ELT (Exremly Large Telescope) Site Testing On Màrocco:jbel Aklim

Laboratory for High Energy Physics
and Astrophysics (LPHEA)
University Cadi-Ayyad Marrakech Morocco
http://www.ucam.ac.ma

A.BENHIDA

Ifrane 2009

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Part I: Presentation of laboratory LHPEA

The Laboratory for High Energy Physics and Astrophysics (LPHE) is one of Eight laboratories of the Department of Physics of the Faculty of Sciences Semlalia (FSSM) of Cadi Ayyad University Marrakech (UCAM).

The activity of the Unit of Astrophysics LPHEA structured around some main themes:

the atmospheric and optical characterization of astronomical observation site,

the Asteroseismology (especially helioseismology) and around new themes introduced recently as interferometry, the detection of exoplanets.

Keywords:

Site testing ,Construction of a seeing monitor, helioseismology

Photometric studies

Research topics

The LPHE consists of two research teams: High Energy Physics (EPHET) and Astronomy and Astrophysics (EA2). The research themes developed within the two units are:

Team High Energy Physics and Theory (EPHET)

- Physics of the Higgs boson and phenomenology of supersymmetric models
- Confinement in the theories of non abelian gauge
- Physics Hadronique.
- Electromagnetic and hadronic calorimetry.
- Nuclear Astrophysics.

Team Astronomy and Astrophysics (EA2)

- Astronomy and High Angular Resolution
- Optical and Upper Atmospheric Angular Resolution.
- Quantum Optics, Optical linear and nonlinear.
- Asteroseismology and Solar Physics
- Atomic Physics relativistic

History

1987 Selection of Oukaimeden for IRIS* French network of solar seismology

1988 Selection of Oukaimeden for site testing by the team of GONG** U.S. network

1988-1994 Oukaimeden site testing

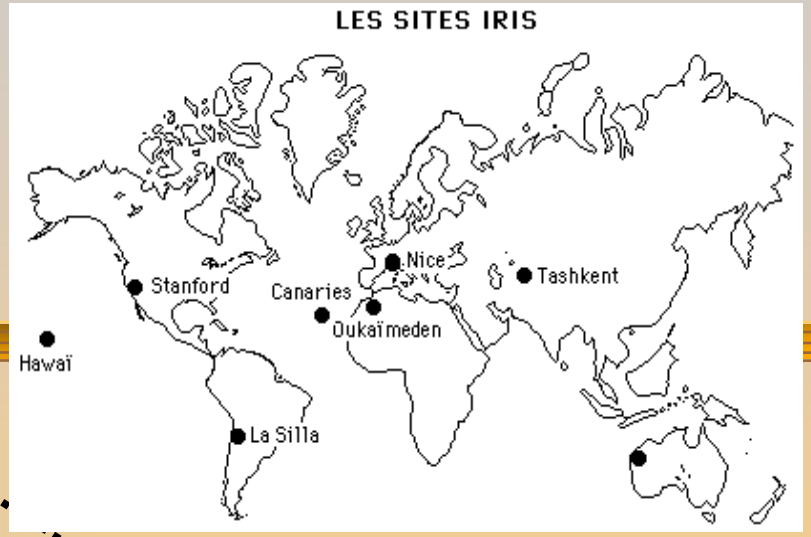
1994 Defense of the first thesis in astrophysics at the Cadi Ayyad University (Marrakesh) .

1994-1997 Moving to the Cadi Ayyad University.

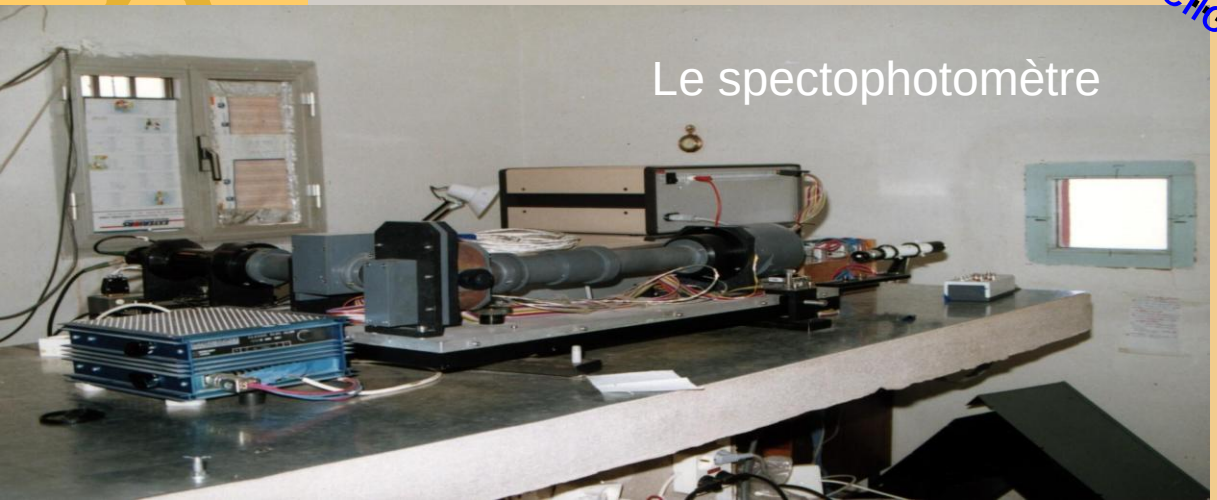
* International Research of the Interior of the Sun
** Global Oscillation Network Group

Oukaimeden observatory at 1997
IRIS experiment

Cabane abritant l'expérience



Héliostat



Le spectophotomètre

Present Situation

A laboratory of research in Cadi Ayyad University : LPHEA (18 professors and researchers (11 in Astronomy), 2 Technicians)

A College Observatory in Oukaimeden equipped with C14 Telescope with an automatic piloting system and CCD cameras.

A laboratory of Optics in the « ecole normale supérieure » for the preparation of experiences and student internships.

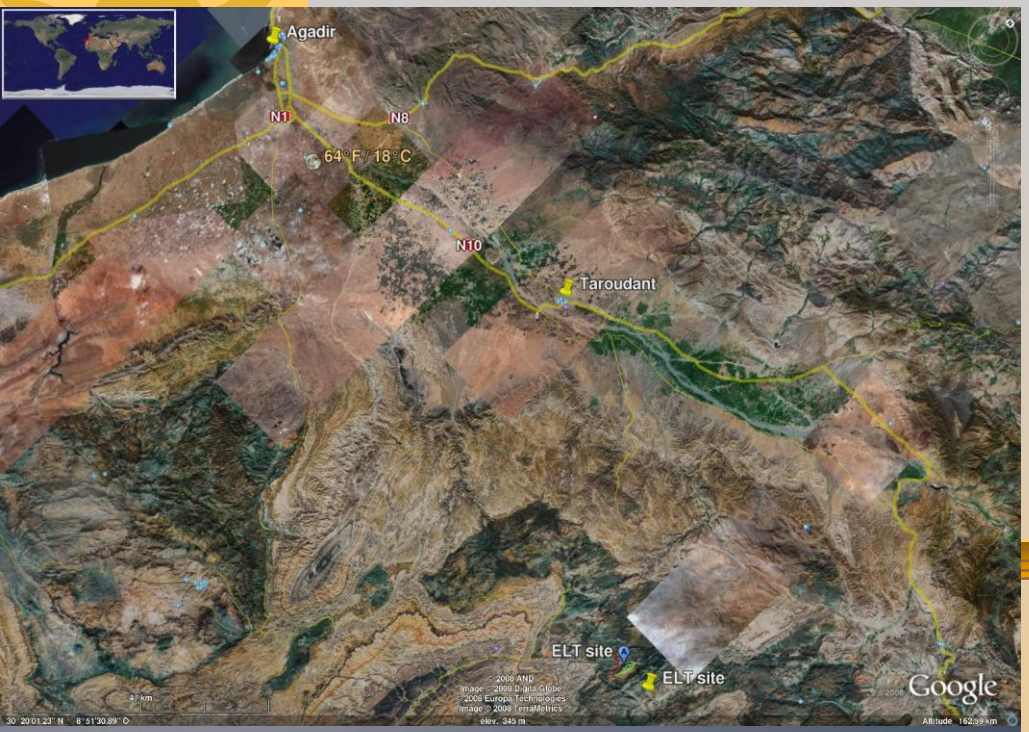
An obervation site in qualification in Jbel Aklim, candida for the installation of the ELT (European Extremely LargeTelescope)..

Post graduate training in Astrophysics (3 promotions of DESA and one UFR).

Research Contracts: European Contract, Academy Contract, ESO, PICS, PARS ...

About Fifty publications in Astrophysics

Selection of Jbel Aklim as E-ELT site candidate



Subjects currently developped

Site Testing: Maesure and modelisation of seeing, Meteorological Studies (Satellite and Meteorological Data Base)

High Angular Resolution and Interfermometry:

- Single Star Scidar
- Interferential Seeing Monitor
- Cophasing and Limit Magnitude

Extra solar planets :

- Choronography and appodisation of telescope aperture
- Transit Method

Asterosismology:

- Vibration Modes and Solar Model.

Thesis supervised

Thesis and PHD's:

2 PHD's

Jabiri Abdelhadi. (DE), «L'Oukaimeden Comme site d'Observation Astronomique : Caractérisation climatologique et optique et modélisation de la turbulence atmosphérique », Université Cadi Ayyad, FSSM, Mai 2001.

Siher El Arbi (Doctorat d'Etat), « Extraction de l'extinction Atmosphérique à Partir des données Heliosismologiques et Satellitaire », FSSM, Décembre 2004.

3 Thesis (Doctorat):

Abdelhoahed Abahamid, « Contribution à la modélisation et l'évaluation de la turbulence atmosphérique & Mise en oeuvre et exploitation d'un moniteur de seeing astronomique », FSSM, 2005.

Habib Abdelfettah, « Application de la technique du Scidar aux étoiles simples et Réalisation d'un « Single Star Scidar » », FSSM, 1-03- 2007.

Thami El Halkouj, « Vers la détection des sources Extragalactiques ...» 10 Janvier 2008.

Ongoing thesis:

Oussama Azagrouze: Exoplanétes- Choronographie

Mohamed Sabil: Site testing

Youssef Hach: Mesure et modélisation du seeing

Aziza Bounhir: Qualification de site: Aerosols et Climatologie

Colloque IAU site 2000

- 22 Countries
- 160 participants
- Proceedings Édités par ASP*

SCIENTIFIC ORGANISING COMMITTEE

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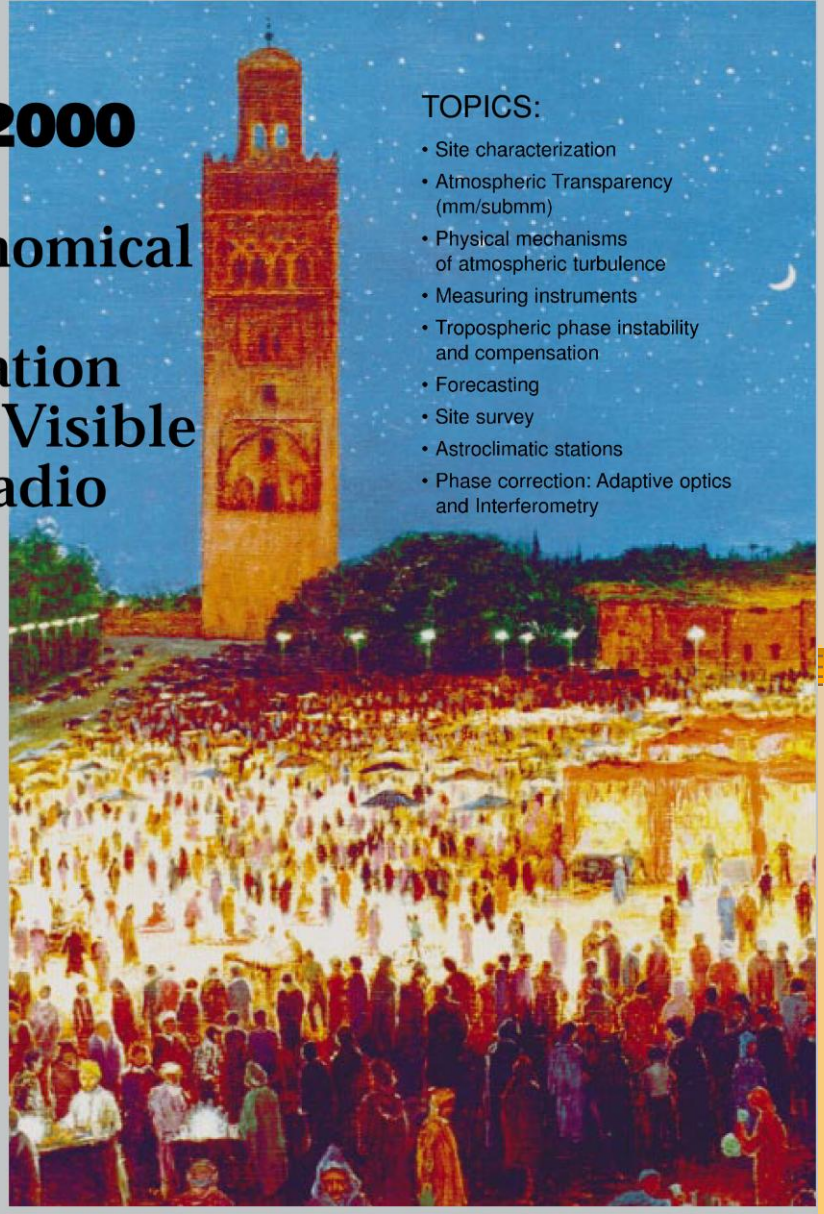
*ASP: American Society of the Pacific



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EL AZHARI Youssef,
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NAMIR Adil,
Association d'Astronomie Amateur de Marrakech.

RAZOUKI Abdelaziz,
École Normale Supérieure, Marrakech, Maroc.

TABBAAI Abdelkader,
Association d'Astronomie Amateur de Marrakech.

Contact

BENKHALDOUN Zouhair
Faculté des Sciences Semlalia
Bd Prince Moulay Abdellah
BP 2390
Marrakech 4000,
Maroc.
Tél. : 212 24 43 46 49
Fax : 212 24 43 74 10
Mél : zouhair@ucam.ac.ma

OISA

École Internationale d'Astrophysique de l'Oukaïmden
Oukaimeden International School of Astrophysics

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Oukaïmden International School of Astrophysics

1ère édition

09 au 12 mai 2007
Oukaïmden - Maroc

et

Inauguration de l'Observatoire Universitaire d'Astronomie de l'Oukaïmden

avec le soutien de

L'ASSOCIATION D'ASTRONOMIE AMATEUR DE MARRAKECH (3AM)

L'URANOSCOPE DE L'ILE DE FRANCE

CENTRE NATIONAL POUR LA RECHERCHE SCIENTIFIQUE ET TECHNIQUE

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FACULTÉ DES SCIENCES ET TECHNIQUES – MARRAKECH (FSTG)

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ÉCOLE DES HAUTES ETUDES ECONOMIQUES ET COMMERCIALES

AMBASSADE DE FRANCE

Organisée par

l'Observatoire Universitaire d'Astronomie de l'Oukaïmden

Université Cadi Ayyad

mél : zouhair@ucam.ac.ma
web : www.ucam.ac.ma/marrakechastro/oisa

2ème Circulaire

Accueil

Ce Projet de Formation Scientifique a été adopté par le Comité Scientifique de l'École de Printemps de l'Oukaimeden

Public :

L'école est destinée aux étudiants en troisième Cycle (Master, DEA, DESS, DOCTORAT), aux chercheurs et aux enseignants-chercheurs. Les cours traiteront des différents aspects de la planétologie tels que la géologie et géophysique planétaire, les sciences des atmosphères planétaires, l'observation astronomique des petits corps du système solaire et l'instrumentation des sondes spatiales. L'Ecole sera ainsi un ensemble de 8 cours de 3 heures réalisés par des planétologues de différentes universités françaises ainsi que de l'Agence spatiale Européenne.

Note :

Organiser une école de printemps, régulière au Maroc sur le thème de l'astrophysique constitue un intérêt certain pour le développement de cette science au Maroc. Après une première école d'astrophysique en 2007, la deuxième école aura pour thématique la planétologie. La formation de troisième cycle initié depuis l'année 2000 par la création de l'UFR astrophysique et Physique des Hautes Energie a permis de former plusieurs doctorants en astrophysique.

La planétologie est pour le moment peu développé au Maroc et cette école permettra de faire découvrir cette science aux étudiants et chercheurs en astrophysique ainsi qu'en Sciences de la Terre. Il pourrait ainsi être envisageable dans les années suivantes de développer dans les différentes universités marocaines un département de planétologie.

Cette école sera l'occasion ainsi de voir quelles perspectives sont envisageables pour le

Actualité

Votre inscription doit être faite avant le 20 mars 2009 Pour bénéficier des frais d'inscription réduits. De plus le nombre de participants sera limité à 30.

* Le programme préliminaire peut être consulté, il sera mis à jour ultérieurement.
* Pensez à consulter la rubrique infos pratiques

Organisation

Ces journées sont organisées par le Laboratoire d'Astrophysique et de Physique des Hautes Energie de l'Université Cadi Ayyad en collaboration avec plusieurs de ses partenaires.

Présentation

OISA, la première école d'astrophysique du genre au Maroc, a été initiée à l'occasion de la réalisation du premier observatoire universitaire d'astronomie au Maroc : l'Observatoire Universitaire de l'Oukaïmden. Sa première édition coïncidera avec l'inauguration officielle de cette institution.

En organisant cette manifestation, le Laboratoire de Physique des Hautes Énergies et Astrophysique (LPHEA) espère en faire un rendez-vous périodique qui permettra aux jeunes chercheurs locaux de côtoyer leurs pairs des différents pays de la planète.

Les cours de OISA seront assurés par des astrophysiciens de renommée internationale. Ils portent sur les thèmes :

Astronomie Observationnelle et Astrophysique

Programme

L'école se déroulera sur trois jours : deux jours de cours et une demi journée de séminaires. Chaque cours durera 2 heures, les séminaires seront d'une durée de 20 à 30 minutes.

Les participants sont invités à présenter leurs travaux de recherche sous forme de posters.

Des activités pratiques sous coupole ouverte, seront organisées les soirées du mercredi 9 et jeudi 10 mai 2007.

Mercredi 09 mai :

- Départ pour Oukaïmden — 14h00 – 15h45
- Conférence – *A. Labeyrie* — 17h00 – 18h30
- Coupole ouverte — 20h00 – 00h00

Jeudi 10 mai :

- C1 : Images et télescopes – *P. Léna* — 08h30 – 10h15
  Nouvelles cibles astrophysiques. Nécessité de la très haute résolution angulaire. Télescopes monolitiques, télescopes segmentés, hypertélescopes. Détection et traitement du signal.
- C2 : Effets atmosphériques – *J. Vernin* — 10h45 – 12h30
  Turbulence atmosphérique, propagation en milieu turbulent, scintillation, agitation. Images instantanées, pose longue.
- C3 : Optique adaptative – *A. Ziad* — 14h00 – 15h45
  Principes de base et performances, mise en œuvre, boucle d'asservissement, censeurs de front d'onde, MCAO.
- C4 : Interférométrie stellaire – *A. Labeyrie* — 16h15 – 18h00
  Synthèse d'ouverture, interférométrie grande base. Interféromètres imageurs, hypertélescopes.
- Coupole ouverte — 20h00 – 00h00

Vendredi 11 mai :

- C5 : Sismologie stellaire – *E. Fossat* — 08h30 – 10h15
  Héliosismologie et astérosismologie, méthodes physiques d'étude et résultats obtenus.
- C6 : Effets atmosphériques – C. Aime — 10h45 – 12h30
  Méthodes de détection. Caractéristiques des exoplanètes connues et conséquences. Vers l'observation directe, contraintes et pistes retenues. Résultats attendus et perspectives lointaines.
- C7 : Étude des Nébuleuses planétaires – *T. Hua* — 14h00 – 15h45
  Intérêt, détermination des propriétés physiques des NP, principe et mise en œuvre.
- C8 : Éléments de cosmologie – *Audouze* — 16h15 – 18h00
  Observation de l'expansion de l'Univers. Énergie noire, matière noire.
- Session poster — 20h00 – 00h00

Samedi 12 mai :

- Séminaires (20 minutes) — 08h30 – 10h15
  - S1 : Grands projets au sol – ELT (M. Sarazin)
  - S2 : Projets spatiaux (K. Oudrhiri)
  - S3 : Astronomie en antarctique (E. Fossat)
  - S4 : Prospection de sites (Munõz Tunõn)
- Inauguration officielle de l'observatoire — 10h45 – 12h30
- Cocktail offert par la FSSM — 14h00 – 15h45
- Retour à Marrakech — 16h15 – 18h00
- Diner de clôture offert par la mairie de Marrakech — 20h00 – 00h00

Part II: Exremly Large Telescope (ELT)

INTRODUCTION

* The parabolic mirror telescope with a diameter of 8 to 10 meters.

* The VLT (Very Large Telescope): uses several telescopes spaced parabolic mirror of a few tens of meters and the technique of interferometry to reconstruct a single image.

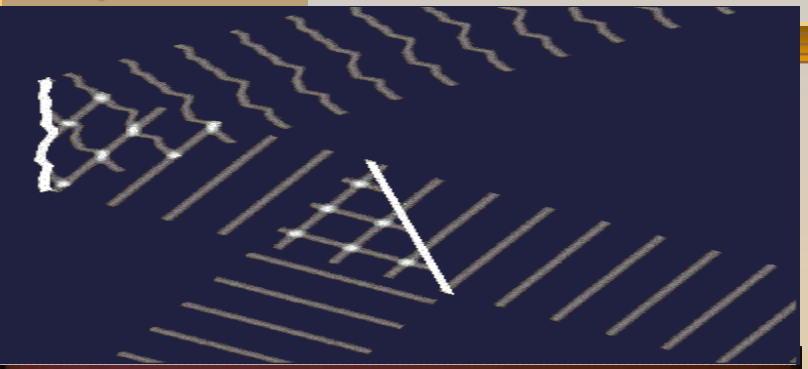
* The adaptive optical telescopes; mirror is composed of many 'small' movable mirrors. This mobility is managed by a computer that adjusts the shape of the parabolic mirror as a function of the atmospheric layer in order to gain detailed

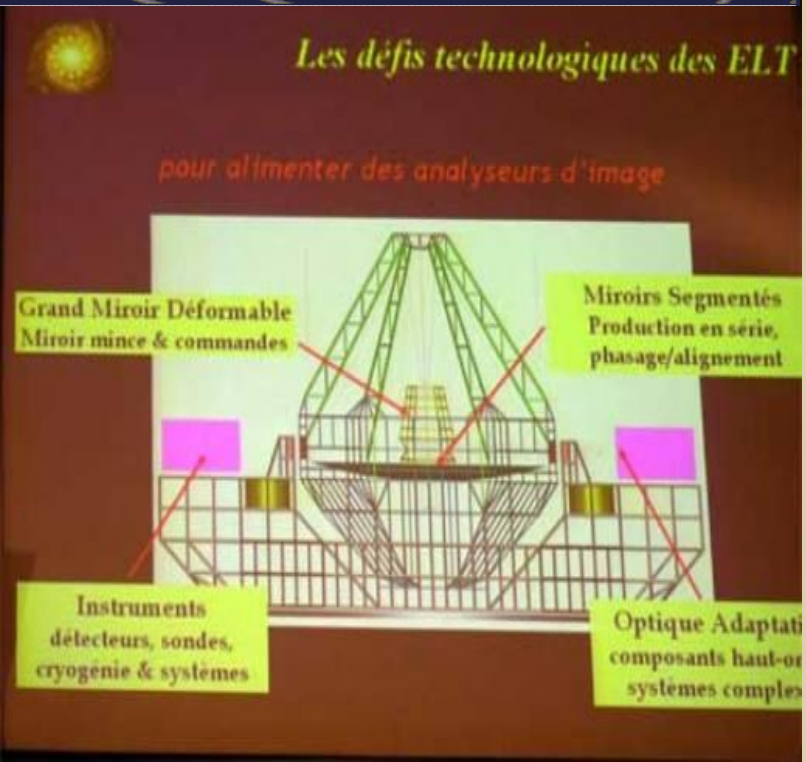
* The Space Telescope: Hubble.

ELT Why?

- The three major scientific goals of these new telescopes are:
- Understanding the emergence of complex structures and the notions of dark matter and dark energy
- Study the laws of physics at the Planck scale (approx 10-35m and 10-43 sec). With an ELT could detect a possible variation of fundamental constants
- Detection of exo planets including exo Lands.

Description ELT?



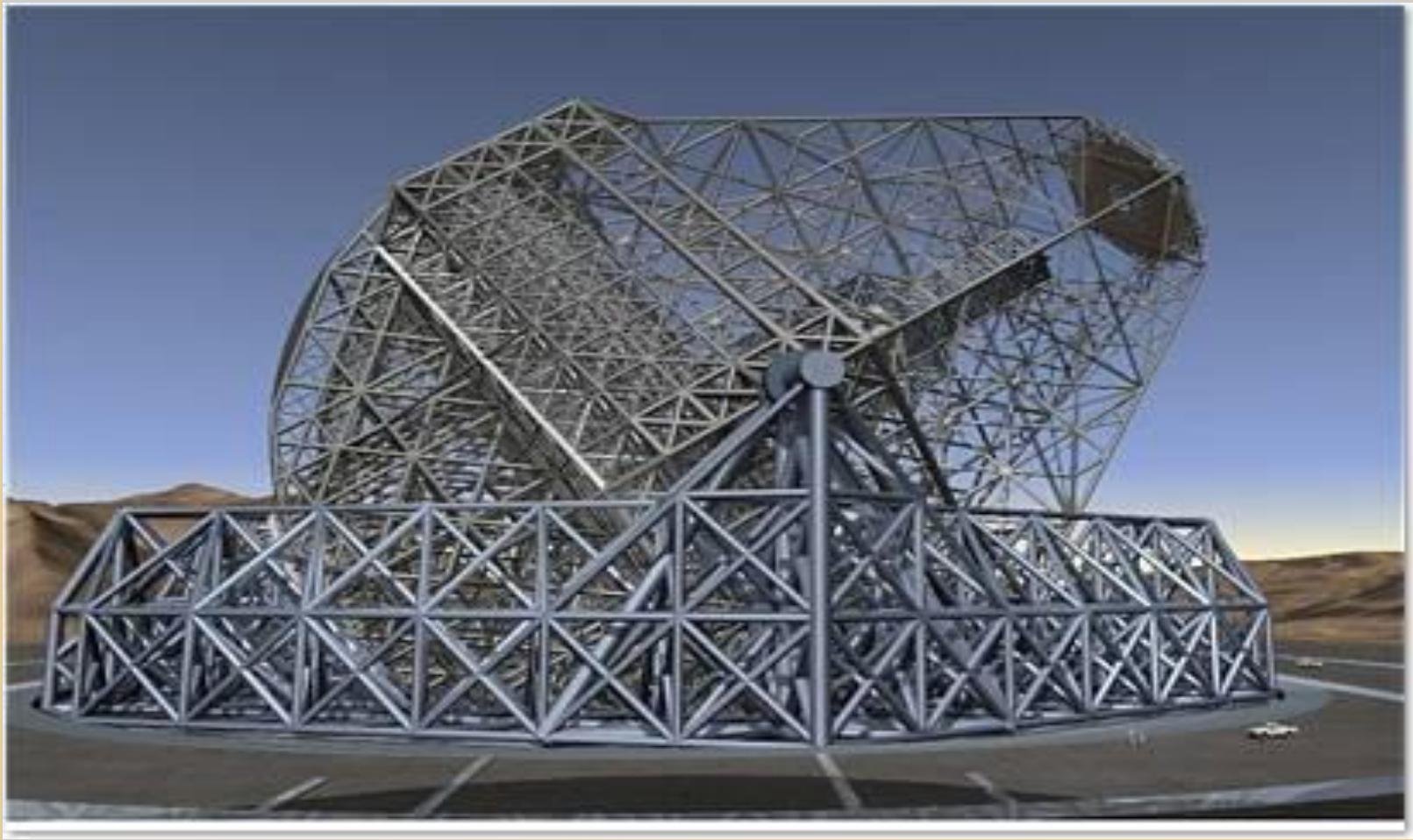


A giant mirror, an approximately 1200 square meters, will consist of a mosaic of a thousand "little mirrors" adjusted micron hexagonal close.

The instrument has an adaptive optics.

These techniques allow ground telescopes to compete with the space telescope image quality through a corrective mirror deformation to compensate for optical defects generated by the atmosphere, climate and gravity

Conceptual view of a 42m ELT



Projet du télescope ELT de l'ESO
(European Southern Observatory)

In December 2004, the ESO Council decided to build very large telescopes (ELT) in order to make Europe the leader in the field of astronomy: 42 meters in diameter whose construction will require close a billion.

The feasibility study of a telescope ELT: Jean Vernin, University of Nice and the Work Package Manager entitled 'Site Charaterrization', respectively C.Muños assisted-Tuñón (Astrophysics Institute of the Canary Islands, Spain) and M . Sarazin (ESO, Germany).

The European Community has chosen Morocco as three other countries in the world Chile, Spain, Argentina to host

large telescopes in the project 'ELT'

Qualification criteria for a site Astronomical observation

- Altitude: partially or fully quantify the effects of atmospheric turbulence
- Removal of the light sources.
- Accessibility.
- Exposure: lack of cloud cover
- Good transparency of the sky.

History: Choice of Morocco

- Choice of Morocco has made for: potentially excellent sites and local skills.
- Over the past ten years, a team of astronomers was formed at the Laboratoire d'Astrophysique (LPHE) of Marrakech, in the issue of qualification of astronomical sites
- site characterization of the Oukaimeden development including the construction of a device, the Differential Image Motion Monitor (DIMM) in collaboration with ESO.

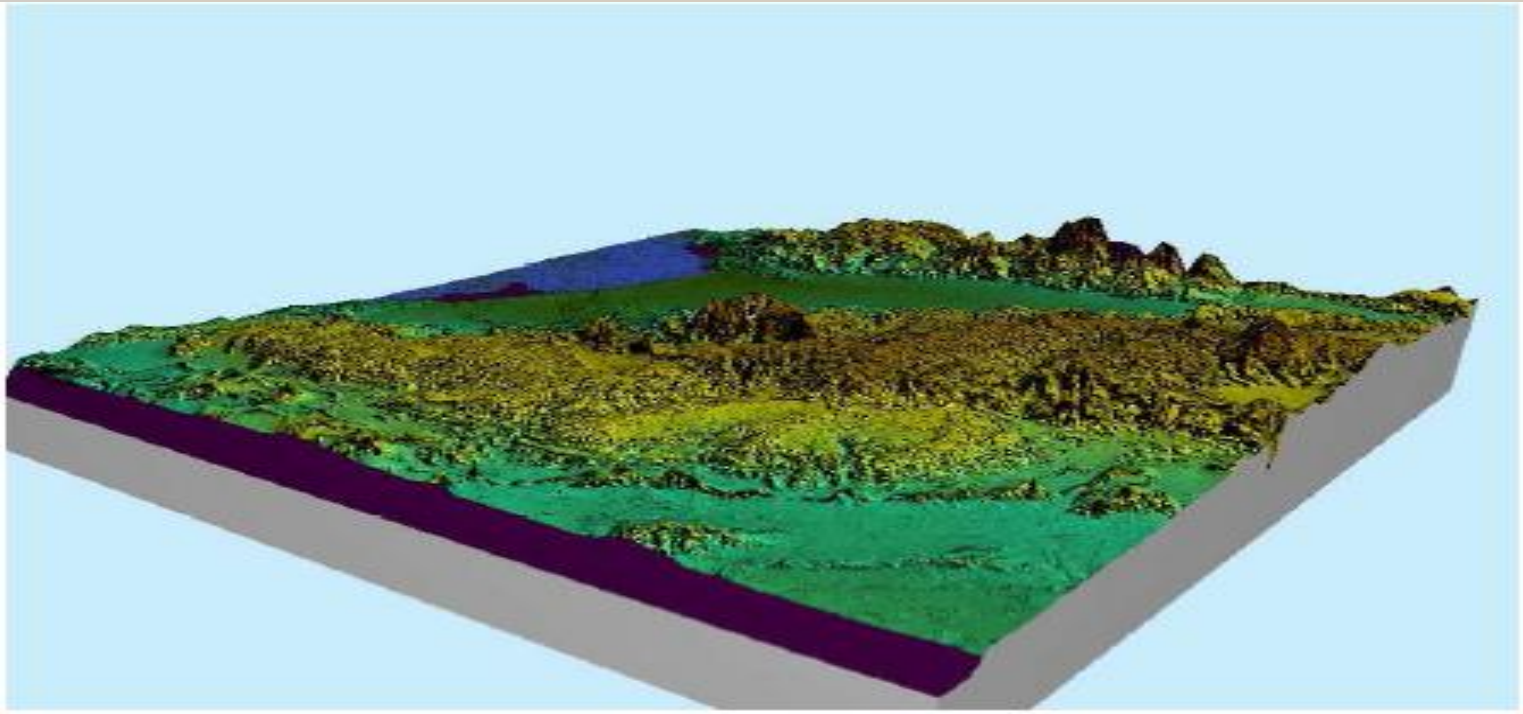
Reconnaissance missions in the region of the Anti-Atlas

- Selection on the basis of a study climate and organic permits selected a region in the Anti Atlas of Morocco.

- A primary mission of 19 to 23 December 2004, was undertaken by Mrs. Benkhaldoun, Sarasin, Siher. This mission has allowed the selection of two sites:
- * Mount lekst at 2359m near Tafraout
- * Mount Adrar aklıma located Ighrem to 2531 m.

- Team consisting of Mrs.: Benkhaloun, Benhida, Errouane,, Lazrek, Ochaaou, Sabil conducted a series of missions to the two sites
- Lkest Mont and Mont aklıma;
- Mission from 15 March to 23 March 2006
- Mission 23-27 January 2007
- Mission from 22 February to 4 March 2007
- Mission of 03 to 10 April 2007
- Mission from 11 April to 02 May 2007

3D view of the area surveyed



Vue 3D de la région prospecté

Map showing the route to reach the sites explored

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Panoramic view of Jbel LKEST (Tafraout): south of morocco

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Panoramic view of Jbel Aklim:south of morocco

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Choosing Aklım jbel

Aklım which culminates at an altitude of 2390m is part of the mountain range of Anti Atlas and the selection criteria summit aklım are:

* ease of access, the more to the west.
* No obstacle is located to the west which suggests a low mechanical turbulence as winds from the Atlantic.
* In addition to this summit has a broad plateau, which would build a pillar height of 1.20m, a cabin and the next round of 5m.

Region Aklim

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Sky Aklim

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Features Jbel aklım

- Longitude: 8 ° 18'31"west
- Latitude : 30 ° 07'39"North
- Altitude : 2393 m
- Distance from the sea about 150 km
- Form the top plate
- Rare vegetation
- Major city nearest Agadir, about 156 km road

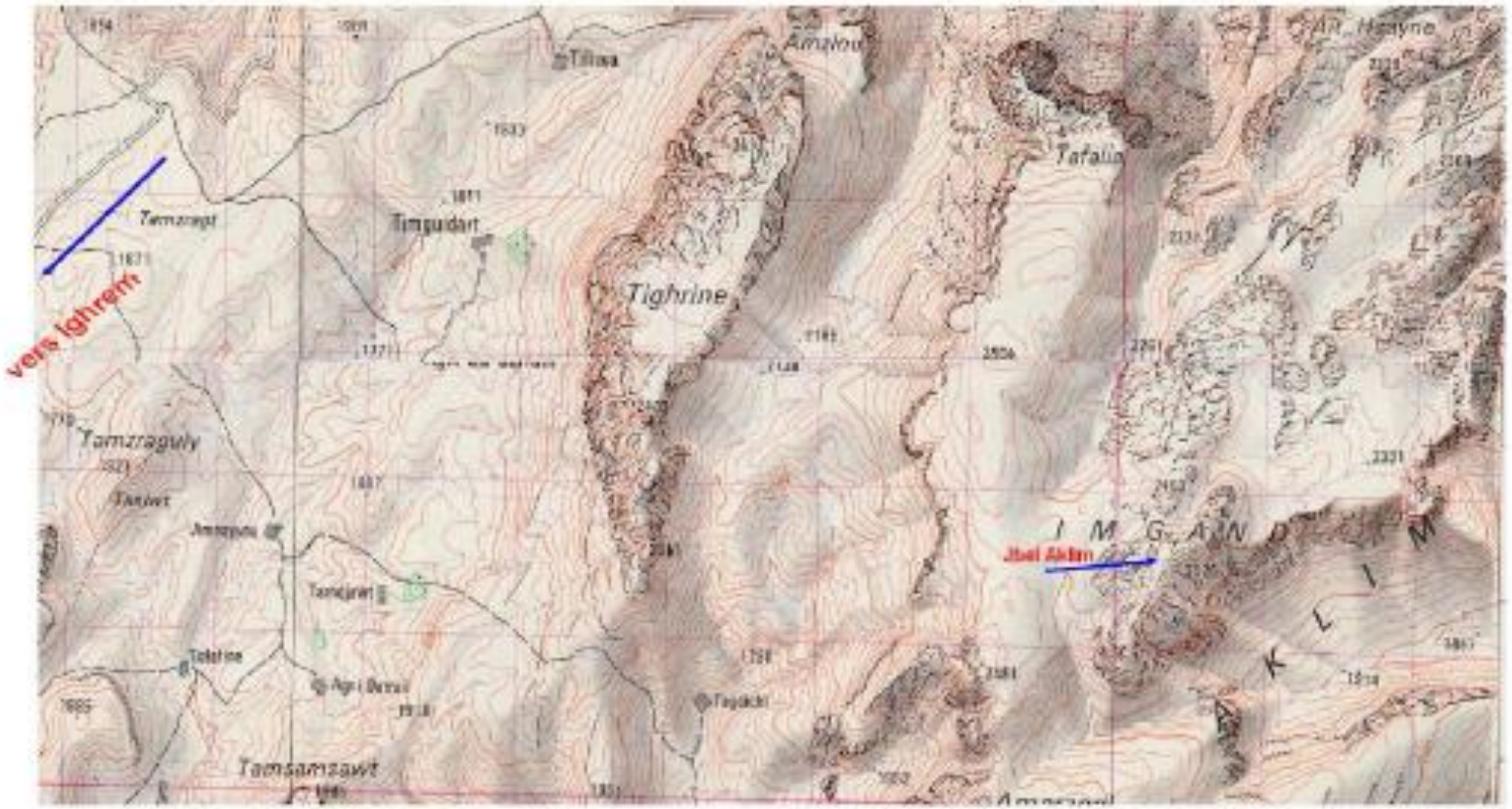
Geological and geographical situation of jbel Aklım

- The region is located in the buttonhole of Precambrian Irherm in the western Anti-Atlas, a 80 Km southeast of the town of Taroudant

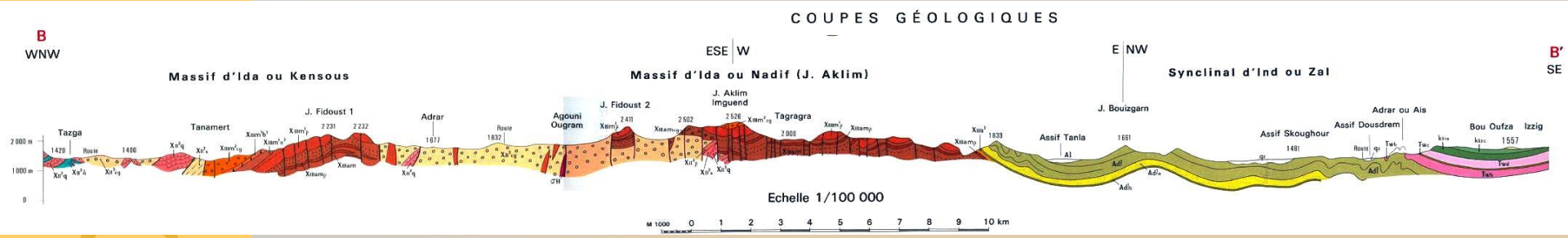
- The climate of this region is arid with low rainfall, making the water scarce and located in deep valleys, in the form of sources.

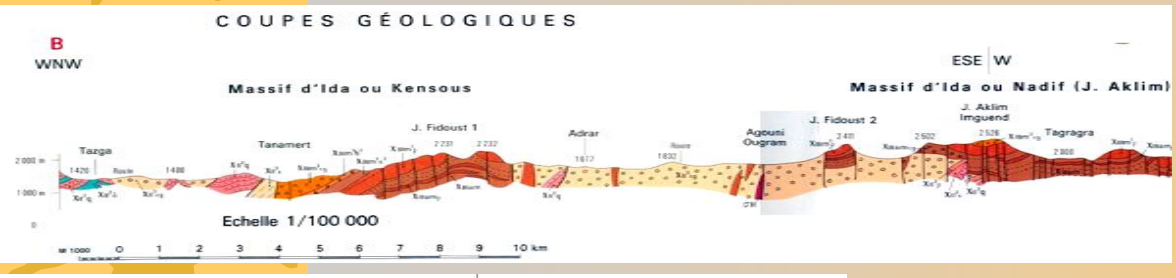
- Access roads are scarce and difficult, only two roads linking Taroudant and Tata Igherm Tafraout to allow a crossing of the longitudinal field. The other lanes are difficult to access tracks.

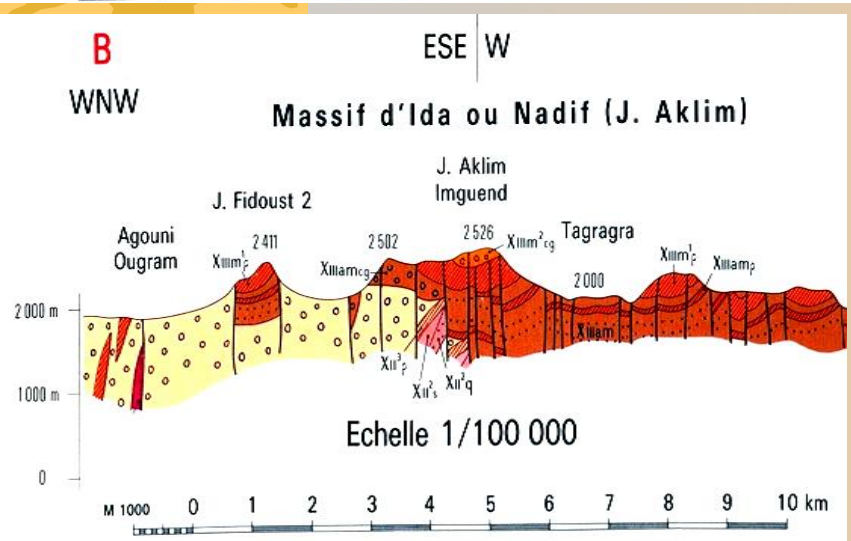
Carte géologique de la région d'Aklim à 1/50 000



Different geological cross the mountain chain Aklım



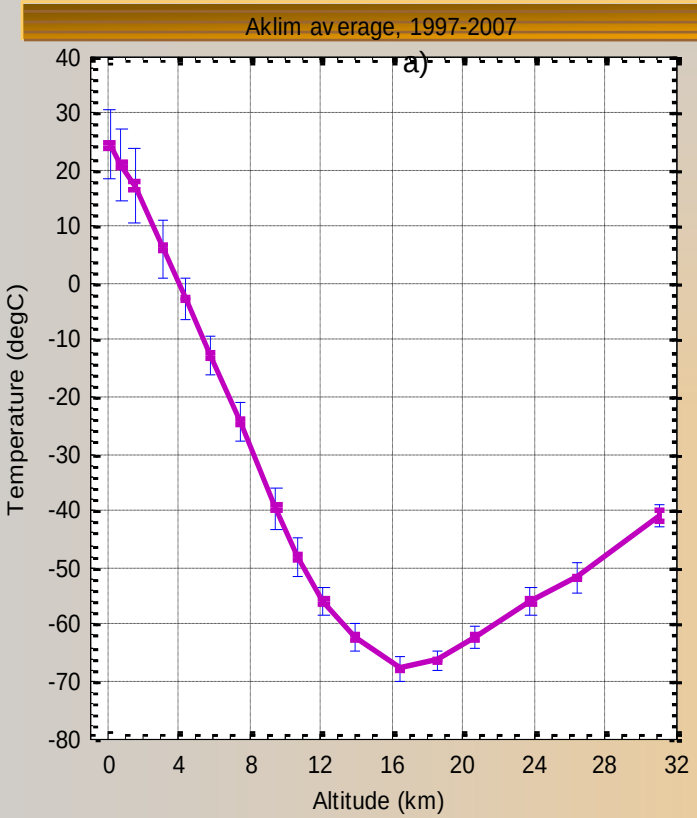


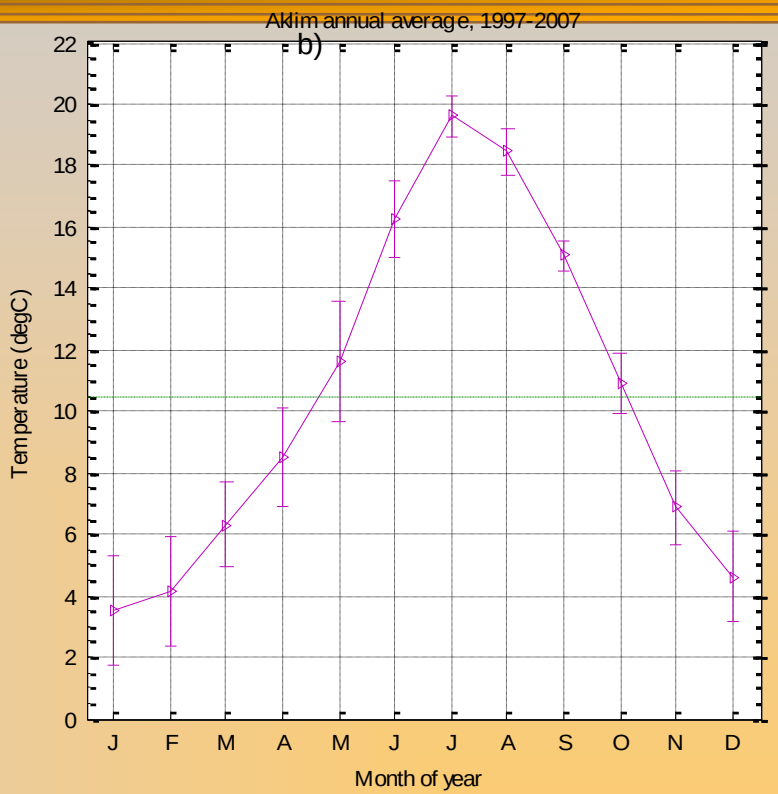


Data (GCM) Aklım weather

National Center for Environmental Prediction/National Center for Atmospheric Research NCEP/NCAR Reanalysis

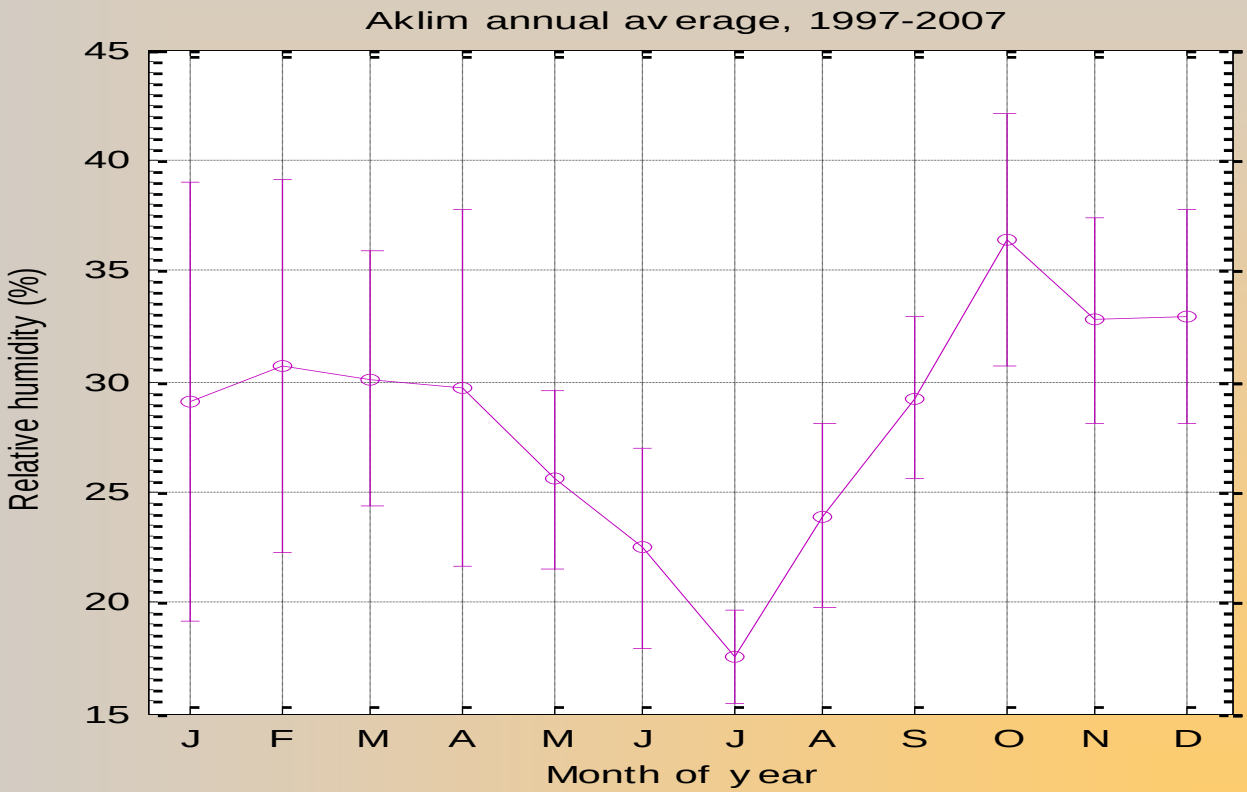
Temperature Aklim





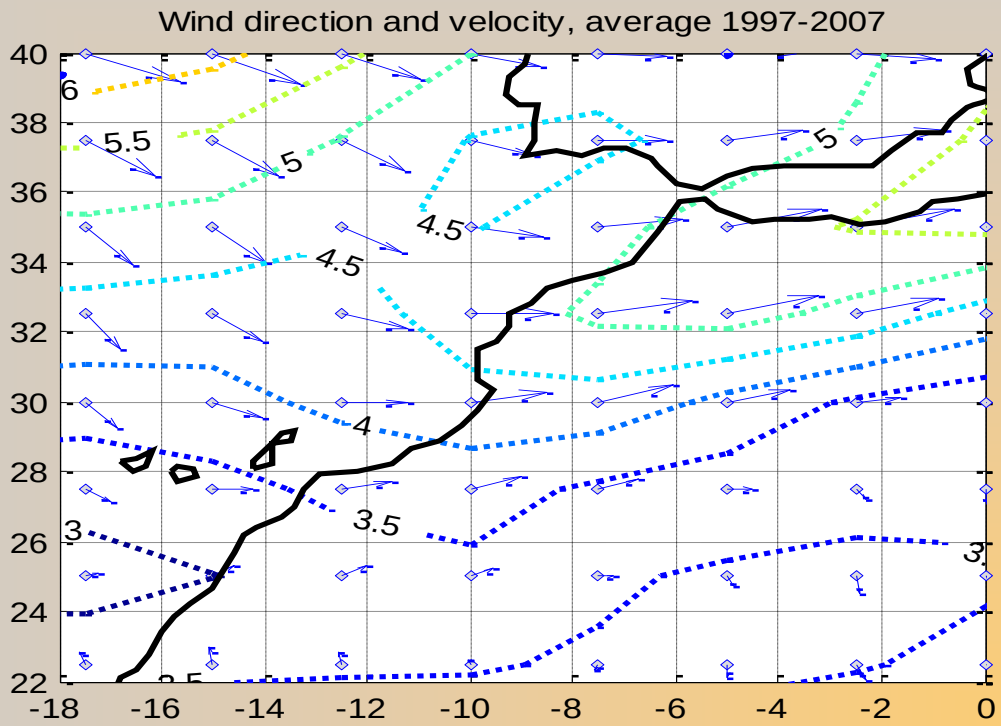
Vertical profile of the temperature over Aklim site, averaged from 1997 to 2007. Annual (short bold) and monthly (long) standard deviations are given. The temperature is in degree Celsius and the altitude in kilometres (a). Figure -b is the annual average over 11 years (1997-2007) of the temperature with standard deviations.

Relative Humidity



Monthly values of relative humidity at ground level averaged from 1997 to 2007.

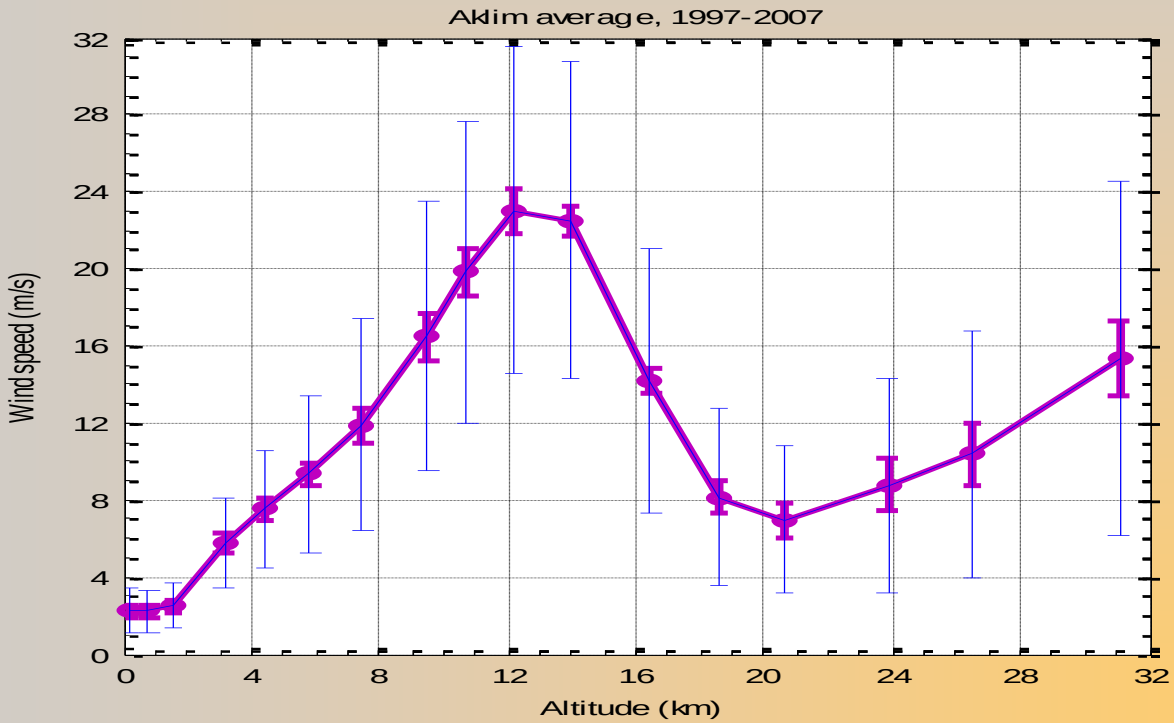
Wind direction of Aklım



Wind vectors and wind velocity iso-values featured on the map from 18 ºW to 0º and from 22 ºN to 40 ºN.

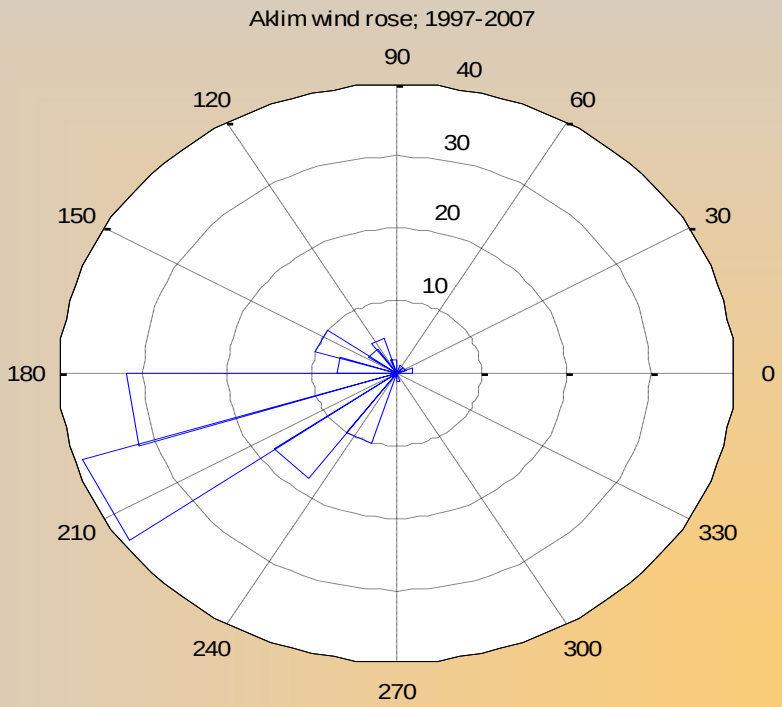
The wind is averaged over 11 years period, from 1997 to 2007

Wind speed as a function of altitude



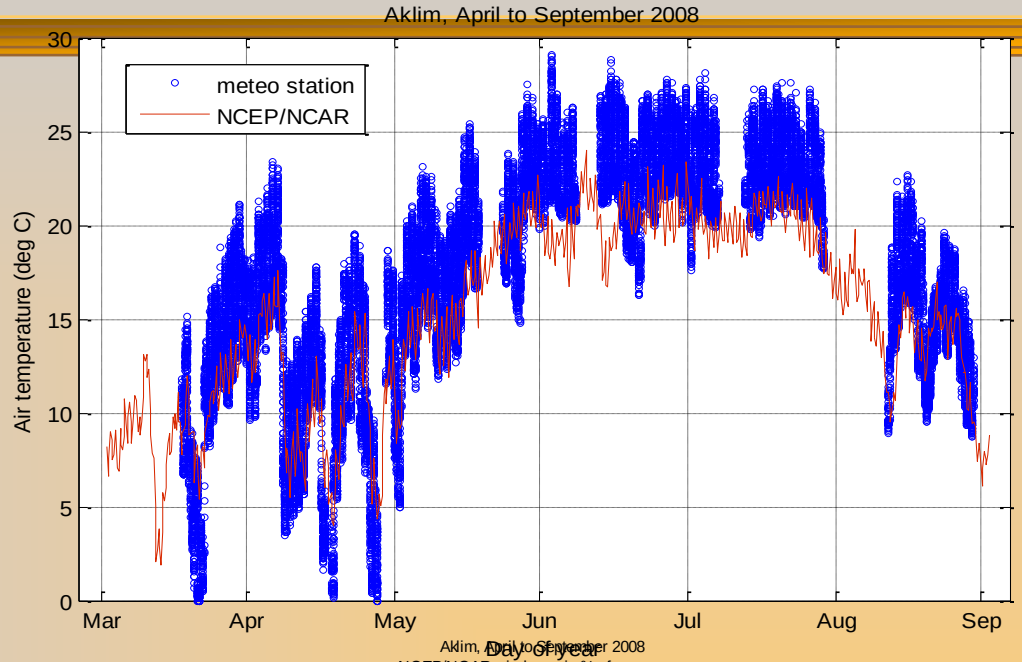
11 years average (1997-2007) wind speed

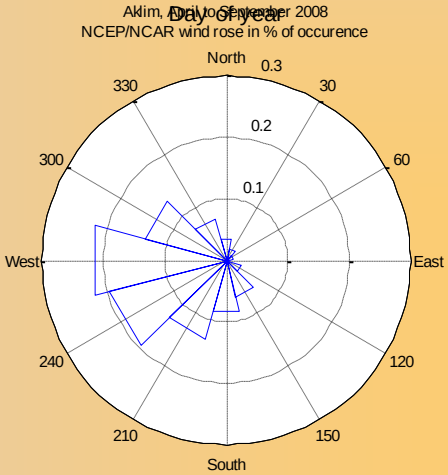
wind rose



wind rose 11 years (1997-2007)

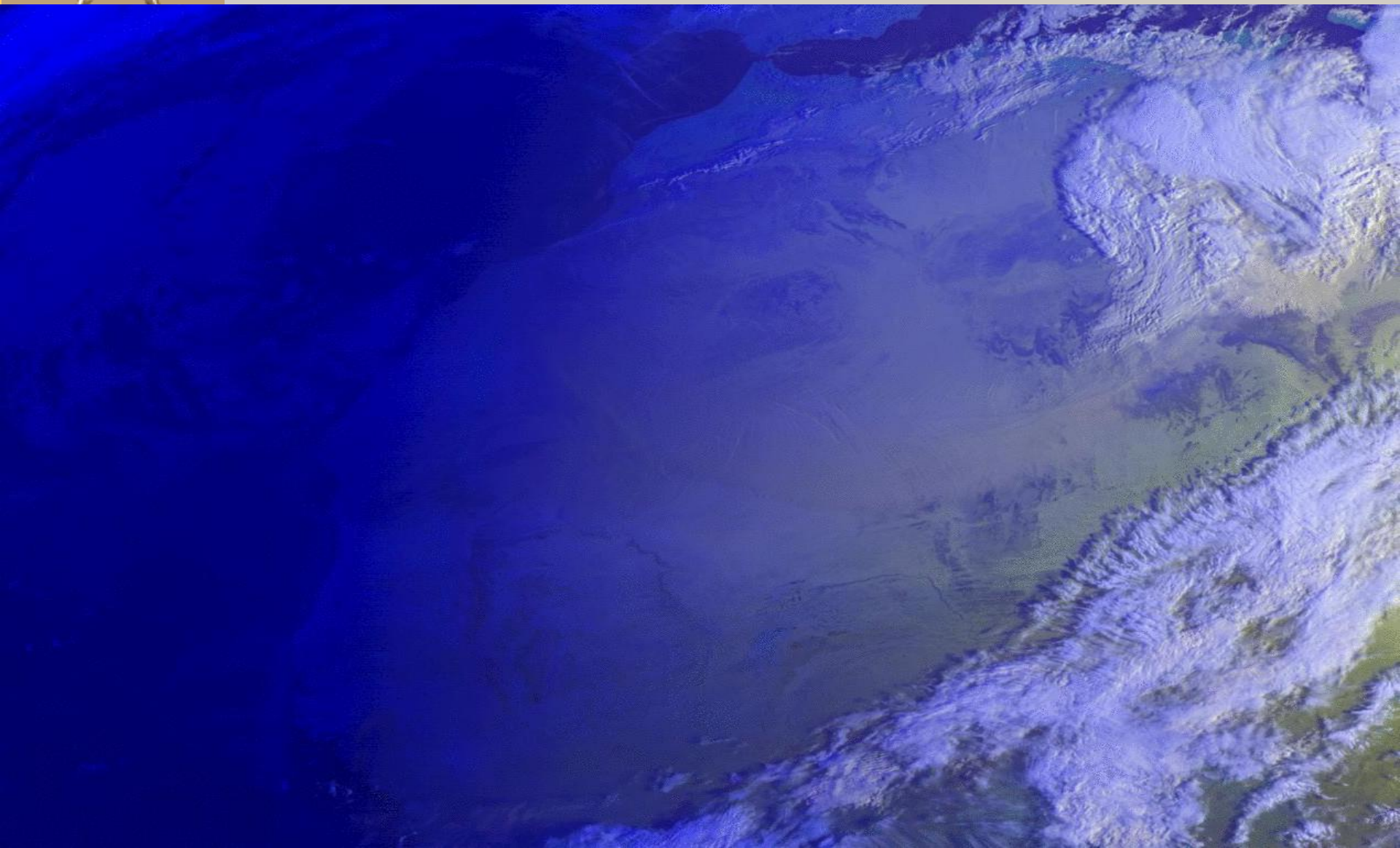
Station météo d' Aklim





Ifrane 2009

Aérosols désertiques sur Aklim



Installation of the equipment at Aklım

- Efforts of the team focused on the site of Mount aklım:
- The first mission from January 2007, were mainly for more research on the exact installation site of the future to undertake our measurements.
- Exploration of the surroundings of Mount aklım shows that on this mountain range several peaks rising to over 2390m.
- The team went up on account of difficulties of access to these peaks and thus to deliver the equipment.
- The choice was finally focused on the most easily accessible and which is also closer to the West: So the top of jbel Tighrine was selected to implement our site for future measures

Departure to the summit (village Tamdjaoute:bottom of the mountain 1870 m)

we charge as we can!

Exploration of the surroundings of Mount aklım

Ascension du Mont aklım pillar support construction of the telescope

Marketing for the Construction of a hut at the top

Just follow the Beast?

Ifrane 2009

Easy downhill!

Ifrane 2009

Who says easy!

Ifrane 2009

Construction of the support pillar of the telescope

Ifrane 2009

Building a hut at the top with local materials

Ifrane 2009

Team of astrophysics

Ifrane 2009

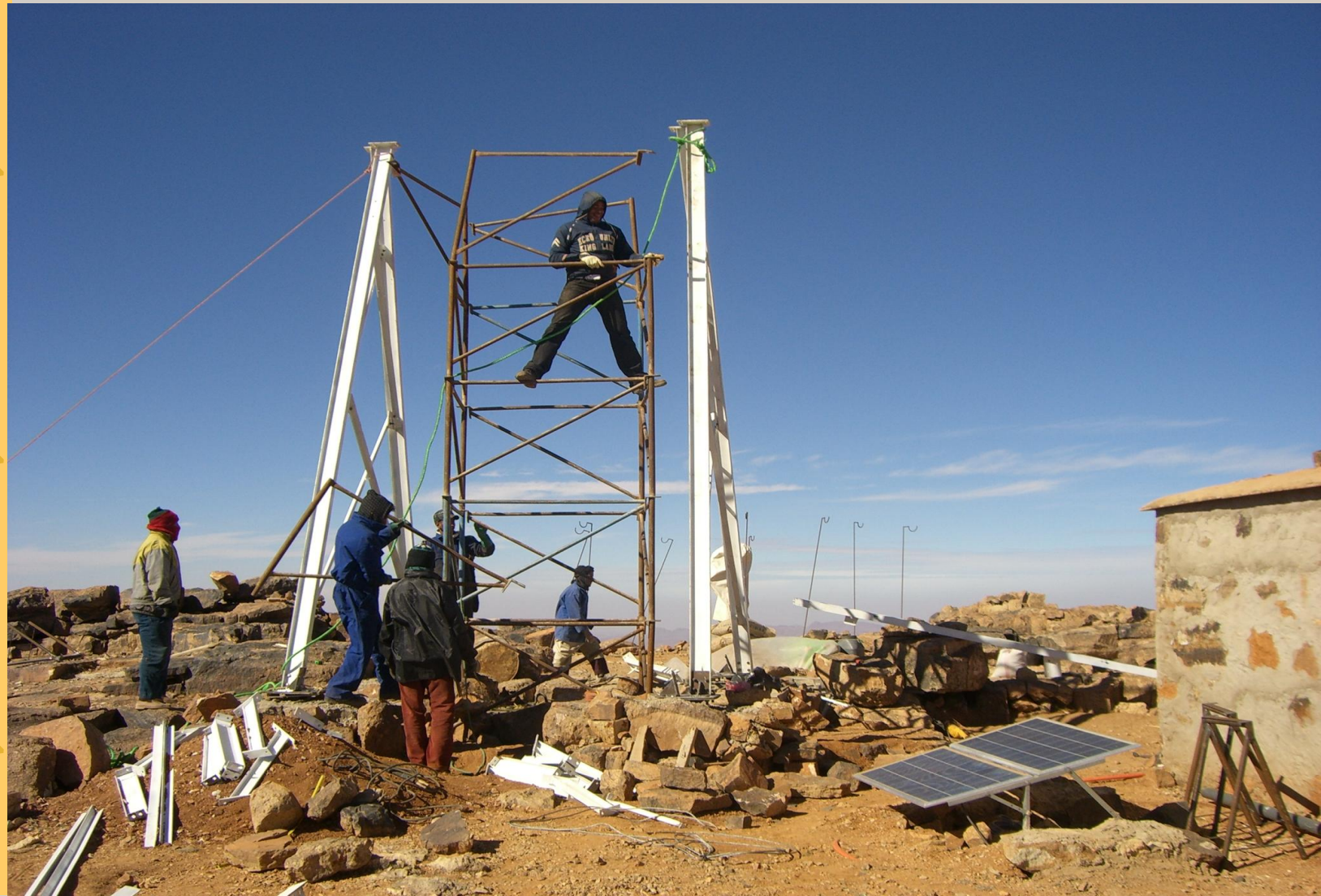
Construction of the tower

Tower:
an assembly of
Steel modules
longueu of reduced
14 February 2008

The construction of the tower height of 5m at the site of aklım to aim to avoid the effects on land values of seeing

Mechanics beast!

Everyone is there for construction!



Proud of the masterpiece!

Site Characterization

- Accurate knowledge and quantified optical effects of atmospheric turbulence is essential to optimize the observations at high angular resolution, and the choice of the best astronomical sites.
- Among the atmospheric parameters that we seek to determine
- * the profile of the structure constant of refractive index, * Fried parameter,
- * Angle isoplanétisme,
- * The time consistency of wavefront
- * The high angular resolution set by the seeing.
- these parameters can be obtained experimentally by several optical instruments such as the DIMM, the MASS, the SCIDAR

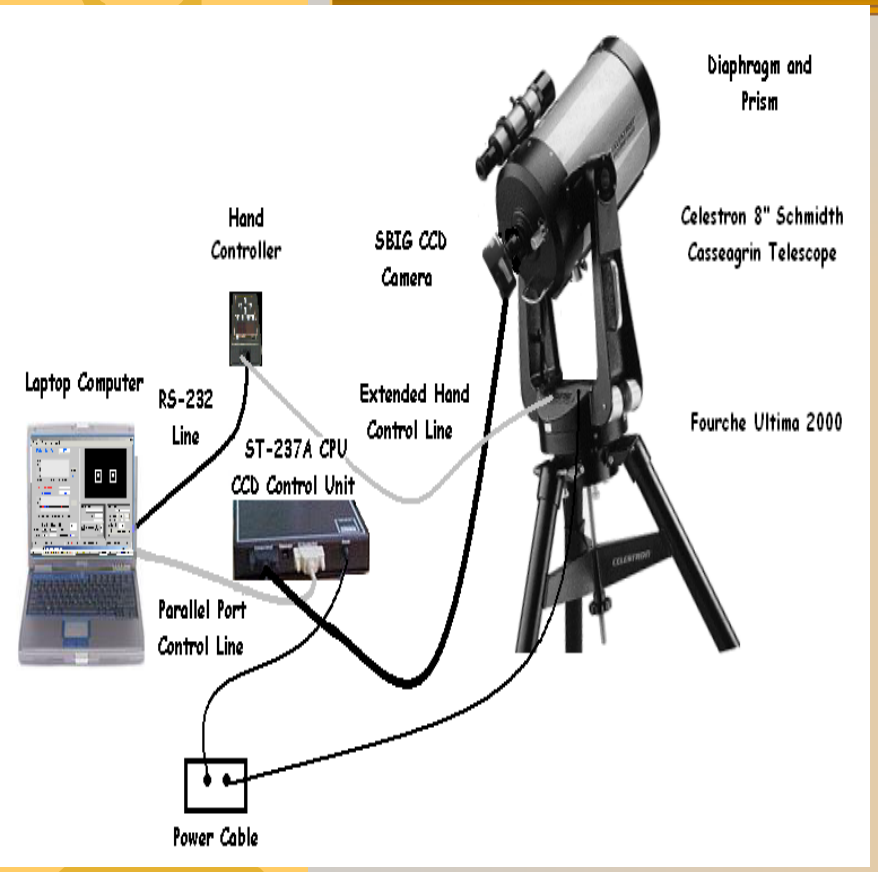
Seeing Parameter

To characterize the deformation of astronomical images, we measure the total width at half height of the intensity of a star at the focus of a telescope, this is also called the 'seeing'.

The value of the parameter Seeing is that it can quantify the integrated effect of atmospheric turbulence on the formation of astronomical images and also provides a measure of the quality of comments on a site. This parameter is independent of the instrument with which make these observations.

The seeing (in arcsecond) is a parameter equivalent to the Fried parameter, it allows to characterize the effect of atmospheric turbulence on light waves.

Measures of seeing by the DIMM



The two images of the star at home
a telescope is affected
in the same way by the movement
of the telescope, the distance between
their barycentres is not
affected by this movement.
The measurement of differential movement
of variances
(longitudinal and transverse) gives
an estimate of the Fried parameter and thus the
value of seeing

Differential Image Motion Monitor (DIMM)

Main program window

monitor Cavadore seeing during the observation

Seeing monitor analyser - v1.10 - Sept, 9th 2006

File Camera Telescope

Arcsec 1 0

03:45 03:50 03:55 04:00 04:05 04:10 04

Clear Plot | Scale auto

Amount of frame : 6 / 100 , valid seeing meas. = 2559

Airy disk radius : 20.66 µm (3.69 pixels)

Star1: X=221.41 Y=237.70 Star2: X=288.81 Y=237.62 Distance= 67.40

Centroid >> Star1: 62 pixels -> 19% Star2: 51 pixels -> 16% Flux>> Star

Star1: move from origin=2.76 Star2: move from origin=3.39

Angle 359.89 ° Parallel motion stdev : 0.37 pixels Perpendicular motion s

Total Flux Mean = 8372 Rms = 556 Xmean Pos = 253.3 Ymean Pos = 2

Seeing = 0.4 arcsec R0= 249.

mean=8.57 max=234.67 Min=1.00 | X=462 Y=18 I=11.33 | 9.92 fps | Telescope not connected

System parameters

Focal length (mm)	2032.0
Hole diameter (mm)	60.0
Hole distance (mm)	140.0
Wavelength (µm)	0.5
Pixel size (µm)	5.6
System noise (pixels)	0.0

BackGround Box definition

X left (pixels)	11
X Right (pixels)	97
Y Bottom (pixels)	21
Y Top (pixels)	51

Noise (ADU) = 1.35
Mean (ADU) = 8.6
Max (ADU) = 12.7

Acquisition parameters

Star Box (pixels)	17
Amount of frames for seeing computing	100
Signal to background noise ratio	20
Keep brightest pixels for centroid computation	
% to keep	80
Max distance from 1st meas. (pixels)	130

- Show discarded pixels when centroiding
- Force AirMass=1
- Stack incoming frames (SNR improvement)

Control

- Enable SEEING computations

- Save seeing measurments: C:\Documents and Settings\vernin\Bureau\ELT\30\Seeing.txt
- Save all measurements (X1,Y1,X2,Y2...): C:\Documents and Settings\vernin\Bureau\ELT\30\Seeing.txt

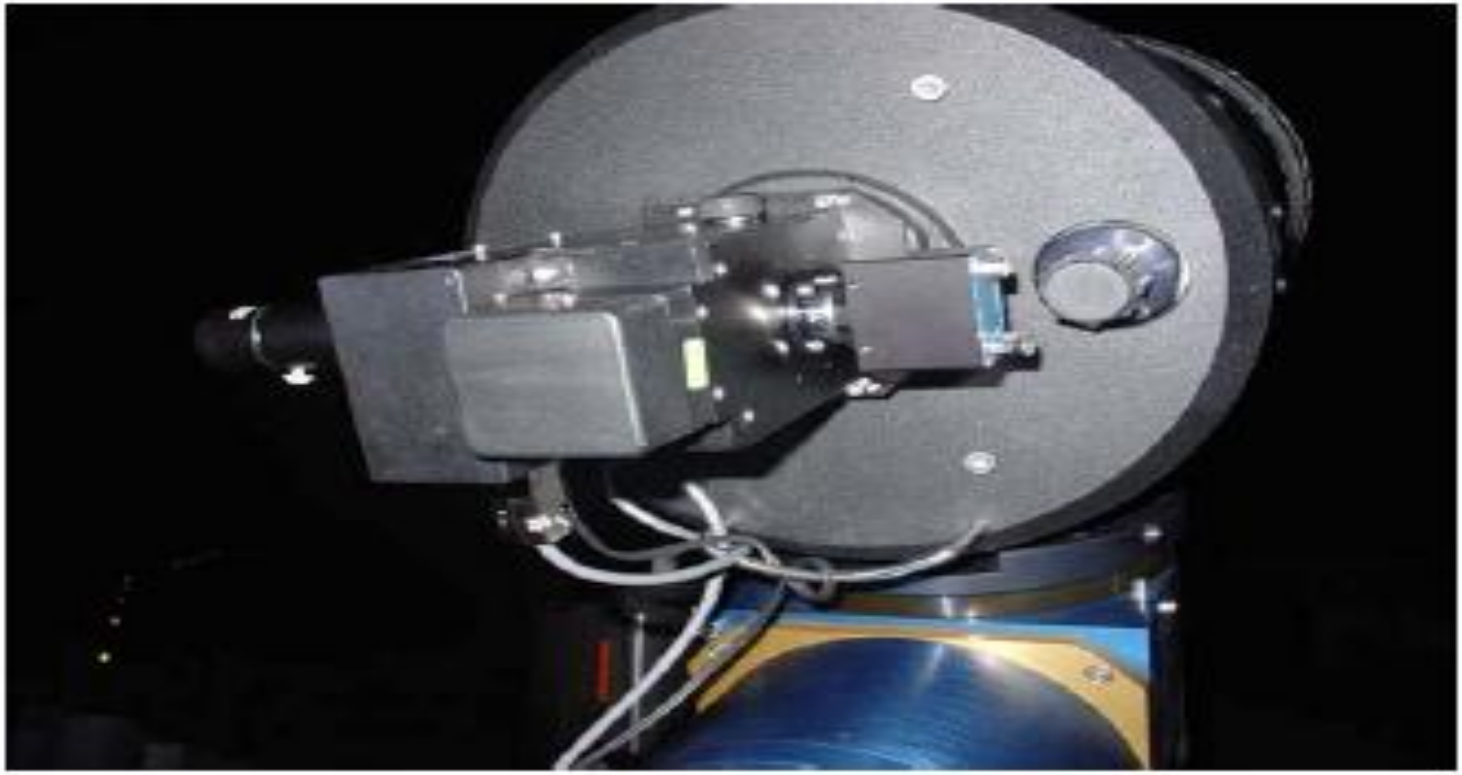
Target

Target location | Stars

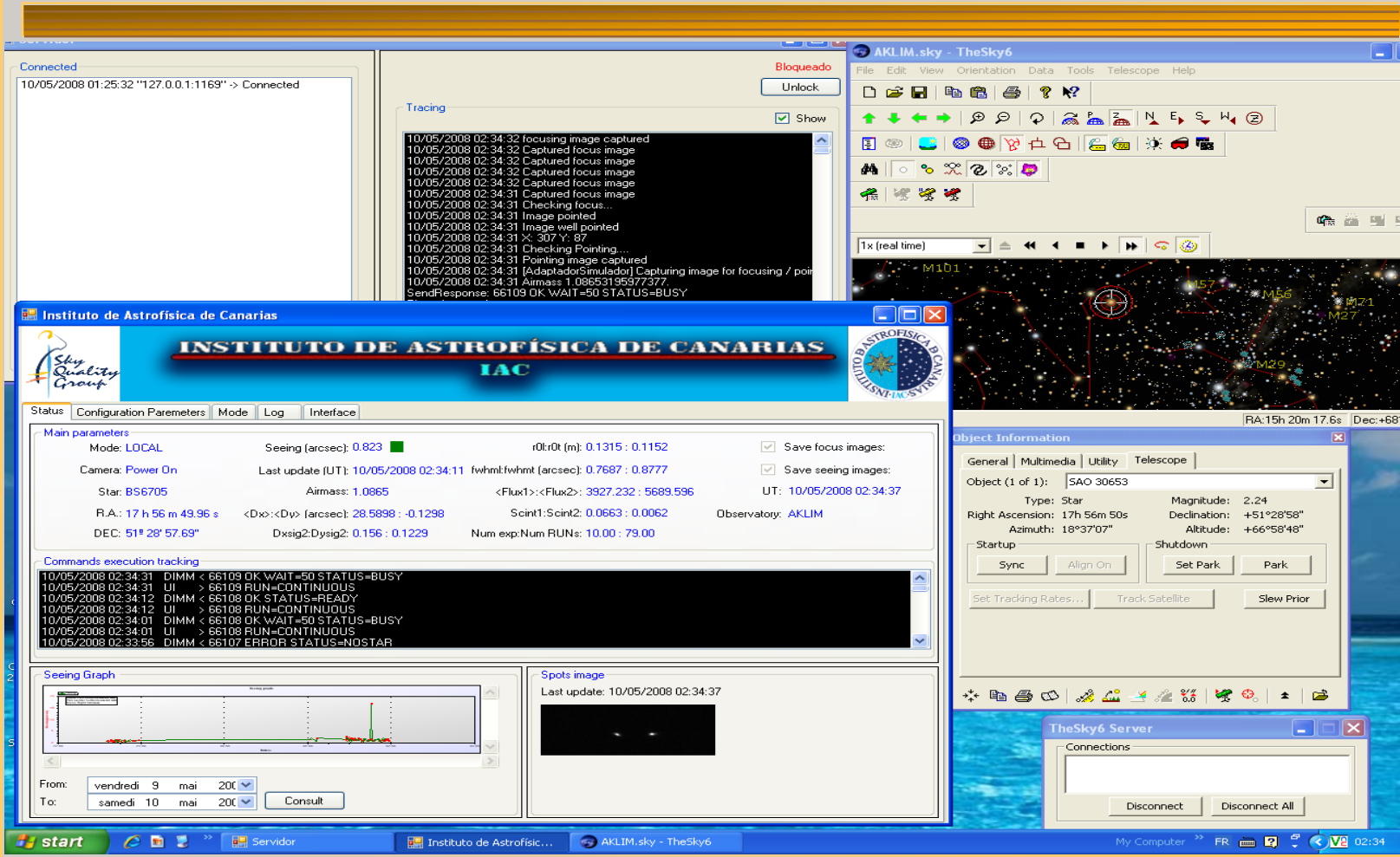
	Name	Alpha2000	Delta2000	Magnituc
4	BSC7235	19h05m24.600s	+13°51'48.00"	2.99
5	BSC6705	17h56m36.400s	+51°29'20.00"	2.23
6	BSC6536	17h30m26.000s	+52°18'05.00"	2.79
7	BSC6148	16h30m13.200s	+21°29'23.00"	2.77
8	BSC7528	19h44m58.500s	+45°07'51.00"	2.87

démarrer | Seeing Monitor | SkyMap Pro - [Map1] | C:\Documents and Se... | FR | 04:04

AC DIMM
connected to a camera pixelFly



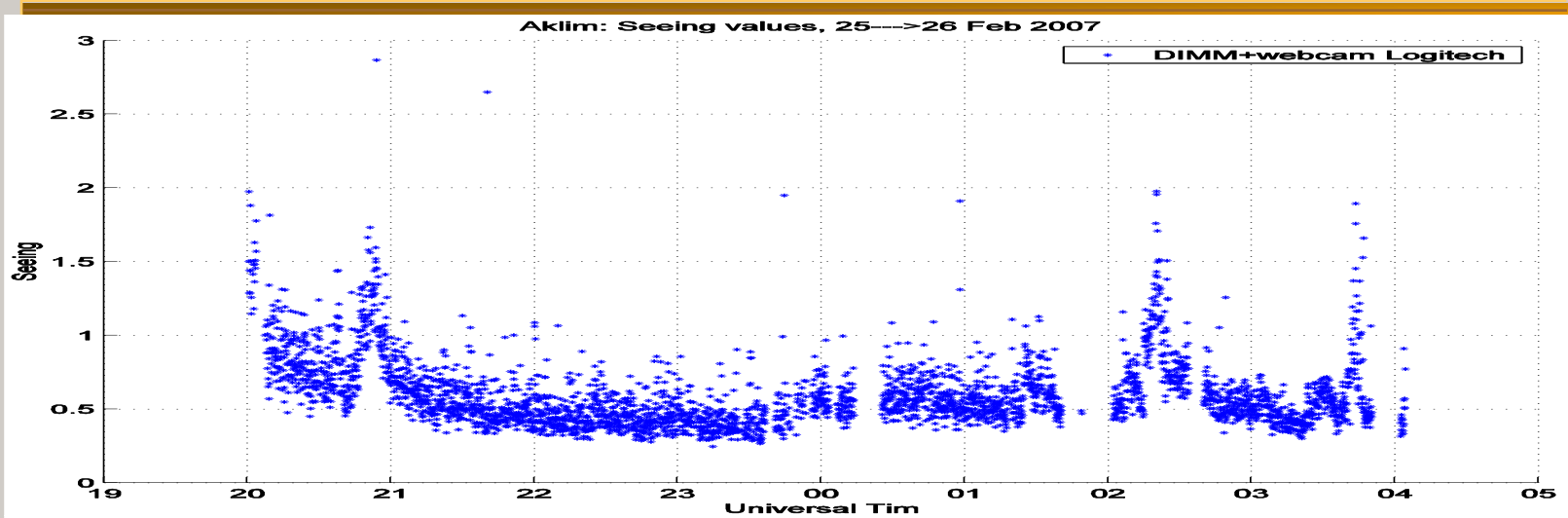
Main program window monitor DIMM IAC seeing during the observation

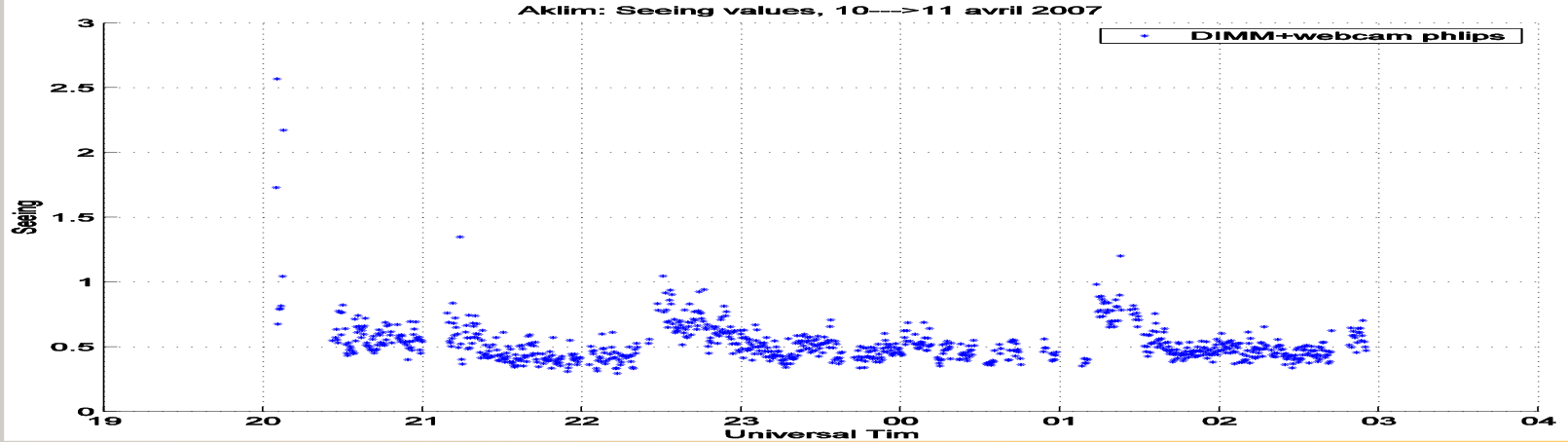


Technical parameters of two DIMMs of Ak lim cross calibration campaign.

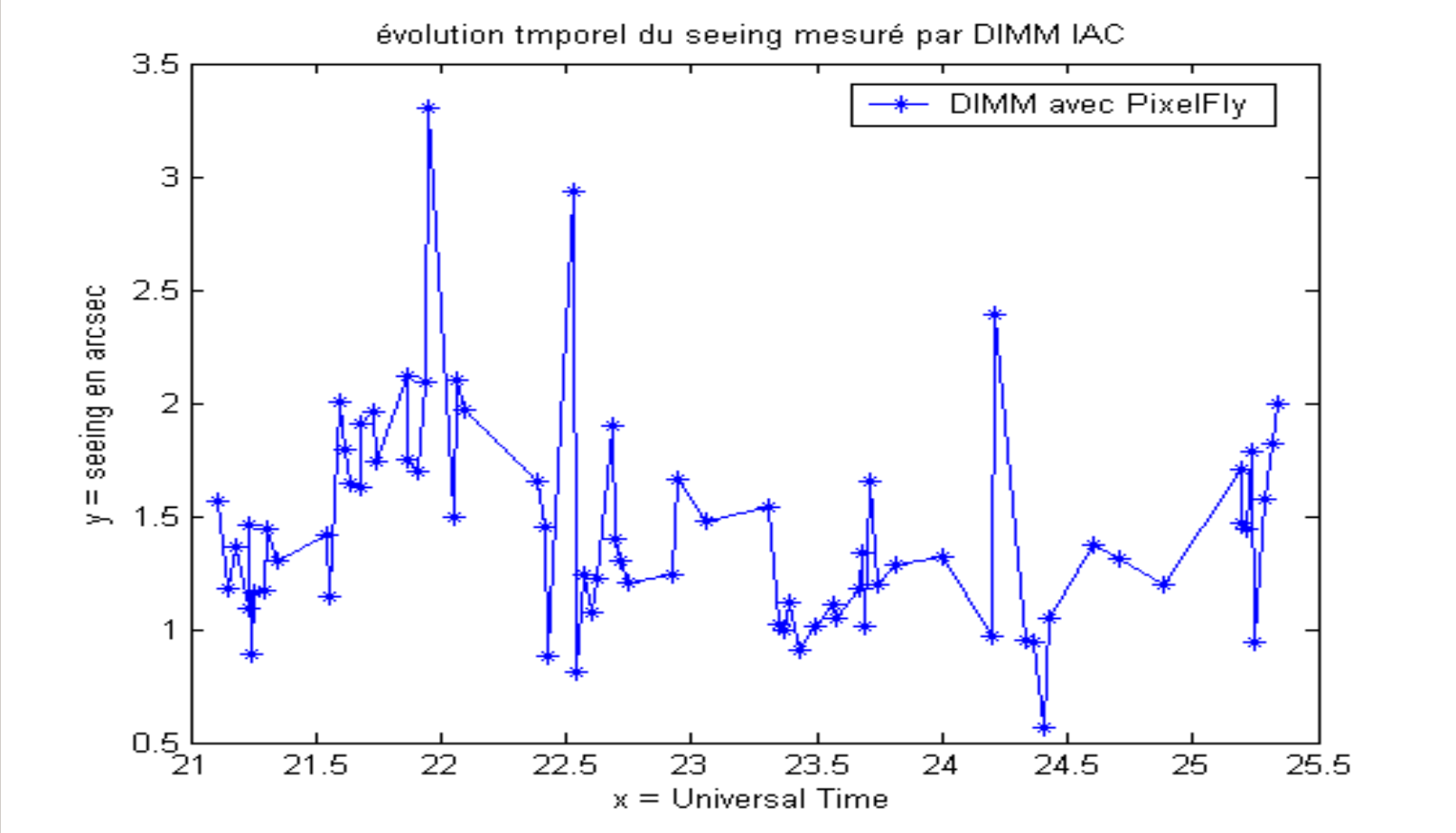
Seeing Monitors	DIMM1 (LPHEA)	DIMM (IAC)
Telescope Model	8'' Celestron	11'' Celestron
Focal Length	2.032m	2.8m
Diameter	20.3cm	2 cm
Mount Type	2000 Ultima Fork (Equatorial)	HGM200 Losmandy
Pupil Diameter	6 cm	6 cm
Baseline	14 cm	20 cm
Camera model	WebCam Philips toCam	PixelFly
Pixel Array	640x480	657x495
Pixel Size (arcsec/pixel)	0.551	0.728
Sorware	Seeing monitor (LPHEA)	DIMM-IAC
Port Link	USB	Cable RG45

Example of temporal evolution of seeing the site Aklım April 2007

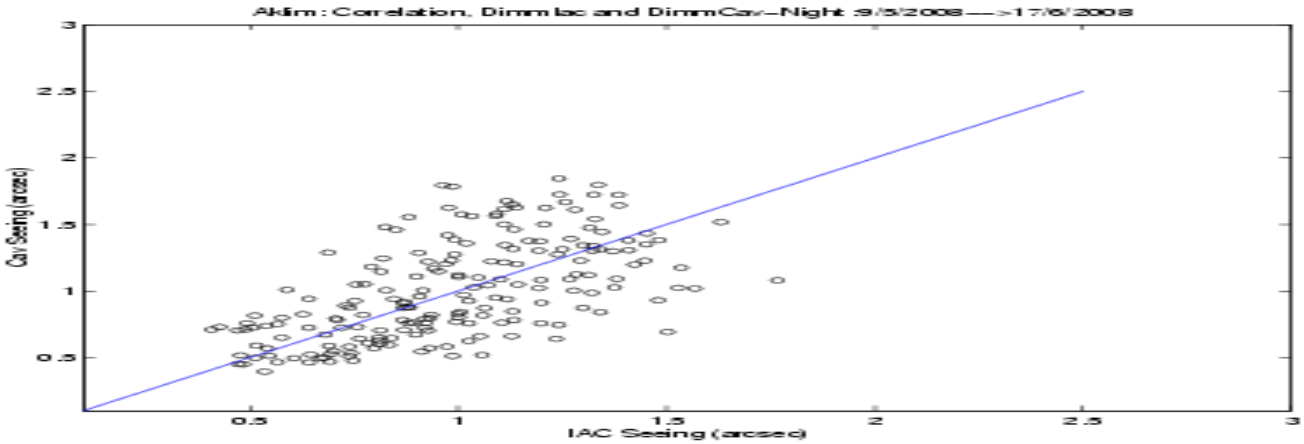




The temporal evolution of Seeing during the night of 10 to 11 May 2008 measured by IAC DIMM



Correlation between the seeing given by DIMIAC and the DIMMcavador.



Instrumentation

MASS-DIMM instruments

9 MASS-DIMMs
are being made
at CTIO+SAI

First light: Oct. 3, 2003

ESO Workshop, Oct 13 2003

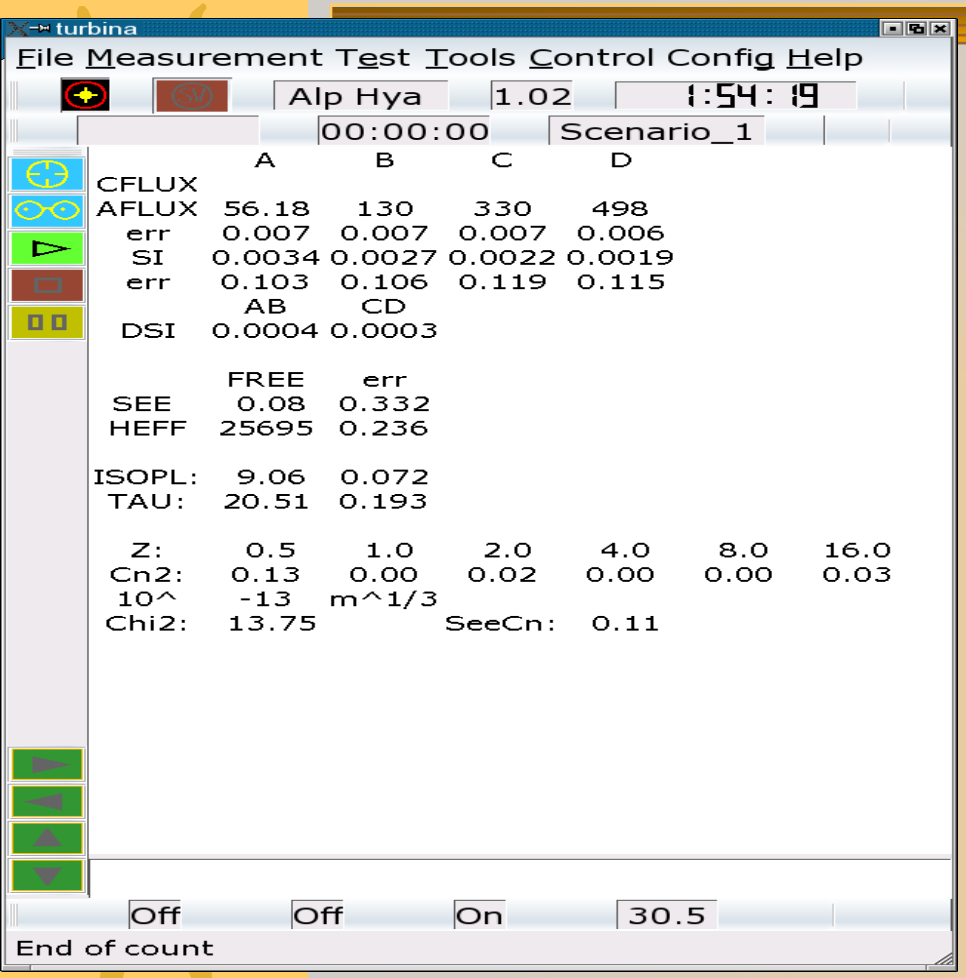
Control Tower

The source of energy

Aklım site is solar energy

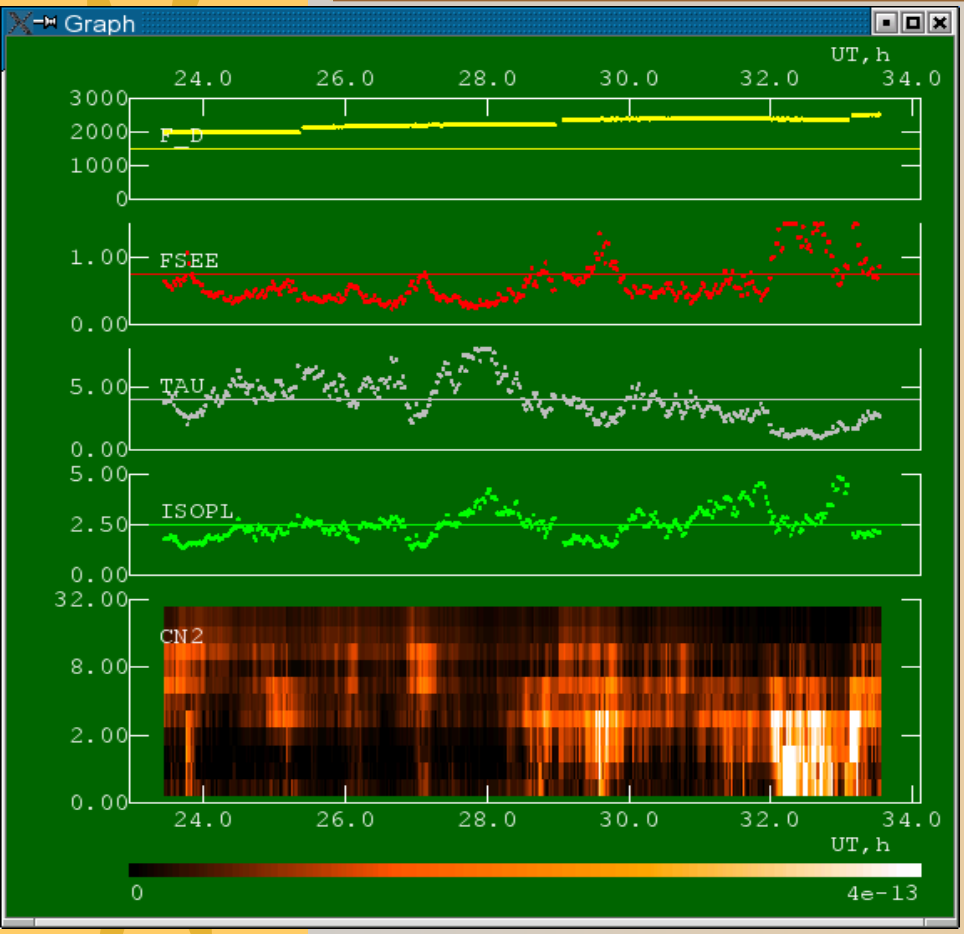
Solar Panel
Solar controller and inverter
Rechargeable Batteries

GUI window for the MASS software Turbina



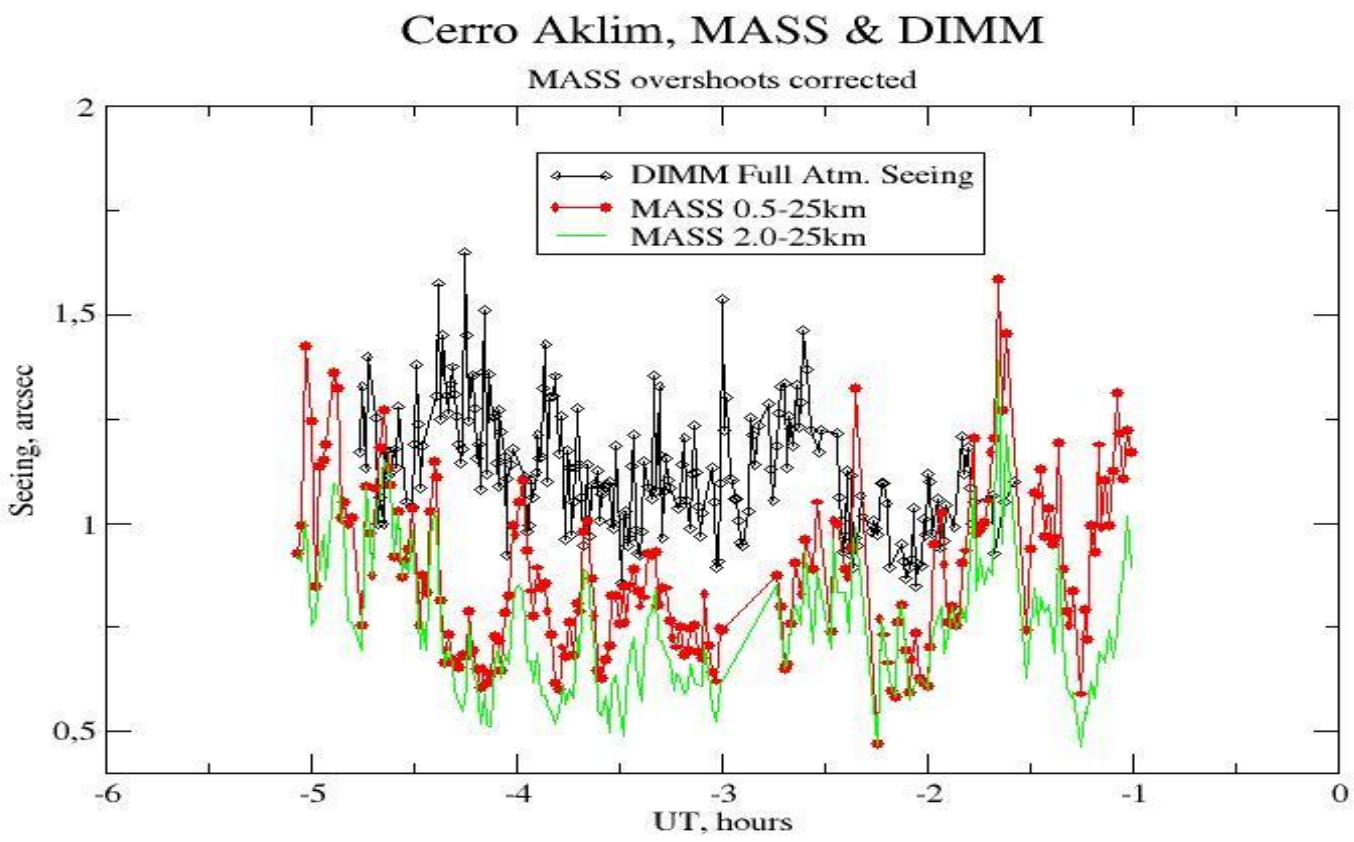
CFLUX: the flow of the star.
SEE: the seeing.
Z: altitude.
Cn2 the structure constant fluctuations of the refractive index of air.

Graph window during a night of observation



Monitor MASS seeing can measure worth seeing by every minute with intermediate values for each 10s.
All settings are made using the main program window Turbina:
Choice of star, one selects from a predefined list on the GUI of Turbina.
Data recording is done automatically.
Display results of atmospheric parameters in real time.

Measurement of seeing by Mass-Dimm: Aklım



Perspectives

* Continue the measurement campaign
* Data processing measures
-DIMM
-MASS
* Installation of new measures
characterization for the qualification of the site:
Seeing of the new SIM method
-Photometrye

We have a dream !

Project ELT telescope of ESO: Morocco