Moroccan Participation to the ATLAS Experiment

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On behalf the ATLAS Moroccan group

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Important Dates

1992: First contribution to the ATLAS
   - Contribution to the CERN RD3 Research & Development project
   - Setting-up and running of an irradiation station for SARA

1996: Official participation to the ATLAS experiment

1997: Creation of the Moroccan High Energy Physics Cluster (RUPHE):
   - 5 Universities: Casablanca, Marrakech, Oujda, Rabat and Tanger
   - The National Center for Energy, Science and Nuclear Technics (CNESTEN)

2004: Signature of the GDRI:
   - International research group (France, Morocco and Sweden)

2008: Creation of the International Associate Laboratory (LIA):
   - International Laboratory for Collider Physics (ILCP)

2010: Action programs between Rabat university and IFIC (valence)

2014: LIA Maghreb (France, Sweden, Algeria, Morocco and Tunisia)
## The Large Hadron Collider (LHC)

- High energy proton-proton accelerator which came online Sep 2008
- Four experiments positioned on the ring: ALICE, LHCb, CMS and **ATLAS**

- 27 Km of circumference + 100 meters underground
- 1,232 dipole magnets @ 8.33T
- Beam characteristics @ 14 TeV: 99.999999% of the speed of light
ATLAS Collaboration

- 38 Countries, 178 institutes, 3000 scientists and engineers (including 1000 students)
- Morocco is the first African and Arab country that started its collaboration with CERN in 1996 as a member of the ATLAS collaboration

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Diameter: 25 m
Barrel toroid length: 26 m
End-cap end-wall chamber span: 46 m
Overall weight: 7000 Tons
The Moroccan contribution to the ATLAS involved several fields:

- In the experimental part (construction, test beam analysis, calibration and alignment of detector ... )
- In the physics analysis (physics analysis of the Standard Model and beyond using both MC and real data)
- In the Grid computing

Important phases

- During the construction phase and the test beam analysis
- After all sub-detectors were installed in the pit: commissioning phase
- After the LHC start-up, since 2009: operating phase
- Upgrade phase to the s-LHC
Morocco in the ATLAS Experiment

➢ Participated Since early 1990’s to the (before become an associate member):
   - CERN RD3 Research & Development project
   - Setting-up and running of a neutron irradiation station for the SARA facility

➢ During this phase, we mainly study:
   - Electronics radiation hardness
   - Pollution of liquid Argon
   - Material selection for LAR
     Electromagnetic Calorimeter
   - Reduce the attenuation of the signal in the LAr

➢ Irradiation activities continued at CERI (Orleans France) after SARA closure

- **Mechanical and electrical test of around 50,000 Presampler anodes in Morocco**
  - High voltage long duration test with 9 plates 450 anodes at 3 KV between the outer and the inner layers for 2 days
- **Sector tests at Grenoble with participation of Moroccan physicist**
- **Participation to the EM calorimeter module assembly and cabling**

64 sectors - 8 modules/sector

In total 512 modules (50,000 anodes)

- Test beams from 1998 – 2004:
  - Crosstalk in the Electromagnetic EndCap
  - Energy resolution
  - Performance study on the Barrel electromagnetic and presampler

- Combined Test beam July – October 2004: all ATLAS sub-detectors integrated and ran together with common DAQ, “final” electronics

- 10 Moroccan physicists were stayed at CERN (stays paid by CERN, flights paid by GDRI)

- Working on the following tasks:
  - Study of individual **detector performance** (efficiency, resolutions, noise)
  - **Combined** performance (material effects, particle ID, photon conversions)
  - Validate the modelisation of the **Monte Carlo**
  - Common ATLAS software used to analyze the data

- Using around 90 millions of events (e, π, μ,γ, p) with an energy between 1 to 350 GeV

- December 2005, a seminar on the combined test beam analysis was held in Morocco
Morocco strongly participated to the cold test before the installation of all sub-detectors:

- Pulsing all lines with the calibration board, and reading pulses back with the front end boards
- Tests of the final Front-End-Crate electronics
  - Noise measurements
- Applying High voltage
  - Slow ramp up
  - Stability test during several weeks

Participation to the commissioning week:

- The barrel commissioning: 10 weeks in summer 2004
- The end cap C commissioning: 8 weeks in winter 2005
- The end cap A commissioning: 6 weeks in summer 2005

Participation to the commissioning weeks after the installation, from 2006 to 2008
**Commissioning Phase: Presampler Response to Cosmic Muons**

- Participation to the commissioning phases: development of new tools and codes for the analysis
- The Presampler response to a real physical signal is through the cosmic muons

- The cosmic data analysis needs the Barrel PS calibration parameters which was missing
- Dedicated data were used for the calibration

Pulse shape plot not implemented for the PS
From Cosmic Data Analysis to Calibration of the Detector

- The missing Presampler calibration push us in involving in the calibration of the whole LAr detectors

In the Calibration part we participated to:

- Calibration of the Electromagnetic Calorimeters (EMB, EMEC, HEC, FCAL and PS)

- Development of new tool for the electronic calibration
  - System to compute in an automatic way Electronic Constants needed to reconstruct the LAr energy cell
    - From taken data at the Atlas Control Room to the calibration of all detectors
  - Investigation of the electronic stability
  - Helps to determine the level of instability caused by detector conditions
  - Changes Data Bases parameters if needed

- Crosstalk measurement using calibration data between the LHC data taking
- Crosstalk Correction

- Study of the tracking system alignment
Physics Simulations

- Study of ATLAS Physical Potential
- Prepare methods for real data analysis
- Subjects of interest: Standard Model Physics and Beyond (New Physics)
  - Physics of electroweak gauge boson
  - SuperSymmetry search (Higgs pairs production in MSSN)
  - Determination of the gluon structure function at LHC
  - Detection of Neutral Trilinear Gauge Coupling
  - $b$-quark, $t$-quark production at LHC
  - CP Violation Study
- Participation to the ATLAS physics TDR drafting
Our groups are focused on many different subjects which are so important at LHC:

- **B-Physics physics**
  - Reconstruction of different channels, CP violation study, polarization and helicity amplitude measurements at the b-baryons

- Search for charged Higgs boson as signal for the new physics

- Top quark physics analysis is crucial due to numerous motivations

In addition some technical studies are ongoing:

- Luminosity and beam spot determination
- Alignment of the Inner detector
- Calibration of triggers
Present Status and Progress

➢ Around 12 thesis are in preparation (5 are planned to be defended this year)

➢ Analysis is going on various subjects using real LHC data

❖ The last ILCP meeting shows diversity and advanced research subjects

✓ Special thanks to J. Collot maintaining this meetings so active
Up to now about 15 Thesis had been defended in ATLAS Framework and more than 100 International publications

About 15 PH.D students are working now on ATLAS experiment and CALICE – ILC

Since 2010: One Fellowship had been set up by the HASSAN II Academy for student working at CERN.

- Selection of the candidate by an International committee from IN2P3, CERN, ATLAS experiment, the Academy and CNRST representatives and the foundation “Sharing Knowledge”

Members of the Moroccan Diaspora coming from the ATLAS community: USA, France, Germany, Sweden, Taiwan ...

2013: Two ATLAS members integrated Moroccan universities (Agadir and Oujda)

Participation on international communities: The Global Young Academy
Followship at CERN
The grid computing plays an essential role on the CERN data analysis

Donation of 161 servers by the CERN computer center to Moroccan High Energy Physics cluster universities and the CNRST

The servers should allow Moroccan scientists, who are mainly collaborating with the ATLAS experiment, to analyse LHC data at their home institutions “says Rolf Heuer, the CERN director General”
Computing Grid – Tier 2

Architecture MaGrid

Services de base MaGrid

BDII_Top  MyProxy  VOMS  WMS  LB  LFC  Gatit  HLRMon

Université Hassan II - Casab

Université Mohamed I - Oujda

Université Mohamed V Agdal - Rabat

Université Cadi Ayyad – Marrakech

Université Abdelmalek Essaadi - Tanger

CNRST - Rabat

MARWAN

34 Mb/s

100 Mb/s

34 Mb/s

34 Mb/s

100 Mb/s
Training at the CNRST

- The servers are all installed and configured
- The servers help increasing more than 400% of the quota
- Training new grid users at the CNRST
ATLAS Overview Week 2013 in Marrakech

The ATLAS week for 2013 will be hosted in Morocco. It is with great pleasure that we are able to invite our ATLAS colleagues to this important event taking place 07 Octobre to 13 Octobre in Marrakech. This event is being organized by the High Energy Physics Cluster (RUPHE) and the Associate International Laboratory (ILCP), along with the support of the Ministry of High Education and Research, the Academy HASSAN II of Science and Technology and the Centre National pour la Recherche Scientifique et Technique. The venue for ATLAS week is the Kenzi Farah Hotel, located downtown in the heart of the trendy cosmopolitan district “L’Hivernage”. see [Map](#).

Sponsorship

Académie HASSAN II des Sciences et Techniques

CNRS-T Centre National pour la Recherche Scientifique et Technique

MINISTÈRE de l’Éducation Nationale, de l’Enseignement Supérieur, de la Formation des Cadres et de la Recherche Scientifique

Useful Links

Visit Morocco

Embassies Consulates of Morocco

Sponsors & Organizers
Conclusions and Perspectives

- Moroccan participation to ATLAS: from R&D to detector exploitation
- Establish experimental expertise for LHC accelerator, in several fields:
  - High standard electronic equipment, physics analysis technics, theory of High Energy Physics ...
- Develop simulation techniques that have environmental and industrial impact.
- Take a leading part in the expected revolution in particle physics
- Train young scientists in Experimental and Theory of particle physics and Data analysis, etc.
- Several young scientist have benefit from participation to the collaboration
  - Training at numerous international laboratories over the world
  - Integration at numerous communities
- Participation to other international project in High Energy Physics:
  - S-LHC upgrade (2020)
  - International Linear Collider (ILC), the Calice collaboration
  - Other experiments at national level: The neutrino observatory project in Taza
Thank you for your attention