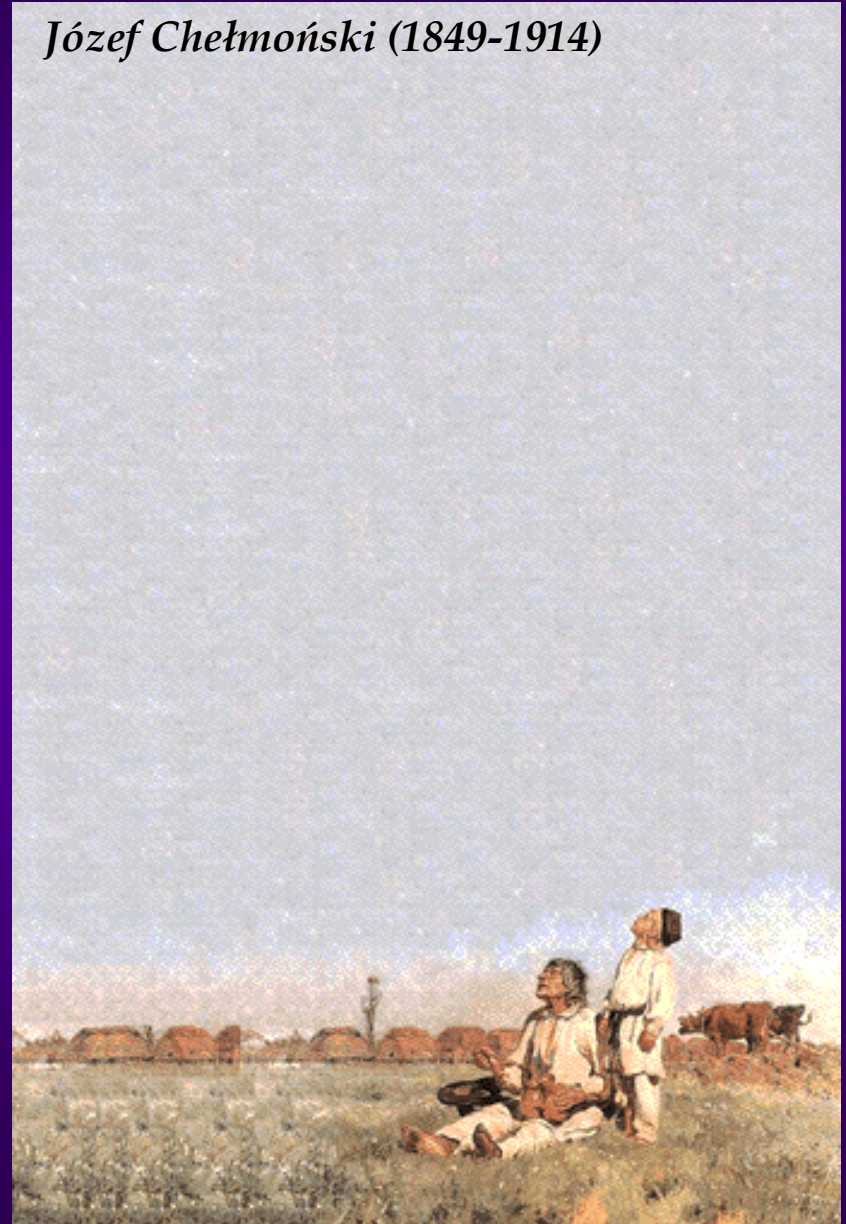


# ***Astroparticle Physics in Poland***

*Józef Chełmoński (1849-1914)*



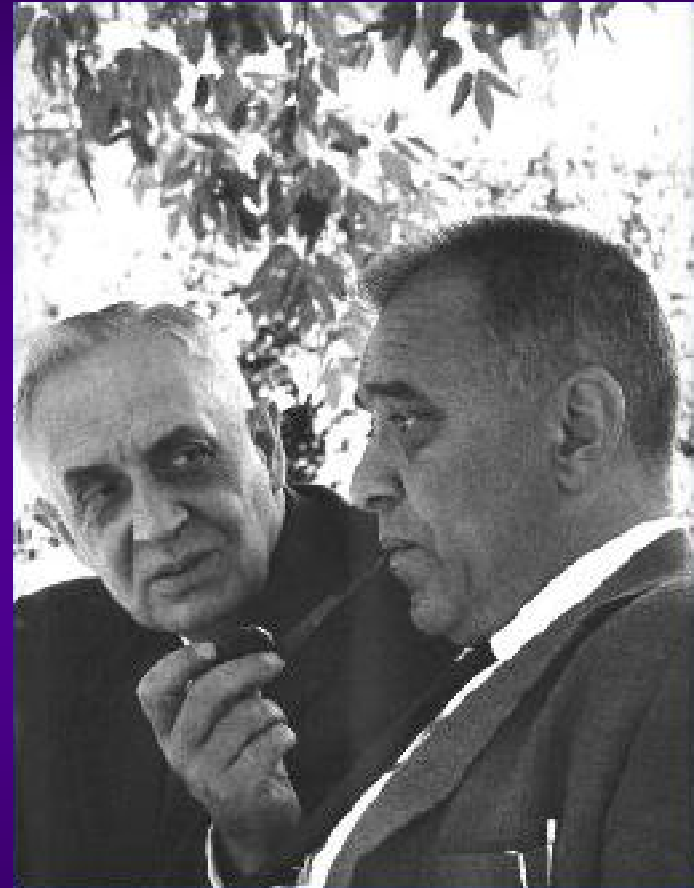
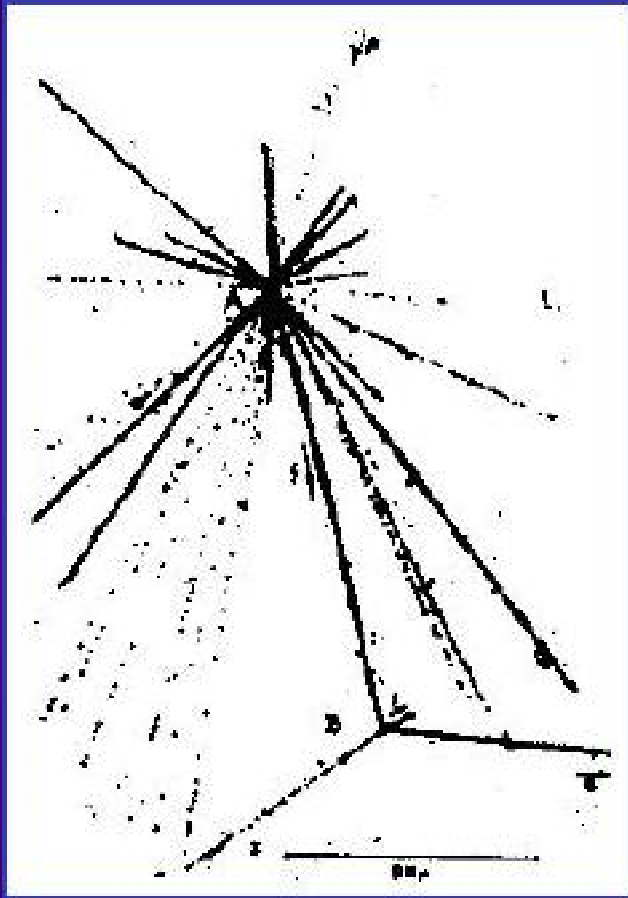
**Grzegorz Wrochna**  
*Soltan Institute for Nuclear Studies*

# ***Astroparticle Physics in Poland***

**Grzegorz Wrochna**  
**Sołtan Institute for Nuclear Studies**



# ***Discovery of hypernucleus in 1952***



**Jerzy Pniewski & Marian Danysz**

# ***Astroparticle Physics in Poland***

Several groups, 2-10 people each

- ◆ **Cosmic rays**
- ◆ **Space weather**
- ◆ **Extraterrestrial neutrinos** — talk by D.Kielczewska
- ◆ **Gamma Ray Bursts**

*Fuzzy boundary between astronomy  
and particle physics ...*

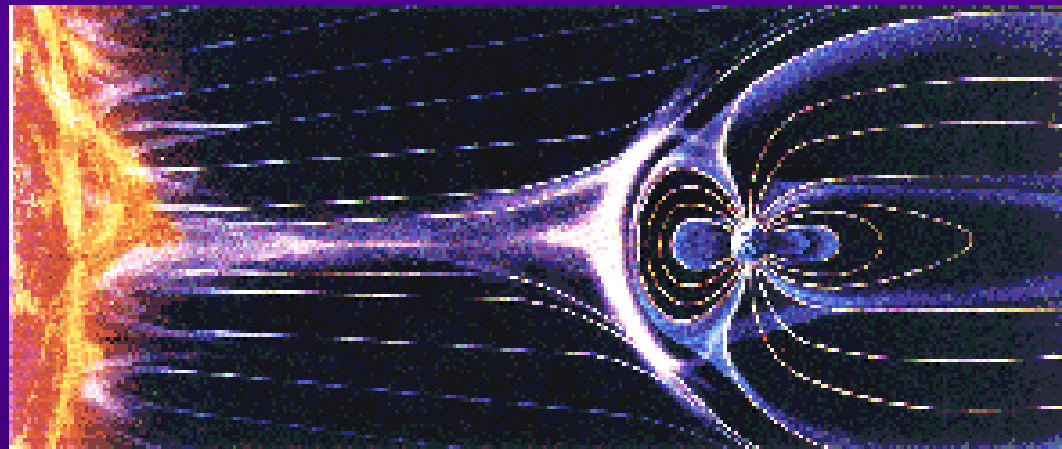
# ***Space Research Centres of Polish Academy of Sciences***

**Warszawa - [www.cbk.waw.pl](http://www.cbk.waw.pl)**

**Wrocław - [www.cbk.pan.wroc.pl](http://www.cbk.pan.wroc.pl)**

**Satellite instruments  
for monitoring  
„space weather”:**

- ◆ **solar activity**
- ◆ **magnetosphere**
- ◆ **radiation intensity**



**Regional Warning Center - [www.cbk.waw.pl/rwc1](http://www.cbk.waw.pl/rwc1)**



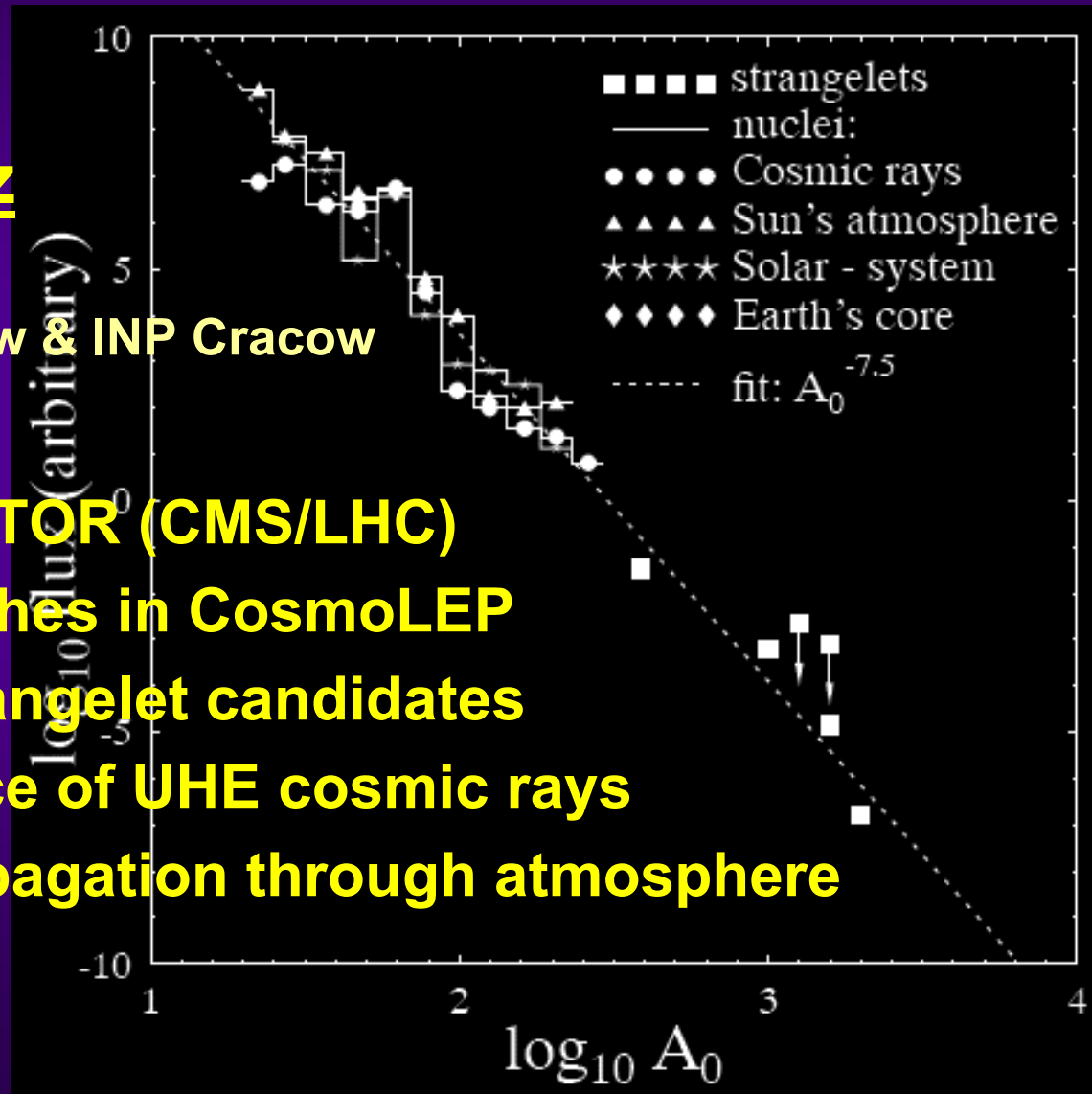
# Kielce - Świętokrzyska Academy

Institute of Physics  
[www.pu.kielce.pl/fiz](http://www.pu.kielce.pl/fiz)

Collaboration: SINS Warsaw & INP Cracow

## Strangelets:

- ◆ search for s. in CASTOR (CMS/LHC)
- ◆ study of muon bunches in CosmoLEP
- ◆ interpretation of strangelet candidates
- ◆ strangelets as source of UHE cosmic rays
- ◆ simulation of s. propagation through atmosphere

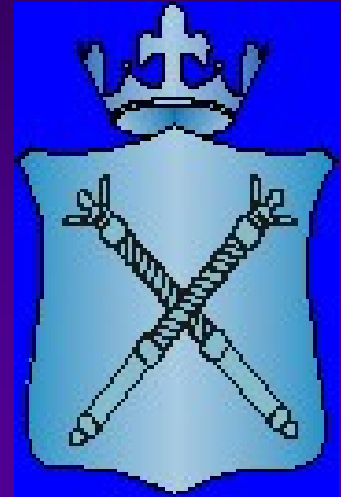


# Kraków

Jagiellonian University  
Astronomical Observatory

[www.oa.uj.edu.pl](http://www.oa.uj.edu.pl)

- Theory of cosmic ray acceleration in interstellar turbulences and shock waves



Institute of Nuclear Physics  
Polish Academy of Sciences  
IFJ PAN - [www.ifj.edu.pl](http://www.ifj.edu.pl)

- Participation in the Pierre Auger Project



# The Pierre Auger Project



A new cosmic ray observatory to study the **highest energy cosmic rays**

Explaining their origin is one of the most prominent problems in present-day astrophysics

Record: **cosmic ray extensive air showers**

Determine:

**cosmic ray energy spectrum**

**arrival directions**

**composition**

Two large air shower detector systems,  
3000 km<sup>2</sup> each:

**Mendoza, Argentina** (construction underway)

**Utah or Colorado, USA** (in planning)

*Hybrid detection system → unprecedented accuracy of extensive air shower measurements*

**15 countries – 50 institutions**

**[www.auger.org](http://www.auger.org)**





# Auger Construction Plan

Years 2000–2001: **Engineering Array**

32 prototype surface detector stations / 2 prototype fluorescence detectors

Year 2002–2003: **Pre-production**

Year 2003–2006: **Full production and deployment**

*Auger already is the largest cosmic ray detection system in the world*

**Preliminary data analysis:**

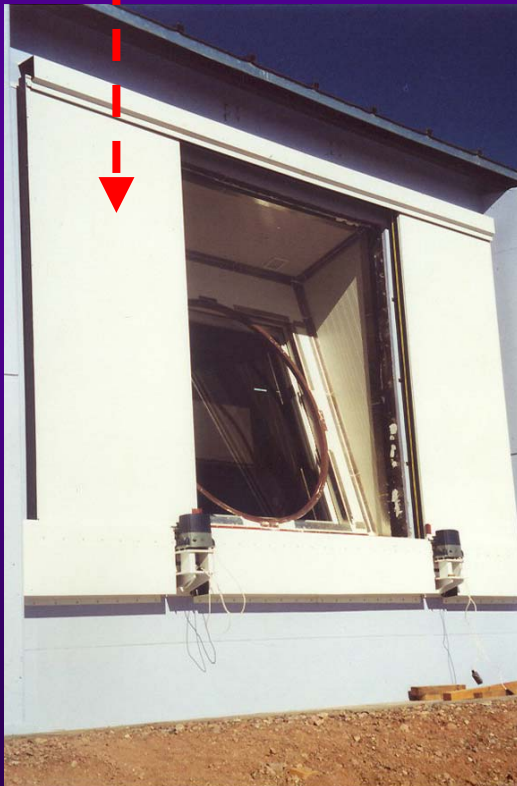
**first science results expected in 2005**



# IFJ PAN participation in Auger - 1

Construction of the Observatory:  
provided parts for mechanical structure  
of the fluorescence detector telescopes

- Aperture box structure
- Mirror mounts
- External shutters



# IFJ PAN participation in Auger - 2

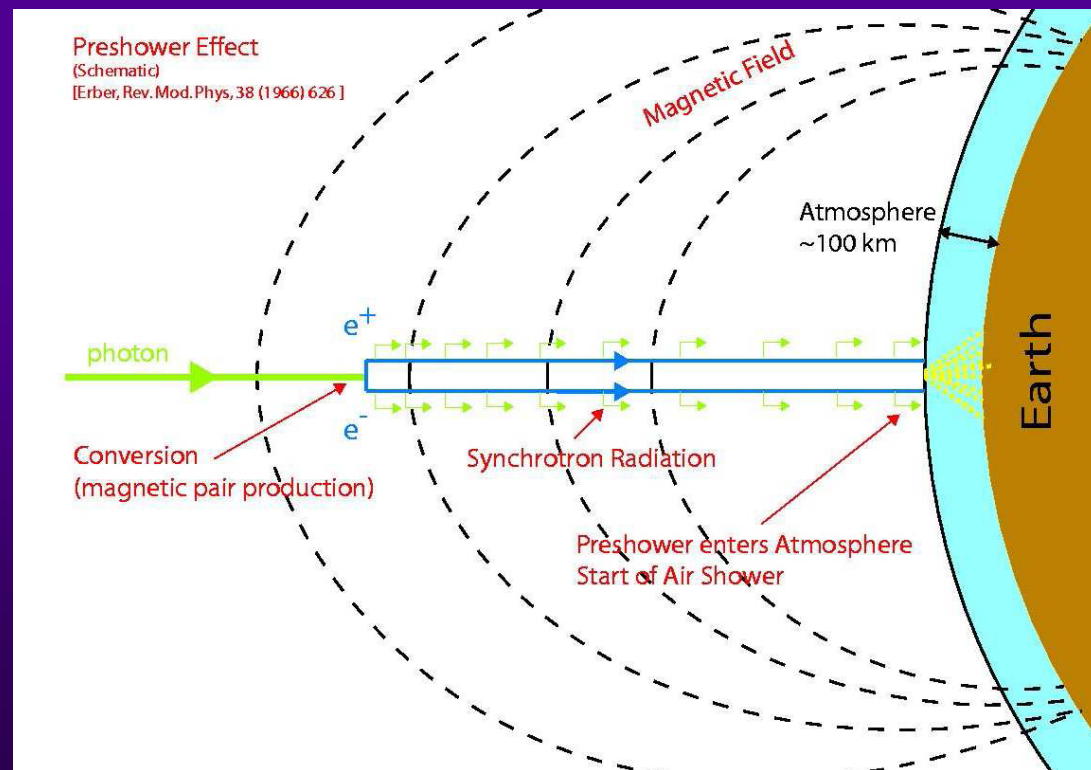
## Improving fluorescence technique of shower detection

- refined the procedure of air shower energy determination (account of lateral spread of air showers)
- better account of atmospheric effects (atmospheric density profiles *measured* instead of a *model*, correction for multiple scattering of light)

## Identification of photons in UHE cosmic rays

### Study of the preshowering effect: photon conversion in geomagnetic field and subsequent air shower development

- developed a procedure to determine the fraction of photons in UHECR
- set the (preliminary) experimental upper limit on photon fraction in UHECR





# ***University of Łódź***

## **Department of Experimental Physics**

**[kfd2.fic.uni.lodz.pl](http://kfd2.fic.uni.lodz.pl)**

### **Division of Cosmic Rays**

- high energy cosmic rays (experiment Auger)
- gamma-ray astronomy (MAGIC)
- cosmic ray interactions in the atmosphere  
(experiment Pamir)

### **Division of High Energy Astrophysics**

- models and mechanisms of X-ray and gamma-ray production  
in cosmic sources
- sources of high energy cosmic ray particles
- acceleration of particles and their propagation inside sources
- propagation of cosmic rays in the Galactic and intergalactic medium

# Łódź - *Sołtan Institute for Nuclear Studies*

## Department of Cosmic Ray Physics

[ipj.u.lodz.pl](http://ipj.u.lodz.pl)

### Domestic experiments:

- Extensive Air Shower (EAS) detector:  $E > 10^{15} \text{eV}$
- Underground Muon Telescope:  $E > 5 \text{GeV}$
- Roland Maze Project

### International experiments:

- Kascade, Kascade Grande (Karlsruhe)
- Baksan (Kaukaz)
- EAS detection at Airbus A380 (College de France)

### Theory, modelling:

- multiparticle production by cosmic rays
- cosmic rays and microwave background correlations

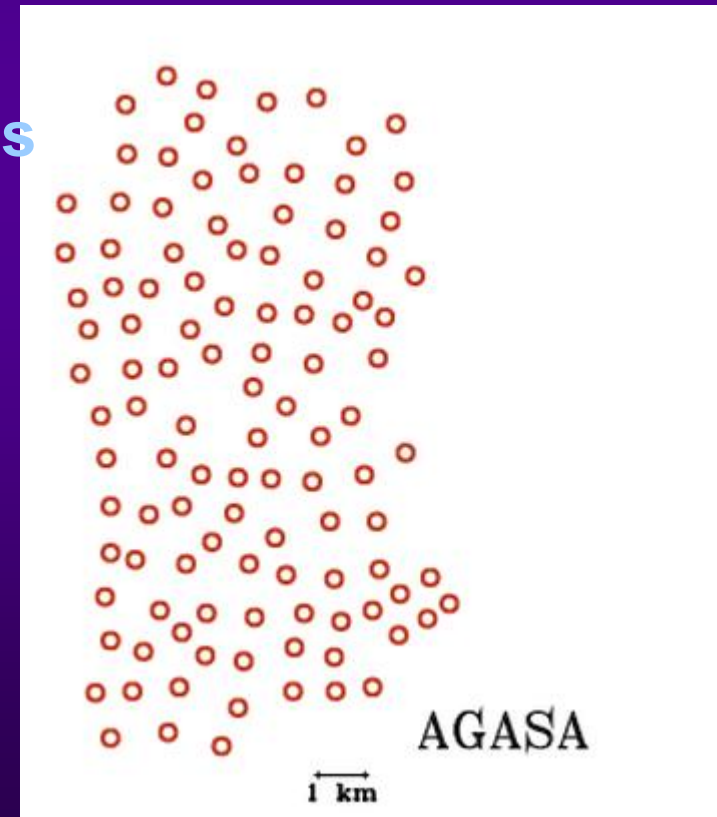
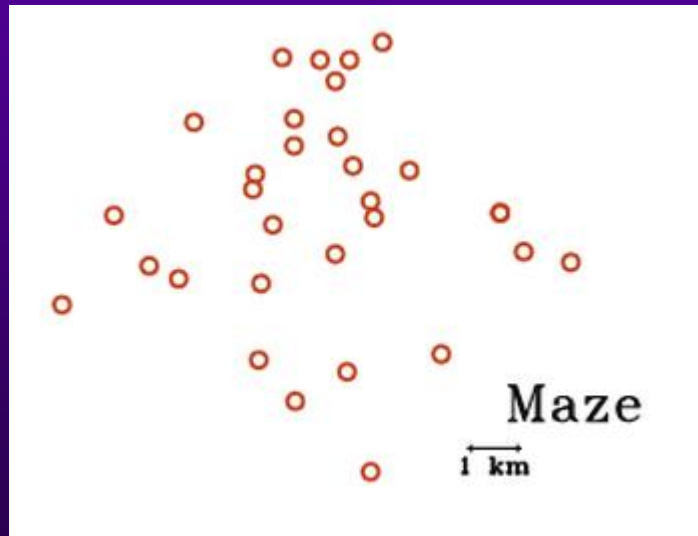




# Łódź - *Sołtan Institute for Nuclear Studies*

## The Roland Maze Project: science + education

- Cosmic ray detectors distributed in schools
- 4 detectors per school
- Detector = 1m<sup>2</sup> of scintillator + PM
- GPS synchronisation (RMS=2ns)
- Local data preprocessing in schools
- Central data storage in the Institute



# Gamma Ray Bursts (GRB)

- Short (0.01-100s) pulses of  $\gamma$  rays  
from pointlike sources in the sky
- Extragalactic origin ( $<13$  M ly,  $z<4.6$ )
- Huge energy:  $10^{51}$  ergs
- Hypothesis (500 papers/year):
  - **supernova collapsing to black hole**
  - **two neutron stars merging into black hole**
  - **creation of quark star**
- Very frequent: 2-3/day (1-2/week detected by satellites)
- Information distributed to ground telescopes etc.  
via GRB Coordinate Network (GCN)
- So far:
  - **~3000 GRB detected by satellites**
  - **~50 observed optically from ground after h or days**
  - **only 1 observed in real time (1 min after GRB)**

# **„ $\pi$ of the Sky”** [grb.fuw.edu.pl](http://grb.fuw.edu.pl)

**„Particle physics – like” way to search for GRB**

- ◆ Continuous monitoring of all ( $>\pi$ ) sky
- ◆ On-line data processing
- ◆ Multilevel trigger system

**Participants:**

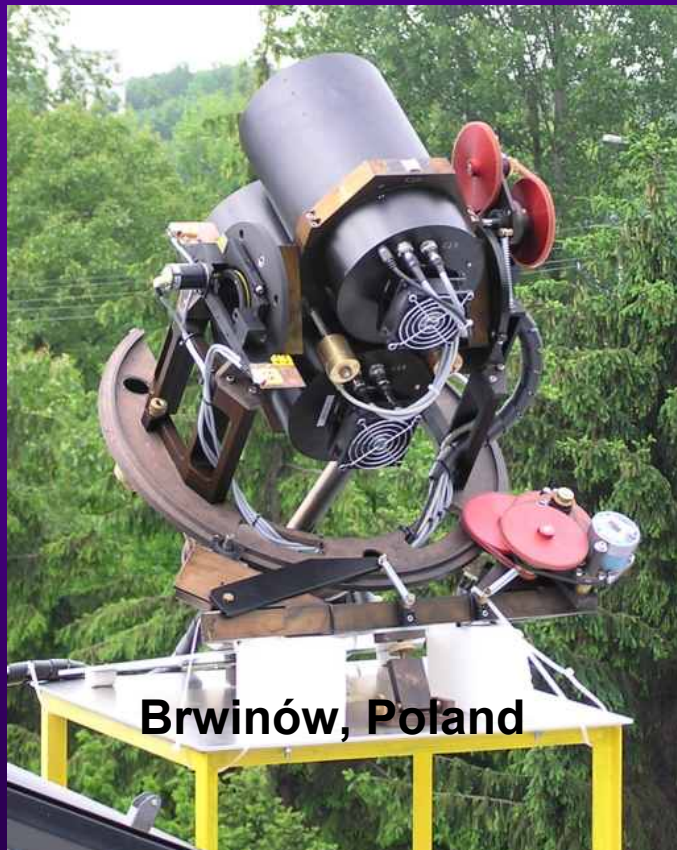
- ◆ **Sołtan Institute for Nuclear Studies, Warsaw/Świerk**
- ◆ **Center for Theoretical Physics, Polish Acad. of Sc.**
- ◆ **Institute of Experimental Physics, Warsaw Univ.**
- ◆ **Warsaw University of Technology**

**In collaboration with:**

- ◆ **Princeton University**
- ◆ **Astronomical Observatory of Warsaw Univ.**

# **„ $\pi$ of the Sky” prototype**

**2 CCD cameras  
covering  $33^\circ \times 33^\circ$**



**Las Campanas Observatory, Chile**



**First results (7.2004-2.2005):**

- 3 limits shortly after GRB
- 1<sup>st</sup> ever limit during GRB
- 1 candidate (not confirmed)



# **„ $\pi$ of the Sky” perspectives**

**2005** – 2×16 cameras to cover all sky

- grant application positively recommended

**2006** – prototype of high sensitivity camera  
for next generation system (>100 cameras)

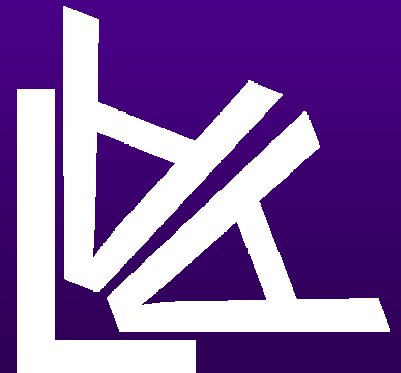
- plan to apply for EU FP7 grant

**2007** – small systems at Greenland and Antarctica

- EoI submitted for International Polar Year

**Proposal to establish**

***Laboratory for Astroparticle Apparatus***  
within Sołtan Institute of Nuclear Studies





# ***Particle physics or Astronomy?***

**I predict – they will merge quite soon**

- Particle physics came from space (cosmic rays)
- The Universe is full of powerfull accelerators
- Particle physics is a key stone of cosmology
- **Recently** – also experimental technics become similar

CCD invention for astronomy was like wire chamber for particle physics.

Astronomy is now moving from single observations of individual objects to massive data acquisition from millions of objects.

All sky surveys, farms of robotic telescopes, etc ...

" $4\pi$ " detectors, huge data streams analysed online, multilevel trigger systems ...

**all that we know so well ...**

# *Nicolaus Copernicus*

The first Polish expert on analysis of large data samples



*Jan Matejko*  
(1838-1893)



