مدينة زويل
ZEWAIL CITY
ESTABLISHED 2000
INAUGURATED 2011

مركز الفيزياء الأساسية
Center for Fundamental Physics

HEPP Activities in Africa and Middle East

Shaaban Khalil

Center for Fundamental Physics, Zewail City of Science and Technology

On the behalf of the HEPP Communities in Africa and Middle East

HEPP Activities in Africa and Middle East

- CMS Collaborations
- ATLAS Collaborations
- ALICE & Other Collaborations
- Theory: Particle Physics, Cosmology and Astrophysics

CMS Collaborations

Egypt / CMS (Ahmed Abdelalim)

- ENHEP experimental groups (Zewail City, Cairo U., Ain Shams U., Helwan U.).
- In total, we are about 35 members.
- Main hardware contribution at the design and construction of the GEMs and RPCs of CMS Muon System.
- The Egyptian efforts started since introducing the GEM detectors at CMS.
- Recently, Egyptian GEM activities have focused mainly on the HV and LV setup quality control in addition to the CMSSW release validation for GEM.
- Egypt is currently participating in the installation and commissioning of the power systems for the GE1/1 GEM super-chambers in both CMS end-caps.

Egypt / CMS (Ahmed Abdelalim)

- Over the next 5-10 years, Egypt will extend its GEM tasks to the expected GE2/1 and ME0 GEM upgrades at CMS.
- On software we contribute to Muon System Performance, Trigger Efficiencies, and Upgrade Studies.
- In addition, Variety of research subjects mostly on BSM Physics e.g **Exotics** dileptons, Long lived particles, **SUSY** and **Higgs BSM**.
- Use **ML** techniques for problems such as Inner Tracker performance.

Turkey/CMS

- 1961(observer state) and 2015 (Associate Member State).
- Number of CERN users from Turkish institutes in 2019 are 129.
- Standard Model Precision Measurement, Beyond the Standard Model Physics and Supersymmetry (SUSY) Searches at the LHC CMS Experiment Using Run II Data and Beyond." PI: Middle East Technical University; in collaboration with four other universities.
- Study of B-physics and Quark-Gluon Jet distinction in the CMS detector and Phase 2 Upgrade." PI: Bogazici University; in collaboration with five other universities.
- Detector Development/Upgrade and New Physics Analysis in CMS Experiment." PI: Cukurova University; in collaboration with five other universities.
- Precision Measurement of Top Quark-Pairs with Artificial Intelligence Techniques at the CMS Experiment and Upgrade Studies for phase II HCAL/HGCAL Detectors." PI: Istanbul Technical University; in collaboration with three other universities.
- Design of a Test and Validation system for Sillicon Modules of High Granularity Calorimeter (HGCAL) and production of a prototype system." PI: TUBITAK-BILGEM

Iran / CMS (Institute for Research in Fundamental Science)

https://cms25.web.cern.ch/institutes/IPM-Iran/

- IPM joined CMS in 2002, sending three students to CERN to perform their PhD research and to provide an in-kind contribution.
- The in-kind contribution was the construction of the support tables for the CMS forward calorimeters, which was later augmented by their cylindrical shielding.
- The group is involved in several physics analyses, mostly around Top physics, Forward Physics, Supersymmetry, Higgs and Exotics. The group is also active in beam test, implementation of the full description of geometrical parts, Geant 4 simulation, and digitisation and reconstruction of the CT-PPS detector.
- Contribution to the Phase-2 Upgrade of the CMS detector is through the fabrication of the Link Boards of the Resistive Plate Chambers (RPCs) for data transmission, control and calibration of the RPC read-out system.

Cyprus/CMS (University of Cyprus, Nicosia)

https://cms25.web.cern.ch/institutes/Cyprus/

- Hardware
  - The group has been a member of the consortium responsible for manufacturing the Barrel Yoke and vacuum tank of the CMS magnet, and has participated in the construction of ECAL, of a specialised station to control its VFE boards, and test beams to calibrate and monitor its performance.
  - Members of the group have contributed to searches for mini black holes due to extra space-time dimensions and rare events as products of their decay processes, have worked on correcting the energy deposited in “dead crystals” of ECAL, have developed search strategies for dark matter candidates of supersymmetric origin, and have helped determine the mass of supersymmetric particles based on toy Monte Carlo generator and fast detector simulation.
- Physics
  - The group’s contributions towards physics analysis includes reconstructing known particles for calibration purposes, studying the performance and data quality of the ECAL and the Tracker, studying the identification of muons from decays of known particles, studying Bose-Einstein Correlations between pairs of identical particles, measuring the properties of b quarks using muons and searching for supersymmetric Higgs bosons.
  - The group currently works on searches for additional Higgs-like bosons and the optimisation of the CMS Trigger. For Phase-2 Upgrades, the group participates in the construction of the High-Granularity Calorimeter and testing its electronics.

Lebanon/CMS (The Lebanese University)

https://cms25.web.cern.ch/institutes/Lebanese-Lebanon/

- The Lebanese University's association with CMS started in 2015 with the signature of the EOI between the faculty of sciences and CMS. Then a major step was set with the approval in September 2016 of Lebanese University as a cooperating CMS institute.
- The group is now composed of five faculty members from the physics department besides PhD students and supporting engineers.
- The main focus of the group is on photon-plus-jet analysis, J/psi and heavy flavours in heavy-ion collision.
- The faculty of science is now part of the MilliQan collaboration looking for BSM particles having charge of the order of 1/1000 that of an electron.
- The Lebanese University is also involved at CERN in several technology projects in collaboration with CERN and CMS; an example is the FOSS4I project.

ATLAS Collaborations

Turkey/ATLAS (Serkant Ali Cetin)

- National Umbrella Project
- “Data Taking, Data Analysis, and Operation, Maintenance and Upgrade of Detector Systems at the CERN-ATLAS Experiment.” Contribution to Exotic Physics, B-physics, Inner Detector Transition Radiation Tracker, Muon System Resistive Plate Chambers (upgrade).
- PI: Istanbul Bilgi University; in collaboration with 12 other universities.

Morocco/ATLAS (Farida Fassi)

- Morocco started its research in experimental particle physics with CERN in 1996 as a member of the ATLAS collaboration.
- **Current ATLAS People (52 Active Members)**
  - 20 physicists, 22 Ph.D. students and 10 master students

Research Program includes 5 axes:

1. Physics Analyses

-Measurements: Standard Model (SM) and Higgs.

-Searches: Beyond the SM and Exotic new physics.

2. Detector Performance

-Jets and missing transverse energy reconstruction.

-Lepton reconstruction.

3. Detector Operation

-Inner detector Offline Commissioning.

-Performance and Optimization.

4. Upgrade

-ATLAS High Granularity Timing Detector.

5. Computing

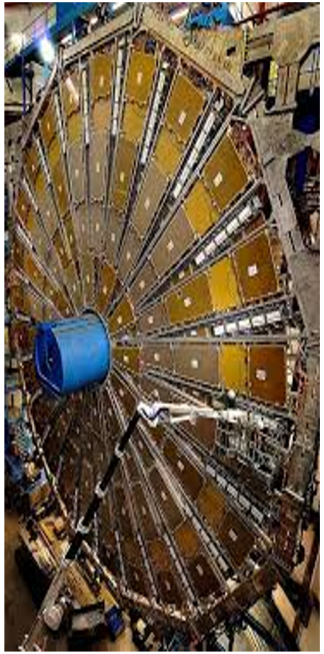
-Grid Data Processing and Analysis.

-Computing Shifts Organization.

-Deep Machine Learning.

High Performance Computing

Israel/ATLAS (Erez Etzion & Eilam Gross)



- Israel is the first non european CERN member state.
- Four ATLAS experimental groups (Technion, Tel Aviv U., Weizmann inst. and Ben Gurion U.).
- About 15 staff members as well as postdocs, engineers, technicians and grad students were central at the design and construction of the TGCs, the Muon trigger chambers of ATLAS endcap.
- Played a key role at the Higgs discovery in 2012.
- Variety of research subjects mostly on BSM Physics e.g Exotics dileptons and dileptons (including trigger leve analysis), Long lived particles, SUSY and Higgs BSM, but also on SM and Heavy Ions.
- Use ML techniques for problems such as charm tagging and tau trigger.

South Africa
SA-CERN programme
ATLAS, ALICE, ISOLDE, CERN

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences | University of Cape Town | University of Johannesburg | University of KwaZulu-Natal | Nelson Mandela University | DUT Durban University of Technology | University of the Western Cape | Cape Peninsula University of Technology | University of the Witwatersrand, Johannesburg | University of Zululand | UNISA university of south africa

Participating institutions : 1 National Facility (iThemba LABS) and 10 Universities

	ATLAS	ALICE	ISOLDE	Theory	Total
PhD	6	5	6	8	25
MSc	19	2	7	15	43
Accad Staff	7	6	6	7	26
Tech Staff	3				3
Post Docs	5	2	2	2	8

2017 numbers, increasing trajectory

- SA has a long history in High Energy Physics, eg : 1st neutrino discovered and studied in nature 1965
  - Long history at CERN, BNL, JLAB, JINR, others
  - Also a long history of theoretical contributions
- **SA-CERN Co-operation Agreement 1992**
- Now formal participation at CERN and JINR

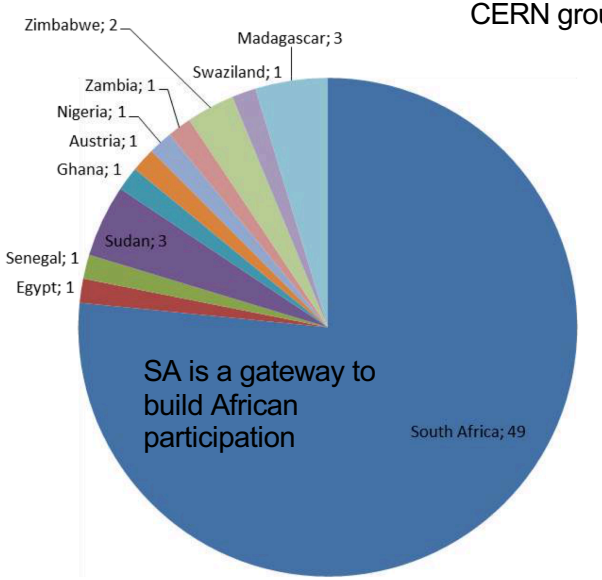
Most HEP now in the SA-CERN and JINR Programmes

- ALICE since 2001
- ATLAS since 2010
- ISOLDE since 2017
- Theory
- JINR since 2005

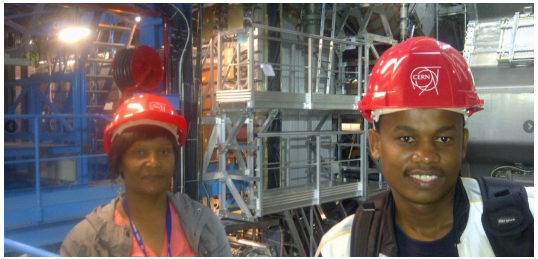
Decades of "ad hoc" participation

SA participates in Physics, Upgrade activities, Engineering, Outreach

Some of the SA-CERN group

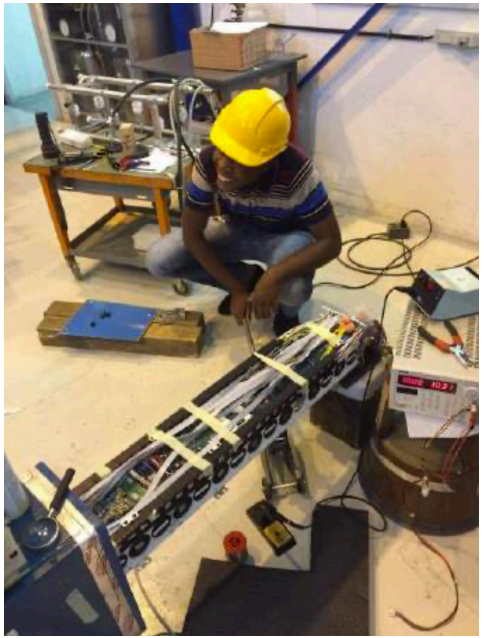


SA is a gateway to build African participation



Staff and students at ALICE

Staff and students at ISOLDE



Testing modules developed in SA for ATLAS

Other Activities

Turkey/Other HEPP Activities

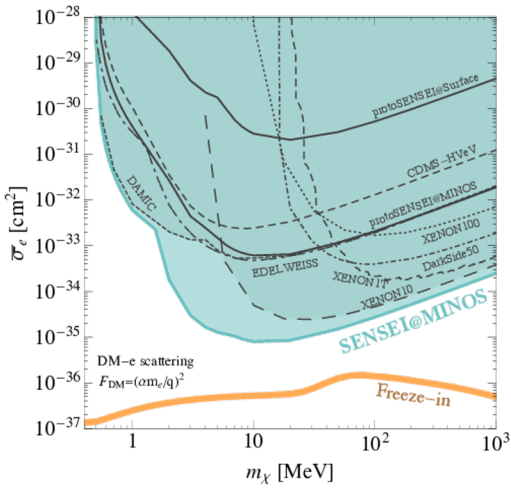
- **FCC:**
  - Detector and Physics Searches for Future Circular Collider at CERN," PI" Bolu Abant izzet Baysal University; in collaboration with four other universities.

- **ALICE:**
  - The ALICE Diffractive Detector: Design and Performance Measurements." PI: KTO Karatay University; in collaboration with one other university.

- **AMS-02:**
  - Measurement of the Proton flux and Analysis of the Space Radiation Environment with the Alpha Magnetic Spectrometer." PI: Middle East Technical University.

Israel/Other HEPP Activities (Erez Etzion)

- Israeli teams are involved in DM searches: Xenon (Weizman) amd SENSEI (Tel Aviv).
- Participate in B-Physics at Belle-2 (Tel Aviv).
- Play key role at the dedicated Long Lived particle detectors: Faser (Technion) 480 from the ATLAS interaction point and MATHUSLA (Tel Aviv) on the surface above CMS (Other teams are most welcome to join !)
- Neutrino Physics in Microboone and the DUNE future experiment (Tel Aviv).
- Tight collaboration with phenomenologists on ATLAS, the DM experiments and the Long Lived Particle experiments.



The University Of Antananarivo Madagascar
The Department Of Physics
(LABORATOIRE DE PHYSICS DES HAUTES ENERGIES)

Member of the DUNE Collaboration since 2016

Nine members (1 Professor, 2 scientists, 6 grad stud)

DEEP UNDERGROUND NEUTRINO EXPERIMENT

- In Collaboration with Assistant Professor David Martinez (South Dakota Mines):
  - Simulation studies for neutron reconstruction in neutrino interactions within the 3 Dimensional Projection Scintillator Tracker (3DST) as an active tracker for the System of on-Axis Neutrino Detector (SAND)
  - Familiarization with the light collection system based on the ARAPUCA light trap for DUNE far detector
- Analysis of anomalous tau neutrino appearance from sterile oscillations in the DUNE Near Detector

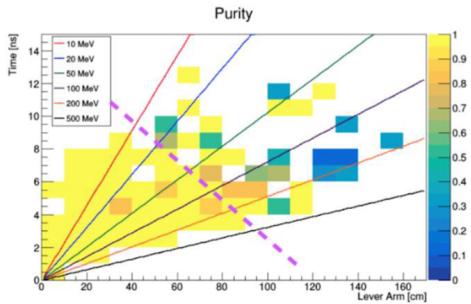


Figure A.47: Purity of the neutron-induced hit in the (time, lever arm) space. The dashed line corresponds to the cut required to select an almost 100% pure sample of signal neutrons. The solid lines are theoretical curves for neutrons with different kinetic energies. Note that this study was performed with a total volume of $2\times2\times2$ m^3. See text for details.

A sample of our student's results presented at the DUNE Far Detector Technical Design Report.
https://arxiv.org/pdf/2002.02967.pdf

Featured in Neutrino Day in June 2020 (https://www.neutrinoday.com/DUNE-Q-A) and Dunescience.org on 2018 (https://nus2surf.dunescience.org/2018/04/madagascar-students-tau-neutrinos/)

Members: R. Razakamiandra [1], M. Andrianjafy [1], A. Sitraka [2,1], M. Rajaoalisoa,[3,1] S. Razafinime [3,1],M. Andriamirado [6,1] F. Andrianala[5,1], L.Rakotondravohitra [4,1], R. Raboanary [1], D. Martinez Caicedo [2]

(1) Universite d'Antananarivo Madagascar, (2)South Dakota School of Mine, (3)University of Cincinnatti, (4)Duke University, (5)CERN, (6)Illinois Institute of Technology

HEP Theory

Egypt/HEP Theory (Shaaban Khalil)

High Energy activities in Egypt aims to foster world-class research in theoretical physics through building and growing a community of scientists dedicated to high-level research.

Research Topics:

1-Physics beyond the standard model

-Supersymmetry (SUSY).
-TeV scale B-L extensions of the standard model.
-Grand unified theories: Left-Right Model.
-Neutrino physics.
-Charge, parity and flavor violation in supersymmetric models.

2. Early universe and Astroparticle physics

-Inflationary Cosmology.
-Dark Matter and Dark Energy.
-Baryon Asymmetry.

3. Quantum Gravity and String Theory

-Flux Compactification
-BLSSM from D-branes
-Quantum Gravity
-Non-conventional Cosmology and Modified Gravity.

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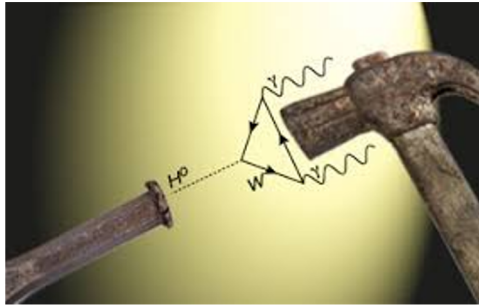
Morocco/HEP Theory (Abdesslam Arhrib)

- Theory activities are developed in about 9 universities, About 20 staff members as well as PhD students and master students, 4 HEP Masters programs around the country.
- **Research Topics:**
  - **Phenomenology:**
    - Higgs physics in the SM and BSM.
    - Neutrino physics.
    - Radiative corrections to SM&BSM processes.
    - Exotic: new fermions, new Higgses.
  - **Theory:**
    - String theory.
    - Modified gravitation theories.
    - Gravitational lensing.
    - Quantum information.
    - AdS/CFT conjecture, Black Hole thermodynamics.
- Moroccan teams are involved in European and Asian working groups (charged Higgs working group, shift project, CEPC study group-physics and detector, hh cross sections working group

Israel / HEP Theory (Eliezer Rabinovici)



- **Founding fathers of theoretical physics in Israel e.g:**
- Racah, Rosen, De-Shalit, Talmi, Ne'eman.
- **Activities:** Israeli theoretical physicists have made many seminal contributions to particle physics. In both phenomenology-theory and theory-theory.
- **Faculty, Postdocs and Students:** Ben Gurion University, Haifa University, Hebrew University, Technion, Tel Aviv University, Weizmann Institute of Science.
- The works have been highly cited over the years.
- Research areas cover from the study of Black Hole, the Standard Model and beyond, Dark Matter candidates, and all the way to String Theory.

HEPP Theory in South Africa

- **High Energy Nuclear Physics (hep-ph/nucl-th)**
  - Thermal and statistical modelling of heavy ion collisions; nuclear matter under extreme conditions of temperature, density, and magnetic field; physics of quark-gluon plasma
  - AdS/CFT, pQCD; Color Glass Condensate (CGC), a highly correlated state of predominantly gluons;
  - Theoretical High Energy/Elementary Particle Physics. Quantum Chromodynamics Phenomenology. Determination of the fundamental parameters of QCD (quark masses, strong coupling, anomalous magnetic moment of the muon, etc.).
- **High Energy Particle Physics (hep-th/hep-ph)**
  - High energy theory, particle phenomenology and gravitational physics.; Physics beyond Standard Model
- **High Energy Physics (hep-th/String-th)**
  - Theoretical High Energy Physics. Nonperturbative Field Theory. Large N. Quantum Gravity. String Theory. Representation Theory; Dynamics of Yang-Mills theories and quantum gravity; non-perturbative properties of field theories, the 1/N expansion, strings and superstrings.
- **Astroparticle Physics**
  - High Energy Astrophysics; cosmic rays; theoretical modelling, computation and data analysis. Some of the astrophysical sources that are studied closely are Gamma-ray bursts (GRBs) and Active-galactic nuclei (AGNs).
- **Professional Bodies**
  - SA-CERN Theory Consortium SA-JINR Theory National Institute for Theoretical Physics
  - Theoretical and Computational Physics Division of the South African Institute of Physics (SAIP)
  - High Energy Astrophysics in Southern Africa (HEASA) Conference SA-GAMMA
- **National and International Facilities in SA/Southern Africa**
  - SKA, iThemba LABS, HESS Upcoming events
  - The International Astronomical Union General Assembly in 2024 (XXXII IAU GA) will be held in Cape Town.

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  - SA-GAMMA

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  - Upcoming events
  - The International Astronomical Union General Assembly in 2024 (XXXII IAU GA) will be held in Cape Town; the first time that the GA will be hosted on the

HEPP @ TURKEY – Theory and Phenomenology

- **High energy theory** and **phenomenology** scene has traditionally been **very active**.
- A brief quantitative summary is given based on data analysis performed in preparation to the first country visit of Restricted European Committee for Future Accelerators, in October 2017. The analysis was performed after automated compilation of data from the **WoS** publication database **in the period 2007-2017**. A search in *mathematical*, *nuclear*, *particles and fields* categories reveals **16627** articles. In order to focus the search to small local collaborations, limiting the **number of authors to be fewer than 10, reduces the list to 2780 articles**. Out of these 1231 are strictly "non-*mathematical*", while 2462 are tagged under at least one category beyond "*mathematical*".
- The analysis of this subset yields very encouraging patterns about the Turkish theory community. One clear feature is the **geographical spread of the researchers throughout the country**, at a level even suppressing the experimental community. Moreover, the article co-authorship information can be used a proxy for measuring the strength of collaborations between authors and institutions, and shows that the **researchers at far away institutions are not isolated and have successfully created bridges of collaboration** that span the long distances between their geographic locations.
- The analysis of the number of articles shows that the cities with the most activity are the top three most populous cities in Turkey: Ankara, İstanbul and İzmir. **Among the top 20 institutions** by the number of citations the articles attract, it is important to underline that **a significant number of these are also those with that have strong experimental groups**.

The locations of the institutions at which the theory community are located. (The curves connecting the locations show collaborations between researchers, with the thickness indicating the strength of collaboration.)

- The analysis also reveals the **significant diversity of topics**. A sampling of subjects in the two largest cities (Ankara & Istanbul) are:
  - **Standard Model** (QCD sum rules, chiral perturbation theory, heavy quark, phenomenology)
  - **Beyond the SM**
  - **Nuclear**
  - **Fields**
  - **Gravity**
  - **Alternative models of gravity**
  - **Cosmology**
  - **Mathematical physics.**
  - **Strings**
- **Collider phenomenology** goes **hand-in-hand with experimental opportunities.** This diffusion from collider phenomenology to experiments is evidenced by the sizeable number of PhD students doing phenomenology who in the meantime contribute to collider experiments such as ATLAS.

The cities with the highest number of theory articles.
The lines connecting the nodes show the strength of collaborations between the researchers.

HEPP @ TURKEY – General Overview

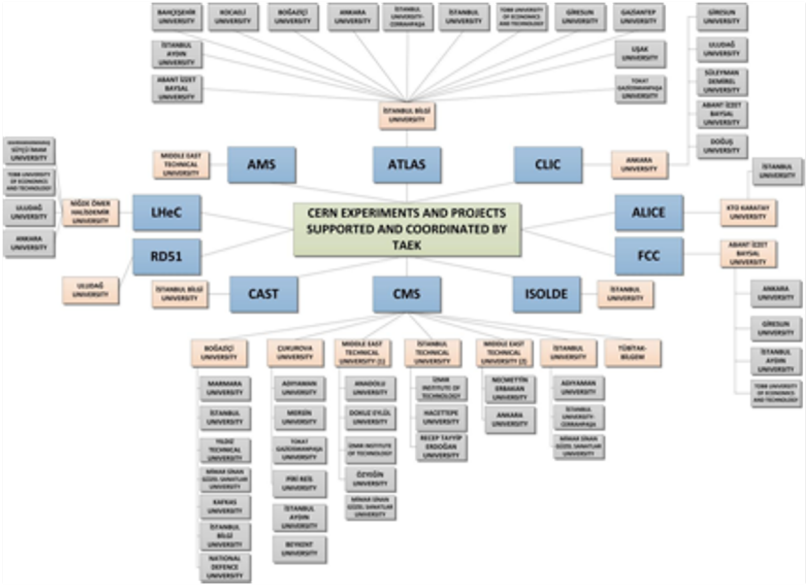
Relations with CERN:

- 1961 - Observer State
- 2015 - Associate Member State
- Number of CERN users from Turkish Institutes (2019): 129
- Number of Turkish CERN users (2019): 164
- Teams participating in: ATLAS, CMS, ALICE, AMS-02, CAST, OPERA, ISOLDE, CLIC, LHeC, FCC, RD51 (*also CHARM-II, CHORUS and SMC in the past*)

Turkish Experimental Particle Physics Community:

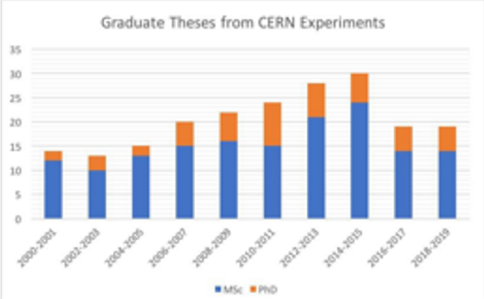
- **~80 PhD's at about 40 different universities** (corresponding to ~20% of the total number of universities in Turkey)
- Participating in **~20 collaborations worldwide** (CERN programmes + ArgonCube, Belle, BESIII, DUNE, Jennifer2, PANDA, Tauwer, Texono)
- Teams in **collider experiments, non-collider experiments, Detector R&D, Accelerator R&D.**

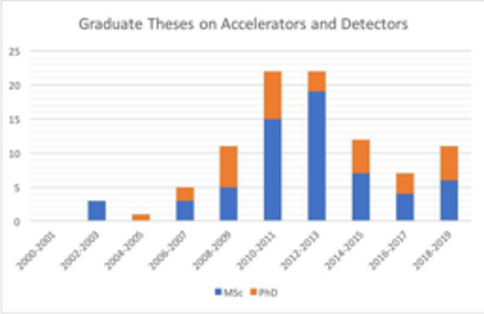
Geographical distribution of universities with academics involved in experimental particle physics.



Organizational Remarks

- Hard to make broadly applicable statements characterizing all the **Turkish universities** involved in HEP, as they **differ** not only **in geographical position**, but also in **size, organization, academician-to-student ratio** and sources of **funding**.
- Representation of **women** is about **30%**, well above the CERN User average (20%), and of **foreign nationals** is about **4%**, slightly higher than the average for associate member states.
- The **HEP groups** tend to be **small in size**, quite often just a single experimental particle or accelerator physicist at a given university, and even the institutions with the largest physics departments, such as the Ankara, Çukurova, İstanbul and Middle East Technical Universities, employ no more than five HEP-ex faculty.





HEPP @ TURKEY – Examples of Local Infrastructure, Local Activities and Other Involvements (1/2)

Turkish Accelerator Centre (TAC) Project

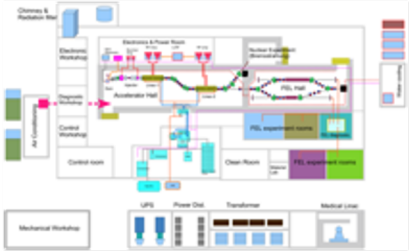
An accelerator-based **national project for fundamental and applied physics** research was concluded in 2016 which included **feasibility and conceptual design reports** for the following proposed facilities:

- **Super Charm Factory**: 1 GeV-3.6 GeV linac-ring type electron-positron collider,
- 3.6 GeV **synchrotron facility**,
- 2 GeV **proton accelerator**,
- 1 GeV **SASE-FEL**
- Establishment of a **test facility**; this progressed as an independent user project since 2016 with name of Turkish Accelerator and Radiation LAboratory (**TARLA**).

Another outcome of the TAC Project was the **Institute of Accelerator Technologies** which was founded in 2011 as an institution in Ankara University. The main goal of the institute is to provide qualified human resources in accelerator and detector technologies and to start the operation of TARLA.

Turkish Accelerator and Radiation LAboratory (TARLA)

Currently, **electron linac** based on state-of-the-art **superconducting** technology of TARLA project, is being commissioned at the Institute of Accelerator Technologies of the University of Ankara. At the first stage of operation, Gamma (**Bremsstrahlung**) radiation and Free Electron Laser (**FEL**) in the IR region will be produced by the **40 MeV electron linac**.



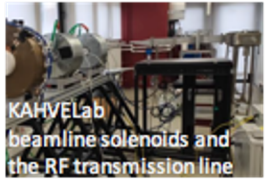
TAEK RFQ Project

- A Proof of Principle RFQ project with the aim of **designing and manufacturing locally** a proton accelerator based on the radiofrequency quadrupole (**RFQ**) cavity with indigenous capabilities while developing human resources in the field of accelerator physics, radiofrequency engineering, manufacturing, instrumentation and measurements, as well as incorporating local industry in the production of accelerator components.
- Designed to operate at 352.21 MHz to accelerate protons from 20 keV up to an energy of 1.3 MeV. Following the RF power conditioning, **preliminary beam commissioning tests revealed** that the protons could be accelerated to about **1 MeV** with less than 1 mA beam current.

TAEK RFQ Accelerator

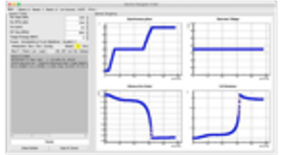
Kandilli Detector, Accelerator and Instrumentation Laboratory (KAHVELab)

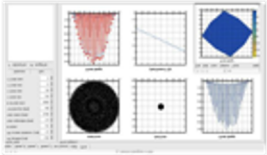
KAHVELab established at *Boğaziçi University* and is the **most diverse of its kind in Turkey**, with about 200m^2 research area including a machine shop, electronics hut, 500-core computer farm, and stations for accelerator and detector research. Beyond the host institution, researchers and students from 8 other institutions (*Ankara U., İstanbul U., İstanbul U. Cerrahpaşa, İstanbul Bilgi U., İzmir Institute of Technology, Kütahya Dumlupınar U., Marmara U., TOBB University of Economics and Technology*) actively collaborate on R&D efforts to **design and construct small electron and proton accelerators and various gas detectors**; such as Electron Beam Welding (**EBW**), world's smallest **RFQ** (~1m) to accelerate protons to 2MeV, **DemirciPro** (a gui based RFQ design software including its ion beam source and low energy beam transport code), Design and construction of **RF Transmission Line** and **Circulator**, Delay Wire Chamber (**DWC**), **Measurement Station** (design and produce a test station for measuring the properties of protons at about 20 keV) . A further 150m^2 extension is intended to house the R&D to retrofit resistive plate chambers as part of the **ATLAS Phase-II Upgrade** project.



KAHVELab beamline solenoids and the RF transmission line

KAHVELab Electron Beam Welding System





Screenshots from the RFQ design program DemirciPRO

HEPP @ TURKEY – Examples of Local Infrastructure, Local Activities and Other Involvements (2/2)

TAEK Proton Accelerator Facility (PAF)

- A **30 MeV** operational **proton cyclotron**.
- The main objective is the production various **radioisotopes**, studies based on charged particle activation on **material research**, **neutron activation** analysis, industrial **applications** and **education/training** on accelerators and related technologies.
- Studies are classified into two areas: The establishment of a new multi-purpose, in-vacuum and computer controlled Low Current and Adjustable Energy Proton Beam Irradiation System (LCAEPIS) (period of 2018-2019) and The Design and Manufacture of 68Ge\68Ga Radionuclide Generator (period of 2019-2021).
- In order to serve multiple users, TAEK-PAF, in cooperation with other institutes, improves the required infrastructure by considering national priorities. TAEK-PAF is open to every internal/external cooperation within an appropriate model like "**METU Defocussing Beamline Project (DBL)**," which is conducted by Middle East Technical University (METU).

Site view of TAEK-PAF

METU-DBL at TAEK-PAF

TAEK-PAF Low Current and Adjustable Energy Proton Beam Irradiation System

SESAME

- Turkey is a **founding member** of SESAME and TAEK is the responsible authority of Turkey for relations with SESAME. The amount of funding given to the SESAME by Turkey is approximately 11 Million US Dollars between the period of 2001 and 2019. TAEK is also funding researchers' experiments and training activities in SESAME and similar facilities in order to develop human resources in this field.
- Turkey also undertakes the **development of a future beamline** of SESAME through the Turkish consortium (TAEK, TARLA, Bilkent University and Koç University) lead by TAEK and for the construction of an **experimental station at Soft X-ray Photoemission Spectroscopy Beamline** in SESAME with a budget of 4 million Euros.

Further Examples of Activities:

- Small detector and accelerator components are being designed, constructed and tested by various HEP groups engaging the local industry; examples include a **solenoid magnet and its robotic mapper** built at *Adıyaman University*, a small **spark chamber** and **muon detector** built at *Gaziantep University* and **microwave discharge ion source** built at *Eskişehir Osmangazi University*.
- *Özyeğin University* has designed and started the construction of Turkey's **first domestic cyclotron**, aiming to obtain MeV-level protons. The electromagnets, built almost entirely by the university personnel, have been successfully commissioned.
- Researchers from *Mimar Sinan Fine Arts University* and *Yıldız Technical University* have collaborated on establishing **detector and data acquisition labs**, where they jointly designed, simulated and constructed a **prototype secondary electron emission (SEE) calorimeter**. As part of this work, a new implementation of the SEE process into Geant4 simulation framework has also been accomplished.
- A new laboratory dedicated to high energy physics (YEFLAB), has been established in *İstanbul University*, conducting research on **characterization and calibration of PMT, SiPMT and scintillator/quartz detectors**, and perform **simulation studies with GEANT4, FLUKA and GATE** for applications on medical physics, radiation detectors and shielding.
- *İstanbul Bilgi University* has established Turkey's first **HEP research and application center**. The center has been providing funding for Turkey's participation to the **CAST** Experiment, running the national **ATLAS** umbrella project funded by TAEK, providing small research grants to students, **organizing events** such as national collaboration meetings of ATLAS and meetings of the Turkish accelerator and experimental particle physics community. The center has also hosted CERN's Accelerating Science exhibition with around 25 thousand visitors in 4 months.