

Universities meet Laboratories

LAL, Orsay

November 3-4, 2016

Some comments on accelerator science and technology in Mexico
and in the Czech Republic

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November 3, 2016

Contents

- These are two talks in one
 - Some comments about accelerator science and technology in the Czech Republic
 - The creation of a group on accelerator science and technology in Mexico
- At the end I would make a few general comments, hopefully related to the goals of this meeting

About particle-accelerator science and technology in the Czech Republic

Disclaimer, sources and thanks

- Disclaimer
 - I have been just a few years in the Czech Republic and working full time in experimental high energy physics
 - This means that I have very little idea of what I am talking about ...
- Sources
 - I got most of the information presented in the following slides from the open session of the RECFA meeting in the Czech Republic:
<https://indico.cern.ch/event/361781/>
 - Specifically I used the talks by
Jaromir Mrazek: Nuclear Physics and Large Facilities
Zdenek Dolezal: R&D of detectors and accelerators
 - I put links to the home pages of the different projects, where more info can be found
- I would like to thank **Zdenek Dolezal** for his help
... any misrepresentation of the information is my fault entirely ...

Education and Facilities

- Education

- As far as I know there is no formal program devoted exclusively to accelerator science and technology in the Czech Republic

- Interested students can take a course, at the undergraduate level, on accelerator physics

- Facilities:

- Van de Graaff accelerator - IEAP CTU

- Microtron

- Centre for accelerators and nuclear analytical methods (CANAM)

- Proton therapy center

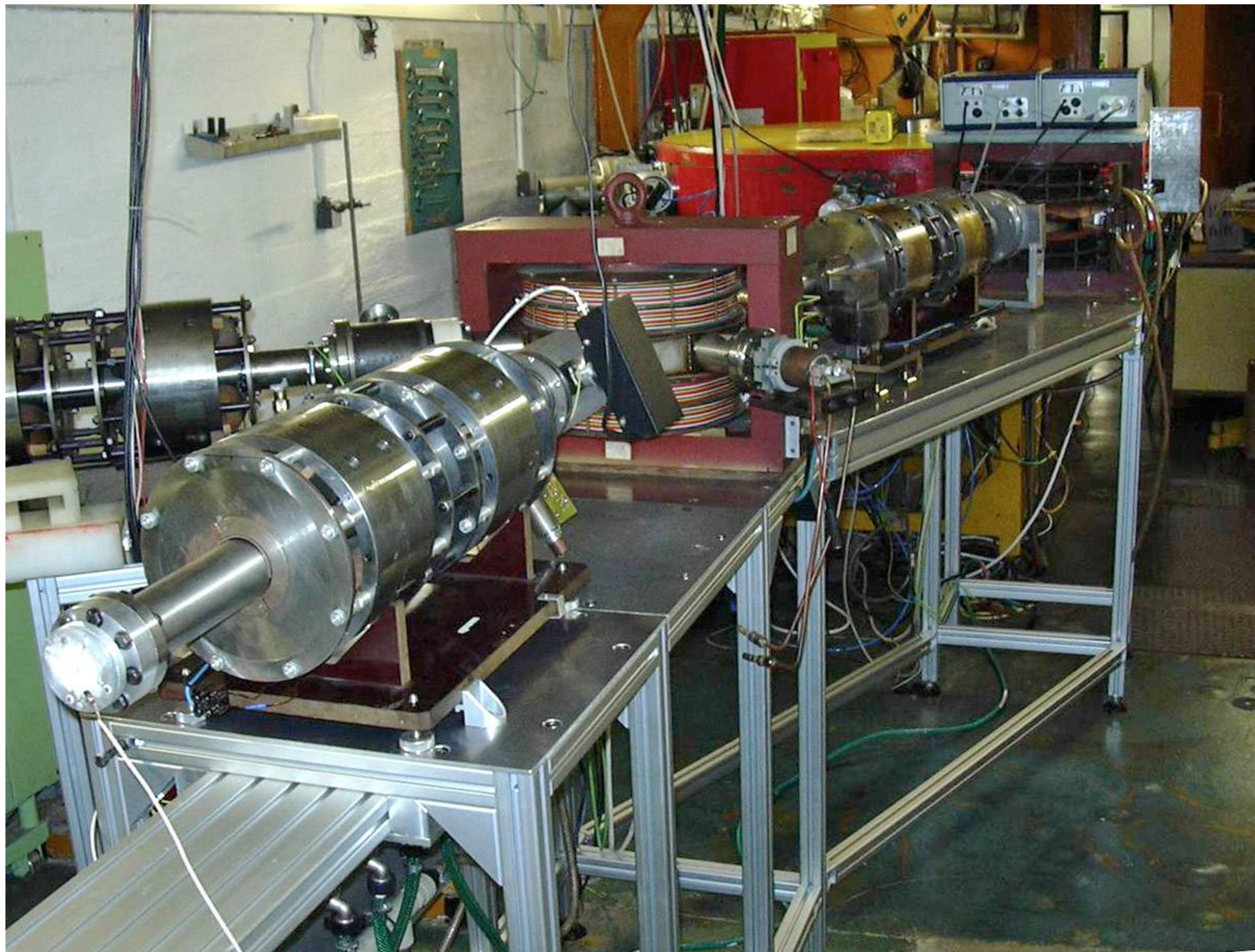
- ELI-Beamlines

Van der Graaff accelerator



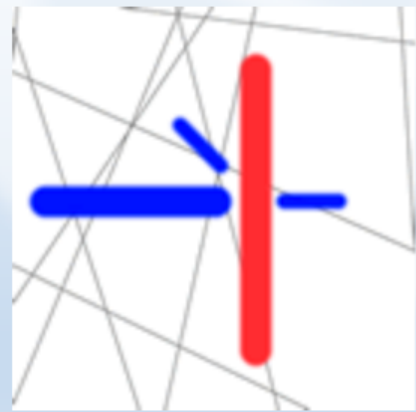
- Devoted to basic and applied research in experimental nuclear physics.
- Applications include testing and calibration of radiation detectors and the development of analytical methods in related areas (material and surface analysis, high-energy physics, space-related research).
- Besides serving as a source of light ions the facility serves namely as tunable source of mono-energetic neutrons in relatively wide energy range (100 keV - 19 MeV).
- In addition to the accelerator, the laboratory houses two stations of discrete gamma rays

Microtron MT25

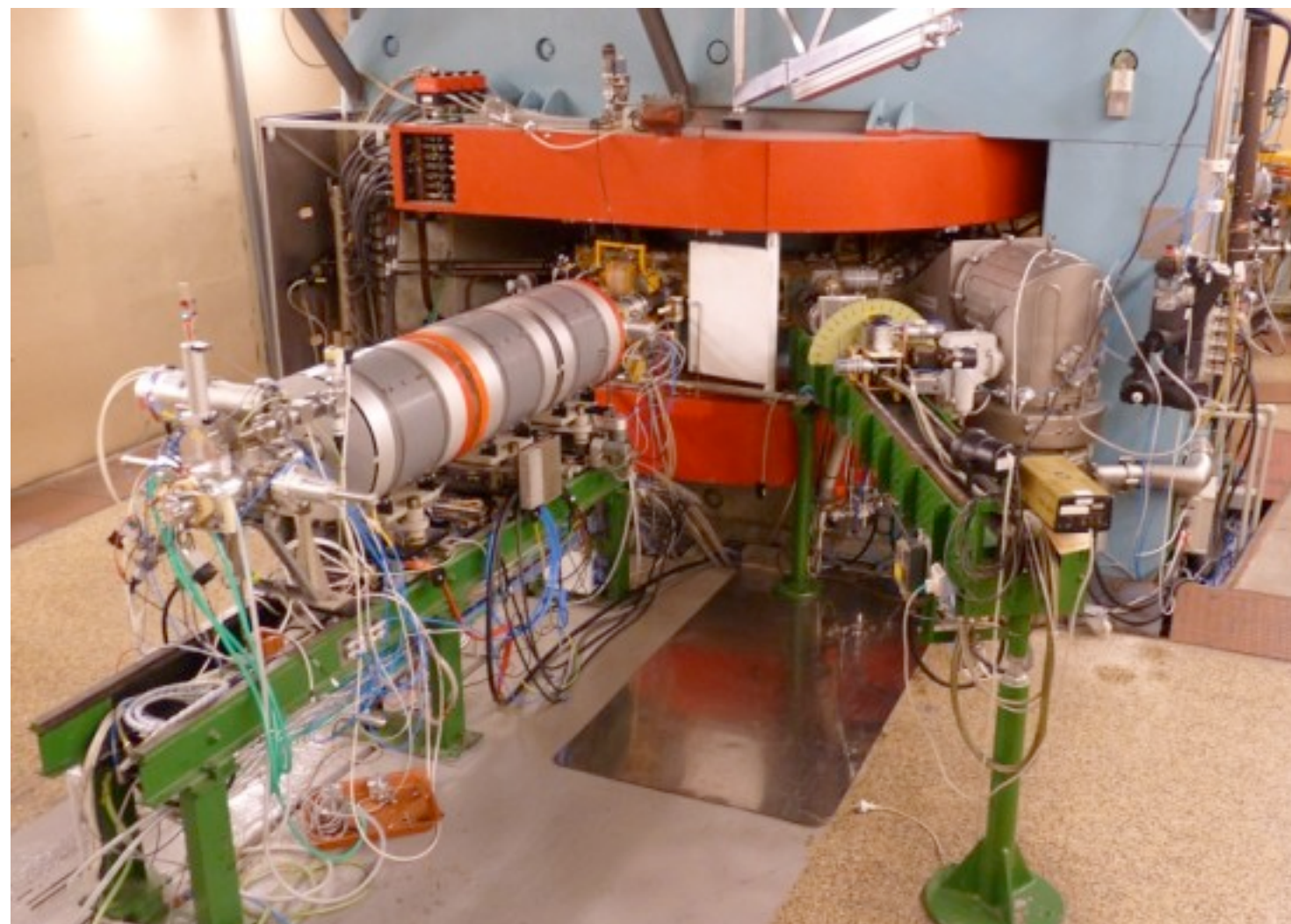


- Maximum 25 MeV, energy is variable in steps of 1 MeV from 12 up to 25 MeV or in steps of 0,5 MeV from 6 up to 15 MeV.
- Pulse length is 3,5 μ s, standard repetition rate is 423 Hz, mean maximum current is about 30 μ A in dependence on electron energy.
- Possibility of converting primary electron beam to secondary photon beam and neutrons.

CANAM



Center of Accelerators
and Nuclear Analytical Methods



Isochronous cyclotron U-120M
Accelerates light ions
(H^+ , H^- , D^+ , D^- , $3He^{+2}$, $4He^{+2}$)
in the energy range from
1 to 55 MeV.

Laboratory of
Cyclotron and Fast
Neutron Generators
(LC & FNG)

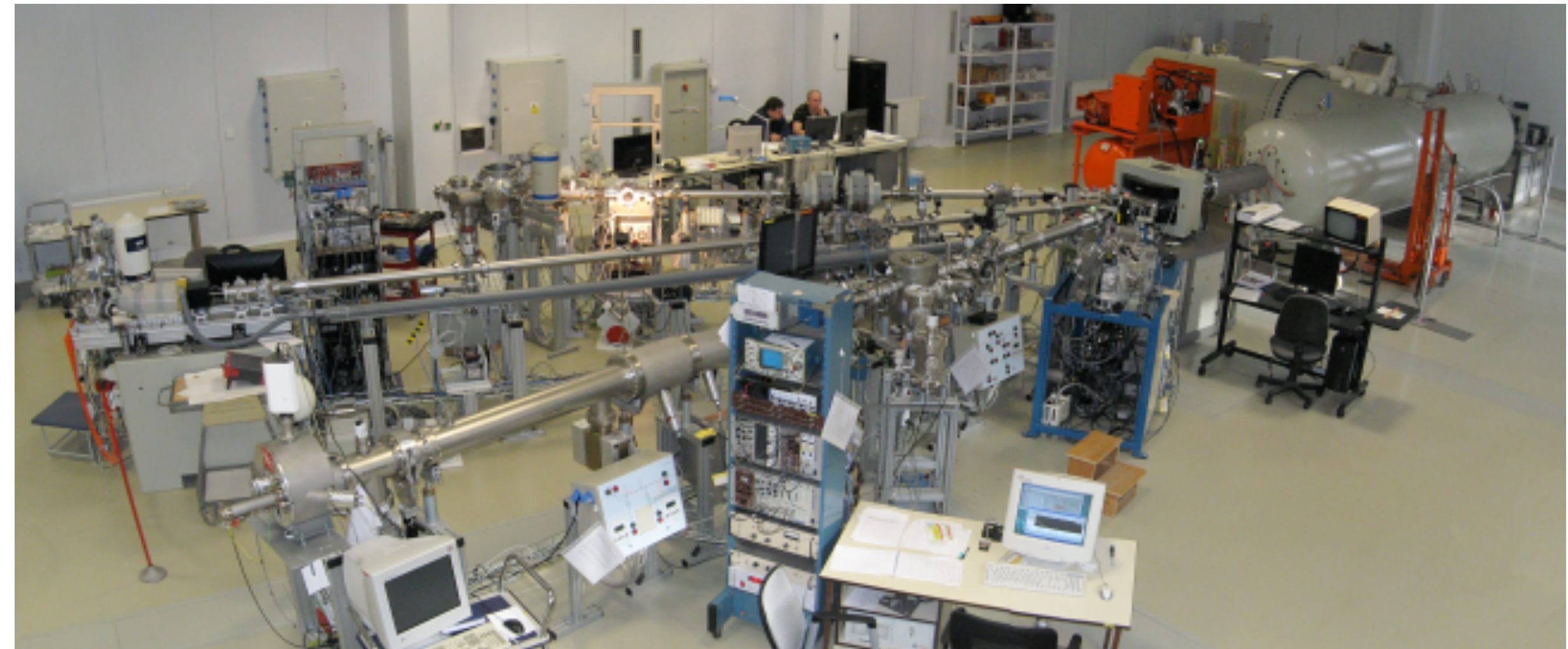
operating the isochronous
cyclotron U-120M

Laboratory of
Tandetron
(LT)

operating an accelerator
Tandetron 4130 MC

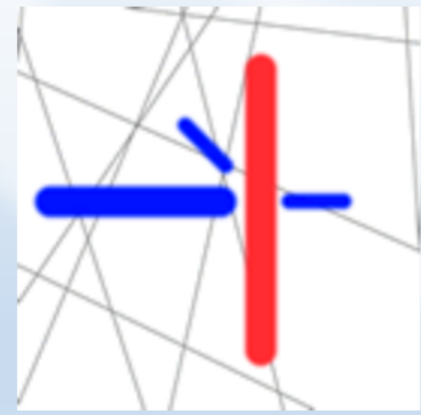
Neutron Physics
Laboratory
(NPL)

providing facilities at the
reactor LVR-15



Tandetron 4130 MC,
Accelerates ions of most of elements from H to Au
with energies from 0.4-20 MeV and intensities up to
tens of mA

CANAM



Center of Accelerators
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In 2015, new cyclotron TR24



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Proton therapy centre

Protheus 230 cyclotron



beam transport system



Proton therapy centre

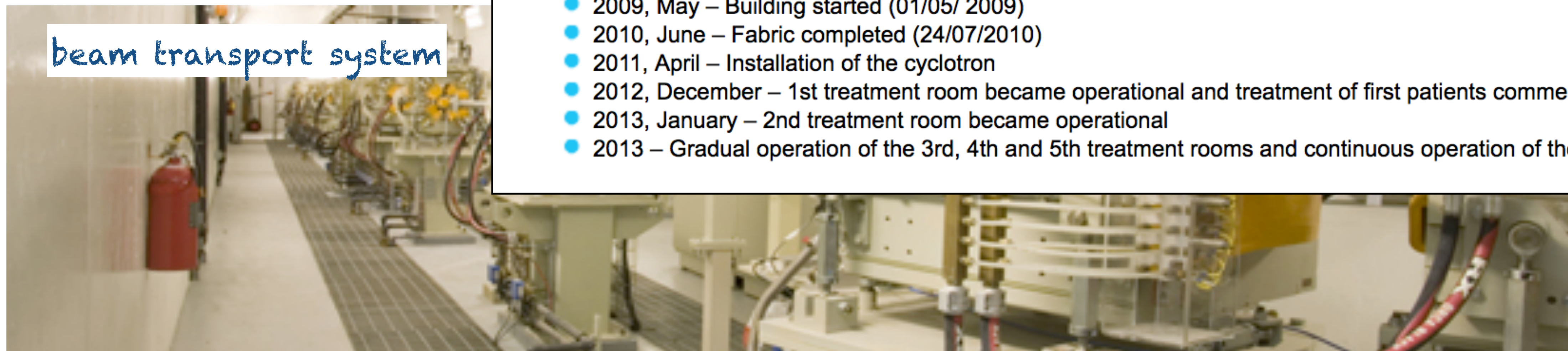
Protheus 230 cyclotron



Milestones:

- 1999 – Vision to build a Proton Center in Prague, The Czech Republic.
- 2004 – Initiation of preparation and planning for the project
- 2006 – Initiation of design work
- 2007, April – Municipal decision (05/04/2007)
- 2008, June – Building permit (09/06/ 2008)
- 2009, May – Building started (01/05/ 2009)
- 2010, June – Fabric completed (24/07/2010)
- 2011, April – Installation of the cyclotron
- 2012, December – 1st treatment room became operational and treatment of first patients commenced
- 2013, January – 2nd treatment room became operational
- 2013 – Gradual operation of the 3rd, 4th and 5th treatment rooms and continuous operation of the center

beam transport system



ELI beamlines



- The project **Extreme Light Infrastructure** (ELI) is part of a European plan to build a new generation of large research facilities selected by the European Strategy Forum for Research Infrastructures (ESFRI).
- The first facility (ELI Beamlines) is to be located in the Czech Republic and creates a new generation of secondary sources for interdisciplinary applications in physics, medicine, biology and material sciences

<http://www.eli-beams.eu/>

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Science



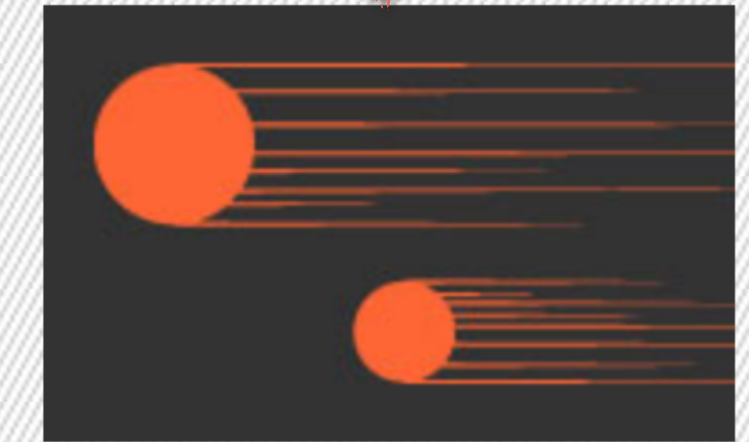
Lasers

CONTINUE ▾



X-ray Sources
Driven by Ultrashort
Laser Pulses

CONTINUE ▾



Particle
Acceleration by
Lasers

CONTINUE ▾



Applications in
Molecular,
Biomedical, Material
Sciences

CONTINUE ▾



Plasma and High
Energy Density
Physics

CONTINUE ▾



Exotic Physics and
Theory

CONTINUE ▾

ELI beamlines



To start on
January 1st,
2018

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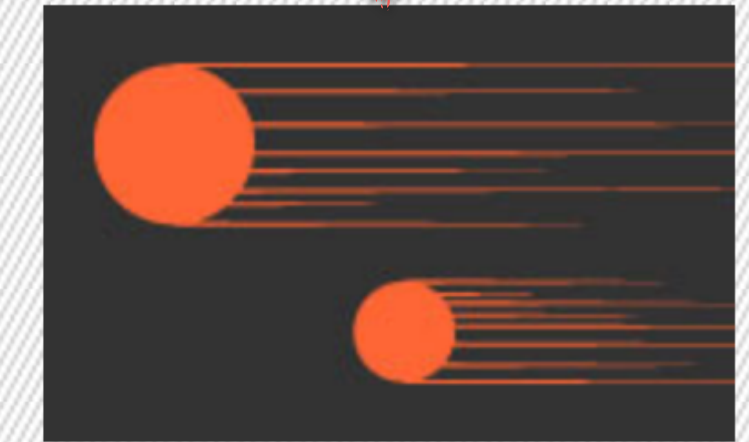
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CONTINUE ▾



Plasma and High
Energy Density
Physics

CONTINUE ▾



Exotic Physics and
Theory

CONTINUE ▾



Creation of a group on particle-accelerator science and
technology in Mexico

Creation of a group on particle-accelerator science and technology in Mexico

See also: <https://arxiv.org/abs/1608.07456>
written with Mauro Napsuciale

Some pre-history

- In Mexico, there is a strong community working on High-Energy Physics
- Up to the 90's almost all the research was on theory and phenomenology.
- This was deemed not healthy.
So a group of colleagues looked for students interested in the experimental side of the field, made contact with the large laboratories and supported the development of this area in Mexico
- By the early 2000's there were already several experimentalists working from Mexican institutions on experiments at Fermilab, DESY and CERN

Some history

- In 2006, the Mexican funding agency, Conacyt (National Council for Science and Technology) opened a call for

Proposal of ideas for the realisation of large scale projects on science or technology

so that they could be incorporated in the agenda of National priorities of science and technology

- Along with a group of colleagues, led by Gerardo Herrera, we proposed the development of the science and technology of particle accelerators with the long term goal of the construction of a light source in Mexico



Red FAE

- The outcome of the call was that the Conacyt created national networks of scientist to discuss the selected ideas, prioritise them and come up with concrete ideas for their realisation
- One of these, was the Network for High-Energy Physics (RedFAE) where our proposal was included
- During the first meeting of RedFAE in 2009 it was agreed to keep pushing the idea of developing accelerator science and technology in Mexico
 - One of the main action items was to start training students in this field

A parallel development

- At that time, the Director for Scientific Development of Conacyt, J. L. de La Peña, created an ad-hoc committee to advise him on the feasibility of large scale accelerator projects in Mexico
- We recommended to support projects to construct in Mexico accelerators for
 - Hadron therapy
 - Light sources
- The panel stressed the need of a strong investment on the training of highly qualified human resources
- From the outcome of this committee and from the input he got from the RedFAE, Dr. de La Peña agreed to look for ways to fund prospective students in this area

Reporte del panel

Aceleradores para el desarrollo científico, tecnológico y social de México

Miguel Ángel Celis

Isaac Hernández Calderón

Jesús Guillermo Contreras

José Manuel Lárraga

Matías Moreno

México, 14 de mayo 2010

The problem of funding

- When starting a new area there is a problem to find funding for students
- The researchers which are experienced enough to be awarded projects have two problems
 - They do not have experience in the new field
 - They have to fund their on field
- It is also crucial to find experienced partners willing to train the new students
- It is crucial to find new ways of getting funding. This implies a change in the policy landscape of the institutions and/or region/country
Here the help of large laboratories is crucial to give the proposal the necessary scientific stature and long term stability

The beginnings of the collaboration with CERN

- Towards the end of 2007, the first student interested in doing postgraduate studies in this field was found
- I contacted Eckhard Elsen for advice. He pointed me to Jean-Pierre Koutchouk who put me in contact with Frank Zimmermann
- At that time I did not know Frank. All contact was per email. He was willing to help, so the student started working with him in the Summer of 2008.
- The student got his M. Sc. (2009) and Ph. D. (2013) under the direction of Frank working on electron cloud effects at the LHC
- Other Mexican students got interested and went to CERN to work towards their Ph. D.
- Funding in the initial years was from many sources, among them EuCARD, HELEN, E-Planet from Europe
Conacyt, RedFAE, Cinvestav from Mexico

The BEAM programme

- Since 1998 there is a cooperation agreement between Conacyt and CERN
- BEAM, an addendum to this agreement, was written to formalise the collaboration between Mexico and CERN

The BEAM programme aims at the transfer of knowledge for the development of particle accelerators between **CERN's** Beams Department and Mexican Institutions, through visits and training in areas of common interest.

- The formalities took a long time. Finally on January 9, 2015 was officially signed, but it was de facto operating before that date
- BEAM has helped in creating an official environment **to ask for** funding and several students have benefit from this

Cooperation CERN-Mexico: The current situation

- Three students have got their Ph. D. from Mexican institutions working at CERN
 - ✓ Humberto Maury
 - ✓ Cristhian Valerio
 - ✓ Bruce Yee
- There are 5 Mexicans working currently at CERN
 - ✓ Alejandro Castilla (CERN fellow)
 - ✓ Gerardo Guillermo (Ph. D. student)
 - ✓ Karim Hernandez (Ph. D. student)
 - ✓ Luis Medina (Ph. D. student)
 - ✓ Alan Valdivia (M.Sc. student)

JLAB and Mexico

- A parallel effort was carried out between JLAB and Mexico
- A Mexican researcher at JLAB, Carlos Hernandez Garcia was the contact person while Mauro Napsuciale organised the activities in the Mexican side
- The funding was more problematic in this case, because there is no formal agreement between Conacyt and JLAB. Nonetheless JLAB, Mexican Universities and Conacyt contributed funds.
- One student is about to get his Ph. D., Alejandro Castilla, now at CERN, three got a M. Sc. and at least seven students participated in the JLAB summer student program
- Currently, as a product of this effort, two other students are working towards their Ph. D. in collaboration with JLAB

The Mexican Particle Accelerator School

- J. L. de la Peña set-up another panel to connect the people interested in building a light source in Mexico, with the users community
- There was some money attached to the initiative and Mauro Napsuciale took the opportunity to organise the **First Mexican Particle Accelerator School in November 2011**
- It took some time to organise the second school, which took place in 2015, with most of the funding from RedFAE, and active participation of our first PhD graduated in the field
- The third school is being planned ... but funding has not been found yet ...

Lectures

Science at Synchrotron Light Sources	Alejandro Aguilar (ALS-LBL)
Science by Mexicans at SR Facilities	José Mustre (CINVESTAV-Mérida)
Light Sources & Science at FELs	John Bozek (SLAC)
Synchrotron Radiation	Albert Hofmann (CERN)
Electron Sources & Vacuum Components	Carlos Hernández (JLAB)
RF Fundamentals, SRF & ERL	Jean Delayen (JLAB)
Accelerator Physics & Compton Sources	Todd Jeffrey Satogata (JLAB)
Synchrotron Light Sources & X-Ray FELs	David Robin (ALS-LBL)
Magnets	Cherrill Spencer (SLAC)
Undulators	Elizabeth Moog (APS-ANL)
Instabilities (Rings)	John Byrd (LBL)
Instrumentation/Control & Photon Beamlines	Arne Freyberger (JLAB)

The Mexican Particle Accelerator Community

- About one year ago, Mexican students working in this field at different laboratories and Universities around the world got together with the recently graduated students to form a community to work together:

<http://www.cmapweb.org/>



- Currently there are some 25 members, many of them outside Mexico, and have started several activities as a group
 - ✓ They are trying to get funds to organise the third school
 - ✓ They have given talks to the High Energy Physics community looking for synergies
 - ✓ They have decided to pursue the construction of a LINAC to start developing this field in Mexico. They are now getting organised and looking for partners (both to construct and to use the accelerator) to prepare a project in the near future

The problem of coming home

- Regarding our graduates in this field
 - ✓ Two are in 'posdoc' positions, one at CERN the other at KEK
 - ✓ One has a 'tenure-track' position in a Mexican University
 - ✓ One has a more uncertain position in a Mexican University
- Several colleagues are trying to find positions for our new Ph. D.
 - ✓ This is difficult, because there are very few positions
 - ✓ These are normally opened for established programs
- One possibility to solve this problem is to have projects which need their know-how
 - ✓ One of the states in Mexico is considering the possibility of building a light source
 - ✓ There are some ideas and initiatives of having a hadron-therapy centre in Mexico
 - ✓ There are smaller projects to develop accelerators for industry, for example cold pasteurisation through food irradiation is being pursued in another Mexican state

My two cents

Universities meet Laboratories: My two cents (1/2)

- We attempted to create a new research area in Mexico
One of the first steps was to attract **students**
- To attract good students we have to offer them
 - ✓ Interesting topics: we need experienced **partners**
 - ✓ Scholarships: we need **funds**
 - ✓ A future: we need new positions and interesting **projects**
- These issues are linked
 - ✓ Interesting topics will give rise to future interesting ideas and projects which will attract the attention of Universities and Funding Agencies
 - ✓ Experienced partners and institutions bring with them the assurance of know-how which improves the chances of getting funding for scholarships and improve the chances of students developing a good CV with which to compete for positions later on ...
 - ✓ The CV requirements to get a position in academia, particularly if the field does not exist in the institution, requires a very solid publication list ... or in more engineering oriented institutions, links with industry (ie money) and patents ...

Universities meet Laboratories: My two cents (2/2)

- From my point of view, the main characteristics that our students and partners have needed in this adventure have been
 - ✓ **Patience** (an infinite supply at least)
 - ✓ **flexibility** to accommodate different needs and requirements
 - ✓ **Endurance** ... we have been at it many years, there is progress, but the group is in no way stable and self sufficient yet ...
- For me these are the keywords that summarise the relation between our universities and CERN/JLAB in this adventure ...

Universities meet Laboratories: My two cents (Summary)

- In the short term
Universities can offer to Labs good students; in return they need that those students develop very strong CV
- In the long term
these students will become future partners and collaborators ... they will help in shaping the future of the field and in obtaining large scale funding from their country funding agencies

with a bit of luck and lots of work, this is a win-win situation