

# Big Data, Big networks, Better Scientific Collaborations

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**Abstract.** Big Data is exploding in these days in all fields of human activities, especially in physics research performed in multinational big collaborations, which demand big data and big networks technologies to operate. This is the case of MINERvA Collaboration (<http://minerva.fnal.gov>) –among others like K2K (<http://neutrino.kek.jp/member.html>), ATLAS ( <http://www.atlas.ch/>)- which involves 7 countries (including Mexico and USA), 22 institutions (including Universidad de Guanajuato and Fermilab) and about 100 physicists. **Physicists are collecting neutrino-nucleus data with MINERvA detector since 2010; at the end of the run, 2016, MINERvA will collect about 150 TB of raw unformatted data, and will require about 600 TB of Monte Carlo unformatted data. MINERvA collaboration details, challenges on big data and big network technologies will be presented.**

# Introduction

## MINERvA Collaboration

## Universidad de Guanajuato and MINERvA collaboration

## Conclusions

## References

# Introduction

Big data concept.



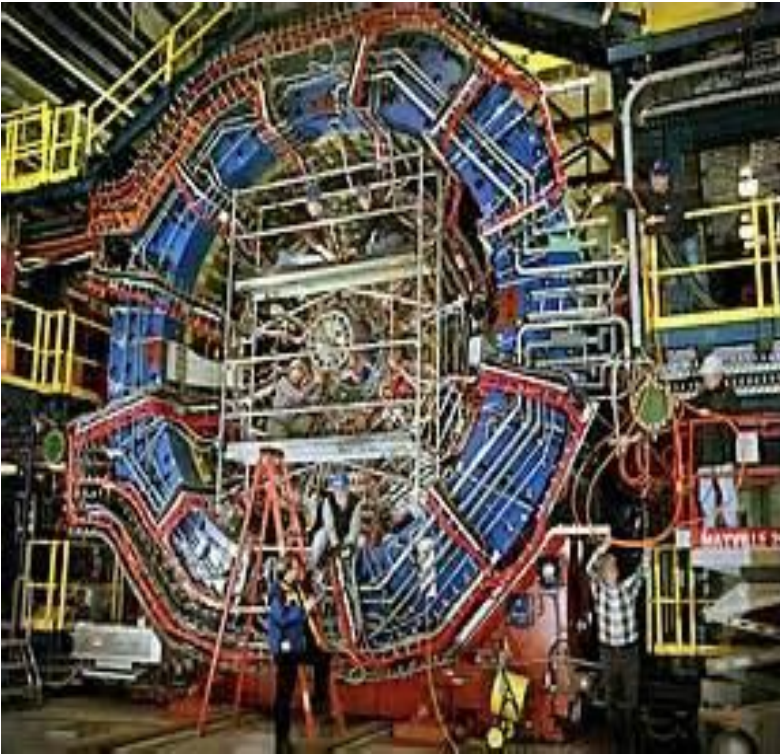


# Big data in all fields of human activity.

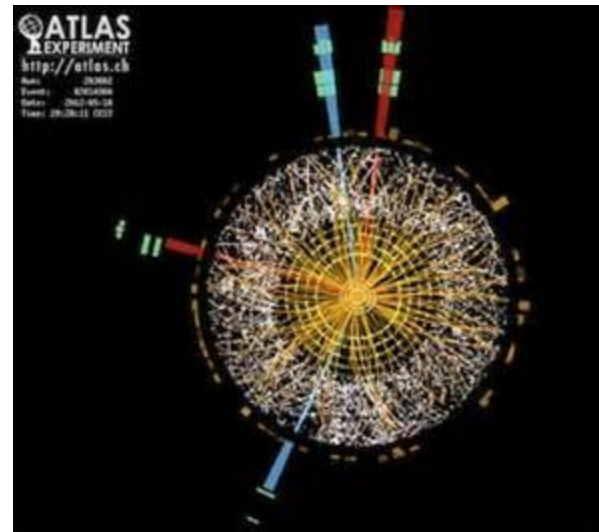








## High energy physics, as a particular case.





# MINERvA Collaboration

~80 collaborators from particle and nuclear physics

Centro Brasileiro de Pesquisas Físicas

University of Florida

Universidad de Guanajuato

Inst. Nucl. Reas. Moscow

Northwestern University

Otterbein University Pontificia Universidad Catolica del Peru

University of Pittsburgh

Rutgers University

University of California at Irvine

University of Minnesota at Duluth

Universidad Nacional de Ingeniería

Universidad Técnica Federico Santa María

College of William and Mary

Fermilab

Université de Genève

Hampton University

Mass. Col. Lib. Arts

University of Chicago

University of Rochester

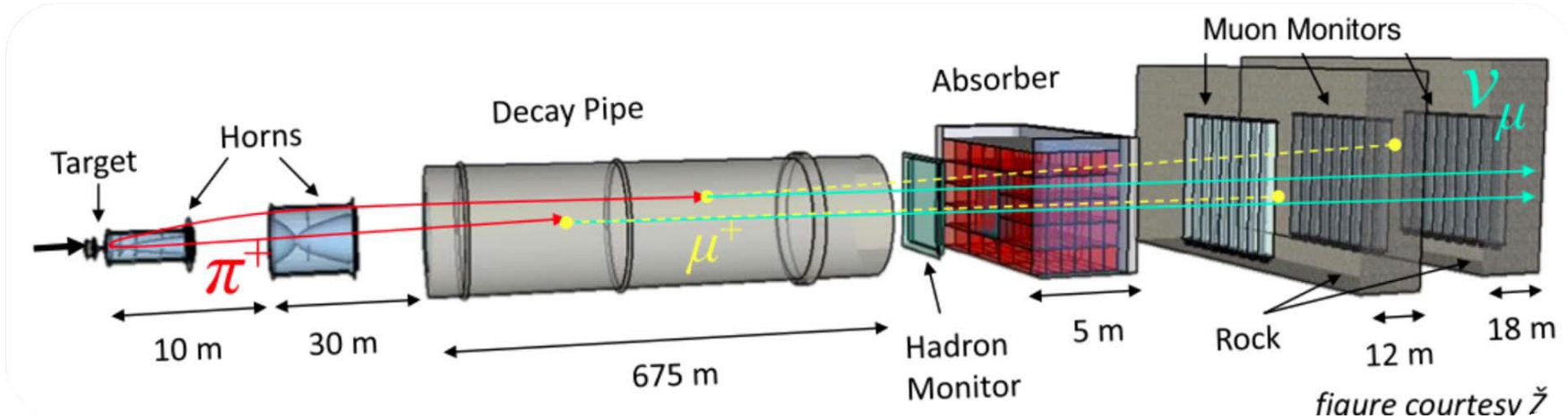
Tufts University



4/22/2015

Big Data, Big Networks. Puerto Vallarta,  
Mexico

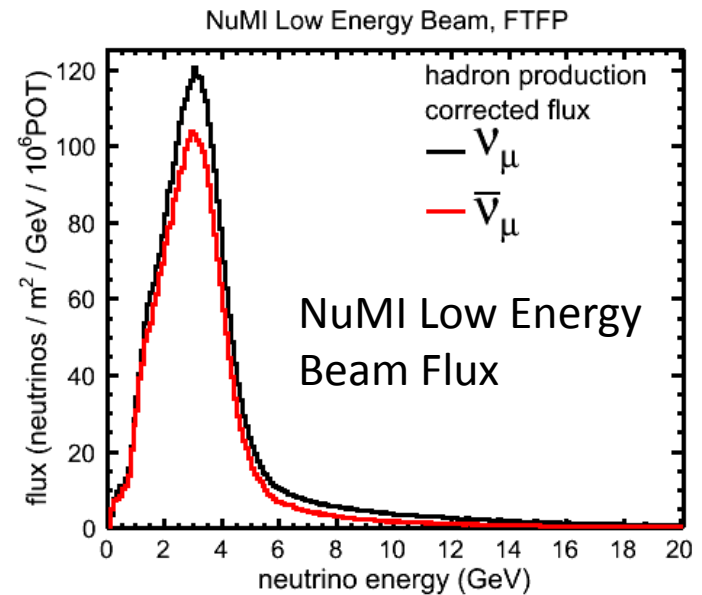
# NuMI Beam (~same for MINOS, NOvA)



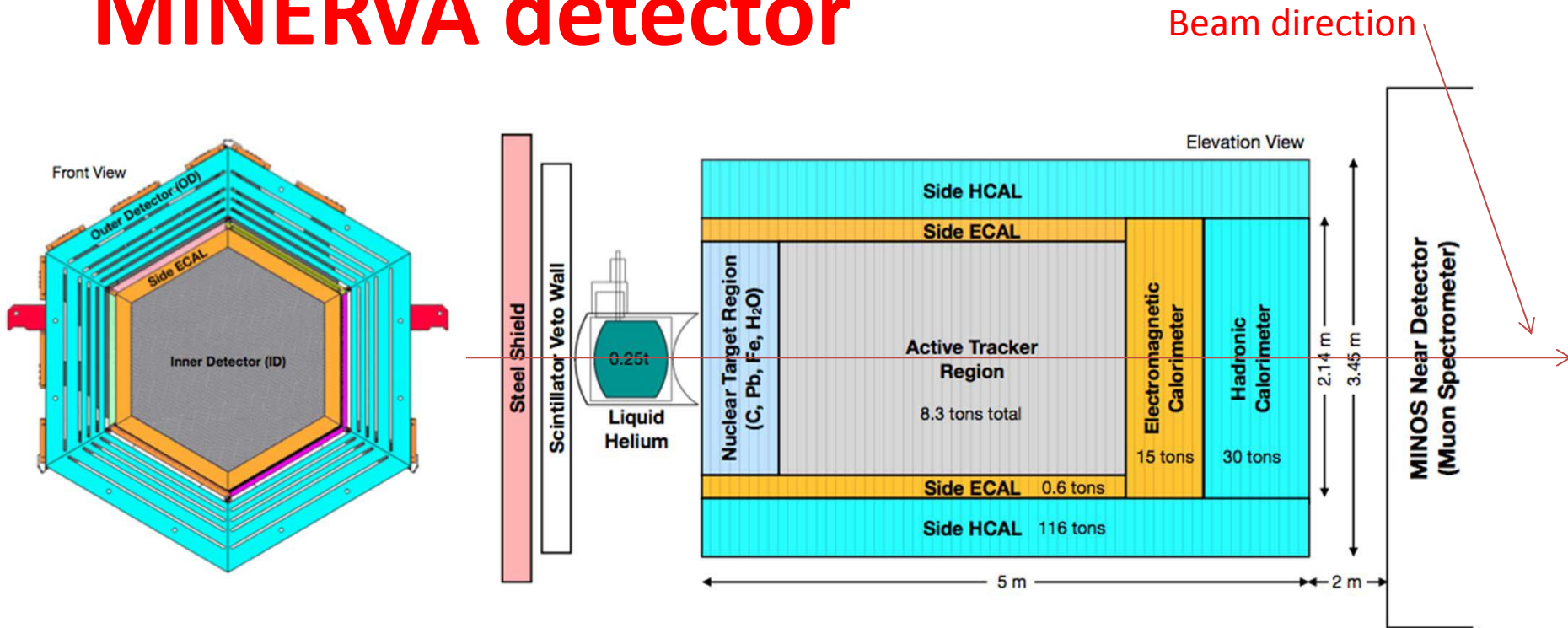
NuMI is a “conventional” neutrino beam, neutrinos from focused pions.

For MINERvA, flux must be calculated, use hadron production data.

Protons on target (POT) to MINERvA,  
 --neutrino (LE): 3.9E20 POT.  
 --anti-neutrino (LE): 1.0E20 POT.



# MINERvA detector



Detector comprised of **120 “modules”** stacked along the beam direction.

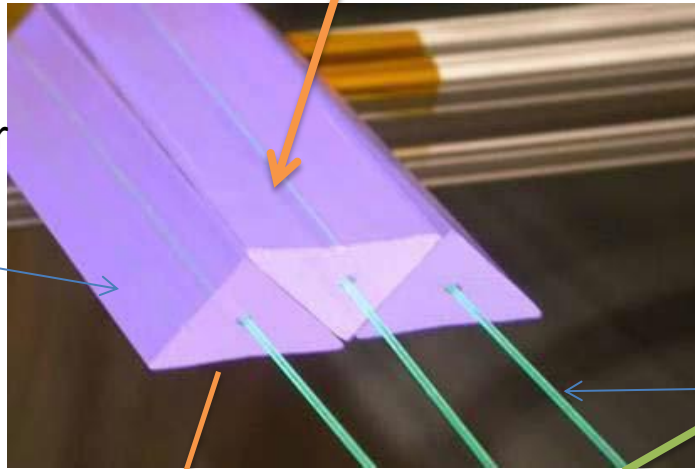
Central region is **finely segmented scintillator tracker**.

~32k plastic scintillator strip channels total.

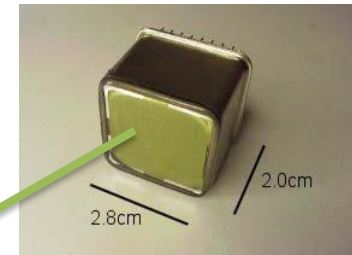
# Detector Technology.

## Scintillator planes in 3 orientations.

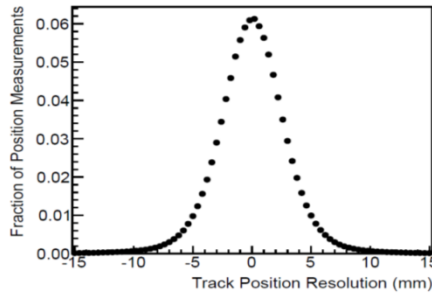
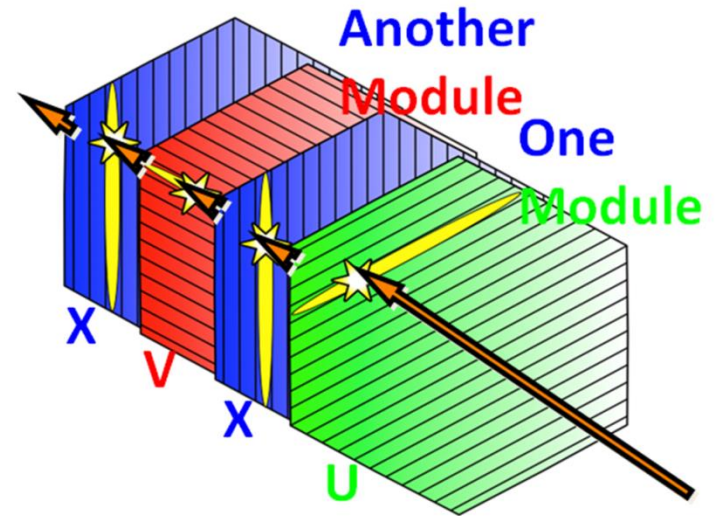
Scintillator strip



64 channel multi-anode PMT



Wavelength shifting fiber



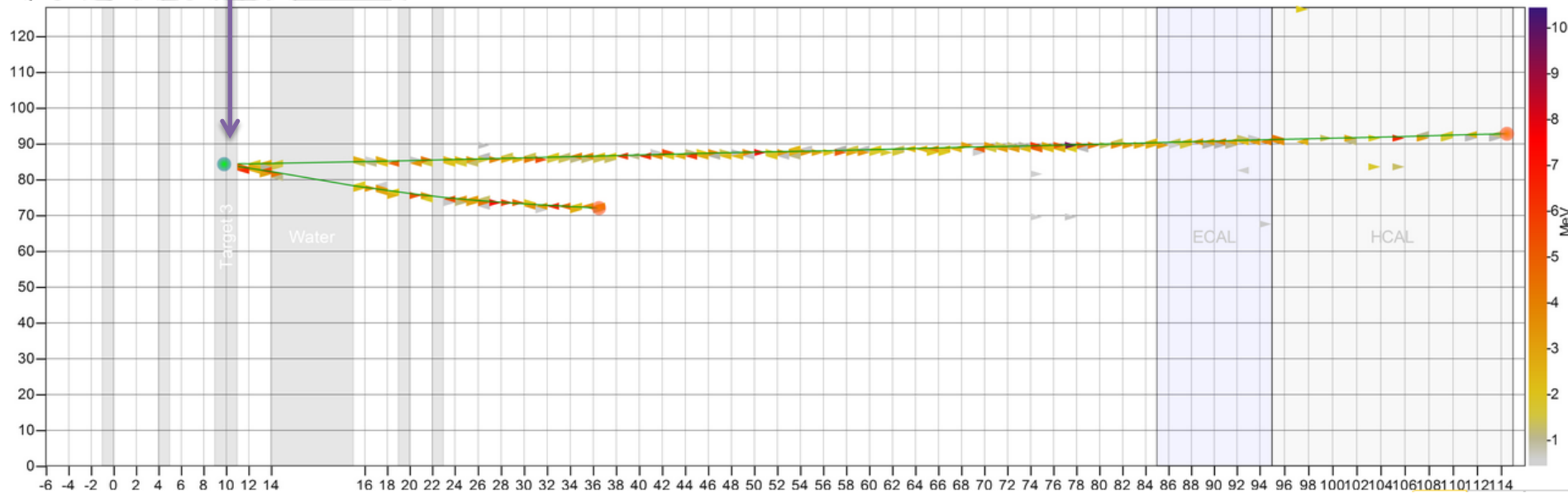
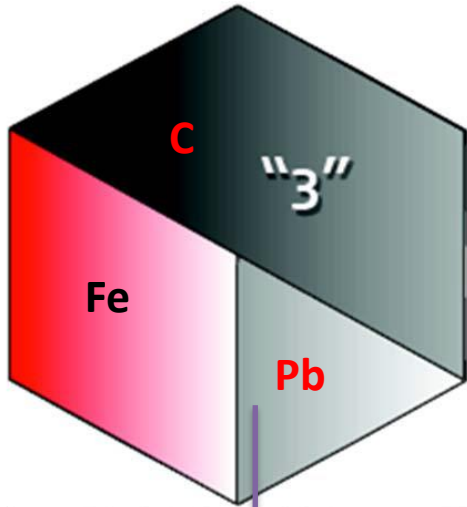


**There are 38 000 channels to collect information from neutrino nucleons interactions.**

**Collect about 150 TB of raw data.**

**Create about 600 TB of Monte Carlo data from simulations of neutrino nucleons interactions inside MINERvA detector.**

# 2-track event from Pb target.





# Data processing,



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**challenges.**



**physics results, mention neutrino communication as a special one with the potential of changing the humankind telecommunication history.**

Each analysis follows a particular procedure, depending on the particular physics topic.

**“neutrino communications”- MPLA Vol. 27, No. 12 (2012). 0.1 Hz, 1% bit error rate. One of top 10 physics results – Physics World – 2012.**

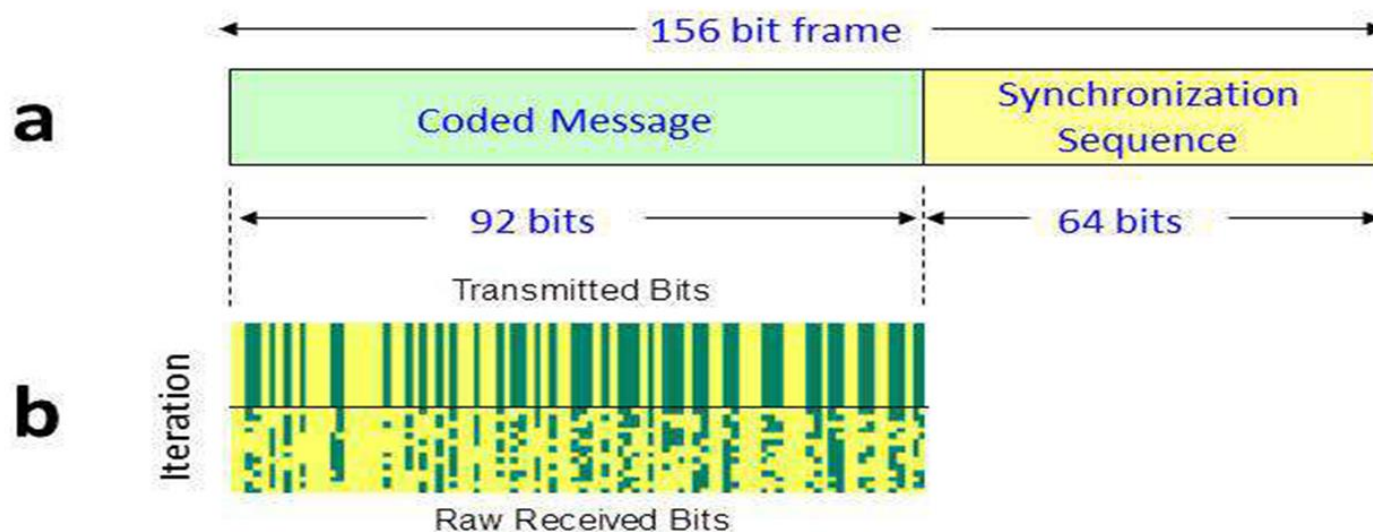
**This Demonstration is analogous of Marconi 1903 experiment.**

**MINERvA experiment proved the possibility of sending messages using neutrino beams.**

**The demonstration is based on the establishment of a low rate ( $0.100 \pm 0.001$  bit/s) communication link using the NuMI beam line and the MINERvA detector at Fermilab, over a distance of 1035 m, including 240 m of earth.**

This is a land mark in the history of humankind communication; for the first time, humanity uses weak force to send messages.

# NEUTRINO



# Universidad de Guanajuato and MINERvA collaboration

**Elementary Particles Laboratory  
(El laboratorio de partículas elementales).  
Describe it.**

<http://laboratoriodeparticulaselementales.blogspot.mx/>

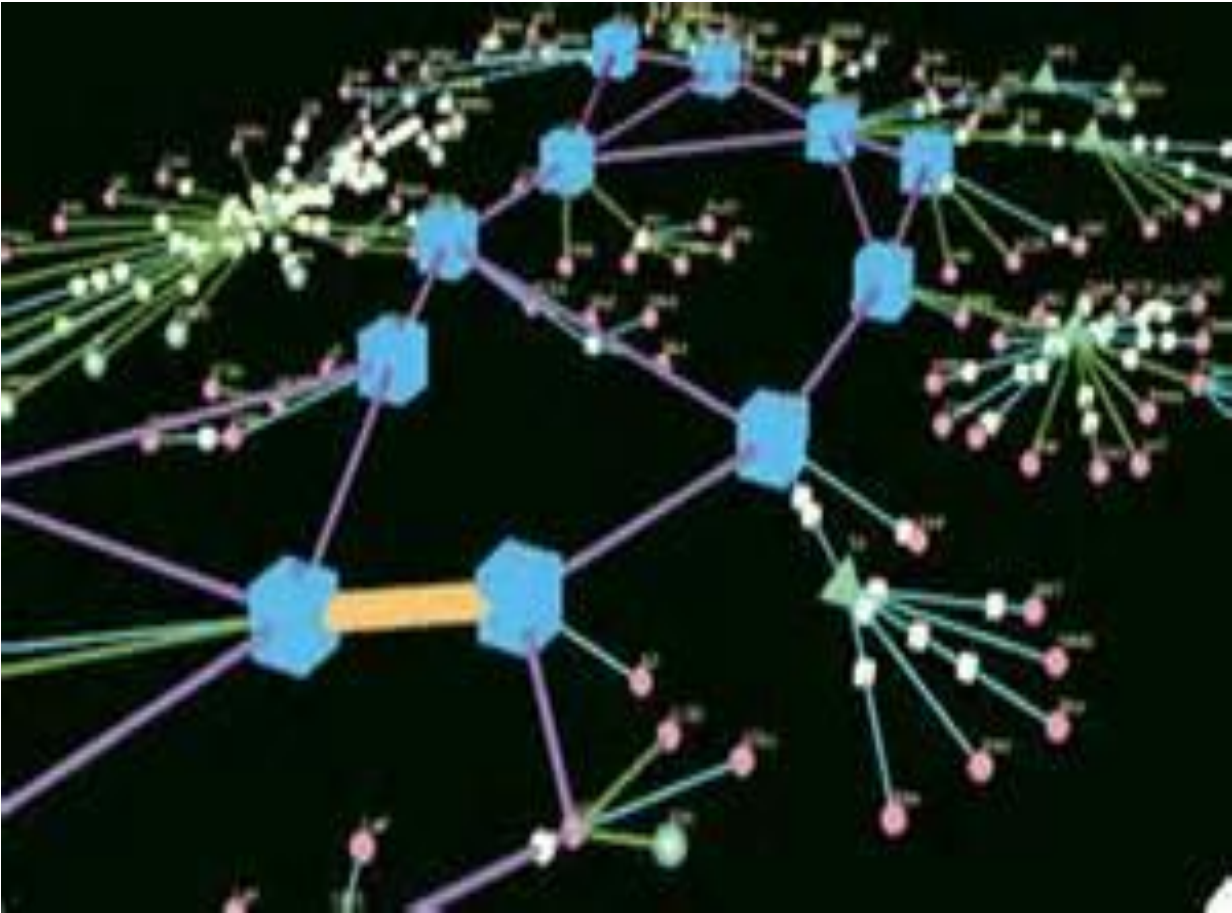
**Main projects.  
Development of cosmic ray detectors,  
Mini particle accelerator,  
radiation detector, and  
MINERvA collaboration.**

**Necessity of computational technology,  
storage,  
communication,  
data taking,  
data curing,  
transferring,  
processing,  
analyzing,  
mining,  
experts.**



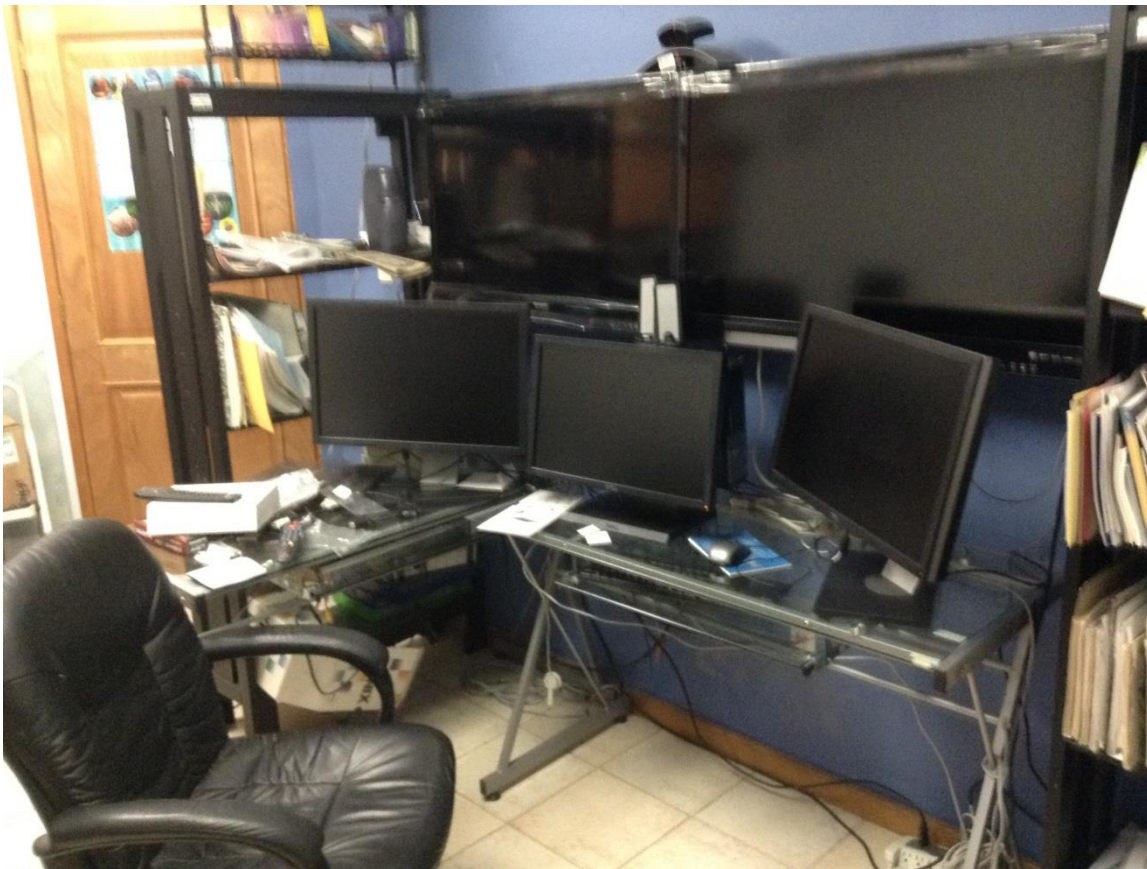


# Grid between León and Guanajuato campus.



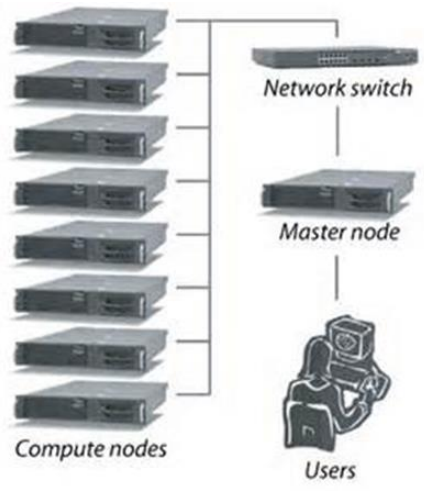
# High speed connection with USA laboratories (Fermilab). Center of control Universidad de Guanajuato-MINERvA Collaboration.

Universidad de Guanajuato could control MINERvA detector from Guanajuato (3500 km away).



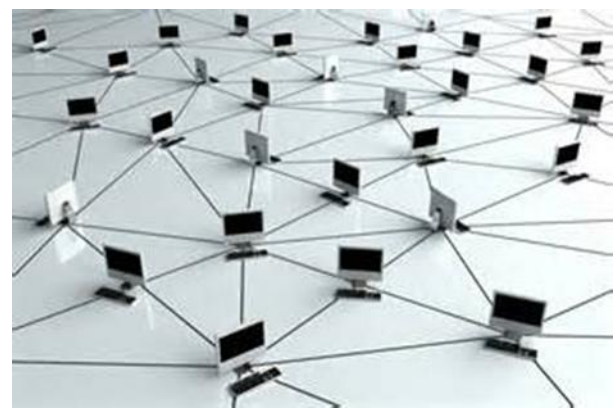
# Solutions and local efforts.

## Experts in HPC,



Source: ILRI High Performance Computing

## big data,



## big networks.

# Conclusions

Big data, big networks, big collaborations between Mexico and USA are already around.

Universidad de Guanajuato (laboratorio de partículas elementales) and Fermilab (MINERvA collaboration) collaborate in High Energy Physics.

It is necessary improve computational capabilities of laboratorio de partículas elementales, big data, big networks, and human training, in particular, and in Universidad de Guanajuato and Mexico in general.

We will have better collaborations across both nations, in reciprocal benefice of Mexico and USA, improving big networks. In speed, the speed of light is the limit; in capacity, probably there is a natural limit, but we do not know yet.

# References

[1] [http://books.google.es/books?id=HpHcGAKFEjkC&printsec=frontcover&hl=es&source=gbs\\_ge\\_summary\\_r&cad=0#v=onepage&q&f=false](http://books.google.es/books?id=HpHcGAKFEjkC&printsec=frontcover&hl=es&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false)

[2] [http://en.wikipedia.org/wiki/Big\\_data](http://en.wikipedia.org/wiki/Big_data)

[3] Executive Office of the President (March 2012). "Big Data Across the Federal Government". White House, 26 September 2012.

[4] Graham M. (9 March 2012). "Big data and the end of theory?". The Guardian (London).

[5] Hilbert, Martin; López, Priscila (2011). "The World's Technological Capacity to Store, Communicate, and Compute Information". *Science* 332 (6025): 60–65. doi:10.1126/science.1200970. PMID 21310967.

# Thank you