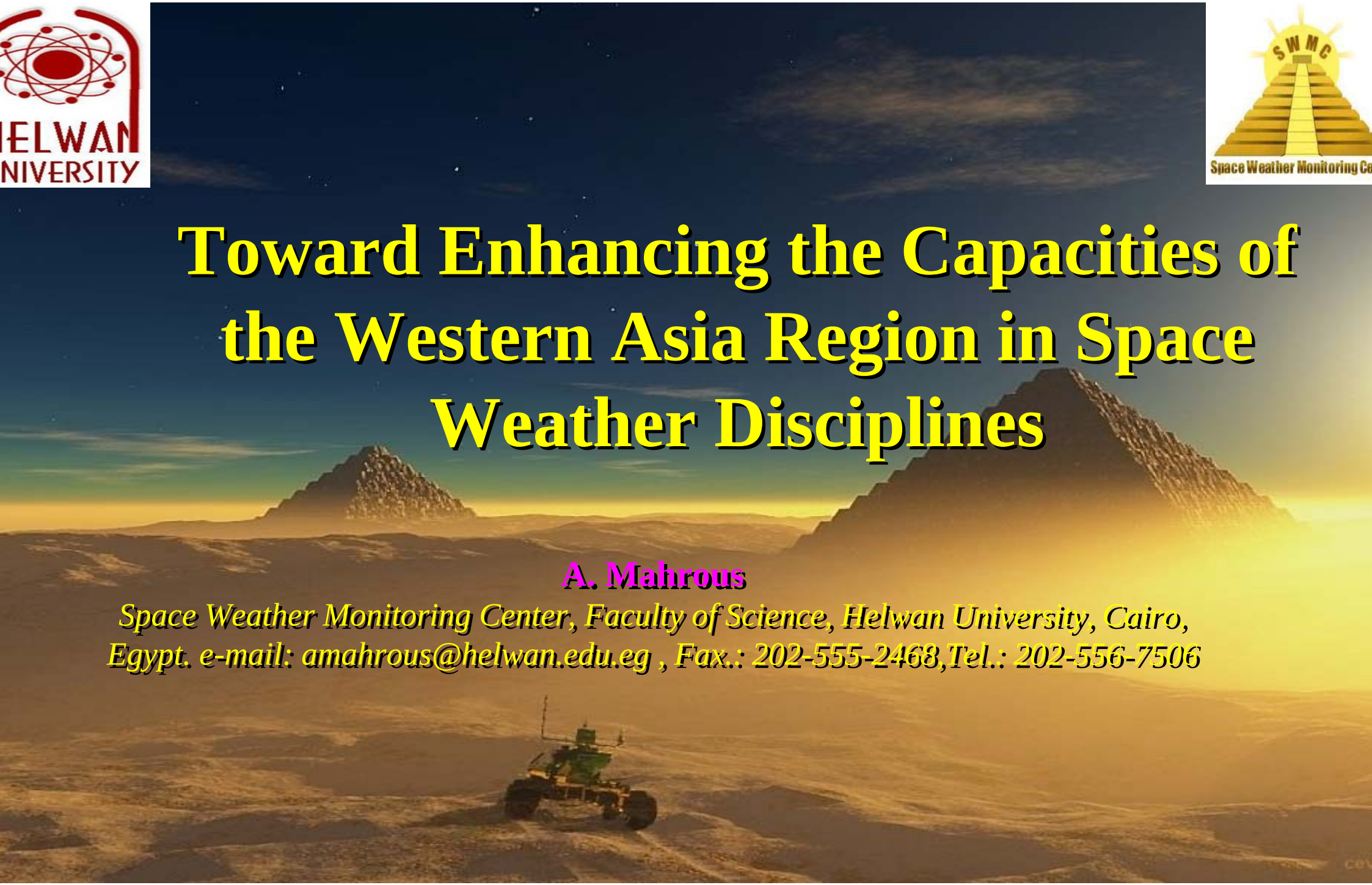


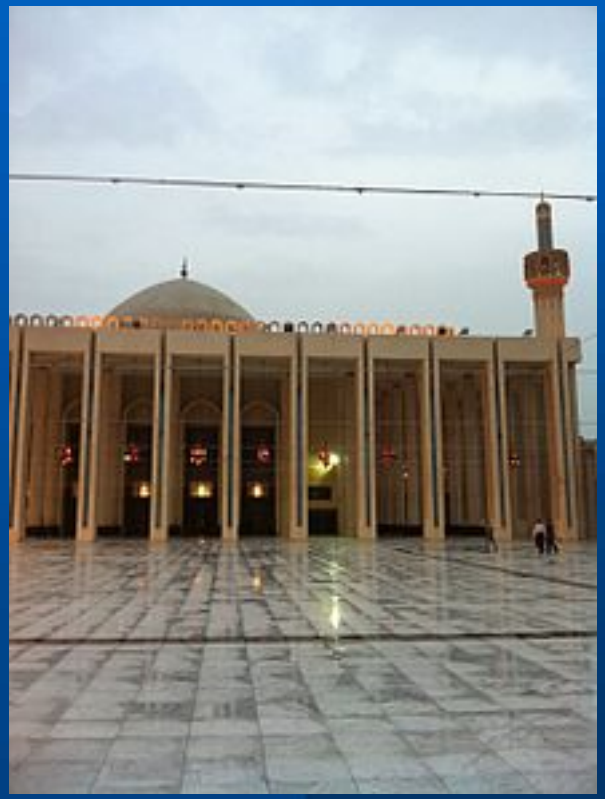
# Toward Enhancing the Capacities of the Western Asia Region in Space Weather Disciplines

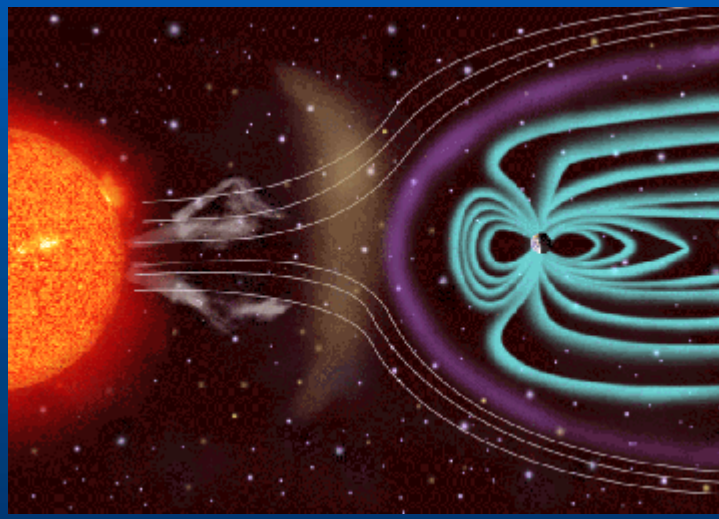
**A. Mahrous**

*Space Weather Monitoring Center, Faculty of Science, Helwan University, Cairo, Egypt. e-mail: amahrous@helwan.edu.eg , Fax.: 202-555-2468,Tel.: 202-556-7506*

# Western Asia

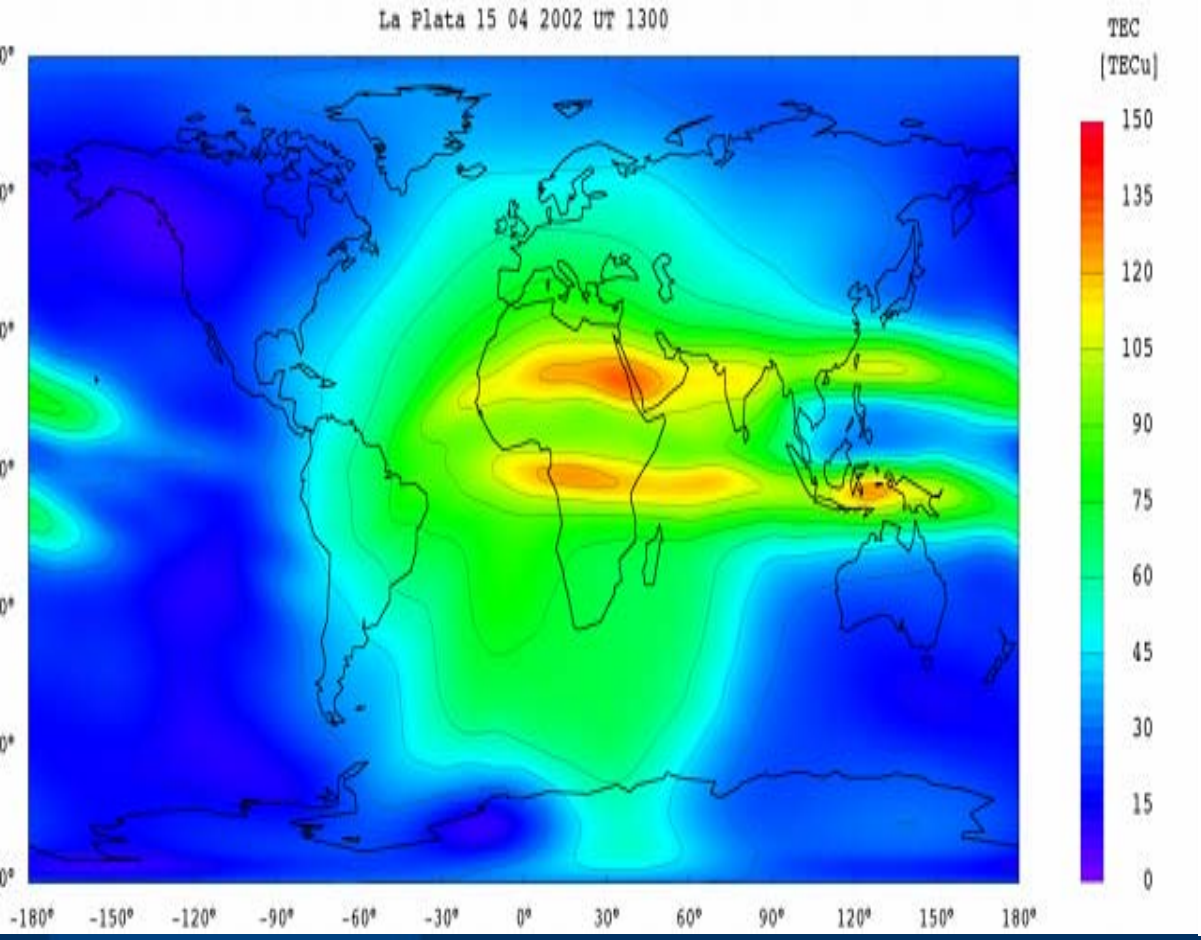

# Western Asia





# Why this area is interesting to SW community ?

# It is located near the Equatorial Anomaly region



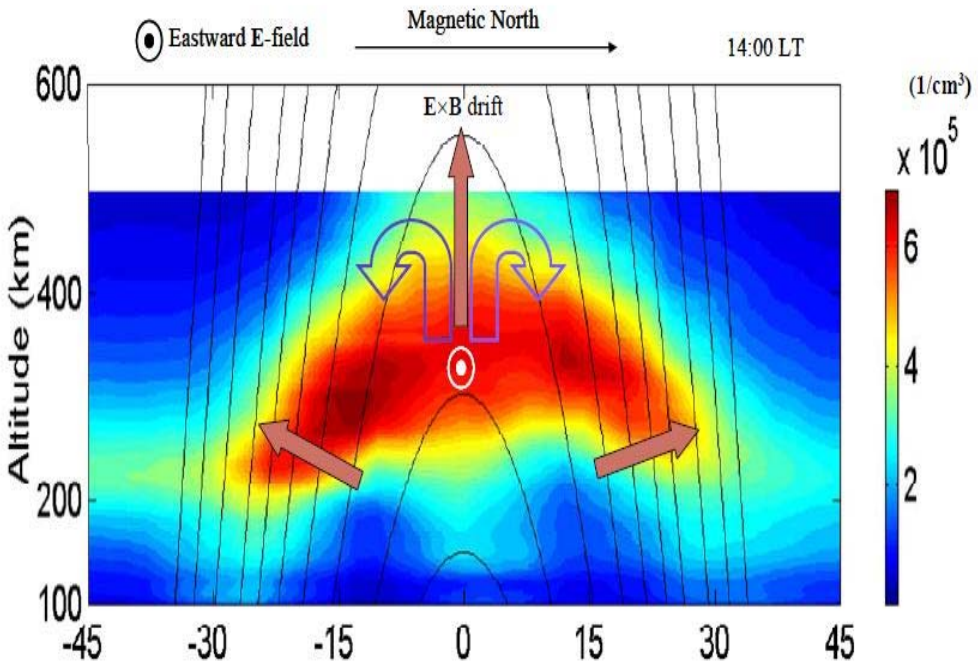
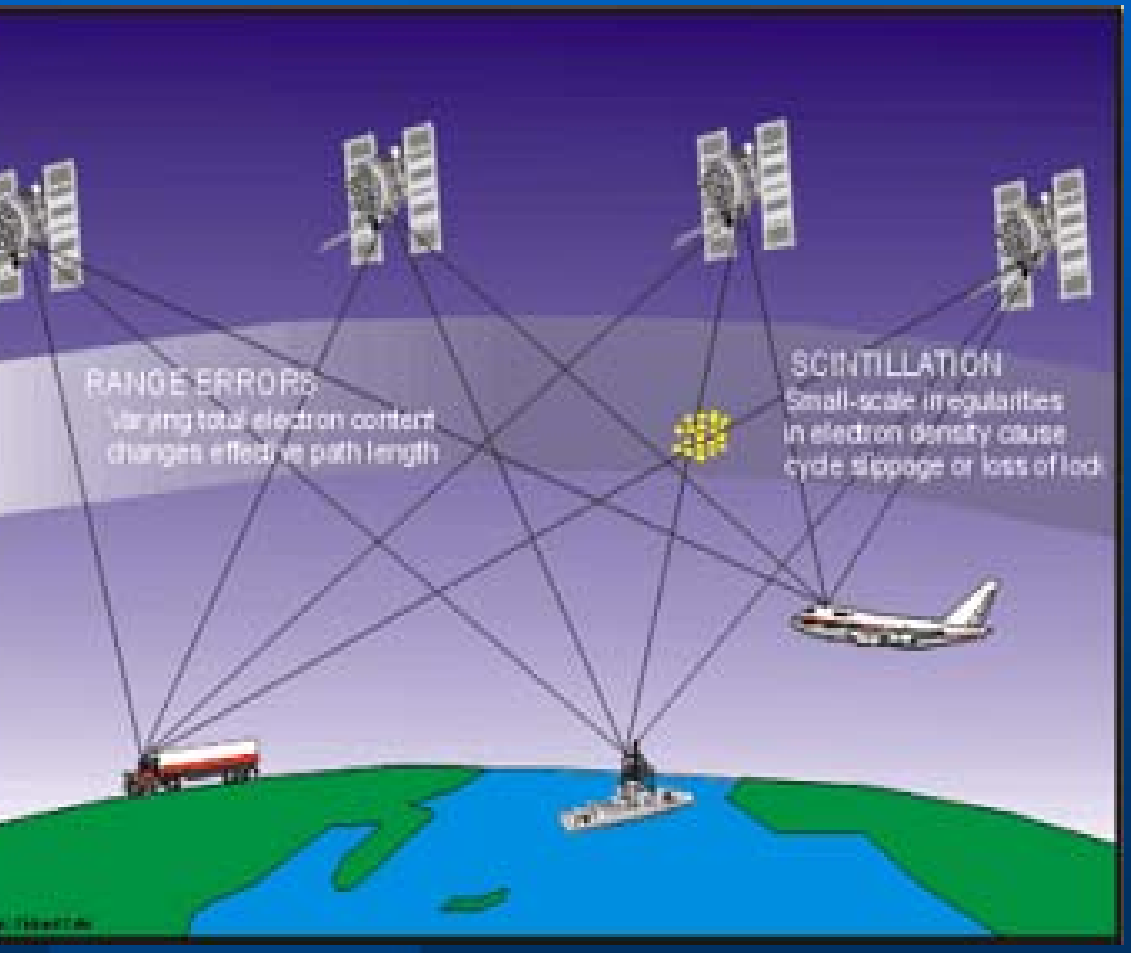
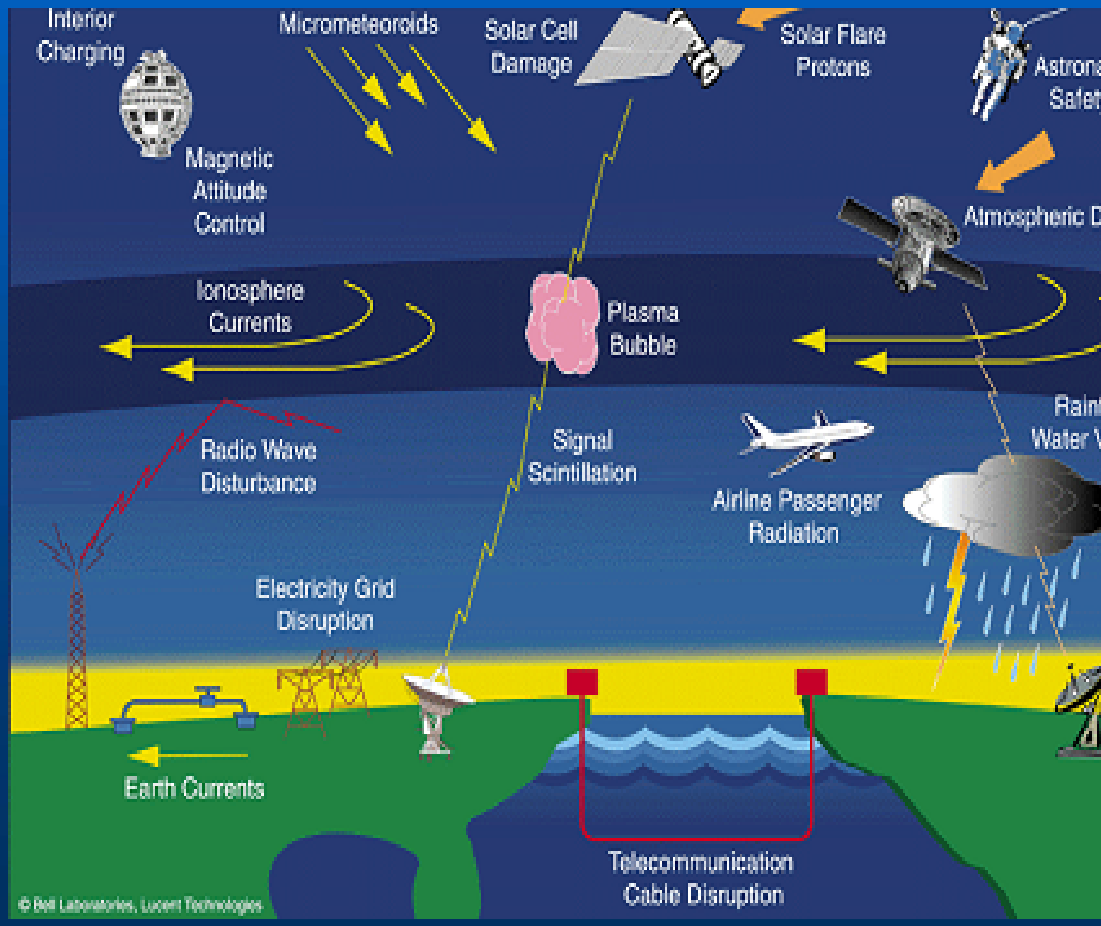



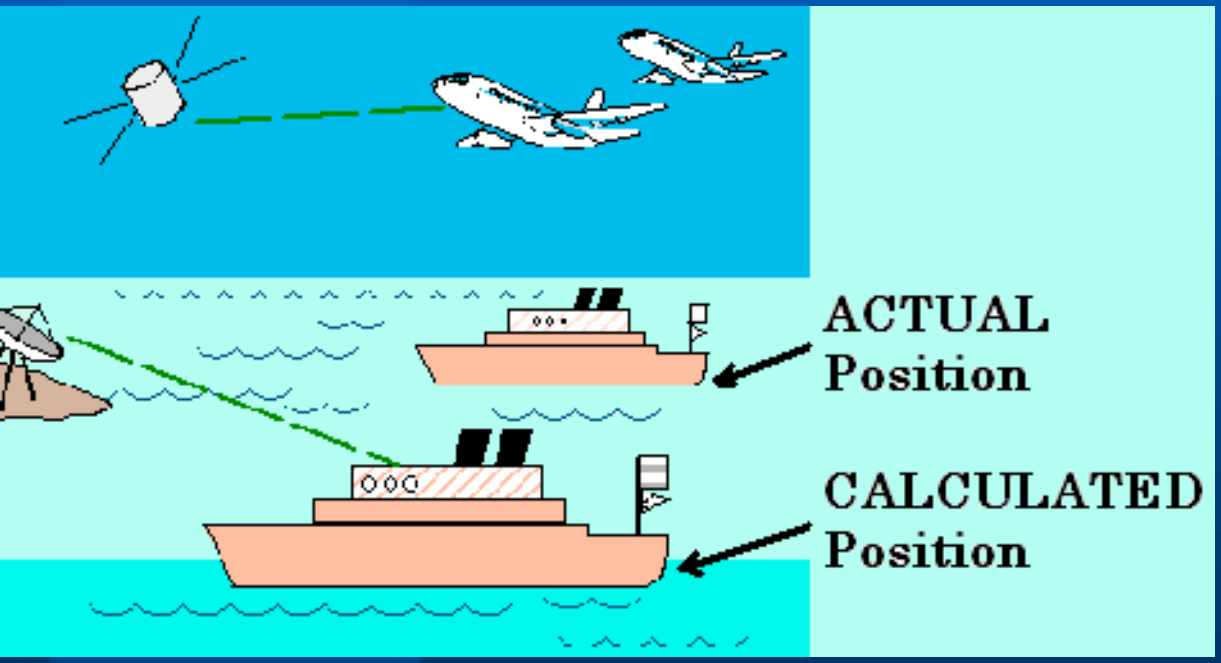

**Figure 1.5.** Contour is the altitude profile of plasma density at 14LT, black lines are magnetic field lines and arrows stand for the directions of ion drifts [courtesy of Liu and Lin, 2006].

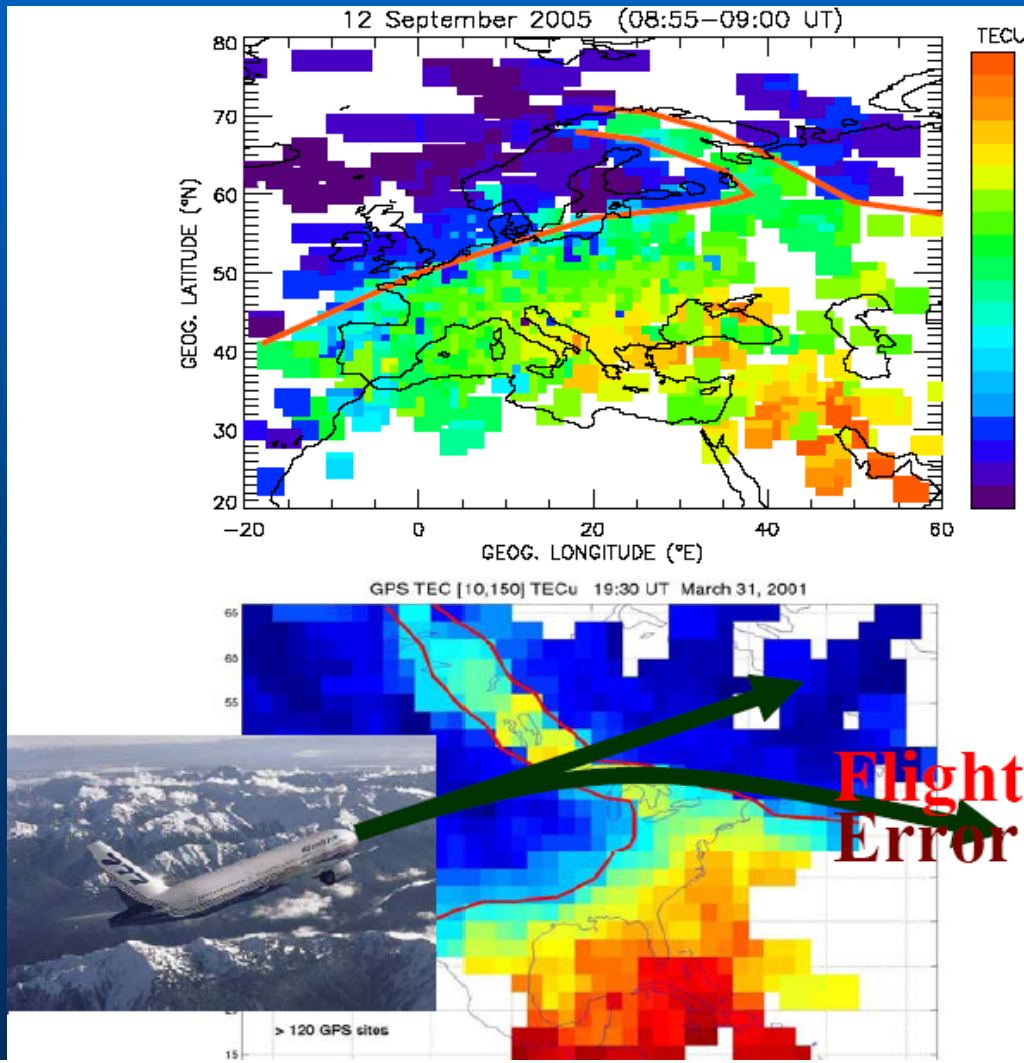
# Space Weather Impacts ?



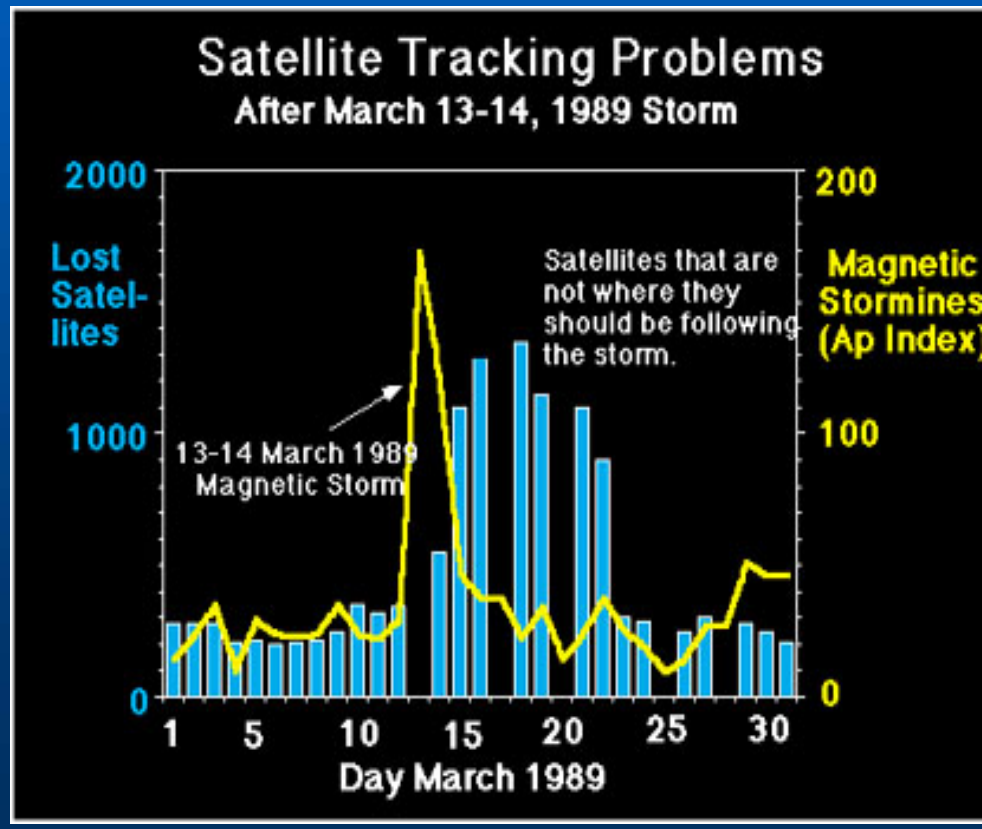



# Position Error

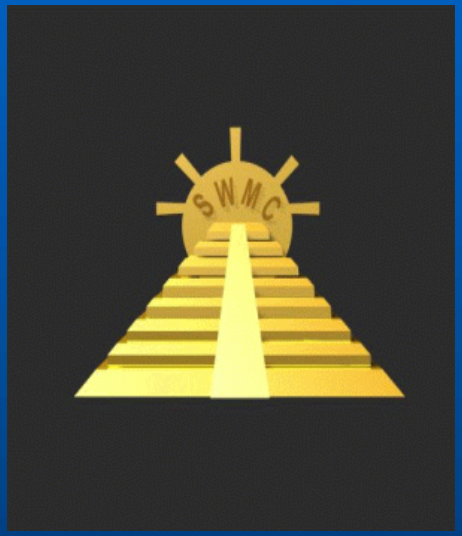


# Spacecraft Damage/Loss

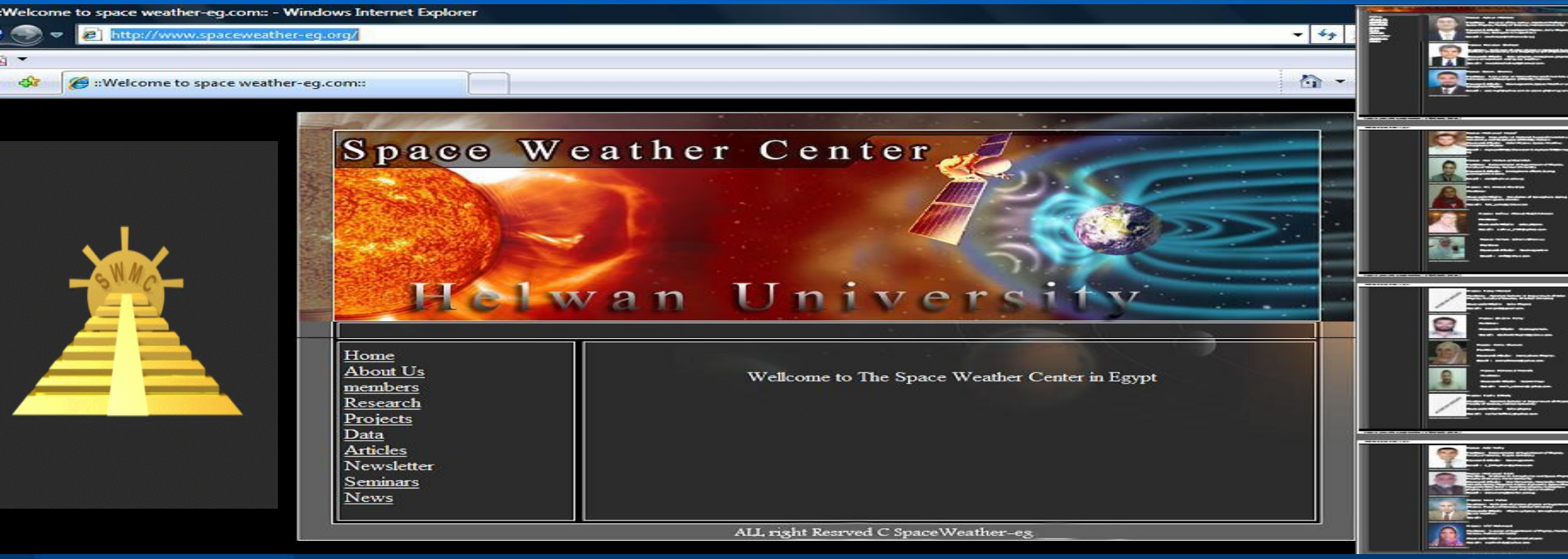


# Regional Center




**SWMC is offering to act as a regional center for space weather science and education in Western Asia to sustain space weather disciplines in this area.**

# Facilities we have ....




**We make available all facilities and capacities that enable Egypt to act as such a regional center .**

# Joint Projects

| | |
|---|---|
| Texas University (USA)<br>CIDR Ionospheric Receiver | Kyusho University (Japan)<br>MAGDAS Magnetometer |
| Stanford University (USA)<br>AWSOME Ionospheric Receiver | SCINDA Ionospheric Receiver |
| European Union TEMPUS | US-Egyptian Joint Board |
| Joining the African Network with European Networks (proposed) | Cyprus-Egyptian Joint Board |

# Erasmus Mundus

| Title of proposal | WELCOME - Widening Egyptian and Lebanese COoperation and Mobility with Europe (8 M Euros) | |
|---|---|---|
| | Name of organisation | Country |
| Applicant | POLITO - Politecnico di Torino | Italy |
| Partner 1 | FUB - Freie Universität Berlin | Germany |
| Partner 2 | IST - Instituto Superior Tecnico | Portugal |
| Partner 3 | KTH - Royal Institute of Technology | Sweden |
| Partner 4 | LUND - Lunds Universitet | Sweden |
| Partner 5 | Sciences Po - Fondation nationale des sciences politiques | France |
| Partner 6 | SGH - Warsaw School of Economics | Poland |
| Partner 7 | UGENT - Ghent University | Belgium |
| Partner 8 | UNEW - University of Newcastle upon Tyne | England |
| Partner 9 | UPV - Universidad Politecnica de Valencia | Spain |

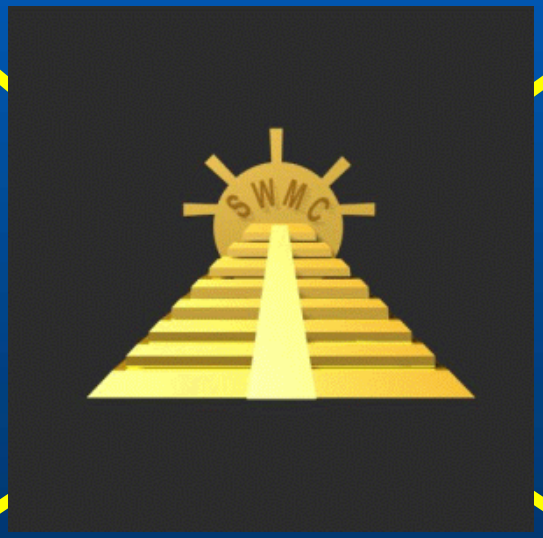
# Erasmus Mundus Action

| Type of Mobility | Outgoing | | Incoming | | | TOTAL |
|---|---|---|---|---|---|---|
| | Europeans | Third country[1] | Third-Country nationals | | | |
| | Target Group 1 | | Target Group 1 | Target Group 2 | Target Group 3 | |
| Undergraduates[2] | 20 | EG | 18 | | 2 | 60 |
| | | LB | 18 | | 2 | |
| Masters | 18 | EG | 15 | 4 | 2 | 57 |
| | | LB | 12 | 4 | 2 | |
| Doctorates | 6 | EG | 12 | 3 | 1 | 35 |
| | | LB | 9 | 3 | 1 | |
| Post-doctorates | 4 | EG | 6 | 5 | | 26 |
| | | LB | 7 | 4 | | |
| Academic staff | 10 | EG | 6 | | | 20 |
| | | LB | 4 | | | |
| TOTAL | 58 | | 107 | 23 | 10 | 198 |

# Research Groups in our Center

Solar Physics

Cosmic Rays

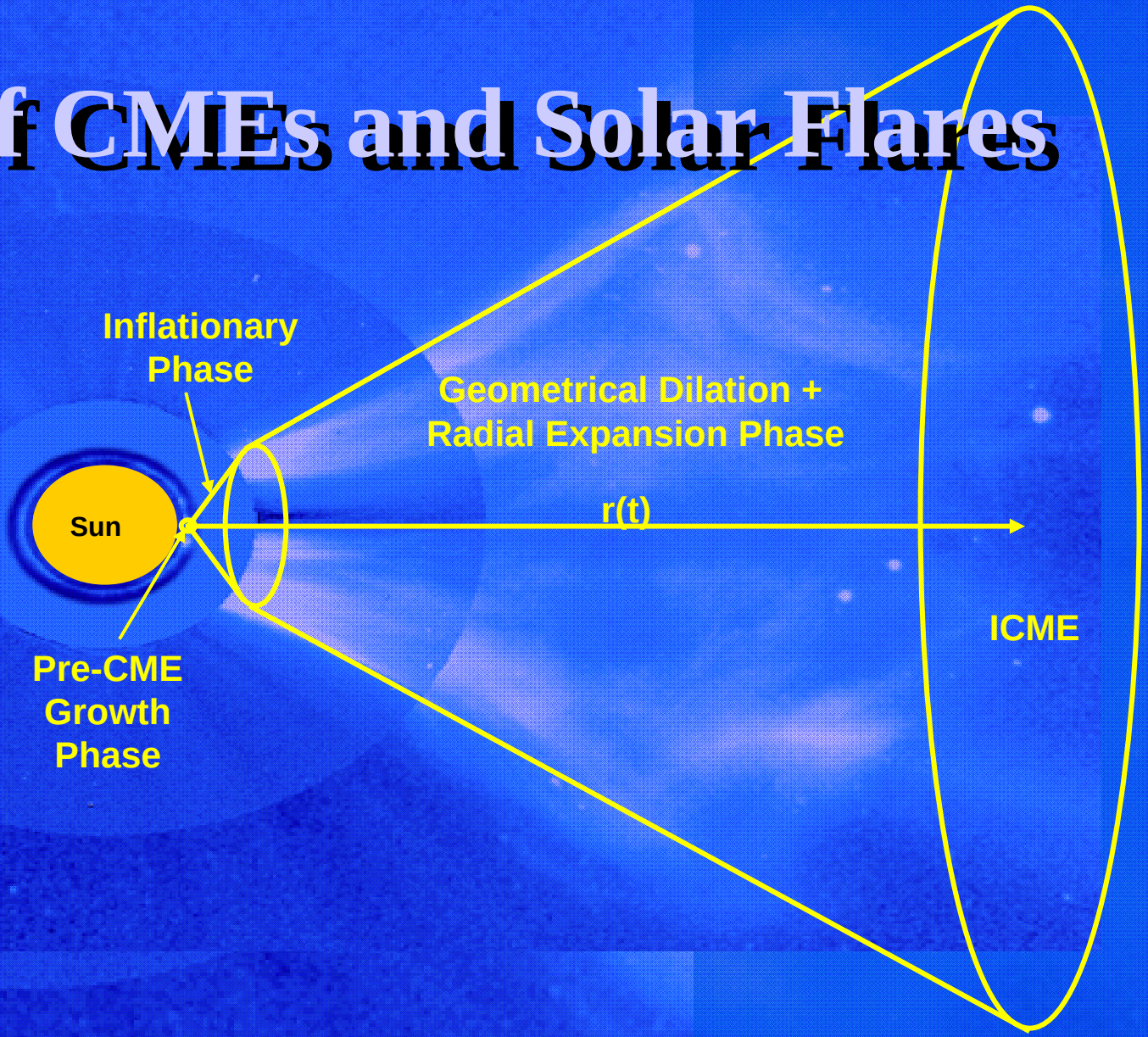



Geomagnetism

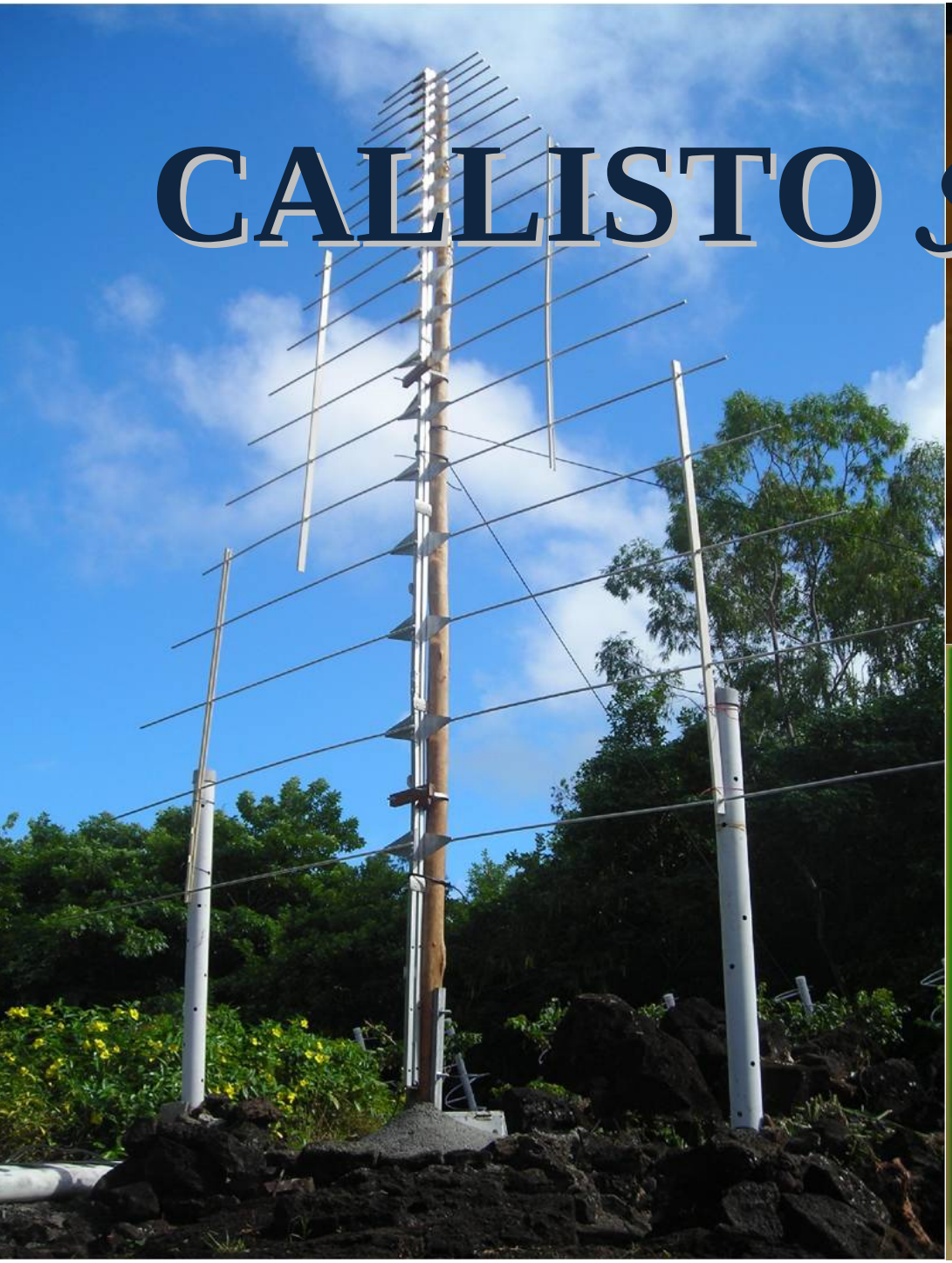
Ionosphere

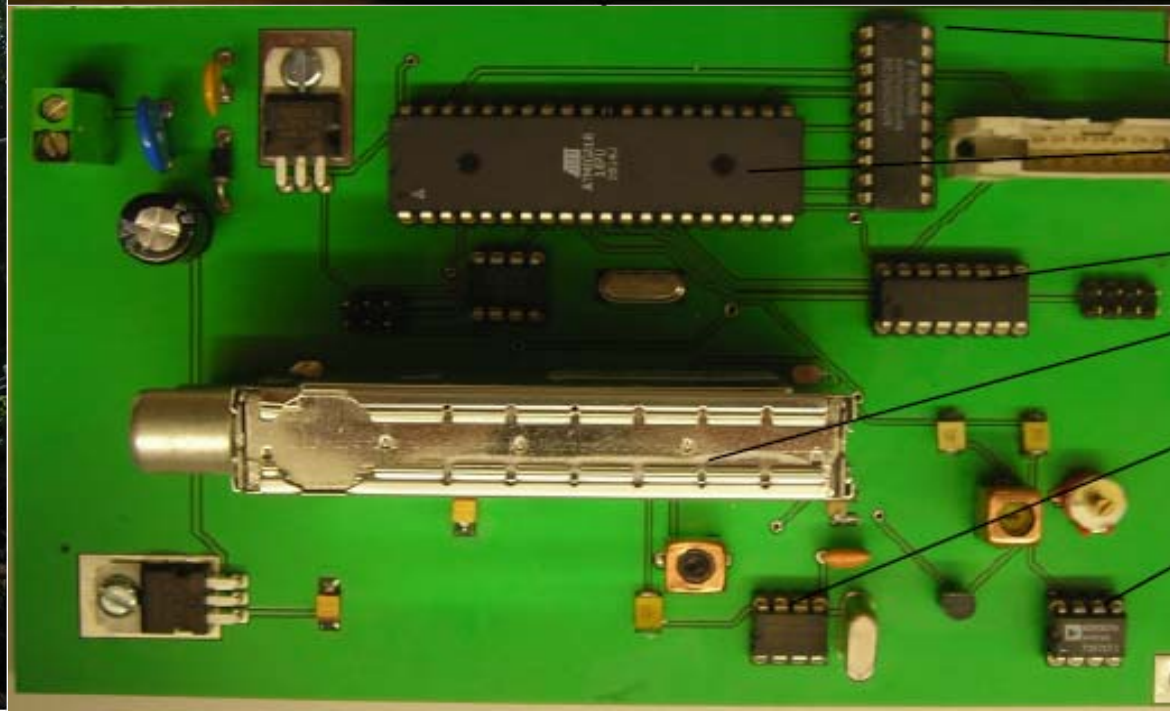
# Solar Physics Group

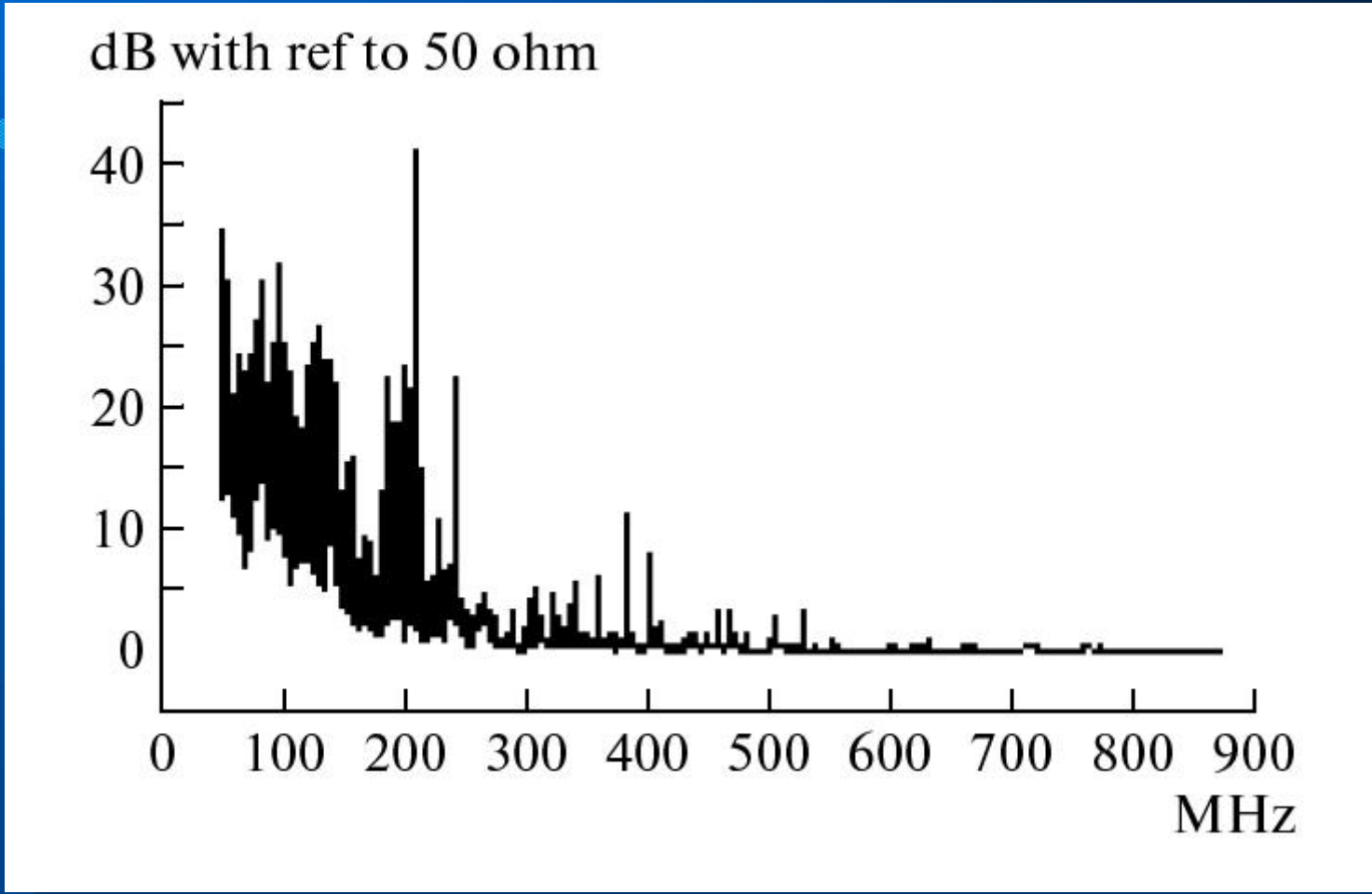
# Monitoring of CMEs and Solar Flares



# CALLISTO *Spectrometers*







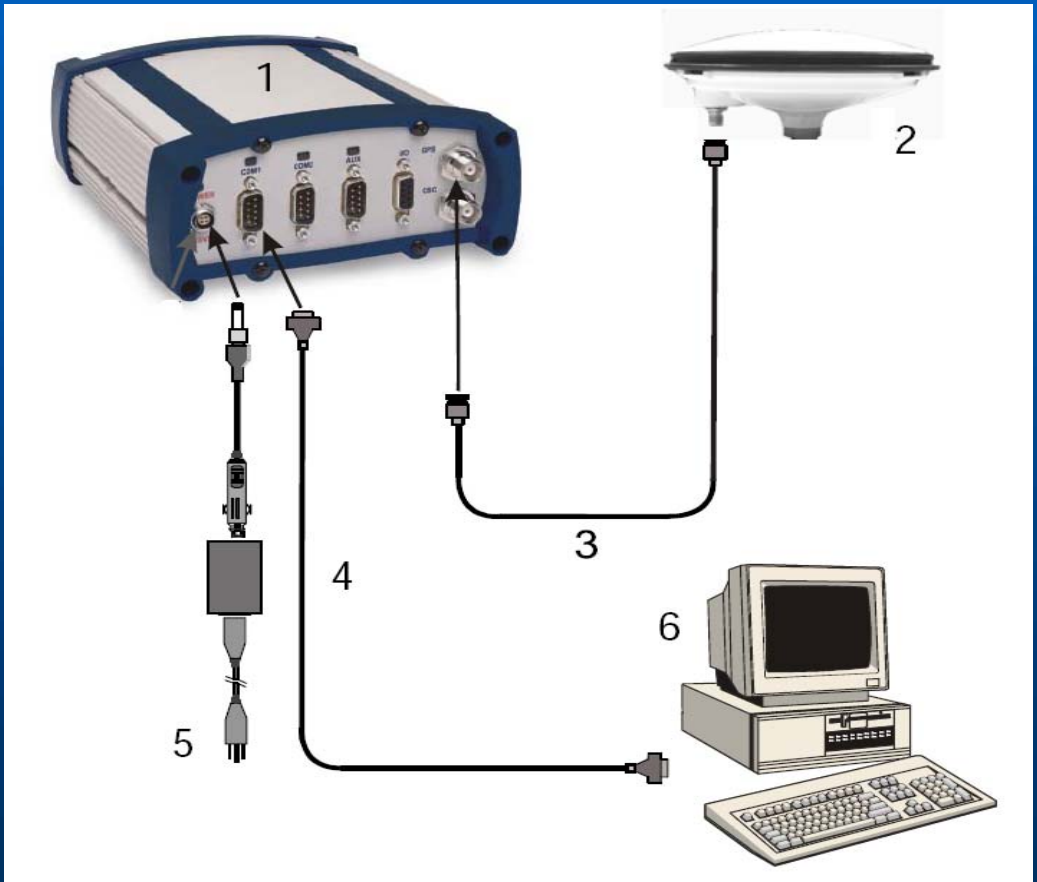

- **The total frequency range is from 45 to 870 MHz covering meter and low decimeter band.**
- **An individual channel has 300 kHz bandwidth**

# Ionosphere Group

## GPS Sub-group

# GPS System at Helwan

# GPS System at Helwan




1: GPS receiver

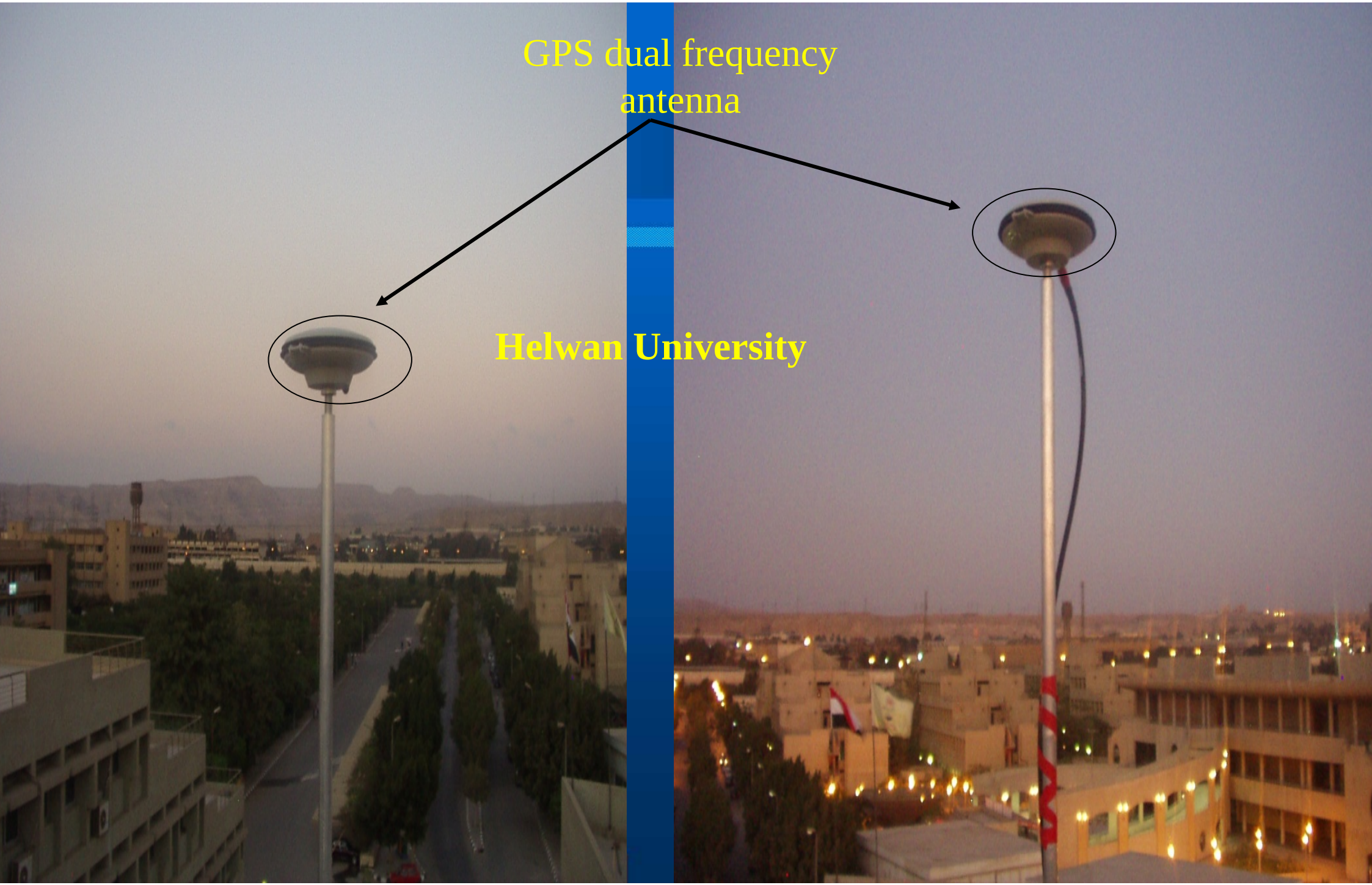
2: GPS dual frequency antenna

3: Antenna cable (30 meter maximum)

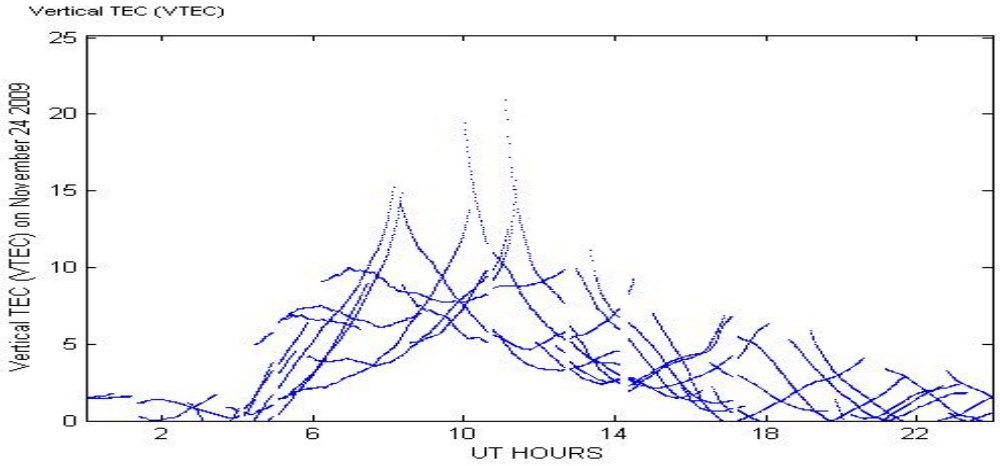
4: Serial cable

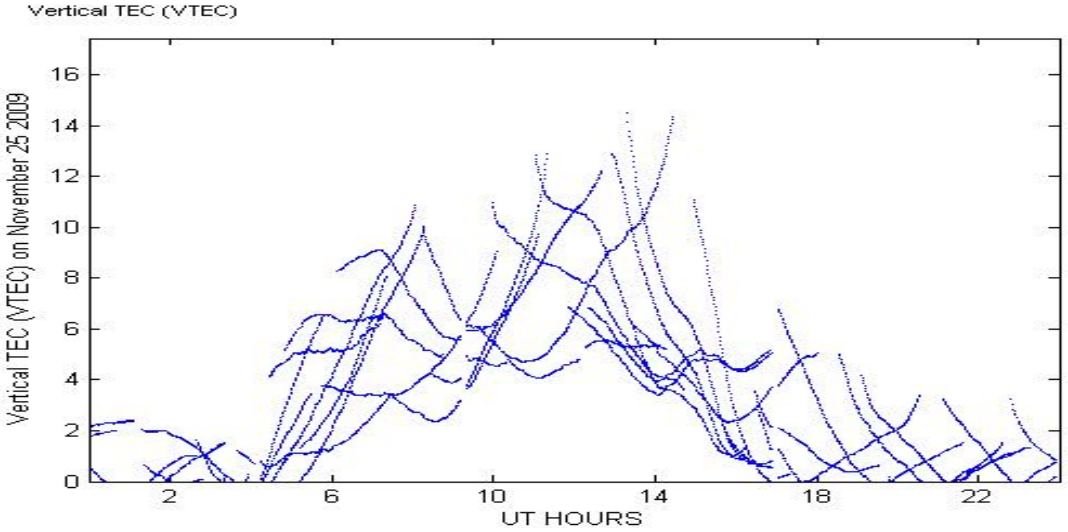
5: Power cable

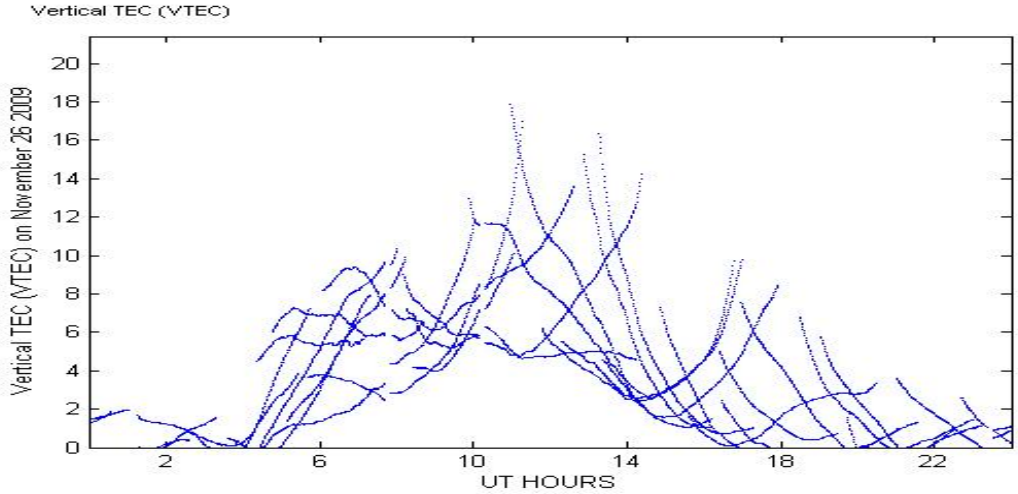
6: Personal computer running Linux

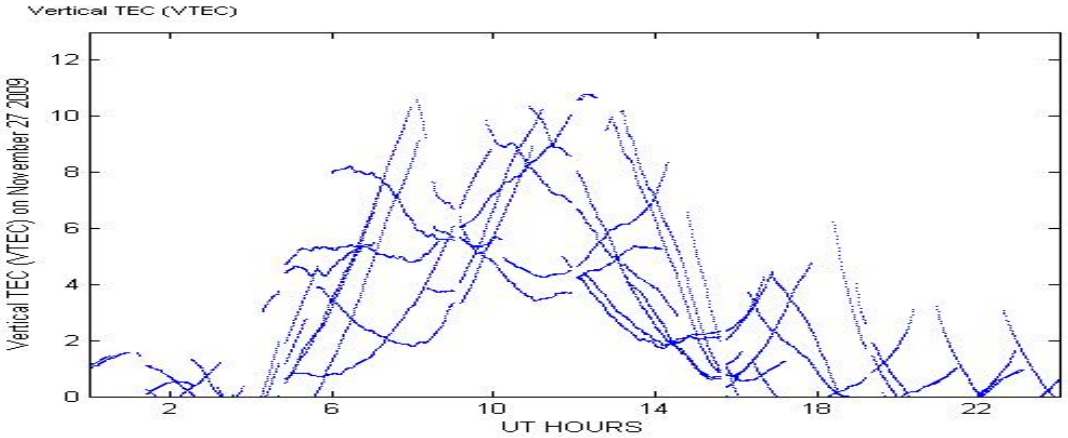

GPS dual frequency
antenna
Helwan University

# TEC Profile


Vertical TEC (VTEC)
Vertical TEC (VTEC) on November 24 2009
UT HOURS


Vertical TEC (VTEC)
Vertical TEC (VTEC) on November 25 2009
UT HOURS


Vertical TEC (VTEC)
Vertical TEC (VTEC) on November 26 2009
UT HOURS


Vertical TEC (VTEC)
Vertical TEC (VTEC) on November 27 2009
UT HOURS

# Ionosphere Group

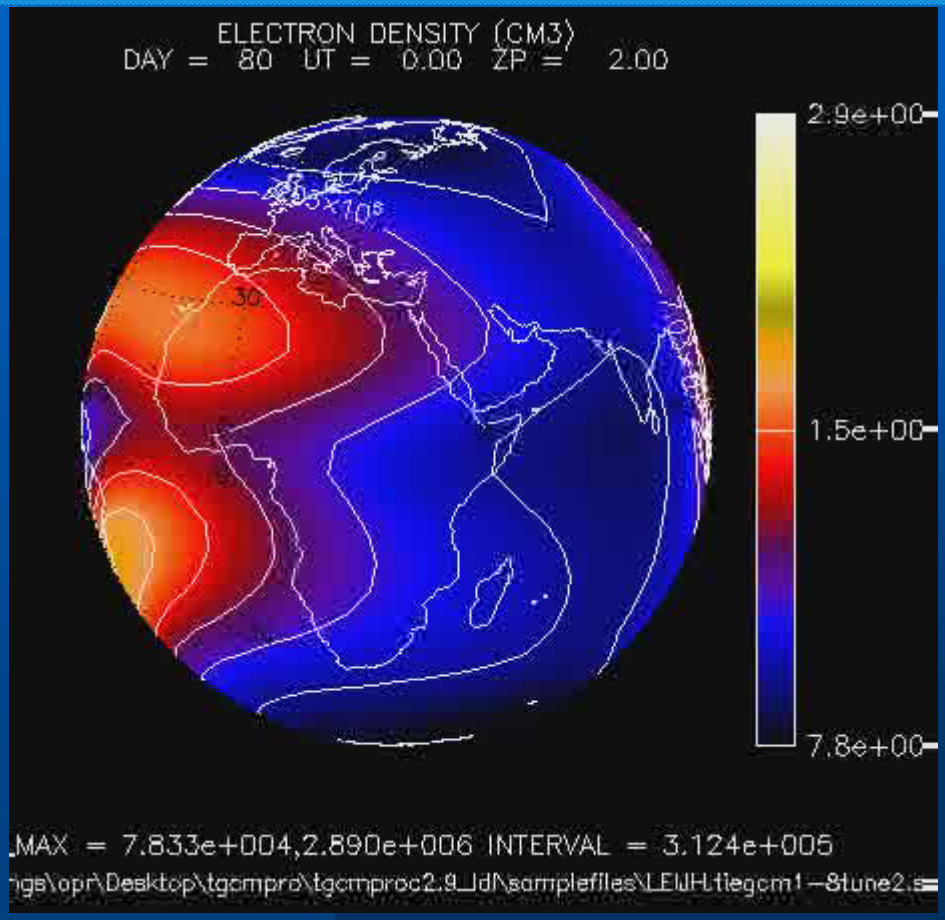
## Simulation Sub-group

# Comparison with Simulations

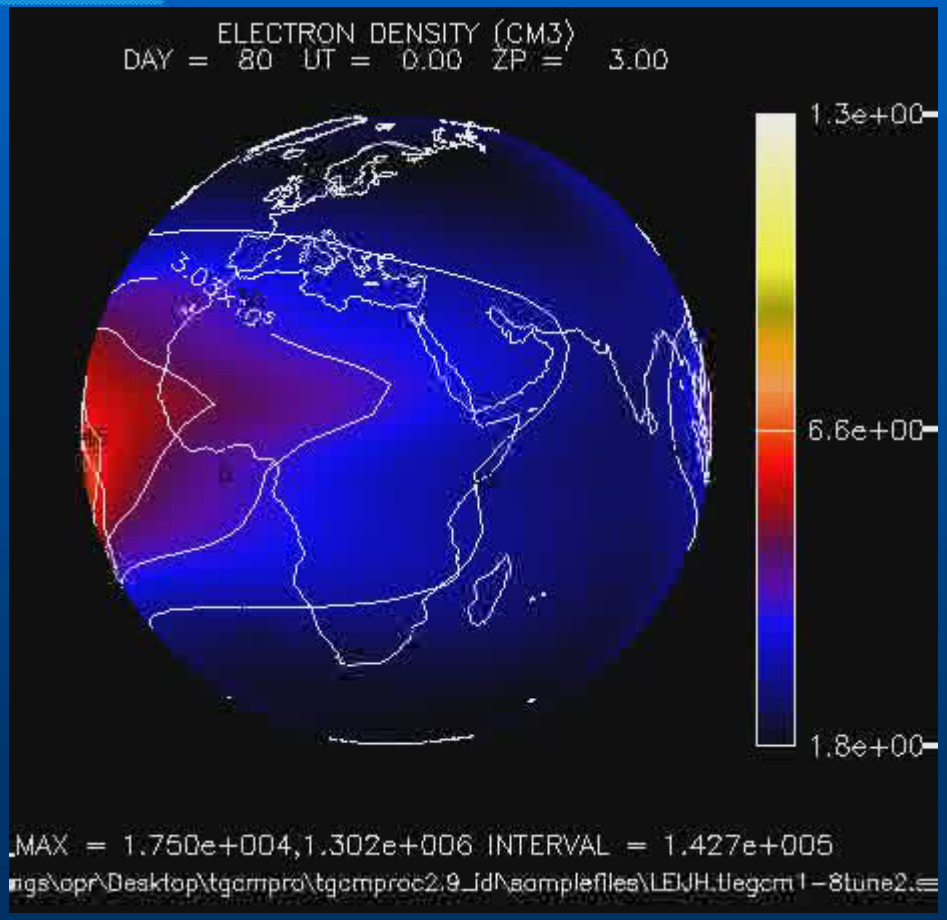
**Thermospheric Ionospheric Electrodynamic General Circulation Model**

**TIEGCM**

# Simulation Results




Energetic Event




Quite Day

# Ionosphere Group

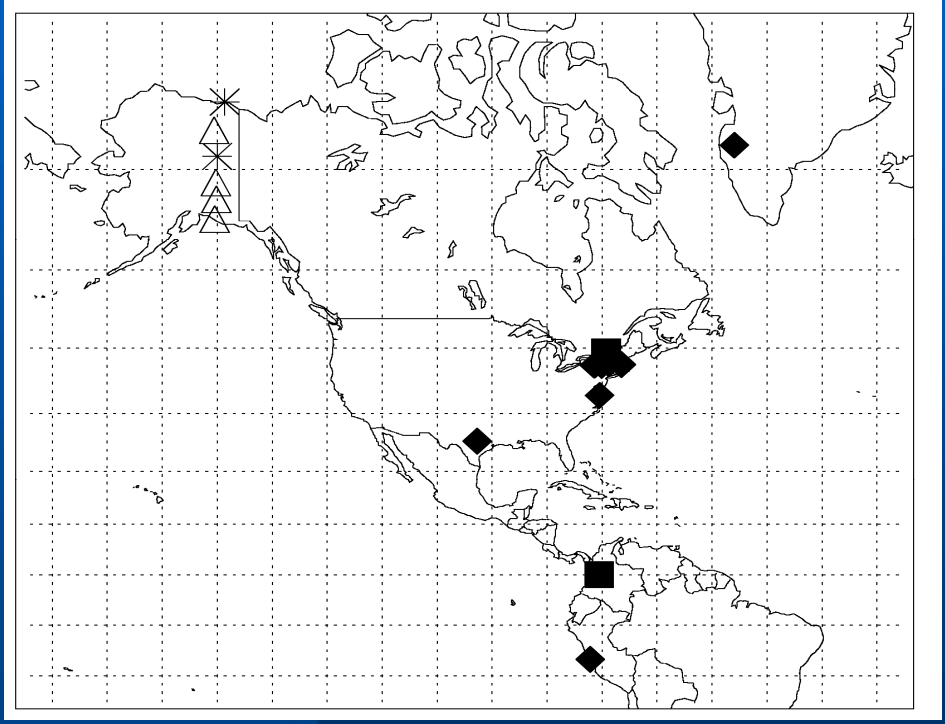
## CIDR Sub-group

# CIDR Project 2008

# Coherent Ionospheric Doppler Receivers (CIDRs)

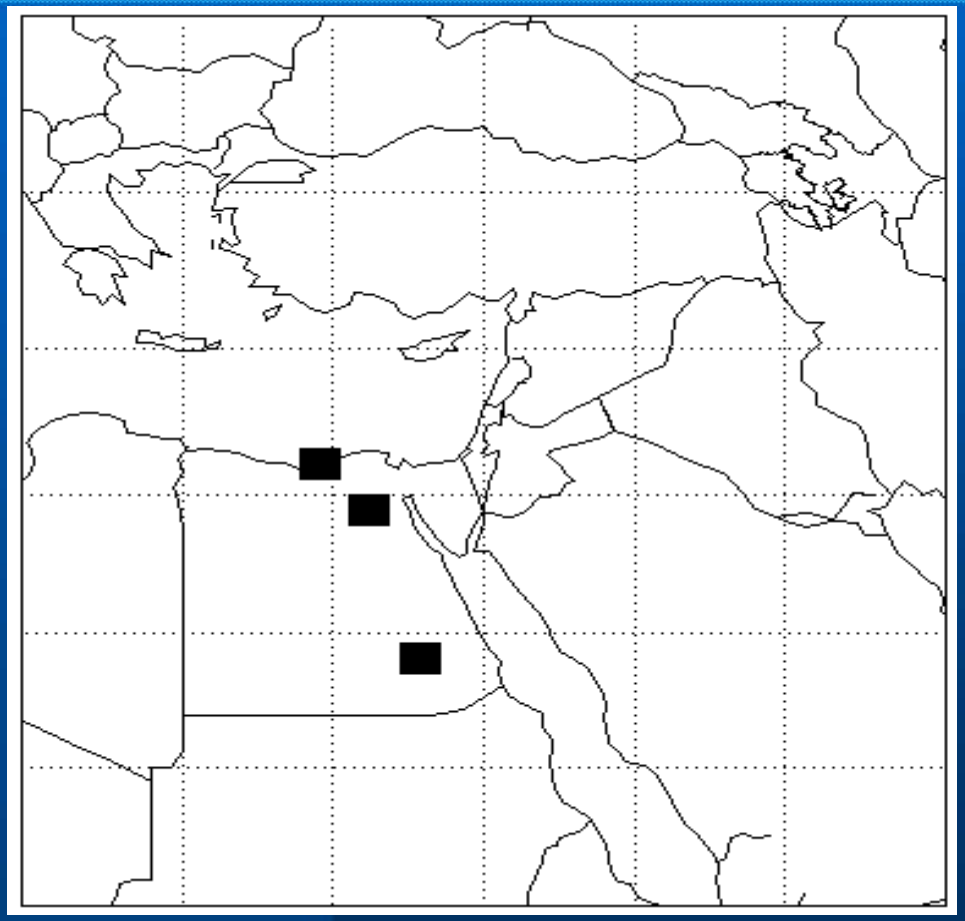


# Coherent Ionospheric Doppler Receivers (CIDRs)



- 7 Diamonds indicate CIDR systems
- Alaskan CIDRs (Stars) are owned by Univ. of Alaska-Fairbanks are part of a tomography chain with similar tomography receivers developed by NWRA (Triangles)
- Future deployments in New York and Columbia (Squares) have the equipment located at or near the site, but not running.

# Coherent Ionospheric Doppler Receivers (CIDRs)



## Three CIDRs will be deployed to Egypt as part of IHY

- US coordinator (Dr.Trevor Garner), Texas University
- Egyptian coordinator (Dr. Ayman Mahrous), Helwan University.

The CIDR will be operated jointly by :

1- Helwan University

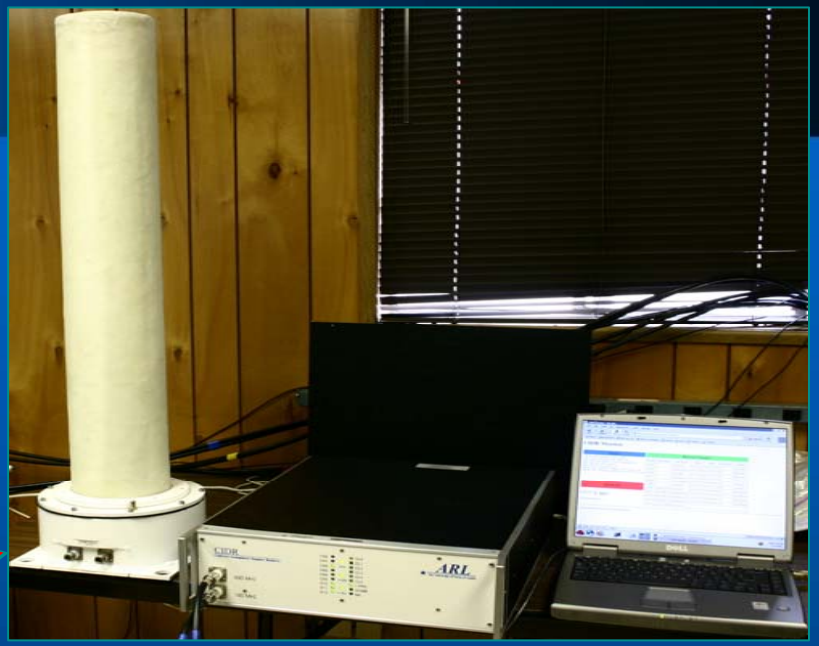
2- South Valley University

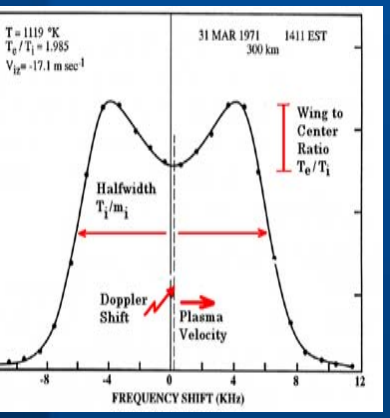
3- Alexandria University

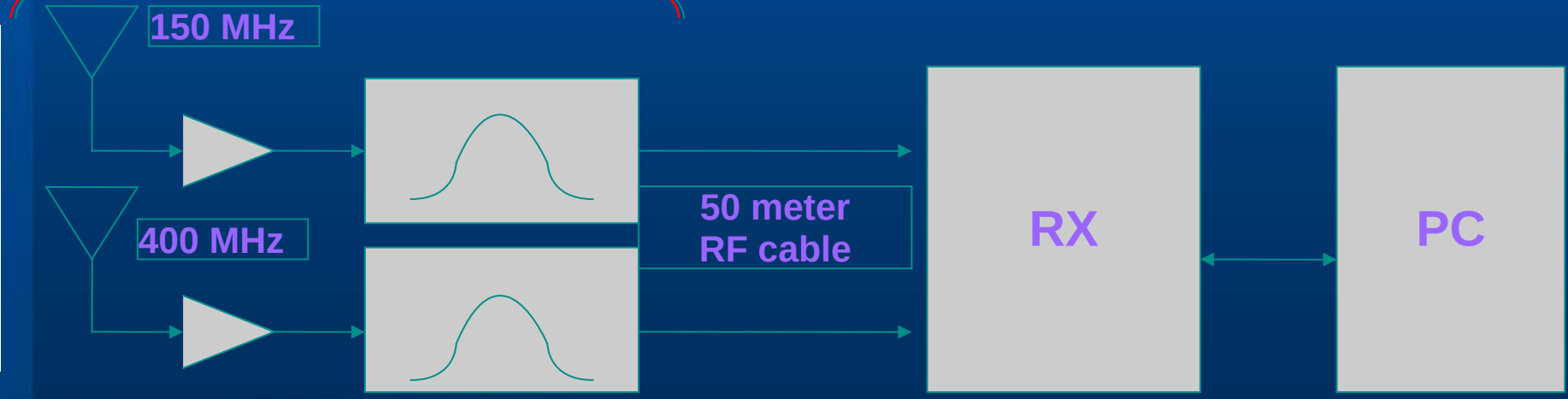
nospheric Tomography Network of Egypt: A New Receiver Network in Support of the International Heliophysical YearT. Garner, Gaussiran, J. York, D. Munton, C. Slack, A. Mahrous, Earth, Moon and Planet, 2009, Vol. 104, pp. 227-235.

# Coherent Ionospheric Doppler Receivers (CIDRs)

- Designed to track 150/400MHz LEO beacons (Transit/NIMS, GFO)
- Provides relative TEC and phase scintillation measurements at 50 Hz
- Useful for examining spatial structure with a relatively sparse receiver network and conducting ionospheric tomography





# RADCAL/GFO Beacon Satellites

RADCAL (1993 to Present)

- 3 RADCAL/GFO Satellites
- 20 RADCAL Ground Stations
  - Archived Data 1993 to Present
  - 5 Second Samples
  - Maintained by AF Western Test Range Vandenberg

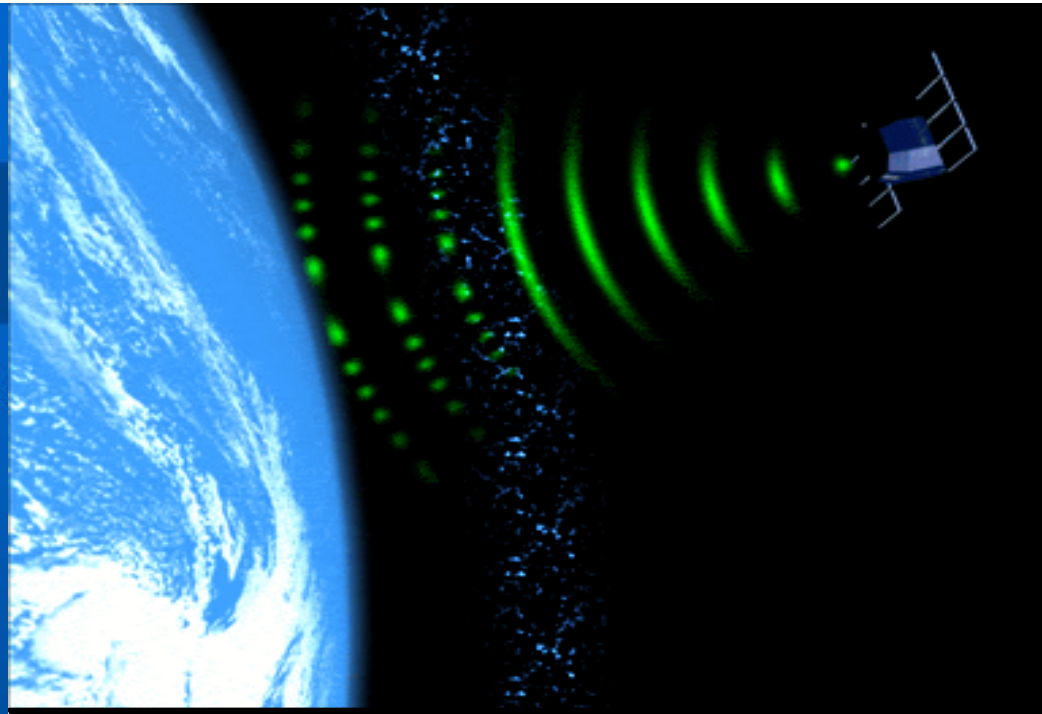
GFO (1998 to Present)

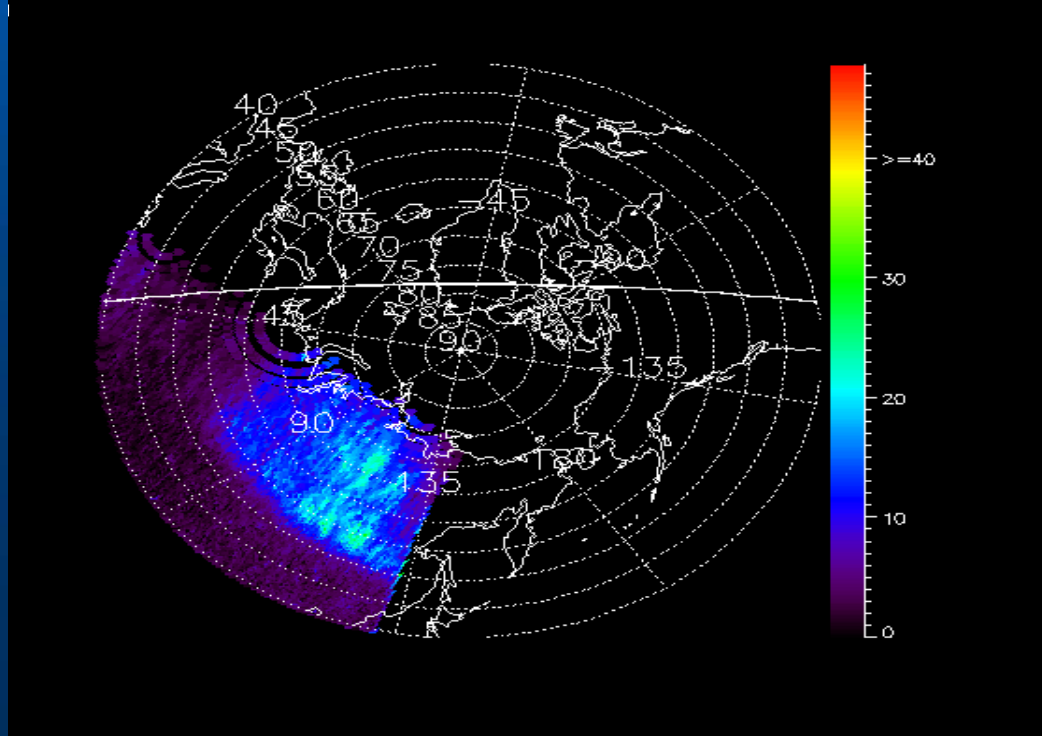
- Radio Altimetry and Ephemeris Satellites
  - 150/400 MHz Radio Beacon
  - Ionospheric TEC Correction Data

RADCAL on DMSP/F15
(Aug 2006 to Present)

# Advantages Over GPS

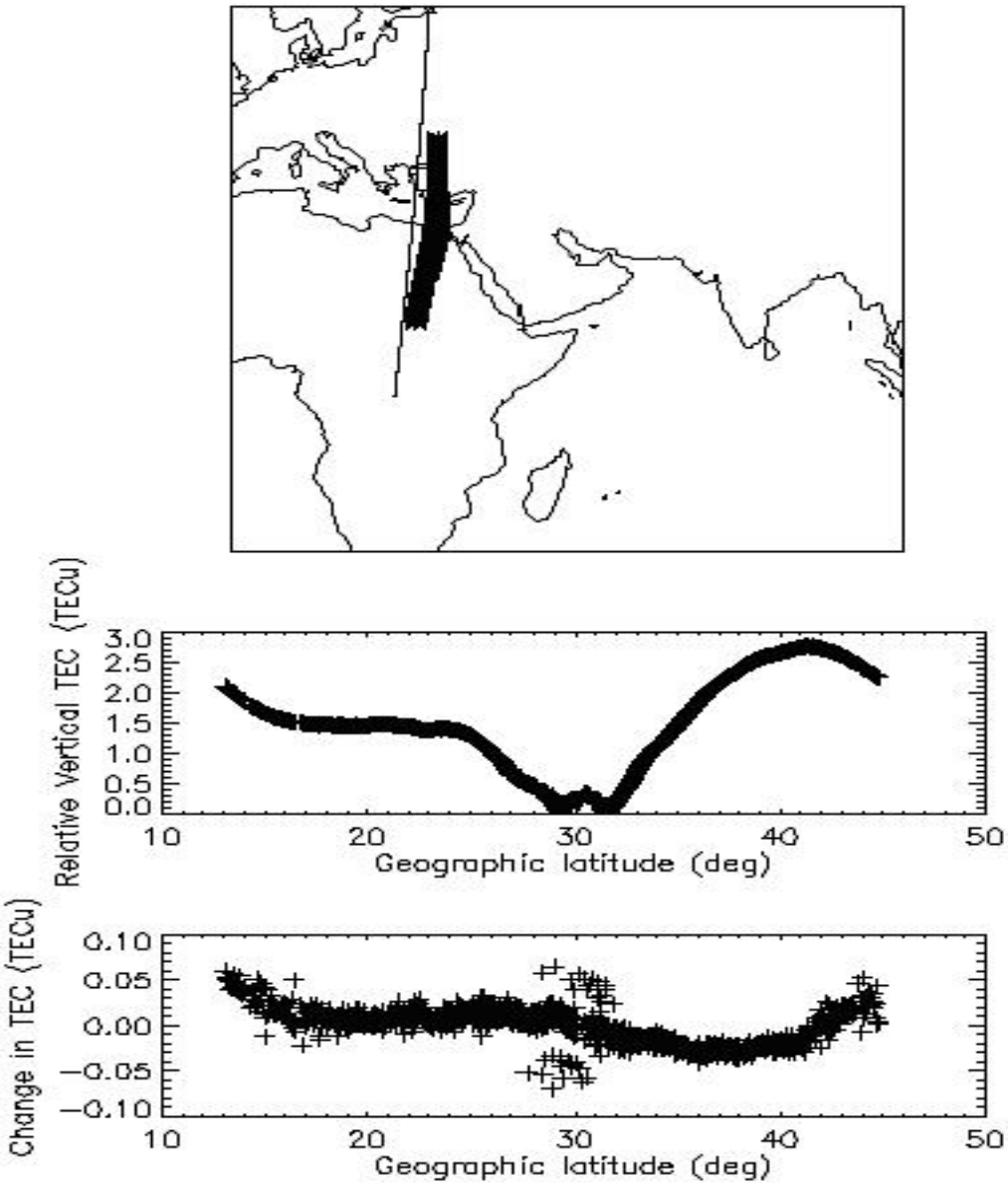
- More accurate, no need for plasmaspheric corrections by using LEO satellites.
- Can measure the spatial structure of the ionosphere.
- A powerful tool for topographic image of the ionosphere





# Night-time: 2236 LT

Figure 8 shows the satellite track over Egypt (Oct11, 2008 at 2036 UT, about 2236 LT at night time) is on the recovery phase (Kp=3, Dst=-42) and is an almost directly overhead pass by the satellite OSCAR32. The TEC minimum is located approximately at 30 degrees.
A mid-latitude trough also appeared at lower geographic latitudes, indicating that the trough is propagating equatorward as it is tracked in the three Fig.6,7and 8 but all the result show pre-reversal enhancement at mid latitude.
At latitudes closer to the magnetic equator, scintillations can also occur during nighttime. The scintillation is associated with spread-F occurrences. After local sunset, the bottom side of the F-region over the magnetic equator is subjected to gravitational Rayleigh-Taylor mechanisms. As a result, irregularities known as plasma bubbles are generated by rise to the topside ionosphere due to non-linear evolution of the instability and produce scintillations in discrete patches (Kumar and Gwal, 2000; Abdu et al., 1991).



# Geomagnetism Group

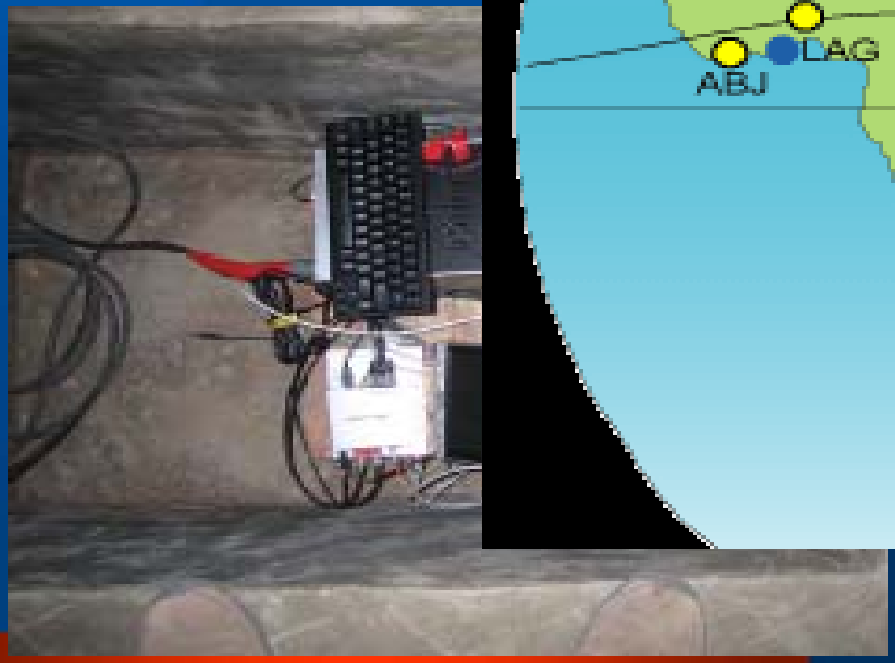
# MAGDAS Project

# MAGDAS Project

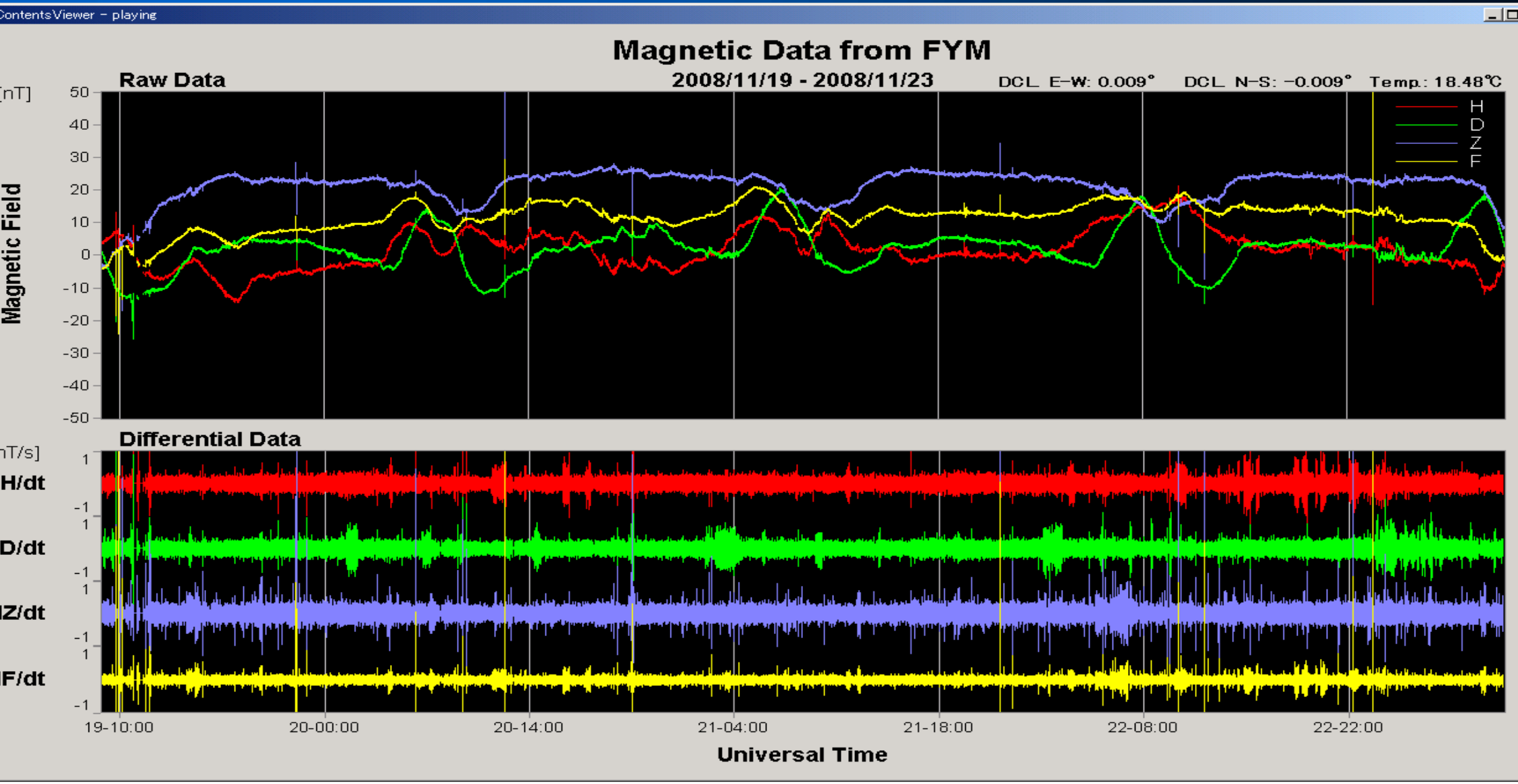
# Installation of MAGDAS at FYM

# MAGDAS-II installation at ASW

Aswan, Egypt,
15.20GMLat, 104.24G
Installed at 08/12/23

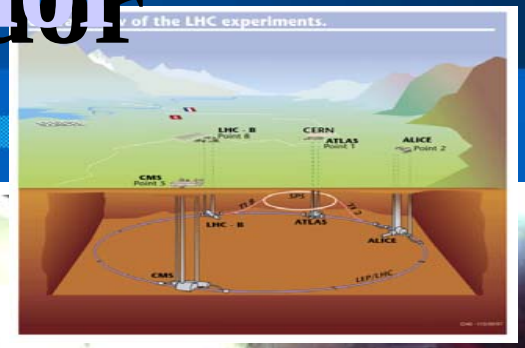
# Real-time Monitoring Data from FYM Station



# Cosmic Ray Group

## Experimental Sub-group

# Large Hadron Collidor




The Large Hadron Collider in the LEP Tunnel

Proton- Proton Collider

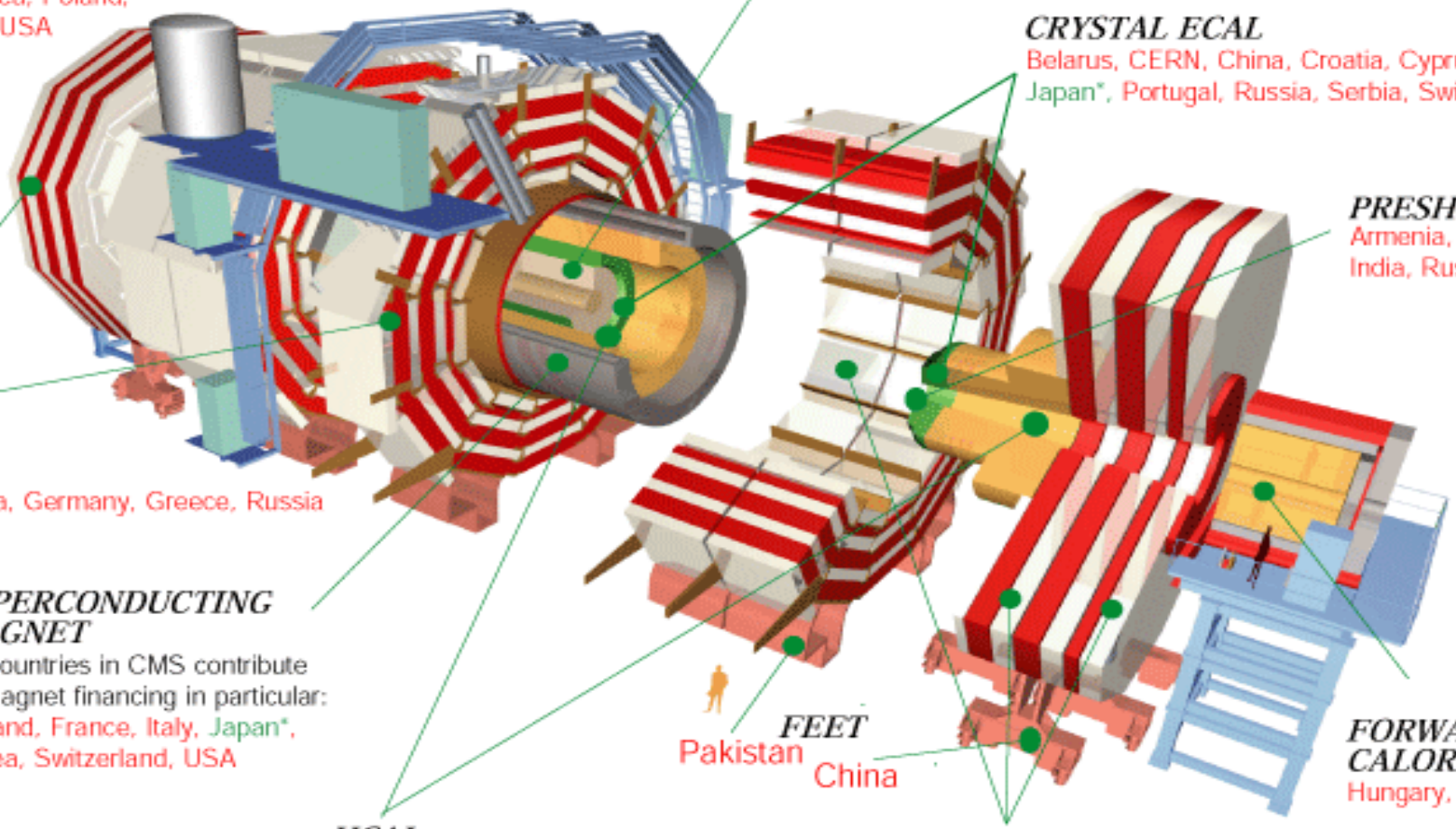
7 TeV + 7 TeV

Luminosity = $10^{34}cm^{-2}sec^{-1}$

first targets:
- Higgs boson (s)
- Supersymmetric Particles
- Quark-Gluon Plasma
- CP violation in B

# CMS Outreach

37 Countries, 155 Institutes, 2000 scientists (including about 400 students) October 2006



*TRIGGER, DATA ACQUISITION & OFFLINE COMPUTING*
Austria, Brazil, CERN, Finland, France, Greece, Hungary, Ireland, Italy, Korea, Poland, Portugal, Switzerland, UK, USA

*TRACKER*
Austria, Belgium, CERN, Finland, France, Germany, Italy, Japan*, Mexico, New Zealand, Switzerland, UK, USA

*CRYSTAL ECAL*
Belarus, CERN, China, Croatia, Cyprus, France, Italy, Japan*, Portugal, Russia, Serbia, Switzerland, UK, USA

*PRESHOWER*
Armenia, CERN, Greece, India, Russia, Taiwan

*RETURN YOKE*
Barrel: Czech Rep., Estonia, Germany, Greece, Russia
Endcap: Japan*, USA

*SUPERCONDUCTING MAGNET*
All countries in CMS contribute to Magnet financing in particular: Finland, France, Italy, Japan*, Korea, Switzerland, USA

*FEET*
Pakistan
China

*FORWARD CALORIMETER*
Hungary, Iran, Russia, Turkey, US

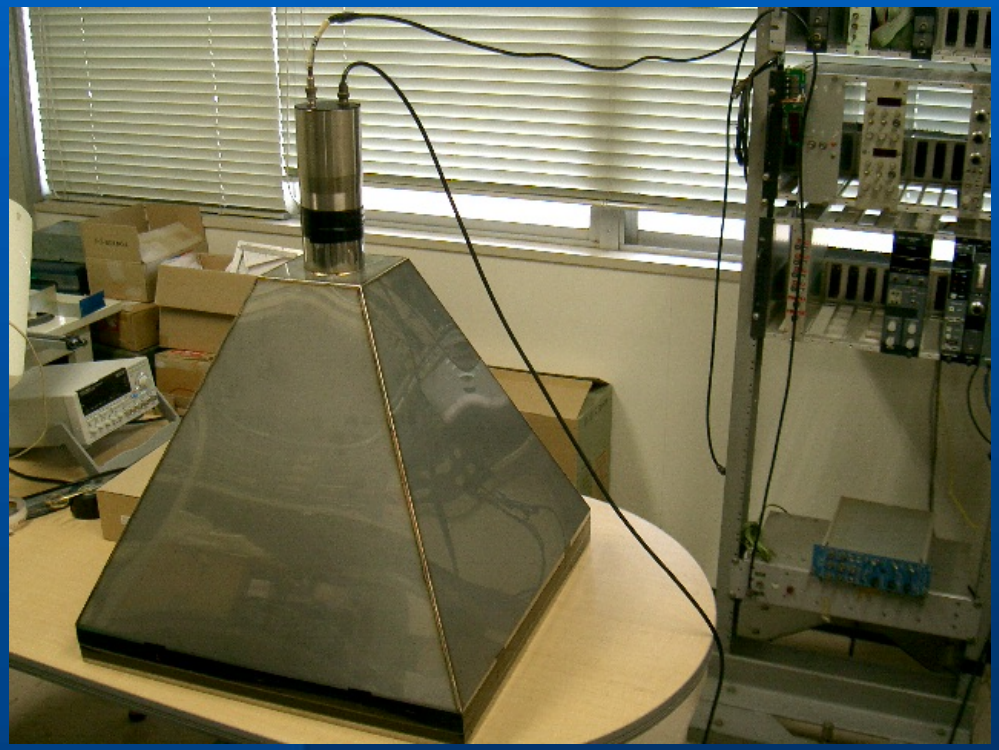
*HCAL*
Barrel: Bulgaria, India, Spain*, USA
Endcap: Belarus, Bulgaria, Georgia, Russia, Ukraine, Uzbekistan
HO: India

*MUON CHAMBERS*
Barrel: Austria, Bulgaria, CERN, China, Germany, Hungary, Italy, Spain,
Endcap: Belarus, Bulgaria, China, Colombia, Korea, Pakistan, Russia, USA

| | | |
|---|---|---|
| tal weight | : | 12500 T |
| erall diameter | : | 15.0 m |
| erall length | : | 21.5 m |
| gnetic field | : | 4 Tesla |

* Only through industrial contra

# Available Equipments



4 scintillators
4 scintillation detector boxes
4 Photo Multiplier Tubes PMT
4 electronic boxes to be attached to PMT
Multichannel analyzer
Digital oscilloscope
High voltage power supply

# Cosmic Ray Group

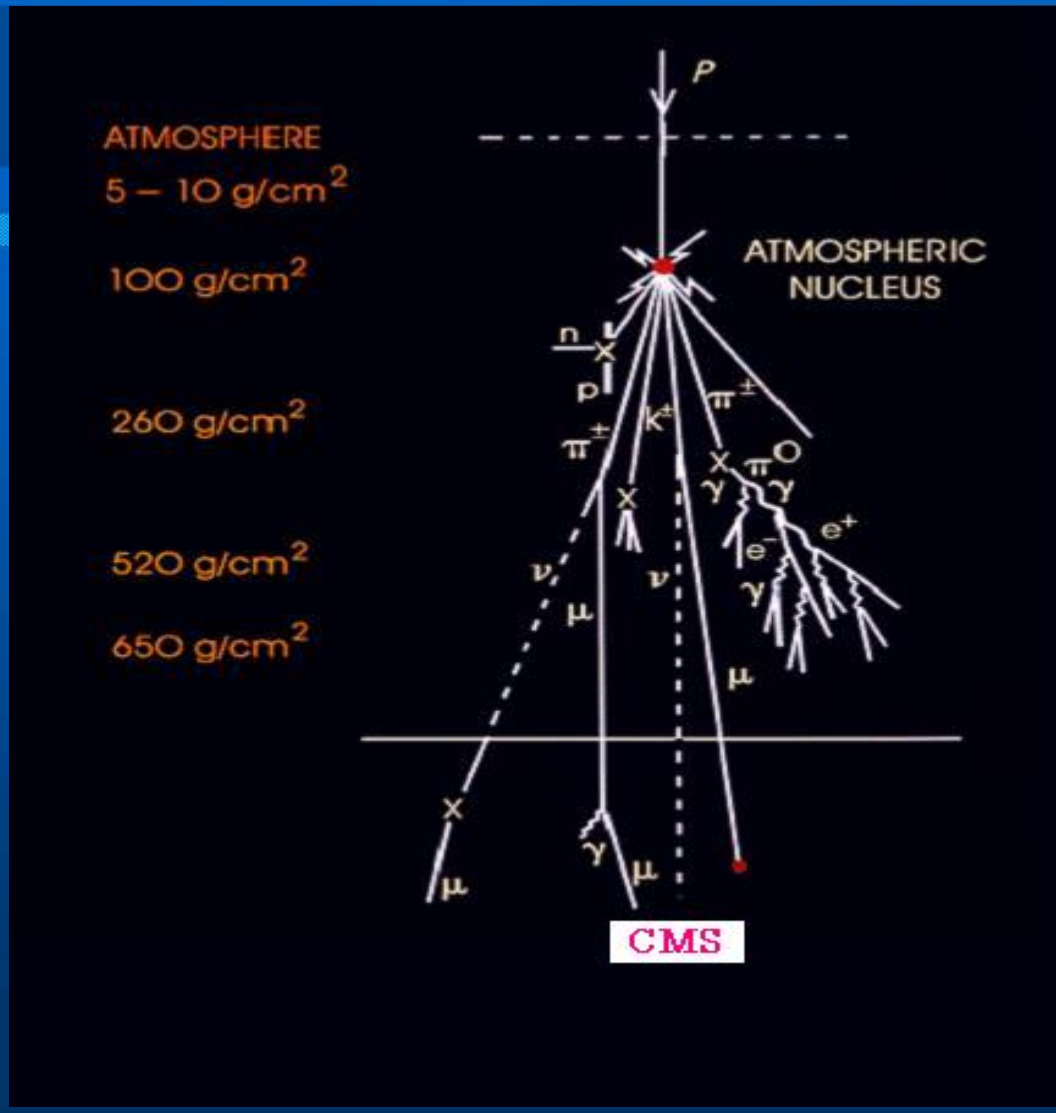
## Simulation Sub-group

# Muons Triggering to CMS

The interaction of cosmic ray particles in the upper atmosphere (primarily 9~15 Km above Earth's surface) usually produces pions (Duldig, 2000), a bound state of an up and anti-down quark.

With lifetime of (2.6 x $10^{-8}$ s), the pion travels only hundreds of meters at velocities between (0.966 C and 0.977 C) before decaying into a muon and mu-neutrino .

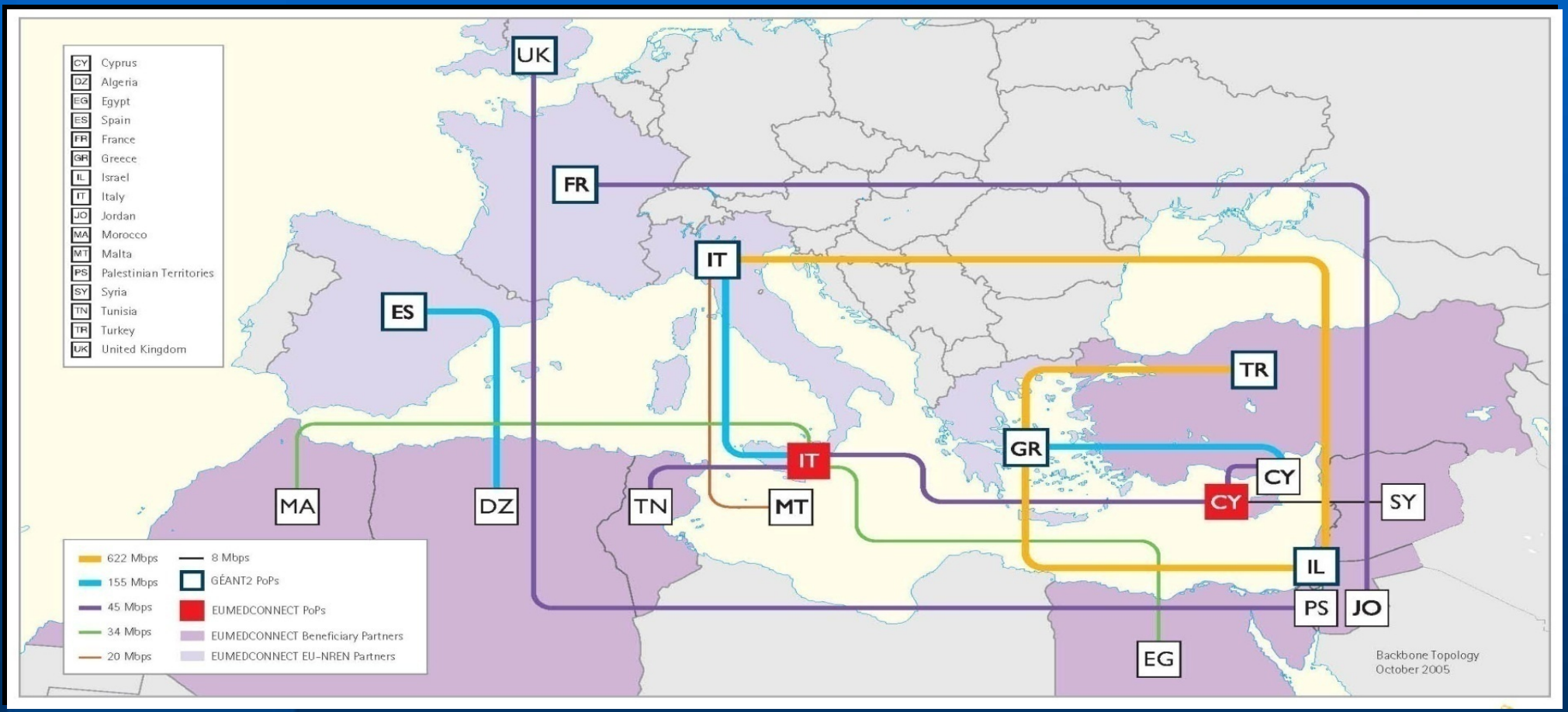
The muons produced in that reaction descend to Earth's surface with ample supply of muons at sea level which facilitates the study of these particles (Caso et al., 2000).



# Data Analysis Group


http://www.eumedgrid.org/application/hero.html

# EUMED Connect

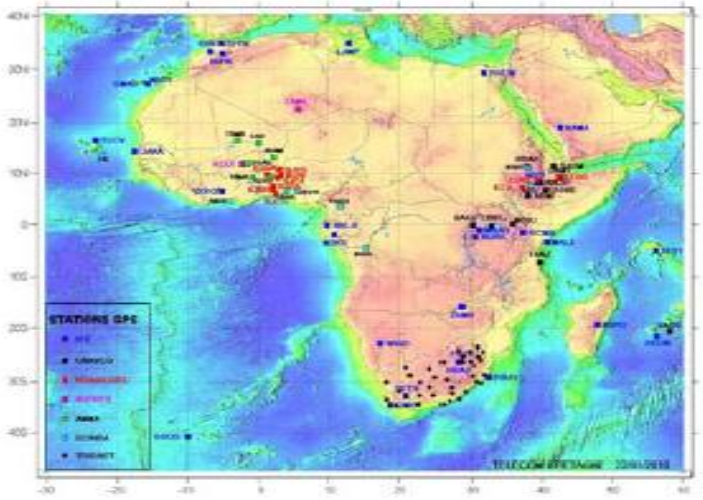


# Proposed Joint Research Project

## MONITORING OF THE WATER VAPOUR IN THE TROPOSPHERE ALONG THE NIL

Prof. Ayman Mahrous
Space Weather Monitoring Centre, Helwan University, Egypt

Prof. Cheristine Amory
Latmos institute, ISWI Africa, Egypt




GPS Network over AFRICA

**PROJECT**

**MONITORING OF THE WATER VAPOUR IN THE TROPOSPHERE ALONG THE NIL**

By using GPS and meteorological stations located in the different countries along the Nil, we can survey the water vapour and develop climatic studies of this area.
In the international programme ISWI (International Space Weather Initiative), the deployment of GPS receivers over Africa is planned.
Therefore it is a necessity to organize training school for the use of GPS data.

# Video By: Undergraduate Students – Space Department


Thank you