Research possibilities at Veksler and Baldin Laboratory of High Energy Physics JINR (ЛФВЭ) - Polish activity.

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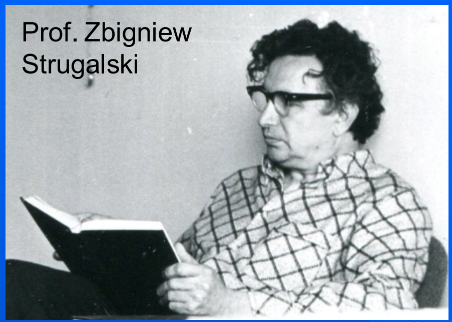
High Energy Physics Laboratory - Polish activity.

Outline

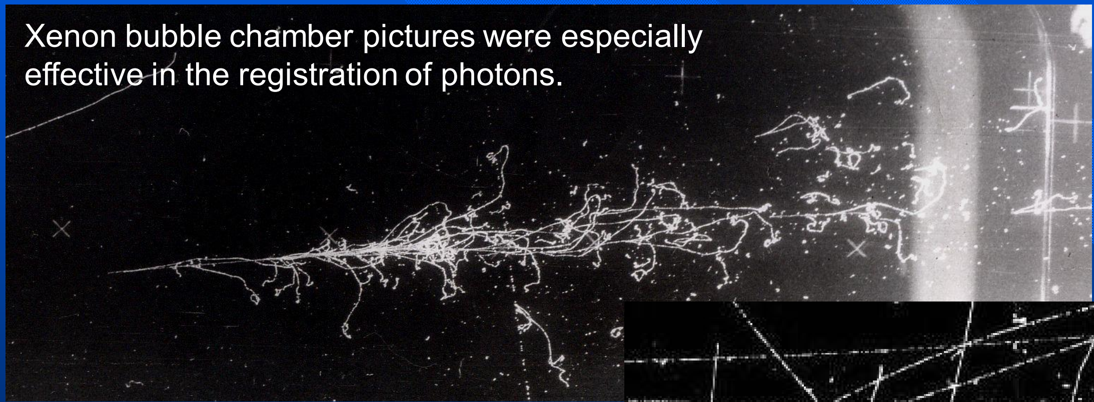
1. Review of cooperation development
2. NICA colider
3. Slow Control System
4. MCORD project
5. Kriogenic
6. Nuclear Phisics (Quinta)

1. Review of cooperation development – begin of cooperation

Almost half of century of cooperation in the domain of high energy physics

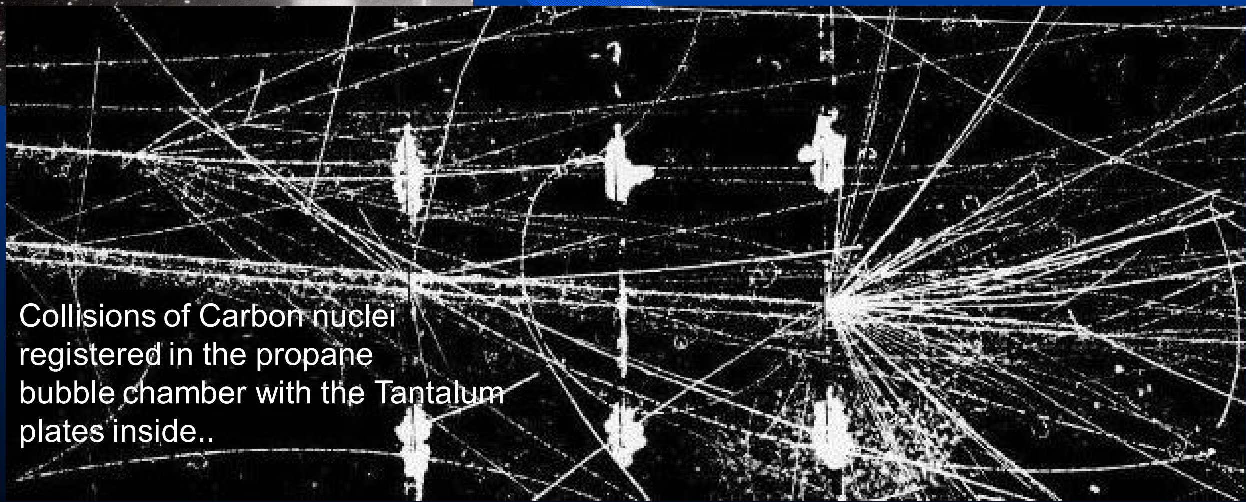


Zbigniew Strugalski (Deputy Director of the Laboratory of High Energies (LVE): 1969-72) has initiated and actively developed the cooperation of Polish institutions with LVE in the analysis of Xenon bubble chamber data. During almost 20 years many Polish physicists, mainly from the Institute of Physics Warsaw University of Technolohy worked effectively in the „Polish Sector" achieving scientific degrees of dr, dr hab. and prof.

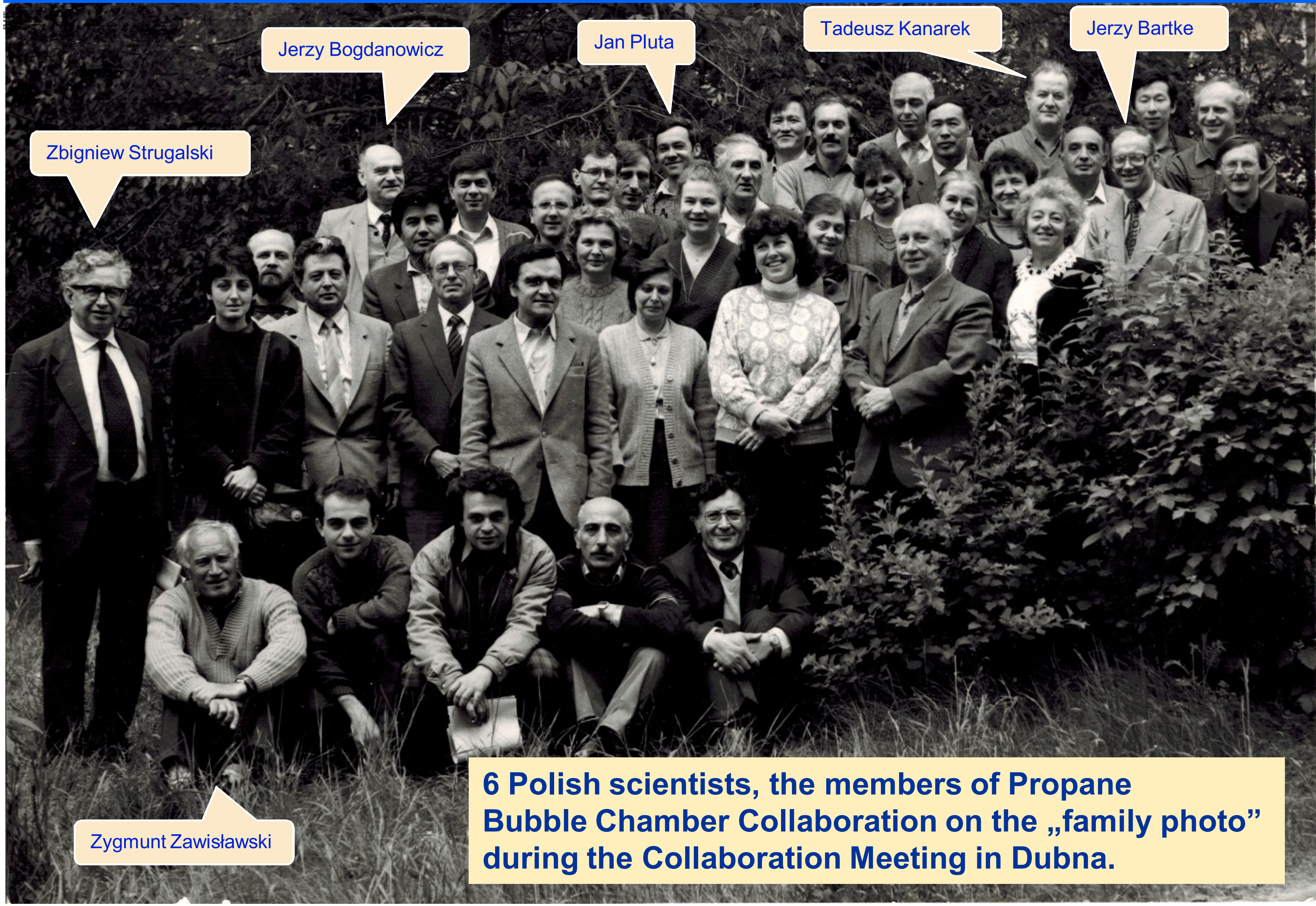


This participation was soon extended to the analysis of light and heavy ion collisions registered in the propane bubble chamber.

During the years (1978 – 84) the Deputy Director of LVE was again Polish scientist (**Jerzy Bartke**).



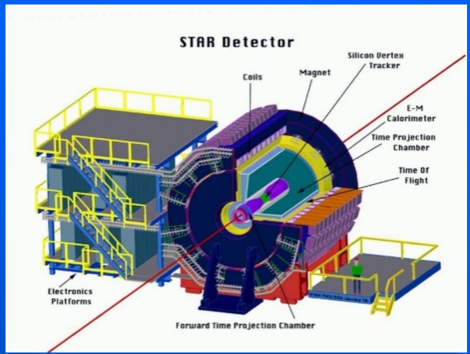
Propane Bubble Chamber Group meeting in Dubna



6 Polish scientists, the members of Propane Bubble Chamber Collaboration on the „family photo" during the Collaboration Meeting in Dubna.

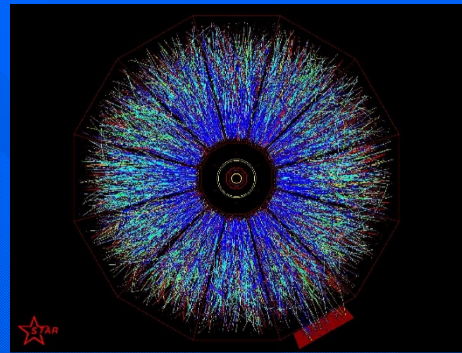
1. Review of cooperation development - External Activity

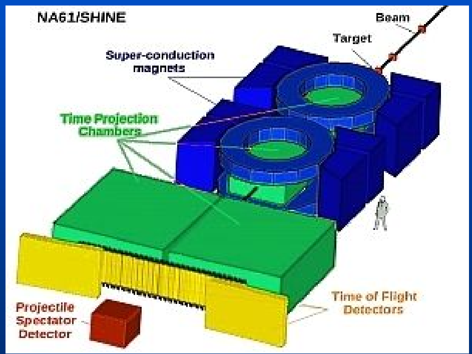
Participation of JINR and Polish physicists in the same heavy ion experiments at the largest physics laboratories; some examples



Brookhaven, RHIC

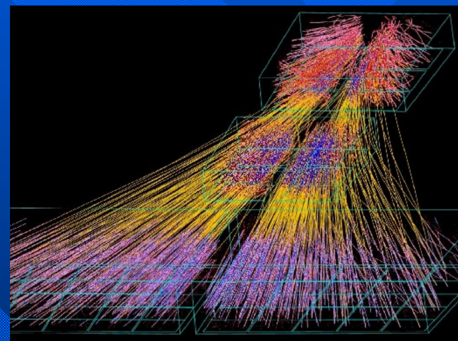
Experiment STAR

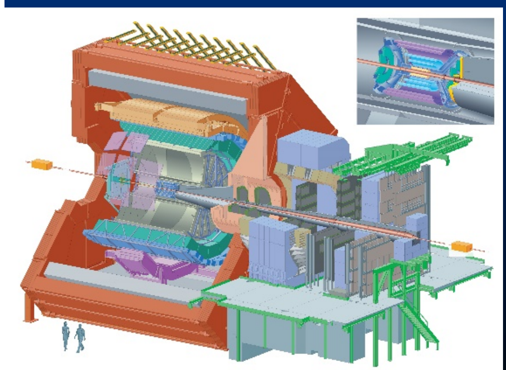




CERN SPS

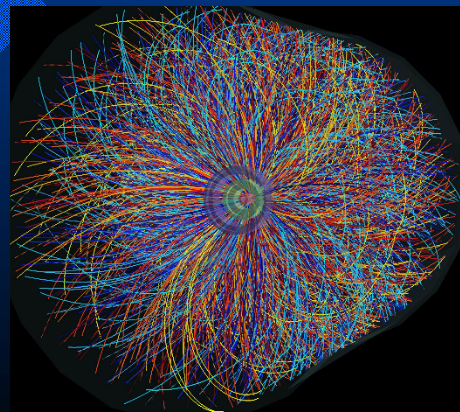
Experiments: NA49,NA61





CERN LHC

Experiment ALICE



1. Review of cooperation development – Collaboration Agreement

FRAMEWORK COLLABORATION AGREEMENT

(THE "AGREEMENT")

BETWEEN: WARSAW UNIVERSITY OF TECHNOLOGY ("WUT"), established at Warsaw, Poland, duly represented by Prof. Rajmund Bacewicz, Vice-Rector for Research,

AND: JOINT INSTITUTE FOR NUCLEAR RESEARCH ("JINR") an Intergovernmental Organization having its seat at Dubna, Russia, duly represented by Prof. Victor A. Matveev, Director of the JINR

Signed on 6 November 2015

The Warsaw University of Technology (WUT)	The Joint Institute for Nuclear Research (JINR)
....	....
Prof. Rajmund Bacewicz	Prof. Victor A. Matveev
Vice-Rector for Research	Director of the JINR

NICA - Nuclotron Ion Collider fAcility

BM@N - Baryonic Matter at Nuclotron

MPD - Multi-Purpose Detector

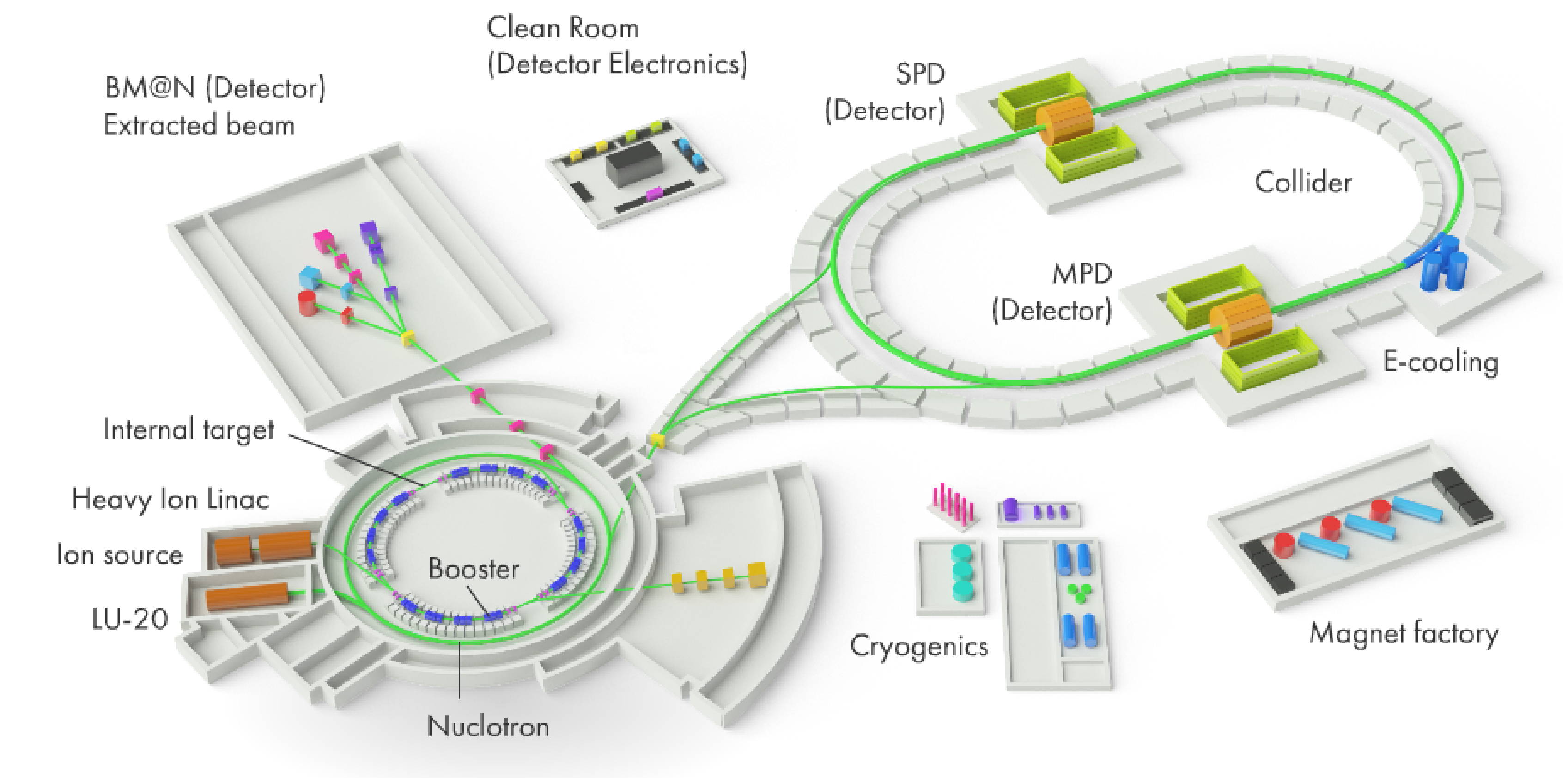
DCS - Detector Control System

EqDb – Equipment Database

SC – Slow Control

MCORD - MPD Cosmic Ray Detector

2. NICA complex



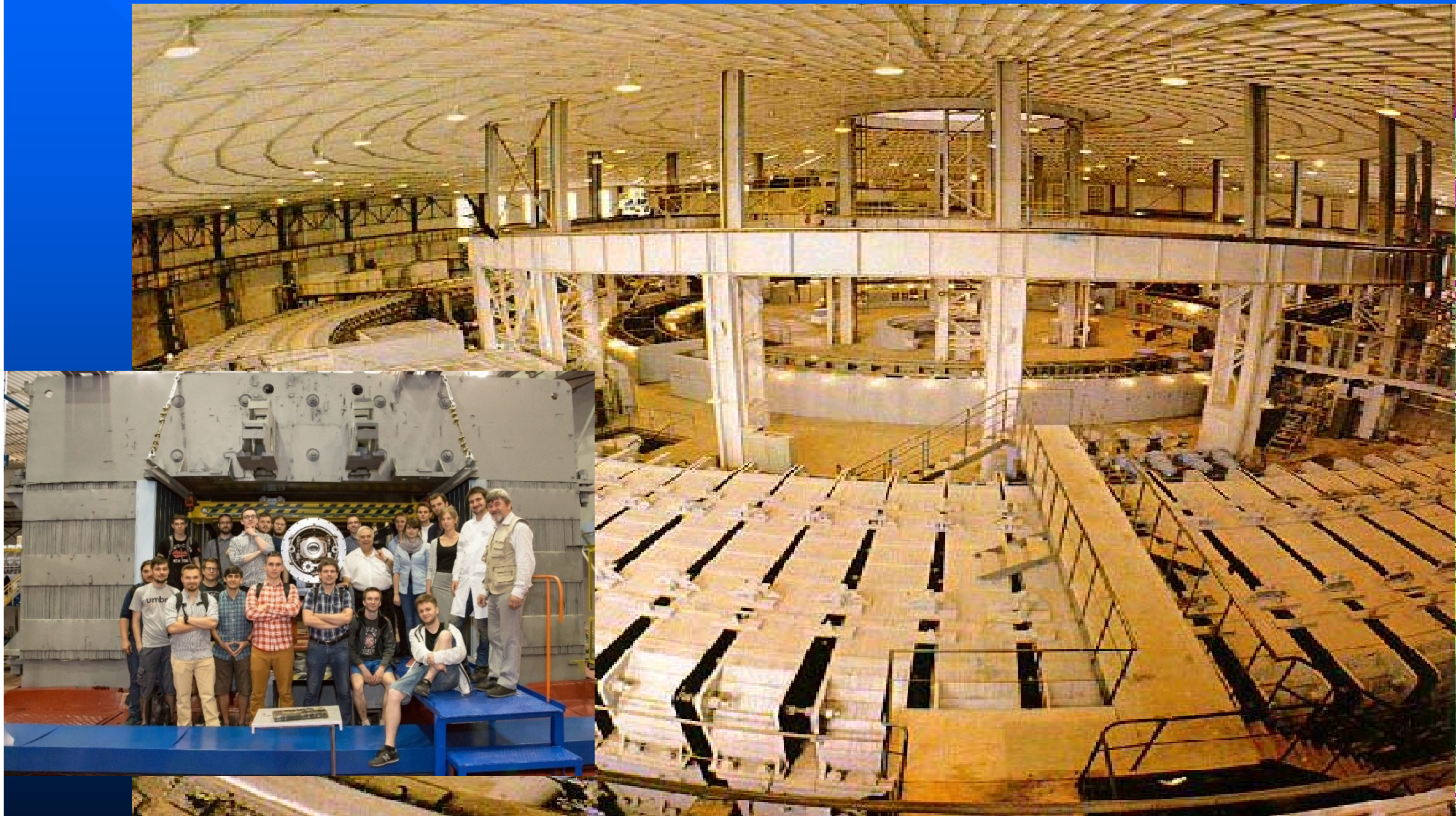
Polarised beams

LU-20
Nuclotron
Extracted beam
Internal target station
SPD (Detector)

Heavy Ions

Ion sourse (KRION-6T)
Heavy Ion Linac (HILac)
Booster
BM@N (Detector)
MPD (Detector)

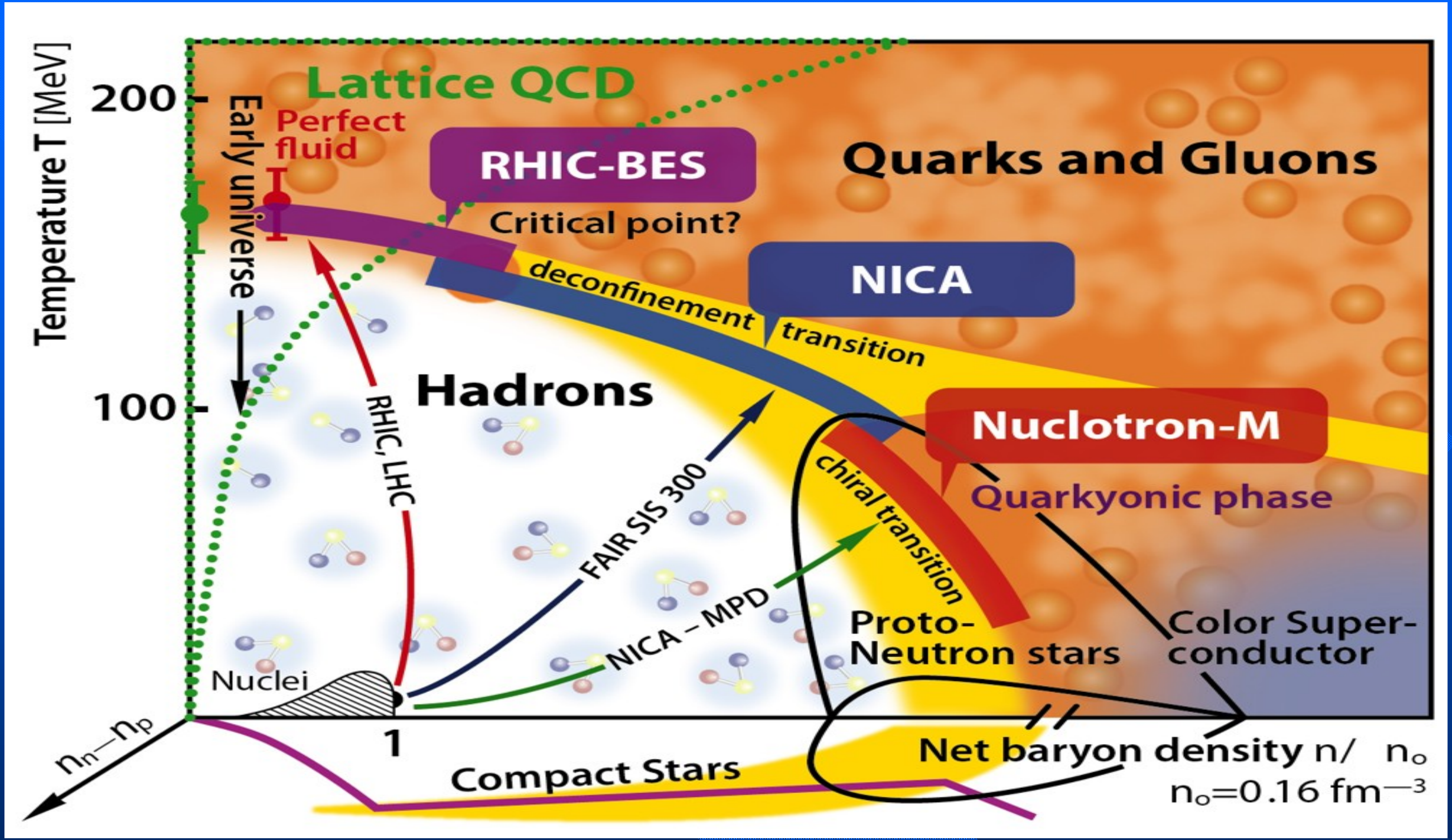
2. Old Sychrophasotron Magnets - Booster)



2. NICA complex

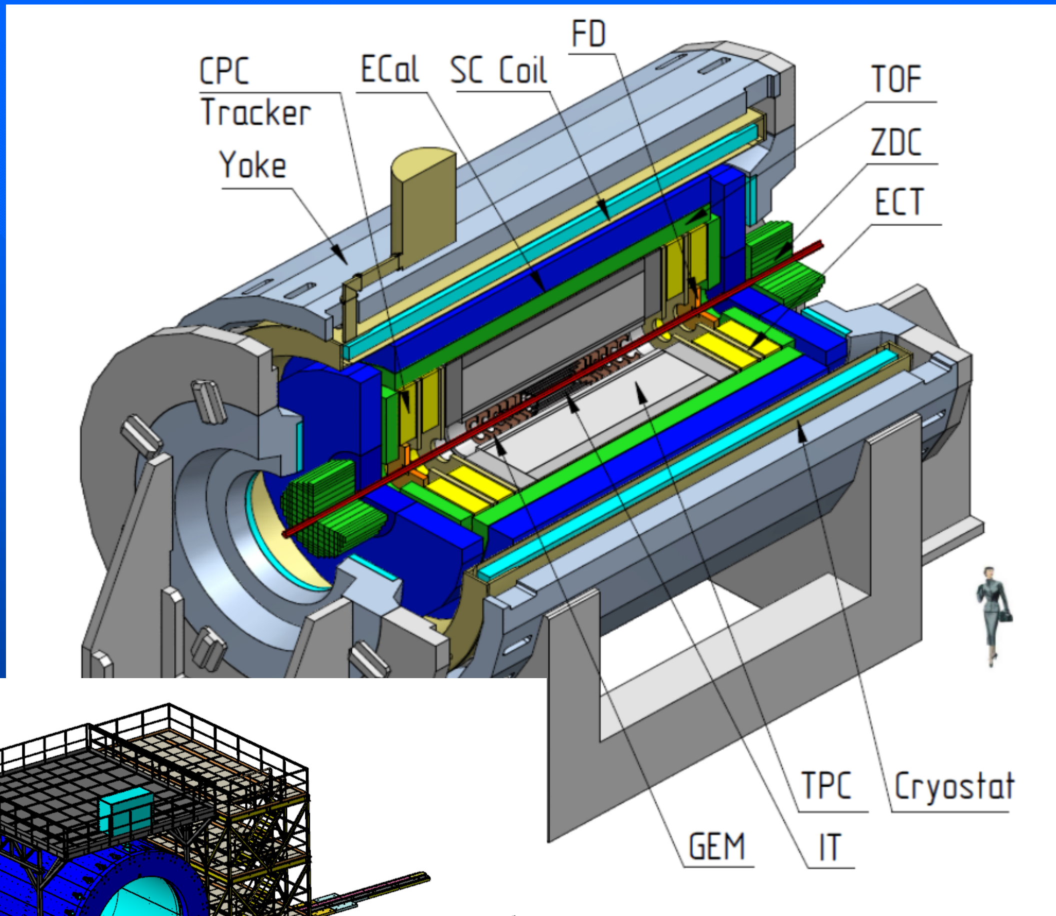
- **Nuclotron (VBLHE) – wide spectrum of possible energies E_p = 500 MeV to 8 GeV, strong focusing, 10^{12} – 10^{13} protons per hour**

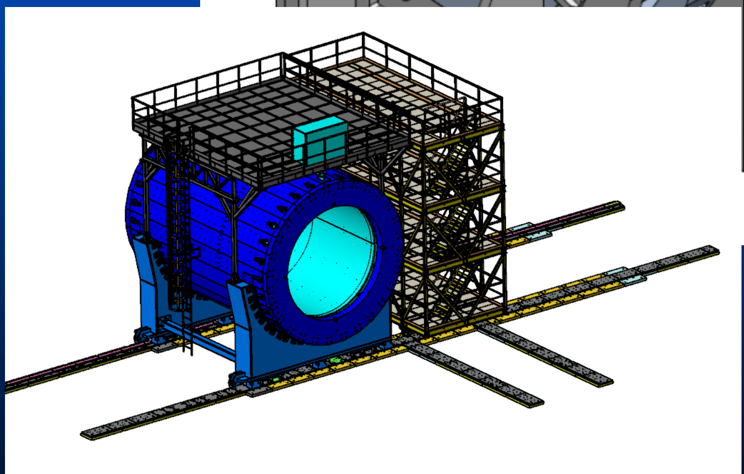
2. NICA complex



The international mega-science project “NICA complex” is aimed in the study in the laboratory of the properties of nuclear matter in the region of the maximum baryonic density.

2. NICA – MPD (Multi Purpose Detector)





- CD-central detector, and (FS-A, FS-B) - two forward spectrometers
- Superconductor solenoid (SC Coil) and magnet yoke
- inner detector (IT)
- straw-tube tracker (ECT)
- Time-projection chamber (TPC)
- Time-of-flight system (TOF)
- Electromagnetic calorimeter (EMC)
- Fast forward detectors (FFD)
- Zero degree calorimeter (ZDC).

http://nica.jinr.ru/video/general_compressed.mp4

3. Slow Control System

Suggestions: **DEFINITION**

DEFINITION:

The **S**low **C**ontrol **S**ystem (**SCS**) is an electronic system, which is intended to support and enable operation of complex equipment for any physical experiment, e.g. for detectors in high energy physics experiments.

Elektroniczny System sterowania procesami powolnymi (milisekundy i dłużej)

Umożliwia eksploatacje urządzeń elektronicznych w dowolnym eksperymencie

Np. detektorami lub urządzeniami kontrolnymi/sterującymi Ustawianie napięć dla wszystkich komponentów (np. tysiące detektorów)Ustawienia zapisane w bazie danych, i automatycznie ustawiane przez komputer . Bieżąca kontrola tych parametrów i korekta

3. Slow Control System

Suggestions: **CHARACTERISTICS**

CHARACTERISTICS of the SCS:

- Modular
- Scalable
- Multiuser
- Open
- EqDb (Database)

3. Slow Control System

Suggestions:

BLOK DIAGRAM SCS

Area of the SCS Slow Control System

MASTER SCS

- The CONTAINER,
- CABINET (RACK) 42 U;
- COMPUTER HARDWARE;
- The terminals
- Engineering panels
- Service panels
- The server
- Workstations

Eq Db

EqDb | EqDb | EqDb | EqDb

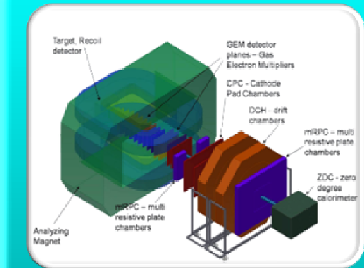
IT DAQ

DIGITAL
- Ethernet FO, Cu
- USB
- RS-232, RS-485
- TTL 0-5 V
- Relay I/O

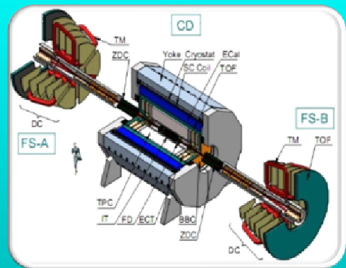
ANALOG
- 0-10 V
- 0-20 mA
- Other

SYSTEM
- CAMAC
- NI PXI; NI RIO
- NIM
- VMEbus
- PLC / PAC

THE INTERRUPT REGISTER
- Digital



THE LAYOUT OF THE CONTROLLED for example... . BM@N
- GEM – Gaseous Electron Multipliers
- DCH – Drift Chamber
- STR – Straw Tubes
- ToF – Time of Flight
- mRPC -Multigap Resistive Plate Chamber
- ZDC - Zero Degree Calorimeter
- TO - Fast Start Detector



THE LAYOUT OF THE CONTROLLED for example... MPD
- TPC – Time Projection Chamber
- IT – Inner Tracker
- TOF –Time of Flight
- FD - Forward Detector
- EMC – Electromagnetic Calorimeter
- ECT - Straw Tube Tracker
- FD - Fast Detector
- BBC – Beam Beam Counter
- ZDC – Zero Degree Calorimeter

3. Slow Control System

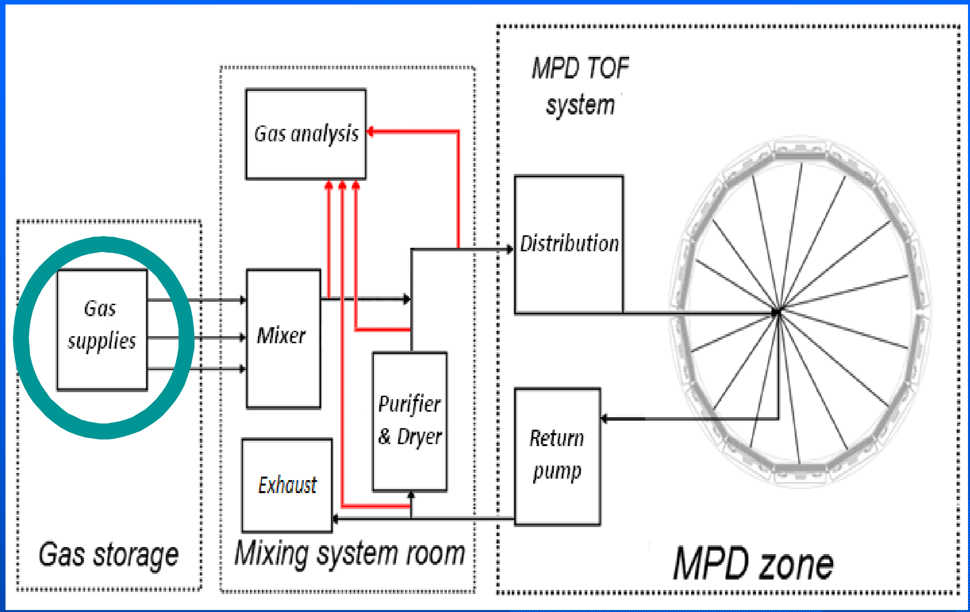
– IMPLEMENTATION; BASE UNIT 42U;

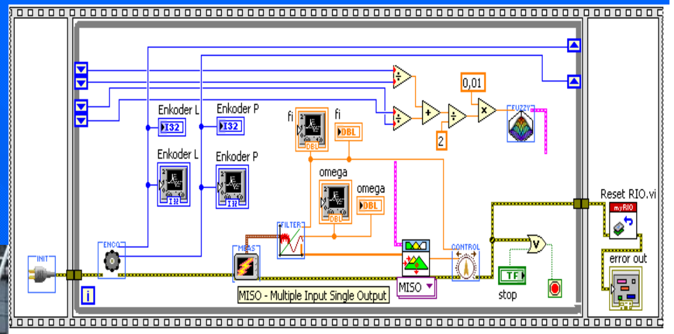
WUT-JINR VPN

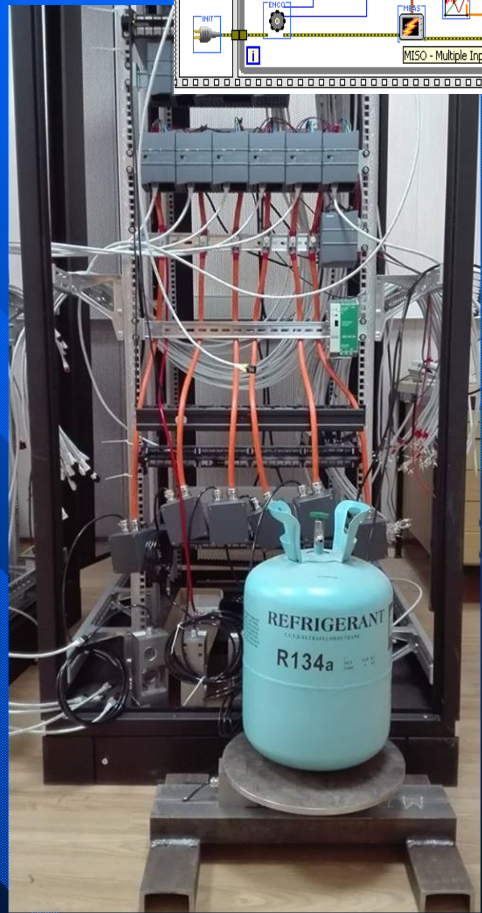
3. Gaz system for TOF (Time-of-Flight detector) detectors

90% $C_2H_2F_4$ + 5% $i\text{-}C_4H_{10}$ + 5% SF_6

3. Gaz system descryption

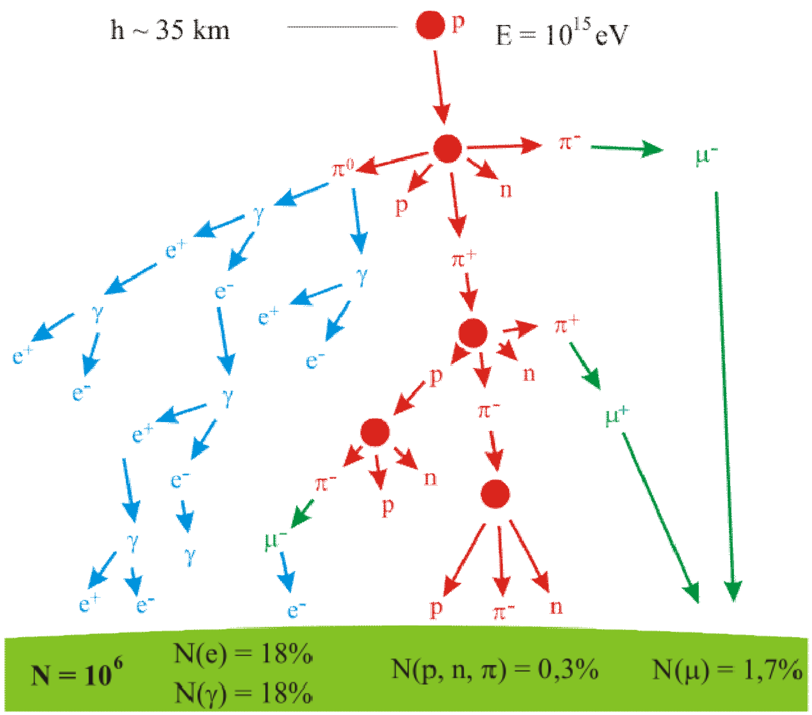




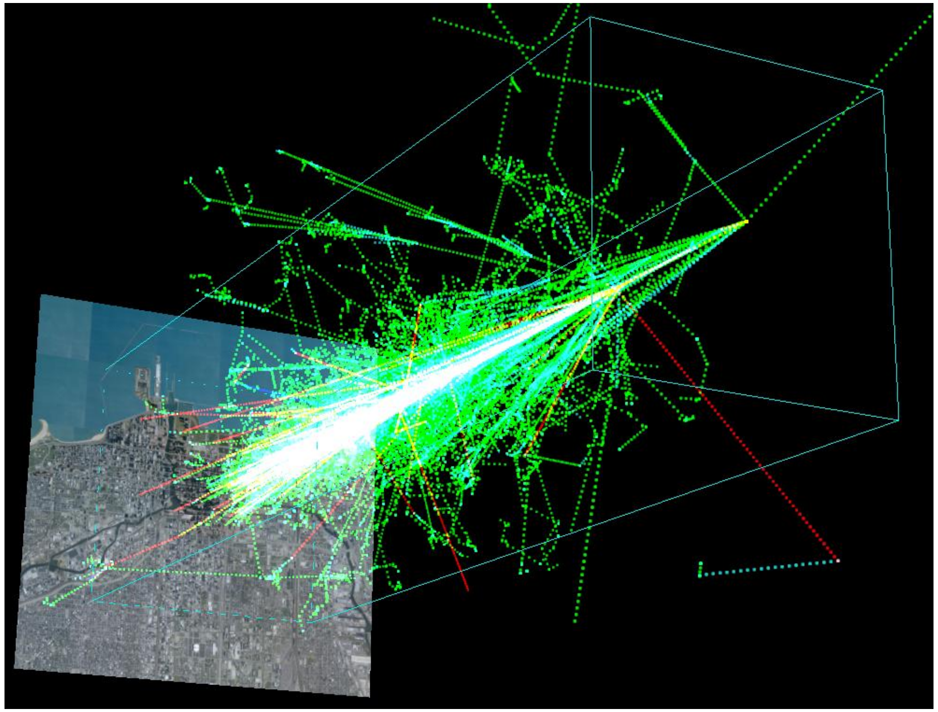


4. Cosmic Ray Detector – Goals

PRIMARY PARTICLE

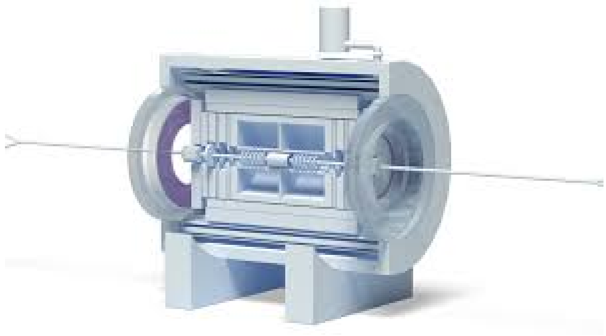


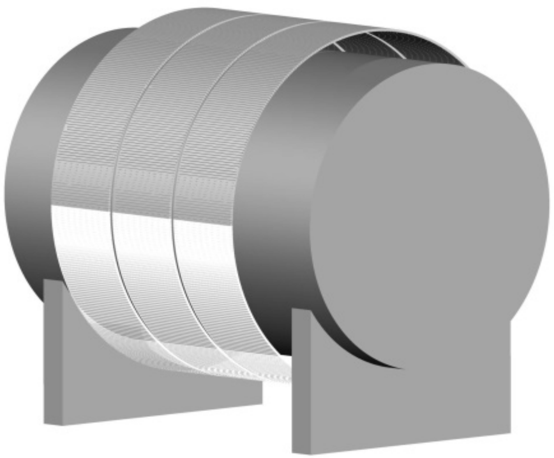
GROUND LEVEL

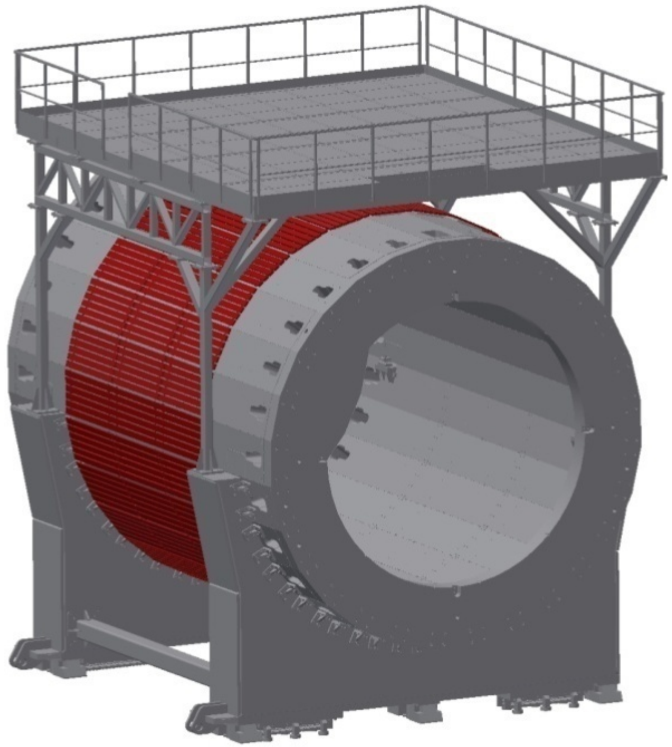


Cosmic ray air shower created by a 1TeV proton hitting the atmosphere 20 km above the Earth. The shower was simulated using the AIRES package.

4. MCORD - proposition

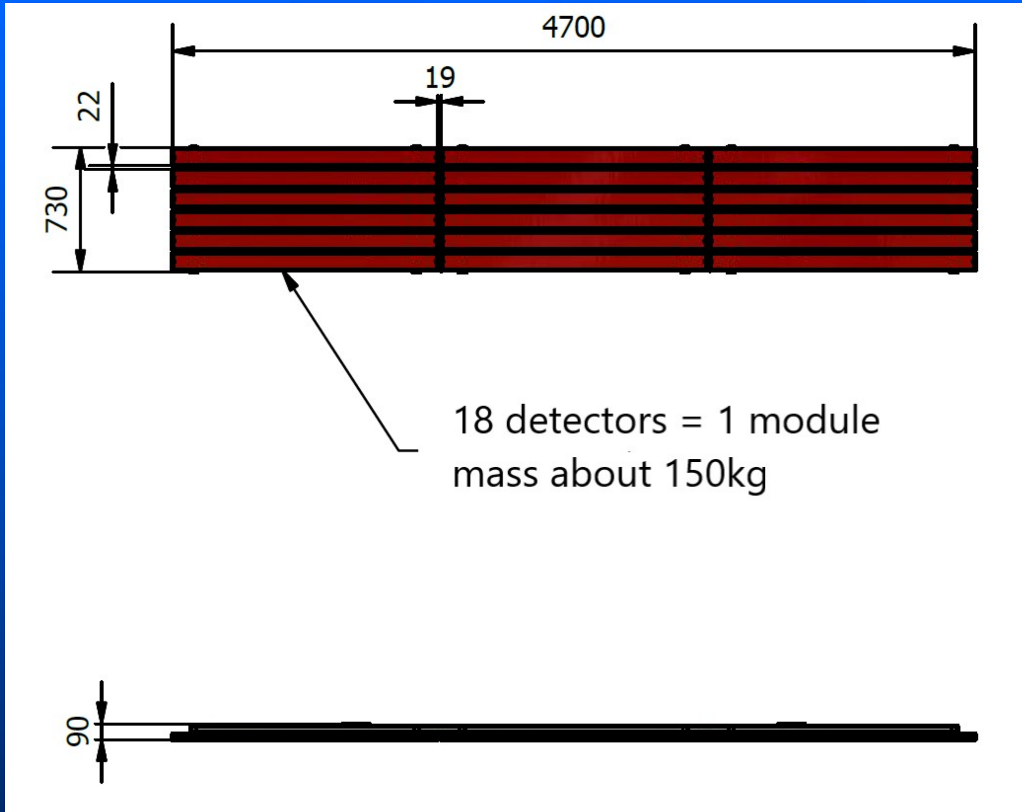


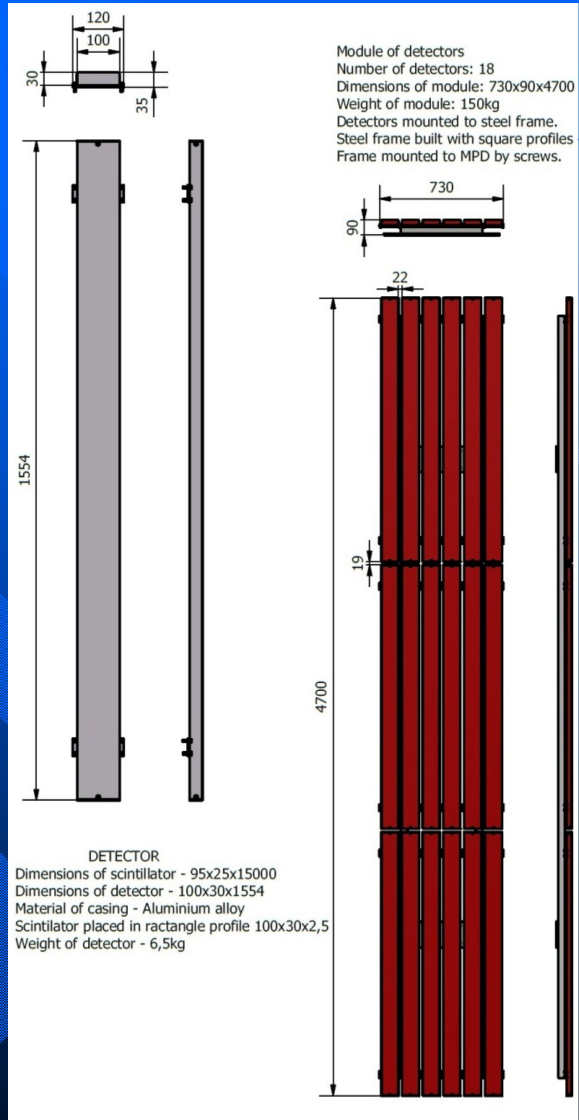




One surface on full circumference

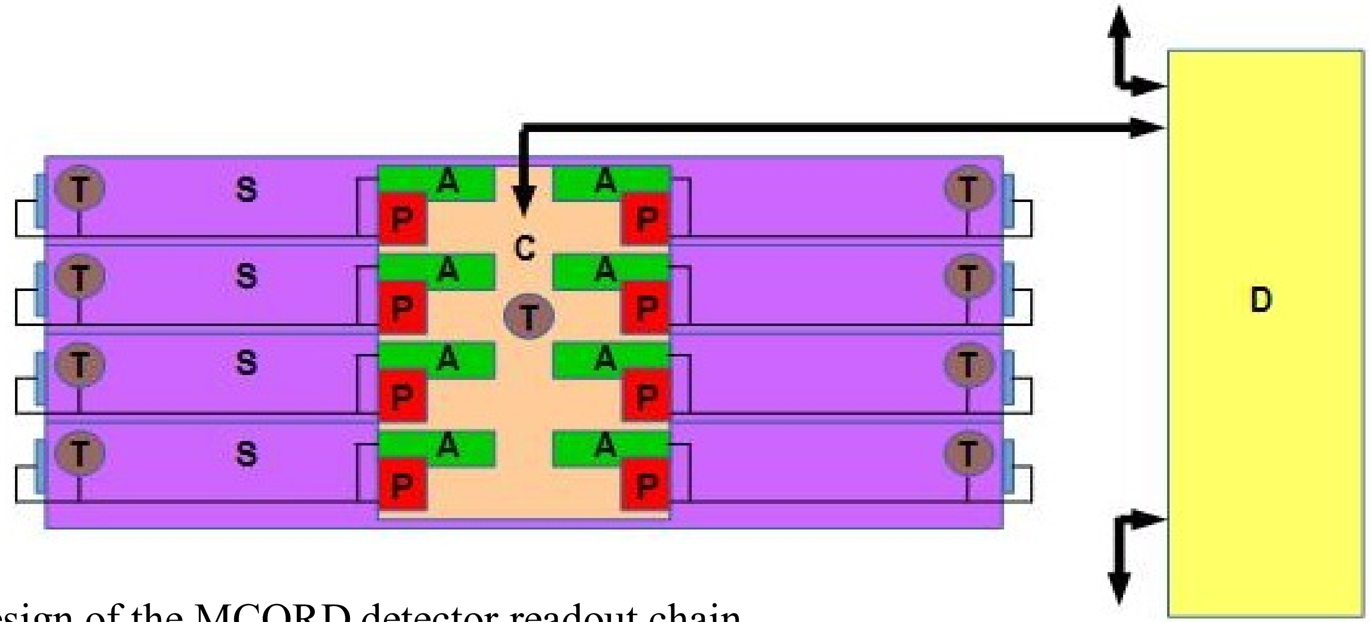
4. MCORD scintilators





4. MCORD - Design, modeling and manufacturing

THE MUON DETECTOR SCHEME



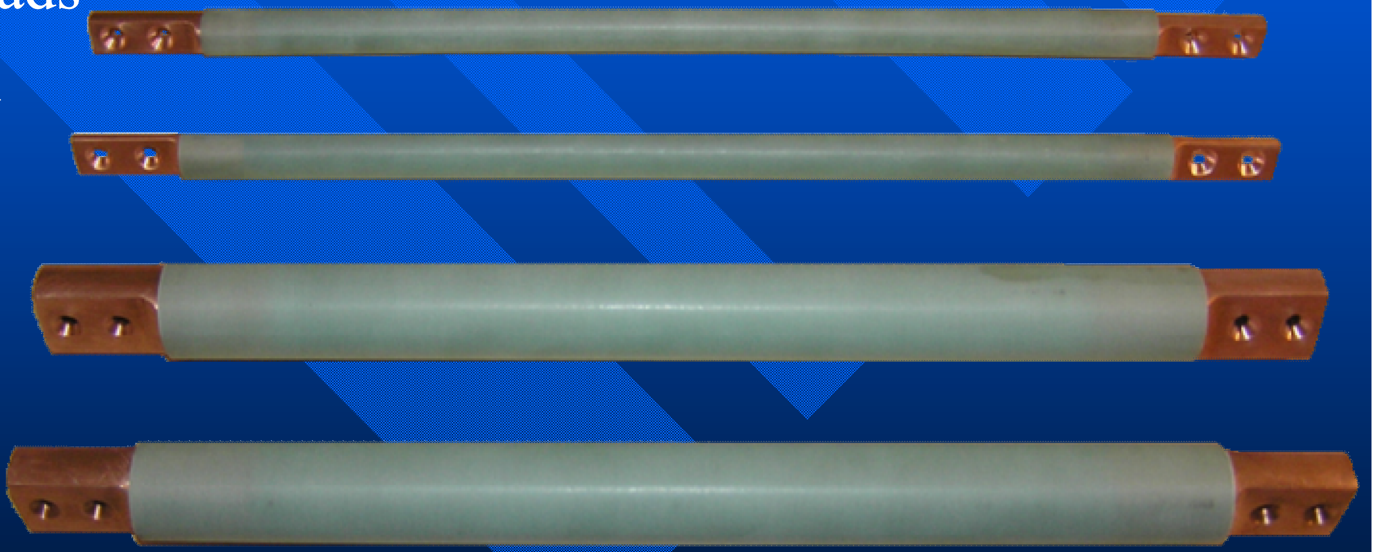
Conceptual design of the MCORD detector readout chain.
Legend: S (violet) – plastic scintillator, (blue) – SiPM, P (red) – power supply with temperature compensation circuit, T (brown) – temperature sensor, A (green) – amplifier, D (yellow) – MicroTCA system with ADC boards, C (orange) – Analog Front End Module.

Standard MTCA crate

Photomultiplier are not so good for us!!!
MPPC are much better !!!

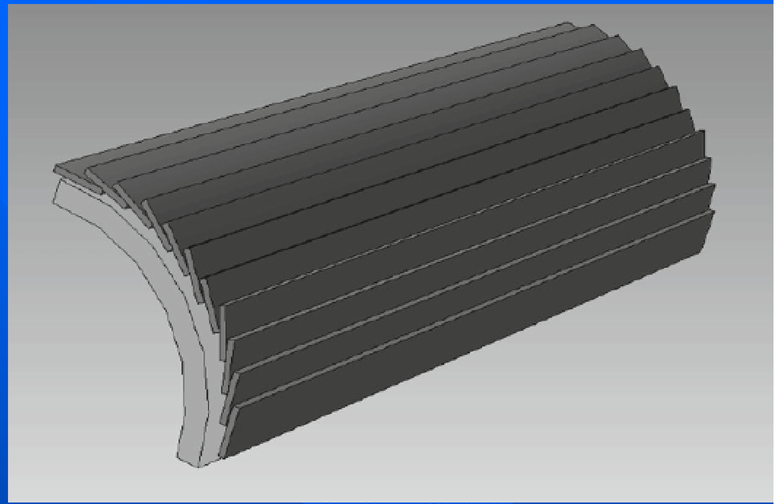
5. Cryogenics - Polish input

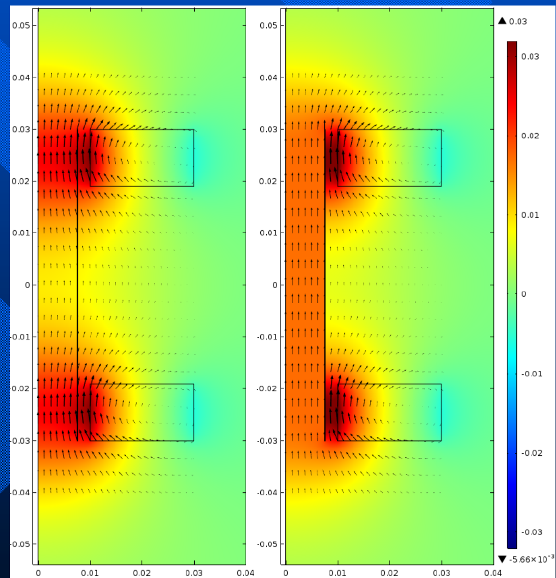
- Thermometry – calibration of helium temperature sensor
  - Decrease of cost of temperature sensors for NICA by calibrating them on-site
  - Approximately 4000 sensors needed for the accelerator
  - Cut the cost from $400 for calibrated sensor to approximately $50 for non-calibrated
  - Allowed measurement error of 0.002%
- HTS Current leads
- Cryostat design
- Quench safety

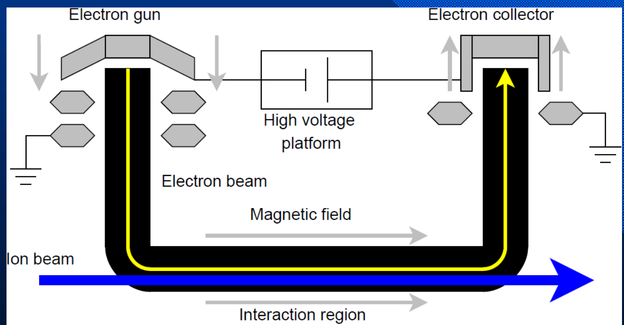


5. Cryogenics - Polish input

- Superconducting magnetic shields for electron cooling system of NICA
  - Reduction of beam size and increase of the number of potential collisions
  - Application of well-defined electron beam interacting with ion beam
  - High magnetic field homogeneity required
- Increase of magnetic field homogeneity
  - Proper placement of HTS tape strips allows to obtain homogeneous magnetic field
  - Cheap and efficient solution in the context of cryogenically cooled accelerator







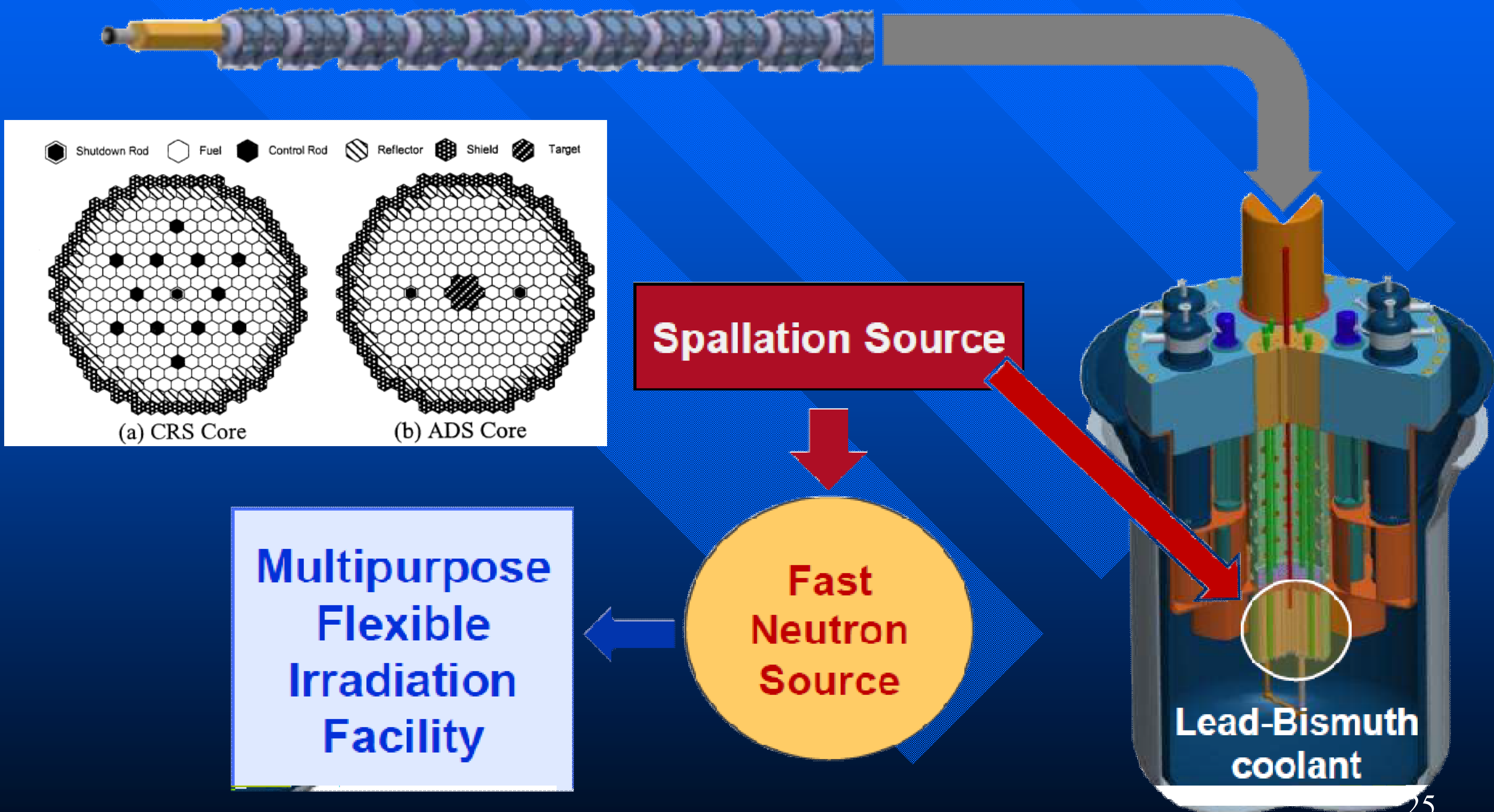
6. Nuclear Phisics – ADS

Accelerator

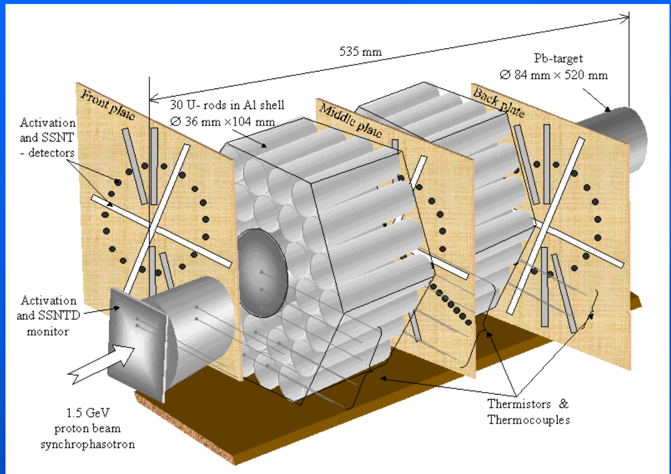
(600 MeV - 4 mA proton)

Reactor

- Subcritical mode
- 65 to 100 MWth



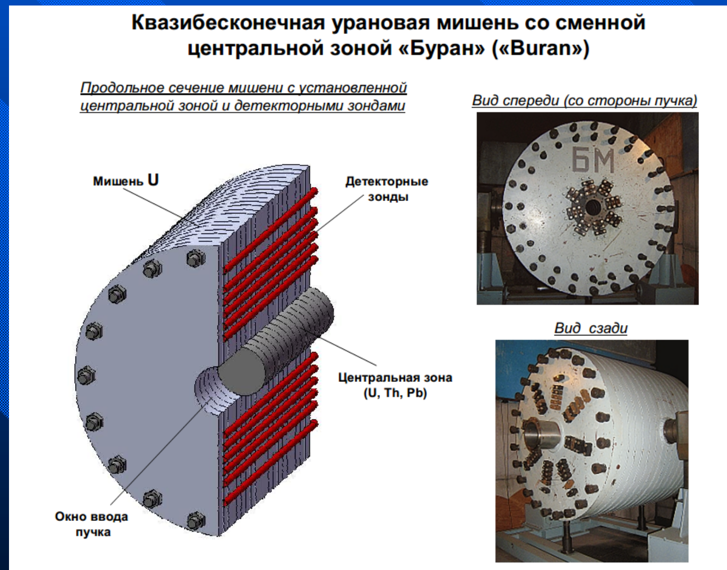
6. Nuclear Phisics – Experimentals assemblys



E+T I
1999-2002

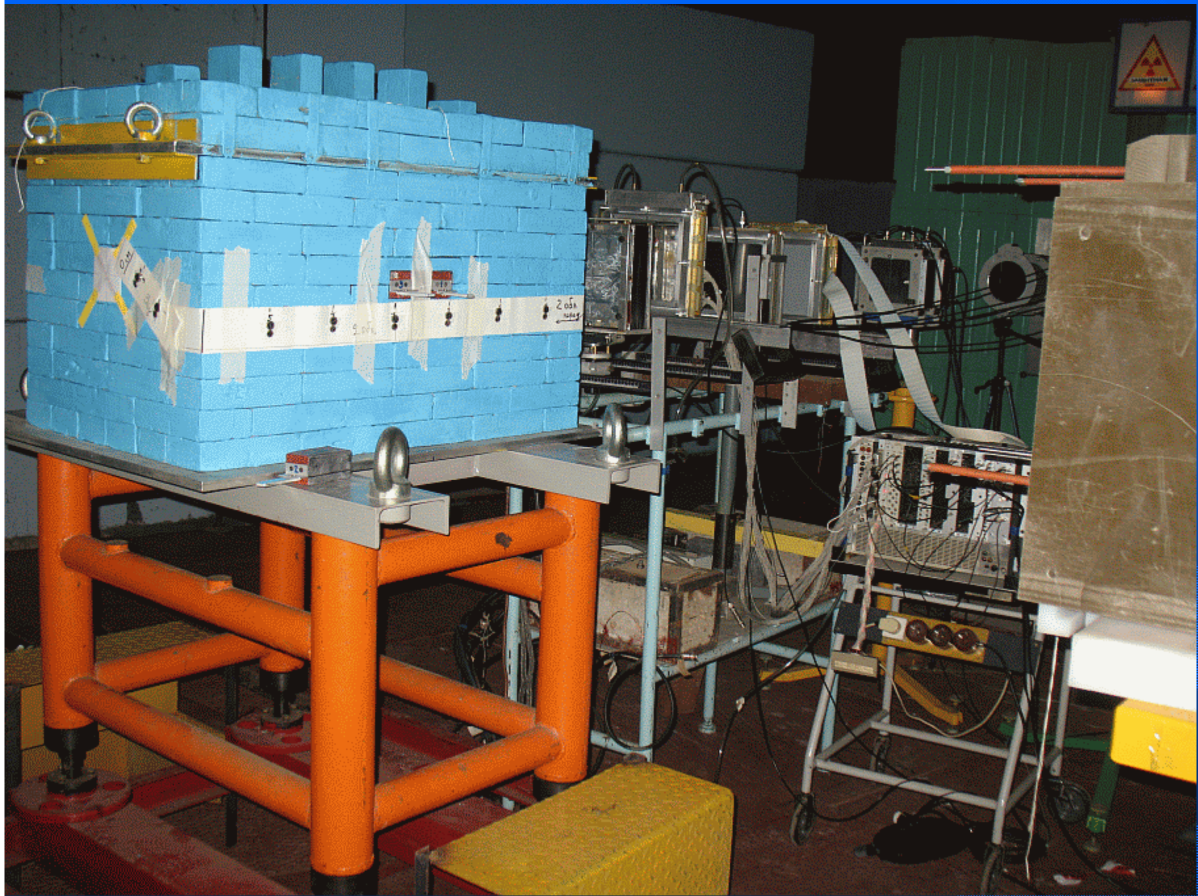
E+T II
2003-2009

Quinta
2011-2017



Buran
2018-

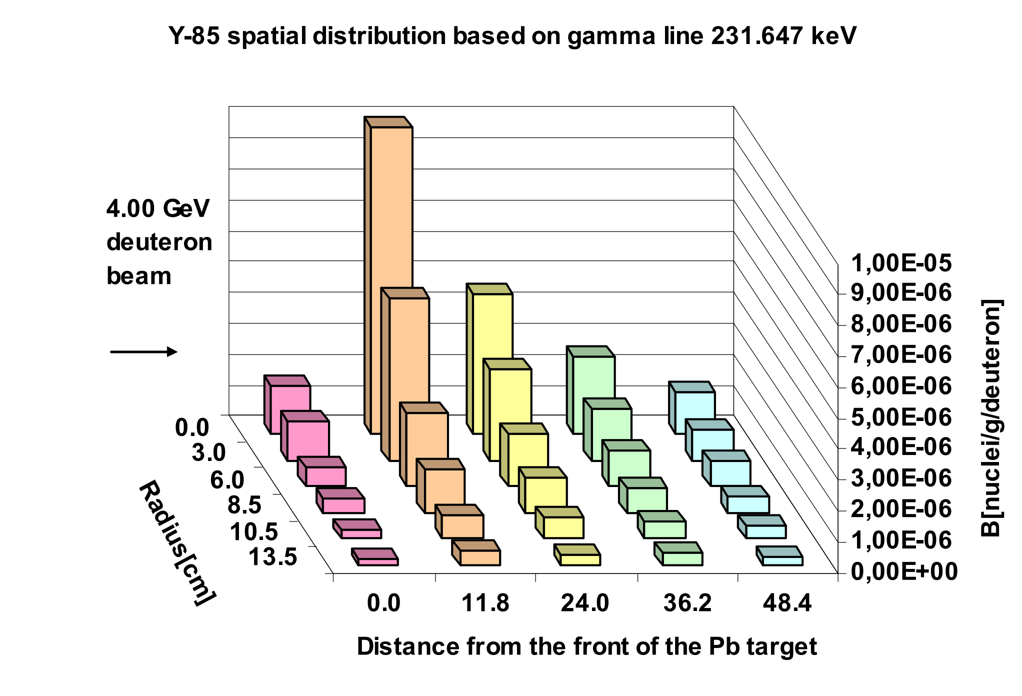
6. Nuclear Phisics – The Quinta Assembly

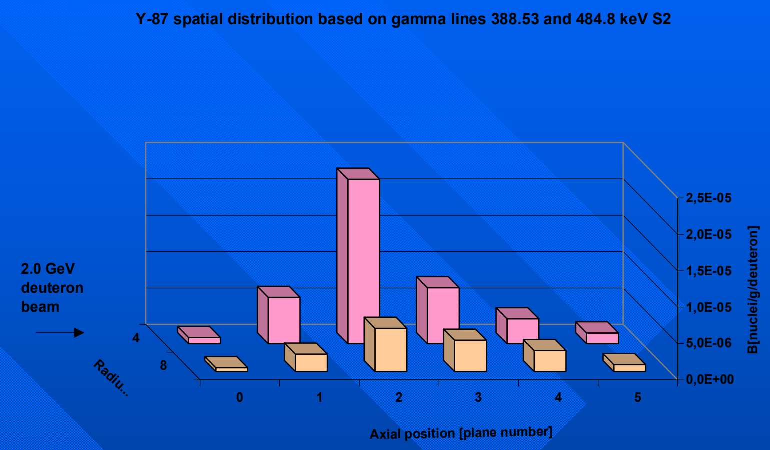


The Quinta is surrounded by lead bricks 100 mm thick on all six sides of total weight 1780 kg. Shield work as a neutron reflector and as a biological shielding for γ-rays. In the front is a square window 150x150 mm.

The setup "Quinta" on the irradiation position (December 2011 - March 2013)

6. Example of Experimental data





Rozkład przestrzenny (radialny & osiowy) produkcji Y85 dla wiązki deuteronów o energii 2GeV, Quinta III.2011r

Rozkład przestrzenny(radialny & osiowy) produkcji Y85 dla wiązki deuteronów o energii 4GeV, E+T 2009r.

Thank you