Argonne NATIONAL LABORATORY

Boris Dolgoshein: Scientist, Leader, Pioneer and Senior Friend

Alexandre Vaniachine

Invited talk at the 2011 Workshop on the Latest Developments of Photon Detectors (Light 11)

Ringberg Castle, Tegernsee, Germany

October 31 - November 4, 2011

U.S. DEPARTMENT OF ENERGY

Milestones

- First projects: spark chambers and Geiger systems
- Early sixties: streamer chambers
- Early seventies:
  - Noble liquids detectors
  - Transition radiation studies followed by many projects
  - Discovery of a μ-nucleon atom
  - Direct lepton production
    - prediction of new particles as a source (charm)
- Mid seventies: acoustic method of particle detection
- End seventies: drift and cathode strip chambers
- End seventies: double beta decay experiment with ^{40}Ca
- Early eighties:
  - Controlled nuclear emulsion
  - New detectors based on pressurized gases (up to 300 atm) for neutrino studies
- Beginning to mid-eighties: R-808 and HELIOS/NA-34 experiments at CERN ISR and SPS
- End eighties: RD6
- Mid nineties:
  - ATLAS, HERA-B, ZEUS, AMS, TRD-based Si detectors for ILC
  - SiPM and its applications

1954: Moscow Engineering Physics Institute

- Boris Dolgoshein graduated from the department of experimental nuclear physics
  - Chair A. Alikhanian
- Boris worked in MEPhI since graduation
  - PhD thesis in cosmic ray physics

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Moscow Engineering Physics Institute

- 1942 – Educational institution in support of the Soviet nuclear program
- 1951 – all Soviet nuclear program education centralized at MEPhI

The cosmic ray Muon Lab was located in the basement of the original MEPhI building in the Moscow centre

First Publications

- A winning combination of the detector techniques and physics measurements
  - From the very start of a long scientific career

531. Title: **Scattering of mu-mesons with momenta of about 100 MeV/c in copper and iron**
Author(s): Kirillov-Ugryumov V.G.; Dolgoshein B.A.; Moskvichov A.M.; et al.
Source: Nuclear Physics Volume: **11** Issue: **2** Pages: **357-367** DOI: **10.1016/0029-5582(59)90275-5** Published: **May 3 1959**
Times Cited: 1 (from All Databases)

532. Title: **Quick-Acting valve for bubble chambers**
Author(s): Dolgoshein B.A.; Kuzin L.A.
Source: Pribory i Tekhnika Eksperimenta Issue: **6** Pages: **116** Published: **Nov. 1958**

- Boris Dolgoshein developed as a superb experimentalist on his own
  - A person who drives the new promising experimental technique to its perfection
    - One of the most imaginative of experimental particle physicists – a pioneer

Streamer Chamber

INSPIRE

HEP :: INST :: HELP ..::.. SPIRES

find a dolgoshein

Search

find j "Phys.Rev.Lett.,105*" :: more

Sort by: year asc. – or rank by – Display results: 25 results

HEP 470 records found 1 - 25 jump to record: 1 Search took 0.17 seconds.

1. **Measurements of the relativistic increase of the specific primary ionization in a streamer chamber.**
V.A. Davidenko, B.A. Dolgoshein, V.K. Semenov, S.V. Somov (Moscow Phys. Eng. Inst.). 1969.
Published in **Nucl.Instrum.Meth. 67 (1969) 325-330**

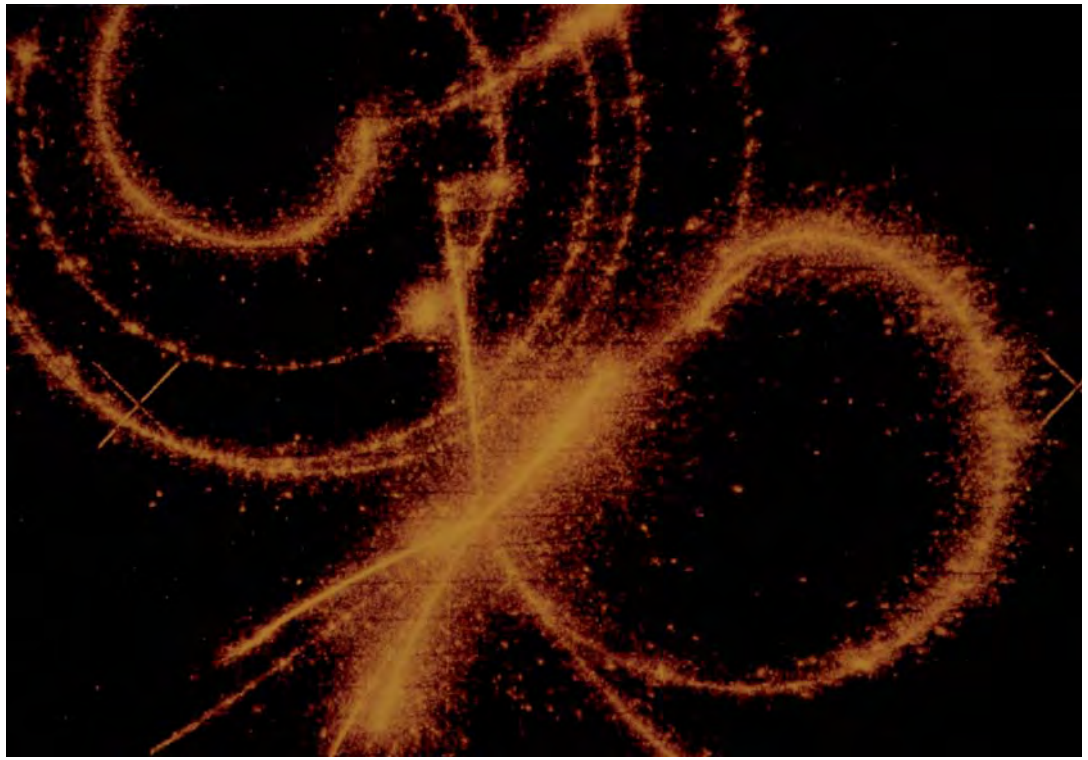
- One of the most influential papers predates Spires:

Streamer chamber:

- B.A. Dolgoshein, B.U. Rodionov, B.I. Luchkov, Nucl. Instr. Meth. 29 (2) (1964) 270.

1960's: Streamer Chamber

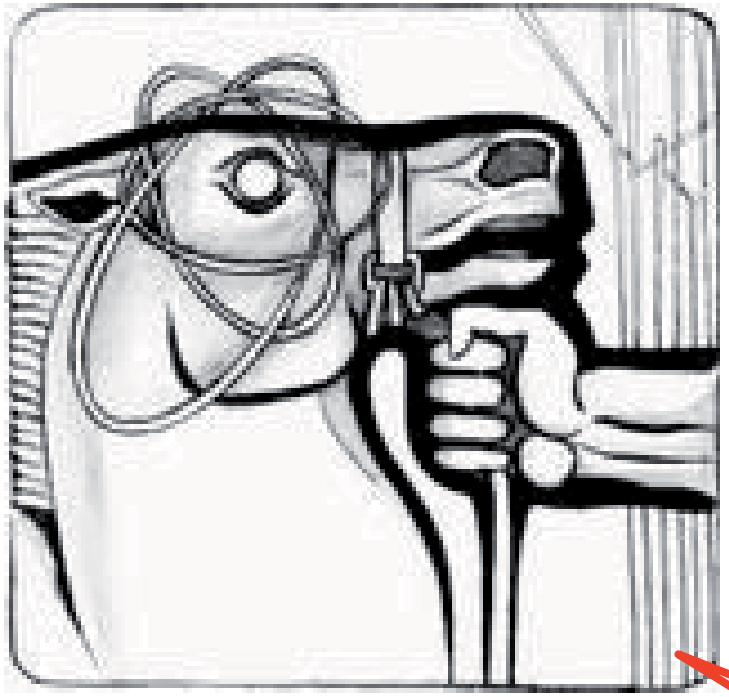
- In the early sixties, Boris Dolgoshein and his colleagues invented and developed a new type of gas-discharge chamber, the streamer chamber, and brought the detector to perfection
- The technique competed with bubble chambers images
- Unlike the bubble chamber, the streamer chamber could be triggered (via the electric pulse) and thus was suited to the study of rare events
- Because of these features, the invention had an impact world-wide:



A. A Brief History

Work on streamer chambers at SLAC began near the end of 1963, shortly after the early Russian articles[3, 4, 51] appeared. Originally, this effort was motivated by the considerable promise which these devices, as compact, isotropic detectors of high resolution, held for colliding beam experiments at energies well above 1 GeV. Within the next year, plans were also being made by a second group

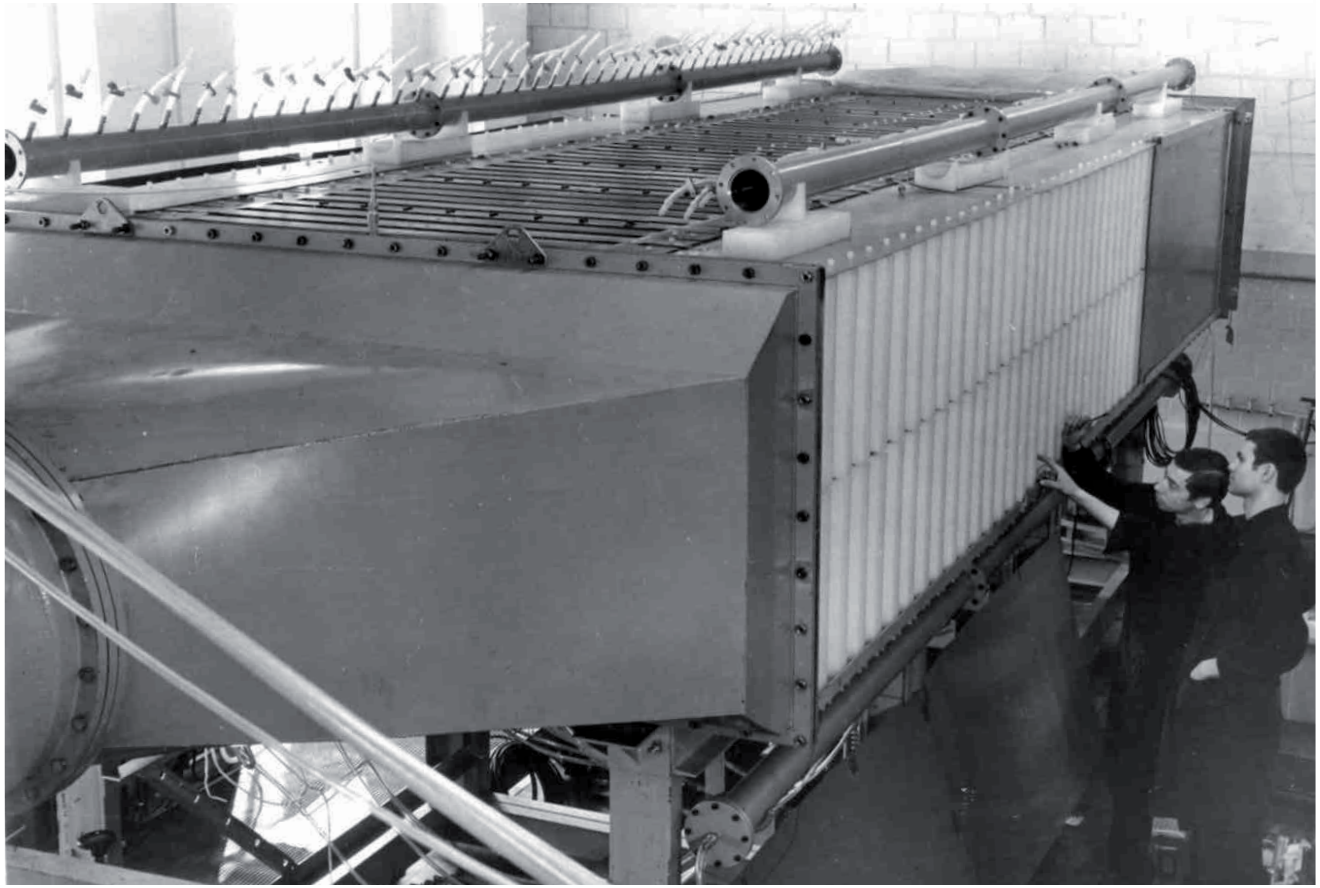
1970: Lenin Prize



Streamer Chamber tracks!

- World-wide impact was a pre-requisite for a Lenin Prize
  - One of the most prestigious awards of the USSR
    - Presented to individuals for accomplishments relating to science, literature, arts, architecture, and technology

Eight-Meter Long Streamer Chamber



- The largest streamer chamber ever built was constructed in 1968 in MEPhI by Boris and his team
  - It was 8x2x1 m^3 in size and operated many years in Protvino at the U-70 synchrotron, searching for the W boson

Prompt Lepton Puzzle

- In Protvino, B. Dolgoshein experiments at 70 GeV/c observed an unexpected excess of muons
  - Other experiments detected prompt lepton excess as well
    - The HELIOS experiment at CERN 200 GeV/c SPS was proposed to resolve the prompt lepton puzzle
      - It became a largest CERN SPS collaboration at time (about 200 physicists)
- To search for prompt leptons, a lepton trigger was required for HELIOS
- Boris realized that rise in the beam energy leads to electron γ-factors producing transition radiation in the keV range
  - Can the Transition Radiation Detector be used for the electron trigger?
    - Can the Transition Radiation Detector be used as a tracker?
- As usual, the intensive and careful R&D program was carried out to move beyond traditional transition radiation detection methods of the time

Transition Radiation Detectors (TRD)

- Today, one cannot mention transition radiation detectors without mentioning Boris. He was the physicist who developed and pioneered these gaseous detectors for particle tracking and particle identification. His experience and expertise with this sophisticated type of detector goes back to the early seventies and there is hardly any TRD in the world to which Boris has not significantly contributed.

"TRDs for the third Millennium"

4th Workshop on Advanced Transition Radiation Detectors for Accelerator and Space Applications

International Advisory Committee

A. Andronic (Darmstadt)
R. Battiston (Perugia)
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D. Muller (Chicago)
C. Rembser (CERN)
A. Romaniouk (MEPHI/CERN)
J. Va'vra (SLAC)
J. Wessels (Münster)

Conference Topics

- TRDs in accelerator experiments
- TRDs in space experiments
- New approaches in TRDs development
- Up-to-date particle identification methods
- Latest trends in detector developments
- Progress in advanced detectors simulation
- Electronics for signal processing

Special Topic

- Homage to Boris Dolgoshein (1930-2010) (invited speakers)

Organising Committee

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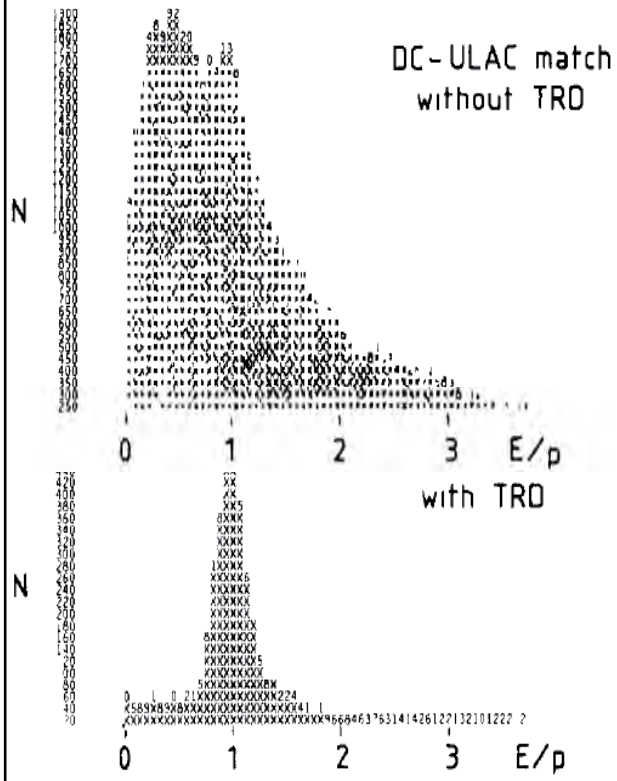
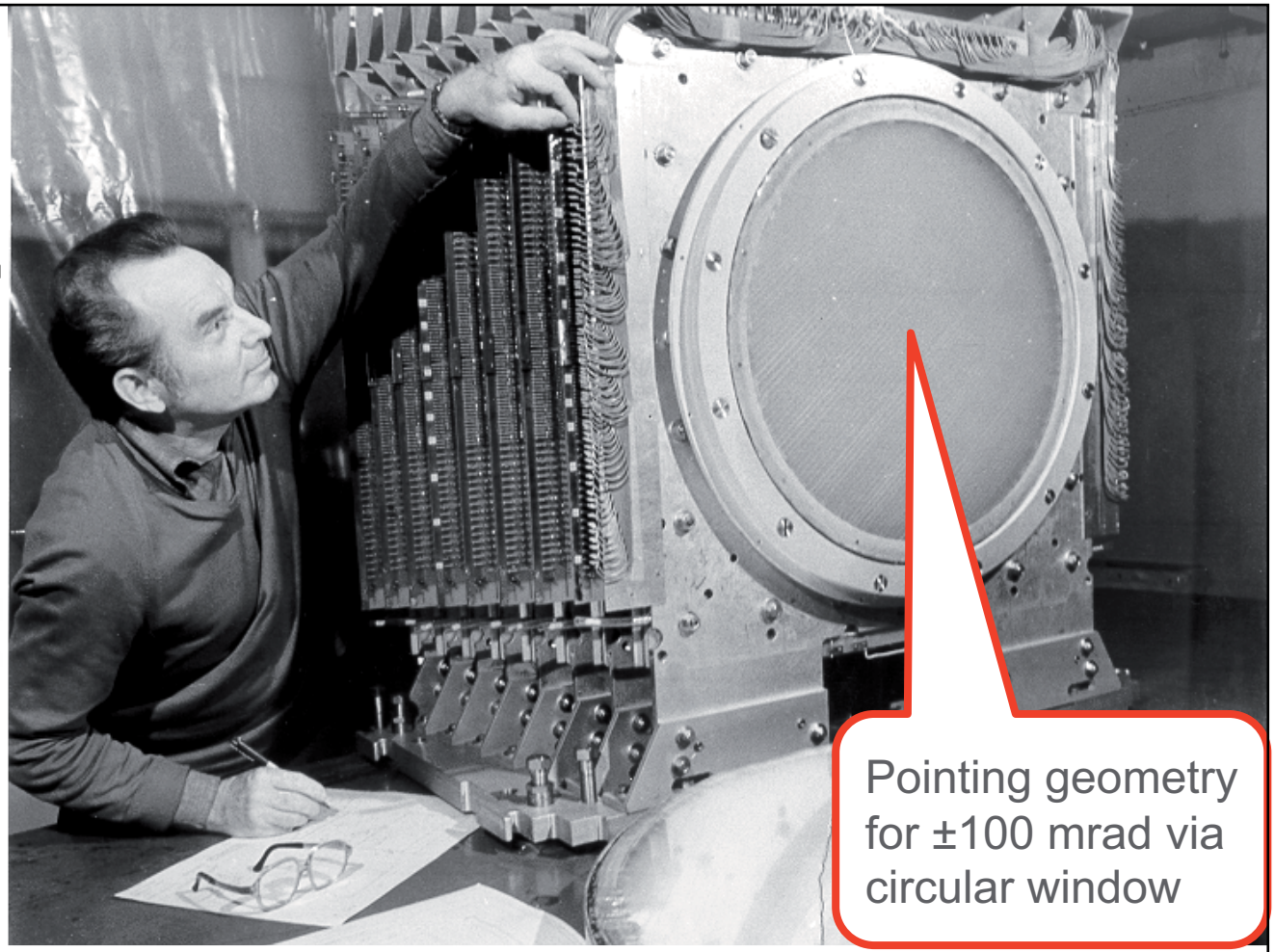
P. Spinelli (chair, Bari)

Bari, Italy, September 14-16, 2011

HELIOS TRD

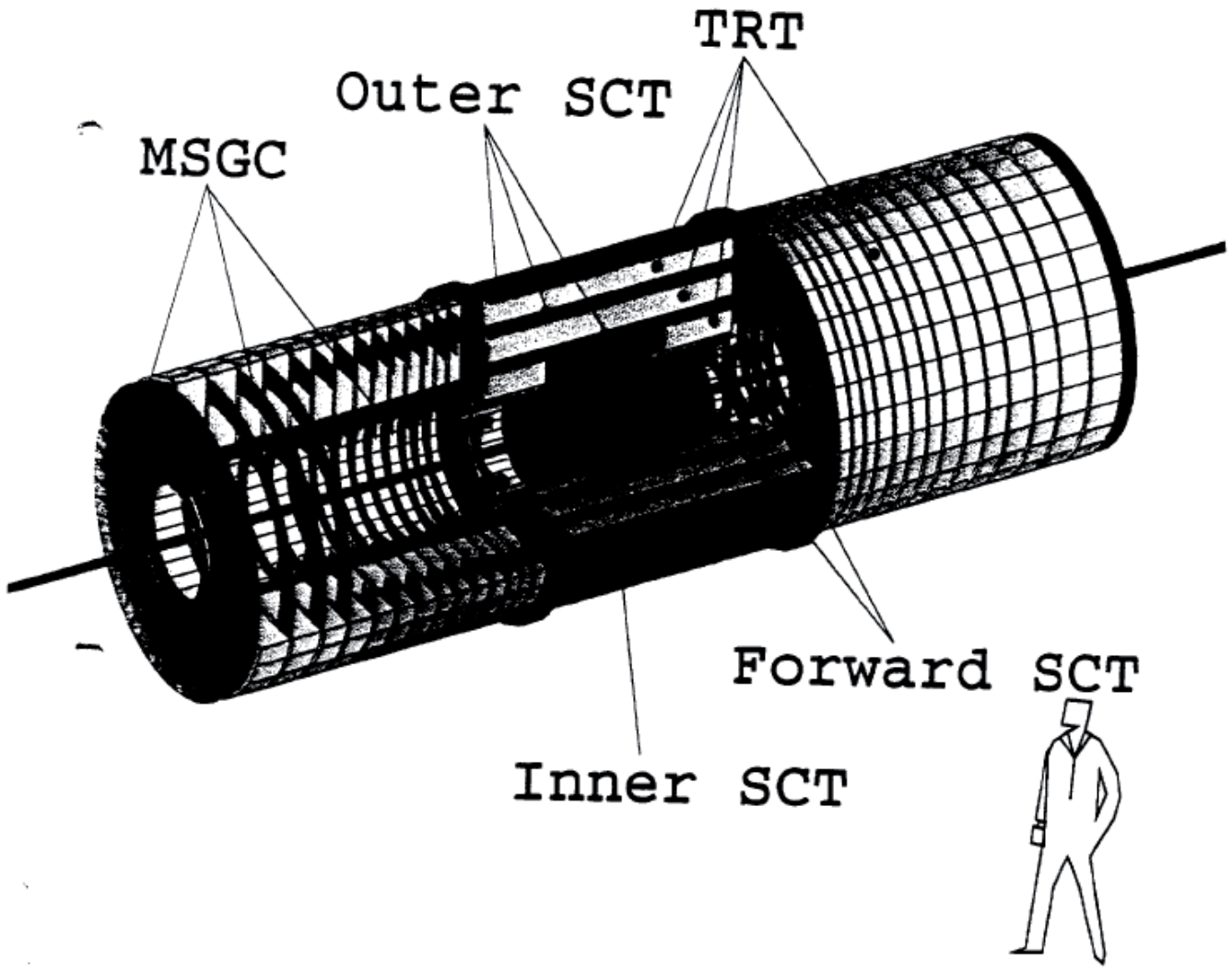




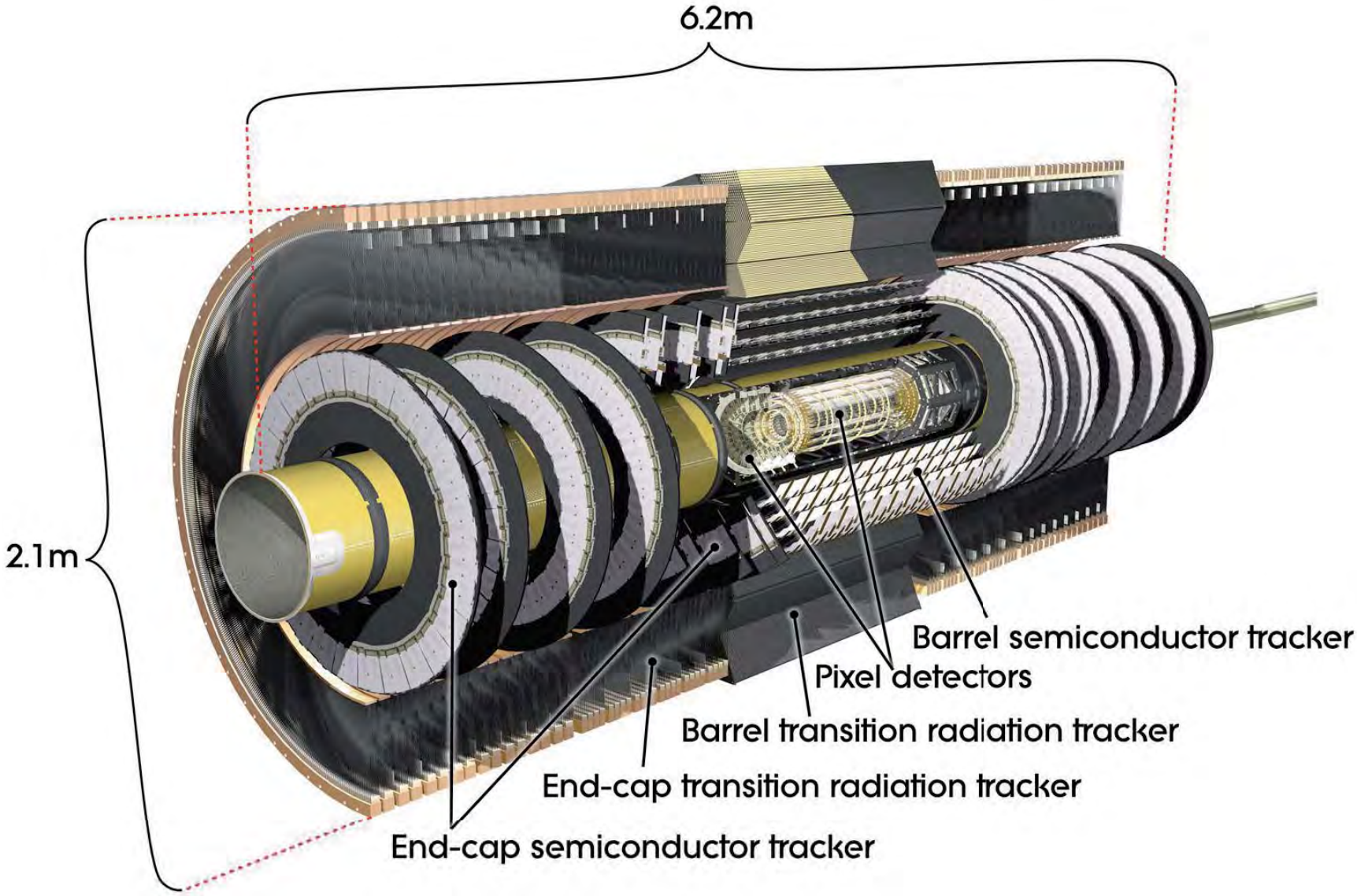
- A success of first tracking TRD in HELIOS paved a roadmap for further TRD/tracker development starting with the RD6 project at CERN (spokesman B. Dolgoshein)
  - Transition Radiation Detectors of the ZEUS and HERA-B experiments at HERA
  - TRD of the AMS spectrometer in the space
  - and the huge Transition Radiation Tracker of the ATLAS experiment at the LHC

ICHEP 1992 Texas: Prospects for TRT at SSC & LHC

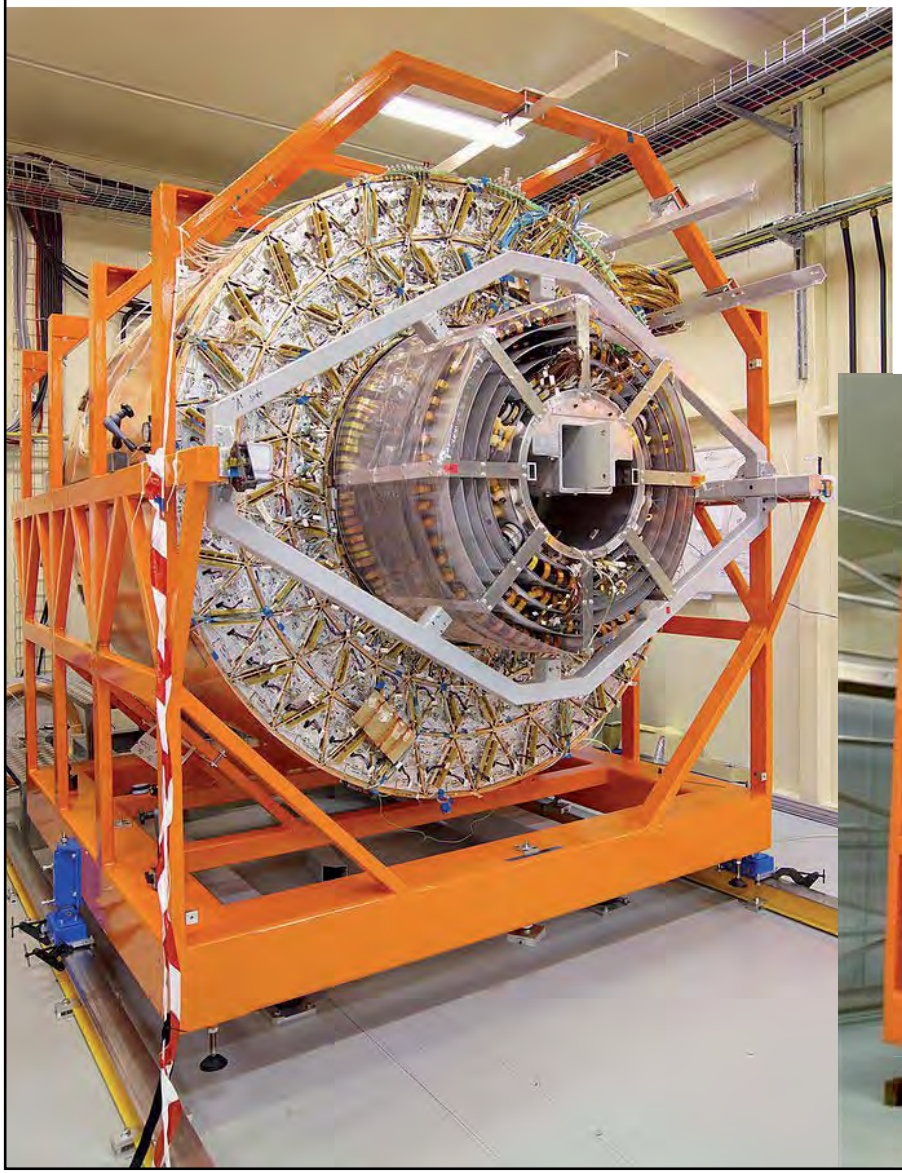
1993: TRT Concept from RD6 Final Report

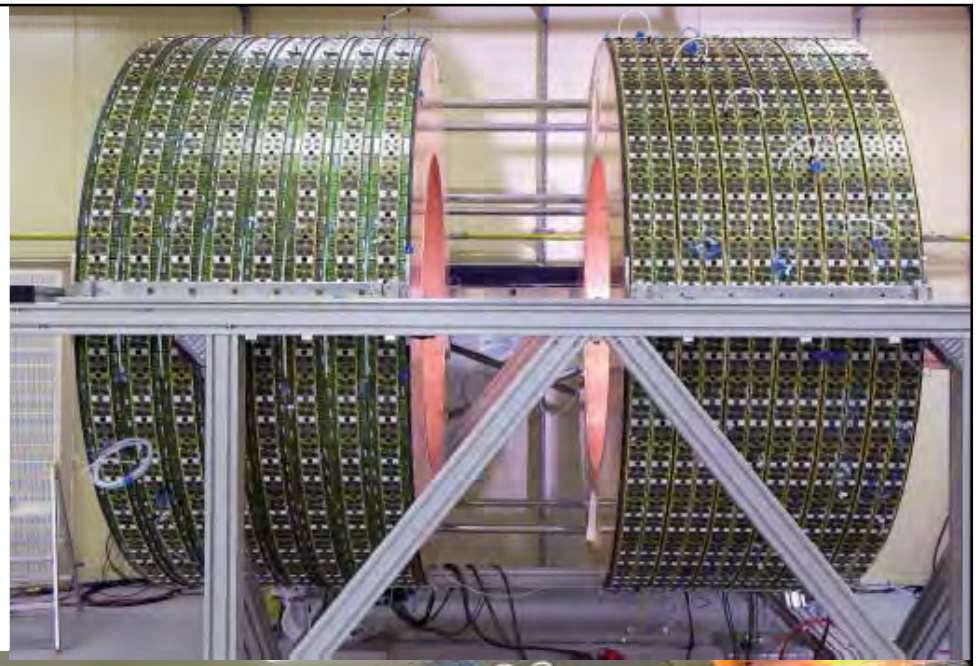


ATLAS TRT Layout

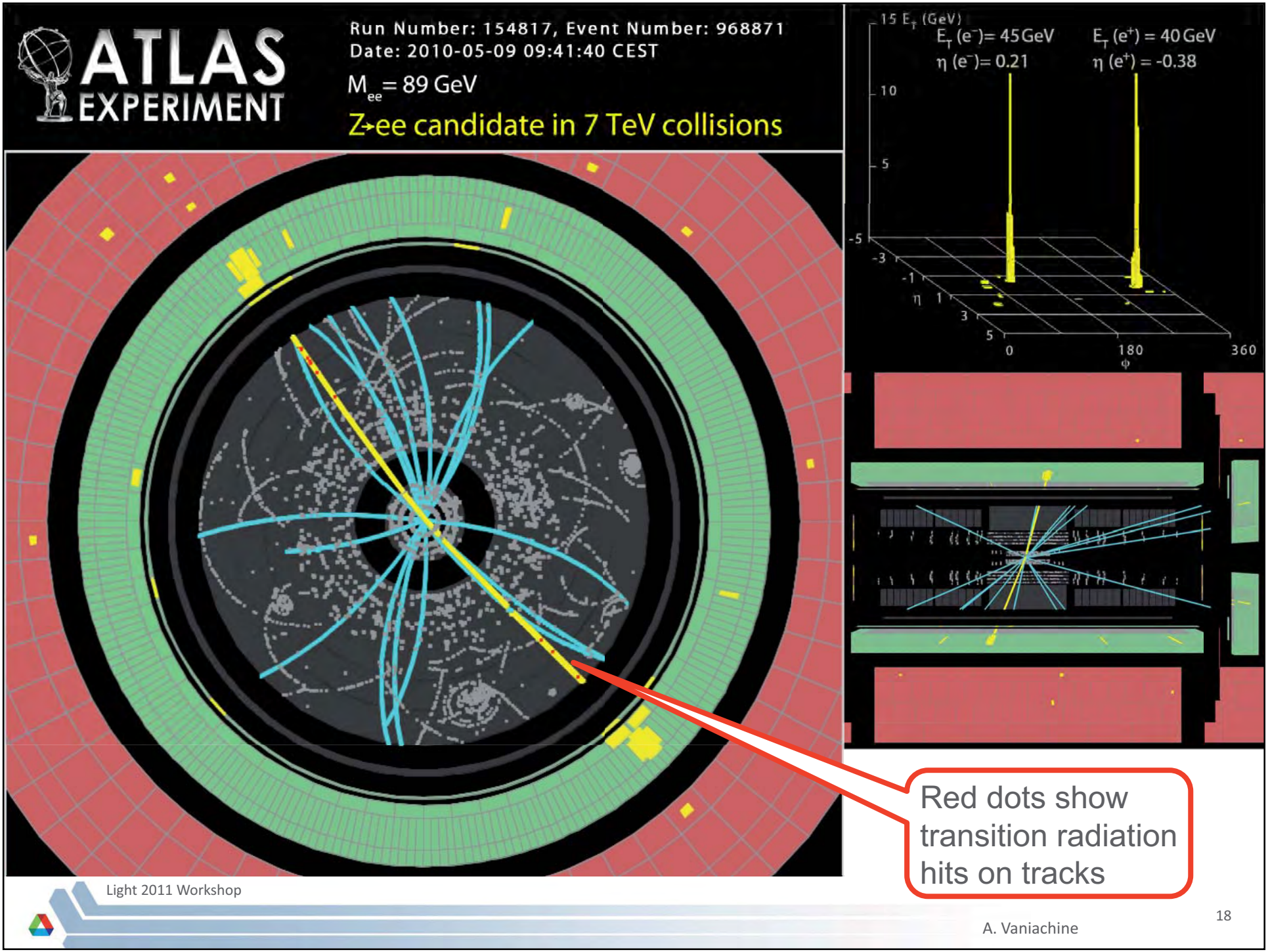


TRT Barrel and Endcaps





TRT EC-A: **weight 1120 kg**


ATLAS EXPERIMENT
Run Number: 154817, Event Number: 968871
Date: 2010-05-09 09:41:40 CEST
M_{ee} = 89 GeV
Z→ee candidate in 7 TeV collisions
15 E_T (GeV)
E_T (e^-)= 45 GeV
E_T (e^+) = 40 GeV
η (e^-)= 0.21
η (e^+) = -0.38
10
5
-5
-3
-1
η 1
3
5
0
180
360
φ
Red dots show transition radiation hits on tracks

Non-Proliferation

- L. Maiani, DG CERN, A. Gérard, ISTC Director, Moscow, B.Onykiy, MEPhI Rector

Outreach

- Press interview, 1990

- School children lesson:
  - Journey into the Matter
    - Russian TV, Summer, 2010

http://www.youtube.com/watch?v=1OEojcdmN_o

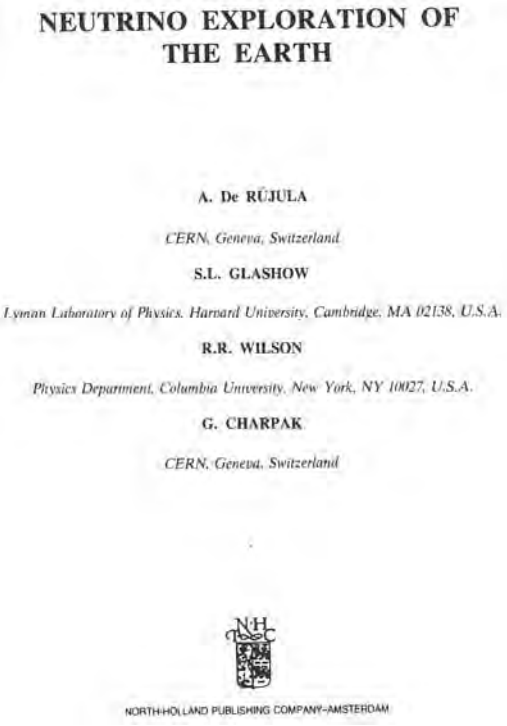
- Russian TV interview:
  - Collider will Discover New World of Particles for Us
    - September 10, 2008

http://www.vesti.ru/doc.html?id=208076&tid=59653

1977: Acoustic Signals from Hadron Showers

- In 1977 Boris proposed the detection of high-energy neutrinos by measuring the acoustic signals from hadron showers created by the neutrinos in the ocean
  - The acoustic method was realized in prototypes in the US and in Lake Baikal and is currently explored in the context of the IceCube and ANTARES neutrino telescopes
    - It may be an option for the Mediterranean KM3NeT project

Light 2011 Workshop



NEUTRINO EXPLORATION OF THE EARTH

A. De RÚJULA

CERN, Geneva, Switzerland

S.L. GLASHOW

Lyman Laboratory of Physics, Harvard University, Cambridge, MA 02138, U.S.A.

R.R. WILSON

Physics Department, Columbia University, New York, NY 10027, U.S.A.

G. CHARPAK

CERN, Geneva, Switzerland

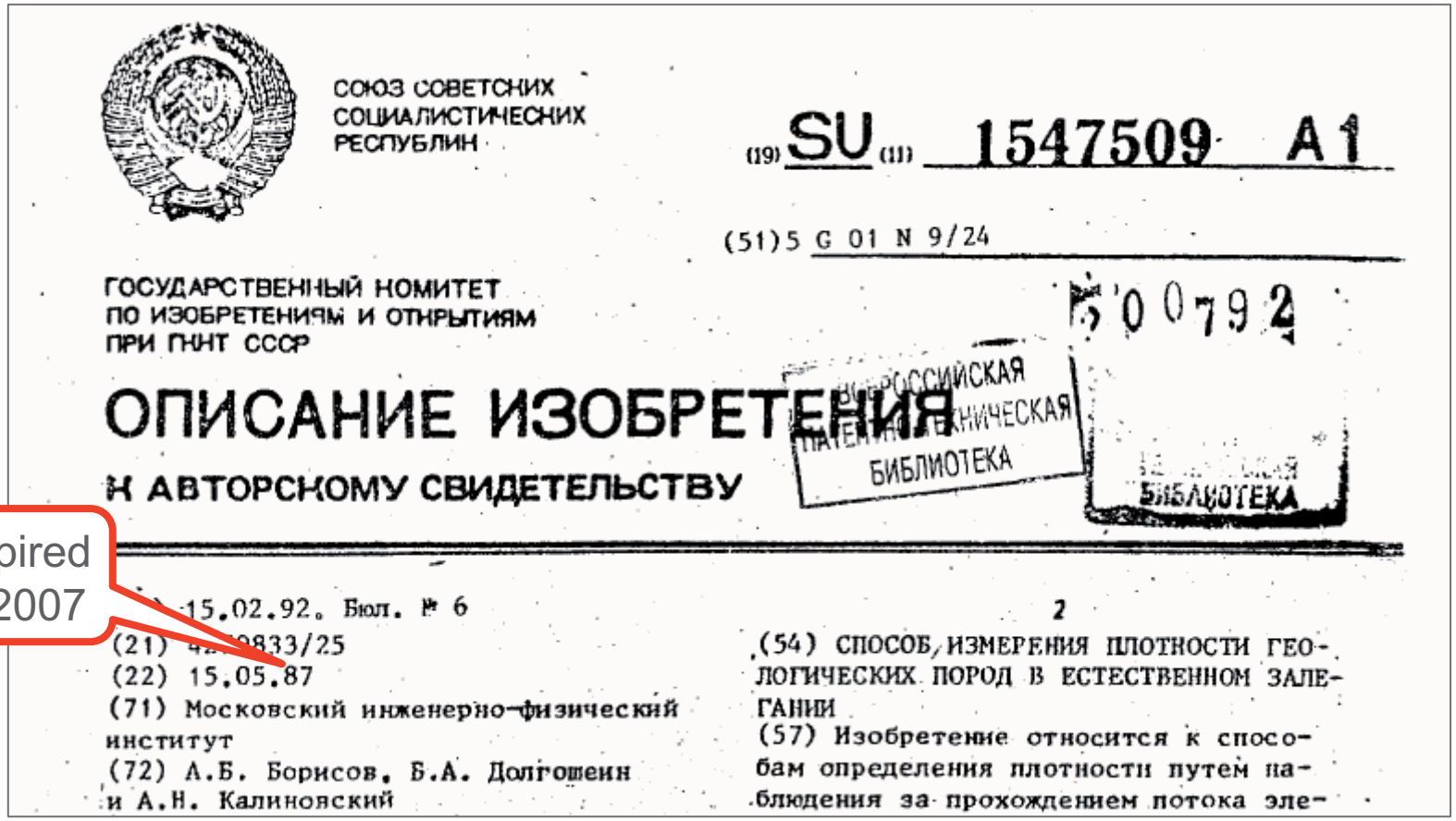
NORTH-HOLLAND PUBLISHING COMPANY–AMSTERDAM

- 1978 , Cologne, after presenting acoustic signal detection idea

Delayed Muon Method

Boris Dolgoshein developed the delayed muon method to search for oil:

- "Method for determination of rock density" *USSR Patent* 1547509, 1987



СОЮЗ СОВЕТСКИХ СОЦИАЛИСТИЧЕСКИХ РЕСПУБЛИК

(19) SU (11) 1547509 A1

(51)5 G 01 N 9/24

ГОСУДАРСТВЕННЫЙ КОМИТЕТ ПО ИЗОБРЕТЕНИЯМ И ОТКРЫТИЯМ ПРИ ГКНТ СССР

5 00792

ОПИСАНИЕ ИЗОБРЕТЕНИЯ

К АВТОРСКОМУ СВИДЕТЕЛЬСТВУ

ВСЕРОССИЙСКАЯ ПАТЕНТНО-ТЕХНИЧЕСКАЯ БИБЛИОТЕКА

БИБЛИОТЕКА

Expired in 2007

15.02.92. Бюл. № 6

(21) 4[illegible]0833/25

(22) 15.05.87

(71) Московский инженерно-физический институт

(72) А.Б. Борисов, Б.А. Долгошеин и А.Н. Калиновский

2

(54) СПОСОБ ИЗМЕРЕНИЯ ПЛОТНОСТИ ГЕОЛОГИЧЕСКИХ ПОРОД В ЕСТЕСТВЕННОМ ЗАЛЕГАНИИ

(57) Изобретение относится к способам определения плотности путем наблюдения за прохождением потока эле-

Grand Engineering Project

- Ten years later, in the review article

  "The Leptons After 100 Years" *Physics Today* **50** (10): 34-40 October 1997

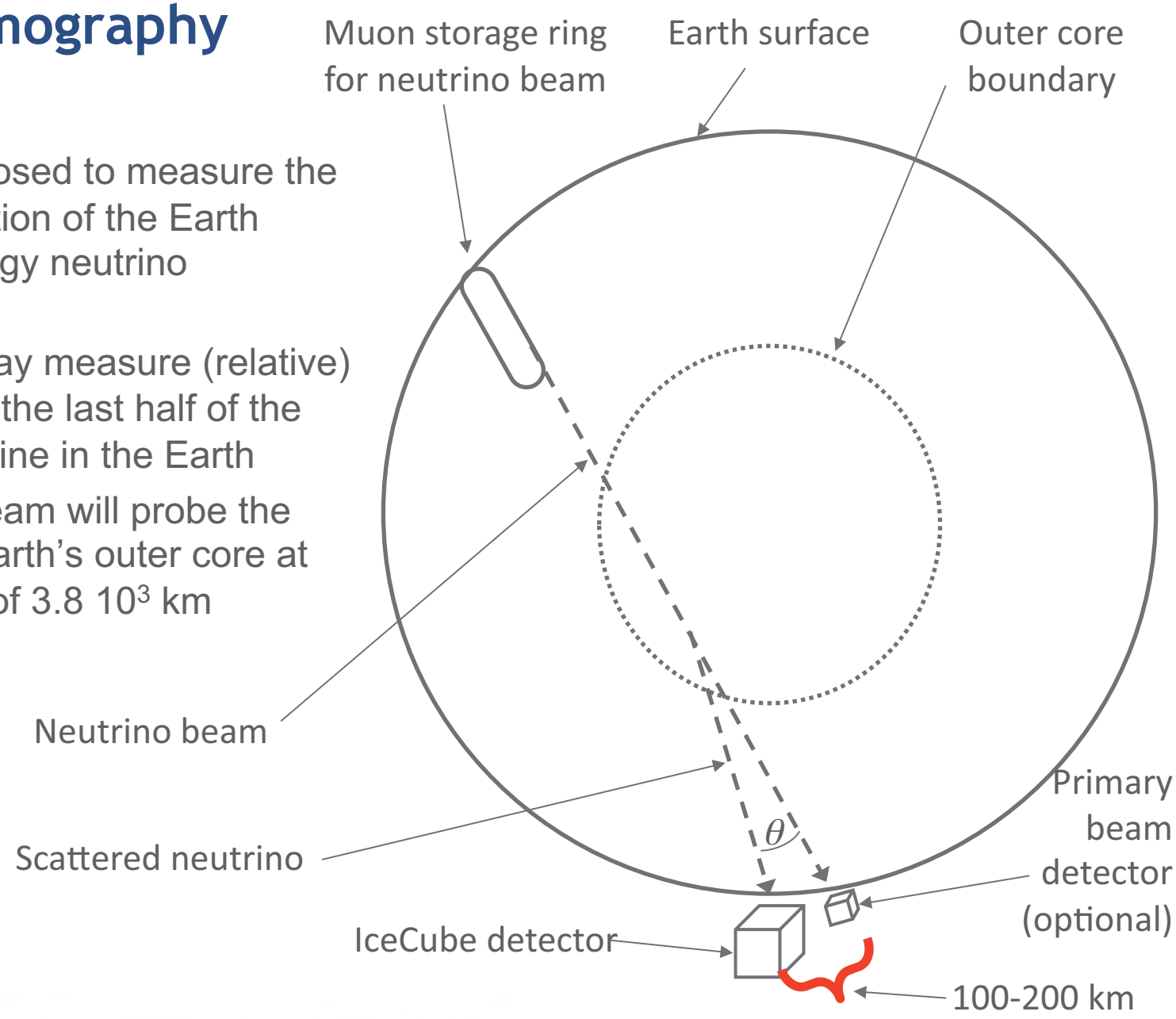
  Martin Perl provided the following assessment:

▷ There have been suggestions that muon neutrino beams could be used for geological research and prospecting deep in the Earth.[18] The rate of interaction of the neutrinos would be proportional to the density of matter, with the interaction rate being measured by the muons so produced. Certainly that would be a grand engineering project.

18. A. De Rújula, S. L. Glashow, R. R. Wilson, G. Charpak, Phys. Rep. **99**, 341 (1983). A. B. Borisov, B. A. Dolgoshein, Phys. At. Nucl. **56**, 755 (1993). ■

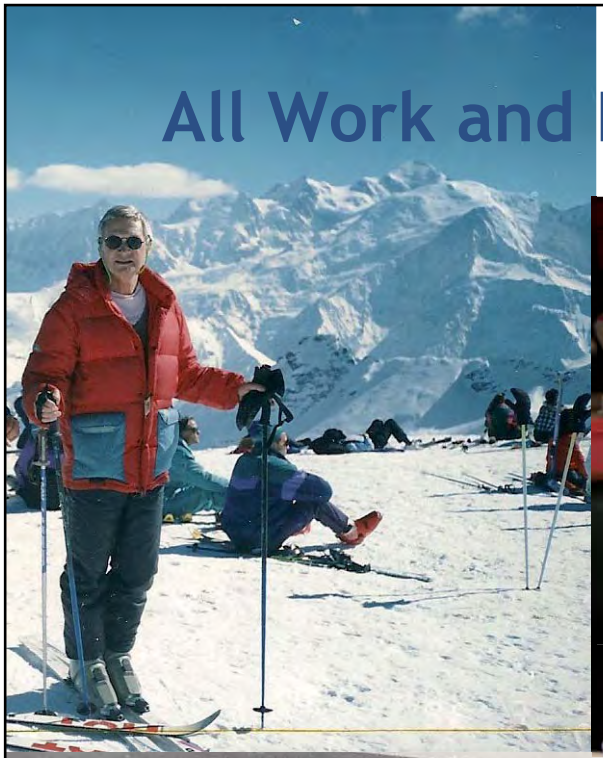
Earth Tomography

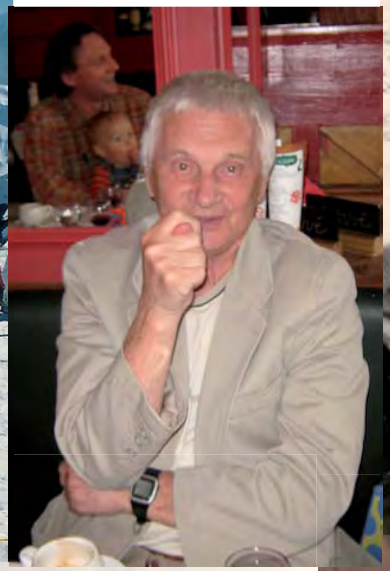
- Boris also proposed to measure the density distribution of the Earth using high-energy neutrino scattering
- Tomography may measure (relative) densities along the last half of the neutrino beam line in the Earth
- The neutrino beam will probe the middle of the Earth's outer core at the max depth of 3.8 10^3 km



Boris with ATLAS Colleagues from MEPhI

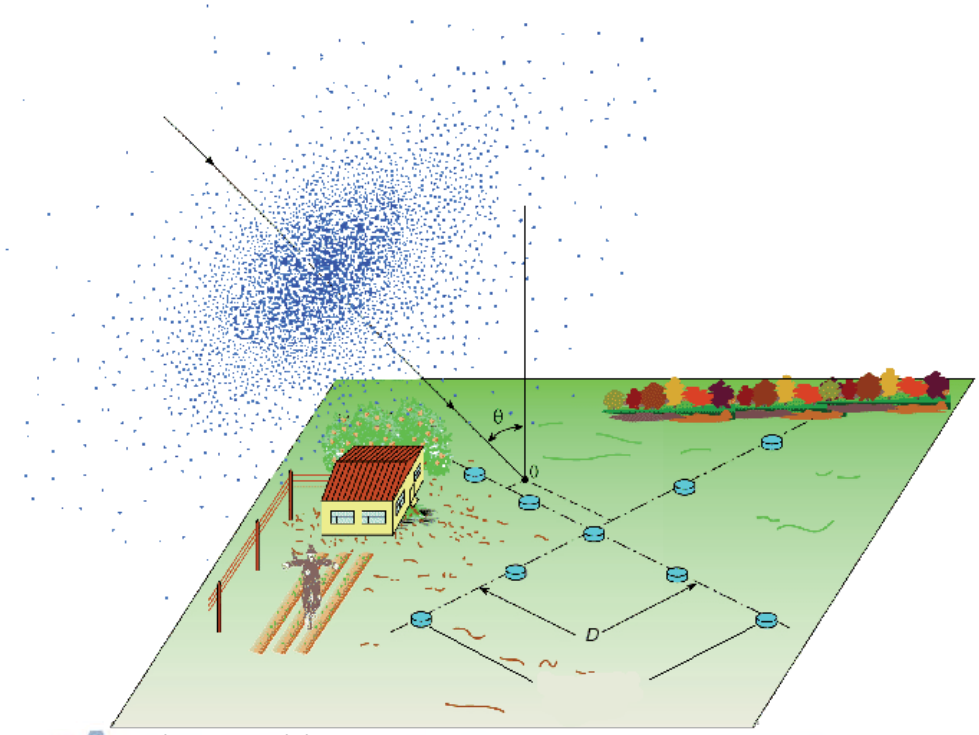
All Work and No Play?





Instead of Conclusion: Silicon Photomultipliers

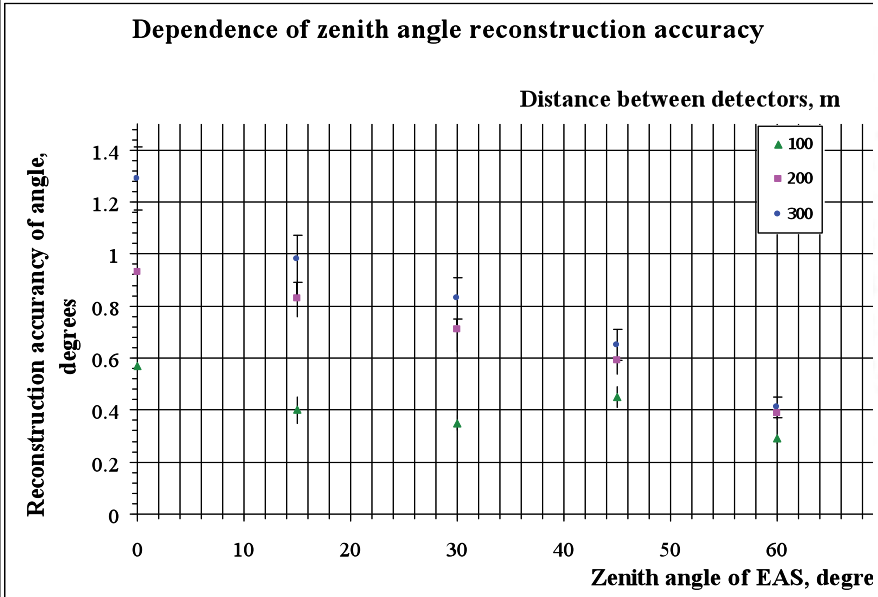
- Perestroika opened access to a treasure-trove of Soviet dual-use technologies
  - Among those was an idea for a needle-like limited-Geiger mode diode developed for communications at MELZ semiconductor division in collaboration with MEPhI
- Boris Dolgoshein recognized a potential of this device as a low light level sensor
  - The history of SiPM developments is a subject of the next talk

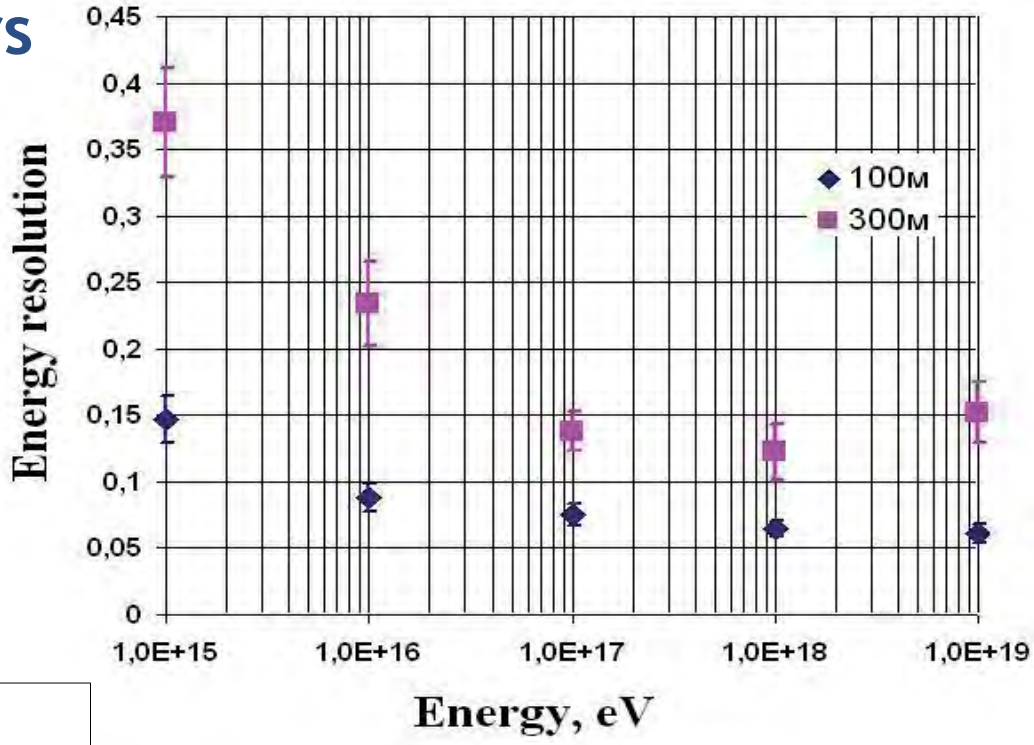


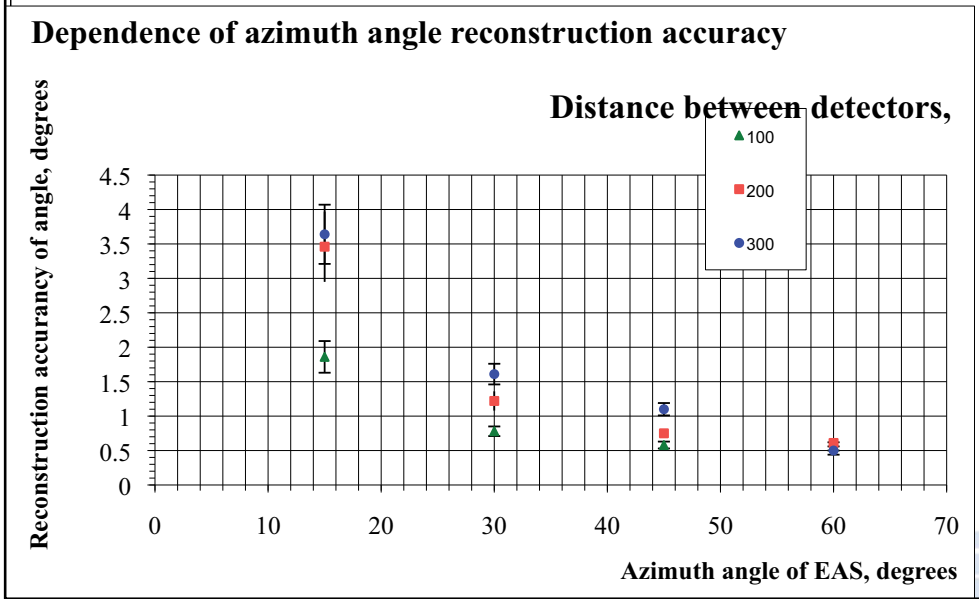
- Since Boris Dolgoshein started his research in a field of cosmic rays, I would like to conclude by relaying his (unpublished) idea for a next generation cosmic ray experiment reaching beyond the exposure of the "Pier Auger" observatory
  - An area detector with just a hundred of ~1 mm^2 SiPMs per square kilometer detecting Cerenkov light from the ultra-high energy cosmic ray shower
    - Alan Watson encouraged discussing this idea at the next World Ground Observatory symposium, CERN, Feb 13-16, 2012 http://indico.cern.ch/event/152124

Extra Materials

Cosmic Ray Detection via Cherenkov Light in a Grid of 1 mm^2 SiPM Detectors

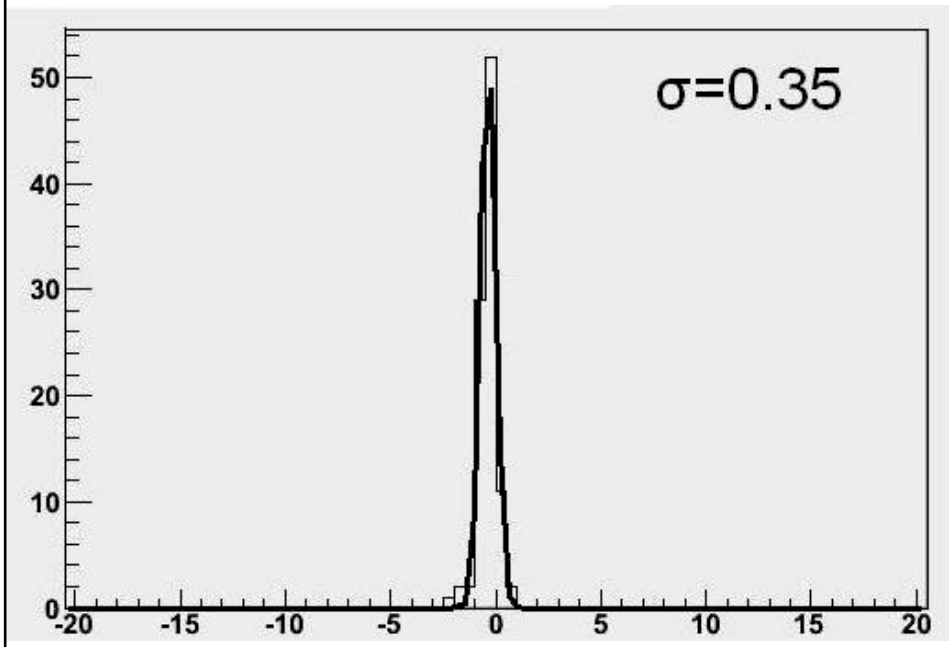


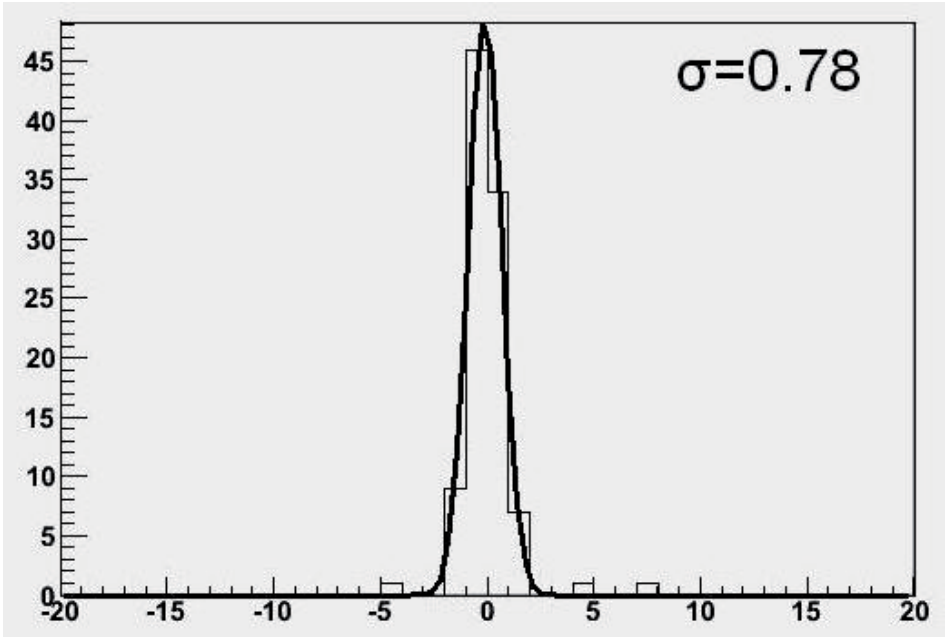




- From slides by B.Dolgoshein, O.Novgorodova, A.Polaykova and V.Tikhomirov

UHECR Arrival Direction Reconstruction Accuracy





- Reconstruction accuracy distribution of zenith angle 30^{o} for a distance between detectors 100 m
- Reconstruction accuracy distribution of azimuth angle 0^{o} for a distance between detectors 100 m

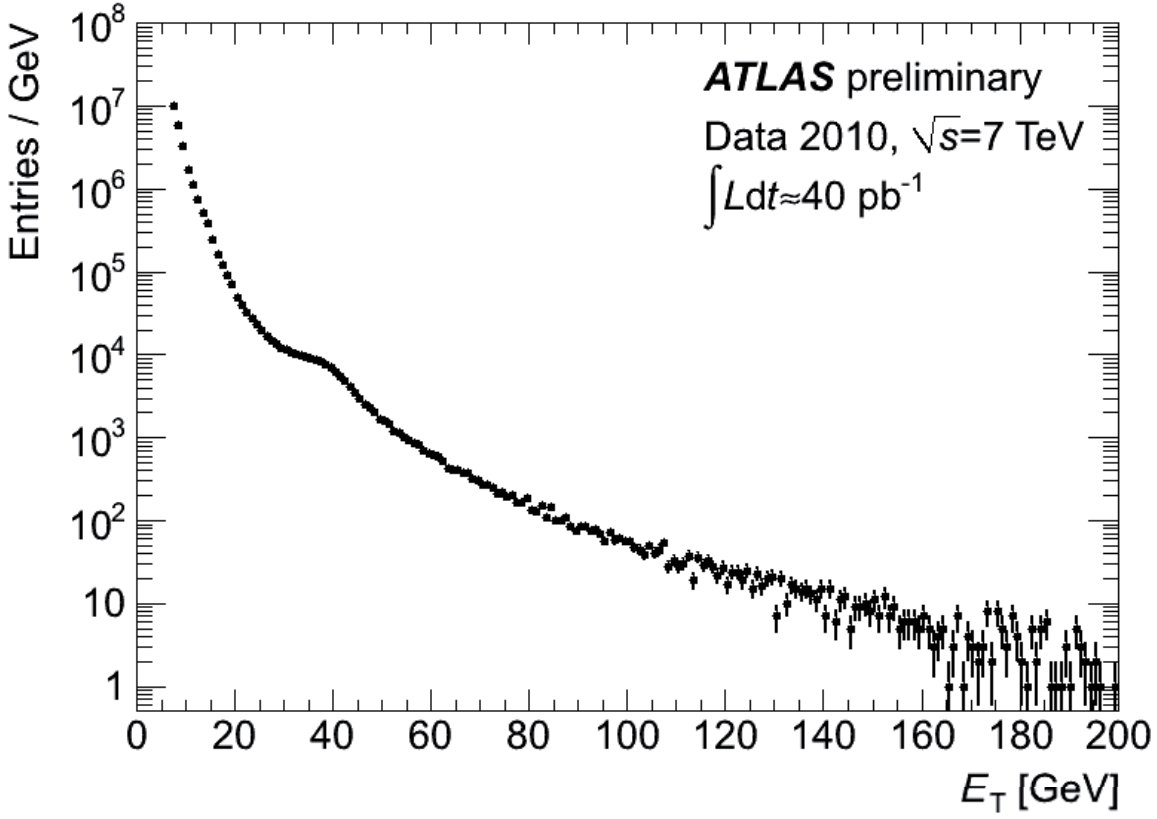
- From slides by B. Dolgoshein, O. Novgorodova, A. Polaykova and V. Tikhomirov

Jacobean Peak

- The search for a W boson at Protvino ended with a finding of a kinematic singularity observed in the W boson discovery:

Title: **EFFECT OF TRANSVERSE MOTION OF A DILEPTON PRODUCED IN PN COLLISIONS ON MASS-SPECTRUM AND SPECTRUM OF INCLUSIVE LEPTONS WITH LARGE TRANSVERSE-MOMENTA**
Author(s): DOLGOSHEIN BA; NIKITIN YP; ROZHNOV GV
Source: SOVIET JOURNAL OF NUCLEAR PHYSICS-USSR Volume: **23** Issue: **1** Pages: **127-128** Published: **1976**

- If ATLAS selects single electrons after applying the tightest selection criteria to reduce the background from hadrons (initially dominant) and photon conversions, inclusive electron spectrum at low pT is ~ 50% pure and Jacobean peak from W->ev decays is clearly visible



Credits

- 1970 Lenin Prize winner Boris Dolgoshein, photo by Mikhail Kuleshov, RIA Novosti
- Enhanced image of streamers taken in a steamer chamber
  - http://mediaarchive.cern.ch/MediaArchive/Photo/Public/1992/9207077/9207077/9207077-A4-at-144-dpi.jpg

Obituaries:

- Boris Dolgoshein 1930–2010, CERN Courier, Feb 23, 2011
  - http://cerncourier.com/cws/article/cern/45162
- Boris Dolgoshein (1930–2010) , by W. Barletta, R. Klanner, P. Krizhan, F. Parmigiani, F. Sauli, D. Wehe, NIM A 647 (2011) 1–2
  - doi:10.1016/j.nima.2011.03.002