA49 Bratislava mainly in pp group



Inclusive Production of Charged Pions in p+p Collisions at 158 GeV/c Beam Momentum

C. Alt[8], T. Anticic[17], B. Baatar[7], D. Barna[4], J. Bartke[5], L. Betev[9], H. Białkowska[15], C. Blume[8], B. Boimska[15], M. Botje[1], J. Bracinik[3], P. Bunčić[9], V. Cerny[3], P. Christakoglou[2], O. Chvala[12], P. Dinkelaker[8], J. Dolejsi[12], V. Eckardt[11], H.G. Fischer[9], D. Flierl[8], Z. Fodor[4], P. Foka[6], V. Friese[6], M. Gaździcki[8,10], K. Grebieszkow[1
M. Kliemant[8], S. Kniege[8], V.I. Kolesnikov[7], E. K
M. Kreps[3], M. van Leeuwen[1], B. Lungwitz[8], M.
G.L. Melkumov[7], M. Mitrovski[8], S. Mrówczyńsk
R. Renfordt[8], M. Rybczyński[10], A. Rybicki[5,9],
P. Seyboth[11], F. Siklér[4], E. Skrzypczak[16], G. Ste
J. Sziklai[4], P. Szymanski[9,15], V. Trubnikov[15]
G. Vesztergombi[4], D. Vranić[6], S. Wenig[9,*)], A

(The NA49 Coll



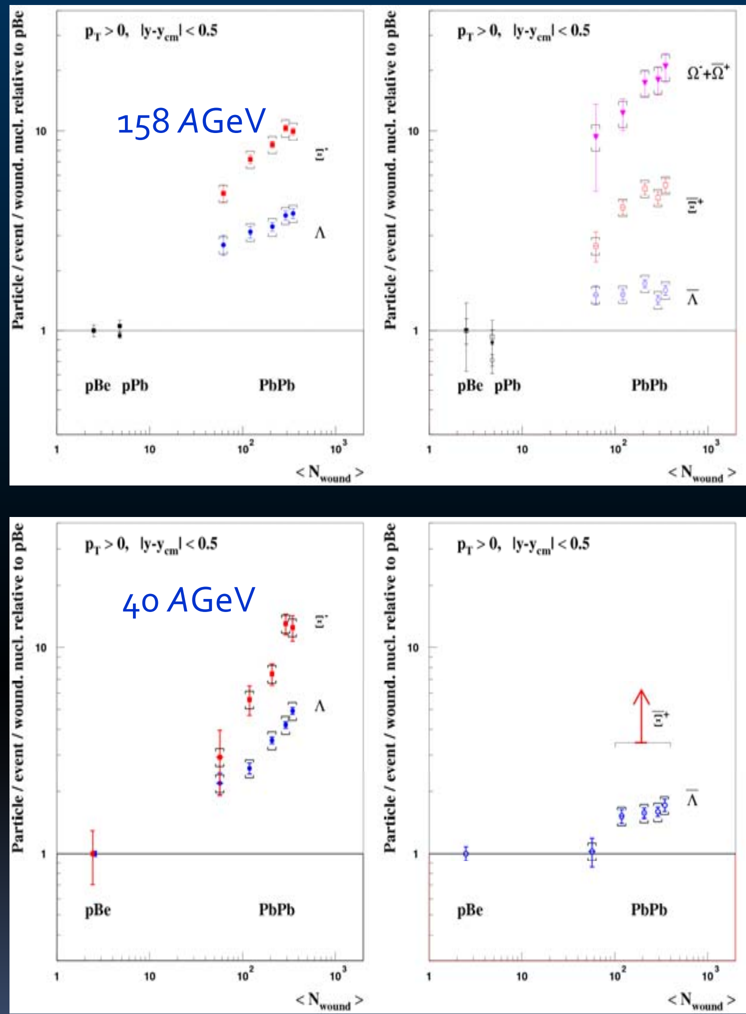
Construction of gap TPC

Excellent student supervising

High quality pion inclusive spectra in pp at 158 GeV

NA57 Experiment at CERN

- Considerable Slovak contribution (~10 physicists from Bratislava and Košice out of ~100 collaboration members)
- Continuation of work done for WA97
  - development of methodical tools
  - DAQ/trigger monitoring software
  - analysis of data and presentation of results
- The NA57 trigger – prototyping of approaches used in ALICE CTP
- Prestigious SAS awards to Na57 team members



Slovakia in ALICE

~25 Slovak physicists and engineers

Comenius University Bratislava,

contribution to the TPC detector (read-out chambers), SPD and to the DCS – the detector control system

Institute of Exp. Physics SAS,
P.J. Šafárik University Košice,

router electronics for the SPD (Silicon Pixel Detector)

contribution to the CTP – the central trigger system

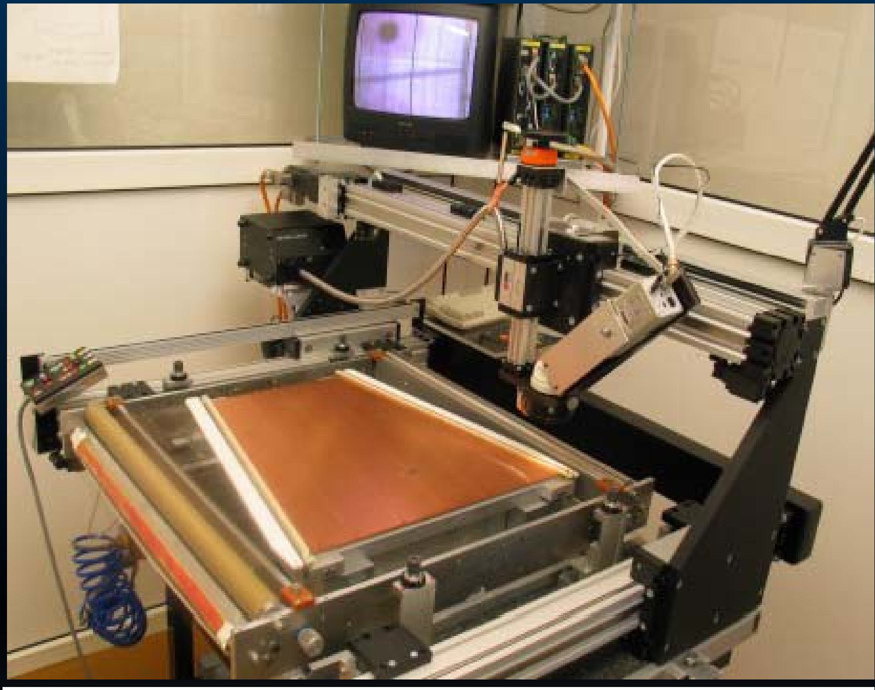
Radiation studies

Installation of Alice TPC

Slovak physicists and engineers contributed to TPC construction and took part in TPC installation at CERN

ALICE TPC IROC Production in Bratislava

Winding machine



Production of IROC
in a high precision Assembly system

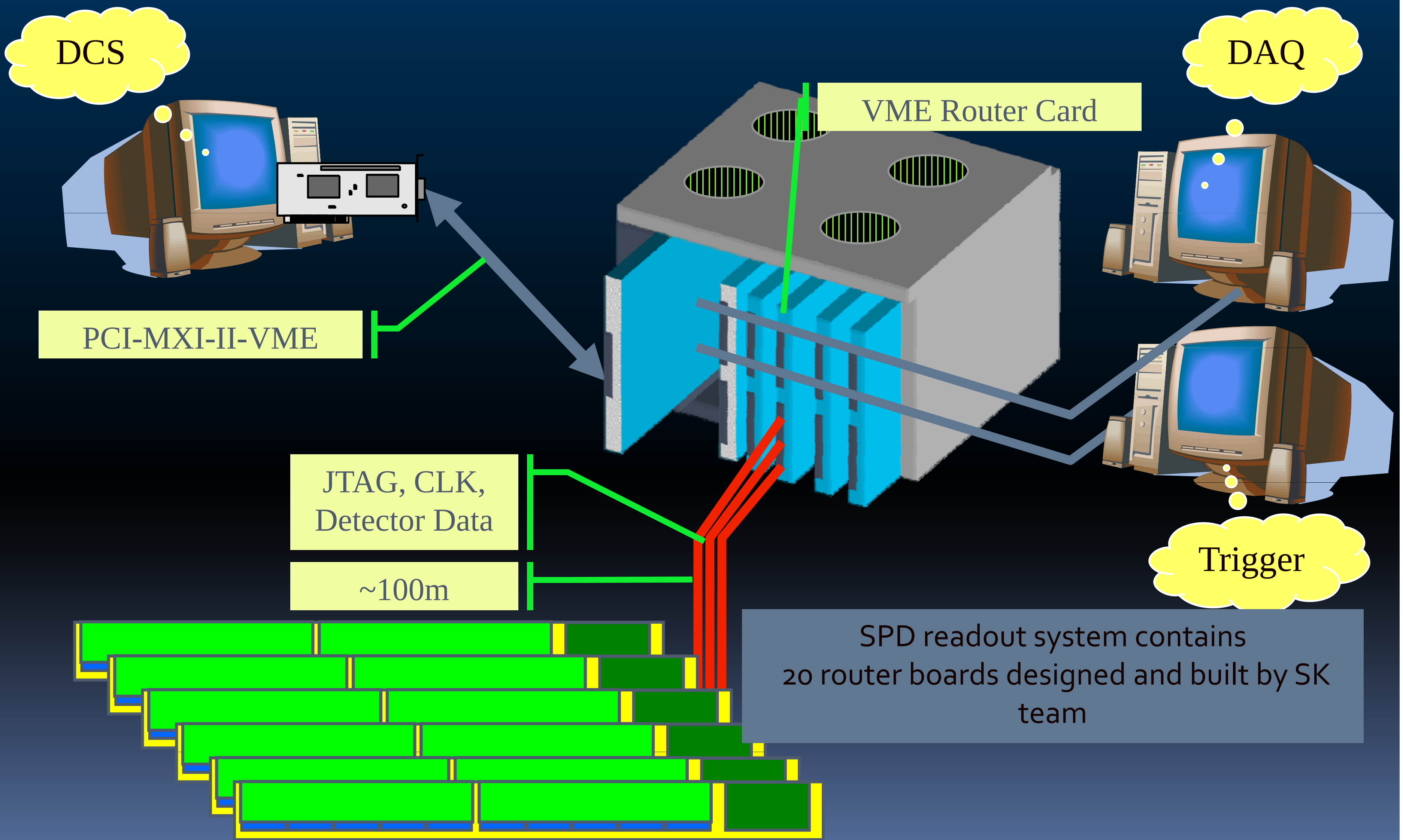
26 Inner Readout Chambers were produced and tested in Bratislava Detector laboratory for Alice TPC

Test bench in Bratislava Detector Lab. for TPC IROC tests.

Contribution to ALICE Detector Control System

- Design and maintenance of central DCS computing facilities
  - Central DCS cluster (~150 nodes)
  - Remote access and security
  - Online Database systems

Silicon Pixel Detector Readout

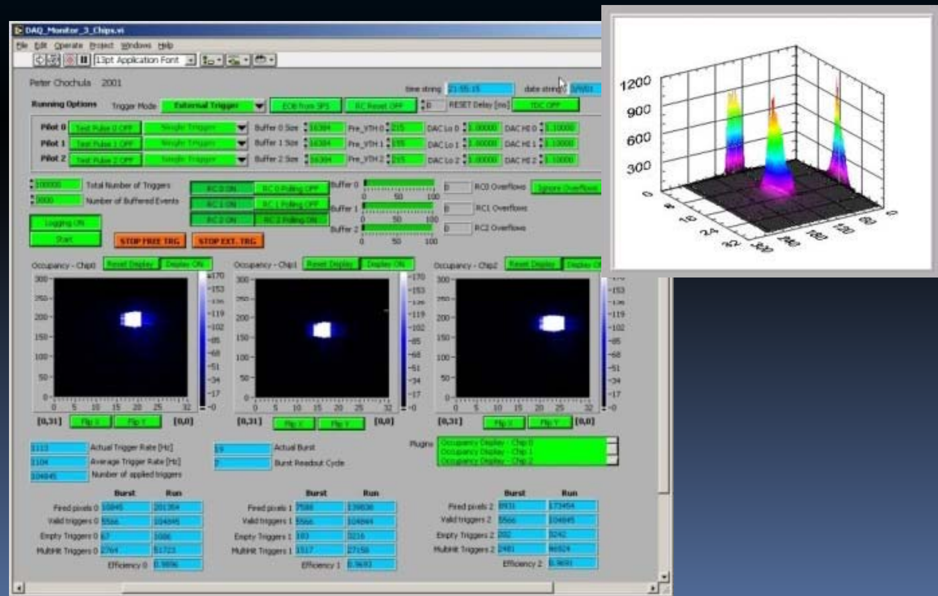


SPD readout system contains
20 router boards designed and built by SK
team

SPD tests and Production

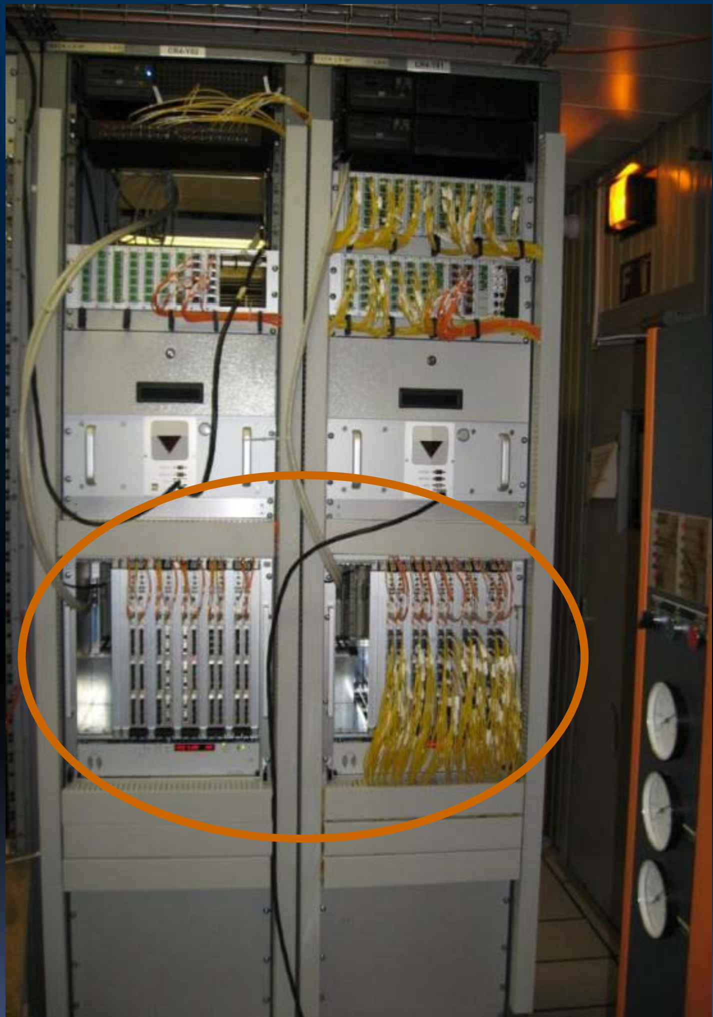
Design and production of JTAG controllers for SPD test setups

Contribution to design of test setups and participation in tests



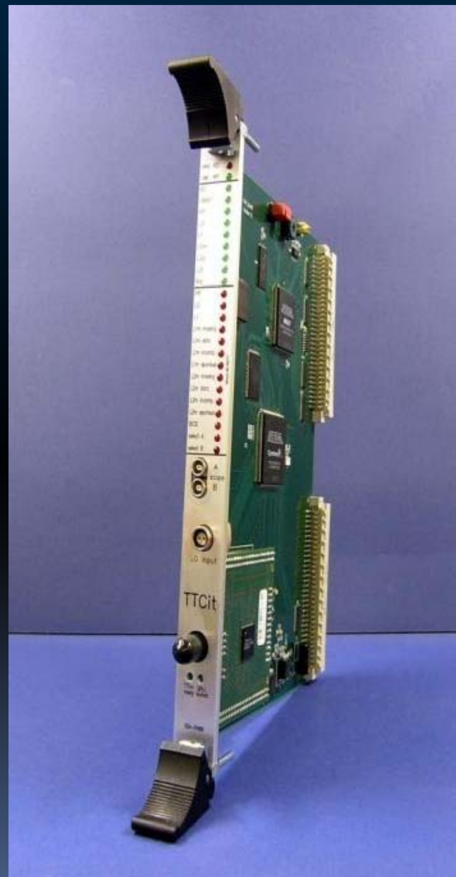
Complex software package for detector tests and commissioning

Electronics for SPD and CTP



SPD Router boards installed at ALICE experimental area

TTCit board for trigger signals monitoring



Radiation simulations for ALICE

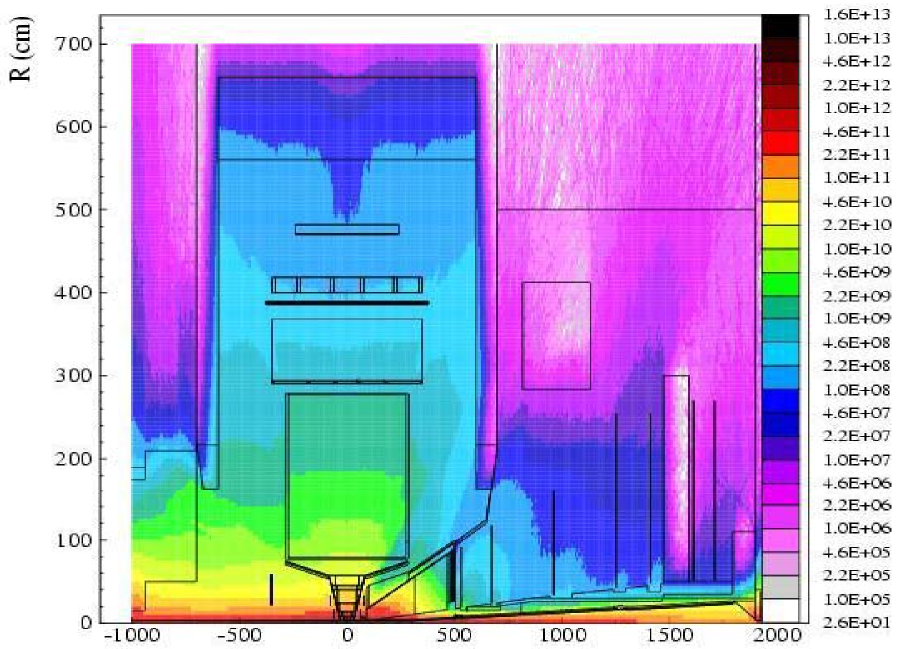
- Large amount of simulations resulting in :

✓ optimization of radiation level in the muon and trigger chambers leading to proposal of an additional shielding

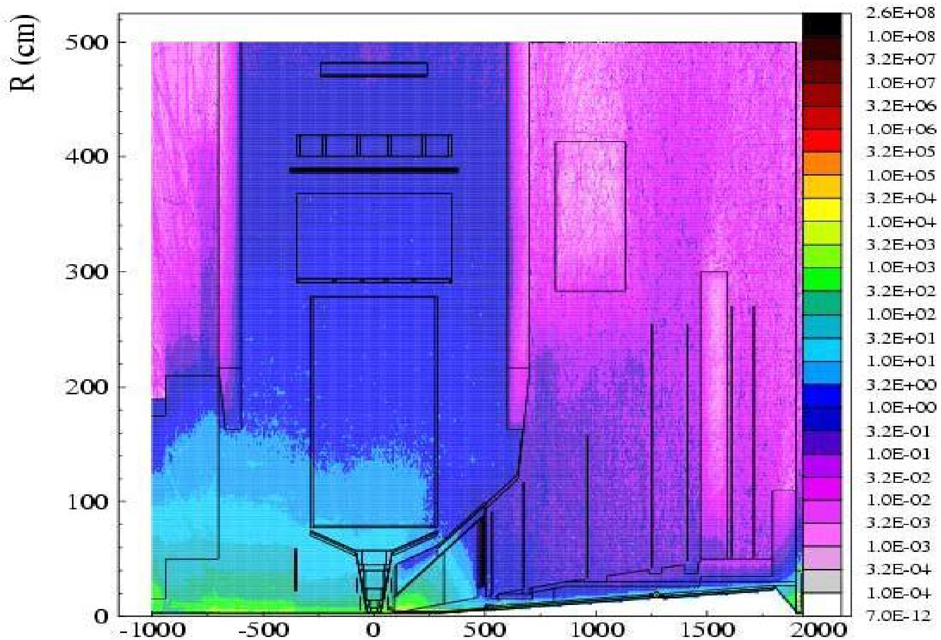
✓ global calculation of radiation level in all subdetectors (including electronics racks) assuming 10 years of ALICE operation

Examples of simulation results :

Charged hadrons fluence map



Dose map (Gy)



Slovakia in ATLAS

~ 11 physicists and engineers

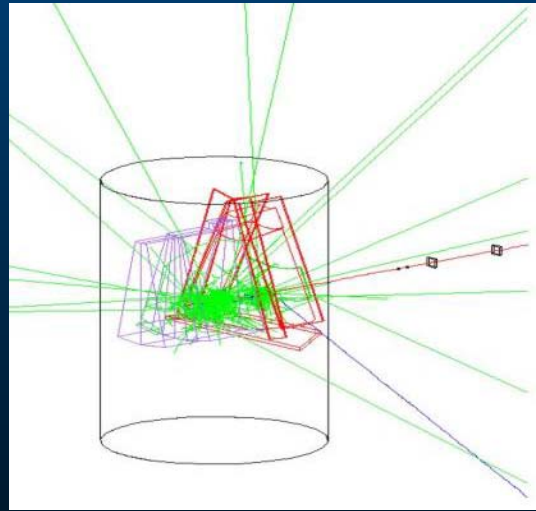
Comenius University Bratislava,
TileCal

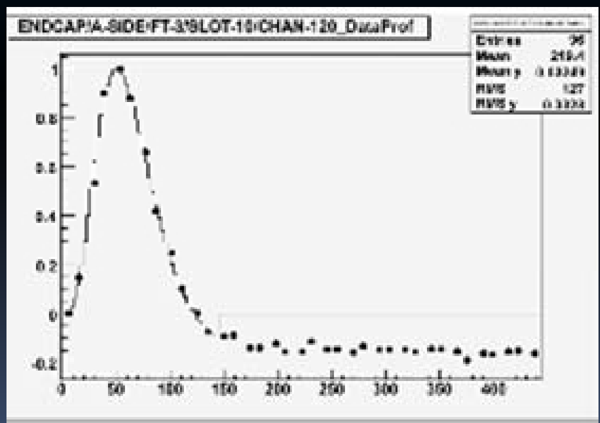
Institute of Exp. Physics SAS,
P.J. Šafárik University Košice,
Liquid Argon Calorimeter

- electronic calibration system for HEC
- Cold test electronics calibration, development of DAQ and analysis software
- responsible for electronics calibration in all endcap beam tests
- MC simulation software development – GEANT4 validation
- T-jets versus QCD jets in calorimetry
- Top quark physics

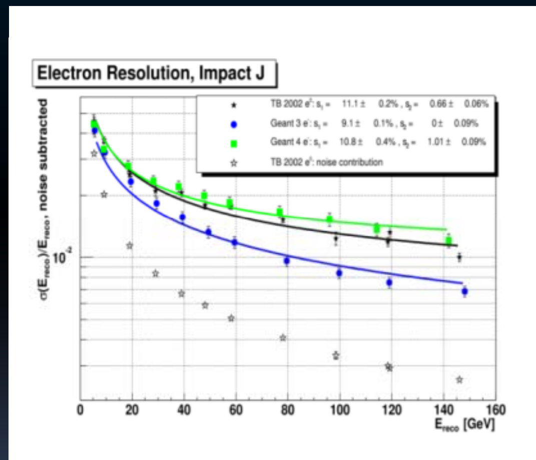
ATLAS Calorimeter Studies

- Detailed MC studies of Atlas hadron calorimetry
- Significant contribution to description of hadronic processes and to data analysis
- Responsible for electronic calibration for end-cap calorimeters
- Close collaboration with MPI Munich





Predicted vs. measured signal shapes

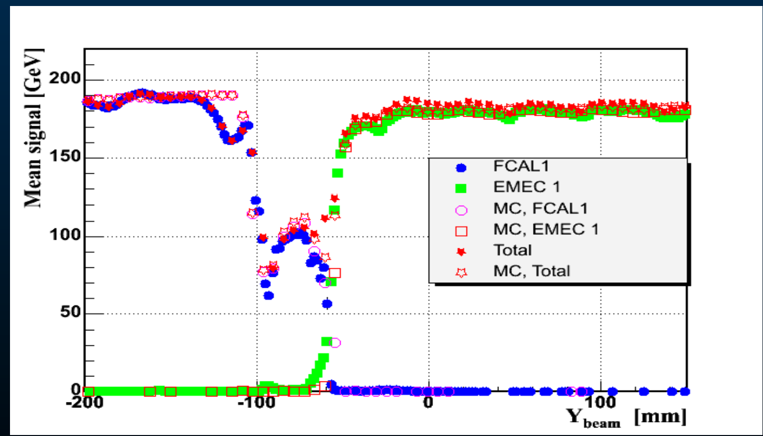


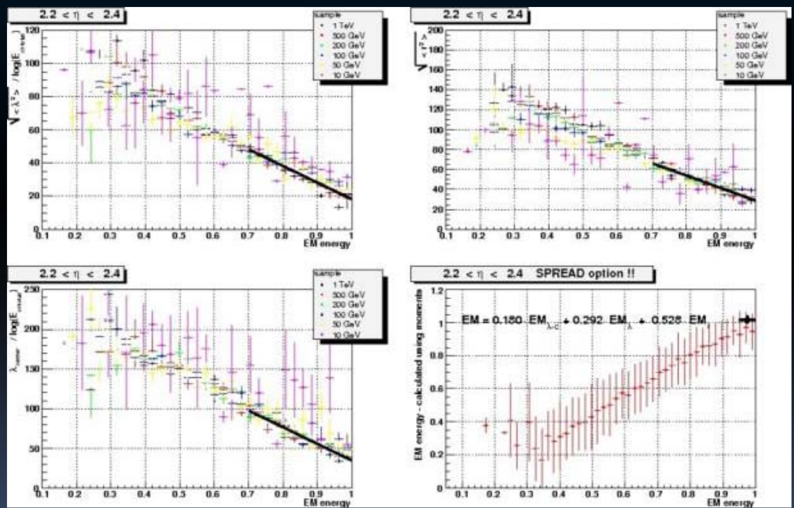
Comparison of simulated (Geant 3.21 and Geant 4) data with test beam results for Liquid Argon End-cap calorimeter

ATLAS Calorimeter Studies

- Close collaboration with GEANT 4 team
- Tests of different simulation strategies
- Comparison of simulated results with testbeam data (beam scans)

G4 validation with test beam data from LHC calorimetry
P. Strizenec for ATLAS and CMS G4 validation groups
Hebden Bridge, England, September 13, 2007



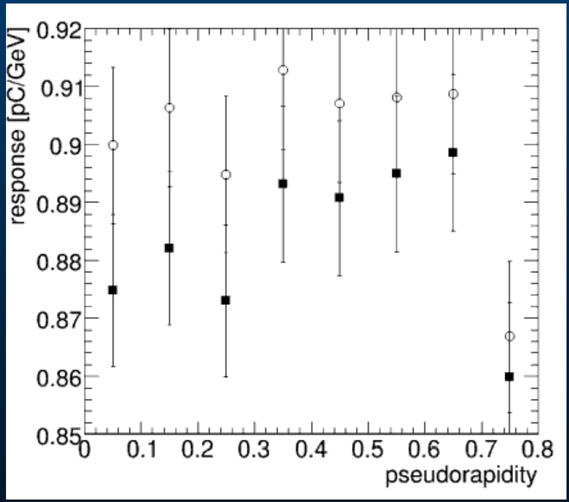


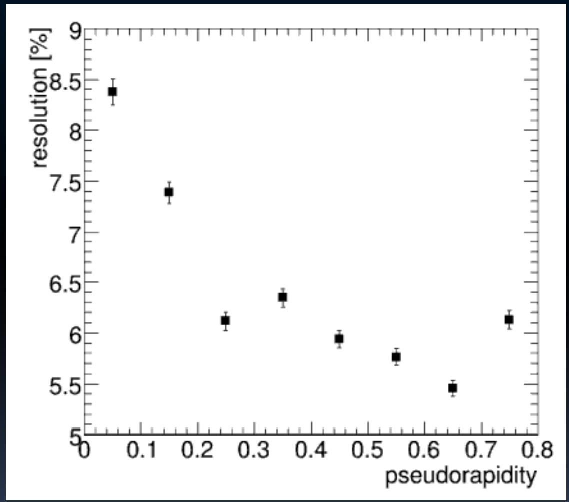
Dependence of cluster (shower) topological moments on the electromagnetic component of energy deposited in particular cluster

- Development of methodology for cluster classification (H1 approach)
- Determination of topological shower moments and calibration constants required for deposited energy reconstruction

ATLAS Calorimeter Studies

- Participation in TileCal tests
- Analysis of data
- Significant contribution to
  - EM scale determination
  - Hadron linearity and resolution
  - Uniformity of EM scale





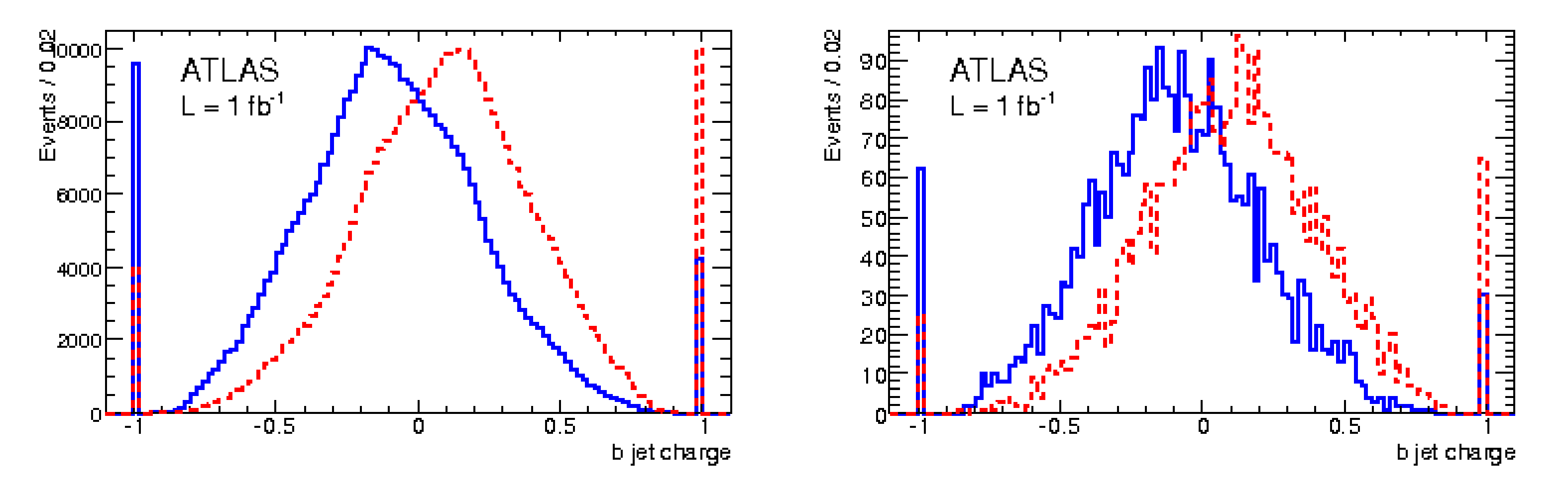
180 GeV π beam: resolution vs. η (bottom) and response vs. η (top) (full squares = raw data, opened circles = longitudinal escape corrected)

Filter boxes with electronics for Atlas calorimeter

70 filter boxes produced for ATLAS

Top quark charge determination via weighting technique

- Analysis of Monte Carlo data has been carried out.
- To find top quark charge, b-jet charge should be reconstructed
- bjet charge determined by charge weighting of b-jet tracks.
- lepton-bjet invariant mass pairing used - enables to distinguish between b-jet charges associated with l^+ and l^- (coming from t and *anti*-t).



b and *anti*-***b*** charge distribution, comparison of MC truth (left) and invariant mass pairing (right).

Technology and Industrial Transfer

IT-2952/EST/LHC - **PRECISION TRANSFER EQUIPMENT SETS**
Winner : VVU ZTS Košice, Slovakia
IT – 3200 /TS / LHC -Motor units
Winner : VVU ZTS Košice, Slovakia
CERN/FC/4865 Supply Burndy conectors
Winner : **Elektrické systémy Trnava,** Slovakia
IT - 4645 Supply and assembly of the LHC short straight section cryostat
Winner: SES Tlmače, Slovakia

ZŤS Košice

SES Tlmače

Elektrické Systémy Trnava

Period	Return coefficient
2001-2004	1.39
2002-2005	1.98
2003-2006	2.44
2004-2007	2.53

Slovakia has been remarkably successful in TT in past years

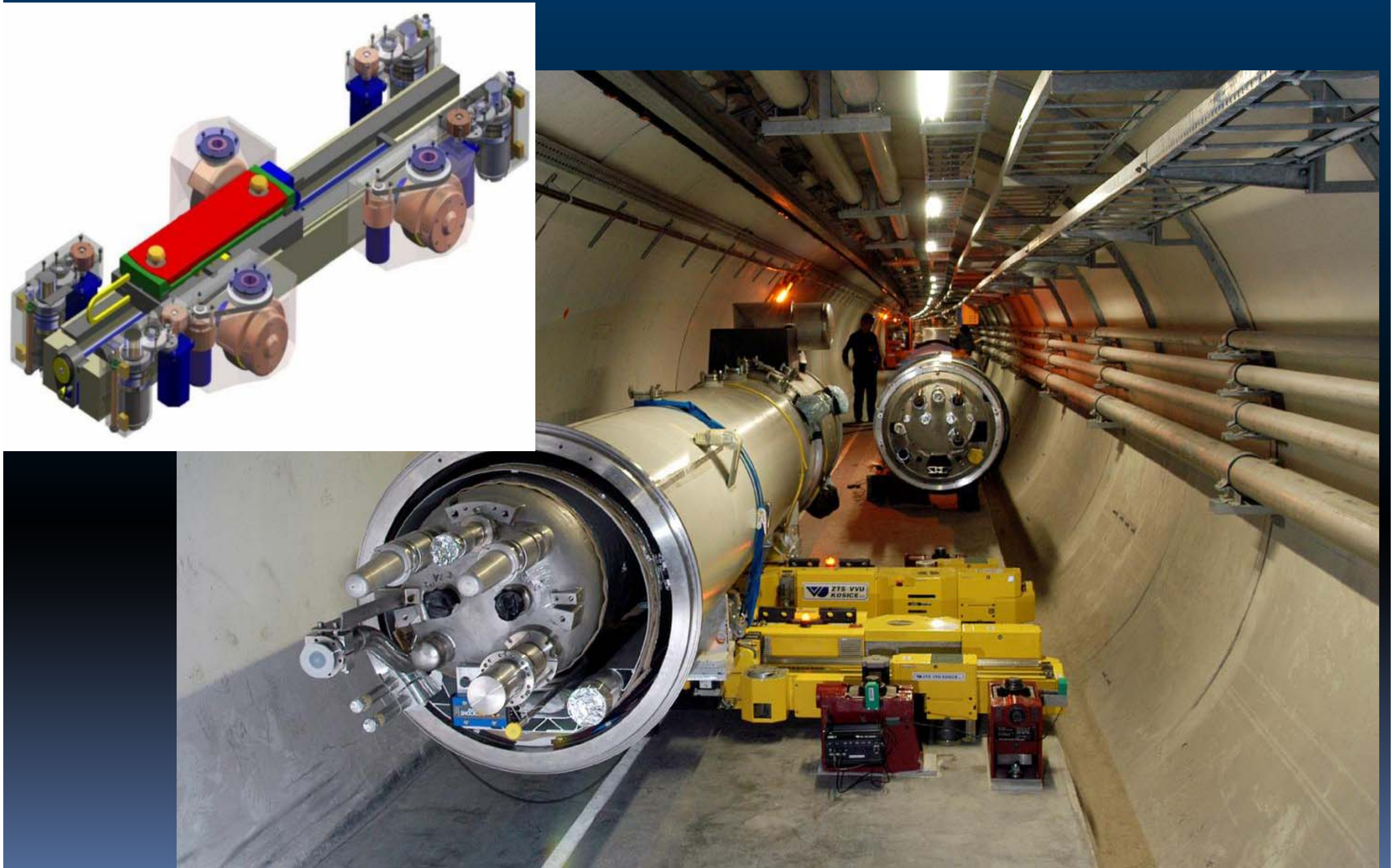
High Precision Equipment Transfer Sets and LHC Cryostat from Slovakia

Robots carry LHC magnets and align them with magnet support jacks

Positioning precision

Lateral (x)	± 0,1 mm
Longitudinal (y)	± 0,1 mm
Vertical (z)	± 0,1mm
Rotation about x	± 0.01 deg
Rotation about y	± 0.22 deg
Rotation about z	± 0.01 deg

Weigh of cryostat 36 000 kg !

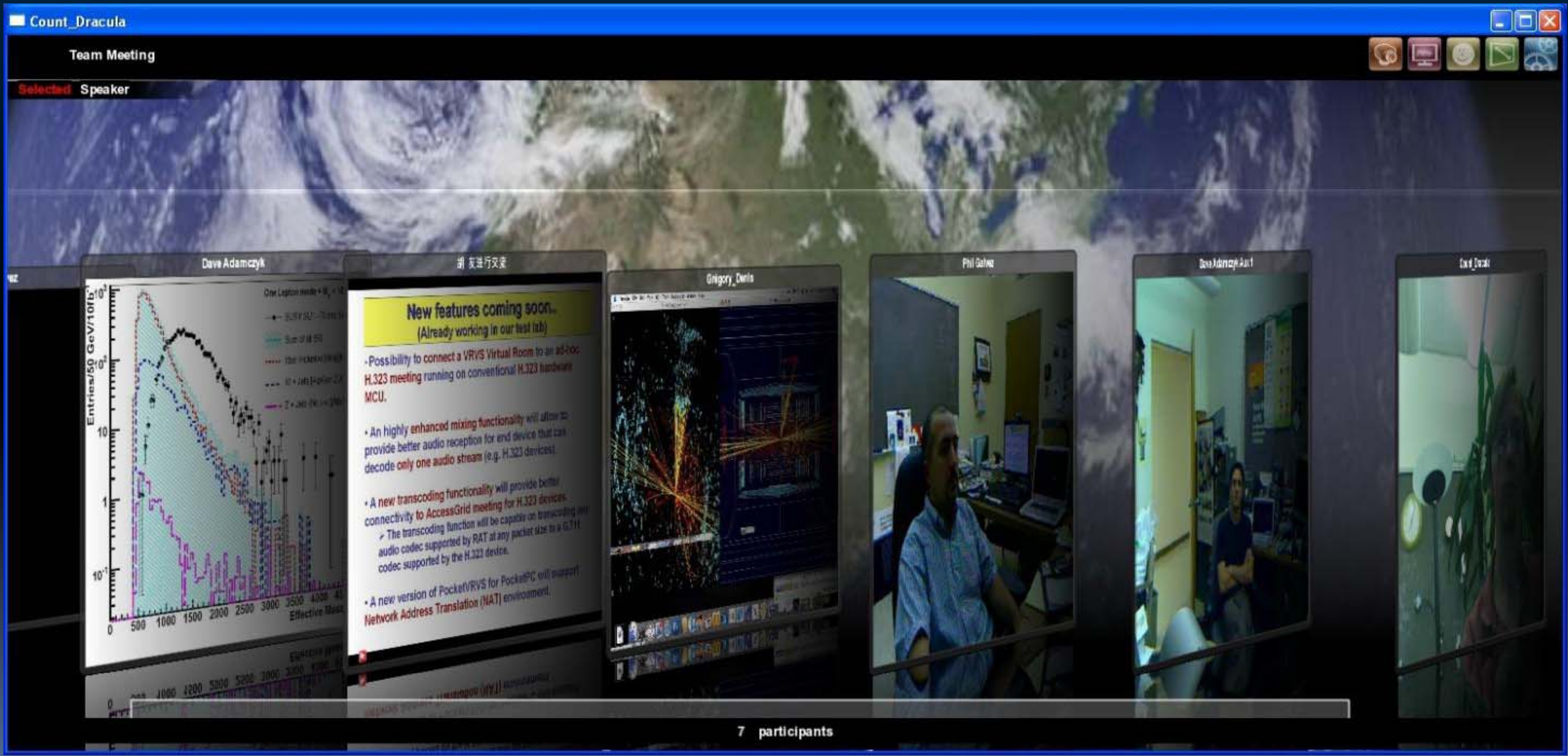


Golden Hadron award, 07.12.2005

L. Vargovčík, representative of the VVÚ ZŤS Košice company

ViEVO Application

- Contribution to EVO developments (video codecs)
- Widely used in Slovakia



EVO: Slovakia usage

SANET

662 Registered Users

1300 Meetings with Slovakian Users

490 Meetings with 3500 Connections

1 Telephone Gateway +421 55 234 2420

International Particle Physics Masterclasses in Slovakia

High school students become particle physicists for one day at 70 universities in 20 countries

Lectures on Standard Model 9:00-12:00

LEP Data evaluation 14:00 - 16:00

International videoconf. 16:30 - 18:00

Slovakia Masterclasses 2008

7 universities visited by 295 students and 21 teachers from 44 high schools

Slovak-Caltech EVO team supported all MC videoconferences worldwide

Global evaluation of International MC 2006/2007 done in Slovakia

Computing for HEP

- 2 LCG farms in Bratislava and Košice
  - Providing resources for ATLAS and ALICE
  - 280 CPUs
  - 90TB of available storage

  - Košice farm included in LHC data processing (ATLAS + ALICE)
  - Bratislava farm being comissioned

Additional capacity available for non-CERN activities and for students

Sub-project coordinator Mr. Babik received prestigious award (Young Scientist of the year) from the President of Slovakia

Financing the HEP activities in Slovakia

- HEP financing covered by grant schemas
- Additional funds for CERN activities, continuous support assured
- New funding for students, PhD. Students and young postdocs as from 2009 (deadline for submission of applications is Today)
  - Received funds for 15 young physicist to be sent to CERN
  - (6 months/year during a period of 3 years)
- Approved funding for FAIR membership, acceptance procedure launched