Czech Republic - midterm report

Jiří Chýla

Emphasis on developments since 2007 RECFA country visit

- **Overview of activities**
- **Institutions**
- **Funding**
- **Status of major activities**
- **New activities**
- **Outreach**
- **Problems**

Overview of Activities

Major involvement in

- ATLAS
- ALICE
- D0
- H1
- STAR
- AUGER
- R&D on detectors for LC and other applications

Theory

- Standard Model oriented
- Strings & related
- Modern Quantum Field Theory

Also in

- Daya Bay
- Compass
- Totem
- Nemo 3, Picasso

Recently started activities

- ATLAS upgrade
- Belle II
- Nova
- Cherenkov Telescope Array
- Large Synoptic Survey Telescope

Institutions

Principal institutions with long time tradition in particle physics:

Universities

Charles University in Prague

- Faculty of Mathematics and Physics (FMP)

Technical University in Prague

- Faculty of Nuclear Science & Physical Engineering (FNSPE)

- Institute of Technical and Experimental Physics (ITEP)

Academy of Sciences

- **Institute of Physics (IoP)**
- **Nuclear Physics Institute (NPI)**

Recently also regional universities

Palacky University Olomouc (PUO)

Technical University Liberec (TUL)

joined particle physics experiments at CERN.

Funding: satisfactory (all numbers per annum)

Centers (supporting most of particle physics activities)

- **Center for Particle Physics** (2005-2011), **0.6 MEUR**
- **Center for Heavy Ion Collisions** (2007-2011), **0.3 MEUR**

EURYI award from ESF, **M. Schnabl**, 2008-2103, 0.16 **MEUR**

Grants from Ministry of Education

ATLAS	2008-2012, **1.2 MEUR**
Other exps. at CERN	2008-2012, **1.4 MEUR**
D0	2008-2012, **0.16 MEUR**
H1	2009-2012, **0.16 MEUR**
STAR	2009-2012, **0.1 MEUR**
Auger	2008-2012, **0.2 MEUR**
Nova	2012-2014, **0.16 MEUR**
Belle II	2009-2012, **0.11 MEUR**
Total:	**approx. 3.5 MEUR**

Status of major activities

	physicists	PhD
IoP	**10**	**9**
FMP	**10**	**7**
FNSPE	**5**	**3**
ITEP	**5**	**3**
PUO	**1**	**1**
total	**31**	**23**

Contributions to

- **TileCal**
- **Silicon Central Tracker** (pixels as well as strips)
- **Data acquisition and processing** (**Tier 2** Center in Prague)
- **neutron shielding and radiation monitoring**
- **Detector ALFA**
- **Physics analysis:**
  - **diffraction physics**
  - **jets in heavy ion collisions**
  - top production
  - W/Z production
  - B-physics and heavy quarkonia production

IoP: 2 physicists
FMP: 1 physicists, 1 PhD
FNSPE 2 physicists, 3 PhD

working on **jets, top physics, forward physics**,
18% of simulations from Prague Computer Center

IoP: 1 physicist
FMP CU: 3 physicists, 2 PhD

working on **jet production in diffraction processes**.

STAR

NPI: 3 physicists, 3 PhD,
FNSPE 3 physicists, 1 PhD,

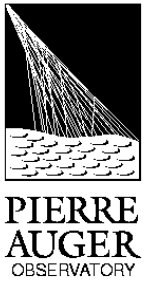
working on

- **Heavy Flavor Tracker**
- Physics analysis: **jets, heavy quarks**

ALICE

NPI: 7 physicists, 2 PhD,
FNSPE 4 physicists, 7 PhD,

- Control system of **Silicon drift detectors** of ALICE
- ALICE **Forward Electromagnetic Calorimeter** FOCAL
- Physics analysis: **HBT correlations, jets, heavy quarks**



IoP: 12 physicists, 3 PhD,
CU: 3 physicists, 1 PhD,
PUO: 2 physicists

- Contribution to the **design and construction of the optical system of the fluorescence detector**.
- Responsibility for **operation and performance optimization** of the fluorescence detector
- Operating the robotic telescope **FRAM** to monitor atmospheric quality above the Observatory.

Topics investigated:

- the **mass composition and anisotropy** of ultrahigh energy cosmic rays
- **hadronic models** for interactions of cosmic rays with nuclei
- impact of **magnetic fields in the Universe** on propagation of charged cosmic rays

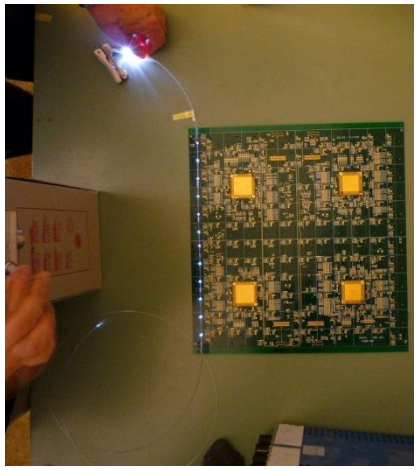
Theory

- **IoP AS CR:** 9 Physicists, 3 PhD
  QCD phenomenology, String Theory & related
- **NPI AS CR:** 3 Physicists, 1 PhD
  Dynamical EWSB, Color superconductors
- **FMP CU:** 5 Physicists, 3 PhD
  BSM Higgs, Effective Field Theory,
  Modern Quantum Field Theory
- **FNSPE TU:** 2 Physicists, 2 PhD

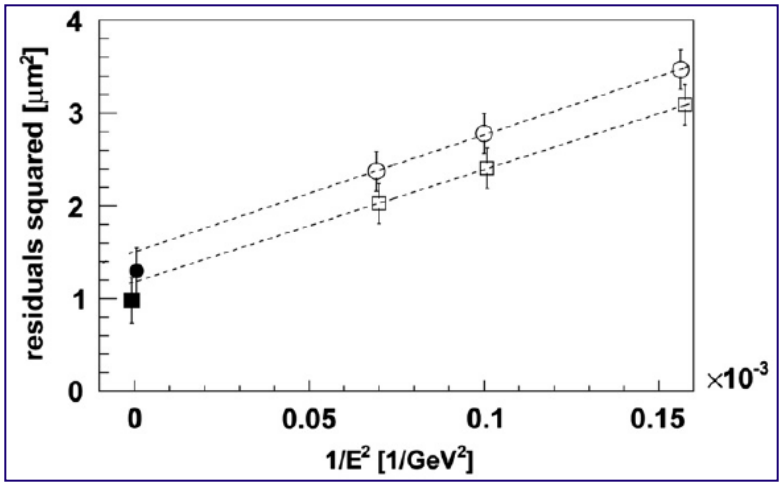
R&D on detectors for LC

Detector development for ILC, CLIC

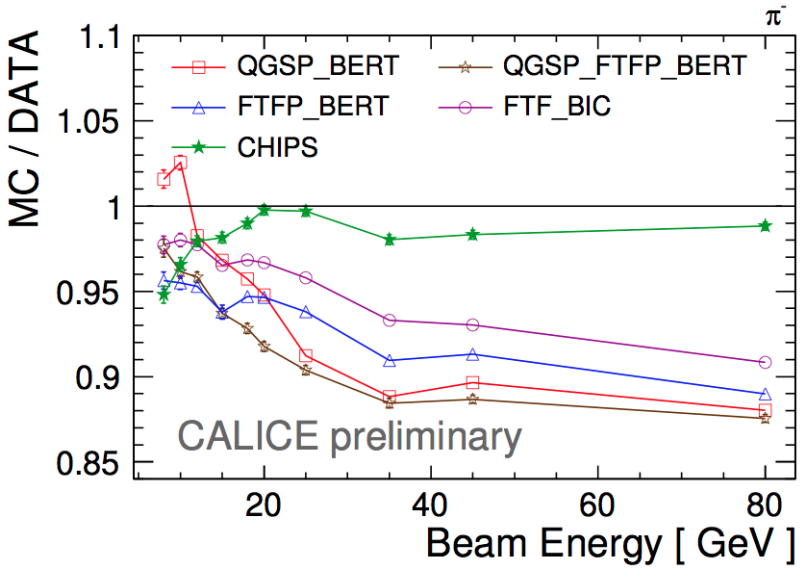
- Participation in **EUDET, AIDA** European programs
- **Electromagnetic and hadron calorimetry (IoP)**
  - LED calibration for modern photodetectors (Si photomultipliers)
  - Important data on hadron shower properties for Geant 4 tuning
  - Si pad detectors design
- **Pixel (DEPFET) detectors** for vertex detector **(FMP)**
  - Beam and laboratory tests, data analysis
  - Achieved spatial resolution ~ (1.0 ± 0.1) μm in energy range 4-120 GeV
  - **At present used in the Belle II vertex detector**



LED calibration light



Extrapolated squared residuals versus energy



Transverse hadron shower radius versus energy

Computing

- 2004 – **Regional Computing centre for Particle Physics**, located in the IoP AS CR, serves as **Tier2 for WLCG**
- high speed network connections by CESNET to local institutes and to several Tier1 centres, starting connection to LHCONE

20 racks, 3 800 cores

2 PB disk space

62 m2 300 kVA UPS

280 kW cooling

Delivery of **substantial simulation capacities** to **D0 (18%), ALICE (4%), ATLAS (2%)** as well as **AUGER** and **STAR**

New activities since 2007 RECFA visit

ATLAS upgrade

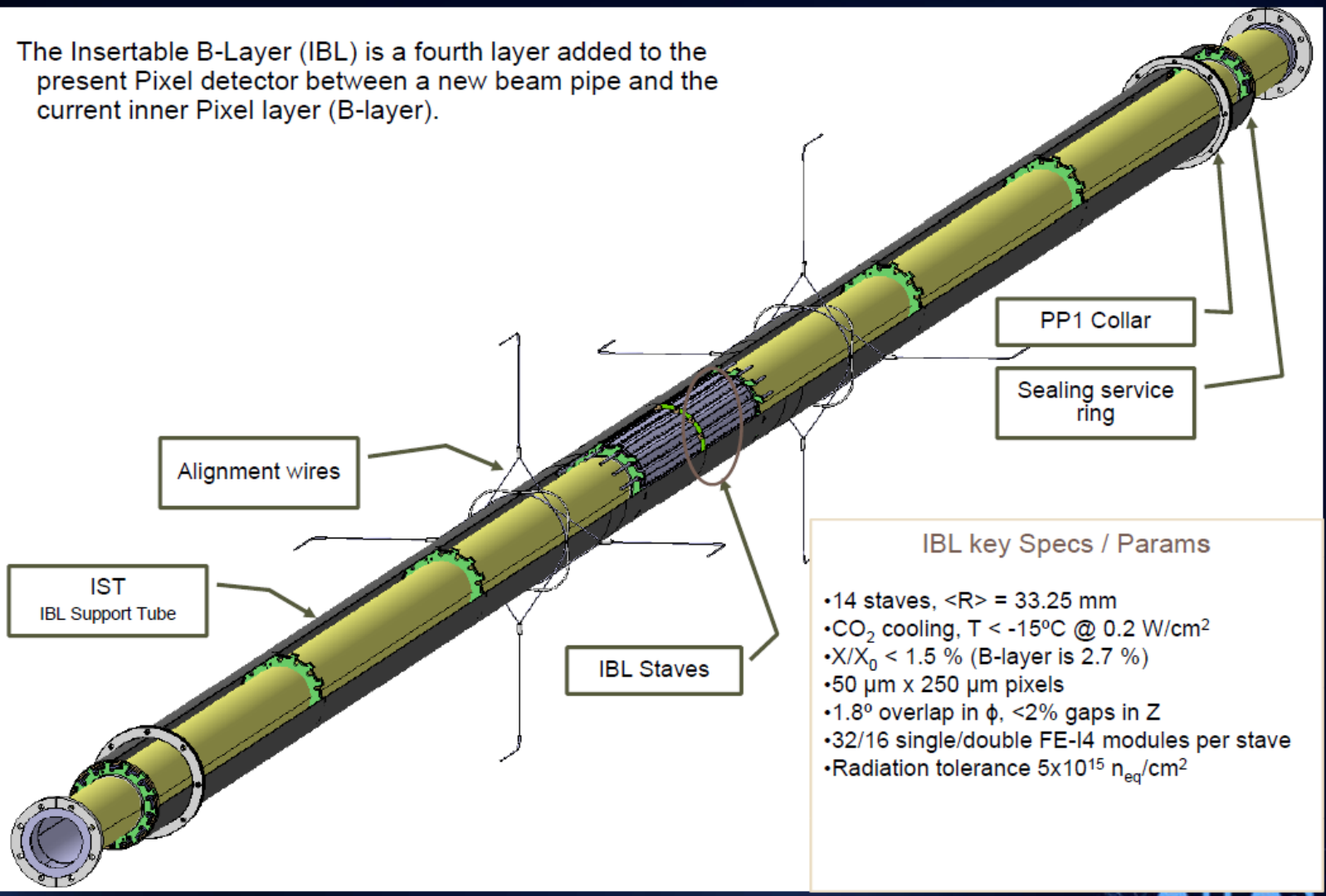
Major involvement in

- **Isertable b-layer Project**
- **AFP (Atlas Forward Physics) Project**
- **TILECAL Low Voltage Power Supplies**
- **Tracker upgrade**

Isertable b-layer Project

IBL Detector

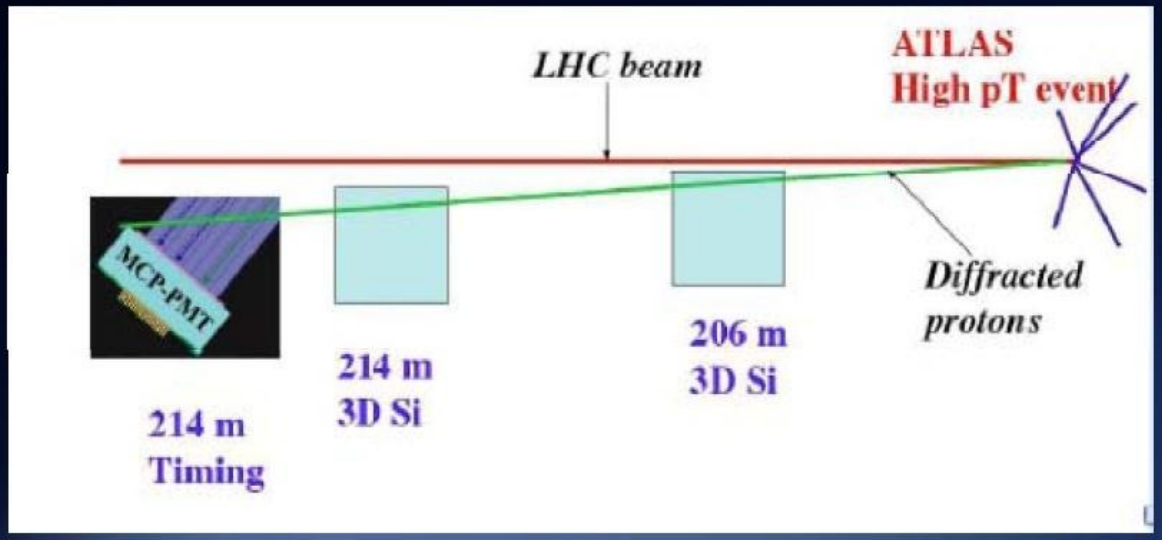
The Insertable B-Layer (IBL) is a fourth layer added to the present Pixel detector between a new beam pipe and the current inner Pixel layer (B-layer).

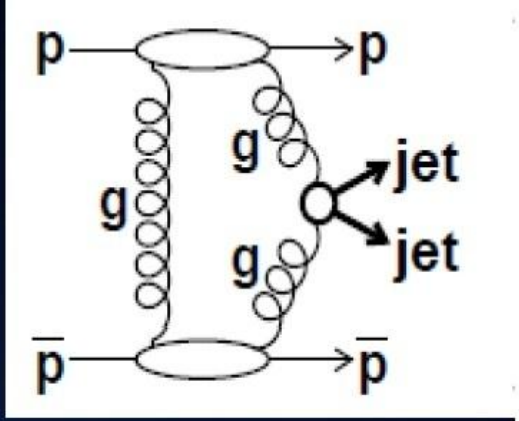


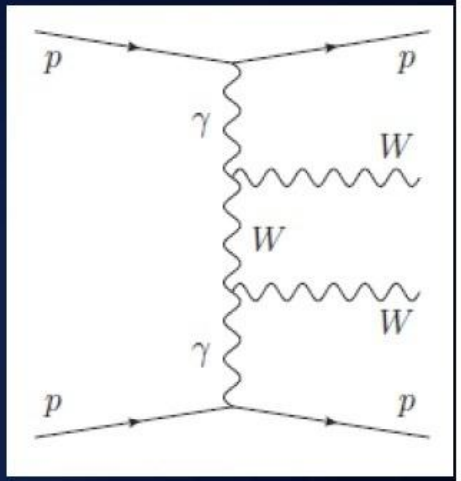
IBL key Specs / Params

- 14 staves, <R> = 33.25 mm
- CO_2 cooling, T < -15ºC @ 0.2 W/cm^2
- X/X_0 < 1.5 % (B-layer is 2.7 %)
- 50 µm x 250 µm pixels
- 1.8º overlap in ϕ, <2% gaps in Z
- 32/16 single/double FE-I4 modules per stave
- Radiation tolerance 5x10^{15} n_{eq}/cm^2

AFP : ATLAS Forward Physics





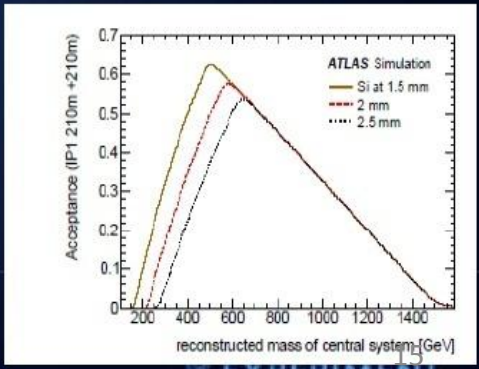


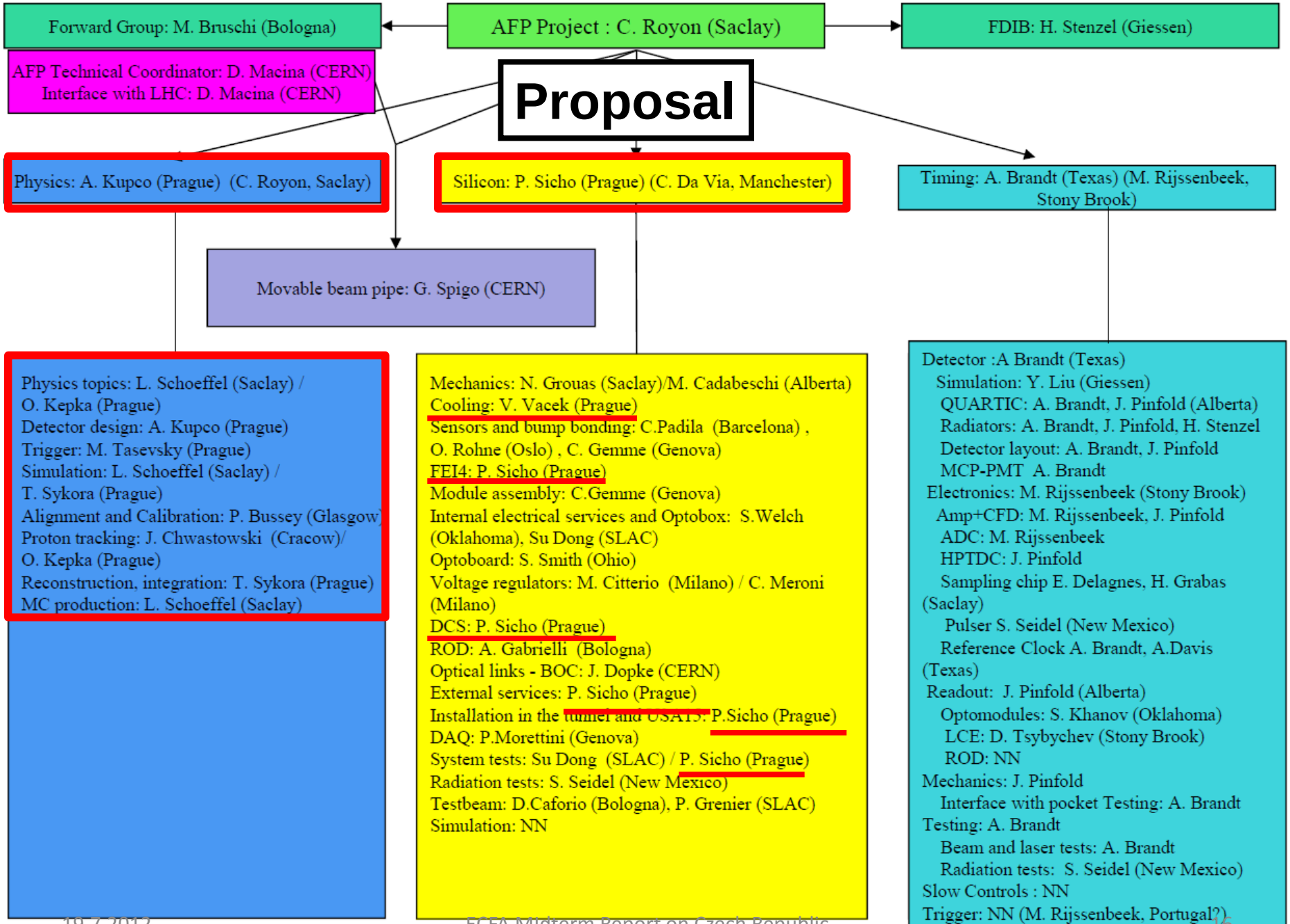
✓Tag and measure protons at ± 210 m

✓Trigger: rely on ATLAS high-P_T LVL1 trigger

✓Detectors: radiation hard "edgeless" 3D Silicon as tracker, 10 ps timing detectors

Allows running in high pileup conditions with association with the primary vertex → **access to RARE processes**




Forward Group: M. Bruschi (Bologna)
AFP Project : C. Royon (Saclay)
FDIB: H. Stenzel (Giessen)
AFP Technical Coordinator: D. Macina (CERN)
Interface with LHC: D. Macina (CERN)
Proposal
Physics: A. Kupco (Prague) (C. Royon, Saclay)
Silicon: P. Sicho (Prague) (C. Da Via, Manchester)
Timing: A. Brandt (Texas) (M. Rijssenbeek, Stony Brook)
Movable beam pipe: G. Spigo (CERN)
Physics topics: L. Schoeffel (Saclay) / O. Kepka (Prague)
Detector design: A. Kupco (Prague)
Trigger: M. Tasevsky (Prague)
Simulation: L. Schoeffel (Saclay) / T. Sykora (Prague)
Alignment and Calibration: P. Bussey (Glasgow)
Proton tracking: J. Chwastowski (Cracow)/ O. Kepka (Prague)
Reconstruction, integration: T. Sykora (Prague)
MC production: L. Schoeffel (Saclay)
Mechanics: N. Grouas (Saclay)/M. Cadabeschi (Alberta)
Cooling: V. Vacek (Prague)
Sensors and bump bonding: C.Padila (Barcelona) , O. Rohne (Oslo) , C. Gemme (Genova)
FEI4: P. Sicho (Prague)
Module assembly: C.Gemme (Genova)
Internal electrical services and Optobox: S.Welch (Oklahoma), Su Dong (SLAC)
Optoboard: S. Smith (Ohio)
Voltage regulators: M. Citterio (Milano) / C. Meroni (Milano)
DCS: P. Sicho (Prague)
ROD: A. Gabrielli (Bologna)
Optical links - BOC: J. Dopke (CERN)
External services: P. Sicho (Prague)
Installation in the tunnel and USA15: P.Sicho (Prague)
DAQ: P.Morettini (Genova)
System tests: Su Dong (SLAC) / P. Sicho (Prague)
Radiation tests: S. Seidel (New Mexico)
Testbeam: D.Caforio (Bologna), P. Grenier (SLAC)
Simulation: NN
Detector :A Brandt (Texas)
Simulation: Y. Liu (Giessen)
QUARTIC: A. Brandt, J. Pinfold (Alberta)
Radiators: A. Brandt, J. Pinfold, H. Stenzel
Detector layout: A. Brandt, J. Pinfold
MCP-PMT A. Brandt
Electronics: M. Rijssenbeek (Stony Brook)
Amp+CFD: M. Rijssenbeek, J. Pinfold
ADC: M. Rijssenbeek
HPTDC: J. Pinfold
Sampling chip E. Delagnes, H. Grabas (Saclay)
Pulser S. Seidel (New Mexico)
Reference Clock A. Brandt, A.Davis (Texas)
Readout: J. Pinfold (Alberta)
Optomodules: S. Khanov (Oklahoma)
LCE: D. Tsybychev (Stony Brook)
ROD: NN
Mechanics: J. Pinfold
Interface with pocket Testing: A. Brandt
Testing: A. Brandt
Beam and laser tests: A. Brandt
Radiation tests: S. Seidel (New Mexico)
Slow Controls : NN
Trigger: NN (M. Rijssenbeek, Portugal?)
LV/HV : NN
Installation: NN

Daya Bay reactor neutrino experiment

6x2.9GW thermal power reactor cores
6x20t Gd doped liquid scintillator detectors
+2 detectors will be installed in 2012

Collaboration ~240 members

Asia (20) IHEP, Beijing Normal Univ., Chengdu Univ. of Sci and Tech, CGNPG, CIAE, Dongguan Polytech, Nanjing Univ., Nankai Univ., NCEPU, Shandong Univ., Shanghai Jiao Tong Univ., Shenzhen Univ., Tsinghua Univ., USTC, Zhongshan Univ., Univ. of Hong Kong, Chinese Univ. of Hong Kong, National Taiwan Univ., National Chiao Tung Univ., National United Univ.

North America (16) Brookhaven Natl' Lab, Cal Tech, Cincinnati, Houston, Illinois Institute of Technology, Iowa State, Lawrence Berkeley Natl' Lab, Princeton, Rensselaer Polytech, UC Berkeley, UCLA, Wisconsin, William & Mary, Virginia Tech, Illinois, Siena College

Europe (2) Charles Univ., Dubna

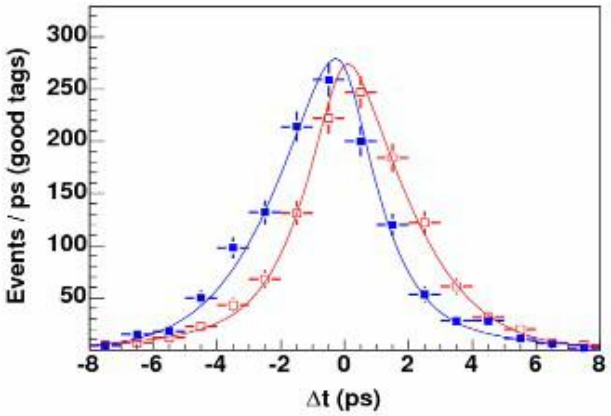
Prague Charles University group
2 faculty + 2 PhD students
-MC studies of muon induced background
-Installations of RPC muon detector

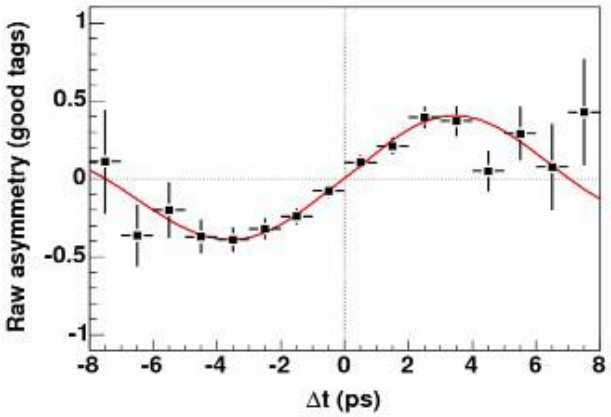
Supported by the Research plan and "Kontakt" project of Ministry of Education

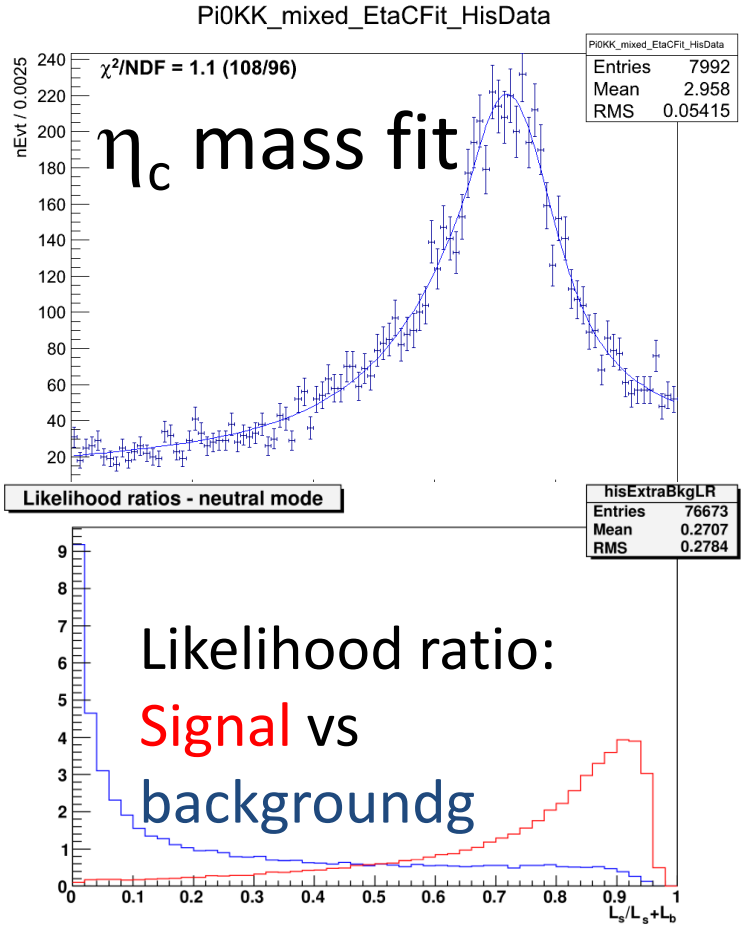
Daya Bay
$\sin^2 2\theta_{13} = 0.092 \pm 0.016\ (stat) \pm 0.005\ (syst)$
Phys.Rev.Lett. 108 (2012) 171803
Update at Neutrino 2012:
$\sin^2 2\theta_{13} = 0.089 \pm 0.010\ (stat) \pm 0.005\ (syst)$
The most precise measurement of θ_{13}

Belle and Belle II in Prague

Determination of the CKM UT angle β/ϕ_1 from $B \to h_c K_s$



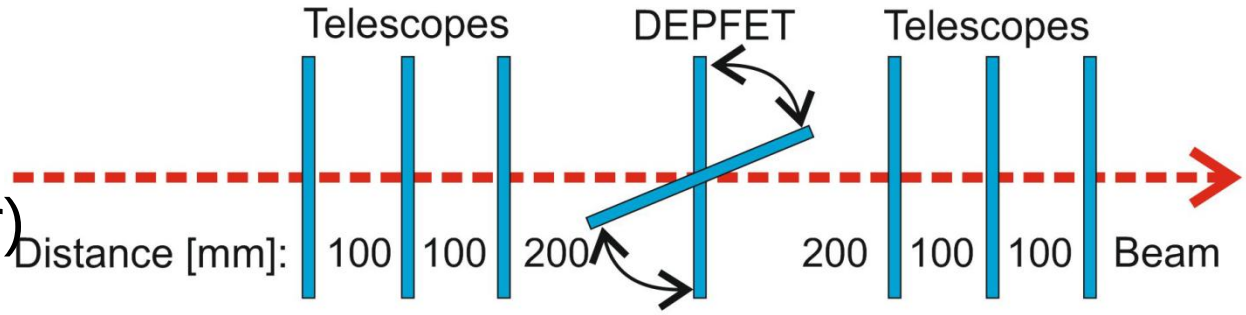




Belle II at Charles Uni in Prague

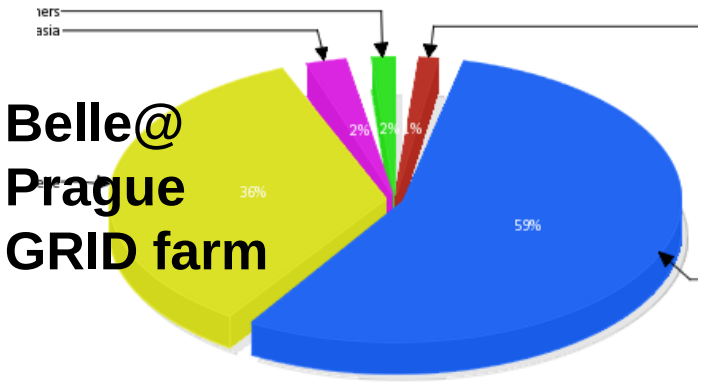
Vertex **DEPFET pixel detector upgrade**

- testbeam
- lab testing (laser)
- Minimatrix setup



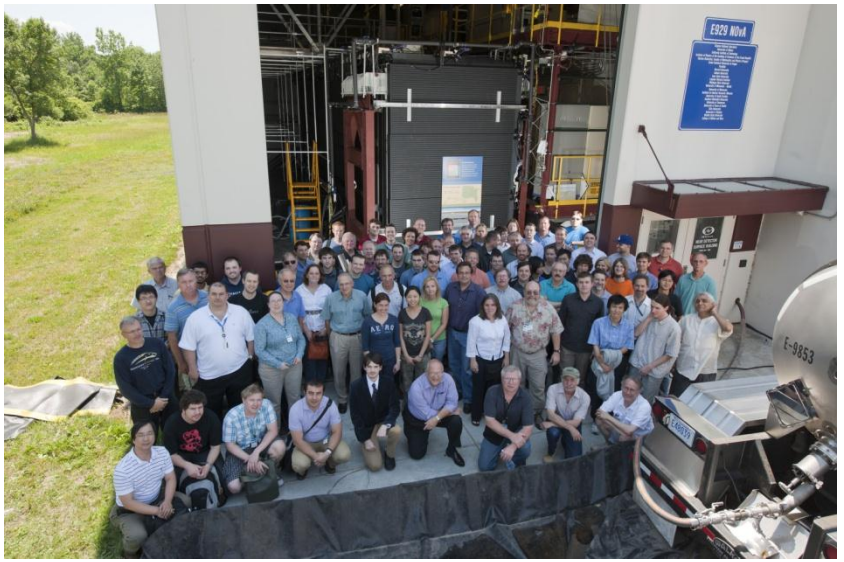
Computing, SW

- Vertex detector optimization
- Si sensor digitizer and geometry
- Data quality monitoring
- GRID



NOvA

NuMI Off-Axis ν_e Appearance Experiment, 220 t near detector, 15 kt far detector



Czech institutions since 2011

IoP :	2 physicists
FMP:	2 physicists, 1 PhD
FNSPE:	2 physicists, 3 PhD

contribution to detector construction, study of APD, preparation for physics program

String Theory at IoP

Formal aspects, as well as possible physical applications to early universe cosmology or particle physics. Three areas

- **String field theory**
- **AdS/CFT**
- **Higher spin holography and higher spin theory.**

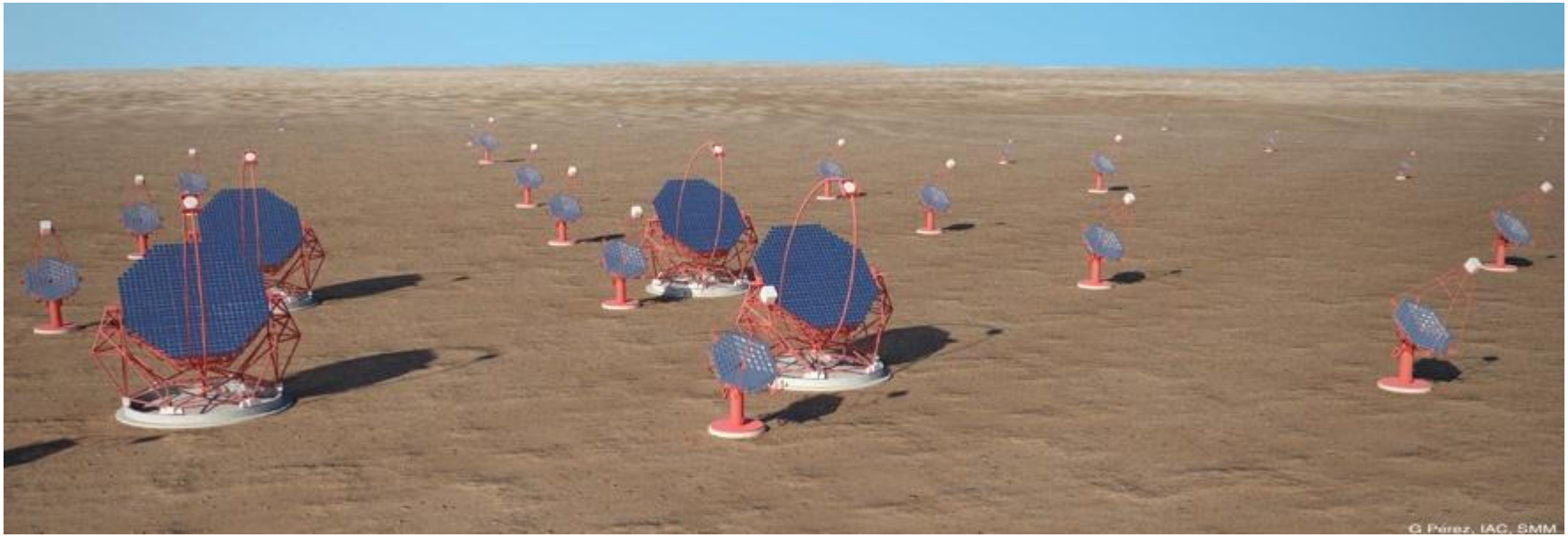
Financed mostly from the **EURYI** award for **M Schnabl** for the period mid 2008 - mid 2013

Modern Quantum Field Theory at FMP

A. Iorio: Noncommutativity and Lorentz invariance violation, gauge symmetry of graphene etc.

Cherenkov Telescope Array

CU has been involved in the **H.E.S.S**. for a decade. **IoP and CU have recently joined the worldwide activity** to design and build **Cherenkov Telescope Array** (CTA).



Contribution to CTA: testing of mirror prototypes, design and installations of full sky cameras to investigate cloudiness as well as satellite data analysis of atmospheric conditions.

IoP & CU: 8 physicists, 1 PhD

Large Synoptic Survey Telescope (LSST).

Precise determination **of dark matter and energy.**

IoP since 2008, 3 physicists

Responsibility for the software for the CCD characterization of the telescope mosaic camera.


Czech Teachers Programme 03/2008
from Sunday 02 March 2008 (16:00)
to Saturday 08 March 2008 (23:00)
Europe/Zurich
at CERN (B6 2-024)
chaired by: Mick Storr
support:
Material:
Czech Follow-up Web Site

Problems & ucertainties

The level of financing has in the recent years been **satisfactory**, but starting in 2012 the situation has become less favorable, as

- The two **Centers** which had provided primarily the money **salaries of postdocs and PhD students** ended by 12/2011.
- **Most of the grants for particle physics end in December 2012.** We are preparing application for their extension and prenegotiated the same level of financing but the results will be known **only in November**.
- General **population decline** expected to dramatically reduce university enrolment in 2 years.
- Permanent **government „reforms“** of university system and funding of R&D