Cosmic Particle School – Projects at DESY

Start of activities: **2004**

2 kinds of experiments:

- **Simple „hands-on":**

  Kamiokannen

  Scintillation detectors (QNet)

- **Web-interface expt's:**

  Trigger Hodoscope

  Cosmic-Detector on Icebreaker
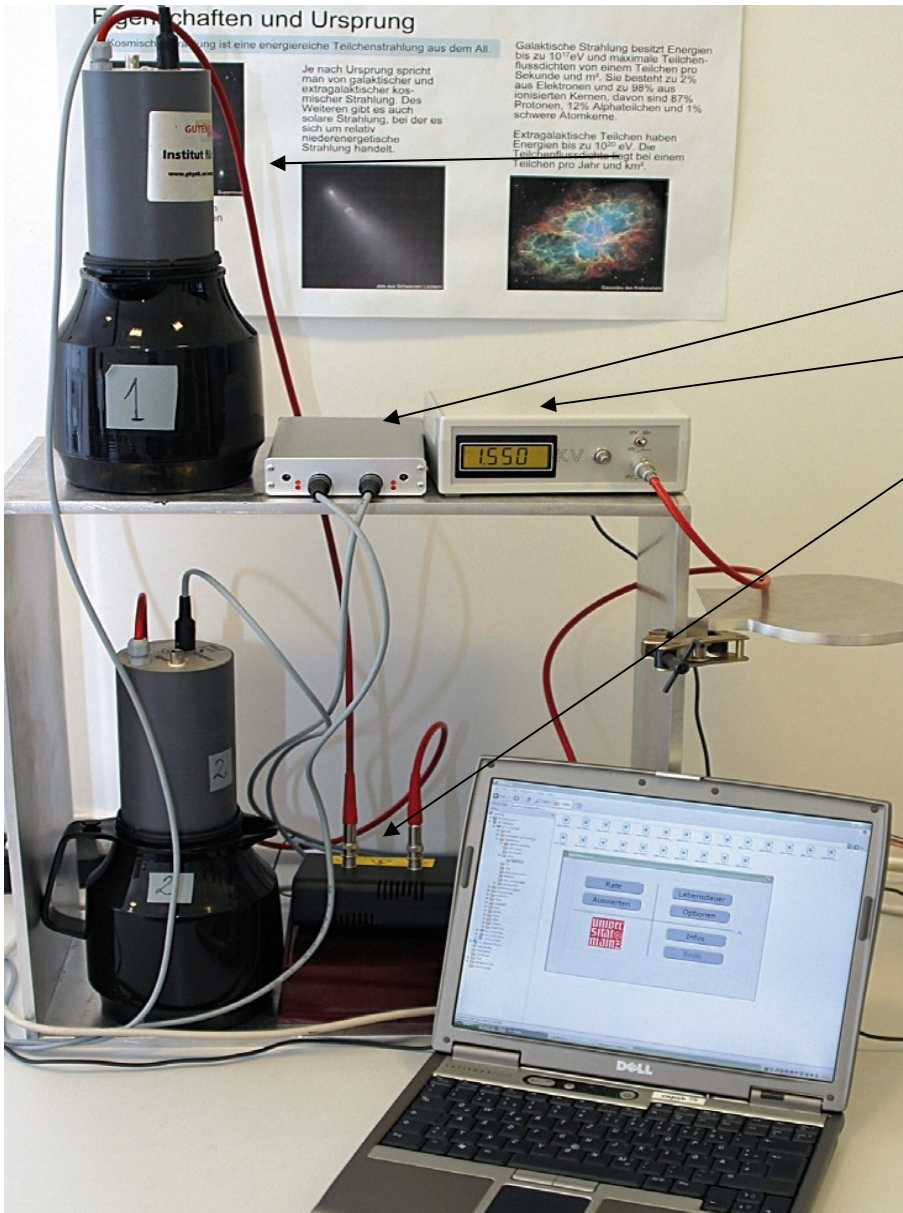
  Future experiments

Kamiokannen

- **Developer:**   Univ. Mainz
- **Detector:**   thermos flask & water
                        & photomultiplier
- **Detection:**   Cherenkov light
- **Expt's with 2 flasks in coincidence:**
  - rate in dependence of angle
  - rate in depend. of absorber material in front or in-between flasks
  - measurem. time: few hours
- **Expt's with 1 flask:**
  - muon lifetime
  - measurem. time: few days

Kamiokannen (2)

- **Components of experiment:**
    - **2 thermos flasks**
    - **DAQ box**
    - **High Voltage Supply**
    - **HV distribution**
    - **Notebook**
- **Software:**   **LabView program „Kanne"**
- **Analysis:**   **Excel tables**
- **Usage:**   **at DESY or lend for 2-3 weeks**
- **Problems:**   **old / bad DAQ**

Scintillation Detectors (QNet)
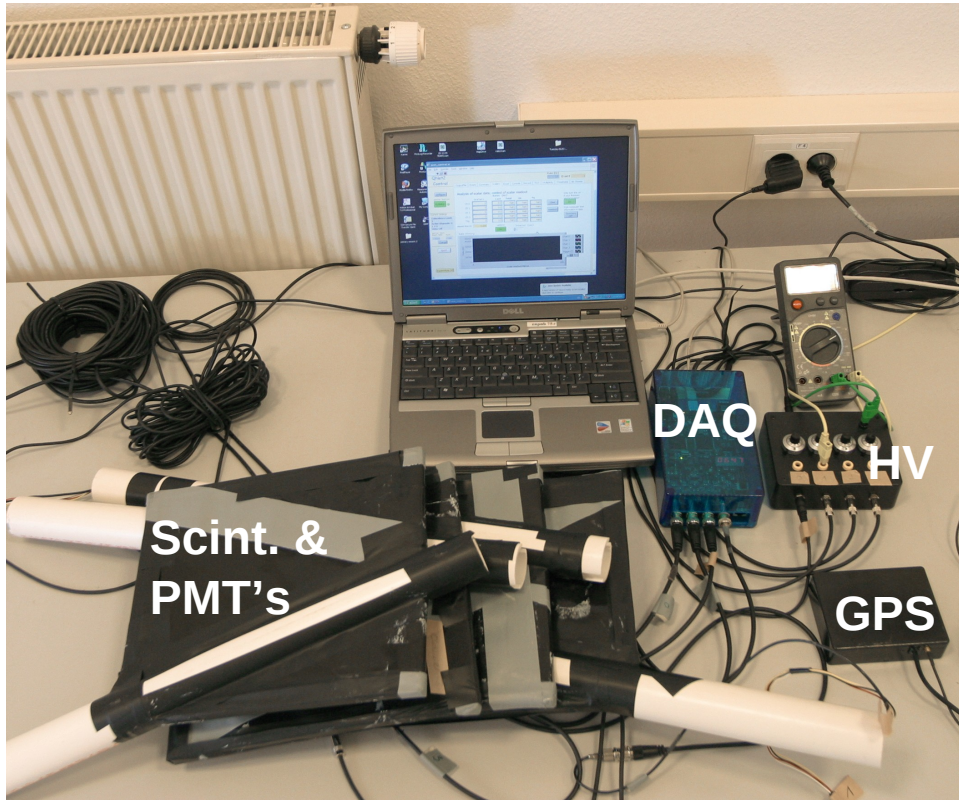
- **Developer:**   Fermilab/USA
- **Detector:**   scintillators
  & Photomultiplier
- **Detection:**   scintillation light
- **Components:**
  - 4 detectors
  - HV supply for PMT's
  - DAQ board:
  - GPS board
  - Notebook

- **Software:** LabView „qnet-desy"
  or Python program or Fermilab web-side:

  http://www18.i2u2.org/elab/cosmic/home/project.jsp

- **Other detectors:** scintillators & PMT's from old expt's
  connected to QNet DAQ board

Scintillation Detectors (2)

- **Expt's with Qnet DAQ:**
  - **particle rate in depend. of angular and of absorber material**
  - **particle showers (with 4 detectors)**
  - **muon lifetime**
  - **muon velocity**
- **Data analysis:**
  - **with special Python or C++ programs or via Fermilab website**

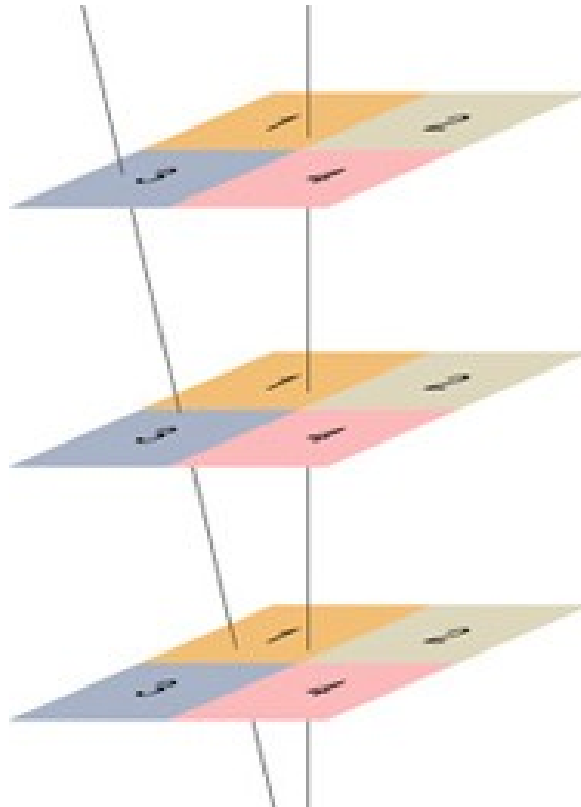**Shower Meassurement**

Muon lifetime
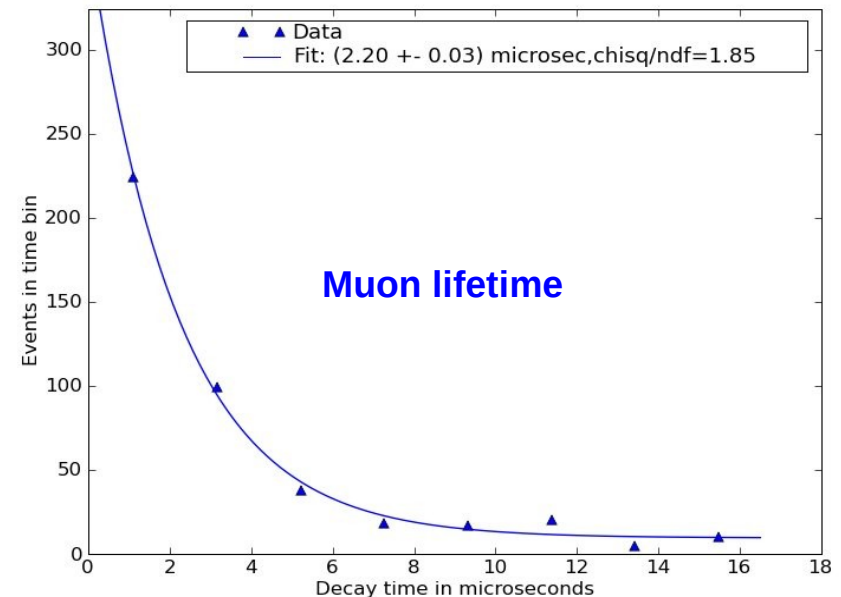
Trigger Hodoscope

- **Developer:** **DESY L3-cosmic group**
- **Detector:** **3 scintillator planes (1 m^2) from L3-cosmic**
  every plane 4 segments (0.5x0.5 m^2)
- **Trigger condition:** **signals in every plane and in >= 1 segment**
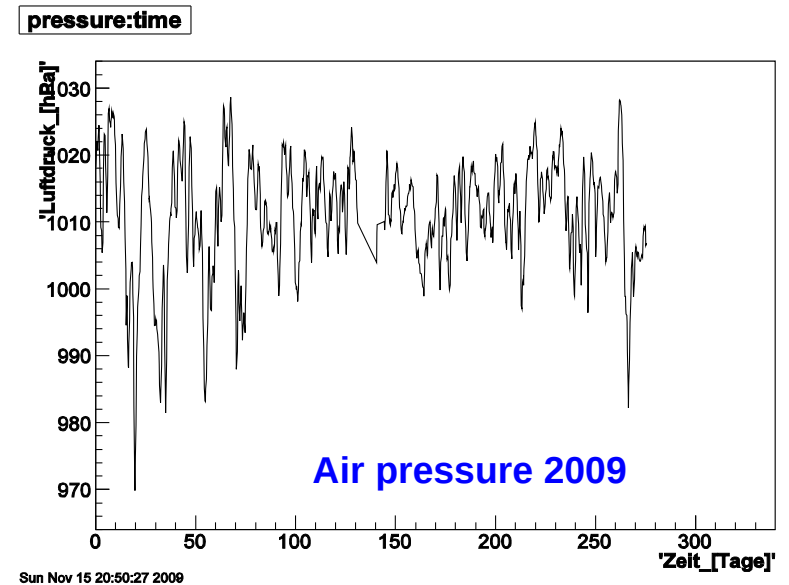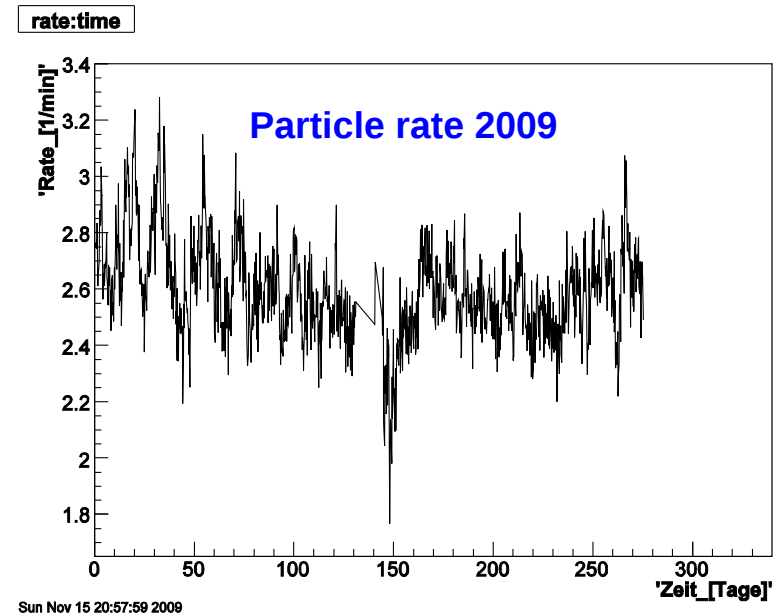
- **Components:**
  - **scintillators & PMT's**
  - **DAQ trigger boards**
  - **weather station**
  - **notebook**
  - **web-server**
  - **web-interface**
    (Root runs as black-box)
- **Data taking:** **since 2004**

Trigger Hodoscope (2)

- **Measurements:**
  - rate dependence on:
    - weather condition (pressure, temperature)
    - triggered segments ("angle", muon, shower)
    - time (years, monthes)
    - Sun cycle
  - search for Sun-flares ("cosmic weather")
- **Data analysis:**
  - via web-interface http://schlab.ifh.de/trigger
  - after ~30 sec histogram pops up

rate:time

Particle rate 2009

'Rate_[1/min]'

'Zeit_[Tage]'

Sun Nov 15 20:57:59 2009

pressure:time

'Luftdruck_[hBa]'

Air pressure 2009

'Zeit_[Tage]'

Sun Nov 15 20:50:27 2009

Cosmic Detector around the World

Notebook

HV supply

DAQ

Scint. counters

Container with detector
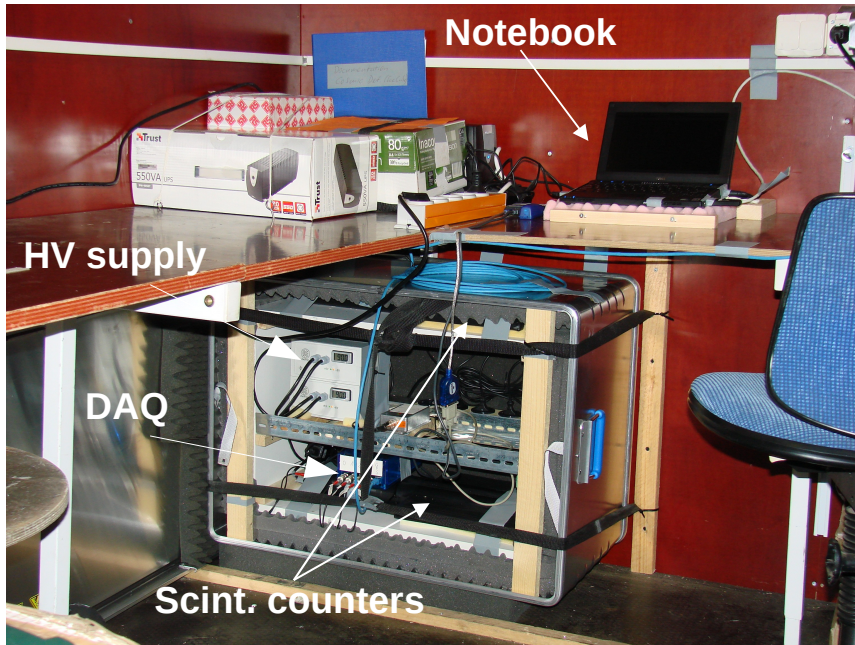
- **Detector: 2 scintillation counters**
- **Components:**
  - **scintillators & PMT's**
  - **QNet DAQ board**
  - **HV supply**
  - **GPS board**
  - **air pressure & temp. sensor**
  - **inclination sensor**
  - **netbook: ubuntu**
  - **software: Python program**
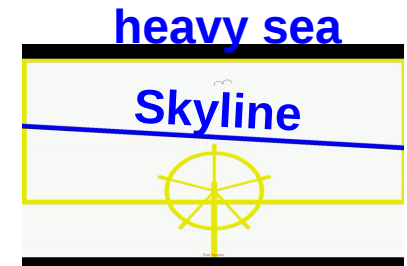- **Installation:**
  - **Swedish icebreaker „Oden"**
  - **19/11/2009 - 20/4/2010**
- **Data: Triggerpulses, GPS data, pressure, temp., inclination**

Cosmic Detector around the World (2)

- **Possible Measurements:**
  - **rate dependence on:**
    - **air pressure & temp.**
    - **lattitude (geomagn. cut-off)**
    - **ship inclination**
  - **observ. of Sun flares**
- **Data analysis (planned):**
  - **via web-interface (DESY server)**
  - **via Fermilab web-side**
- **Oden route with google Earth:**
- **Examples for inclination:**

quiet sea

Skyline

heavy sea

Skyline
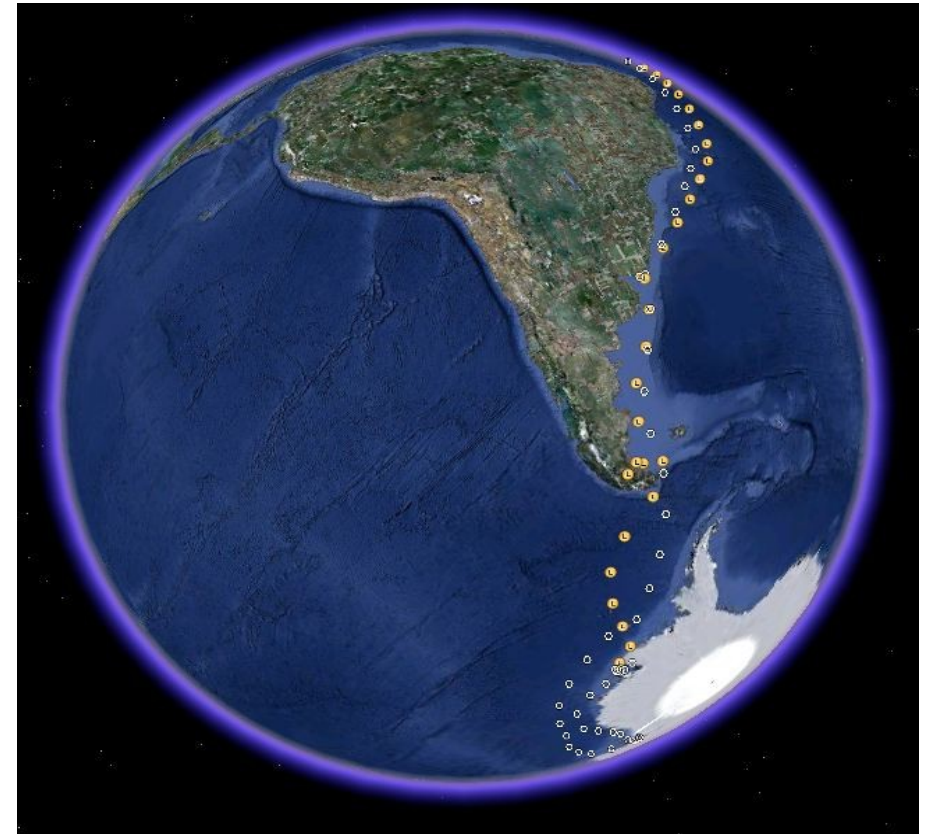
Future Web - Experiments

- **Data taking:** **continuously**
- **Analysis:** **web-interface**
- **Planned experiments:**
  - **cosmic part. "Mill":**
    rate dependence on angle
    (0°, 15°, 30°, 45°, 60°, 75°, 90°
    position with step motor)
    and air pressure
  - **continuation of "Oden" exp.:**
    detector installation on German
    research vessel "Polarstern",
    start 25/10/2010,
    measurement program as for
    "Oden"

Future Web – Experiments (2)

- **Planned experiments (cont.):**
  - **IceTop tank at DESY:**
    triggered by L3-cosmic planes,
    (2 vertical, 2 horizontal),
    calibration with muons,
    rate dependence,
    Sun-flares, cosmic weather
  - **Muon lifetime:**
    continuous data taking,
    high statistics,
    detector type not decided
    (calorimeter module or
    5-10 liter liquid scintillator & PMT

Project Topic: Physics

Particle Physics:

- Cosmic Particle Components:
  proton, light nuclei, electron, positron,
  muon, pion, kaon (particle decays)
  Masterclasses, particle physics at LHC:
  http://www.physicsmasterclasses.org

Physical Effects – Detectors:

- Ionisation of atoms (cloud chamber, Geiger-Müller counter)
- Photo effect   (Photomultiplier)
- Scintillation light   (fast particle detektors)
- Cherenkov-Effect   (detection of relativistic charged particles
                              in water, ice, air, gas)

Project Topic: Physik (2)

Special Theory of Relativity:

- Muon lifetime
- Muon velocity
- GPS functionality

Modern Astroparticle Physics Exp.:

- Auger   (protons, nuclei of highest energy)
- H.E.S.S. & MAGIC   (high-energy gamma-rays)
  IceCube   (high-energy neutrinos)

Project Topic: Astrophysics

Sources of Cosmic Particles (low-energy)

- Sun:
  photons, protons, neutrinos
  Sun wind, Sun flares, cosmic weather
  geomagnetic cut-off
- supernovae:
  neutrinos

Cosmic Accelerators:

- pulsars
- supernova remnants
- active galactic nuclei
- measurmenent of different "messanger" particles
  light, gamma-rays, charged particles, neutrinos

Project Topic: Statistics / IT

Statistical Methods:

• data analysis:

  mean values, statistical & systematical errors

• Excel program

• ROOT program (CERN)

IT / Software Development:

• Introduction into C++

•   "   "   Python

• animation of processes

Project Topic: History

Discovery of Cosmic Particles:

DESY will organize international conference

"100 years cosmic particles", August 6-8 2012

Cosmic Particles – Origin of Particle Physics:

Detectors / Experiments in historical context

Nobel Prizes:

- for cosmic particle physics
- for particle Physics
- for Astrophysics

Project Work at DESY

Praktika:

- 1-2 weeks, up to 6 weeks
- 2009: 17, 2010: 18 school students
- visit of computer center, PITZ- accel., workshops

Project Work over a School Year:

- 2 – 4 students per year

Examples for Project Reports:

- presentation
- website
- poster
- note

http://physik-begreifen-zeuthen.desy.de/offers/cosmic_radiation/project_reports/index_eng.html

Teacher Workshops:

- 2009: 94 at DESY,   2010: 22 at DESY, 35 at CERN

Answers from CERN Teacher WS

This week at CERN:

- **38 teachers**
- **2 hours cosmic particle program with Kamiokannen and Qnet detectors**
- **Questionary:**
- **Use of cosmic program:**

	++	+	-	--
in lectures:	19	35	39	7 %
practica:	13	41	34	12 %
1y project work:	32	26	19	23 %
Project instead examin.:	44	29	6	21 %

- **Use of detectors at school:**

buy:	3	9	23	69 %
rent from DESY:	32	29	27	12 %
Web-interface exp.:	15	62	12	12 %
Detector station at school:	43	20	23	14 %