Accelerator Research
&
Education in Iran

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Area:

total: 1,648,195 sq km

land: 1,531,595 sq km

water: 116,600 sq km

GDP (official exchange rate):

$387.6 billion (2015 est.)

Higher education system generally is:

- Technicians (2 years)
- Bachelor Program (~4 years)
- Masters Program (~2 years)
- PhD Program (~4 years)

Universities: Almost 2800

State universities:

Level A :12

Level B: 18

Level C: 21

Population :

82,801,633 (July 2016 est.)

Non-state universities:

A significant number of private universities

❑ Physics Domestic Societies in Iran: Physics Society of Iran (PSI)

Since 1932

Membership:10014 (students and faculty members)

Branches

- Condensed matter
- Particles and fields
- Computational physics
- Nuclear physics
- Atomic & molecular
- Gravity & Cosmology
- Statistical physics & complex systems

Journals:

Journal of Applied Fluid mechanics (ISI)

Journal of Theoretical and Applied Physics (ISI)

Iranian journal of physics research (Farsi)

General topics in physics (Farsi)

❑ The First Accelerator Machine in Iran

A 3MV Van de Graff was procured in 1956 by Tehran University and transferred to AEOI (1973) aimed at the ion beam analysis by researches and students.

❑ Accelerator Education in Iran

- **Introdutory courses**
- **MSc and PhD theses with accelerator topics in universities**
- **In-house traing course for accelerator staff projects**
- **To motivate the Iranian initiatives :**
  - ✓ **1st course of Iranian Particle Accelerator School (2016)**
  - ✓ **Two national conferences on particle accelerators and their application (2013 and 2015).**
  - ✓ **1st introductory workshop about CERN for high school teachers (2016)**

❑ Institute for Research in Fundamental Science (IPM)

It was founded In 1989. The Institute is comprised of nine schools (2016):

- Astronomy
- Biological Sciences
- Cognitive Sciences
- Computer Science
- Mathematics
- Nano-science
- **Particles and Accelerators**
- Philosophy
- Physics

✓Pioneer of the accelerator physics PhD program in Iran

✓IPM E-Linac & Iranian Light Source Facility (ILSF) accelerator projects

✓ CERN & IPM collaboration (officially signed at 2001 by the ministry of science), with the CMS experiment

IPM School of Particles & Accelerators

- 5 PhD students, 2004
- Courses were passed in-house & JUAS

- 7 PhD students, 2010
- Courses were passed in-house

In-house and out-house (at different light sources) accelerator training courses for ILSF staff

❑ IPM PhD Theses in Collaboration with:

Linac4 (CERN):

- ✓ Beam dynamic & commissioning
- ✓ Magnetic measurements
- ✓ DTL RF cavity measurements

- CLIC (CERN)
  - ✓ CLIC drive beam injector
    - Pre-buncher design
    - Electron gun design
    - Beam dynamics study
  - ✓ CTF3 longitudinal beam dynamics study
  - ✓ CTF3 pulse compressors control
- NSRRC (Taiwan)
- FEL (INFN)

❑ Linac4 (CERN) Activities:

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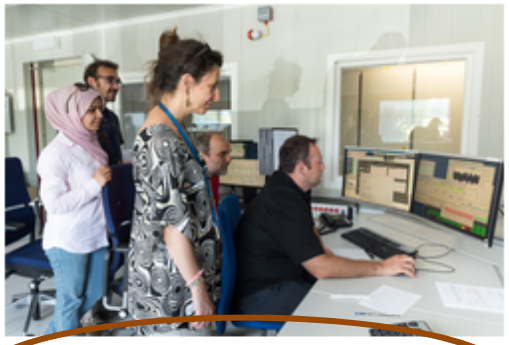
LINAC4 CROSSES THE 100 MEV THRESHOLD

The new linear accelerator, which from 2020 will be the first link in the accelerator chain, has entered a new stage of its commissioning.



Members of the team in charge of the commissioning of Linac4 in the

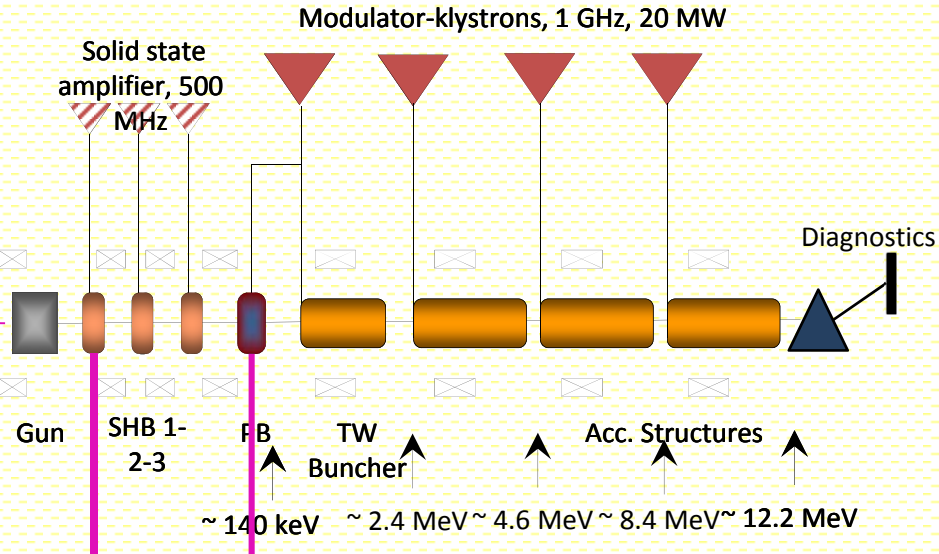
We couldn't have imagined a more appropriate date: on 1 July (1.07), Linac4 reached an energy of 107 MeV. Having crossed the 100 MeV barrier, the linear accelerator is now on the home straight of its commissioning. "This stage was very quick – it took less than two weeks," says Alessandra Lombardi, deputy project leader of Linac4, in charge of the commissioning.

❑ IPM Research Program:

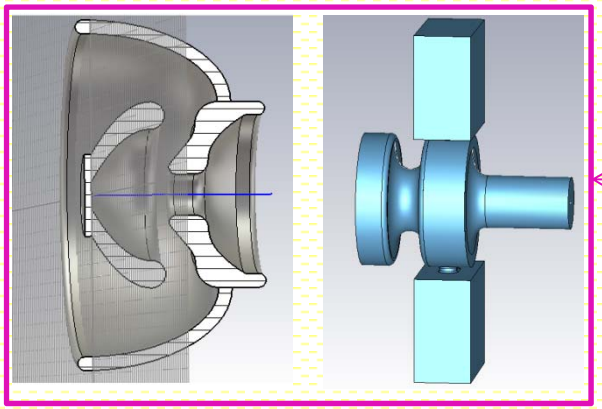
CLIC

- RF design of sub-harmonic bunchers (First one has been machined in the CERN workshop)
- RF design of traveling wave buncher
- Damping ring study

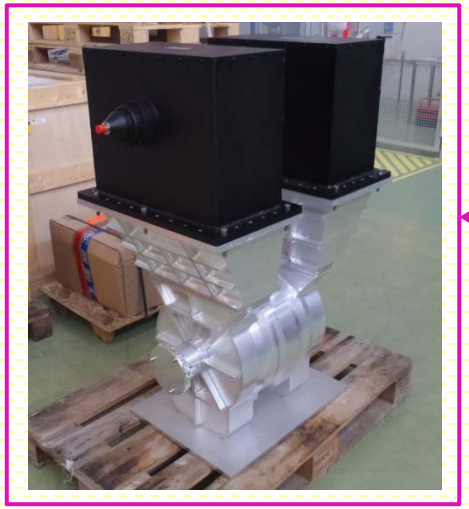
CLIC drive beam front-end layout



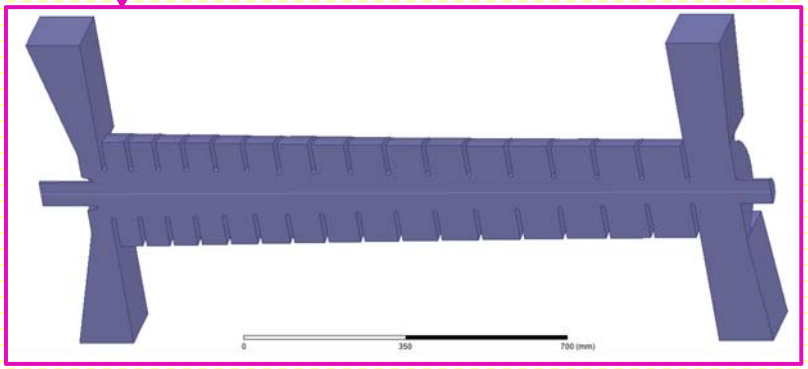
Electron gun



Sub-harmonic bunchers



Traveling wave buncher

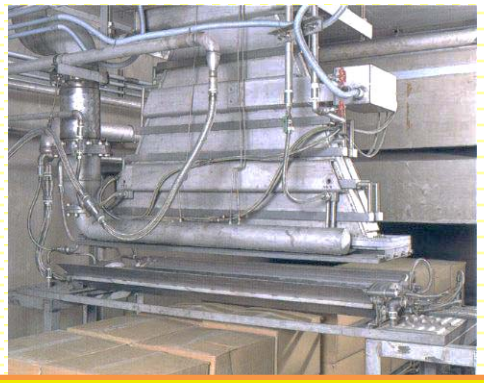


❑ Radiation and Beam Generators:

- It has been used accelerators mostly were procured from commercial companies ~ 100 (2016 est.):
  - Hospital & clinics : 80 electron Linacs and 4 cyclotrons
  - Educational and research institutes: 2
  - Industrial: 1 rhodotron, 8 cargo inspections
- Project completed
  - Ion source
  - 3 of 200keV electrostatic accelerators
- Projects under design/planning and construction
  - Electron Linac
  - Synchrotron light source
  - Baby cyclotron
- Projects in conjuction with CERN & SESAME

❑ Industrial Electron Accelerator of Rhodotron Aimed at Sterilization & Food-Processing

- Procured on 1998
- IBA, TT200
- Beam energy : 10 MeV
- Beam power : 1 to 80 kW
- RF system frequency: 107.5 MHz
- Power RF tetrode type: Thomson TH681
- Total diameter : 3 m
- Total height : 2.4 m
- Weight : 11 T



❑ Successful Manufacturing Experiences:

❑ Penning ion source

- Designed and manufactured at university of Tehran aimed at ion implantation
- Initial idea was to be develop a small accelerator (2005)
- Started with developing a Penning Ion Source (2007)
- Designed and developmed of 100 keV column, 2015
  - Output beam: 10 µA, 5 - 100 keV of O2, N2, He, Ar and H2 gas flow in the source for research

Penning source structure at Tehran University

❑ Projects under Constructions

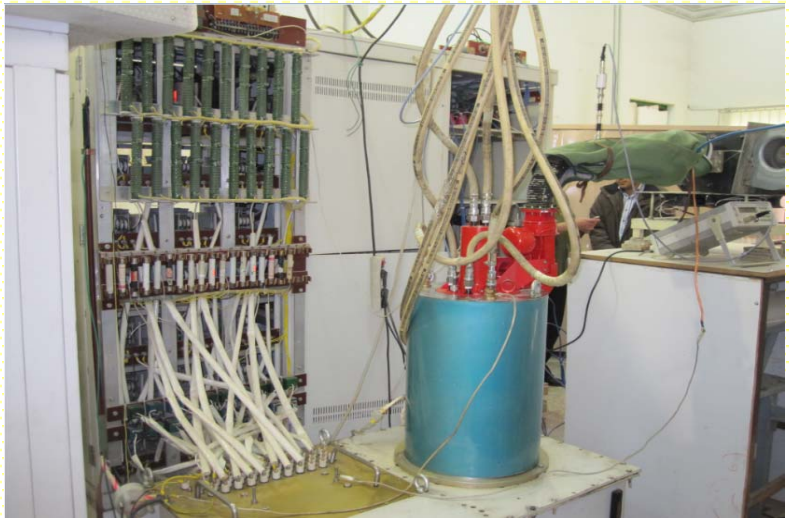
❑ IPM electron Linac

- Aimed at proof of principle, make commercial & the future prospect : some beamlines for users and the injector of the other accelerators
- The main specifications of accelerator

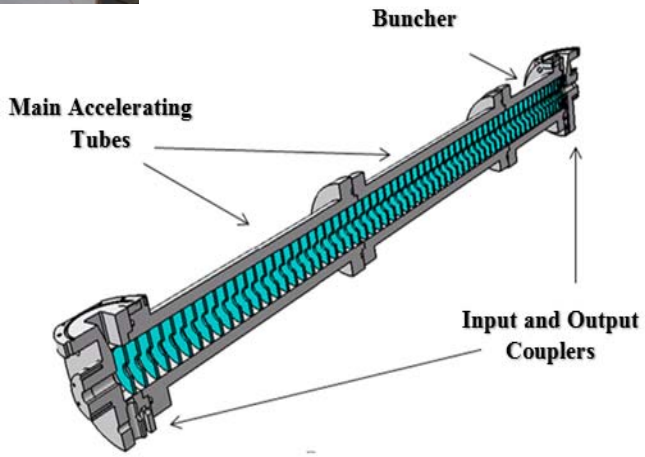
- Output E-gun energy: 45keV
- Maximum E-gun current: 10mA
- Machine Output energy: 8MeV
- Frequency: 2997.92MHz
- Operational mode: π/2-TW
- RF peak power: 2MW
- Maximum PRF: 250Hz
- RF pulse length: 2-7μs
- Accelerating structure ~ 170cm

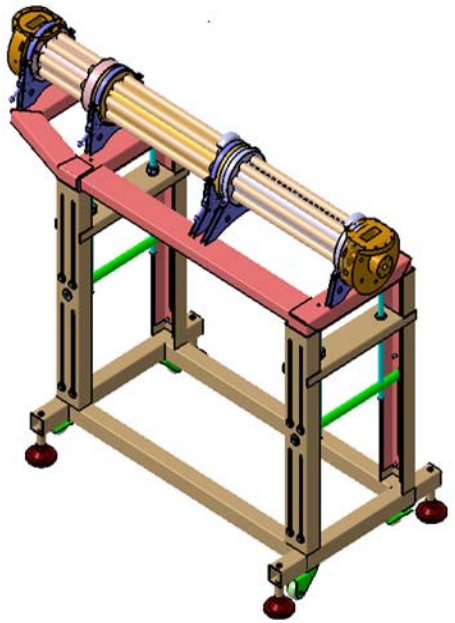
Linac laboratory at IPM, RF (klystron, modulator, waveguide)

Test setup of the KS37 constructed (Iran)

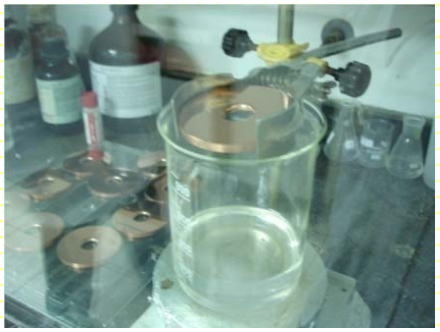
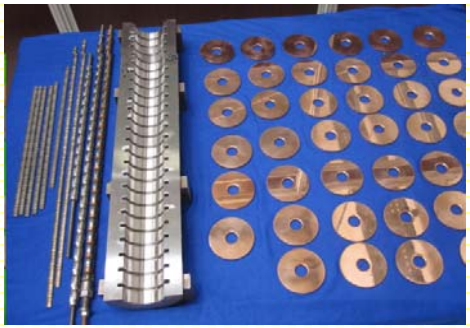
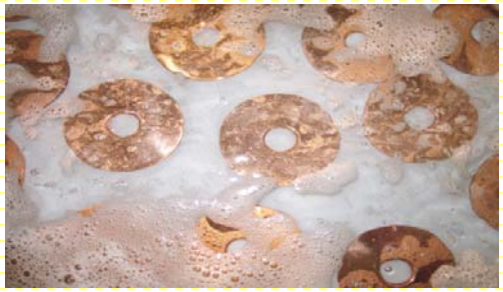
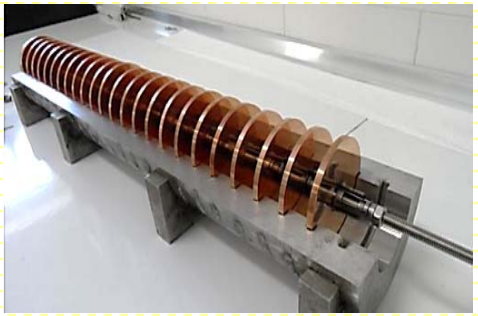


The accelerating tube layout

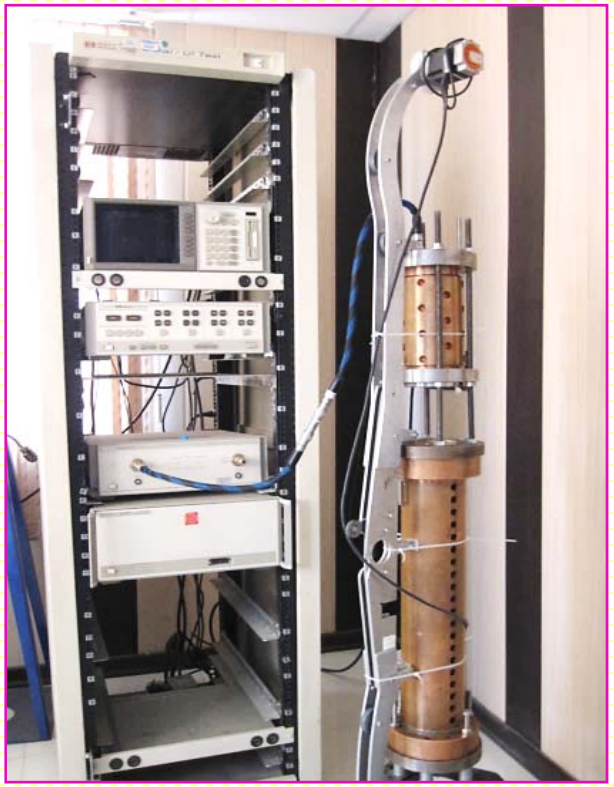




Construction of the accelerating tube

Setup of slater perturbation measurement

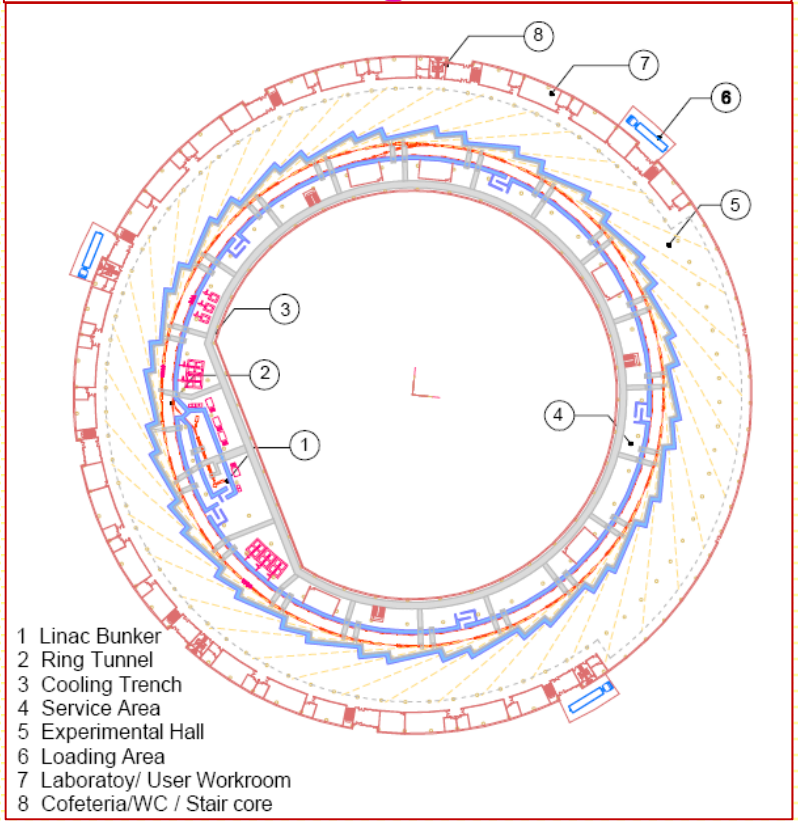


❑ Project under Design and Planning

❑ ILSF (Iranian Light Source Facility), IPM project

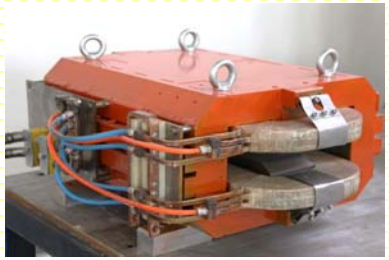
- The main specification of project:
  - 3GeV storage ring
  - Total area: 38000 m^2
  - Machine circumference: 528 m
  - Beam current: 400mA
  - Natural emittance: 0.28 nm.rad
  - RF frequency: 100MHz
  - Lattice structure: 5BA
  - Number of super periods: 20
  - No. of dipole/quad./sext.: 100/240/320
  - Project proposal was submitted to the ministry of science (2009)
  - Conceptual design report (CDR) (2013)
  - Project design approval (MAC) meeting (2015)

General layout of ILSF

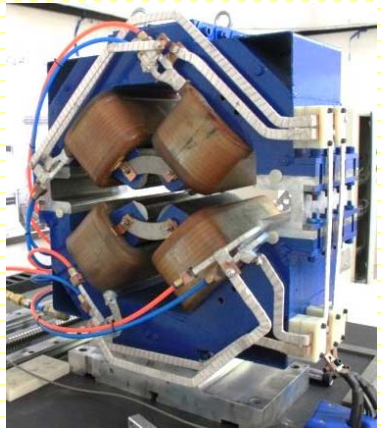


Fabricated prototype magnets

Dipole-H

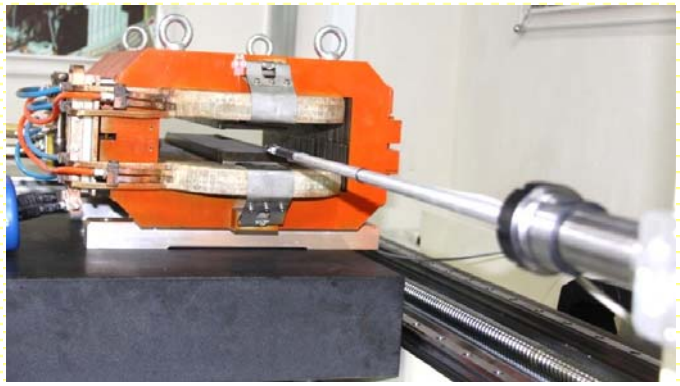


Quadrupole



Alpha magnet

3 axis hall probe measurement bench

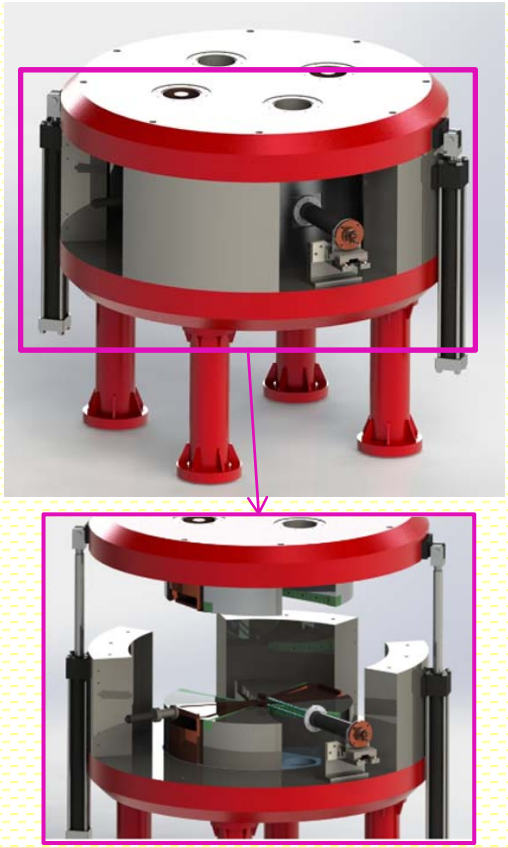


❑ Project under Design and Construction

❑ Baby cyclotron (IRANCYC10)

- The machine main specifications :
  - A self-shield AVF baby cyclotron (diameter: 176cm)
  - Four sector magnets & two RF cavities
  - Out-put beam: proton & the max energy of 10MeV
  - PIG internal injection ion source
  - RF power: 11kW
  - Maximum magnetic field : 1.78T
  - Operating frequency: 71 MHz
- The main institute: Amirkabir university of technology, Iran
- The collaborators :
  - Shahid Beheshti university, Iran
  - Tehran university, Iran
  - SungKyunKwan university, Korea
- The sponsor : Ministry of Science
  Ministry of health and medical education

IRANCYC10 layout



Colaboration with Projects in CERN & SESAME

CERN

- CMS experiment: Data analysis
  HF table (2004)
- LINAC4 project
- CLIC project

SESAME: The membership was signed by Ministry of Science (2005)

- Having national accelerator projects, labs and International collaboration ➡ Pushing forward the frontiers of technology, research and science in the country.

- The beneficent/necessity of accelerator group and lab in the universities or institutes:

Pro's:

- Improve the industries and the science environment
- Varity of fields involvement
- Connection between the university & industry

Con's:

- New physics field and not wide/well-known in the academia
- It is not easy to find an academic job
- Difficulties to fulfill the publication interest of the universities

This talk is mainly based on my personal view.

with help from: Prof. M. Lamehi-Rachti , Prof. J. Rahighi, Dr. M. Mahjour-Shafiei, Prof. H. Afarideh

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