

Hungarian Activities in the CERN LHC ALICE and CMS Experiments

and more...

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OUTLINE

- CERN, LHC, Hungary
 - The LHC facility, and the RMKI's Budapest GRID
- NA49/NA61 Shine
 - Forward/backward TPC development
- Activity in CMS Experiment
 - Analysis of proton-proton, and heavy ion data
- Activity in ALICE Experiment
 - Hungarian contribution to the TPC's field cage
 - Developments on DAQ system
 - Detector development for ALICE upgrade

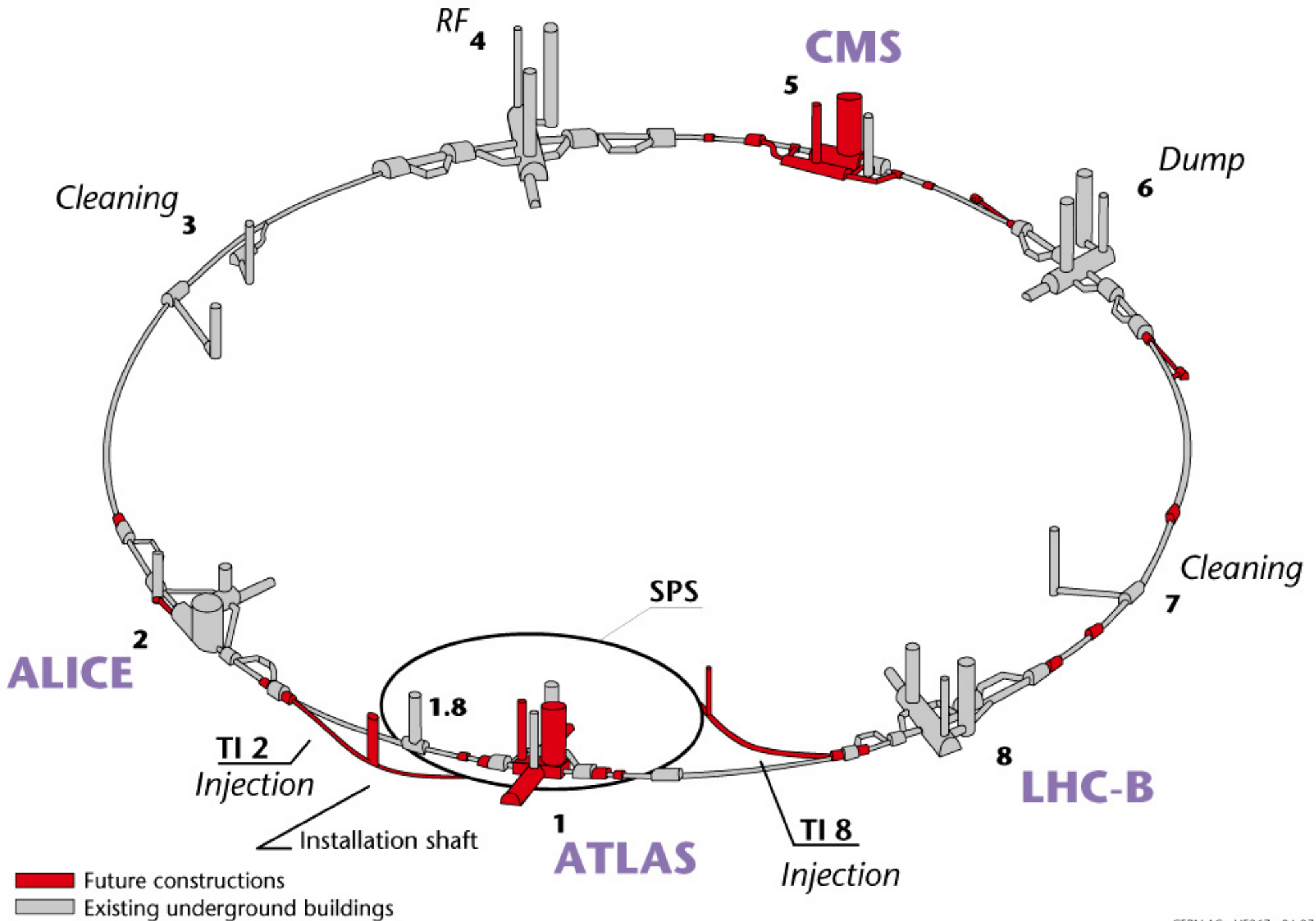
The Twenty Member States of CERN



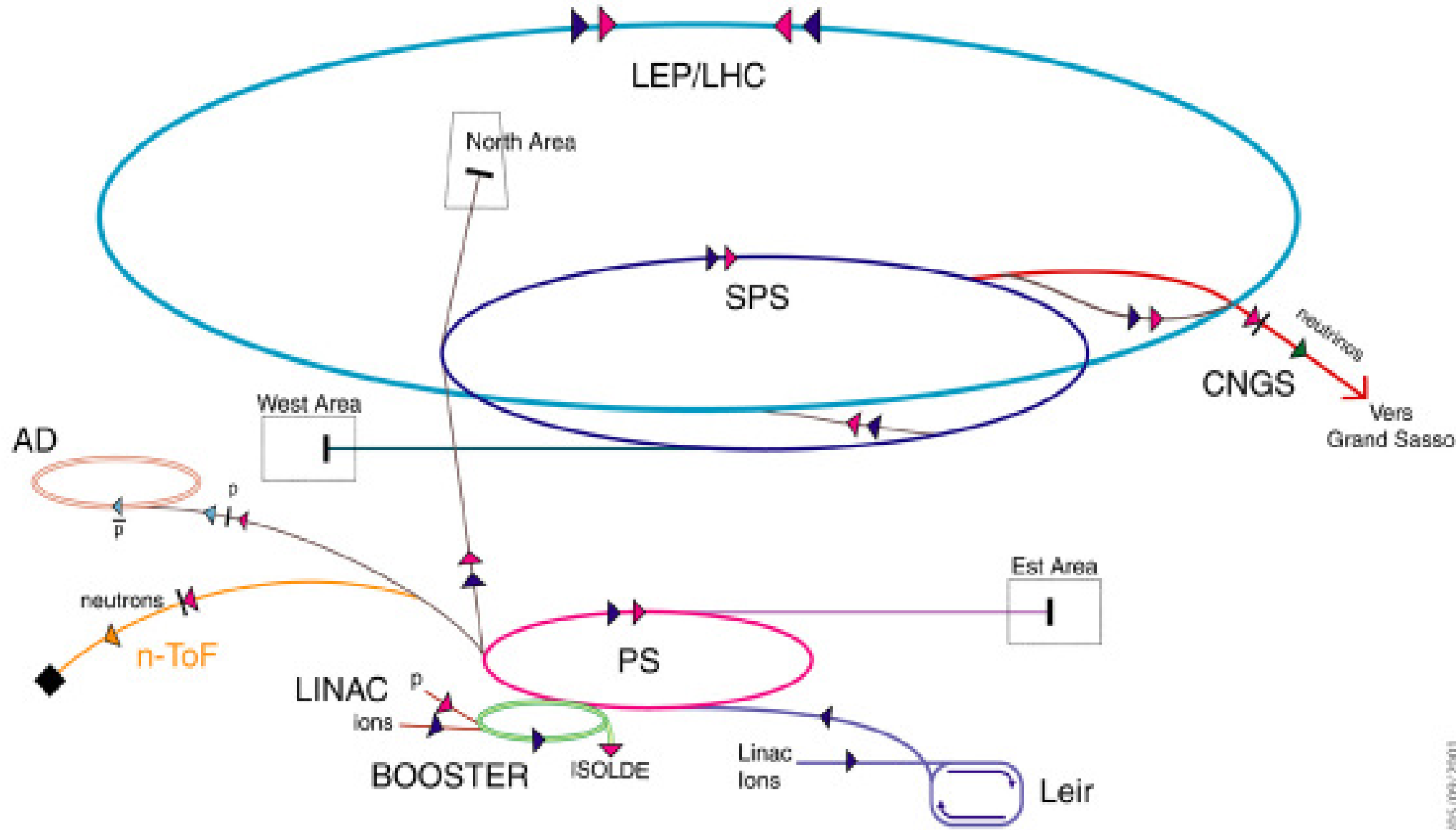
Member States (Dates of Accession)

 AUSTRIA (1959)	 DENMARK (1953)	 GREECE (1953)	 NORWAY (1953)	 SPAIN (1/1961-12/1968-1/1983)
 BELGIUM (1953)	 FINLAND (1991)	 HUNGARY (1992)	 POLAND (1991)	 SWEDEN (1953)
 BULGARIA (1999)	 FRANCE (1953)	 ITALY (1953)	 PORTUGAL (1986)	 SWITZERLAND (1953)
 CZECH FR (1993)	 GERMANY (1953)	 NETHERLANDS (1953)	 SLOVAK FR (1993)	 UNITED KINGDOM (1953)

The LHC Tunnel System

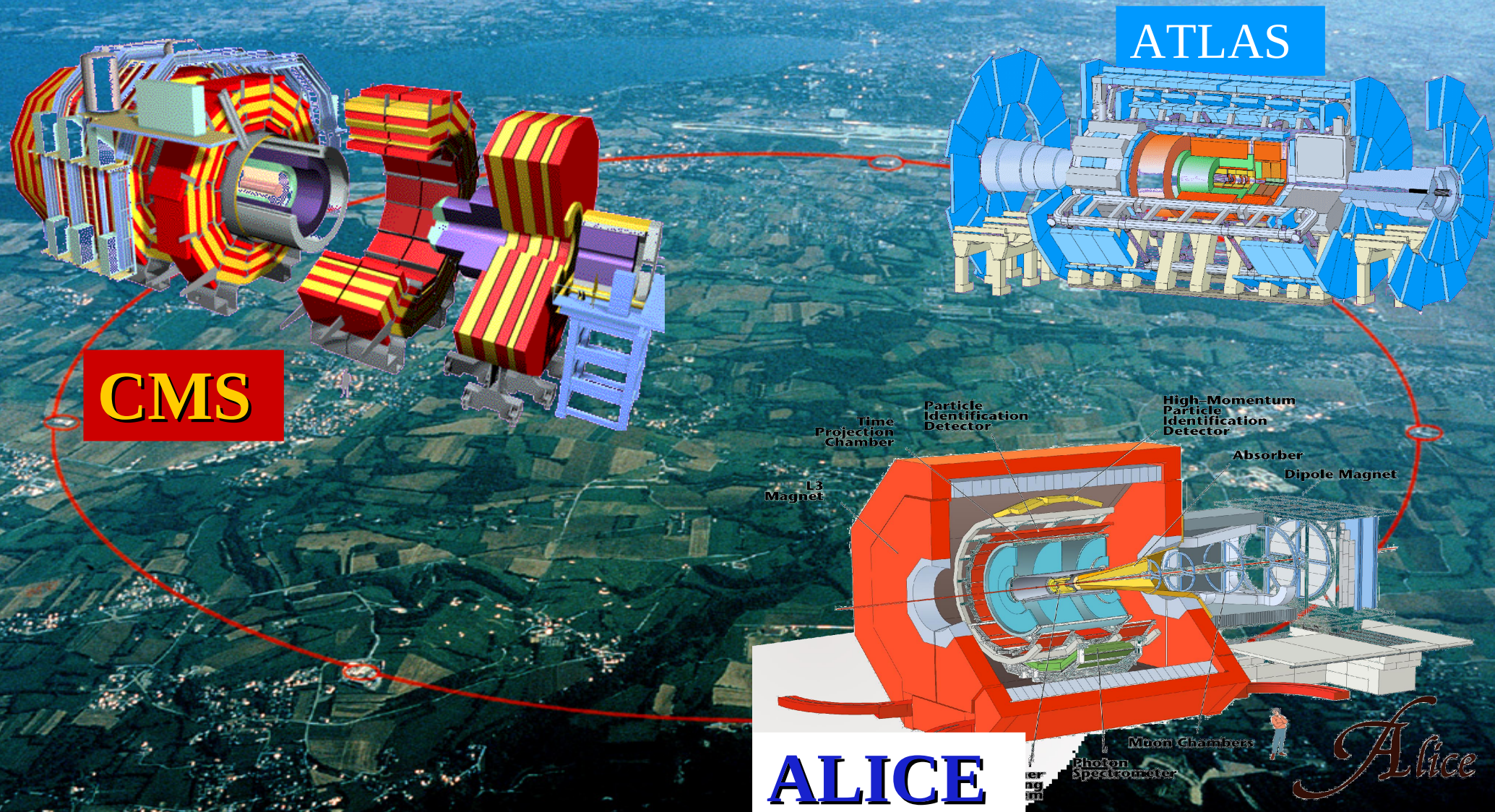


Accelerator chain of CERN (operating or approved projects)



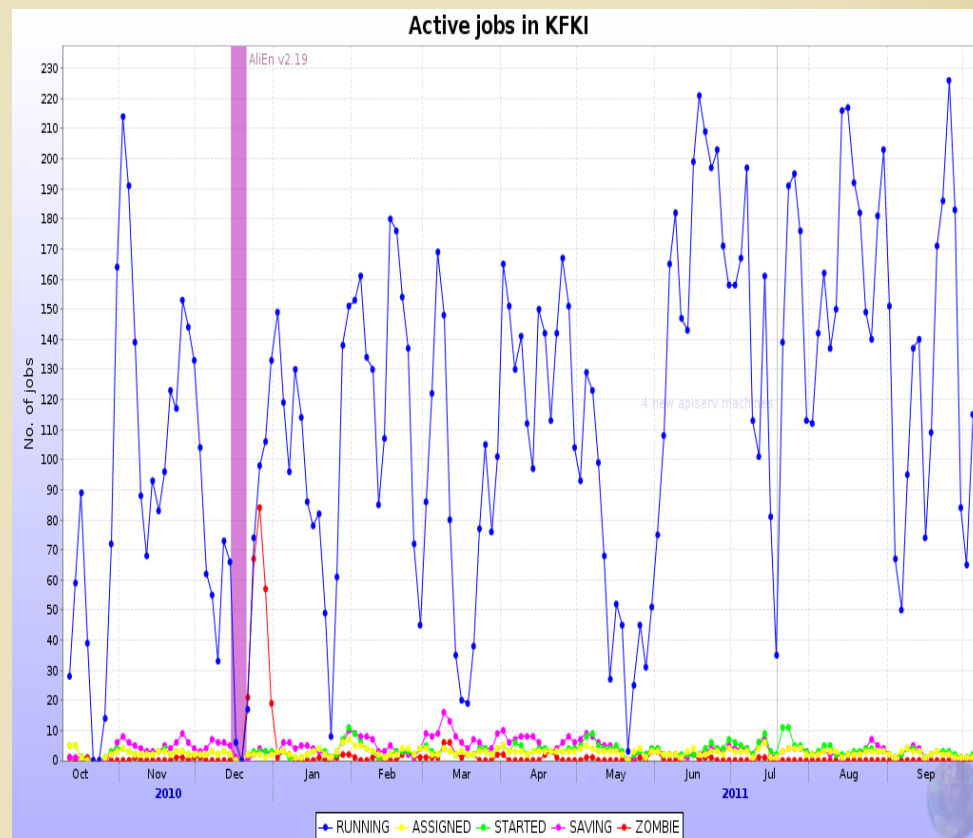
- p (proton)
- ion
- neutrons
- \bar{p} (antiproton)
- proton/antiproton conversion
- neutrinos
- AD Antiproton Decelerator
- PS Proton Synchrotron
- SPS Super Proton Synchrotron
- LHC Large Hadron Collider
- n-ToF Neutrons Time of Flight
- CNGS CERN Neutrinos Grand Sasso

Large Hadron Collider - LHC



The RMKI WLCG (GRID)

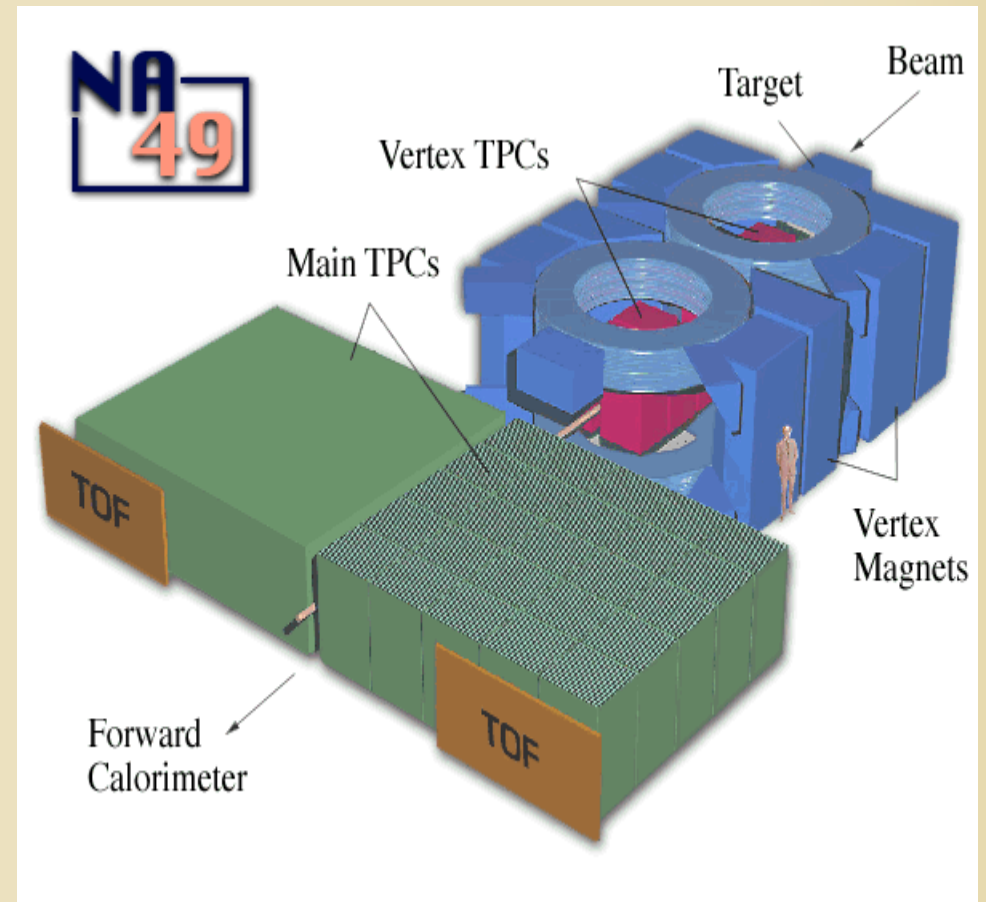
- Budapest Tier-2 site
- Working since 2003
- WLCG: Worldwide LHC Computing Grid
- 500 CPU (shared CMS:ALICE = 2:1)
- 350 TB data storage
- Additional development cluster for ALICE
- 2-5 technicians



Hungarian Contribution
to the
CERN SPS NA49/NA61 Shine Experiment

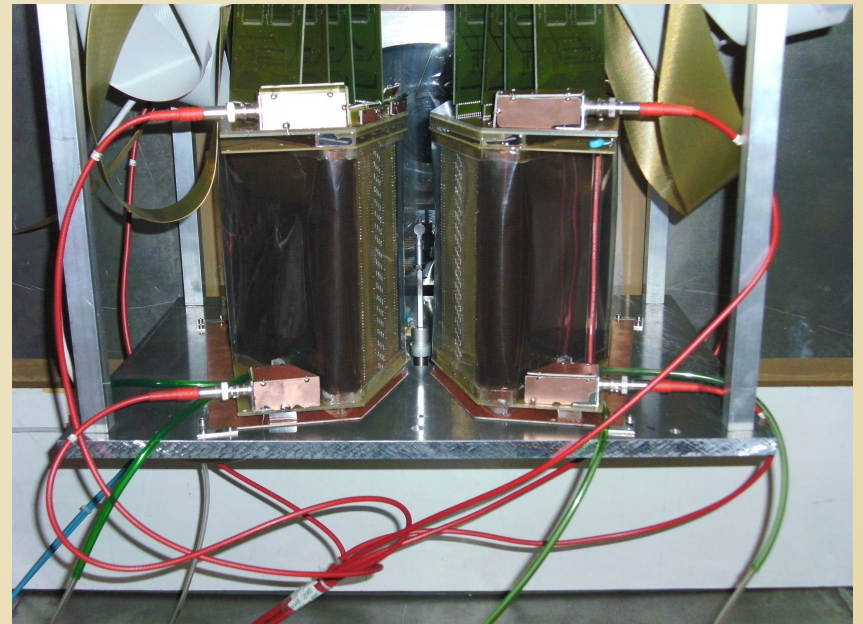
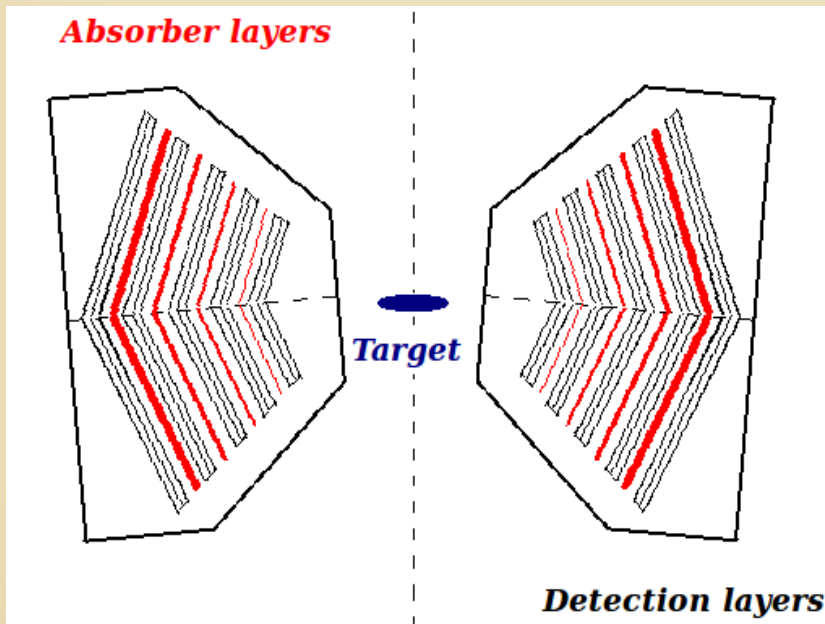
The NA49 Experiment

- The first heavy-ion experiment Hungary joined.
- 5-10 physicists
- Large acceptance hadron spectrometer.
- Several pp, pA and PbPb collision measurements a less than 20 GeV c.m. energy range.



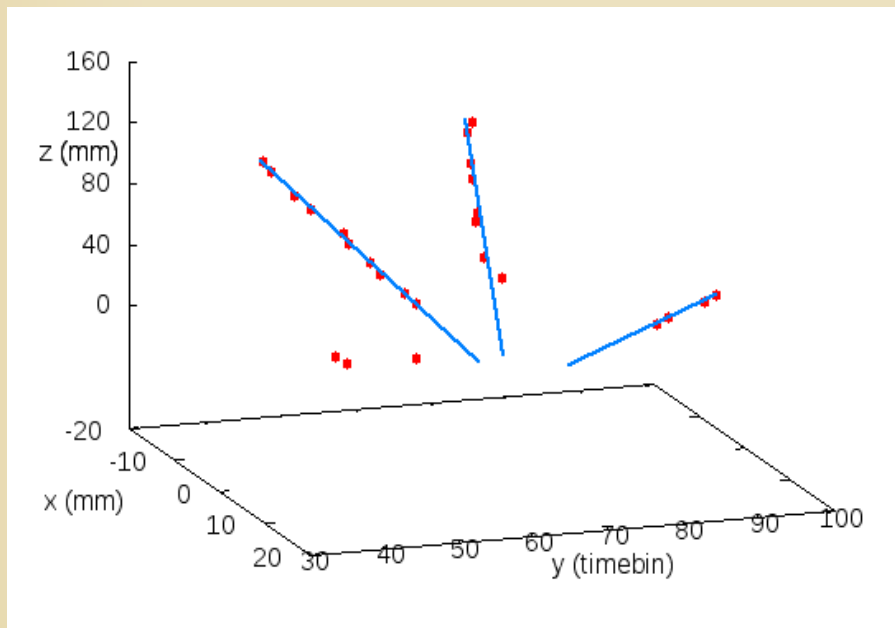
Low Momentum Particle Detector for CERN NA61 in pA Collisions

- Transition from nuclear to particle physics
- Combined range and ionization measurement
- Detector around the NA61 target: protons and nuclear fragments

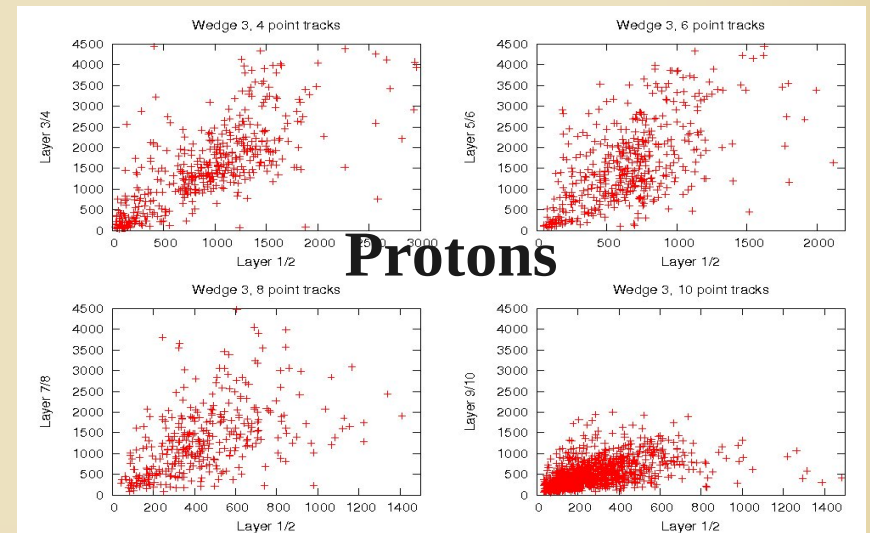


Low Momentum Particle Detector for CERN NA61 in pA Collisions

- Small time projection chamber measures tracks in up to 10 points
- $p = 0.15 - 0.35 \text{ GeV}$
- **PID:** protons and pions separated by ionization at given range
- **Momentum measured**



Ionization in second layer



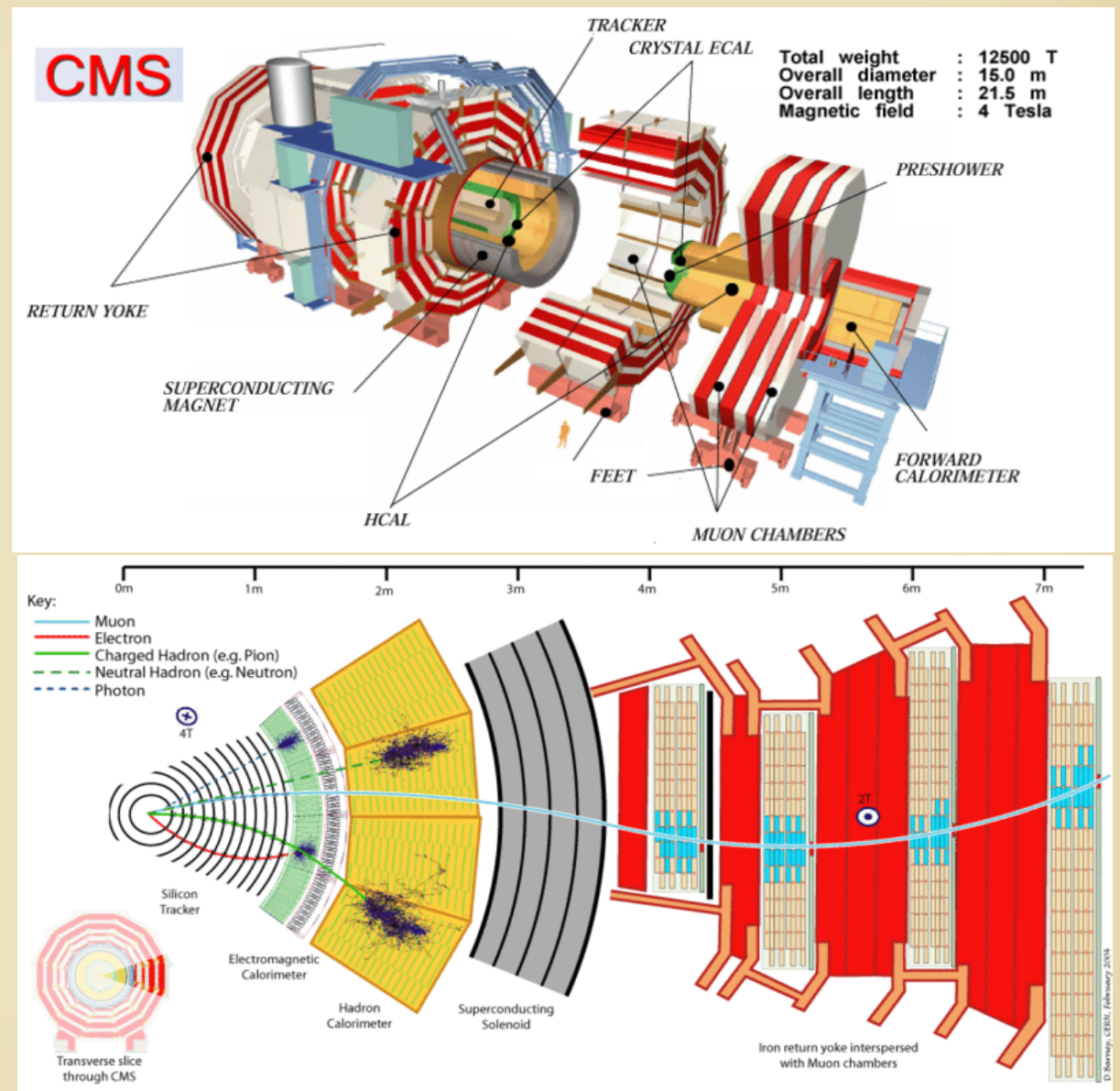
Ionization in first layer



Hungarian Contribution to the CERN LHC CMS Experiment

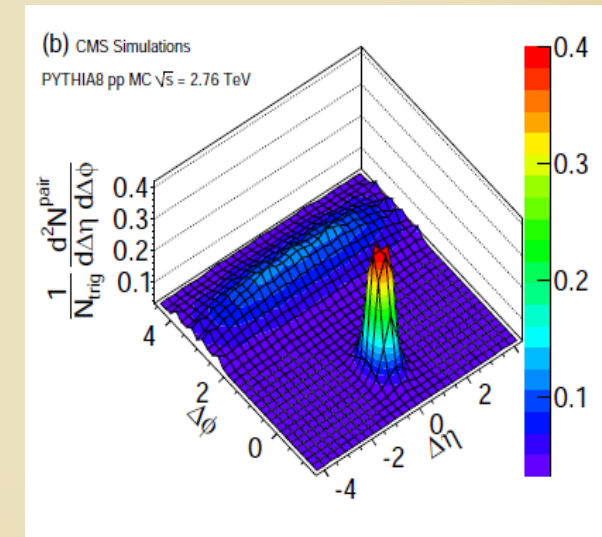
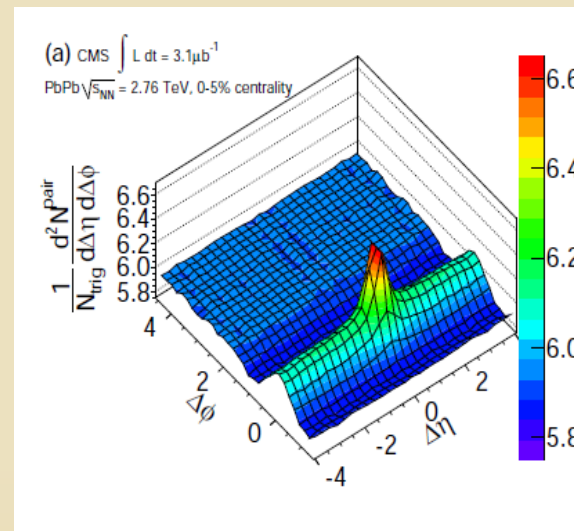
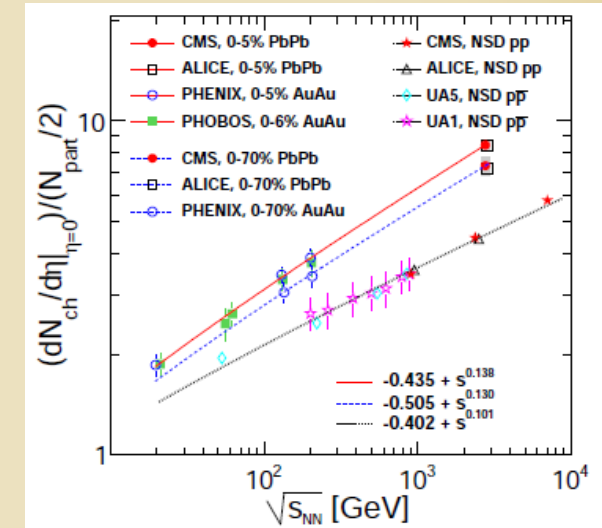
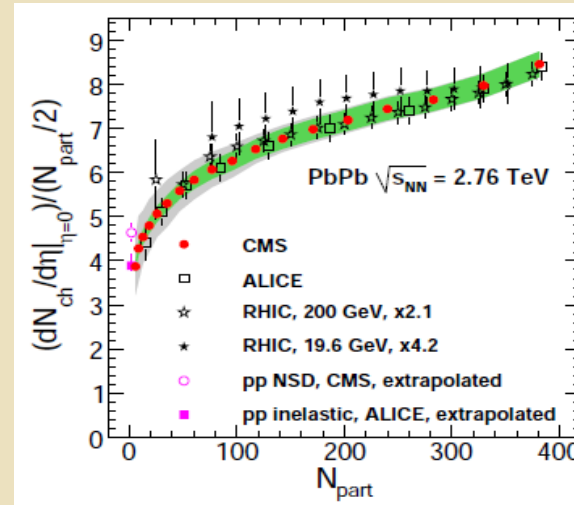
Compact Muon Solenoid – CMS

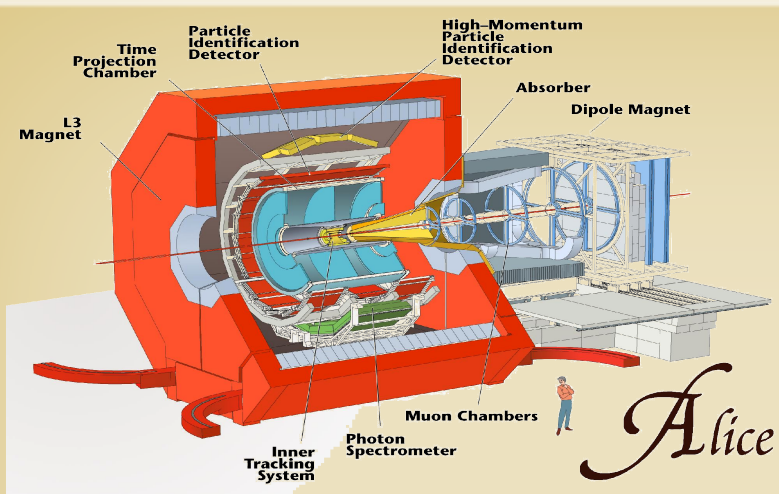
- Detector construction
- Trigger coordination
- Data analysis in pp collisions
- Data analysis in PbPb collisions
- Heavy-ion group
- QCD group
- 5-10 physicists
- 2-3 at CERN



Physics with the CMS

- $dN/d\eta$ vs. N_{part}
- $dN/d\eta$ vs. c.m. energy
- Ridge physics analysis
- R_{AA} , the Nuclear Modification Factor
- Jet analysis





Hungarian Contribution to the CERN LHC ALICE Experiment

Solenoid magnet 0.5 T

Cosmic radiation trigger



„Forward” detectors

- PMD
- FMD, T0, V0, ZDC

Specialized detectors

- HMPID
- PHOS

Central tracking system

- ITS
- TPC
- TRD
- TOF

MUON Spektrometer

- 1• L3 MAGNET
- 2• HMPID
- 3• TOF
- 4• DIPOLE MAGNET
- 5• MUON FILTER
- 6• TRACKING CHAMBERS
- 6'• TRIGGER CHAMBERS
- 7• ABSORBER
- 8• TPC
- 9• PHOS
- 10• ITS

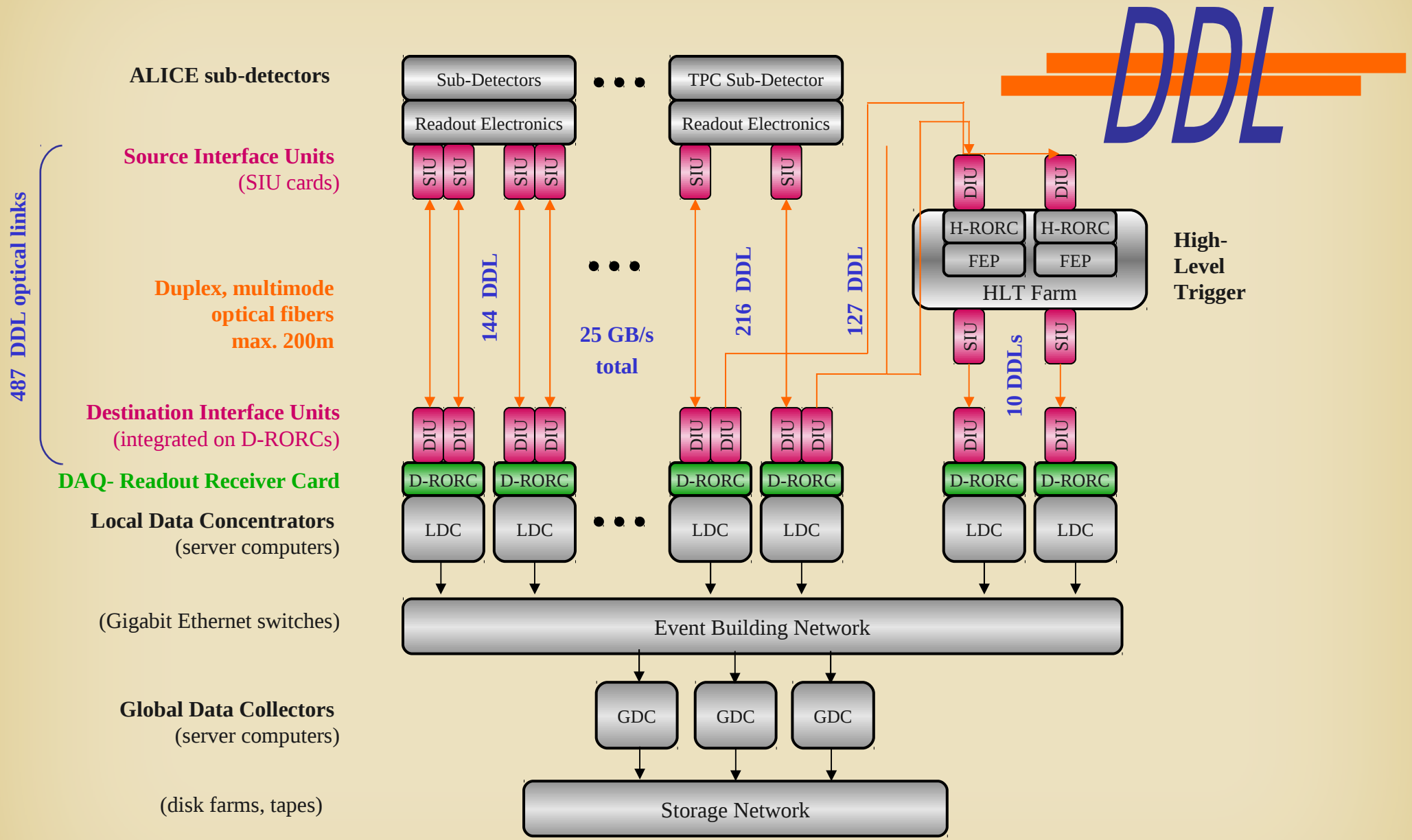


Detector Development and Tests

- Early participation: in ALICE TPC construction.
- ALICE TPC field cage were developed.
- L3 solenoid magnetic field measurement.
- Full member since 2005
- 15-20 physicsics + students are involved
- 2-3 at the CERN

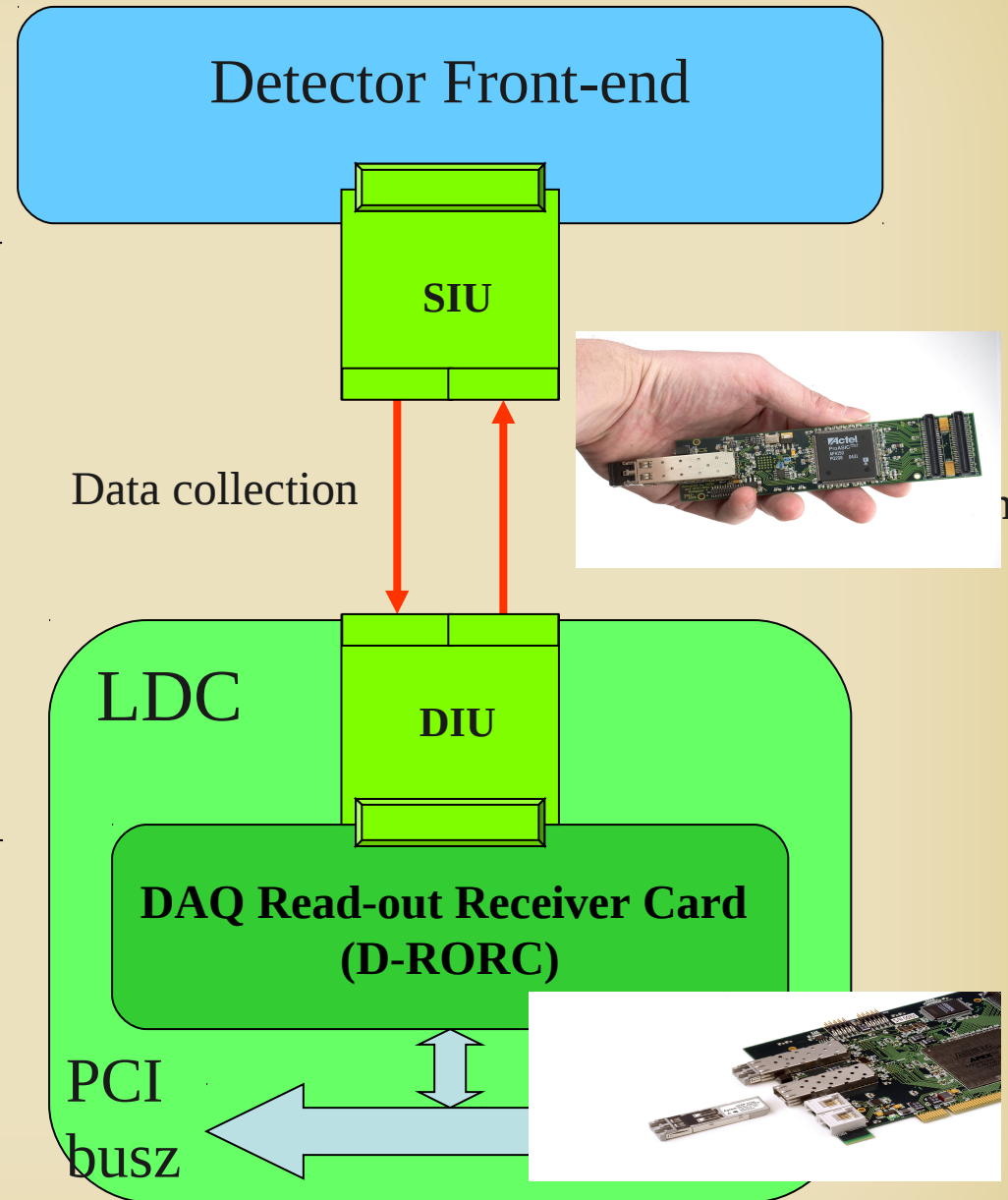
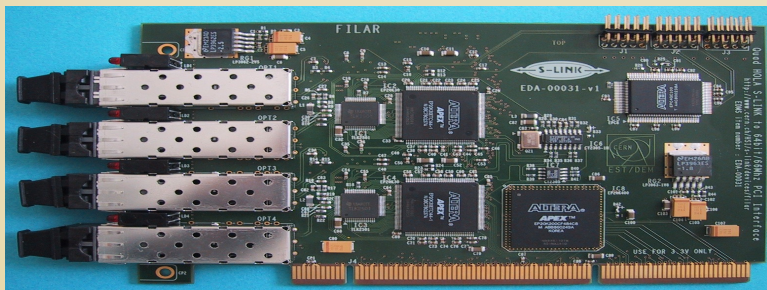


DAQ system for ALICE and more



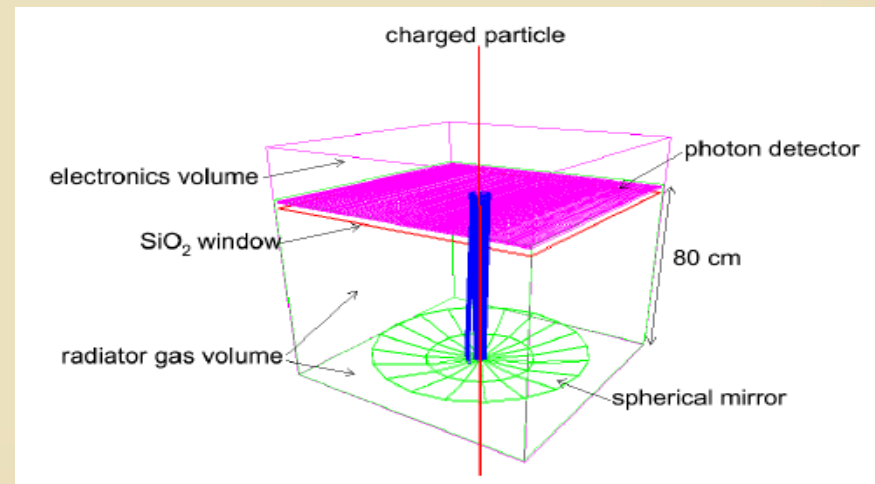
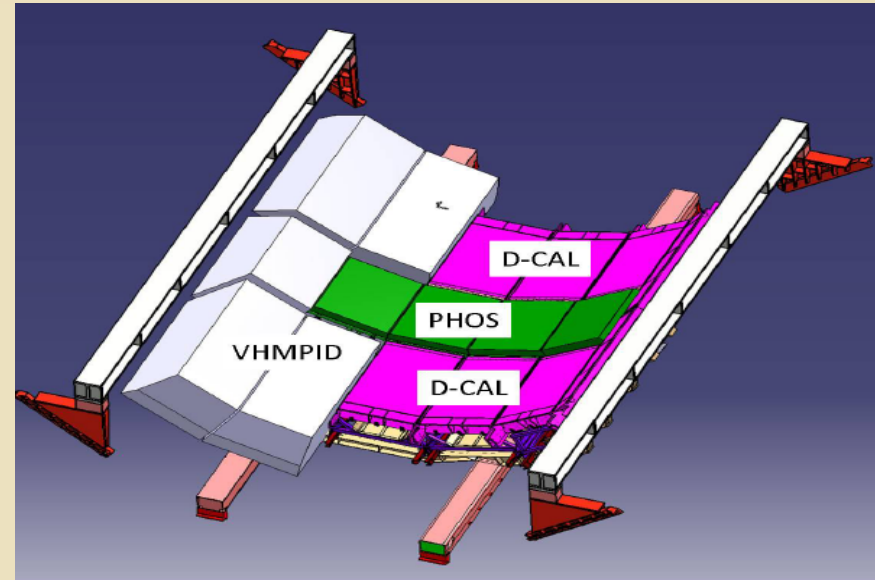
DAQ system for ALICE and more

- DDL:
 - RMKI and CERNTech
 - 2.5 GB/s optical link
 - 200m distance
 - radiation tolerance
- S-Link
 - High-speed optical link



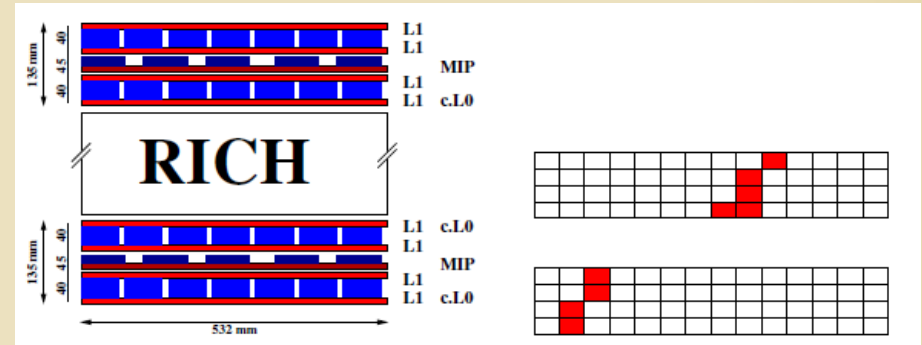
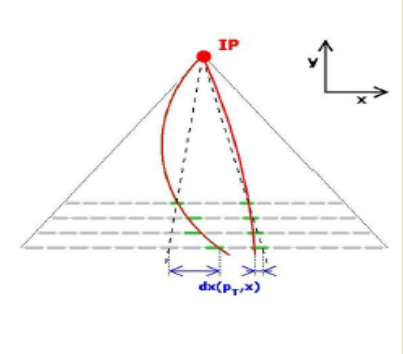
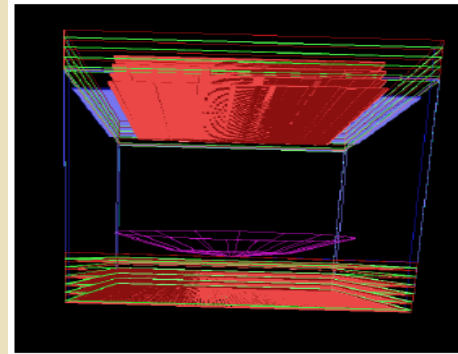
Detector Development for ALICE upgrade

- VHMPID a Very High Momentum PID
- Pion, kaon, proton detection
- Sensitivity within the $5 \text{ GeV}/c < p < 25 \text{ GeV}/c$ momentum region
- RICH module + trigger
- Lol is at the IRC



Detector Development and Tests

- HTPD and MIP detection
- Detector R&D by the REGARD group (tomorrow's lab visit)
- Based on the Close Chatod Chamber (CCC) technology
- Production at RMKI
- Beam tests at CERN



S U M M A R Y

- Hungarian high energy physics is strongly connected to the CERN SPS and LHC experiments
 - Detector development, and simulations
 - Data analysis
 - GRID computing
 - Theoretical works (See: T.S. Biró's talk)
- Participations in Collaborations
 - About 30-40 member (including students)
 - NA49/NA61 shine, CMS, ALICE
 - See more TOTEM by M. Csanád, and D. Horváth

The Main Users of DDL and S-Link

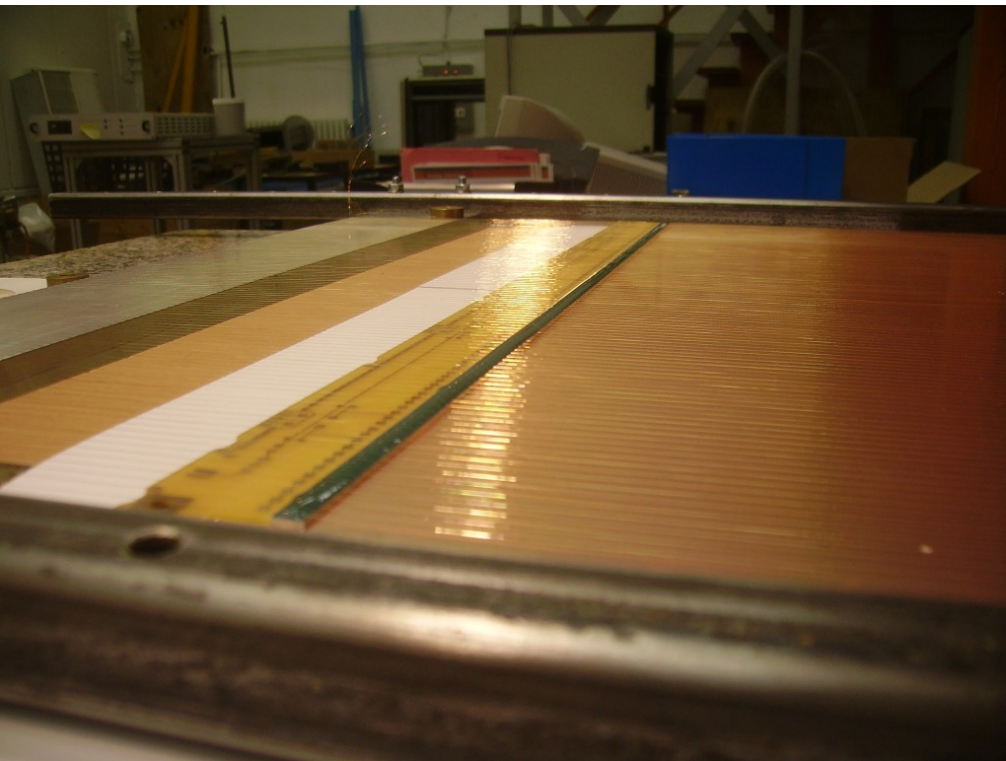
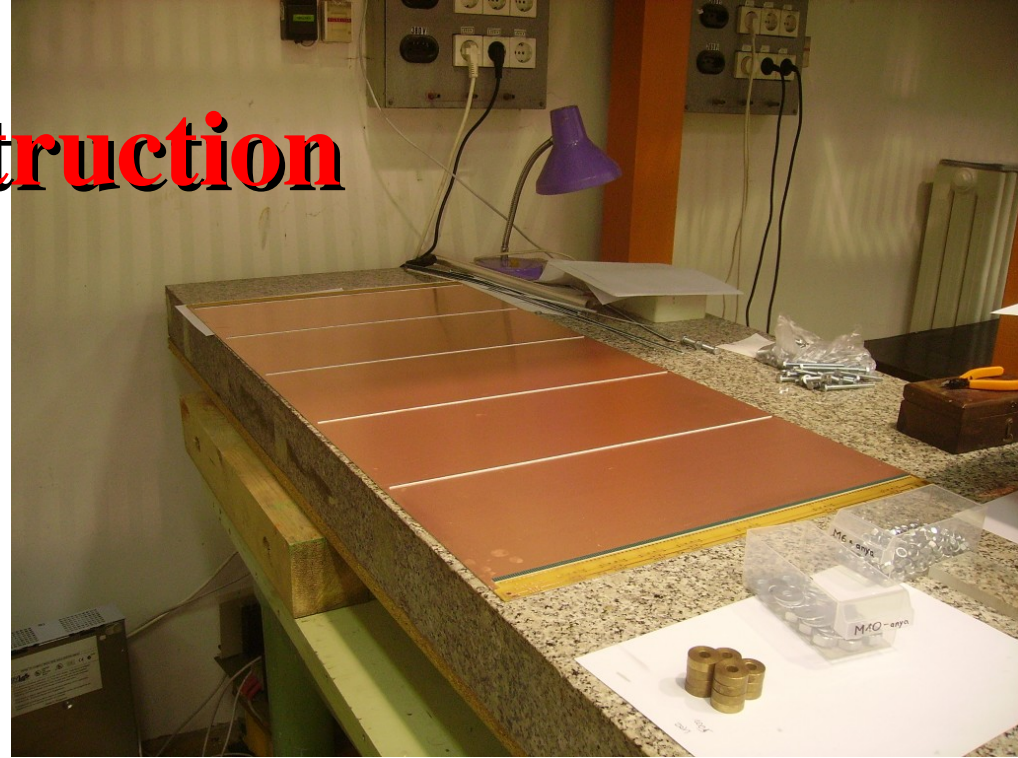
- **In High energy Physics Institutes:**

- **S-LINK cards for CERN and collaborators (ATLAS, CMS, COMPASS, etc.)**
 - different versions (altogether cca. 700 units)
- **DDL, D-RORC, and other DAQ hardware for ALICE at CERN**
 - different versions (altogether cca. 1300 units)
- **DDL and RORC cards for STAR at BNL**
 - (altogether cca. 260 units)
- **DDL, RORC (and other read-out cards) for SHINE (NA61) at CERN**
 - (altogether cca. 15 units, plus cca. 260 other interface cards)
- **Now all three major TPC detectors in the world (ALICE, STAR, and SHINE) use DDL as the data link from the detector to the DAQ computers!**

- **S-Link or DLL also works at:**

INFN (Roma • Torino • Bologna • Napoli • Pisa • Pavia) • IPN (Orsay, Nantes)
• CEA (Paris) • NIKHEF (Amsterdam) • Max-Planck Institute (München) • KFKI-RMKI (Budapest) • Stockholm University • IFAE (Univ. of Barcelona) • Univ. of Valencia
• Univ. of Lausanne • TU München • Bärigische Univ. Wuppertal • Johannes Gutenberg Universität • Manchester University • Univ. of Chicago • Indiana University • Caltech (Los Angeles) • Argonne Nat. Lab. (Chicago) • Los Alamos Nat. Lab. • Fermilab (Batavia)
• Rice University • IRAM (Institut de RadioAstronomie Millimetrique, France) • CFHT (Canada - France space telescope in Hawaii) • Waseda University (Tokyo)

L0 Construction



L0 Construction

