



# S'Cool LAB

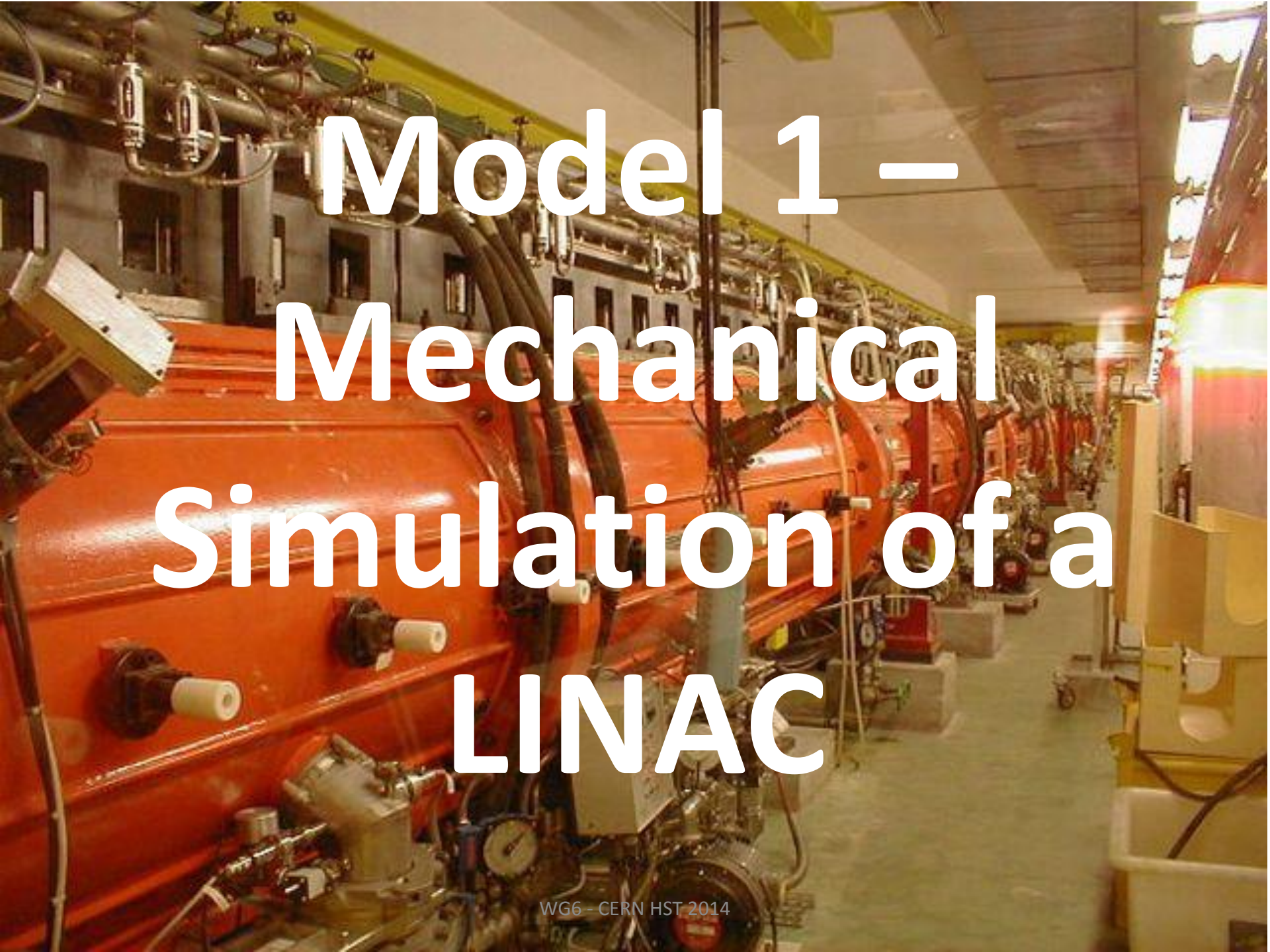
## **New School Experiments and CERN's S'Cool LAB**

WG6@HST 2014

# AIMS

- To bring physical simulations of aspects of particle physics into the classroom
- To be affordable for the majority of schools
- To provide explanations and documentation on the use and limitations of the experimental setups.





# Model 1 – Mechanical Simulation of a LINAC

# Model 2-Electron Accelerator and Quadrupole Magnet



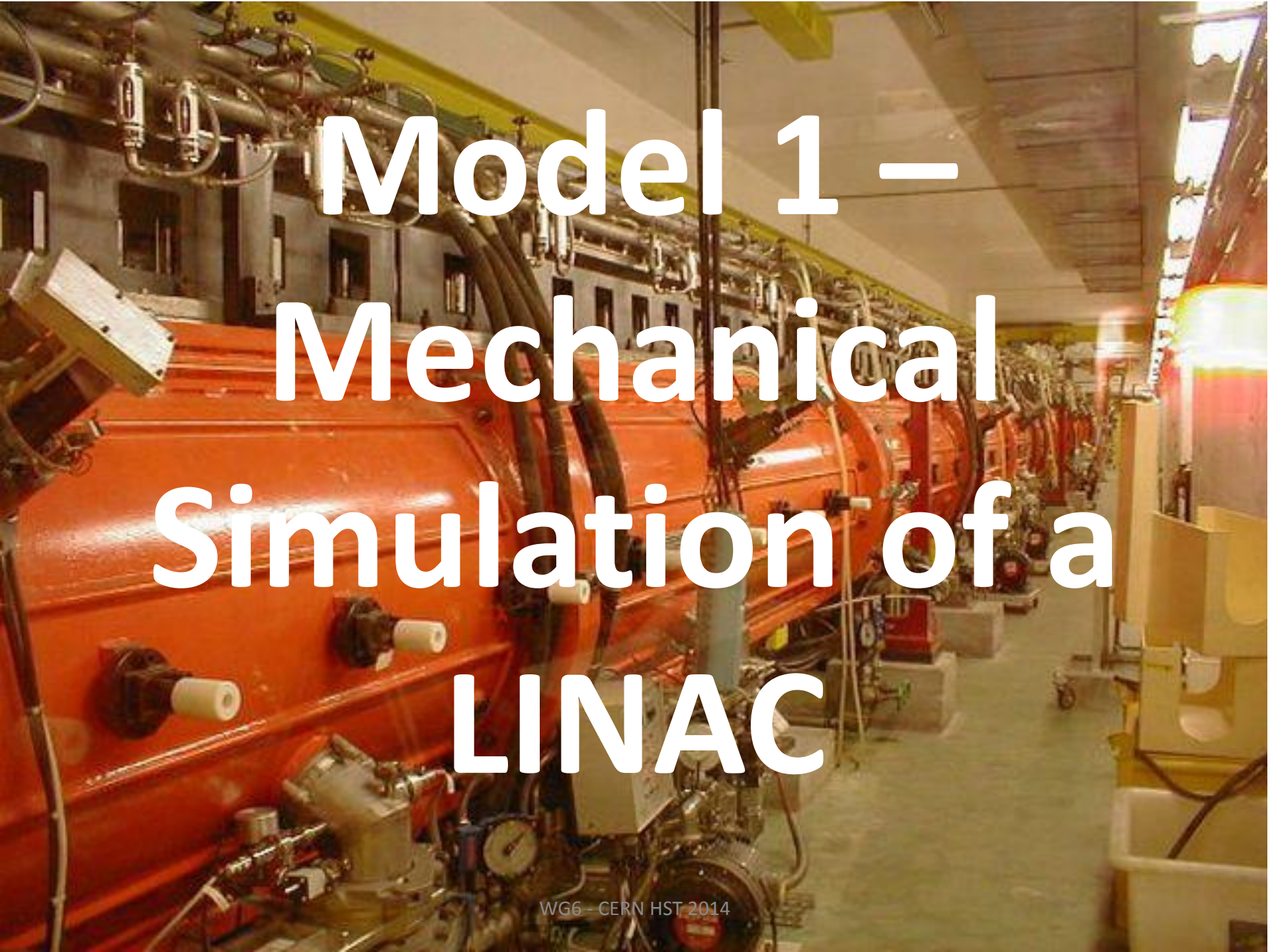
The image shows the interior of the ATLAS detector tunnel. The central feature is a large, circular structure, likely the central detector or the entrance to the interaction region. The tunnel is lined with numerous large, cylindrical components, which are the toroidal magnets, arranged in a repeating pattern. The structure is highly complex, with many layers and components visible. The lighting is bright, highlighting the metallic surfaces and the intricate geometry of the detector. The overall appearance is that of a massive, industrial-scale scientific instrument.

# Model 3 – ATLAS Toroidal Magnets



# S'Cool LAB

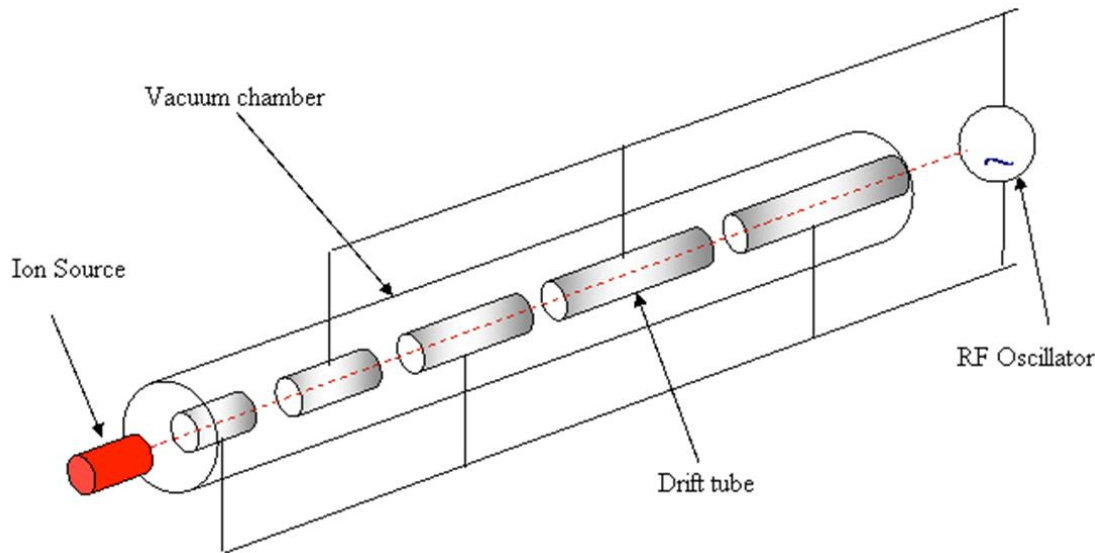
Enjoy playing!



# Model 1 – Mechanical Simulation of a LINAC

# Model 1 – Mechanical Simulation of a LINAC

- Linear accelerators use radiofrequency cavities to accelerate particles.
- The protons pass through the conductors, which are alternately charged positive or negative.
- The conductors behind them push the particles and the conductors ahead of them pull, causing the particles to accelerate.



Video [LINAC](#)



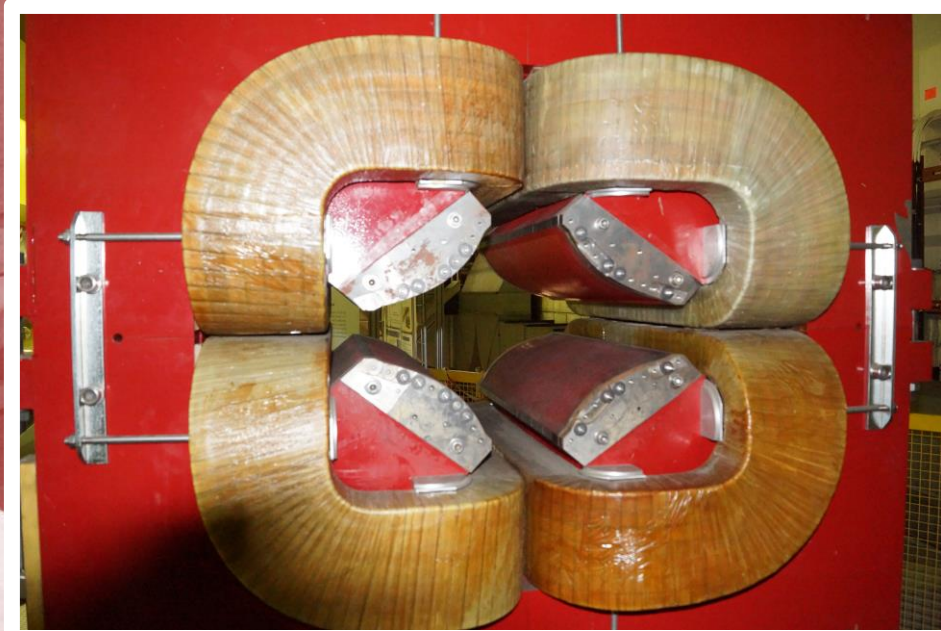
# Model 1 – Mechanical Simulation of a LINAC

## Learning Activity:

- Simulate a LINAC accelerator



# Model 2-Electron LINAC and Quadrupole Magnet



# Model 2-Electron accelerator and Quadrupole Magnet

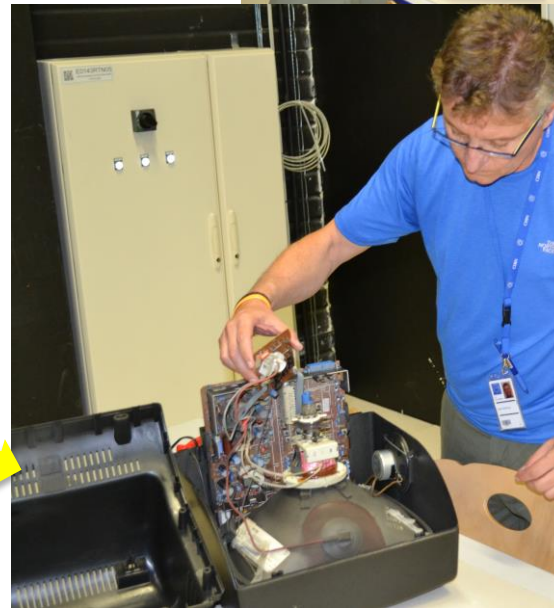
## Learning Activity:

- **Constructing an electron accelerator from a old Cathode Ray Tube TV.**
- **Constructing a quadrupole magnet.**
- **Checking the focusing effect on an electron beam.**

# Model 2-Electron accelerator and Quadrupole Magnet

## How to get an electron accelerator from an old TV

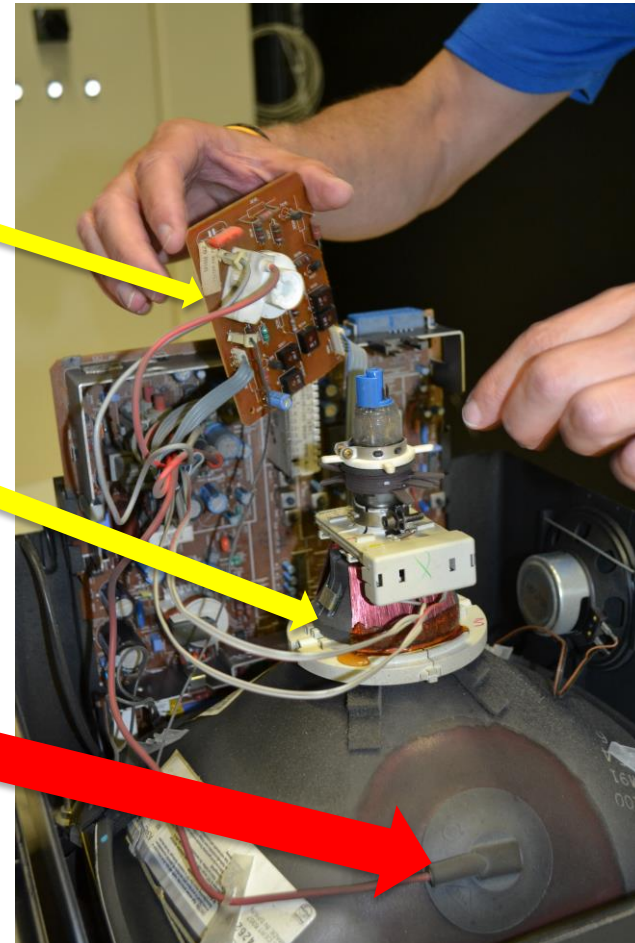
- Get an old TV that works!
- Be sure the TV set is unplugged.
- Take the back case out.



# Model 2-Electron accelerator and Quadrupole Magnet

## How to get an electron ...

- Carefully unplug the emitter feeder (power supply).
- Gently unscrew the focusing magnet.
- Be careful!



# Model 2-Electron accelerator and Quadrupole Magnet

## Focusing the beam...



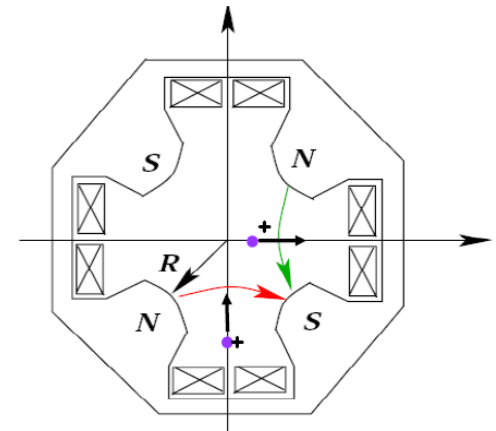
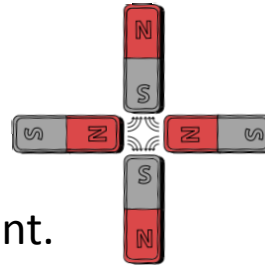
Handmade  
Quadrupole Magnet



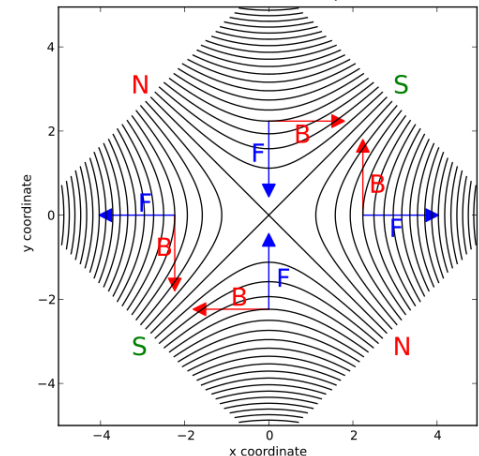
# Model 2-Electron accelerator and Quadrupole Magnet

## How a quadrupole works:

- Quadrupole: 4 magnets in square arrangement.
- A first quadrupole focuses the beam by squeezing it into a smaller elliptical cross-section, similar to the effect of a lens focusing light.
- A second one squeezes the beam in a perpendicular direction related to the first one so the packets become round.



Source: Aceleradores em Física de Partículas.2008, Luís Peralta



[http://en.wikipedia.org/wiki/Quadrupole\\_magnet](http://en.wikipedia.org/wiki/Quadrupole_magnet)

[Video](#)

[LHC  
Game](#)



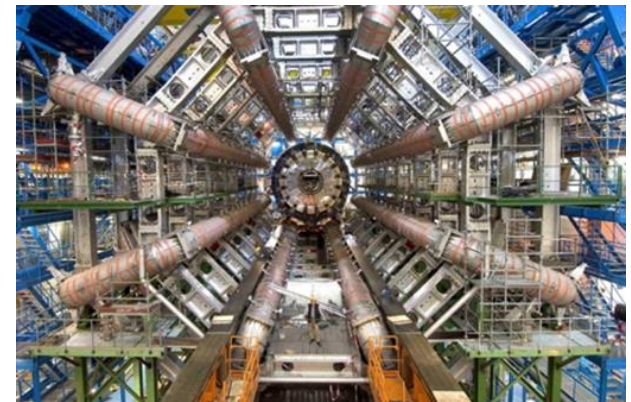
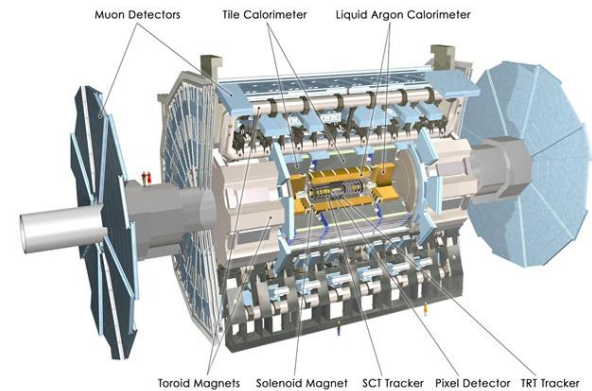
# Model 3 – ATLAS Toroidal Magnets



# Model 3 – ATLAS Toroidal Magnets

## Barrel Toroidal Magnet:

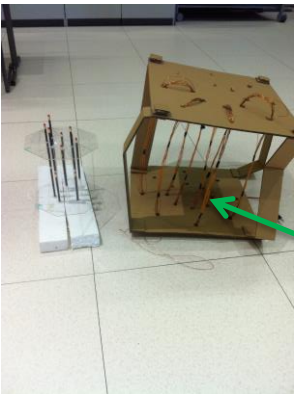
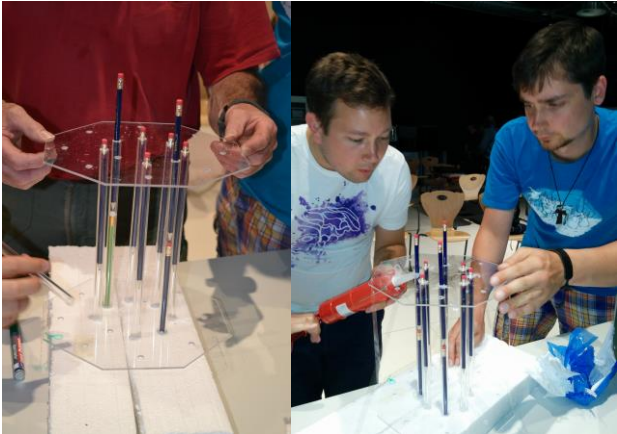
- 8 coils assembled radially every 45 degrees around center.
- The inner detector and muon spectrometer are placed in a magnetic field for the measurement of the momentum of charged particles.
- This magnetic field causes a bending of the particle beam, with a radius of curvature dependent on the momentum value.



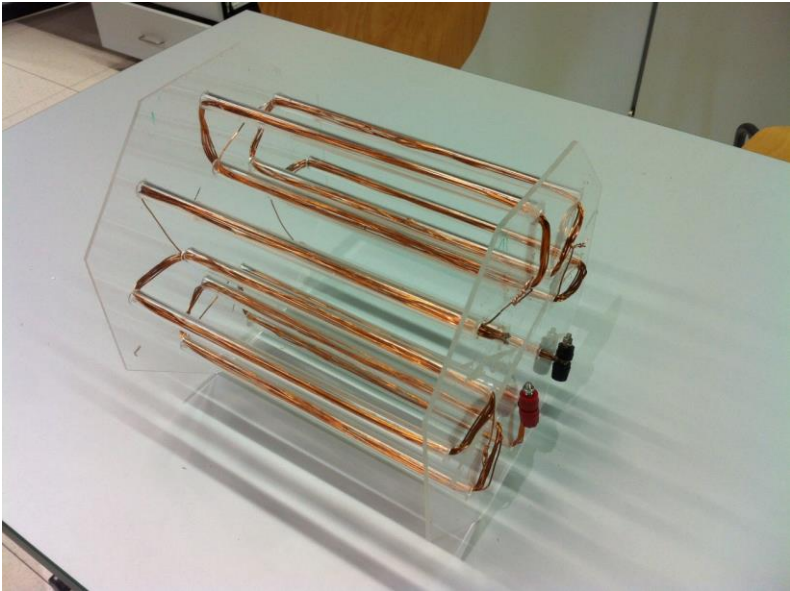
# Model 3 – ATLAS Toroidal Magnets

## Learning Activity:

## Simulate an Toroidal Magnet field



**First  
prototype**



# Model 3 – ATLAS Toroidal Magnets

CERN HST 2014  
 ATLAS TOROIDAL  
 MAGNET - DIY TEMPLATE

Juba Wanie

Basa Istiaq

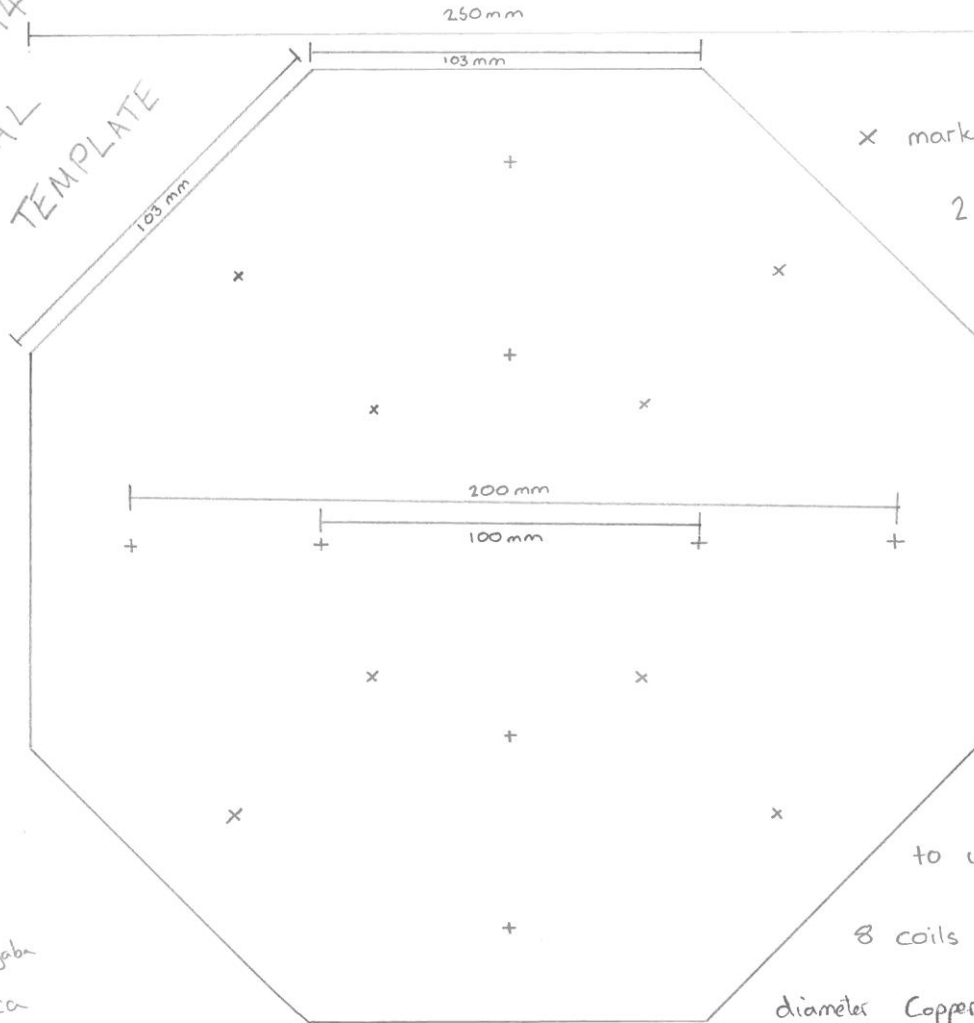
Ed Wright



Jeremy Taylor

Therese Maniragoba

Paulo Fonseca



x marks an 8mm diameter hole

2 End Plates need to be cut

They should be separated

by 16 x 250 mm tubes

The tubes can be

held in place by the

tension on the wire

and do not need

to be fixed prior

to winding. We used

8 coils per loop of 1mm

diameter Copper wire (38.4m).



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- [http://en.wikipedia.org/wiki/Quadrupole\\_magnet](http://en.wikipedia.org/wiki/Quadrupole_magnet).
- <http://home.web.cern.ch/about/accelerators/linear-accelerator-2>.