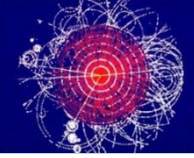
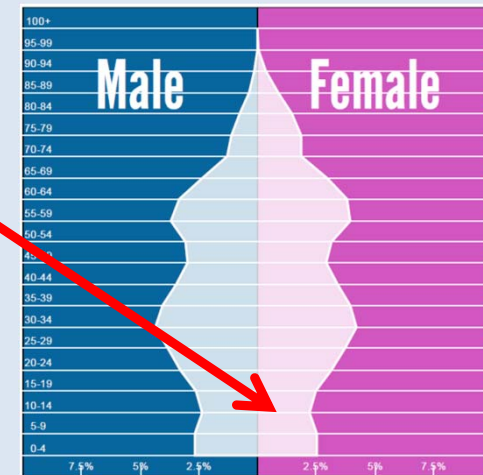


Poland in numbers



- ✓ Area : **312 679 km²** (6th in EU, 8th in Europe)
- ✓ Population: **38 425 000** (6th in EU, 8th in Europe)
- ✓ Male/female: **0.94**
- ✓ Natural increase: **-0.7‰** (per 1000)
- ✓ GDP: **475 G\$** (rank: 23st)
- ✓ GDP per capita: **12361 \$** (rank: 44th)

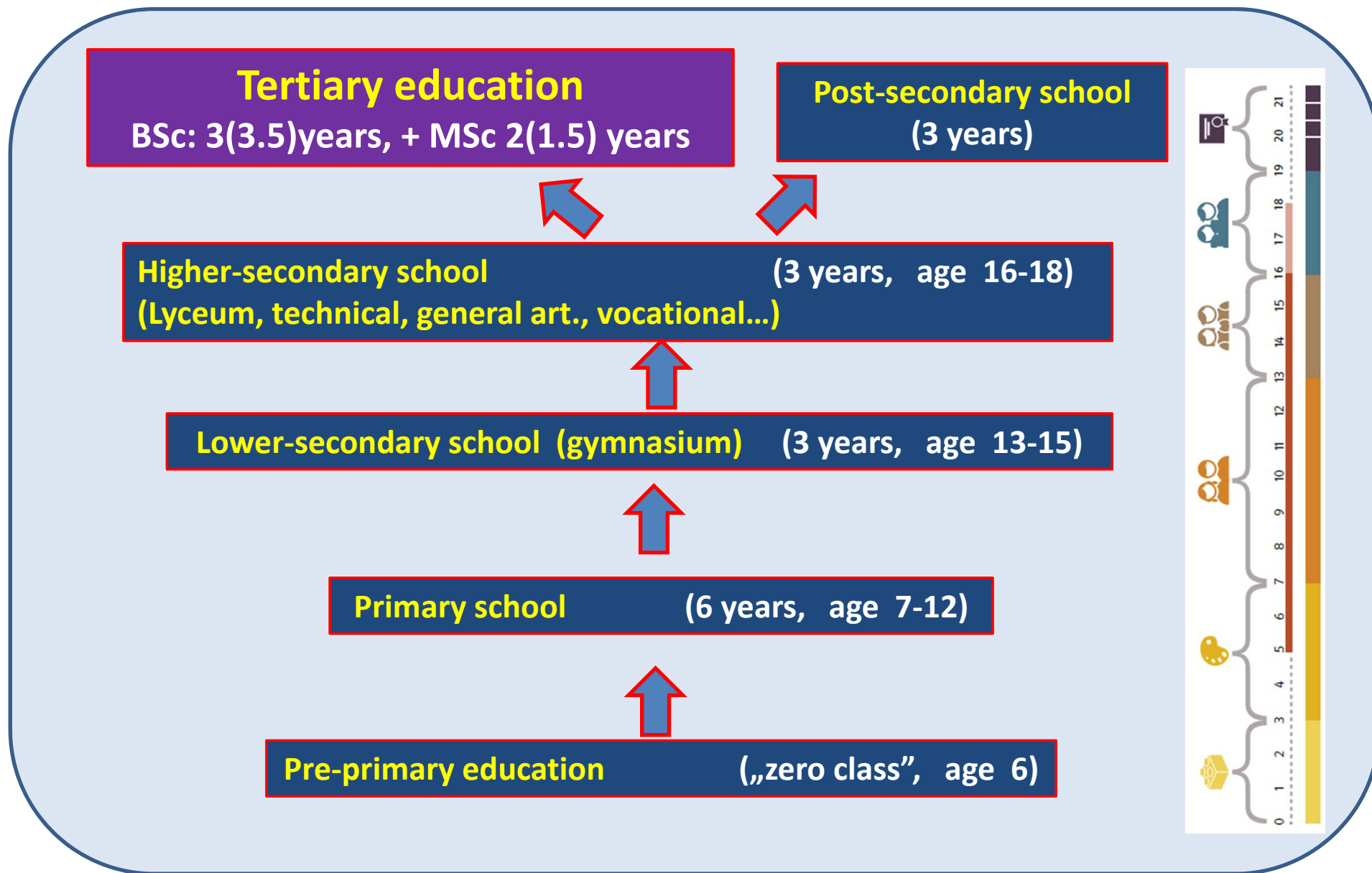
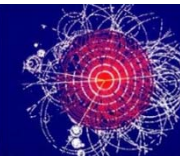
As from: <http://stat.gov.pl>
<http://data.worldbank.org>



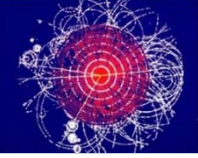
- ✓ CERN membership since July 1991, observer since 1963
- ✓ Contribution to CERN budget: **2.75%**
- ✓ Number of users: **246**, Institutes: **18** (2015 data)

As from : <http://usersoffice.web.cern.ch/annual-statistics>

Education



Higher Education



- ✓ **434** higher education institutions (2014)
- ✓ **19** universities and **25** technical universities (all public)

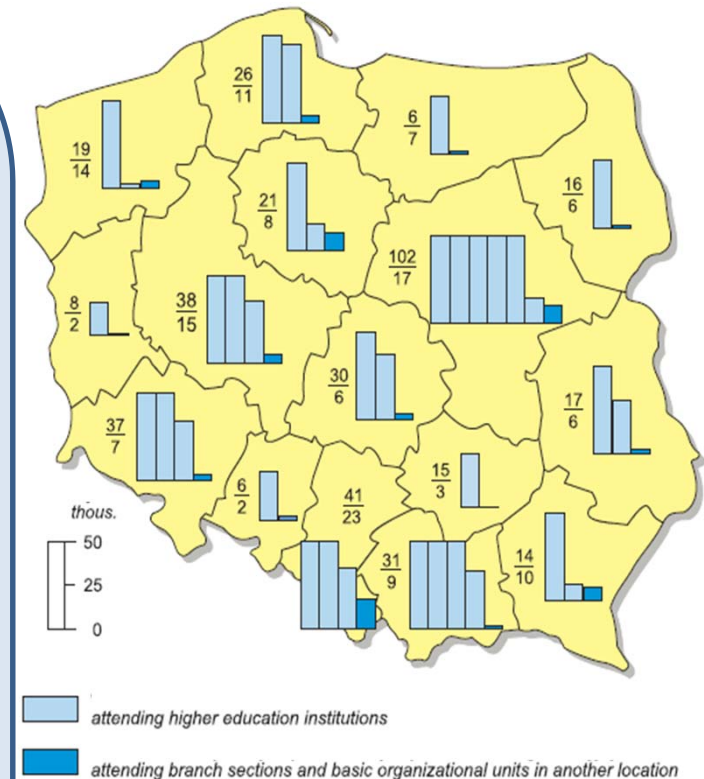
- ✓ Total number of students (2014/15) **1 469 400**
74% in public; female rate: **58%**



<http://public.mzos.hr/fgs.axd?id=20476>

- ✓ PhD students (2014/15): **43 400**; female rate: **54%**
- ✓ PhD students (physics): **4 110**; female rate: **55%**
- ✓ State budget expenditure on higher education: **4.6%**
(0.8% of GDP)

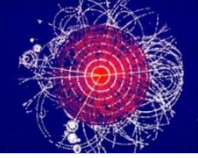
As from: <http://stat.gov.pl>
<http://eurydice.org.pl>



Model of academic career:

Bachelor → Master → PhD
→ Habilitation
→ Academic Professor Title

Research in Poland



- ✓ Higher Education Institutions in R&D activity: **211** (**133** public)
- ✓ Polish Academy of Sciences (PAS): **70** institutes
- ✓ Branch R&D Units supervised by sector ministries : **119** institutes

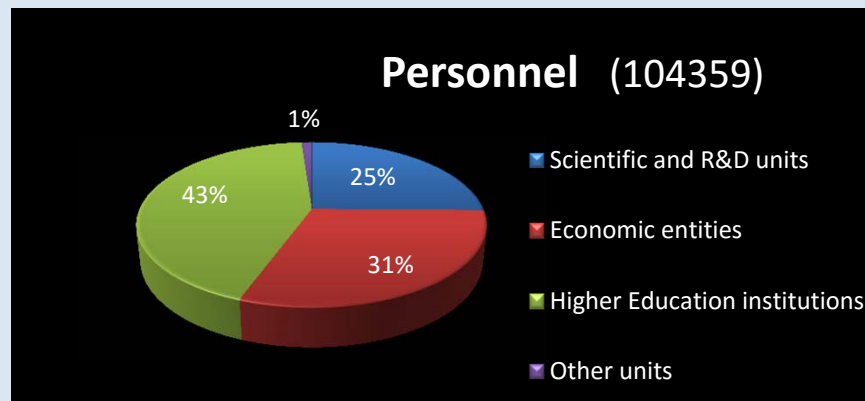
Source:

<http://stat.gov.pl>

As of 31.12.2014

- ✓ **4.5** researchers for 1000 FTE
- ✓ R&D expenditure of GDP:
GERD / GDP = 0.94% (2014)

(GERD - Gross Domestic Expenditure on R&D)

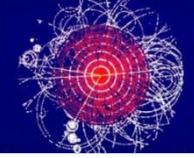


	2010	2011	2012	2013	2014
GERD [mln PLN]	10 416	11 687	14 353	14 424	16 168
GDP [mln PLN]	1 445 060	1 566 557	1 628 992	1 656 341	1 719 097
GERD/GDP [%]	0,72	0,75	0.88	0.87	0,94

(Labour costs of **43%**)

(EUR/PLN ≈ 4.4
USD/PLN ≈ 3,95)

Research Funding



Public:

✓ National Science Centre (NCN)

- financing research projects, inspiring international cooperation in basic research; special attention paid to PhD students and young researchers.

✓ National Centre for Research and Development

- management and execution of R&D programs; support of commercialization and other forms of transfer of scientific research results

✓ Ministry of Science and Higher Education

- Financing „statutory activities” supporting research programmes and international cooperation carried on higher education inst., and research units.

Private:

✓ Industry

✓ Foundations

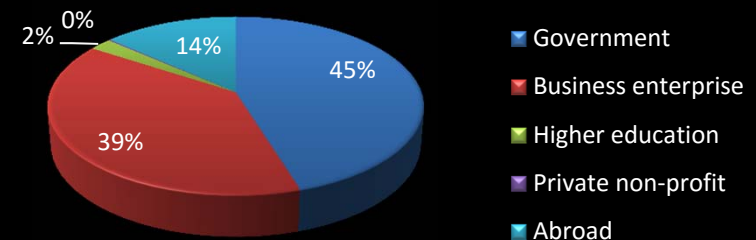
(The Foundation for Polish Science)

EU funding:

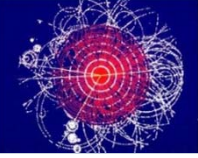
✓ Structural Funds

✓ Framework Programmes

GERD by source of funds



HEP in Poland



Warsaw:

- University of Warsaw (UW)
- Warsaw University of Technology (PW)
- National Centre for Nuclear Research (NCBJ)
- N. Copernicus Astronomical Centre (CAMK)
- Space Research Center (CBK)

Cracow

- AGH U. Science and Technology (AGH)
- Jagiellonian University (UJ)
- Cracow University of Technology (PK)
- Institute of Nuclear Physics PAS (IFJ PAN)

Katowice

- University of Silesia (UŚ)

Wrocław

- University of Wrocław (UWr)
- Wrocław University of Technology (PWr)

Kielce

- Jan Kochanowski University (JKU)



Łódź

- University of Łódź (UŁ)
- National Centre for Nuclear Research (NCBJ)

Toruń

- N. Copernicus University (UMK)
- N. Copernicus Astronomical Centre (CAMK)

Human Resources (1)

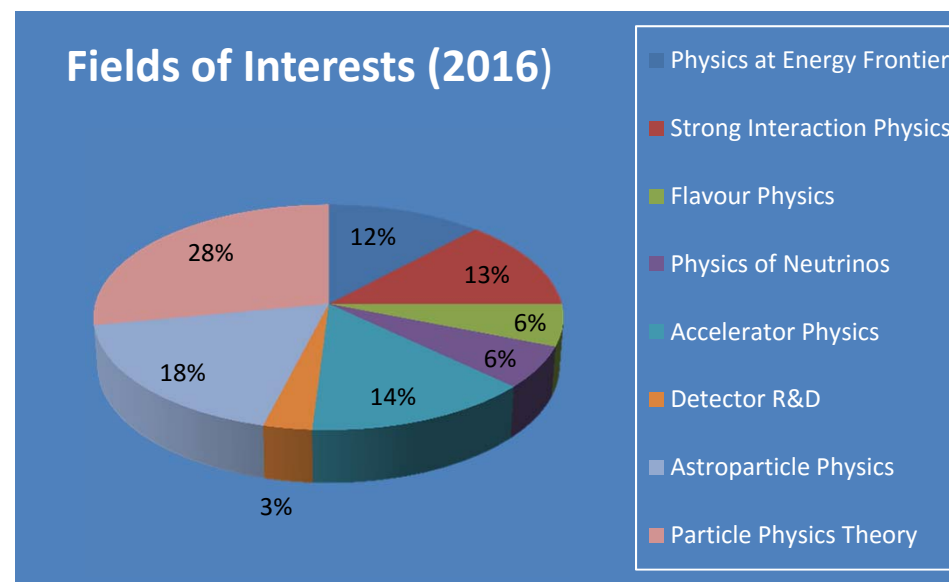
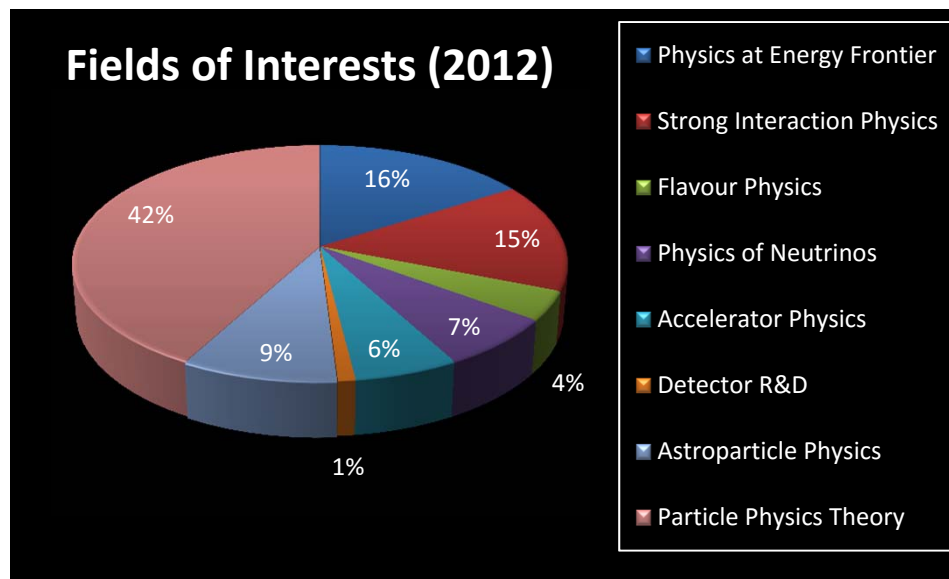


Project	Total (FRA)	Total (FTE)	Physicists (FTE)	Engineers (FTE)	PhD students (FTE)
ALICE	24	22,7	16,4	0,8	5,5
ATLAS	48	41,6	27,1	4,5	10,0
CMS	21	19,4	14,0	1,4	4,0
LHCb	37	25,5	14,0	4,5	7,0
Belle/Belle II	11	10,5	4,0	4,5	2,0
NA61/SHINE	44	35,0	24,0	1,0	10,0
COMPASS	15	7,8	6,0	-	0.5
HERA	16	7,7	7,7	-	-
STAR	18	13,0	4,0	-	9
Neutrino physics	49	35	24,5	0,2	10,3
Astroparticle	129	110,6	56,4	27,8	26,4
ILC/CLIC/FCC	24	16	8	3,5	4,5
Theory	176	176	132	-	47
Accelerator physics	85	85	10	70	5
Detector R&D	30	17,0	6,5	6,0	4,5
total	727	625,8	354,6	125,5	145,7

Human Resources (2)



Field	2009 (FTE)	2016 (FTE)
Energy Frontier	62	77,0
Strong Interactions	58	86,2
Flavour Physics	15	36,0
Neutrino Physics	27	35,0
Accelerator Activities	23	85,0
Detector R&D	4	17,0
Astroparticle Physics	35	110,6
Theory	159	179,0
Total	383	625,8



Energy Frontier: ATLAS, CMS, ILC

Strong Interactions: ALICE, COMPASS, H1, ZEUS, HERMES, NA61, STAR

Flavour Physics: Belle(II), LHCb

Human Resources (3)



Experimental HEP

	2009	2016
Total	189	251,2
Physicists	109	156,2
Engineers	43	27,7
PhD students	37	67,3

Astroparticle

	2009	2016
Total	35	110,6
Physicists	21	56,4
Engineers	7	27,8
PhD students	7	26,4

Theory

	2009	2016
Total	159	179
Physicists	102	132
Engineers	-	-
PhD students	57	47

Accelerator activities

	2009	2016
Total	35	85
Physicists	21	10
Engineers	7	70
PhD students	7	5

All data in FTEs

Population [mln]	38,425
GDP [GEUR]	426
FRA (total)	725
FRA / population [mln⁻¹]	18.9
FRA / GDP [GEUR⁻¹]	1.7

GEUR = 10⁹ x EUR

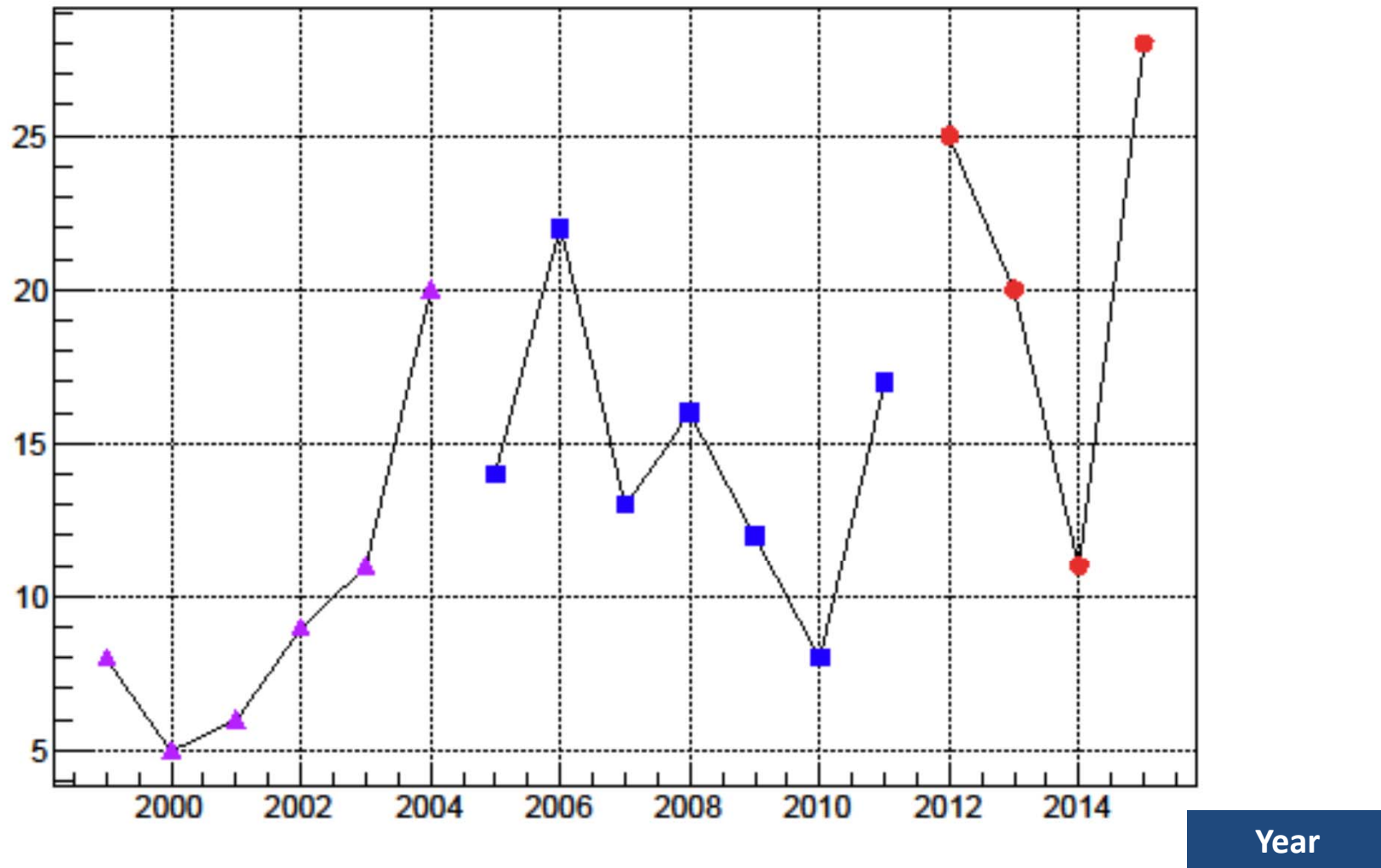
PhD Degrees



Average = 9.8

Average = 14.6

Average = 21,0



Institutions & People [FTE]

	Phys.	Eng.	PhD stud.
Institute of Nuclear Physics PAS (IFJ PAN) , Kraków	8,0	0,3	1,5
National Centre for Nuclear Research (NCBJ), Warsaw	5,0	0,5	2,0
Warsaw University of Technology (PW)	3,4	-	2,0
Total:	24 FRA,	22,7 FTE	

Physics Studies

- HBT interferometry, long range correlations
- ultra-peripheral collisions and diffraction
- prompt and direct photons
- nuclear modification factor
- electromagnetic probes

Detector involvement

- Time Projection Chamber (TPC) – simulations, calibrations, database
- Photon Spectrometer (PHOS) – simulations, calibrations

Upgrade

Plans for further participation in the TPC and PHOS

Funding

Grants from the National Science Centre and from the Ministry of Science and Higher education

Yearly needs: ~220 kCHF Maintenance and Operation, 70 kCHF – shifts

Institutions & People [FRA/FTE]

	physicists	Engineers	PhD students
Inst. of Nucl. Phys. PAS (IFJ PAN):	17 / 17.0	5 / 3.0	6 / 6.0
AGH U. of Science & Technology:	10 / 8.5	3 / 1.5	4 / 3.0
Jagiellonian Univ. (associated institution):	2 / 1.6	-	1 / 1.0
Total:	48 members	48 FRA	41.6 FTE

Physics Studies

- SM and BSM processes with tau leptons
- Hot QCD matter in heavy ion (HI) collisions
- Forward physics (diffractive, elastic)
- Development of MC tools (TauSpinner, HI)
- Detector alignment
- MC production for HI WG
- Trigger menus for HI WG

Detector operation and maintenance

- SCT: FEE, HV PS, LV PS, DCS
- TRT: gas Stabilization, DCS, Run Coord.
- ALFA (Absolute Luminosity for ATLAS): TDAQ
- AFP (ATLAS Forward Protons): integration, TDAQ, DCS
- High-Level Trigger software
- Expert on-call shifts (SCT, TRT, Trigger)
- Computing: Tier2, Tier3

Upgrade: Phase I

- TDAQ – Level 1 topo
- AFP upgrade – installation, consolidation

Upgrade: Phase II

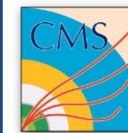
ITk (new Inner Tracker)

- Si Strip FEE, Powering for Strips, Strip DCS
- MC simulations (geometry description)

TDAQ

Funding

short-term grants(1-3 yrs.) from the National Science Centre (2011-2016);
application for upgrade in preparation



Institutions & People, Warszawa [FRA/FTE]

	physicists	Engineers	PhD students
National Centre for Nuclear Research (NCBJ):	9/9	0	0
University of Warsaw (UW):	5/5	3/1.4*	4/4*
*2 engineers and 1 PhD student are also employes of Warsaw University of Technology (PW)			
Total: members (FRA, FTE)	14/14	3/1.4	4/4

Physics Studies

- Higgs decays to taus
- Long-lived particles
- Forward physics
- WW scattering
- Heavy Ion physics

Detector operation and maintenance

- L1 Pattern Comparator Trigger (PACT) for the muon system, based on resistive plate chambers (RPC)
- New L1 muon trigger for overlap (barrel:endcaps) region
- Computing: Tier2

Upgrade

Involvement in the muon trigger under discussion
When decided, the funding (from Polish agency) will be needed

Funding

6 grants from the National Science Centre

Institutions & People [FTE]

Institute of Nucl. Phys. PAS (IFJ PAN) , Kraków	10,0
AGH Univ. of Science and Technology (AGH), Kraków	8,5
National Centre for Nucl, Research (NCBJ), Warszawa	7,0

Detector involvement

Outer Tracker: contribution to design, construction and maintenance

Vertex Detector (VELO): control and calibration s/w

Trigger (HLT)

- reconstruction algorithms: primary vertex, short tracks
- monitoring tools

Computing

- Tier-2 Data center (300 TB disk space)
- contribution to development of distributed analysis software (DIRAC)

RICH: software activities

On-call shifts: OT, VELO, RICH

Funding

- Core funding assured
- Individual, dedicated grants from the Nat. Science Centre
- New application for upgrade in preparation; few previous attempts failed

Physics Studies

- **CP violation:**
 - γ from $B \rightarrow DK$, $B_s \rightarrow D_s^\mp K^{*\pm}$, $B_s \rightarrow D_s^{*\mp} K^{*\pm}$
 - β_s from $B_s \rightarrow J/\psi \phi (\rightarrow e^+e^-)$,
 - CPV charm.
- **Rare decays:** $B \rightarrow K^* \mu^+ \mu^-$, $\Lambda_c \rightarrow p \mu^+ \mu^-$
- Baryon and lepton number violating decays: $\Lambda_b \rightarrow h^+ \mu$ ($h^+ = K^+, D^+$), $\tau \rightarrow \mu \mu \mu$
- **CPT symmetry violation**
- B-jets, bb cross-section
- **Bose-Einstein correlations**
- Search for hadronic exotics

Upstream Tracker:

Upgrade

- Design of „SALT” ASIC chip
- Calibration and monitoring software
- Silicon response simulation software
- Test beam data taking and analysis

VELO Upgrade:

- Calibration and monitoring software
- Control software for Opto-Power Board (OPB)

RICH Upgrade:

- Contribution to ASIC chip design (Claro)
- Simulation of digitization

Detector Description:

- Design and implementation of the simplified detector model for the on-line trigger system

Belle / Belle II



Institution & People [FTE]

Institute of Nuclear Physics PAS (IFJ PAN), Kraków:
4 physicists, 4.5 engineers, 2 PhD students

Physics Studies

- B reconstruction with missing energy employing different Btag reconstruction
- $B \rightarrow D^{(*)} \tau \nu$ decay properties, semileptonic B decays, (e.g PRD 86, 072007 (2012))
- s-sbar production in B decays (e.g. PRD 91, 032008 (2015)) and $D_{(s)}$ mesons spectroscopy,

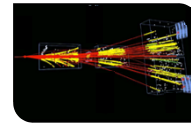
Contributions to hardware & maintenance

- **The Belle II silicon vertex detector:** part of the readout system
- **The Belle II pixel detector:** contribution to power supply - surge overvoltage protection
- R&D for next generation of pixel detectors for Belle II in SOI technology
- SVD Slow control and software, B field measurement

Funding

NCN grants, Horizont 2020

Institutions & People [FRA]



6 universities

Jan Kochanowski University in Kielce (UJK)	- 6
Jagiellonian University (UJ), Kraków	- 8
University of Silesia (UŚ), Katowice	- 7
University of Warsaw (UW)	- 6
University of Wrocław (UWr)	- 3
Warsaw University of Technology (PW)	- 7

2 research institutes

Nat. Centre for Nucl. Research (NCBJ), Warszawa	- 3
Institute of Nuclear Physics PAS (IFJ PAN), Kraków	- 4

44 FRA, 35 FTE, (24 phys. 2 Eng, 10 PhD)
43 authors (143 all) = ~30% of the collaborators

Detector Involvement

- ❖ Development of Silicon Strip Vertex Detector (UJ)
- ❖ „Z detectors” for beam ion tagging (UŚ)
- ❖ Participation in the development of the Projectile Spectator Detector (UW)
- ❖ Upgrade and development of the TPCs’ gas system (UW)

Physics Studies

- ❑ **Strong interactions program**
 - search for the critical point of strongly interacting matter
 - study of the properties of the onset of deconfinement
 - study high p_T particles production
 - production of strangeness and exotic resonances in $p+p$, $p+A$ and $A+A$ interactions
- ❑ **Hadron-production measurements for neutrino experiments**
 - reference measurements of $p+C$ interactions for the current and future neutrino experiments - initial neutrino fluxes at J-PARC and FERMI LAB

Funding

- 2008-2012 KBN/SPUB
- 2013-2018 National Science Centre NCN/HARMONIA.
- Application submitted to the Ministry of Science and Higher Education for funding the CF until 2020
- NCN/OPUS for development of the Silicon Strip Vertex Detector (UJ)

COMPASS



Institutions & People

National Centre for Nuclear Research	- 5,0 FTE
University of Warsaw	- 1,8 FTE
Warsaw University of Technology	- 1,0 FTE

Physics Studies

- ❖ **GPD (Generalized Parton Distributions) program**; muon production from photons and mesons
- ❖ **gluon orbital angular momentum** via Sivers asymmetry in γ^*g fusion
- ❖ **gluon polarisation** via longitudinal double spin asymmetries in photon-gluon fusion
- ❖ **TMD (Transverse Momentum Dependent distributions) program**
- polarised Drell-Yan in $\pi^- p^\uparrow$ scattering

Contributions to hardware

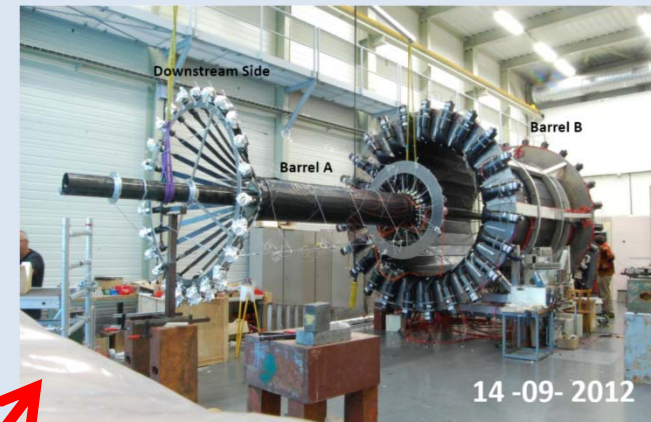
- **Recoil detector**: provision of a part of PMTs, design of preamps, mechanical, electric and electronic equipment for PMTs
- **Calorimeter**: provision of a half of photodectors MAPD, testing MAPD, design of FE electronics, calorimeter assembling and tests

Funding

Two Polish NCN grants: in 2011 and 2016

Constructed new detectors

Recoil proton detector (TOF system)
24 inner & outer scintillators
1 GHz SADC readout



Large-angle electromagnetic calorimeter

Shashlyk modules + MAPD readout
 $\sim 2 \times 2 \text{ m}^2$, $\sim 2200 \text{ ch.}$



Experiments @ HERA



Institutions & People



Physics Studies

Warsaw (ZEUS)

University of Warsaw (UW): 1.0 FTE
National Centre for Nuclear Research (NCBJ) 0.5 FTE

Cracow (ZEUS, H1)

Inst. of Nucl. Phys. PAS (IFJ PAN) 0.5 FTE
AGH Univ. of Science and Technology (AGH) 2,5 FTE
Jagiellonian University (UJ) 0.3 FTE

- Vector mesons in photoproduction
- **Effective quark radius**
- Contact interactions;
- **MC simulation: muon trigger system**

- Particle correlations
- **QCD Instantons**
- Inclusive di-jet production in DIS : diffraction

Funding

Support from DESY

Institution & People



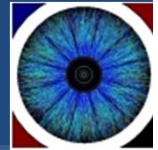
Physics Studies

National Centre for Nuclear Research, Warsaw:
4 physicists, FRA=4, Total FTE=2.9

Funding

Support from DESY

1. Leptoproduction of vector mesons
 - 1.1 Spin density matrix elements
 - 1.2 Transverse target spin asymmetries
2. **Bose-Einstein correlations in hadron-pairs**
3. Transverse target single-spin asymmetry in inclusive charged pions and kaons
4. **Beam helicity asymmetry in DVCS**



Institutions & People [FRA/FTE]

	Physicists	Engineers	PhD students
Warsaw University of Technology (PW):	5 / 2.5	-	7 / 7.0
AGH Univ. of Science and Technology (AGH), Kraków:	2 / 1.0	-	2 / 2.0
Institute of Nuclear Physics PAS (IFJ PAN), Kraków:	2 / 0.5	-	-
Total:	18 members	(18 FRA,	13 FTE)

Physics Studies

- Investigation of heavy ion collisions (femtoscropy, heavy flavour production)
- **Forward physics in proton-proton collisions (diffractive, elastic, identified particle spectra)**
- Central exclusive production in proton-proton collisions
- **Investigation of the nature of the proton spin**

Detector Contributions:

- Participation in the upgrade of the Roman Pot detectors
- **Detector alignment and simulation in Geant4**

Future Plans

Involve in the preparatory phase and physics programme at the Electron Ion Collider (EIC) which is the next DOE high priority project (eSTAR/eRHIC)

Funding

NCN grants (1 finished (2012-2014); 1 received by AGH in 2016; application from PW in 2016)

Neutrino Physics (1) – Long Baselines



Institutions & People

	phys/engin.	PhD stud.
Inst. of Nucl. Phys. PAS (IFJ PAN), Kraków	– 3,0 FTE	3
NCBJ, Warszawa	– 8,5 FTE	2
University of Warsaw (UW)	– 2,0 FTE	2
Warsaw U. of Technology (PW)	– 2,5 FTE	2
University of Silesia (UŚ), Katowice	– 2,9 FTE	1
University of Wrocław (UWr)	– 1,4 FTE	2

Polish neutrino group

coordinated activity by 6 institutions



Present experiments



finished



running until ~2023

Detectors and R&D

- SMRD (Side Muon Range) Detector running for T2K near detector,
- **Contribution to work after earthquake**
- Participation in ToF measurement
- **Work on multi-pixel photon counters (MPPC), testing fast DAQ for PMT**
- Determining dependence of timing resolution on pulse amplitude for upgrade

Data analysis , physics studies

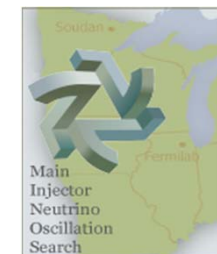
- **Generator of neutrino interactions NuWro**
- Liquid Argon technique and reconstruction,
- **Estimates of external background – MC, data**
- Reconstruction and systematic effects
- **Pion production for ν and $\bar{\nu}$**
- Multi-nucleon effects in neutrino interactions
- **Atmospheric neutrinos in Icarus**

Funding

- **European funds:** Laguna, Laguna-LBNO, **networking:** SK-plus, Jennifer
- **National funds:** National Science Centre (NCN)
 - basic funding for participation in experiments (common fund + shifts)
 - dedicated funding for individual projects

Individual contribution to Minos/Minos+ (Univ. of Warsaw)

- **Tau searches**



Neutrino Physics (2)



Institutions & People

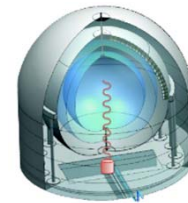
Jagiellonian University (UJ)

phys/engin. PhD stud.
– 5.9 FTE 2

Solar



Search for $0\nu\beta\beta$



SOX

Borexino
with strong
radioactive
source

SBL (Fermilab)

ICARUS liquid Ar TPC
will go to Fermilab
and become far detector

Detectors and R&D

- Development of position sensitive detectors (PSD) for GERDA/Borexino
- Detectors and DAQ development for GERDA

Data analysis and physics studies

- MC simulations for SOX
- Backgr. measurements and simulations
- Material selection for clean detector

Funding

- National funds: National Science Centre (NCN)
 - dedicated funding for individual projects

Projects for future (in preparation)

Short time-scale

short baseline, sterile neutrino searches

Long time scale ~2025

Preparation for these projects
starting with R&D and software
→ already now liquid Ar, HPTPC

Long baseline (LBL)

HyperK
and/or
DUNE

CERN neutrino
platform

Neutrino telescope for astrophysical
observation in Mediterranean sea



Astroparticle Physics (1)



VHE Gamma Astronomy

MAGIC: Univ. of Łódź

Theoretical modeling, data analysis

H.E.S.S.: Univ. of Warsaw, N.Copernicus Astronomical Center, Warsaw & Toruń, Jagiellonian Univ., Kraków, Inst. of Nucl. Phys. PAS, Kraków, Univ. of Toruń
Actuators for the mirror collimation system, purchase of 84 mirror tiles.

CTA: next slide

Cosmic Ray Research

Pierre Auger Observatory: ultra-high energy cosmic rays (ground-based):
Inst. of Nuclear Physics PAS (IFJ PAN), Kraków, University of Łódź
construction of part of fluorescence detectors, data analysis

KASCADE-Grande: cosmic rays above the knee: NCBJ, Łódź, data analysis

JEM-EUSO: ultra-high energy cosmic rays (from space):
NCBJ Warszawa & Łódź, J.Kochanowski University Kielce, Space Research Centre (CBK) Warszawa, Jagiellonian University detector R&D, simulations

Pi of the Sky: NCBJ Warszawa, University of Warsaw, Center for Theoretical Physics PAS, Warszawa : GRB (gamma ray bursts)

Dark Matter (DM)

DarkSide (LNGS): Jagiellonian Univ., Kraków
studies of background sources and of LAr purity

DM Theory: NCBJ, Warsaw, University of Warsaw
DM: candidates, direct and indirect detection , connections with LHC

Astronomical DM: University of Warsaw, Jagiellonian Univ., Kraków, Copernicus Astronomical Centre PAS, Warsaw, Inst. of Nucl. Phys. PAS, Kraków
studies of galactic dynamics, gravitational lensing, GRBs and SN Ia

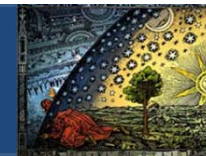
Gravitational Waves (GW)

VIRGO-POLGRAW: Inst. of Mathematics PAS, Warszawa, Univ. of Warsaw, Nat. Centre for Nucl. Research, Świerk, Jagiellonian Univ., Kraków, Univ. of Zielona Góra, N.Copernicus Univ, Toruń, Univ. of Białystok

- Astrophysical sources of GW
- Search for GW from rotating neutron stars
- Search for GW from compact binaries
- Contribution to Advanced Virgo construction
- Development of computing centers

Total: 129 FRA, 110,6 FTE (56.4 researchers, 27,8 engineers , 26,4 PhD students)

Astroparticle Physics (2)



Polish CTA Consortium

13 institutions, > 70 people

8 universities:

Jagiellonian Univ, Krakow

AGH, Kraków

Univ. of Warsaw

Warsaw Univ. of. Technology

Univ. of Łódź

N. Copernicus Univ., Toruń

Univ. of Zielona Góra

Univ. of Białystok

3 institutes of PAS + NCBJ:

N. Copernicus Astr. Centre, Toruń

Space Research Centre, Warsaw

Nat. Centre for Nucl. Research,
Warszawa

Inst. of Nucl. Phys. PAS, Kraków

A computing centre:

CYFRONET AGH, Kraków



Polish project at the ESFRI roadmap

Contributions till now: > 3 MEUR

Small Cherenkov telescope SST-1M

a prototype in IFJ PAN Krakow, collaboration with Geneva and Prague.



Digital camera
with SiPMTs
"DigiCam"

Mirrors based
on composites

CTA Science Gateway
in CYFRONET

CTA data centre application

New e^+e^- Colliders @ Energy Frontier



Institutions & People [FTE]

	Expt.	Phys.	Eng.	PhD stud.
University of Warsaw (UW)	ILD/CLICdp	1,5	-	-
Inst. of Nucl. Phys. PAS (IFJ PAN)	ILD/CLICdp/FCCee	4,5	3,0	1,0
AGH Kraków	ILD/CLICdp	1,0	0,5	3,5
Cracow U. of Technology	FCCee	1,0	-	-
Total:		24 FRA, 16 FTE		

Physics Studies

- FCNC $t \rightarrow cH$ decays
- Search for DM (Inert Doublet Model)
- Single photon processes $e^+e^- \rightarrow \gamma X$
- Photon structure function
- EW observables (A_{FB}^{bb})
- Search for Heavy Neutral Leptons
- Theor. Studies related to MC generators

Detector R&D - FCAL

Development of the luminosity detector for forward calorimetry:

- silicon sensors
- multi-channel readout ASICs
- FPGA-based backend electronics

The completed detector prototype has been used in several test-beams of FCAL collaboration



Funding

- European funds: AIDA-2020, AIDA, EUDET (AGH & IFJ PAN)
- National funds: unsuccessful applications the National Science Centre (NCN).

Theory (1)



University of Warsaw

21 staff, 13 Phd

Activities: SM and beyond - 2HDM, SUSY, extra dimensions, strings, dark matter, neutrino physics, heavy flavor physics, models of inflation, baryogenesis, perturbations in homogeneous universe, cosmology, LHC and ILC/CLIC phenomenology, QCD bound states

National Centre for Nuclear Research , Świerk/Warszawa

16 staff, 3 Phd

Activities: physics beyond the Standard Model, partonic distributions, physics of quark – gluon plasma, relativistic viscous hydrodynamic, theory of nuclear structure and dynamics, super-heavy elements, dark matter, string theory

Jagiellonian University, Kraków

30 staff, 7 Phd

Activities: QCD and EW at higher orders, Monte Carlo event generators for HEP, proton structure, hadron models, non-perturbative methods, strong-coupling methods AdS/CFT, classical and quantum field theory, quantum gravity and cosmology, random matrix theory, discrete field theory and lattice QCD

Institute of Nuclear Physics PAS, Kraków

24 staff, 4 Phd

Activities: EW and QCD at higher order, modeling of generalized parton distributions, tau physics, neutrino physics, flavor physics, development of Monte Carlo generators, phenomenology of strong interactions

Theory (2)



University of Silesia, Katowice: 9 staff, 8 Phd

Activities: low energy e^+e^- hadron physics, LHC, ILC/FCC – phenomenology, neutrino physics, loop calculations, Phokhara MC generator based tool in analysis by KLOE, Babar, Belle, ...

University of Wroclaw: 15 staff, 9 Phd,

Activities: heavy ion collisions, gravitational waves, quantum theory of gravity, physics of supernovae

Jan Kochanowski University, Kielce: 5 staff, 3 Phd

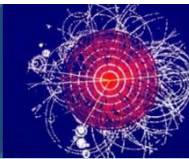
Activities: quark-gluon plasma, non-perturbative QCD

Universities of Lublin, Łódź, Szczecin, Toruń, Zielona-Góra: 12 staff, 0 Phd

Activities: neutrino physics and neutrinoless double beta decay, dark matter and ADS/CST correspondence, cosmology, QFT, cosmology, gravitational waves...

Total: 132 researchers, 47 PhD students

Accelerator Activities



	Institution	Localization	Projects	Sum of FTE (2011-15)	
				PL-paid	non-PL paid
AGH	University of Science and Technology		LHC		~50
IFJ PAN	Institute of Nuclear Physics Polish Academy of Sciences	Cracow	ESS, FAIR, ILC, LHC, SPIRAL-2, XFEL, CCB	150	70
PK	University of Technology		LHC, FAIR, SOLARIS,		~30
UJ	Jagiellonian University		SOLARIS	~50	
PŁ	University of Technology	Lodz	ESS, LHC, XFEL	~20	~30
NCBJ	National Centre For Nuclear Research	Warszaw	ESS, LHC, XFEL	~140	~60
PW	University of Technology		ESS, LHC, XFEL	~20	~30
PWr	University of Technology	Wrocław	ESS, LHC, XFEL, FAIR	~40	~10

85 FTE (10 phys. 70 Eng, 5 PhD)



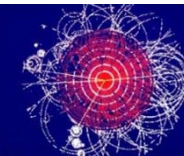
FUTURE

- **European Spallation Source**
(Polish in-kind contribution ~37M€)
- **Large Hadron Collider upgrade**
(Collaboration Agreements with CERN)

FUNDING

- **European funds:** EU Structural Funds, Eurofusion (F4E), EuroNu
- **National funds:** Polish in-kind contributions
- **Projects funds:** CERN, SPIRAL-2, ...
- **Local funds:** IFJ PAN funds for research

Accelerator Activities



cyclotron AIC-144

Proton Radiotherapy of Eye Melanoma



**Cyclotron Centre Bronowice
(CCB) IFJ PAN Kraków**



cyclotron Proteus C-235

**National Synchrotron Radiation
Centre SOLARIS,
Jagiellonian Univ., Kraków**



Quality Assurance of LHC superconducting magnets



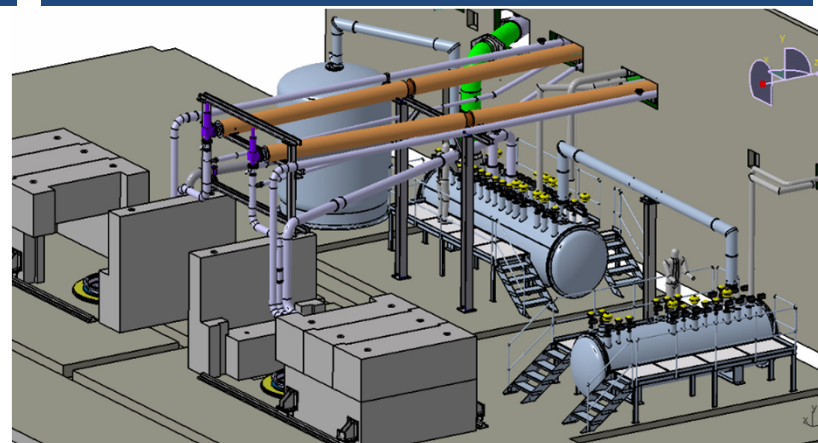
Buncher cavity for Linac4, LHC
(courtesy: S. Wronka, NCBJ)



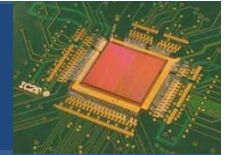
XFEL cryomodules tests



XFEL cryogenic system
(courtesy: M. Chorowski, PWr)



Detector R&D



Institutions & People [FTE]

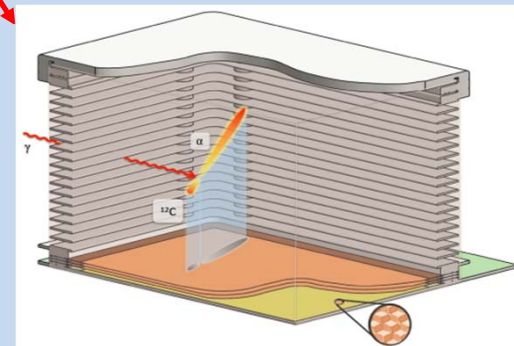
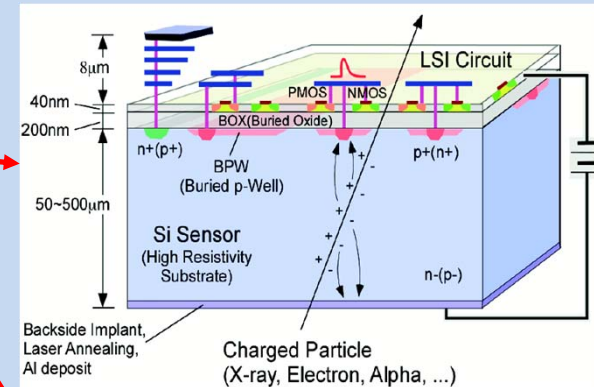
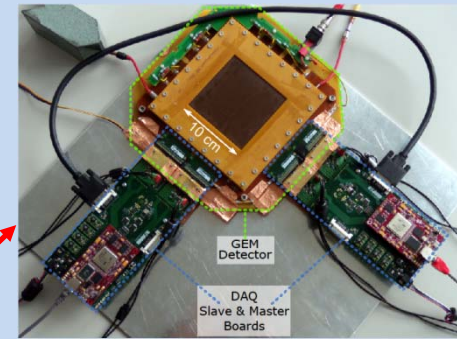
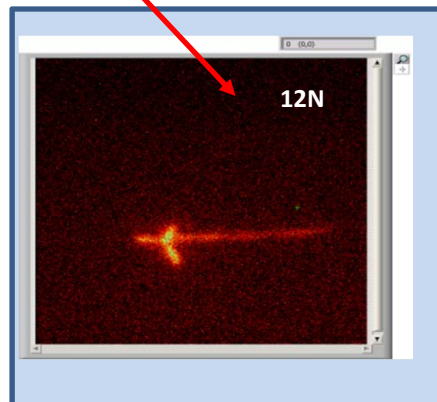
University of Warsaw (UW)	5.0
AGH Kraków	5.5
Jagiellonian University (UJ), Kraków	6.5

Activities carried on within international collaborations: RD50, RD51, SOIPIX plus generic R&Ds

- Development of Micro-Pattern Gas Detectors Technologies (RD51)
- **Development of monolithic SOI pixel detectors (SOIPIX)**
- Radiation hard silicon sensors (RD50)
- **Development of an Active Target TPC for photonuclear reactions (ELI-NP)**
- Development of General Electronics for TPCs (Saclay, CNBG Bordeaux)
- **Optical Time Projection Chambers (JINR Dubna)**
- Development of Straw Tube Detectors

Funding

- European funds: MC-PAD (**AGH & IFJ PAN**)
- National funds: dedicated grants from National Science Centre (NCN).
- Contracts with ELI-NP and JINR DUBNA (UJ)



Technology transfer



- From the onset, active collaboration with HEP (mainly CERN)
- GEM (Gas Electron Multiplier) detectors for industry
- In Europe, GEM foils are manufactured uniquely at CERN and by TECHRA
- TECHTRA is also an official provider of GEM foils for CERN

<http://techtra.pl/en/node/32>

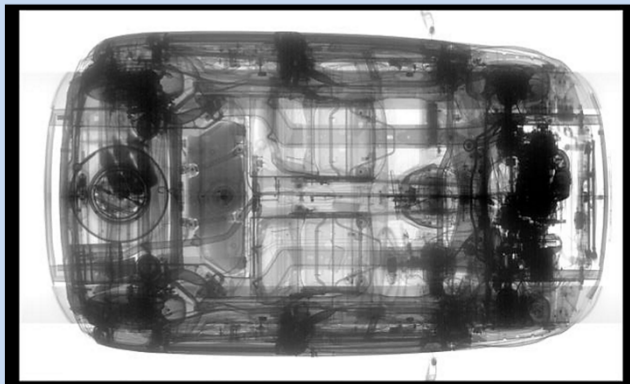
NCBJ – National Centre for Nuclear Research
Świerk / Warszawa

Over 40 years experience in
implementing accelerator technologies

➤ Linear accelerators of electrons for:

- Medical radiotherapy
- Industrial radiography
- Cargo scanning

➤ Specialized detectors for high-energy
radiography & Computed Tomography (CT)



Computing



Computing for High Energy Physics is based on Polish Grid Infrastructure (NGI).
 Contributions to LHC Grid come from federated Polish Tier2 and standalone institute clusters.
 Pledges at the level of (1-5)% of LHC experiment needs are fulfilled.

Federated Polish Tier2

[ACK CYFRONET AGH](#) – Academic Computer Centre, CYFRONET AGH, Kraków

[ICM UW](#) – Interdisciplinary Centre for Mathematical and Computational Modelling, Warsaw

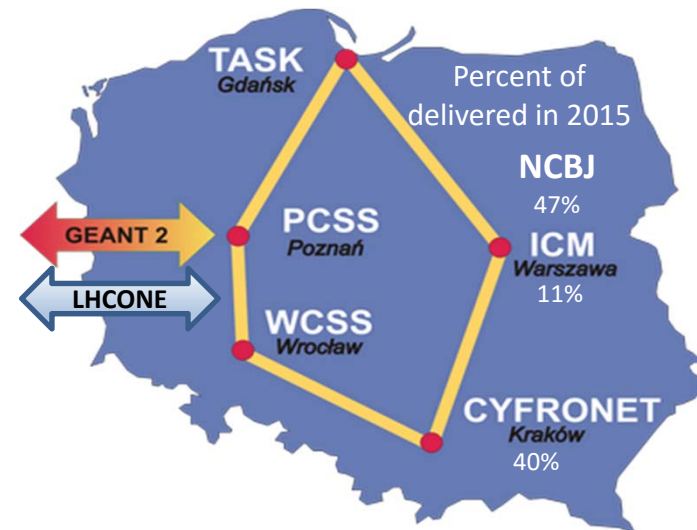
[PCSS](#) – Poznań Supercomputing and Networking Center

[NCBJ](#) – National Centre for Nuclear Research, Świerk (Warsaw)

[PW](#) – Warsaw University of Technology

[WCSS](#) – Wrocław Centre for Networking and Supercomputing

[IFJ PAN](#) – Institute of Nuclear Physics, Polish Academy of Sciences, Kraków

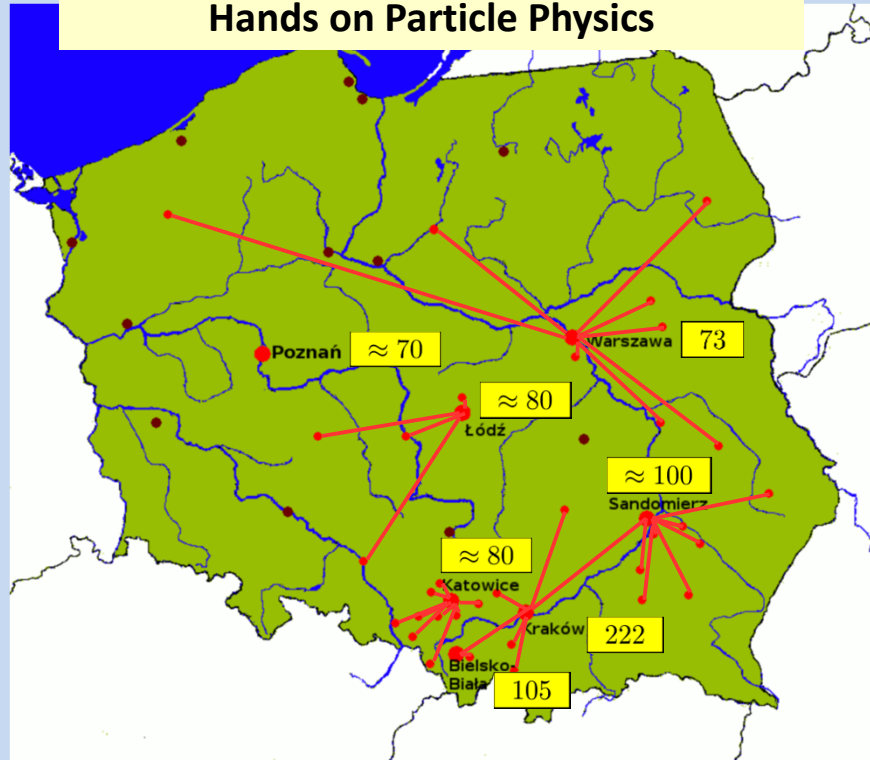


Pledges	2014	2015	2016
CPU (HS06)	19,200	20,800	23,000
Disk (TB)	1,120	1,110	1,230
Delivered	2014	2015	2016
CPU (HS06)	16,800	22,500	35,500
Disk (TB)	1,120	1,110	1,140

Outreach



Physics Masterclasses 2016 in Poland Hands on Particle Physics



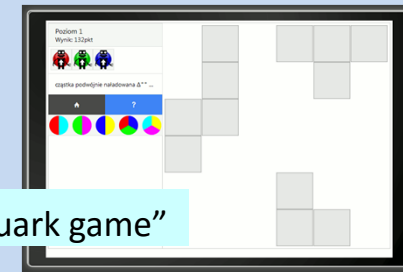
- 710 students in Poland (12960 in 46 countries)
- Among top five in Europe (Italy, Portugal, France, Germany, Poland)

- **Funding:** scarce individual grants SKILLS eNgage from the Foundation for Polish Science (≈ 100 000 PLN); support from institutions

19th Science Festival in Warszawa September 19-27, 2015



16th Science Festival in Kraków May 19-21, 2016



„Quark game”



"Star Dust" theatrical performance



Conferences



CERN Council Strategy Group

OPEN SYMPOSIUM ON EUROPEAN STRATEGY FOR PARTICLE PHYSICS

September 10th - 12th, 2012 Kraków, Poland

MESON 2016

14th International Workshop on Meson Production, Properties and Interactions

2nd - 7th June 2016, Kraków, Poland

A Panorama of Holography

56. Cracow School of Theoretical Physics

May 24 - June 1, 2016 Zakopane, Poland

Theoretical Aspects of Neutrino Physics

February 2016, Łądek Zdrój

Trans-European School of High Energy Physics

Morsko, Poland

July 9-16, 2015

International Particle Physics Outreach Group

3rd Warsaw Spring Workshop CP violation

MATTER TO THE DEEPEST

13-18 September 2015 Ustron

11th IPPOG Meeting in Kraków

XXII Cracow EPIPHANY Conference on the Physics in LHC Run2

7-9 January 2016

DIS2014

Warsaw, 28 April - 2 May 2014

XI Workshop on Particle Correlations and Femtoscopy

3-7 November 2015 Warsaw, Poland

COSMO-15

7-11 SEPTEMBER 2015 WARSAW, POLAND

Low-x Meeting 2015

1-5 September, Sandomierz, Poland

"Collider Physics" 2nd Symposium of the Division for Physics of Fundamental Interactions of the Polish Physical Society

13-15 May 2015 Katowice

SCALARS 2015

03-07 December 2015 Warsaw, Poland

2nd Belle II Theory Interface Platform (B2TIP) Workshop

Krakow Poland

27-29 April 2015

Neutrino Day

Warsaw

14 January 2014

1st Symposium of the Division for Physics of Fundamental Interactions of the Polish Physical Society

Various Faces of QCD

Institute of Physics, Jan Kochanowski University Kielce, Poland

May 10-11, 2014

Status of the Standard Model after the first LHC Phase

7-8 april 2014

LHCphenonnet Summer School

Cracow, Poland

7-12 September 2013

The Third Strangeness Workshop

Spring 2016

Warsaw Poland April 22-23

Theory Meeting Experiment 2014 :: Neutrinos And Cosmos

Warsaw, September 3-5, 2014

Warsaw Workshop on Non-Standard Dark Matter: multicomponent scenarios and beyond

stringtheory.pl

Teoria string w Polsce

Warsaw

PLANCK 2012

FROM THE PLANCK SCALE TO THE ELECTROWEAK SCALE

28 MAY - 1 JUNE 2012, WARSAW, POLAND

Astroparticle Physics in Poland

Warsaw, May 11-13, 2015

PASCOS 2014

22-27 JUNE · WARSAW, POLAND

20th International Symposium on Particles, Strings and Cosmology

Weak Points

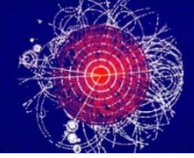


- **Funding:**

- generally scarce and short –term
- the overall tendency to finance rather „applications” instead of „basic research”
- the lack of stable, separate funding for generic activities (e.g. detector R&D at CERN)
- difficulties in getting recognition from the National Science Centre (NCN), while applying for R&D and/or not-yet-approved projects
- lack of balance: salaries for professor positions only half of those from external sources (ESR, ER (ITN))
- difficulties in encouraging foreign candidates to apply for positions
- the scarce resources and major bureaucratic troubles while attempting for finances from signed bilateral agreements
- decreasing amount of statutory (budget) funding which is crucial for starting any new activity or international collaboration

- Decreasing number of students in physics and their quality
- Substantial migration of students abroad and also from smaller Polish centers to bigger ones
- Growing administrative (paperwork) burdens

RECFA Recommendations from 2012



The RECFA committee would like to encourage the Polish colleagues to continue their comprehensive programme. **However, where appropriate, the efforts of smaller groups should be joined to make an even larger impact in the experiments. The introduction of a national coordination body which peer reviews the projects and proposes priorities in particle and astroparticle physics research could be helpful in this respect.**



- Some progress in consolidation of Polish HEP community
- Several groups are highly visible in native collaborations
- The Consortium of Polish High Energy Physics has been set up as the body representing units involved in HEP research, in particular to coordinate the efforts related to funding HEP activities in Poland

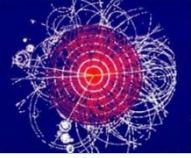


The scientific programme of the Polish particle and astroparticle physics community is indeed impressive, **especially when considering the rather limited research budget available. Moreover, the funding system for science is not necessarily very suitable for long time projects.** ... In many sciences larger and larger projects over increasing time periods are necessary. **To cope with this evolution we would like to encourage the installation of an additional scheme for the funding of long time projects.**



- Still lacking: the separate, stable path of funding activities at CERN (in spite of many efforts, coordinated by the Consortium)
- Longer-term (5 years) funding path now opened by Ministry of Science & Higher Education (open competition with other branches of science)

RECFA Recommendations from 2012



We would like to suggest to make PhD studies more attractive at Polish institutions, for example by supporting also long time stays of students at the laboratories where experiments with Polish participation are conducted.



- *Preparations to launch the programme of long-time stayings at CERN of Polish PhD students were quite advanced. They were, however, turned down by the authorities*
- *The National Science Centre has opened new grants (ETIUDA) offering PhD students few months of staying at external science centre*

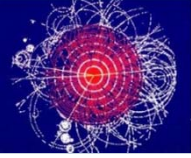


The mobility of scientists should be supported in general. This could be achieved by introducing special regulations to reduce the financial load for institutions sending their employees abroad



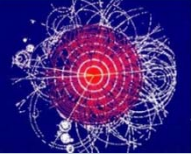
- *Short stayings related to e.g. shifts, meetings are still covered mainly from grants and internal funds of Institutions.*
- *Some (limited) improvement: mobility grants offered by the Ministry of Science and Higher Education, for travels abroad as well as for post-docs willing to change the group inside Poland*

Summary



- Polish HEP community is active and visible in all four LHC collaborations, as well as in other CERN experiments.
- Significant involvements of Polish researchers in other laboratories (Belle II, neutrino and astroparticle physics, ILC, ...).
- Polish theorists: high quality and leading role in several domains e.g. Beyond the Standard Model theories, Monte Carlo generators.
- Many valuable activities in accelerator physics, detector R&D, GRID computing and outreach.
- Several issues of funding still troublesome.

Acknowledgements



Special thanks to

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who contributed enormously by collecting inputs, giving comments/remarks ...