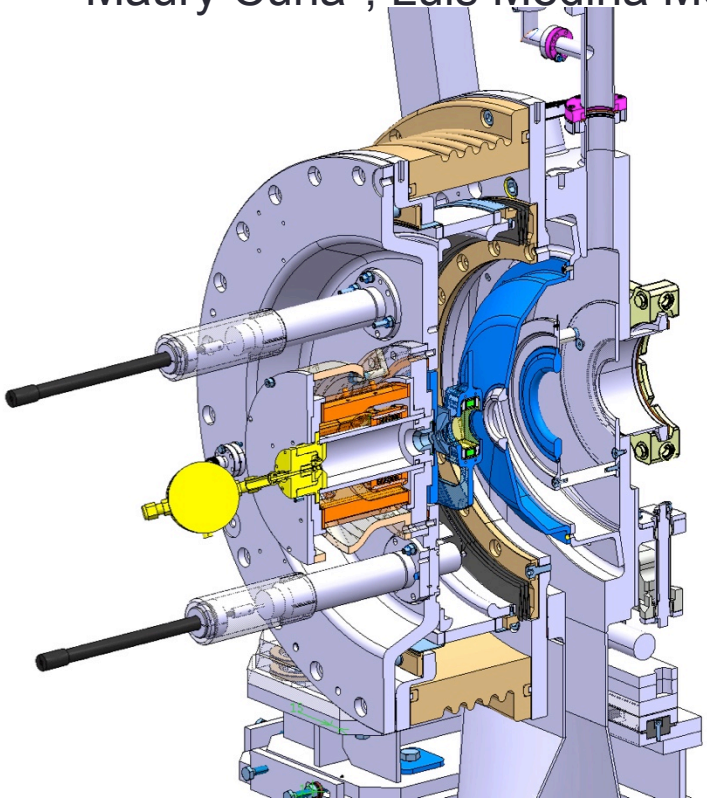
SCIENCE AND TECHNOLOGY OF ACCELERATORS

Cristhian Valerio Lizarraga[+], Alejandro Castilla Loaeza[§], Gerardo Guillermo Cantón[♯], Carlos Duarte[+], Daniel Chavez Valenzuela[§], Karim Hernández Chahín[§], Humberto Maury Cuna[§], Luis Medina Medrano[§], Juan Reyes Herrera[♭], Salvador Sosa Güitrón[♮], Alan Valdivia García[§], Bruce Yee Rendón*



XXX REUNION ANUAL DE LA DPC-SMF

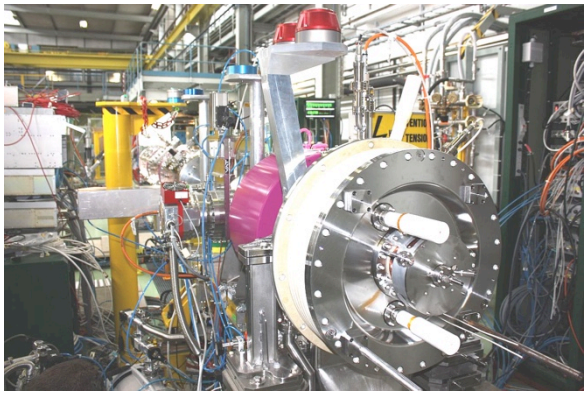
Content:

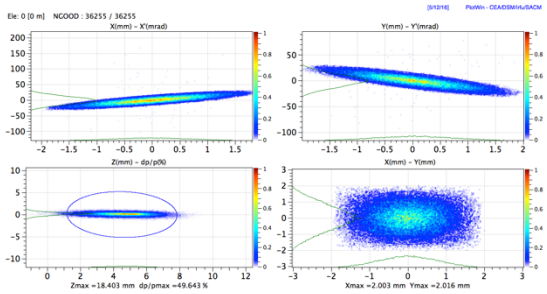
- **CMAP**
- **Members**
- **The Linac Project**

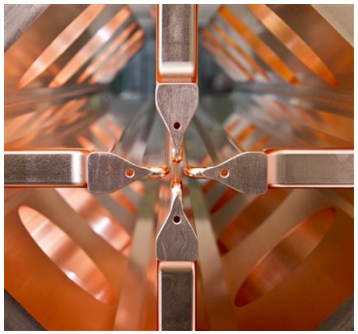
[+]Universidad Autónoma de Sinaloa,[§]Universidad de Guanajuato, [♯]Centro de Investigación y de Estudios Avanzados del I.P.N. , [♭]Universidad Nacional Autónoma de México, [♮]Old Dominion University, *The High Energy Accelerator Research Organization.

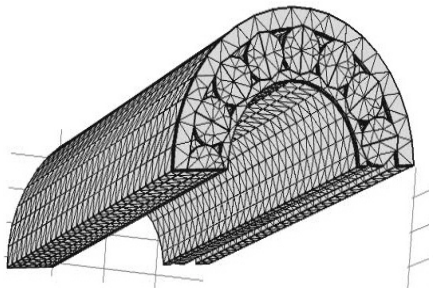
New Accelerators Science in Mexico

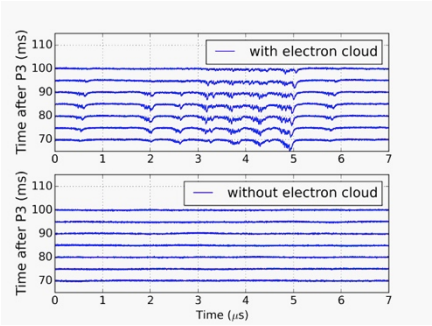
- Since 2007, the community of particle physics send a group of students to different labs to learn about particle accelerators.
- There are many other isolated efforst around the country
- Now there are collaborations in this field Mexican Universities and international Labs such as CERN, Jefferson Lab,Berkeley Lab and ALBA.
- Two Mexican Particle Accelerators Schools (MEPAS) were realized in the last 5 years.











CMAP (Comunidad Mexicana de Aceleradores de Particulas)

- In 2015, the Mexican Particle Accelerator community was created to develop the science and technology of accelerator physics in Mexico.

The collaborations with international labs bring many benefits.

It is crucial to develop our own projects in Mexico.

CMAP has members to cover different aspects of the accelerators science and technology.

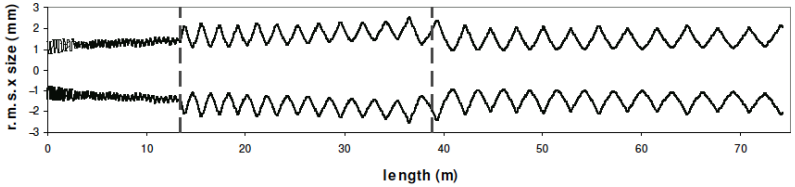
CMAP MEMBERS

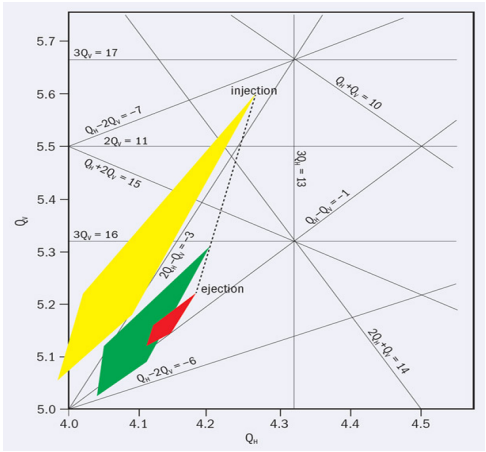
- Putting together all the knowledge from the members is possible to aboard different projects.
- Accelerator physics cover many areas and each member work in different subjects.

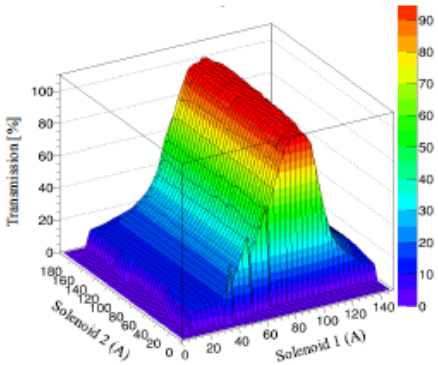
Beam Dynamics

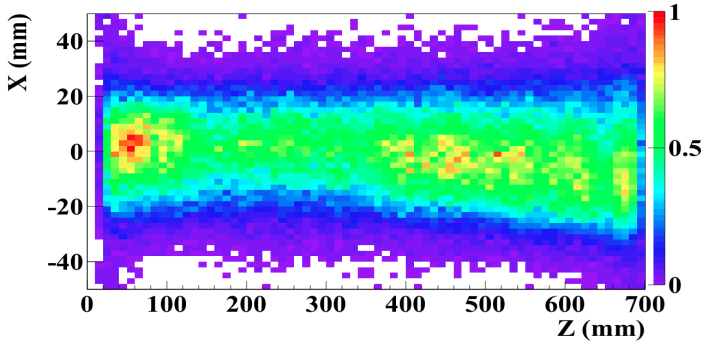
- **Members are working in:**
- Beam Optics
- Beam Losses
- Tune shift
- Emittance Growth Mechanism
- Effects of No linear Fields

- **Beam Physics**
- Plasma Physics
- Space charge
- Bremsstrahlung
- Electron cloud









lmedina@cern.ch

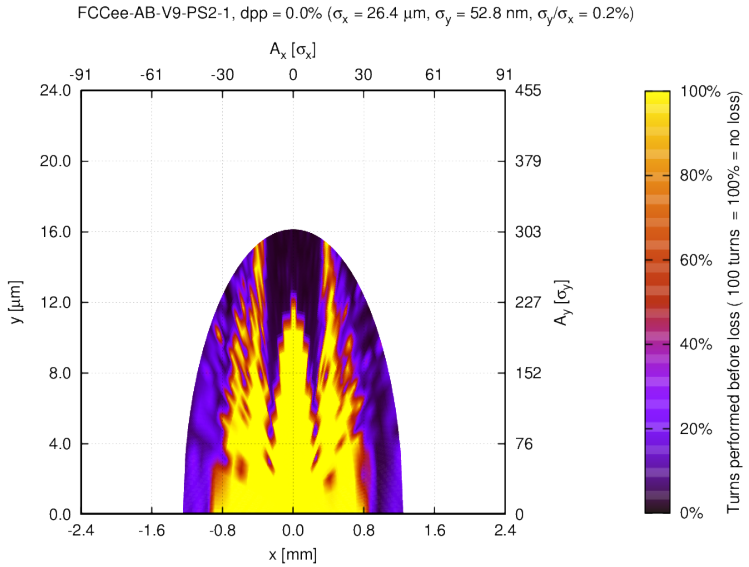
Name: **Luis Eduardo Medina Medrano**

Degree: **Master in Physics**
Affiliations: **University of Guanajuato/CERN**
Institutions where develops his research: **CERN**

Areas of interest:
Beam dynamics, lattice design, optics measurements and corrections

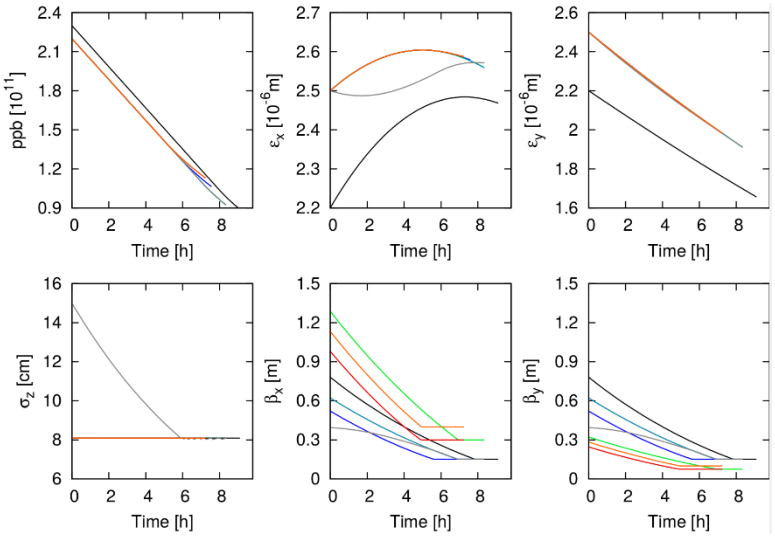
Dynamic Aperture Studies for the Future Circular Collider – ee (FCC-ee)

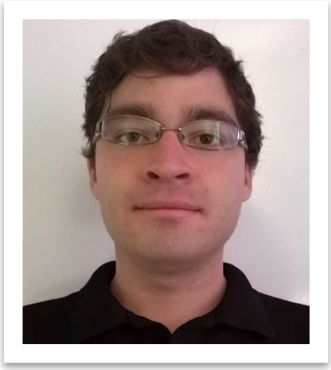
- Development of tools for the computation of dynamic aperture including several effects.



Performance and Operational Aspects of High Luminosity LHC (HL-LHC)

- Simulations of the evolution of luminosity for the baseline and alternative scenarios.





Name: **Marco Alan Valdivia**

Degree: **Bachelor in Engineering**

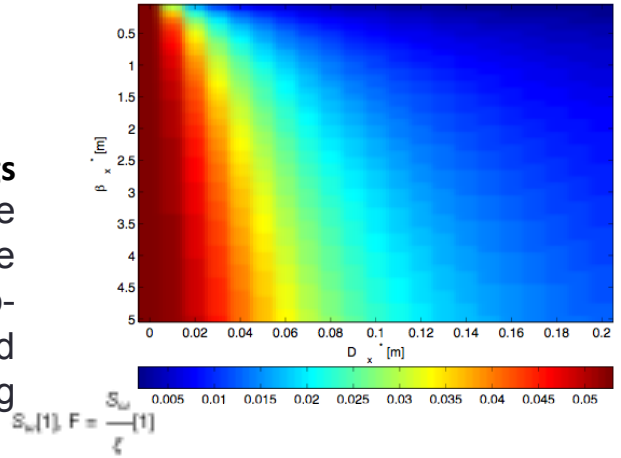
Affiliations: **University of Guanajuato/CERN**

Institutions where develops his research: **CERN**

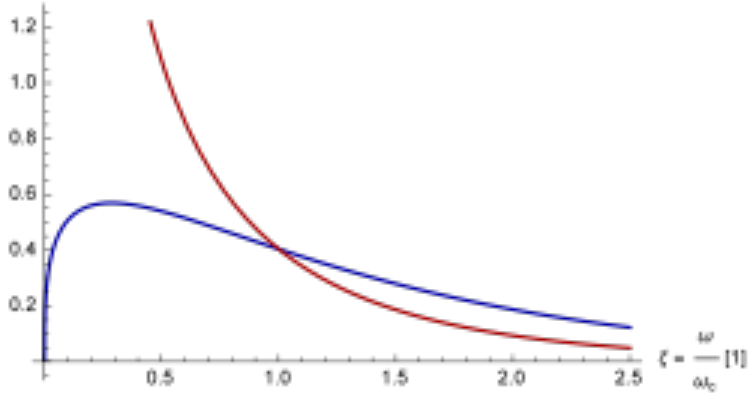
alan.valdivia@cern.ch

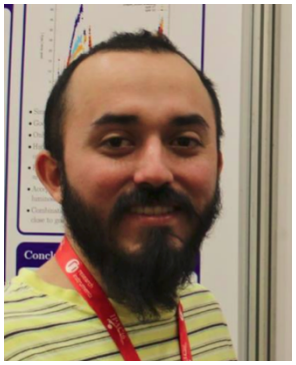
Working topic:

EffectTowards a monochoromatizaition scheme for direct Higgs productions: Direct Higgs production in e+e- collisions at the FCC is of interest if the centre-of-mass energy spread can be reduced by at least an order of magnitude. A mono-chromatization scheme, to accomplish this, can be realized with horizontal dispersion of opposite sign for the two colliding beams at the interaction point (IP).



Effect of Beamstrahlung on Bunch Length and Emittance in Future Circular e+e– Colliders: In future circular e+e- colliders, beamstrahlung may limit the beam lifetime at high energies, and increase the energy spread and bunch length at low energies. If the dispersion or slop of the dispersion is not zero at the collision point, beamstrahlung will also affect the transverse emittance.





gerardo.guillermo.canton@cern.ch

Name: **Gerardo Guillermo Canton**

Degree: **Master in Physics**

Affiliations: **CINVESTAV (Merida)/CERN**

Institutions where develops his research: **CERN**

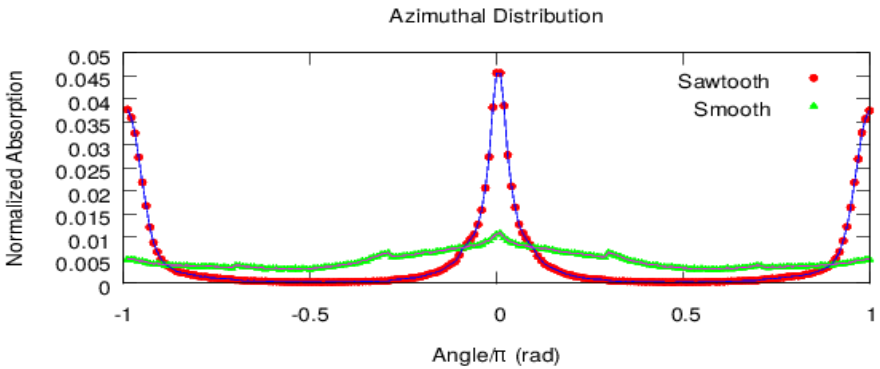
Working topic:

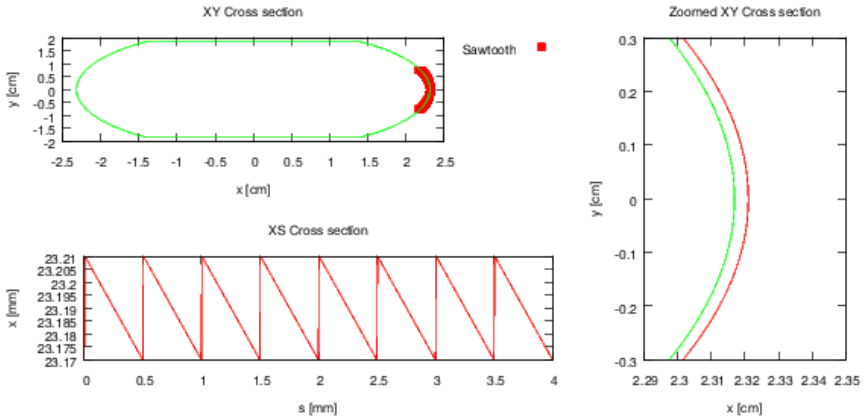
Estudios de Absorción de Radiación de Sincrotrón(SR)

Mediante el uso de herramientas de métodos numéricos (Montecarlo) se simulan fotones de SR a lo largo de un acelerador y se siguen estos fotones a lo largo de sus reflexiones, hasta la absorción en la cámara de vacío.

La Herramienta utilizada es Synrad3D, desarrollada en la universidad de Cornell por D. Sagan utilizando un modelo matemático desarrollado por G. Dugan

El efecto de patrón de diente de sierra impreso en la pared exterior del LHC, y los efectos de los cambios a la óptica ATS del HL-LHC





Name: **Bruce Yee Rendon**

Degree: **Doctor**

Affiliations: **The High Energy Accelerator Research Organization (KEK)/ Japan Proton Accelerator Research Complex (J-PARC)**

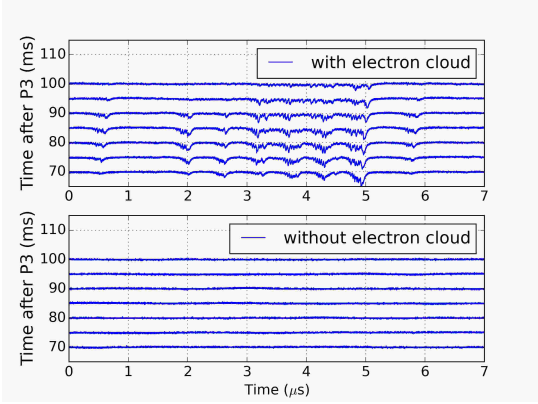
byee@post.j-parc.jp

Institutions where develops his research: **The High Energy Accelerator Research Organization (KEK)/ Japan Proton Accelerator Research Complex (J-PARC)**

Working topic:

ELECTRON CLOUD AT J-PARC MAIN RING

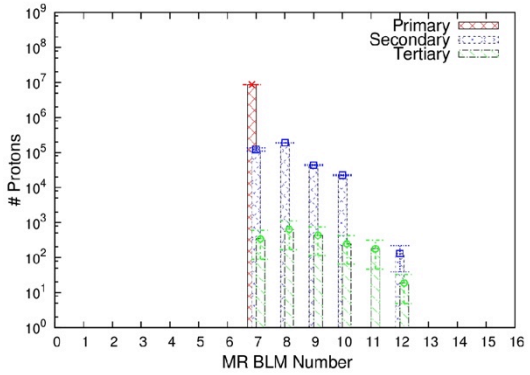
Electron cloud affects the stability in the high intensity proton beams. At J-PARC, I'm studying its origin, making measures and finding a way to mitigate it.



Electron cloud signal detector for the case with and without Electron cloud. P3 is the time in which the cavities are turn off to unbunched the beam.

SIMULATIONS OF THE BEAM LOSS DISTRIBUTION AT J-PARC MAIN RING

At some detectors the signal register is less than the one measure my hand dosimeters Thus, using SAD and Geant 4, I'm developing a model which can explain that differences.



Lost distribution of primary, secondary and tertiary protons at the collimation area.

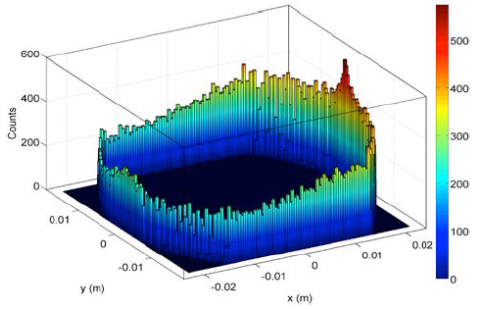
Name: **Humberto Maury Cuna**

Degree: **Doctor**

Affiliations: **University of Guanajuato/CERN**

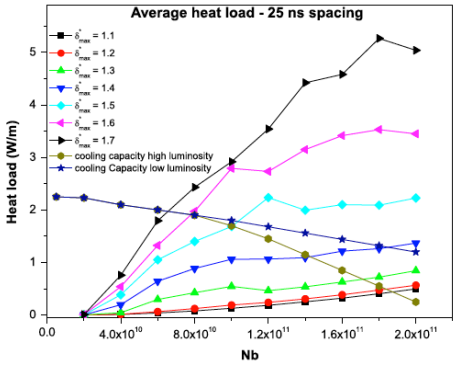
Institutions where develops his research: **CERN**

israel.maury@ugto.mx



Working topic:

Electron cloud effects in the LHC and FCC:
An electron cloud is an important issue for the LHC performance and beam quality. I am woking on studies to mitigate this effect. In addition, how EC will affect the future accelerators like FCC is being investigated.



Mapping of the beam-induced synchrotron radiation at the LHC:
The EM radiation due to the beam in the LHC is a key ingredient to electron cloud build-up codes. Employing codes as SYNRAD3D can help to map the distribution of the SR photons along the LHC.

Particle Accelerator Group at UG: Currently, I am coordinating the particle accelerator group at Universidad de Guanajuato. The group is formed by 2 mechatronics engineers, 1 Electromechanic engineer and two undergrad physics students.

Areas of interest: **collective effects, synchrotron radiation, cyclotrons, accelerators for industrial applications.**

jureyherrera@gmail.com

Name: **Juan Reyes Herrera**

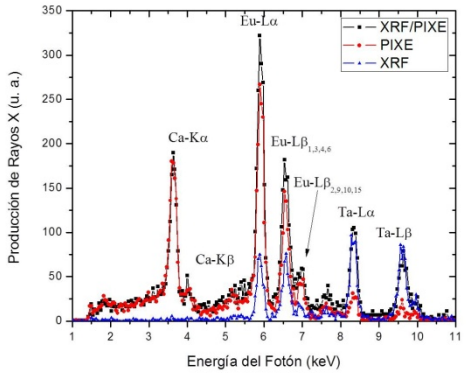
Degree: **Doctor**

Affiliations: **Institute of Physics, UNAM** – CDMX, México

Institutions where develops his research: **ALBA Synchrotron Light Source** – Barcelona, Spain.

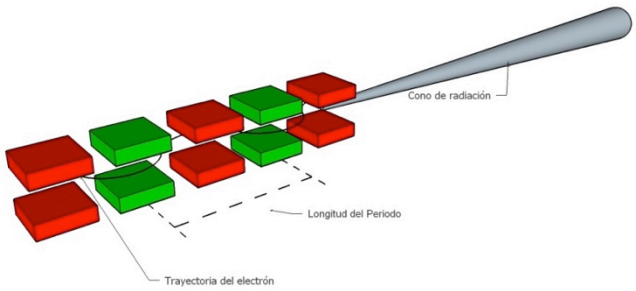
Working topic**:**

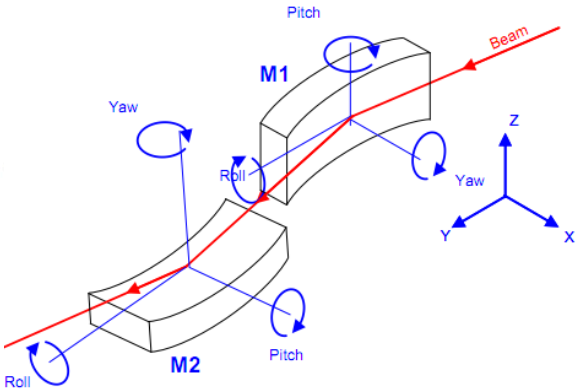
Simultaneous PIXE and XRF elemental analysis.

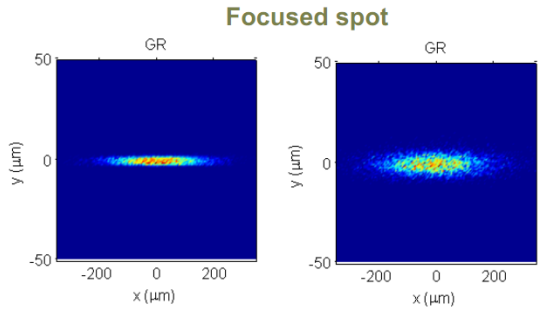


Areas of Interest**:**

- **X-ray spectrometry.**
- **Synchrotron light sources.**
- **X-ray optics and beamline design.**
- **Surface plasma process.**
- **Accelerator physics.**

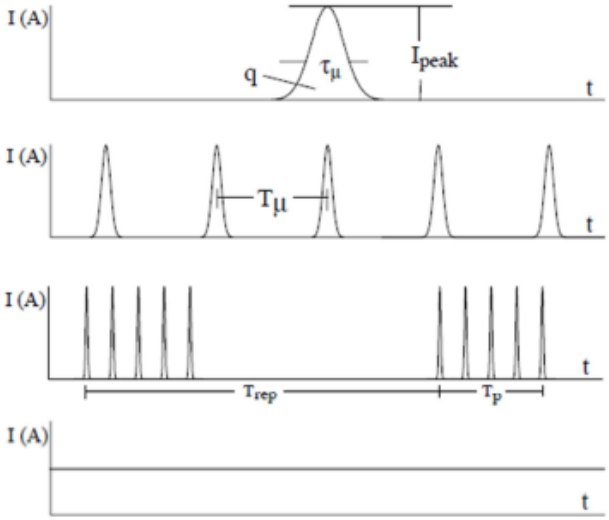


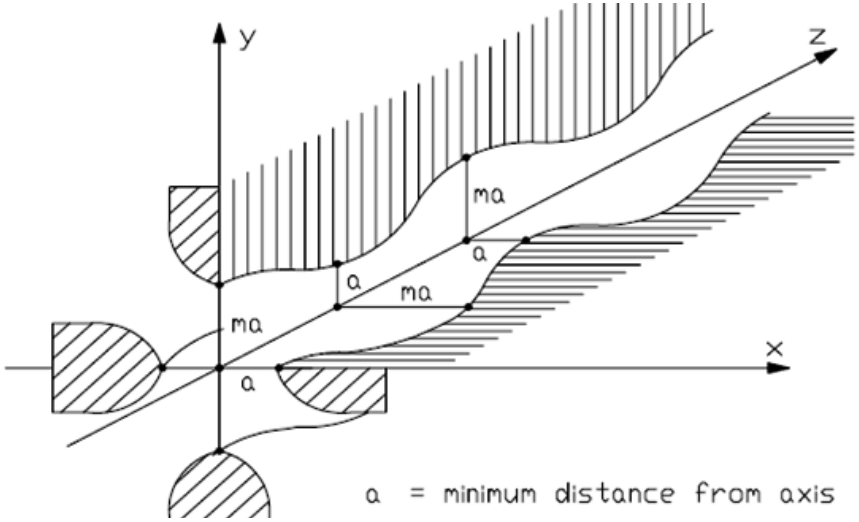




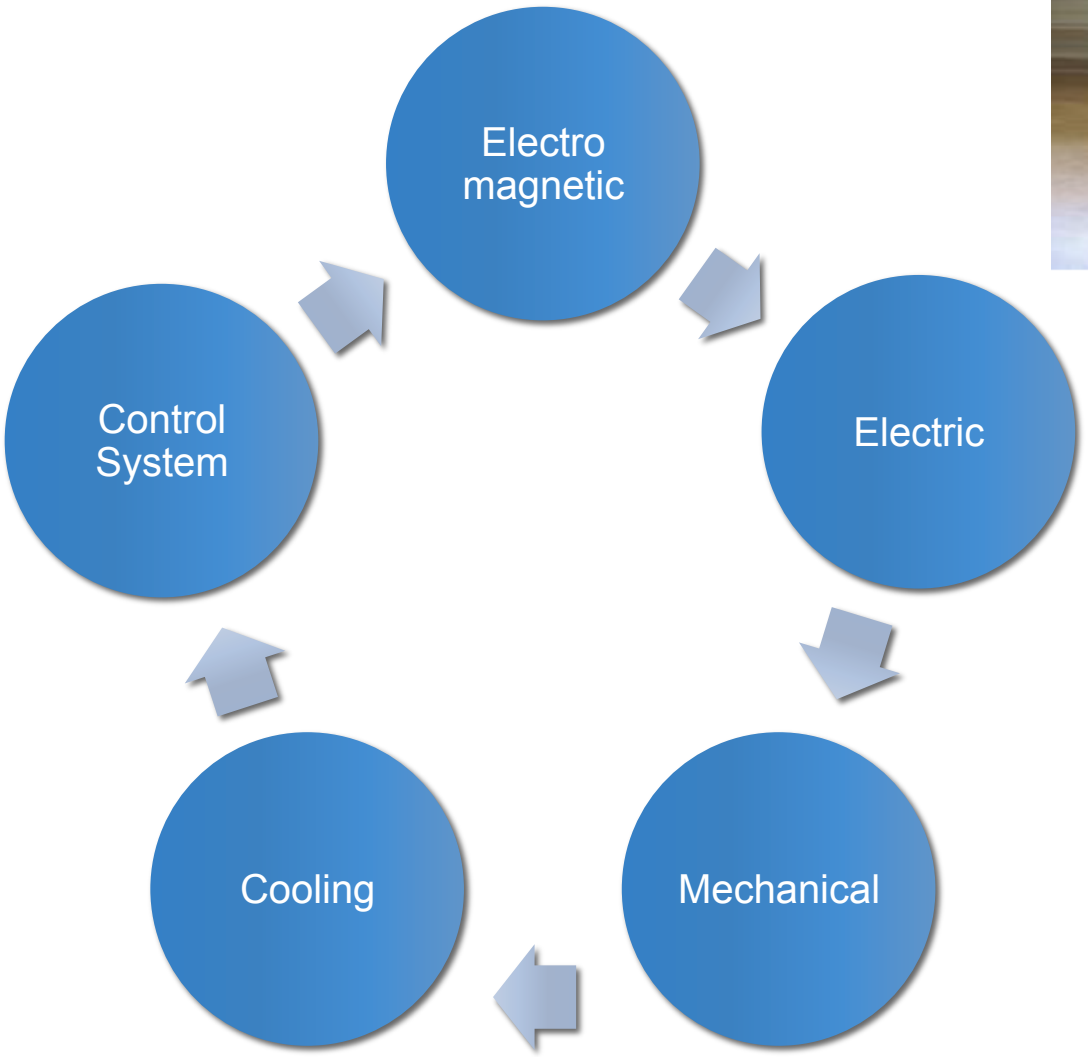
Beam optics

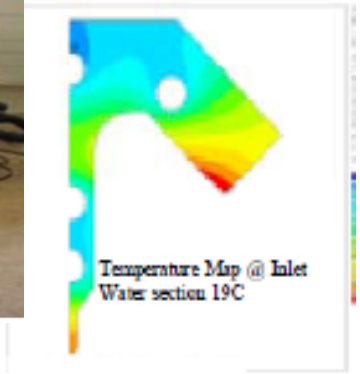
- Once the basic design of optics is finish, the next step is to design the magnets and acceleration cavities in concordance with the accelerators parameters.
- Nowadays, the machine design has several steps.

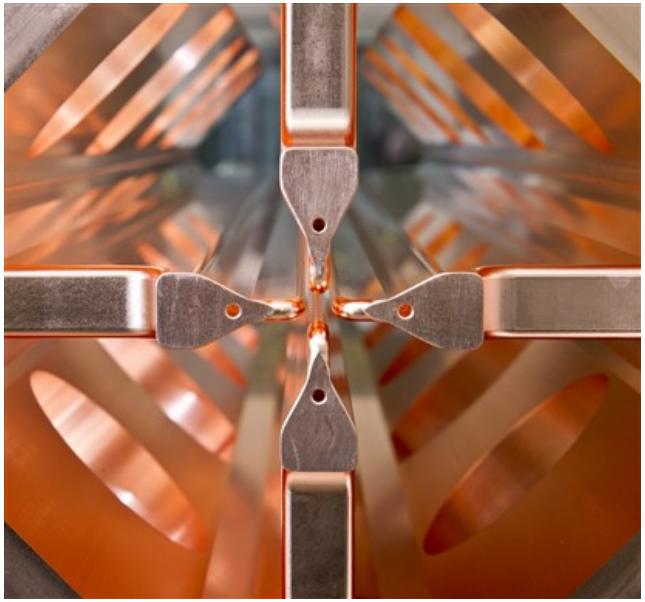




Stage of the Design







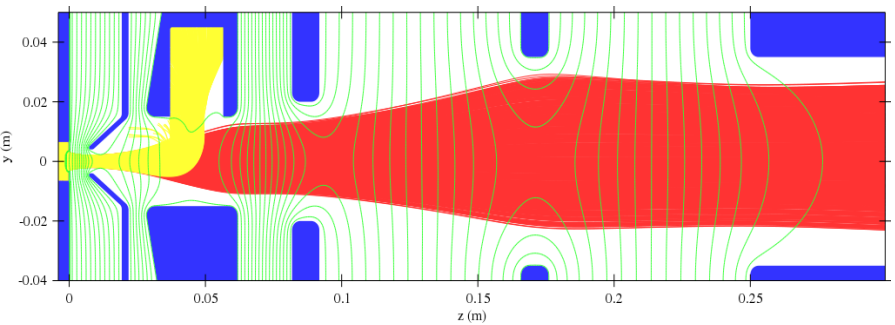
Name: **Cristhian Alfonso Valerio Lizarraga**
Degree: **Doctor**

Affiliations: **Universidad Autonoma de Sinaloa**

Institutions where develops his research: FCFM/UAS, **CERN, LINAC4**

cvalerio@uas.edu.mx

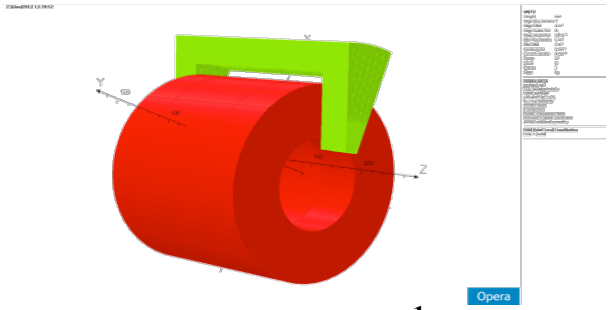
Working Topics:
Particle Source Simulation and Design
Negative Ion Beam
Plasmas Physics
Beam Transport

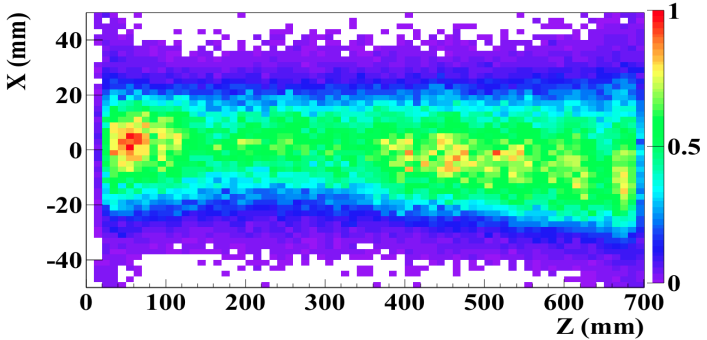


Simulation of the Linac4 Ion source
Electodes(Blue)
H- Beam (Red)

Negative ion extraction

3-D models of Space charge compensation
Magnet Design





Name: **Salvador I. Sosa Güitrón**

Degree: **Master in Physics**

Affiliation: **Old Dominion University** - Norfolk, VA

Institution where develops his research: **Center for Accelerator Science** – ODU. **Jefferson Lab** – Newport News, VA

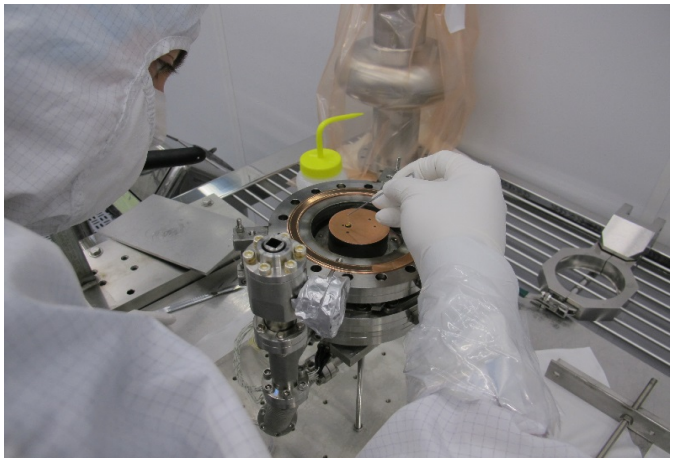
ssosa006@odu.edu

Cavidad de aceleración SRF para International Linear Collider.

Working Topics**:**

Películas Superconductoras para Cavidades SRF en Aceleradores de Partículas

- Cavidades SRF limitadas principalmente por el material de fabricación, Niobio.
- Materiales alternos a Nb:
  - Mayor gradiente de aceleración.
  - Reducción de costos de criogenia, al incrementar la temperatura de operación del acelerador de 2 a 4 K.
  - Películas delgadas superconductoras aplicadas a cavidades de Nb.



Preparando la cavidad SRF para pruebas de materiales superconductores en Jlab.

Area of interest: **Radio Frecuencia en Superconductores (SRF), propiedades Magnéticas de Superconductores**.

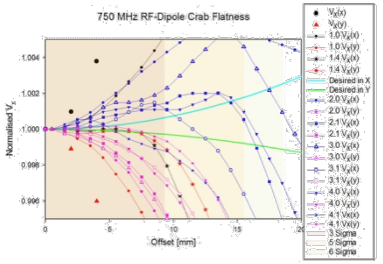
a.castilla@cern.ch

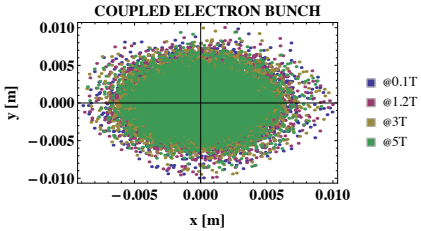
Name: **Alejandro Castilla Loeza.**

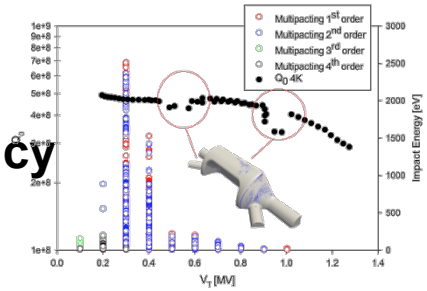
Degree: **PhD. Candidate In Physics.**

Affiliations:
CERN Beams Group RF-SRF – Geneva, CH.
Universidad de Guanajuato – León, Gto.
Jefferson Lab – Newport News, VA.
Old Dominion University - Norfolk, VA.

Institutions where develops his research:
CERN Beams RF-SRF – Geneva, CH.
Center for Accelerator Science – ODU.
Jefferson Lab – Newport News, VA.





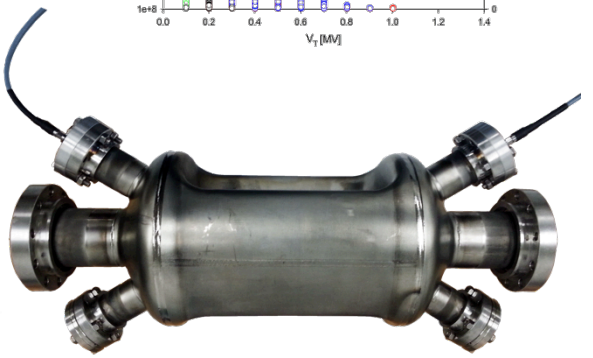


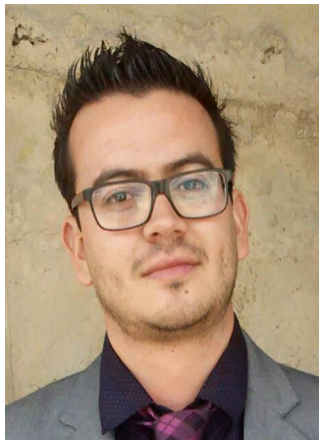
Project Subject:

Design and Operation of Superconducting Radiofrequency Cavities for Particle Accelerators.

- Radiofrequency Applications Beyond Acceleration.
- High Luminosity Future Colliders.

Areas of Interest:
•Superconducting RF.
•Beam Dynamics at the Interaction Region.





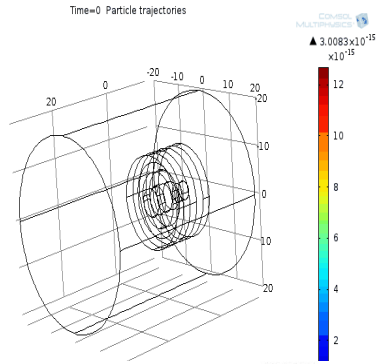
Name: **Daniel Chávez Valenzuela**

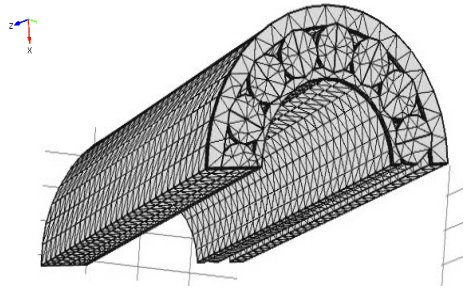
Degree: **PhD. Student**

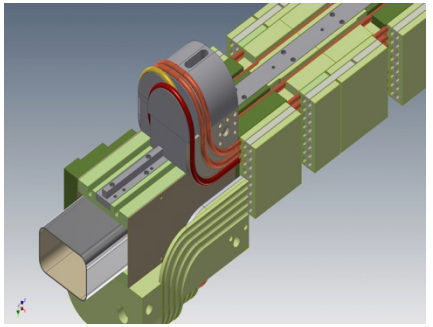
Ascription:
Universidad de Guanajuato – León, Gto.

Institution where Project is being developed:
Texas A&M University- College Station, Tx

dchavez@fisica.ugto.mx



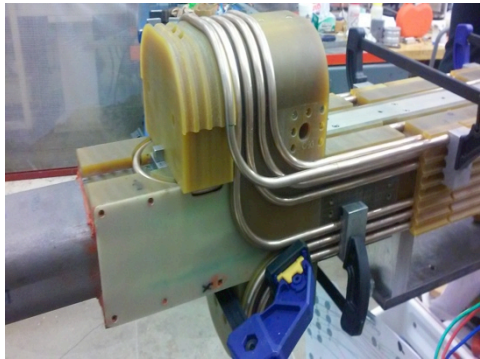




Research Project:
R&D of a NbTi Cable-in-Conduit superconductor for the 3.5T Superferric arc dipole for the Medium-energy Electron Ion Collider @JLAB

Area of interest:

- **Design and develop Superconducting Cable-in-conduits for high field magnets applications.**
- **Simulation of thermo-electrical instabilitys (quench) in superconductors**
- **Inventor desing**
- **Magnetic modeling for dipoles, quadrupoles, etc.**
- **Genetic algorithms.**



karim.gibran.hernandez.chahin@cern.ch

Name: **Karim Gibrán Hernández Chahín**

Degree: **Master in Physics**

Affiliation: **Universidad de Guanajuato, División de Ciencias e Ingenierías Campus León** – León Gto. México

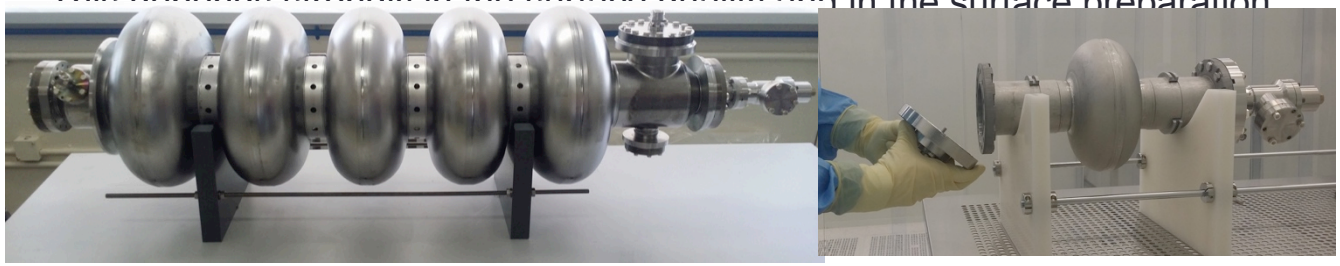
Institution where develops his research: **CERN**

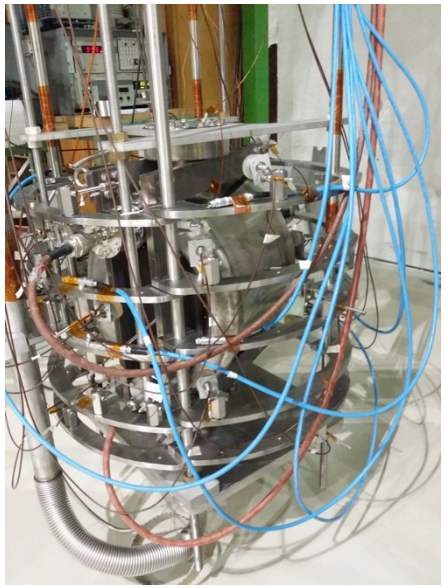
Areas of interest: **Radio Frequency (RF), Superconductors (SC), Quench analysis, RF Cavities**

Working Topics:

Superconducting Radiofrequency Cavities: Preparation techniques, performance measurements and quench analysis

- The main limitation for the SRF cavities are the field emission and quench. This depends strongly in the surface quality and in the surface preparation





- Objectives:

Reach operation requirement reducing:

- Quench
- Multipacting
- Field emission /Radiation

Optimize

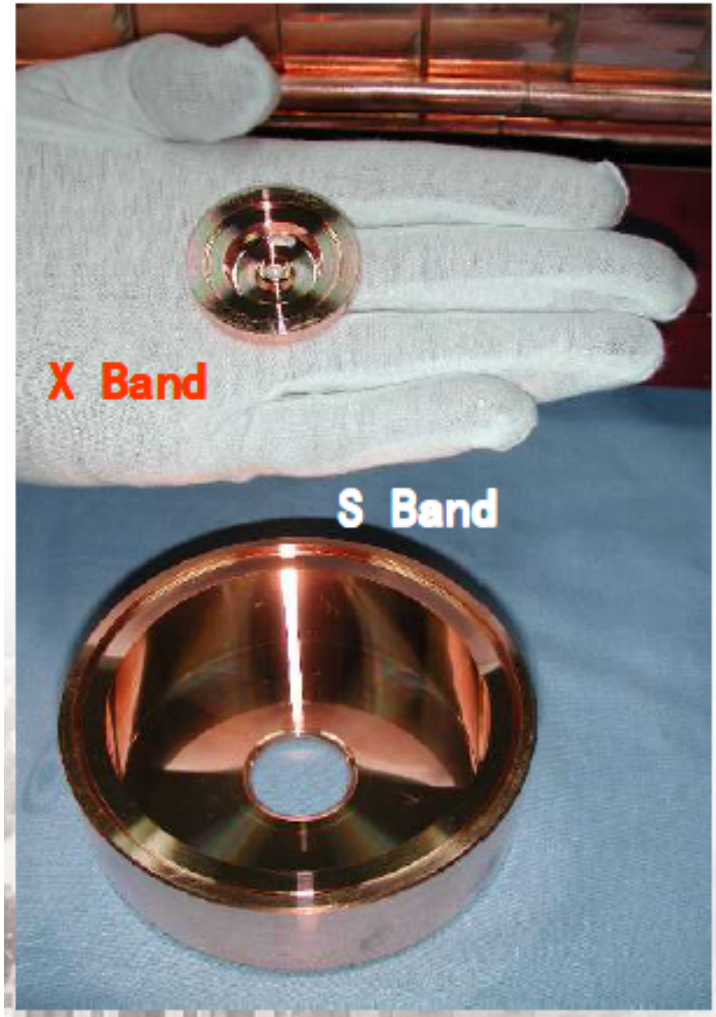
- Mechanical/Chemical/ Thermal treatments
- High pressure rinse
- Handing and assembly in clean rooms

Measurement and data analysis

- Temperature monitoring
- Quench localization using OST signals
- Magnetic field and estimation of the trapped flux in the superconductor
- Correlation between field emission measurement with the surface defect size

Why to design in-house our own accelerator?

- To have a solid collaboration with the industry is important to be the owners of the designs.
- For the maintenance and upgrade of the own accelerators.
- To create an industry in this area.
- Now, the technology like X-Band accelerators start to be available and is vital to be involved in the development of the technology to replace the radioactive sources from the market.



What should we build?

What does the user community want?

Easy to translate to industrial applications

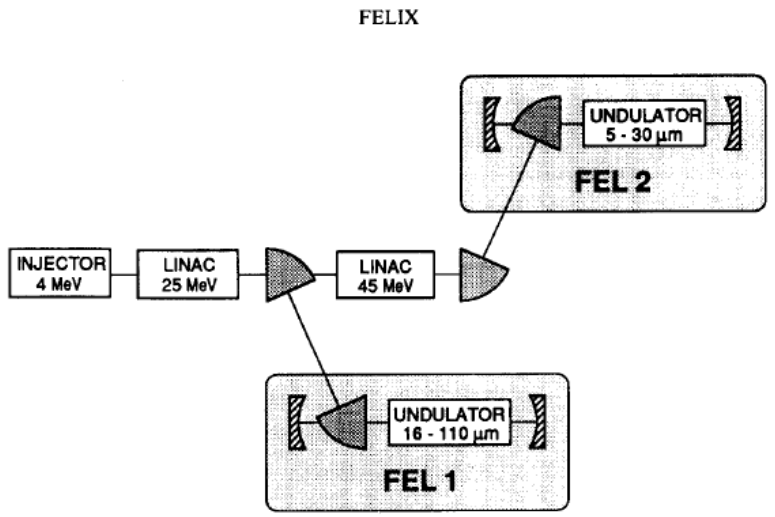


Fig. 2. Schematic layout of FELIX.

Can it be done without SCRF?

Multiple beam lines

> 1 kHz operations

Rate at individual beamlines programmable

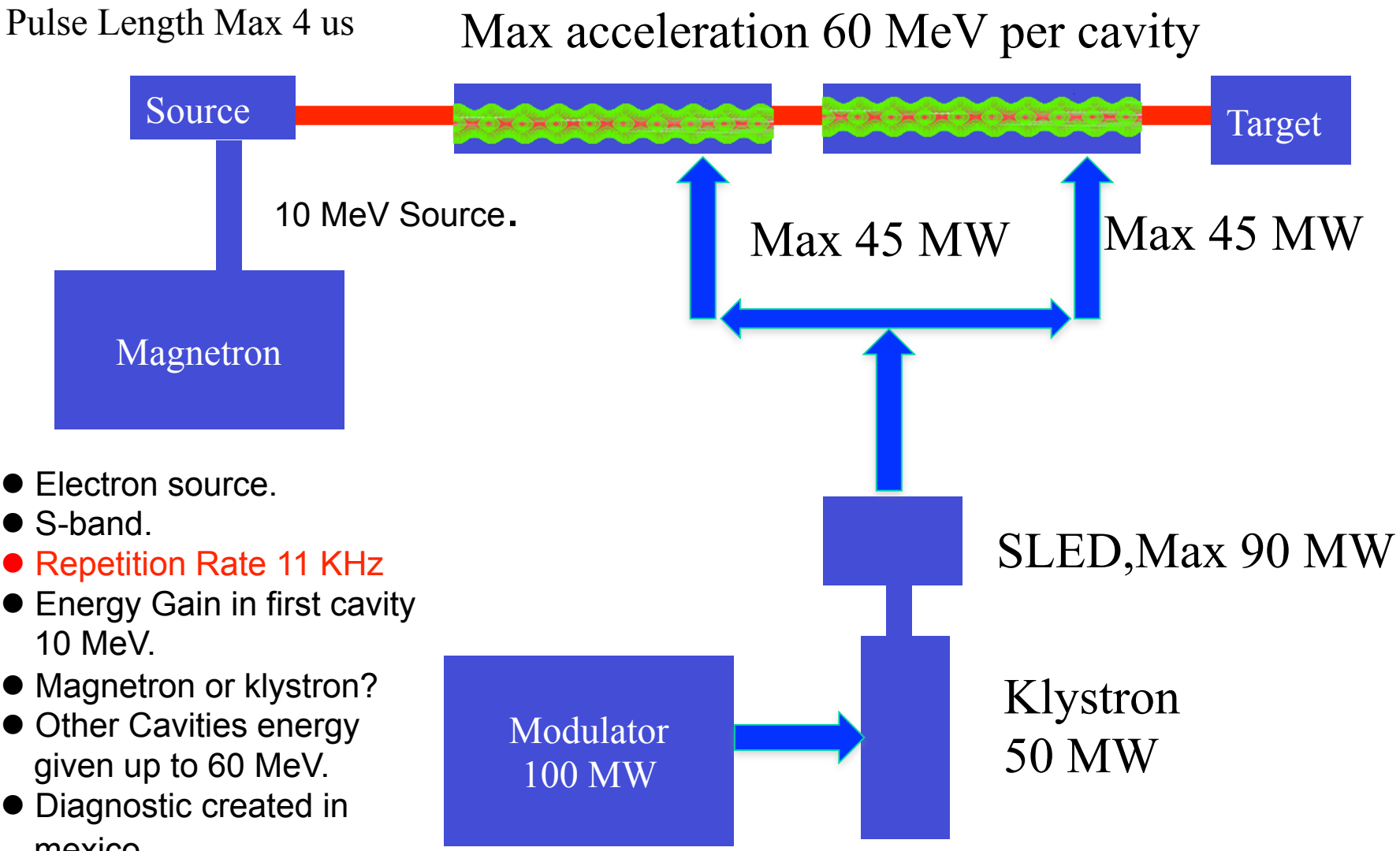
Requires fast switching system

FEL FELIX

Linac Project

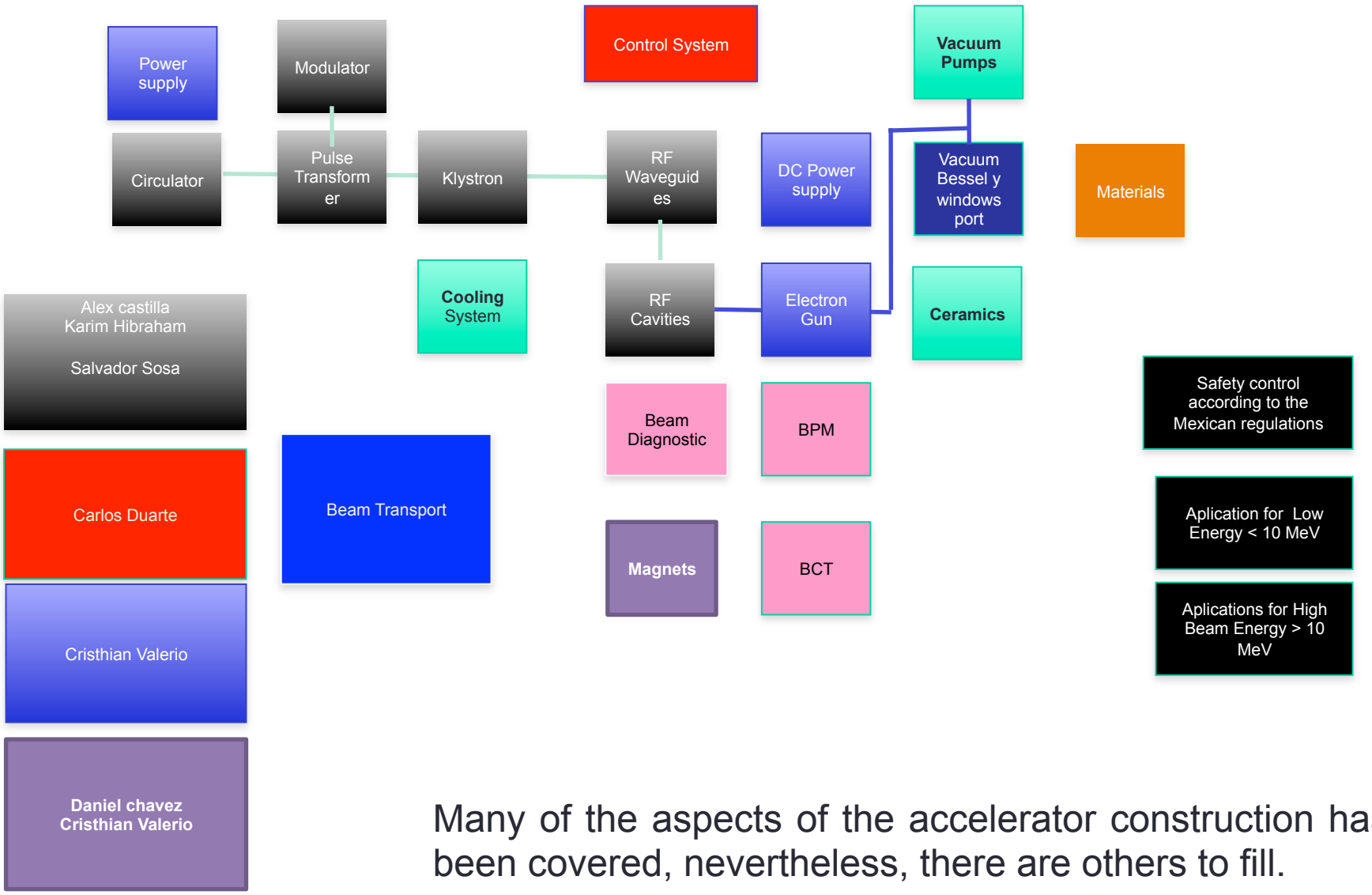
- The first project developed for the CMAP is a electron Linac.
- CMAP will design the accelerator, however, it is necessary the collaboration of several institutes and the high energy particle community among others to achieve this goal.
- The cost of the LINAC can be considerably reduced.

Linac Basic Design



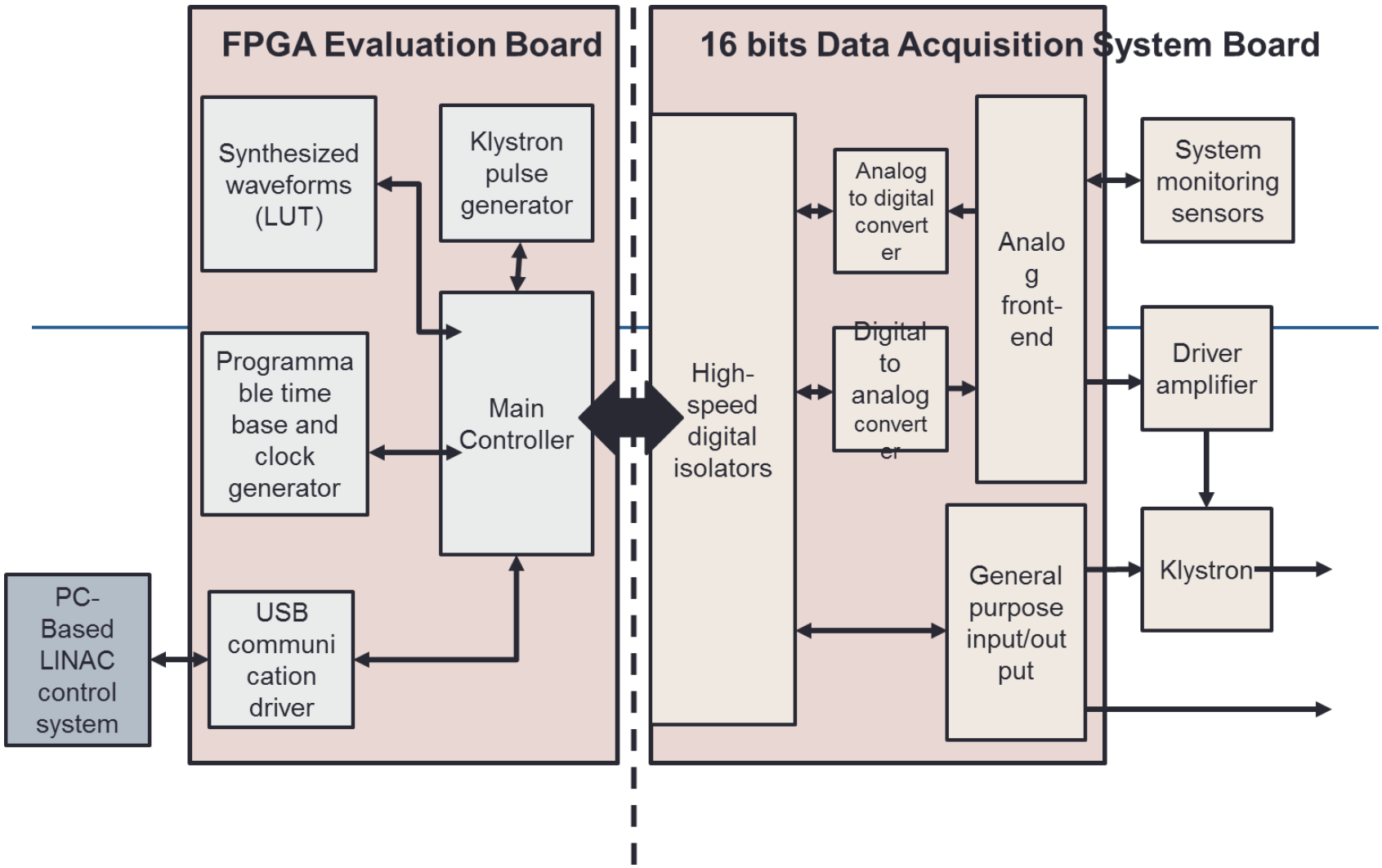
- Electron source.
- S-band.
- Repetition Rate 11 KHz
- Energy Gain in first cavity 10 MeV.
- Magnetron or klystron?
- Other Cavities energy given up to 60 MeV.
- Diagnostic created in mexico

Working Group and Activities

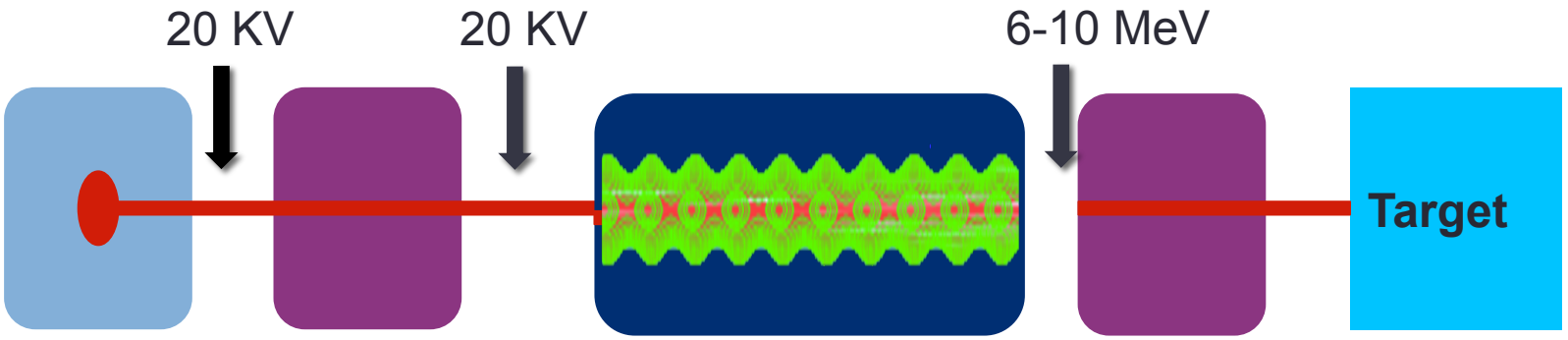


Many of the aspects of the accelerator construction has been covered, nevertheless, there are others to fill.

LINAC CONTROL SYSTEM BY CARLOS DUARTE GALVAN - UNIVERSIDAD DE SINALOA



Linac RF Source



Two operation modes:

- **Electron: Detector calibration and industry process, mini Free electrón Laser, material science.**
- **Gammas: Food Irradiation, radioterapy research, detector calibration,Envioremental aplications.**

Simulating the Source and Linac

A complete in-house simulation is key for:

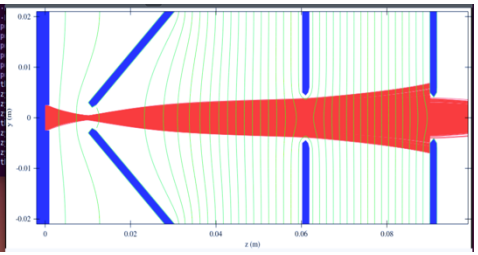
- Understanding the beam formation and development along the LINAC
- Debugging during the commissioning phase and the
- Further developments and improvements

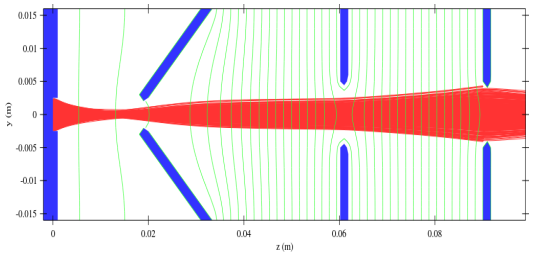
We need:

Accurate description of the source + **speed for optimization**

Ion Beam Simulator, IBSimu **MADX, TRAVEL**

- Accurate Field an particle tracking:



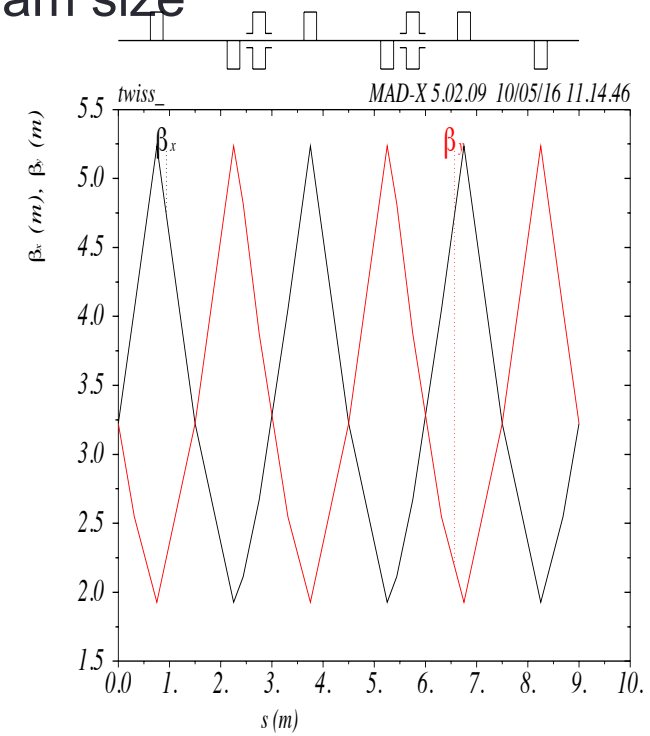


- Much faster
- More efficient for:
  - parameter scans
  - error study
- Compatible with high energy studies

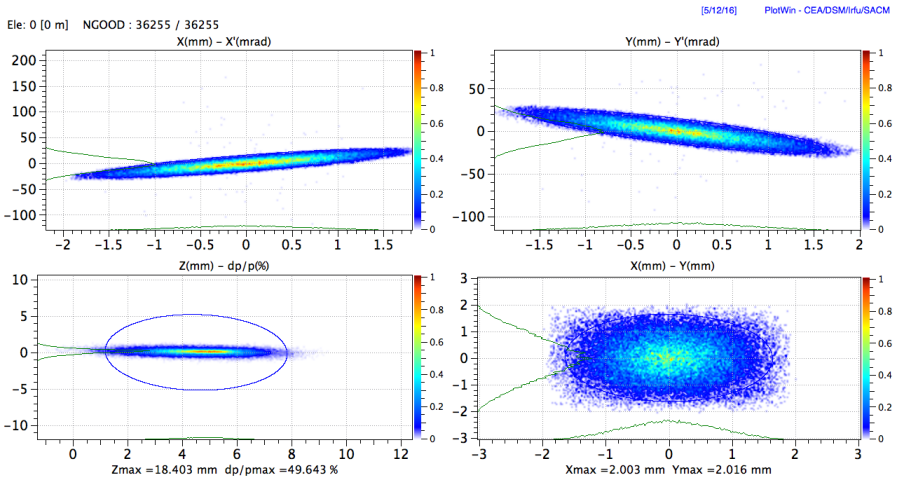
- Finite Elementary Method in 2D/3D
- Space charge
- Versatile: rich C++ library, open source, free, actively developed, CAD import etc.

Linac beam optics

- The beam dynamics determinate the length and form of the Linac.
- Setting constrains such as:
- Maximum Emittance
- Beam current
- Beam size



- MADX simulations



Summary

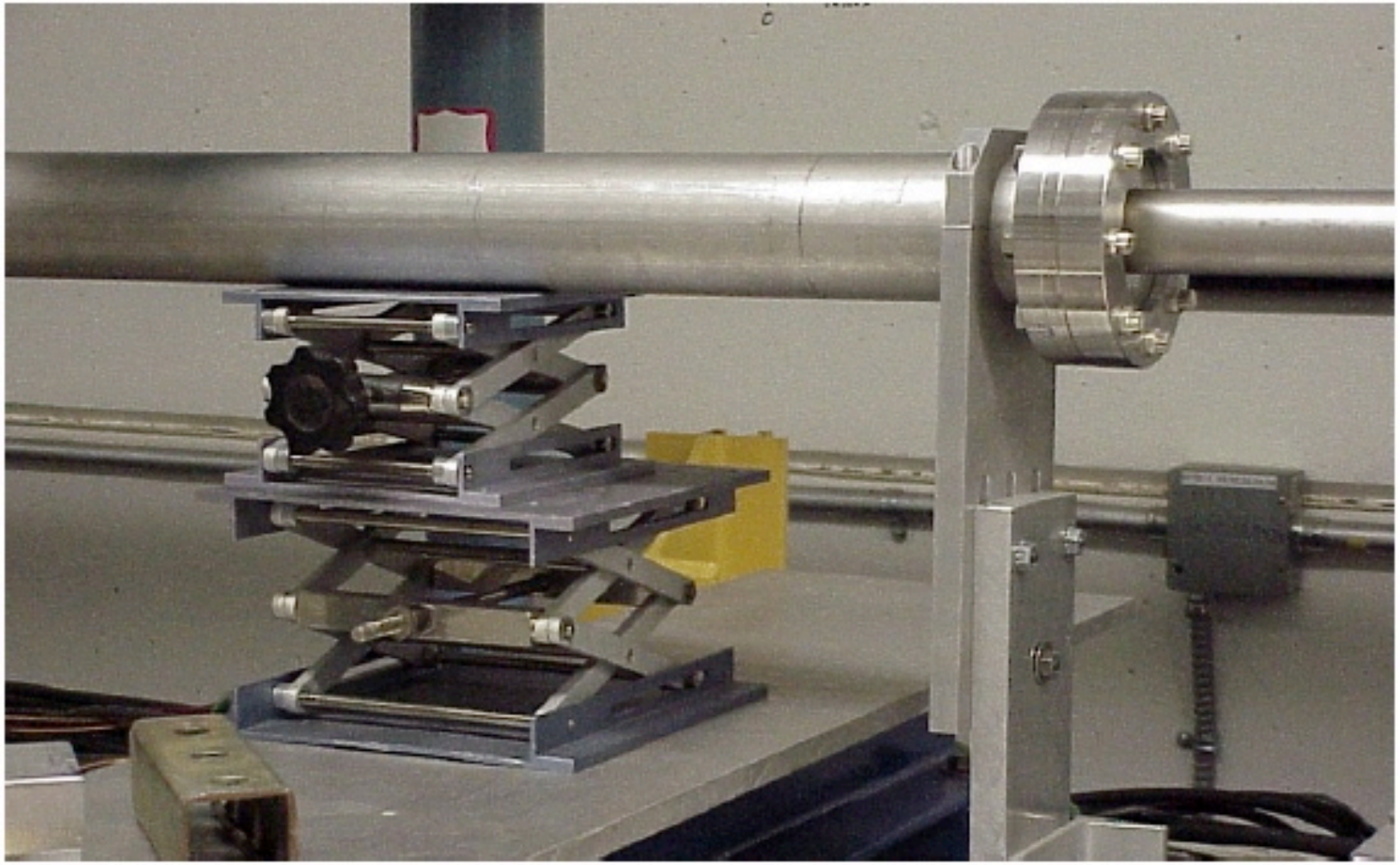
- There are outgoings collaborations related to accelerator physics between international institutes and Mexican universities

- Sinaloa-Cern,LINAC4
- Guanajuato-CERN-JLAB
- Cinvestav-CERN
- UNAM-ALBA

- With the acquired knowledge so far, it is possible to start small projects.
- To collaborate with the industry is necessary to own the technology before start the transfer of technology.

Thank You

If the implementation goes wrong….



Steps For create the Source Design

AutoCad Design

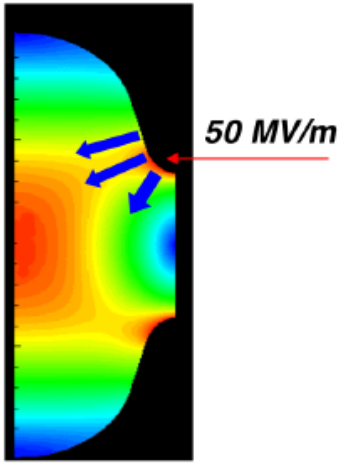
Import The Geometry to program

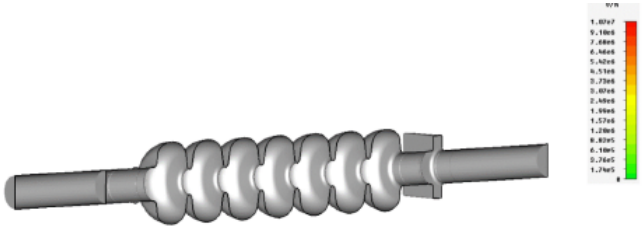
Analyse the Results

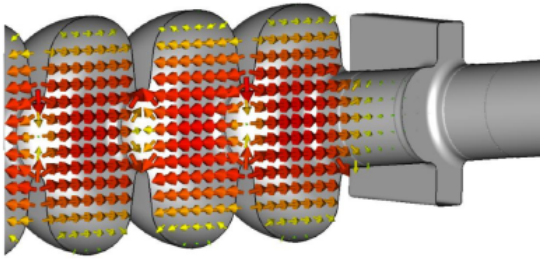
Solving the problems in design and start again

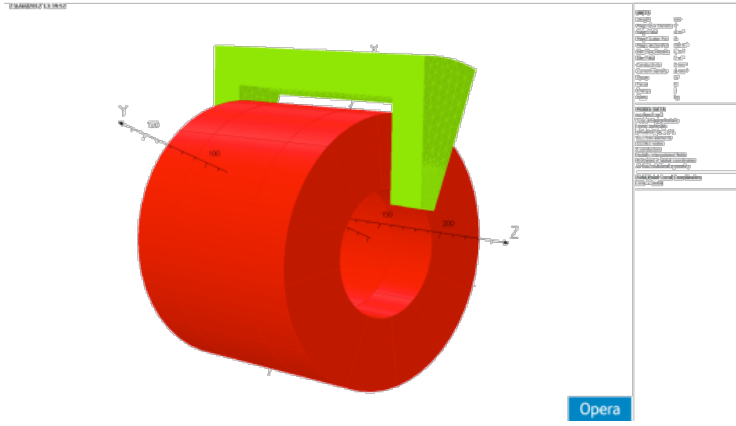
Linac Cavity and Magnets Design

Once the Beam dynamics group Decide the constrains of the Linac other part of Cmap will work in the part of the cavity and magnets design









LINAC CONTROL SYSTEM BY CARLOS DUARTE GALVAN