International Workshop on Advances and Perspectives of Basic Sciences in Caucasus and Central Asian Region
Tbilisi, Nov 1-3, 2011

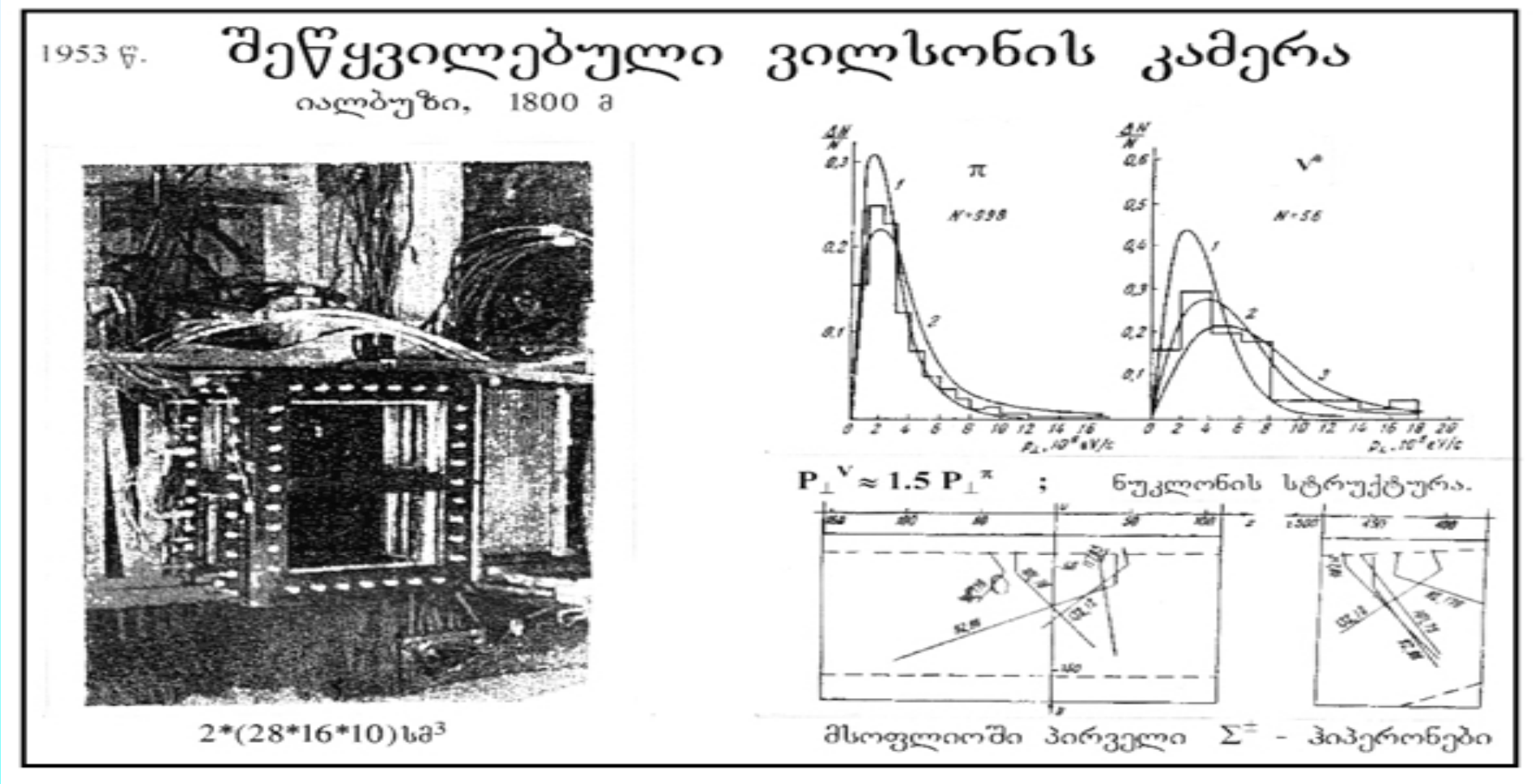
PHYSICS in GEORGIA:
Particle Physics and Cosmology

Jon Chkareuli
(AIP - Tbilisi State U & ITP - Ilia State U

I. Looking back

1949

The first Georgian Cosmic Ray Station on Mt Elbrus (5,642 m)
(Andronikashvili, Chikovani, Manjavidze)



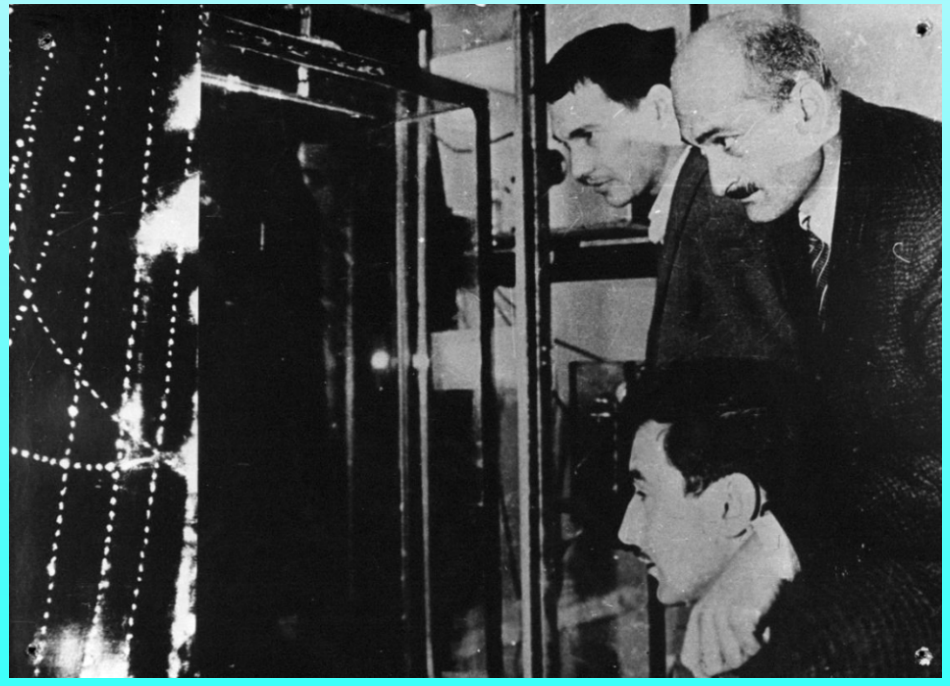
The first results emerged in the primitive twin Wilson chambers used:

(i) transverse momenta of kaons to be less restricted than those of pions (some hint to the composite structure of hadrons)

(ii) indications on an existence of heavy strange baryons which later were identified as sigma-hyperons on accelerators (starting move to“eihtfold way” for hadrons)

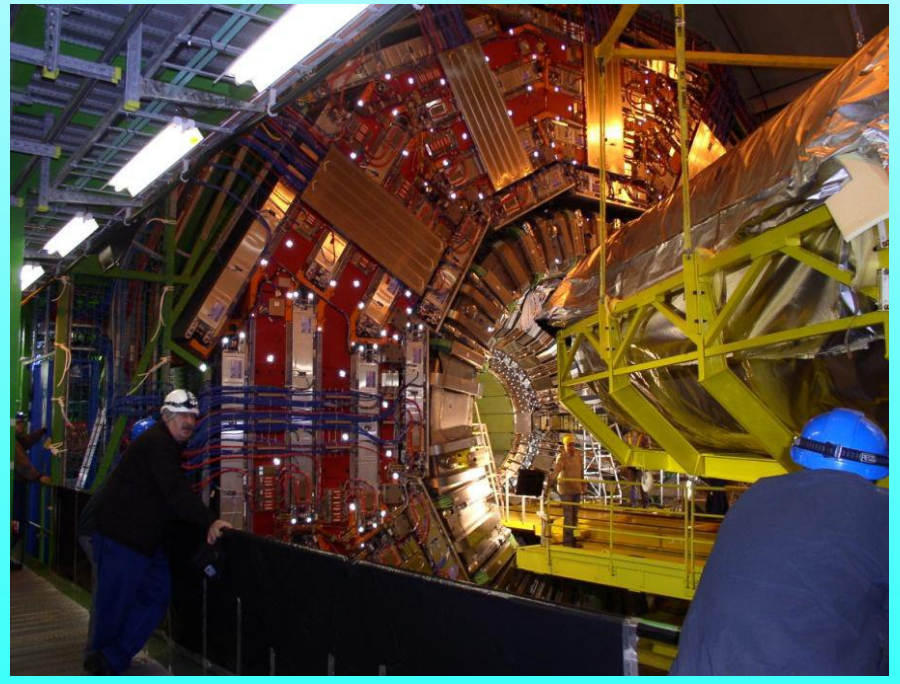
1959

Georgian streamer chamber
(**Chikovani & Roinishvili**)



2009

Georgians at LHC



II. Main HEP Institutions in Georgia

AIP — Andronikashvili Institute of Physics –Tbilisi State U

HEPI — High Energy Physics Institute - Tbilisi State U

Both belong to top 500 HEP institutions in the World (SPIRES)

RMI — Razmadze Mathematical Institute – Tbilisi State U

ITP — Institute of Theoretical Physics – Ilia State U

AIP 1950

Particle Physics Department

Divisions of PPD

- Particle Theory Group
- High Energy Physics Group at Accelerators
- Cosmic Ray Physics Group

Research staff : 23 Members
Theory - 10, Cosmic Rays - 8, Accelerators - 5

Research: Theory (Research topics & interests)

- **Lepton-Hadron and Hadron-Hadron Scattering at High Energies** (*Abramovsky-Gribov-Kancheli theorem, 1975*)

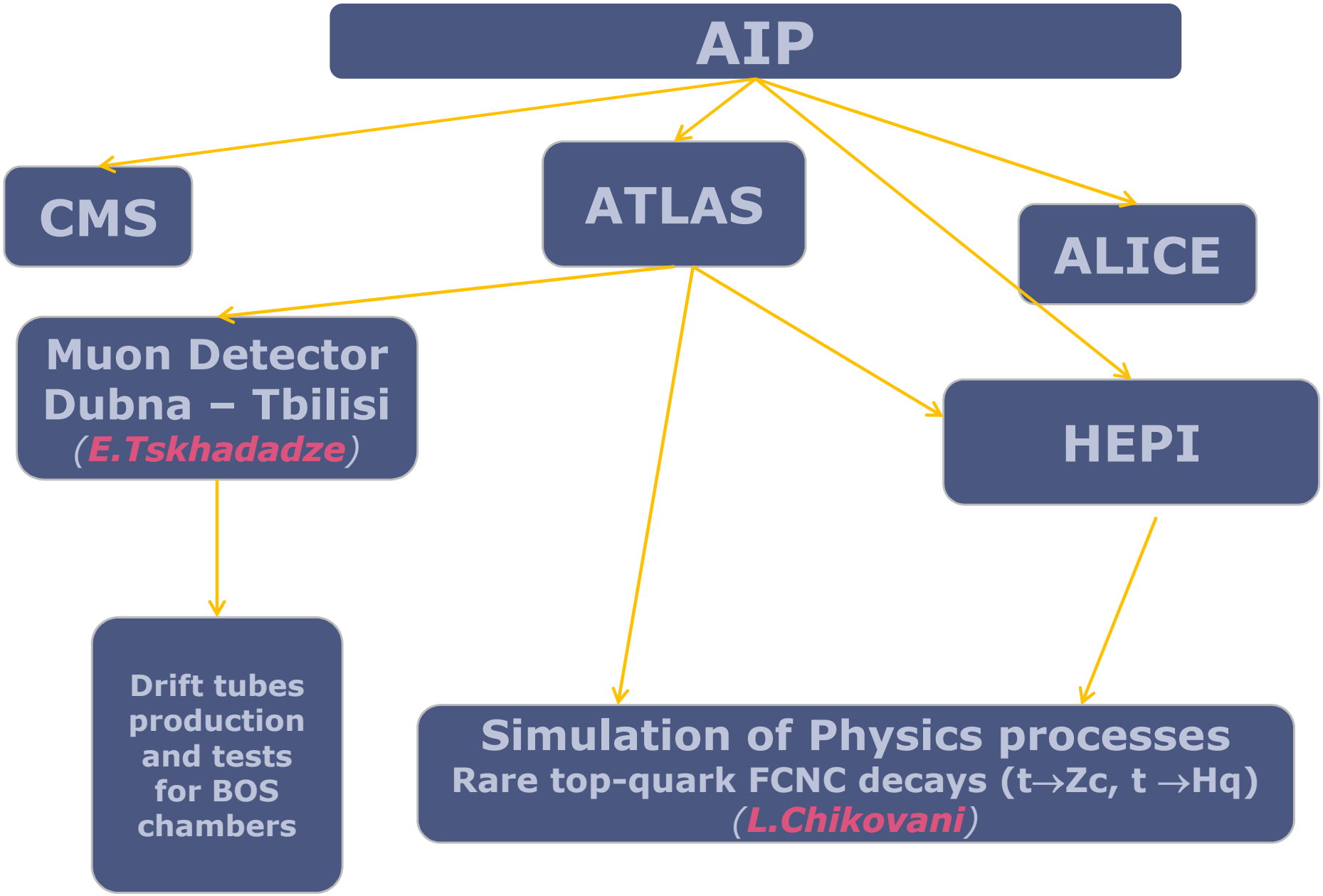
- **Flavor Physics** with a new SU(3) symmetry introduced for quark-lepton families and a role of flavor topological defects in the early Universe investigated (*Z.Berezhiani, J.Chkareuli, G.Dvali, 1980-1990*)

- **Supersymmetric Grand Unified Theories** with the doublet-triplet problem solution found (*J.Chkareuli, A.Kobakhidze, I.Gogoladze, 1998-2000*)

- **Extra Spacetime Dimensions and Brane Models** with the warped geometry in 5D theory (*M.Gogberashvili, 2000-02*)

- **Extended General Relativity** with the resulting theory appearing as noncommutative version of the unimodular theory of gravitation (*A.Kobakhidze, 2006-08*)

Research: High Energy Physics Group at Accelerators



Research: Cosmic Ray Physics Group

- **Investigation of the primary content of high energy cosmic rays in Extensive Air Showers studying both muon and hadron component spectra** *(T.Barnaveli)*

- **Scientific-Educational Project in Cosmic Ray Physics: Investigation of Extensive Air Showers by constructing of the Network of the Cosmic Rays Stations in Georgia allocated in high schools and universities.** ***Currently three CR stations operate*** *(M.Svanidze)*

HEPI 1979

HEP Divisions of HEPI

- **Department of Theoretical Physics**
- **Department of Experimental Physics**

Research staff : 28 Members
Theory - 7, Experiment - 21

Research: Theory (Research topics & interests)

- **The quark structure of hadons: composite baryons** (*T.Kopaleishvili*)

- **Spin physics in deep inelastic processes, QCD in the infrared area** (*A.Khelashvili*)

- **Physics beyond Standard Model: flavor-changing neutral currents** (*G.Devidze*)

Research: Experiment

- **Spin Physics, ANKE/PAX Experiment in the Julich Research Center (*M. Nioradze, M.Tabidze*)**

- **Top Quark Physics, ATLAS Experiment (*T.Jobava*)**

- **Physics of Relativistic Ions (*Yu.Tevzadze*)**

RMI

1972 **Department of Theoretical Physics (10 Members)**

HEP Research topics & interests:

- **Quark matter at finite temperature and density, Light-front dynamics, Gauge invariance in effective field theory** (*A.Kvinikhidze*)
- **Conformal field theory, String theory, AdS/CFT correspondence, Liouville theory** (*G.Jorjadze*)
- **Early Universe, Self-gravitating solitons, Black hole physics, CMB temperature anisotropy** (*G.Lavrelashvili*)

ITP2008

Divisions of ITP

- **Center for Elementary Particle Physics (CEPP)**
- **Center for Theoretical Astrophysics (CTA)**

Research staff : 16 Members

CEPP - 6, CTA – 10

MSc &PhD Students -12

http://www.cepp.iliauni.edu.ge/

CEPP Research topics & interests:

- **Realistic Grand Unified Theories, neutrino masses and mixings, physics of rare processes** (*Z.Tavartkiladze*)
- **Quantum gravity running/reduction, coincidence problem, the gravity deformed quantum mechanics** (*M.Maziashvili*)
- **Spontaneous Lorentz violation in vector and tensor field theories, origin of internal symmetries , vector field domain walls in Cosmology** (*J.Chkareuli, J.Jejelava, Z.Kepuladze*)
- **String theory, dynamics of higher spin fields, BRST, dimensional reduction** (*M.Tsulaia*)

Teaching at CEPP-ITP

Mandatory courses for MSc students

- Special and General Theory of Relativity
- Quantum Theory of Particles and Fields
- Introductory Course on Cosmology
- Theoretical Particle Physics - Standard Model and Beyond
- Special Course on Gravity

Optional courses

- Experimental High Energy Physics
- Basics of Classical Astrophysics
- Topological Aspects in Condensed Matter Physics
- Theory of Superconductivity
- Elements of Set Theory
- Group Theory and Geometric Structures

III. Collaboration and Contacts

CERN , ICTP , JINR, KEK
Niels Bohr Institute
University of Heidelberg
Glasgow University
Lancaster University
University of Maryland
New -York University
Oklahoma State University
The Bartol Research Institute
University of Melbourne
University of Liverpool
University of Helsinki
University of Berlin
University of Bonn
University of L'Aquilla
Julich Research Center
Moscow Lebedev Institute
Yerevan Physics Institute

IV. Georgian HEP in numbers

People

32 (Theory) and **36** (Experiment) in home institutions

16 (Theory) and **24** (Experiment) working abroad on permanent or long-term positions

Publications

Over **2,500** since 1975

312 in the last 5 years

(mostly in the leading HEP journals)

International Conferences (co-) organizecd

24 since 1975 including

Rochester Conference (1976), Bi-Annual Seminars "Quarks" (1980-90), Workshop "SM and Beyond" (1996), ISPM (1998-2004) etc

3 in 2011:

"Recent Advances in Quantum Field and String Theory" ,
"Low Dimension Physics and Gauge Principles",
"Physics in the LHC Era"

Awards and Grants

International: **36** since 1991 including

Royal Society fellowships and grants for joint research, INTAS, ISU, CRDF, ISTC, DFG and others

Georgian NSF: 13 since 2007

V. Conclusions

- Georgian HE Physics has long and strong traditions. Presently, it is seriously involved in the most fundamental experimental researches (primarily at LHC), while theory successfully covers many perspective directions in the modern particle physics and cosmology.

- HEP community can provide the high-professional education for a new generation of HE physicists both in theory and experiment. Actually, most of our young people successfully working abroad have made their PhD degree here in Tbilisi.

- Many of them would be happy to return home, if some new and strong activity in terms of **Center for Fundamental Sciences** might start in our region so in this way the very serious problem of "brain drain" for all of us could be successfully resolved with time.