How it was starting…

Jemal Khubua
High Energy Physics Institute of Tbilisi State University, Georgia

Allow please also for me to great you on our I would say a traditional conference.

By saying “traditional” I was not mistaken as our conference is already a seventh one and, besides that it finds larger and larger support and understanding from Tbilisi St. University Administration and from the Georgian Science leaders.

This conference subjects are mainly connected to the HEP and to its questions, but in parallel we great and welcome any interesting reports with the close problematic under the item of an “invited talks” – talks which meet an higher interest of a scientific community.

Now a little excurses to the conferences history. Their start up is the year of 2001 coincided with not an easy country life period (economics, political tensions, special relation to the science etc…). But thanks God in Georgia have appeared group of persons headed by Academy of science president, academician A. Tavkhelidze, by parliament member and chairmen of committee on science and education academician N. Amaglobeli and others who were thinking that the isolation from the world scientific community is a killing for country and they have began to try all ways for support of a science in country.

From the other side the mentioned period coincided with widening of relations with CERN and with JINR (here I note that these relations are of an old times and very efficient…) so it happened that in some sense naturally appeared an idea of carrying out of a series of conferences on different directions of the fundamental science. Of course among them was also a physics and in the year of 2001 took place the very first conference called: “Physics at the future colliders”.

Now a few words about our relations with CERN. The very first contacts with this organization appeared in the mid-60th of a previous century when as a member of Soviet Scientists delegation Prof. A. Tavkhelidze has visited CERN and presented a report at a Theory department as well as first Georgian experimental physicist George Chikovani who soon was invited for the long term stay in the group of Maglic at CERN.

Our contacts with started gradual widening and soon after G. Chikovani at CERN appeared V. Roinishvili, then after some pause started to arrive a young physicists: V. Kartvelishvili, E. Chikovani, N. Jaoshvili, a bit later G. Dvali and many of others. But unfortunately all these contacts were because of some individual recommendations, and we had to wait for the long time by official Georgia – CERN relations appearance.

After the USSR – collapse all member republics who became to be countries and who had high enough level of schools in physics and mathematics all of them started to look for contacts with CERN in an independent way.

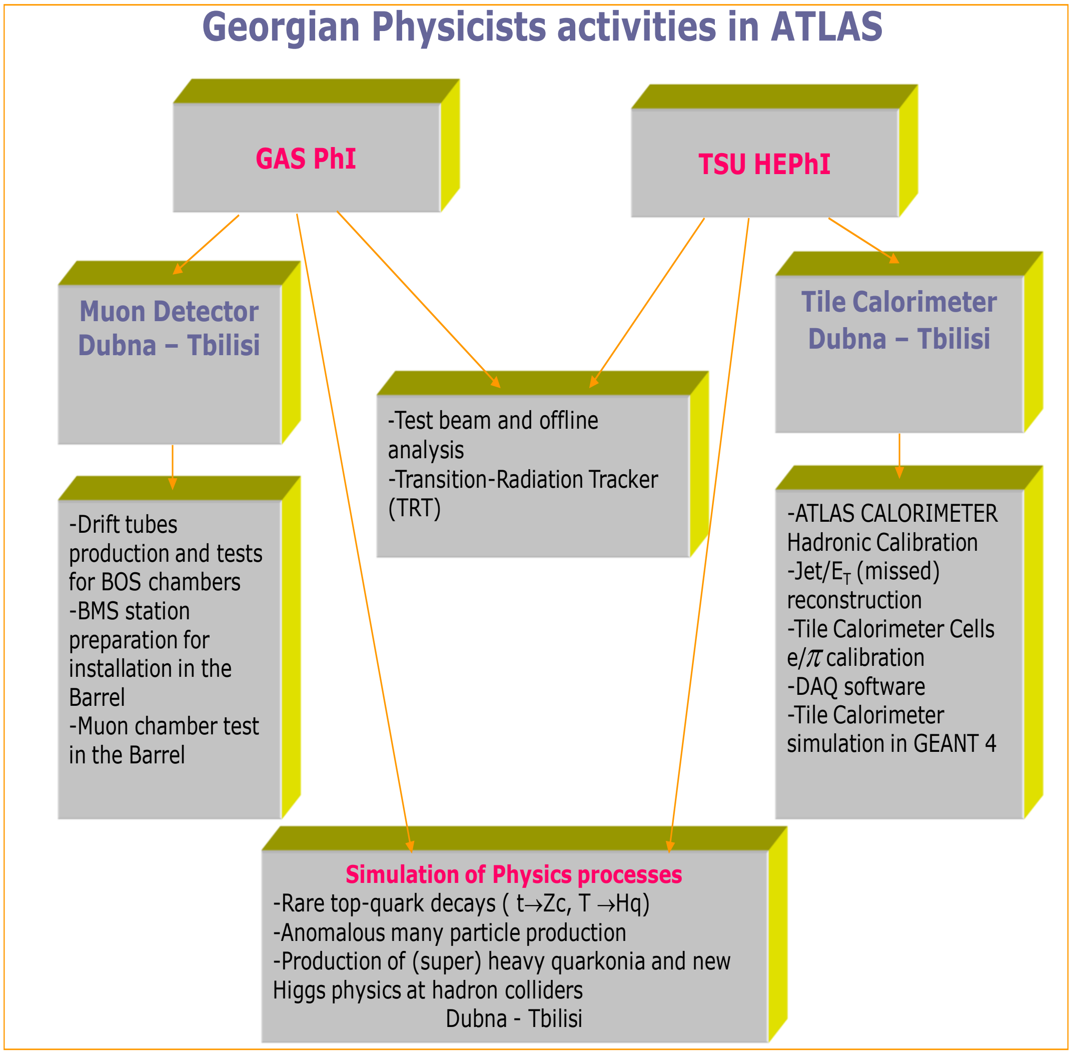
From the other side at about the same time it was decided to build a new large hadron collider (LHC) with a record for our times energy (14 TeV) and highest luminosity of $\approx 10^{34}$ cm^{-2}sec^{-1}. A few very large experiments ATLAS, CMS, ALICE, LHCb (and a bit later smaller ones) were planned with a different but to some extend overlapping physics tasks for beyond all known today.

The solving of the LHC research program needed to attract a highest qualification experts in preparing and education of whom the gigantic role was played by the another international centre – by the Joint Institute of nuclear research (JINR) in Dubna.

Georgia, as a USSR member – republic had a highly tight contacts with the JINR starting the very first moment of its foundation in 1956. In the Dubna Institute there were educated and prepared pleads of highest rank scientists who were participating in practically all physics research direction at the JINR.

So the Georgia participated at JINR first as “the USSR-unit” and after its collapse as an independent member-country starting March, 1993. So I must say that due to our membership at the JINR we in Georgia have never felt a lack of high-class scientists for the large international projects.

And in the year of 1993 the very first direct negotiation have been started concerning Georgian physicists participation in the ATLAS and CMS – experiments, which have resulted in the adoption of Georgia as an independent country-participant in the ATLAS experiment and in the so called RDMS-block for CMS experiment.



So in September of 1994 two Georgian institutes: High Energy Physics Institute of Tbilisi St. University (HEPI TSU) and Physics Institute of Georgian National Academy of Sciences, already as a joint team with a common name "Tbilisi" became to be a full right and independent ATLAS collaboration member.

Following their interest these two institutions representatives have been actively connected to the program of creation of two different ATLAS sub detectors:

--Muon system with responsibility of PI of GAS, and

--Hadron Tile Calorimeter with responsibility of HEPI TSU.

All these works have been performing mainly at the JINR and CERN but Georgian experts participation was highly essential and of principal significance on the all key stages of Calorimeter and of muon complex creation.

Georgian joint team – "Tbilisi" in ATLAS

Surguladze N.
Georgian representative in
The ATLAS RRB

IHEPI, TSU

- Arabidze G.
- Djobava T.
- Glonti G.
- Grigalashvili N.
- Kekelidze A.
- Khoriauli G.
- Khubua J.
- Devidze G
- Liparteliani A.
- Minashvili I.
- Salukvadze G.

IoP GAS

- Chikovani L.
- Gongadze A.
- Manjavidze T.
- Shubitidze N.
- Tskhadadze E.
- Tsulaia V.

GTU Team

- Sharmazanashvili A.
- Bitadze A.
- Surmava A.
- Sharmazanashvili N.

Simultaneously was organized the both institutes representatives common group deeply involved in date analyses problems, mathematical simulations (modeling) and experimental data studies to investigate such a rare processes as special (rare) top-decays, search for supersymmetry effects manifestation, very high multiplicity studies, and others.

One must mention that this group really worked Heroically and at the very uneasy Tbilisi (and country !) conditions. All the data and results achieved by Georgian group with drs. T. Jobava, L. Chikovani and M. Mosidze, were agreed with the CERN colleagues and reported at CERN.

In the years of 2001-2002 to the Georgian ATLAS group have jointed the very high class computers design experts from the Georgian Technical University headed by Prof. A. Sharmazanashvili. These new colleagues actively entered ATLAS team and have played out a very significant role in the successful completion of ATLAS creation works. All the mentioned works and their executors I summarized in the Table 1-2.

As I have already mentioned our contacts with CERN have a long history but they unfortunately had a fragmentary, recommendatory and up to some extend private character. But permanent extensions of these contacts, disappearance of the SU and appearing of a new scientific programs connected to the unique LHC machine gave a favor to appearing of a very first Georgia-CERN collaboration AGREEMENT signed by that time (1996) Georgian President E. Shevardnadze and CERN Director General Prof. Lluevelin-Smith, and a concrete conditions of Georgia participation in ATLAS were signed by Academy of Sciences President A. Tavkhelidze and ATLAS spokesperson P. Jenni.

Gradually these Georgia-CERN relations also started to become wider, more of a different educational Georgian Institutions were involved in participation in CERN research program and these circumstances demonstrated the necessity to draw up a new AGREEMENT which takes into account a new realities and finally has been signed in the year 2008 by the deputy of Georgian minister of education and science (by that moment the conducting of science came from GAS to the Ministry of Education and Science) Prof. N. Surguladze and CERN Dir. Gen. that time Prof. R. Aimar.

So today the enlarged list of organizations cooperating with CERN currently includes:

1. HEPI, I. Javakhishvili TSU,
2. E. Andronikashvili IoP, TSU,
3. I. Javakhishvili TSU,
4. Georgian Technical University (GTU),
5. Computer Design Center (CAD-CAM) GTU,
6. I. Chavchavadze University,
7. Ministry of Education and Sciences.
8. Georgian Rustaveli Foundation.

The scientific leader of this joint group of Georgian scientists in the ATLAS experiment starting 1994 by today is Prof. J. Khubua.

As my personal participation in ATLAS experiment was connected with the design and creation of the central part of the so called TILE CALORIMETER I allow to myself to stop shortly this subject on.

The ATLAS collaboration is concerned with preparing a multipurpose experiment for studying proton– proton interaction at 14 TeV at the Large Hadron Collider (LHC) at CERN (Geneva).

The parameters of ATLAS detectors make it possible to investigate a wide range of expected physical processes and to operate in the field of new unexpected physical phenomena [1].

One of the most important parts of the ATLAS installation is the Hadron Calorimeter with the so-called cellular structure: the scintillating plates (tiles) are fixed into a steel absorber and a tile signal is read out by wavelength-shifting optical fibers. Tiles are located in a plane perpendicular to the direction of colliding beams (Fig. 1). The calorimeter consists of three sections: the central section (barrel) and two additional sections (extended barrels); each of these sections is assembled of 64 wedge-shaped modules; the length and weight of the module in the central (barrel) section of the calorimeter are equal to 5.6 m and 20 t, and those of the additional sections are 2.8 m and 10 t, respectively. The module is assembled of submodules mounted with an adequate relative linear and angular precision on a common base—a straight massive beam (girder).

Design requirements for the calorimeter [1] are as follows:

(i) a jet energy resolution $a/E = 50\%/\sqrt{E} \oplus 3\%$;

(ii) energy linearity ±2%.

It is also necessary to meet a number of stringent design requirements on the precision of the mechanical assembly of modules. The key requirement is the tolerance for the non-flatness for the module lateral surface (1.9 **x** 5.6 m): it should be less than 600 **μ**m. This precision is high, and to ensure such a precision, one has to solve a difficult engineering and technical problem considering the weight and dimensions of the module and the specificity of its structure.

To implement the fundamental design scheme stipulated by the physical requirements, advanced technologies are necessary for the industrial-scale production of calorimeter components as well as the assembling of submodules, modules, and the calorimeter as a whole. It is clear that, at all mentioned stages, it was necessary to develop and use the corresponding methods of precision metrological control including the laser-control spacer technique, which was introduced in the modern practice of assembling especially large detectors for the first time.

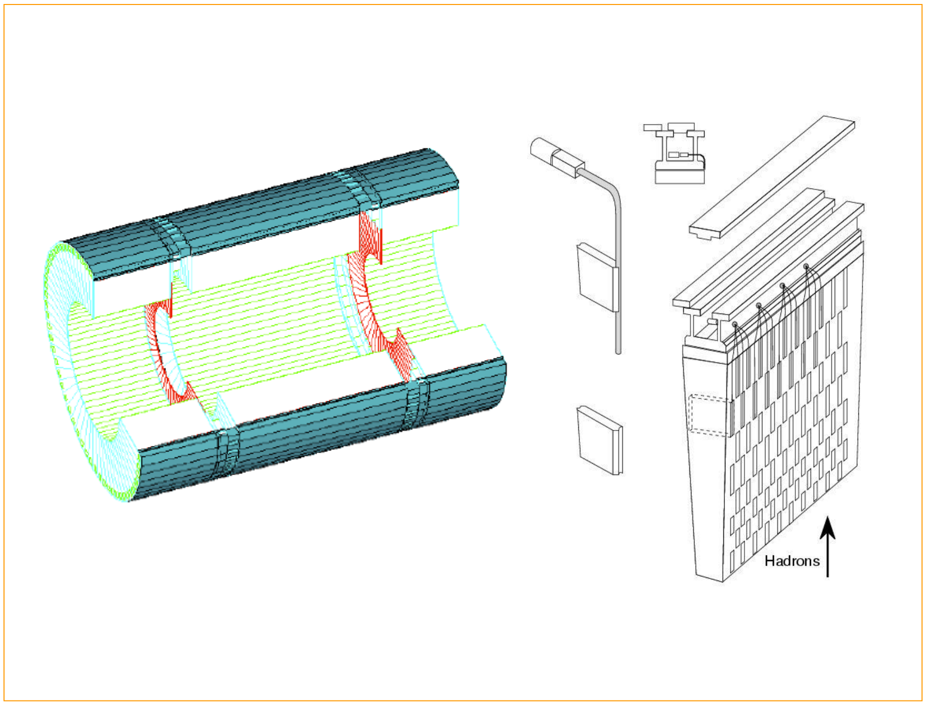


Fig. 1. Schematic drawing of (a) the arrangement of the ATLAS calorimetric system and (b) the module of the Hadron Calorimeter barrel section relative to the beam.

When assembling modules, the submodules must be mounted on the girder so that their symmetry-axis position is vertical up to 0.15 mm per 1.6 m, which corresponds to the eighth accuracy class in machining details. This precision (taking into account that one module contains 19 submodules of about 1 t each in weight) was achieved through the development and introduction of the unique *laser-control* technique at JINR. Before the full-scale production of submodules and modules at JINR, principally important stages of R&D works were performed.

The development and application of the laser-control technique in the precision assembly (=50μm) of the six-meter 20-t modules became a new word in metrology. The culture of the precision assembly developed at JINR can be claimed not only in constructing the calorimeter but also the ATLAS installation as a whole and the LHC accelerator itself.

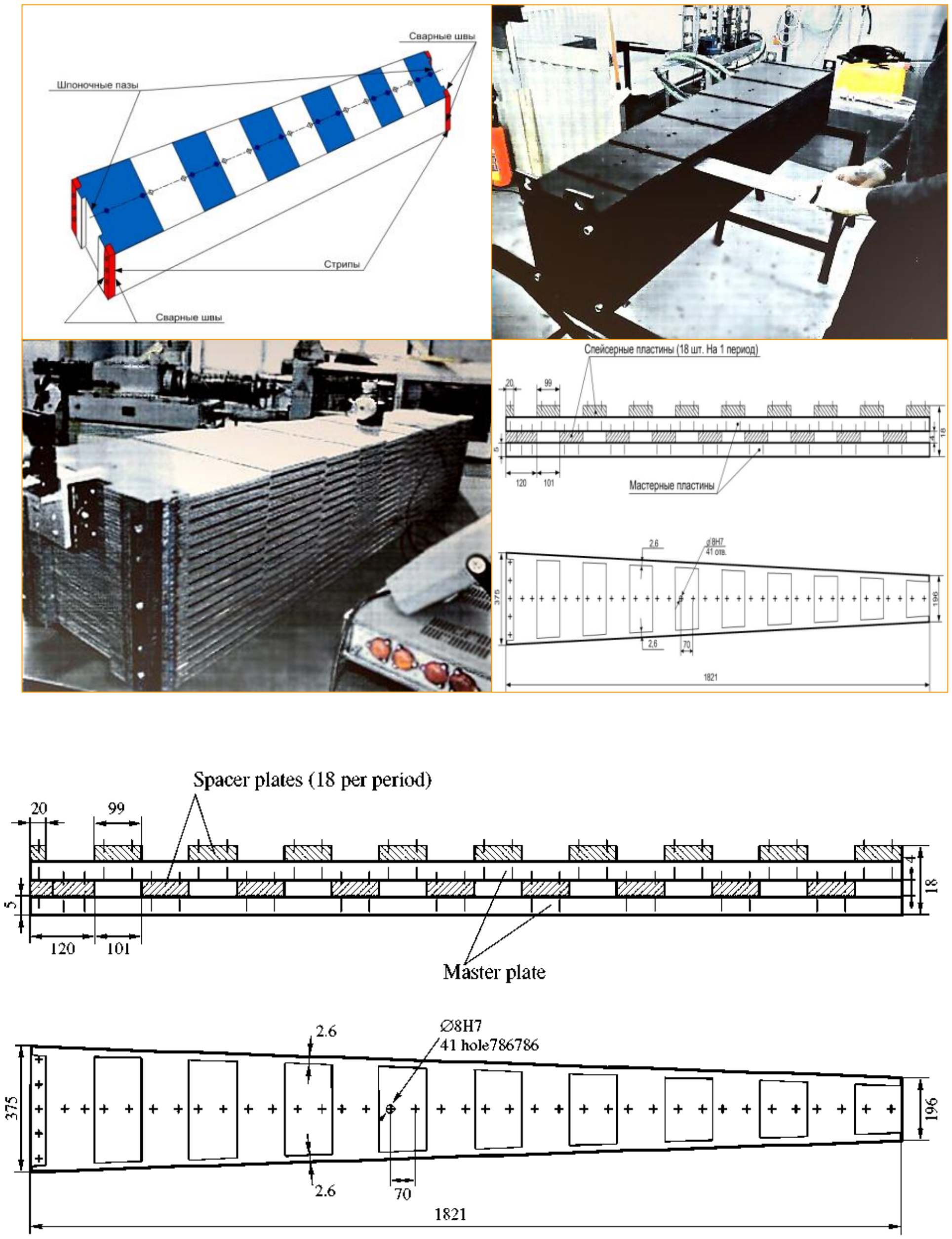
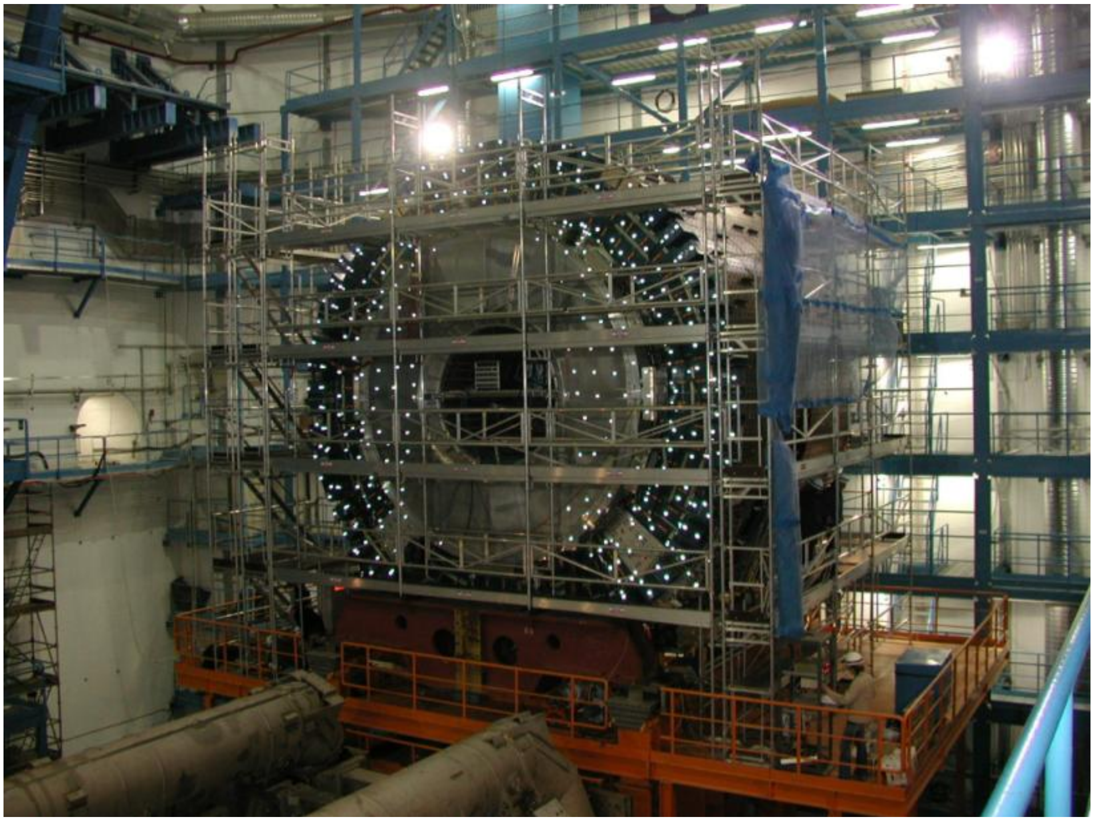


Fig. 2. Schematic image of one of 55 periods of the one-meter submodule prototype.

Having resolved the complicated R&D problem of the precision assembly of calorimeter barrel modules [2], the collaboration further experimentally showed the conformity of the calorimeter parameters (resolution and linearity) to the design physical values. When investigating calorimeter fragments in the test runs, it was established that the ATLAS calorimeter meets the experimental requirements on energy resolution $50\%/\sqrt{E} \oplus 3\%$ and linearity ±2% [3], placing it among the most high-precision instruments of its type.



This review briefly summarizes certain essential eight-year (1994-2002) results following mainly the chronology of completed tasks.

These are the following tasks:

(i) the outline designing of the main structural units of the calorimeter, the accompanying R&D works, the production of prototypes;

(ii) the mass industrial production of =300000 steel nuclear absorbers and the bearing beams;

(iii) the creation of submodules and modules and the development and application of precision technological techniques including the laser technique.

The authors consider it their duty to emphasize once again the exclusive efficiency of the joint activity of the large collective of workers, technicians, engineers, and physicists from many scientific centers and industrial enterprises reflected in the successful fulfillment of the unique engineering and technical problem of construction of modules and their delivery to CERN.

The further fate of the Dubna created and delivered to CERN modules of the barrel (central) part of the hadron calorimeter is as follows: prior to the final assembly in the underground LHC experimental hall (at the depth of 100 meters) the whole procedure was repeated at CERN on the surface level to avoid some unexpected situation and problems one might expect when final assembling in the area where the possibilities to change and repair are highly limited.

The experience accumulated during this preliminary, on the earth surface, assembly was used when final assembling. All this works both on the surface and in the experimental hall were executed with an active participation of the JINR engineers and technicians.

After the preliminary assembly the barrel part of the calorimeter (consisting of 64 modules) was disassembled to 8 modules unit and all of them together with the support have been delivered by 250 tons crane to the experimental area where works were continued to assemble full 64 modules set.

December 2004 was marked by a significant achievement in preparing experiments at LHC: in the underground hall, the first large unit of the ATLAS installation, the Barrel Hadron Tile Calorimeter, was assembled. The barrel is the central and largest section of the entire calorimetric complex, which is twice as large in size as the so-called Extended Barrels adjoining it.

The barrel assembly place was not a final destination. After assembly the barrel started its “travel” to the experimental hall center on the specially created transportation mechanism using the air-cushion. And in December 2004 the barrel arrived at its final position, leaving its former place free for the remaining calorimeter parts assembly – the EBA and EBC units which also passed the preliminary surface assembling. By the middle of 2006 all works to assemble the full scale calorimeter were completed.

The huge experimental data flux from the calorimeter and other ATLAS subsystems during data taking runs will be directed to the data control board. Therefore in parallel to the ATLAS parts assembly also was executing cabling (high voltage, low-voltage, high frequency, etc) to connect ATLAS subdetectors with the data acquisition and control stations. The unique scientific data, arriving as “raw material”, will further be with INTERNET and GRID distributed and analyzed among many world research centers, enabling the national groups in different countries to be active participants of the realization of the scientific program of the world largest proton collider LHC.

On the March of 2010 the unique ATLAS research complex on the world greatest collider started to collect scientific results on the energy and luminosity of the colliding particles, unprecedented in laboratory conditions…, which was so impatiently waited by the world scientific community.

Just about these first research results will be told on this conference.

Today we know that all this effort of many peoples, from different countries of the world (among them Georgia), poured out in a huge success, in receiving the Nobel Prize on physics.

I think participants, present here, have full right to congratulate each other by applause this big success.