# Astronomy: from Networks to the Grid

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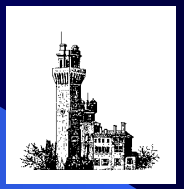
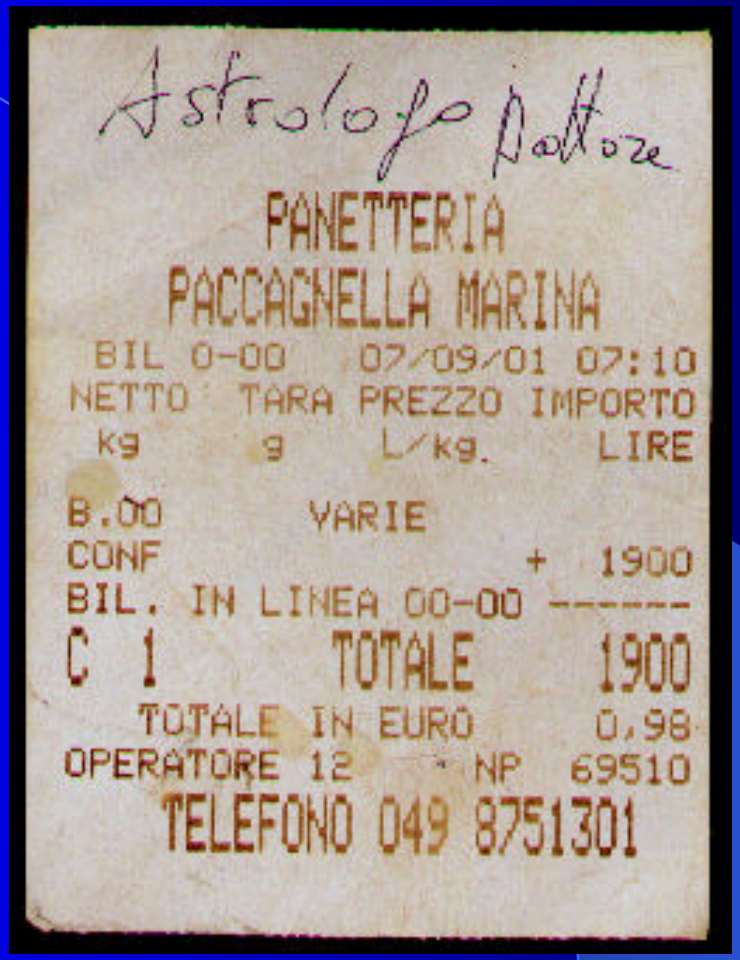


# What really Astronomy is ?

# .. What ‘bout instruments ...

# .. And what ***really*** people think astronomers are…



# What Astronomy really is …

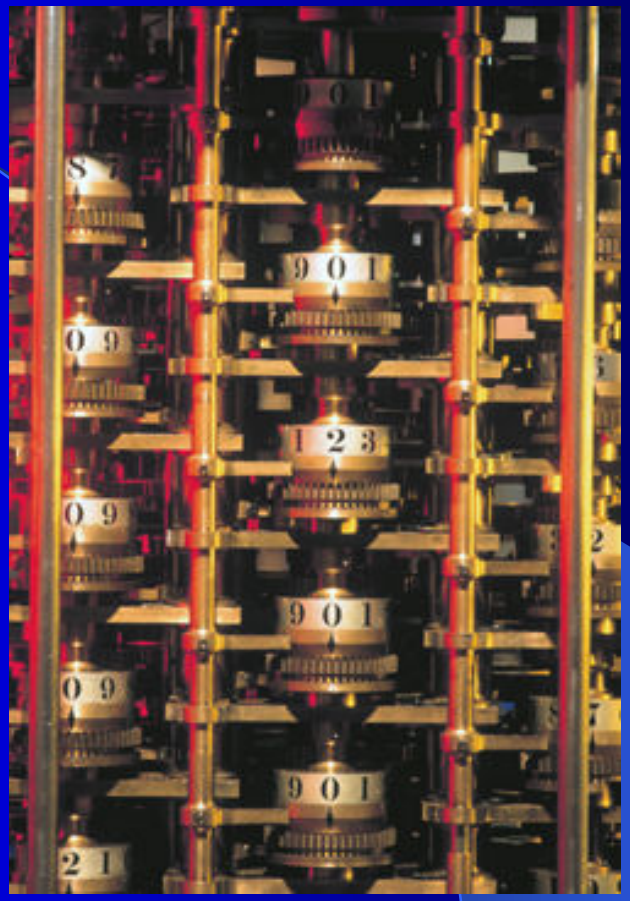
**1 : Machinery**

**2 : Communication**

# Once upon a time
# up to date supercomputer

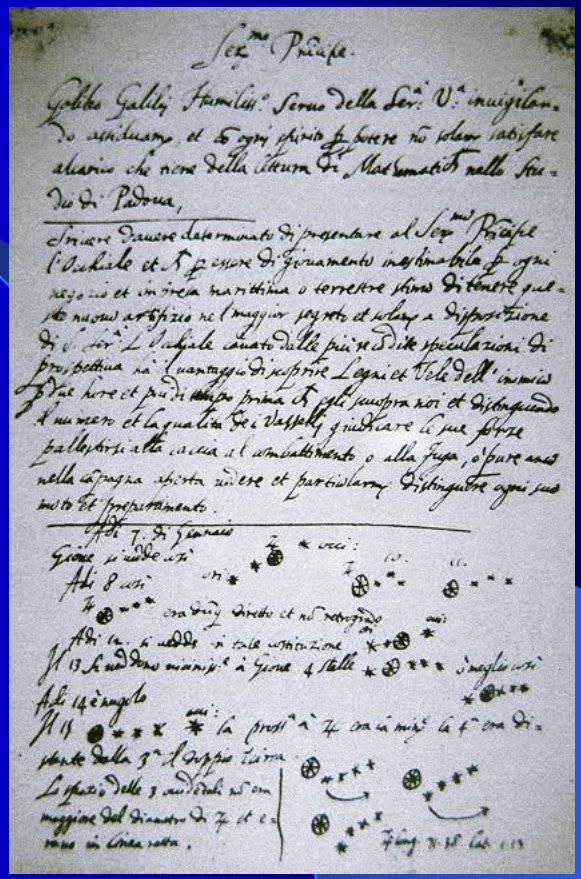
# More recent efforts : ephemeredes

# The mother of all the cpu’s



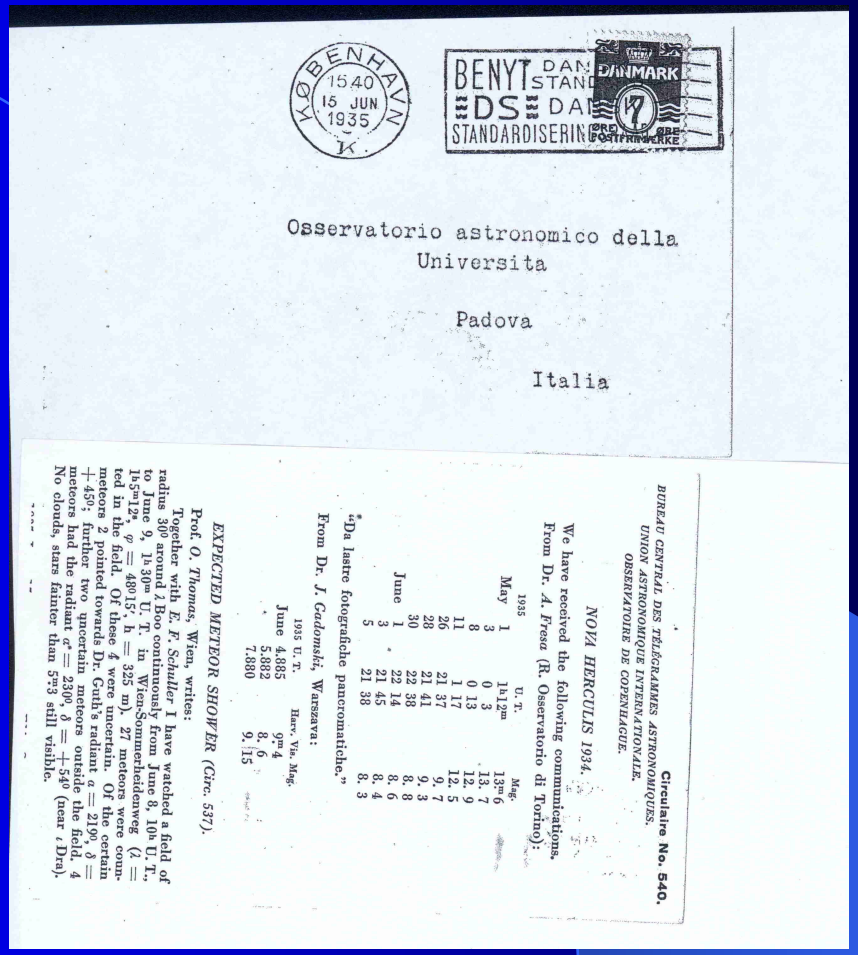
# Communication and Astronomy

**Roots are in the Renaissance**



# The first “globalised” Science

**1900 IAU Telegram**



KØBENHAVN 1540 15 JUN 1935 K

BENYT DANSK STANDARDISERING DS DANMARK ØRE ØRE POSTFRIMÆRKE

Osservatorio astronomico della
Universita

Padova

Italia

*BUREAU CENTRAL DES TÉLÉGRAMMES ASTRONOMIQUES.*
*UNION ASTRONOMIQUE INTERNATIONALE.*
*OBSERVATOIRE DE COPENHAGUE.*

**Circulaire No. 540.**

*NOVA HERCULIS 1934.*

We have received the following communications.

From Dr. *A. Fresa* (R. Osservatorio di Torino):

| 1935 | | U. T. | Mag. |
|---|---|---|---|
| May | 1 | 1h12m | 13m.6 |
| | 3 | 0 3 | 13. 7 |
| | 8 | 0 13 | 12. 9 |
| | 11 | 1 17 | 12. 5 |
| | 26 | 21 37 | 9. 7 |
| | 28 | 21 41 | 9. 3 |
| | 30 | 22 38 | 8. 8 |
| June | 1 | 22 14 | 8. 6 |
| | 3 | 21 45 | 8. 4 |
| | 5 | 21 38 | 8. 3 |

“Da lastre fotografiche panoromatiche.”

From Dr. *J. Gadomski*, Warszava:

| 1935 | U. T. | Harv. Vis. Mag. |
|---|---|---|
| June | 4.885 | 9m.4 |
| | 5.882 | 8. 6 |
| | 7.880 | 9. 15 |

*EXPECTED METEOR SHOWER (Circ. 537).*

Prof. *O. Thomas*, Wien, writes:

Together with *E. F. Schuller* I have watched a field of radius 30° around *J* Boo continuously from June 8, 10h U. T., to June 9, 1h 30m U. T. In Wien-Sommerheidenweg ($\lambda = 15^h 12^m$, $\varphi = 48°15'$, $h = 325$ m). 27 meteors were counted in the field. Of these 4 were uncertain. Of the certain meteors 2 pointed towards Dr. Guth's radiant $\alpha = 219°$, $\delta = +45°$; further two uncertain meteors outside the field. 4 meteors had the radiant $\alpha = 230°$, $\delta = +54°$ (near *t* Dra). No clouds, stars fainter than $5^m.3$ still visible.

# Why communication is so important in Astronomy from centuries?

# Farthest and farthest …


**1906** **Los Angeles** **1990**

# Best places are mountains in the middle of a desert…

# Where the weather is (generally) good ...

# And partners are wonderful

# Anyway results are encouraging

# Last 25 years revolution in Astronomy : I

# Last 25 years revolution in Astronomy : II

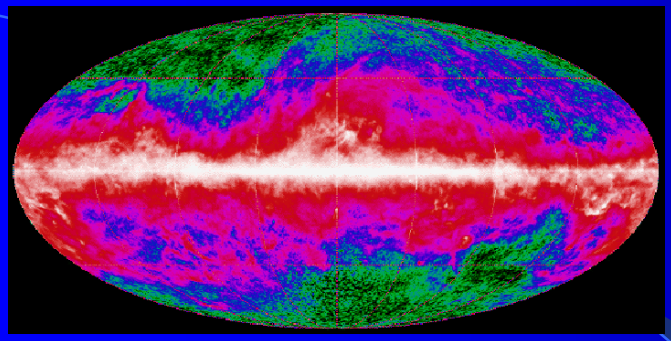
# Last 25 years revolution in Astronomy : III

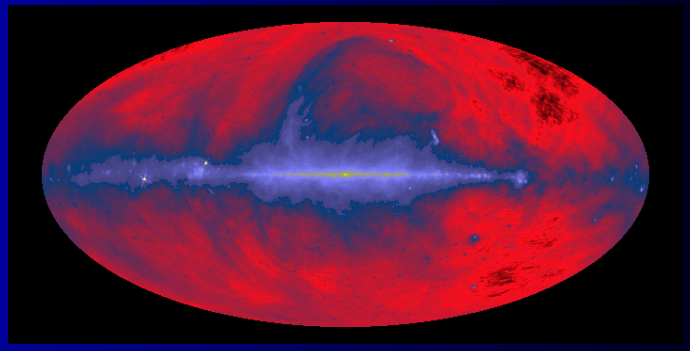
# And the most important …

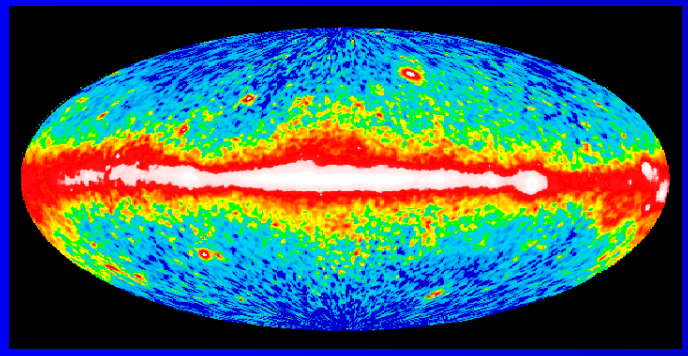
**Farewell to the blinding atmosphere**

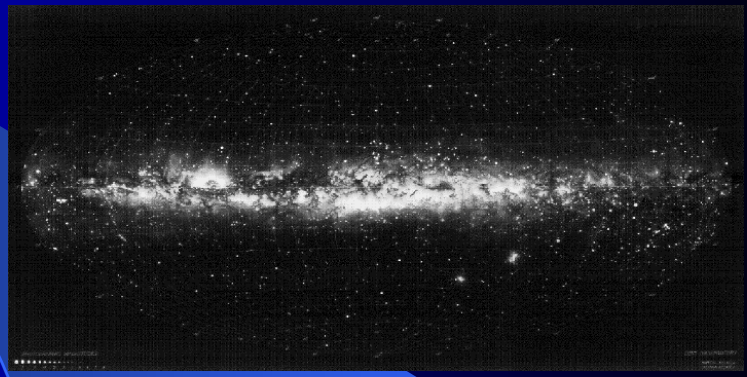
# Space Astronomy: “more Physics” or a different one?

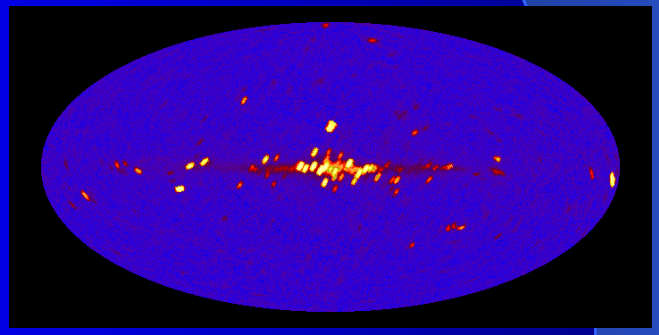
# Different glasses different phenomena …



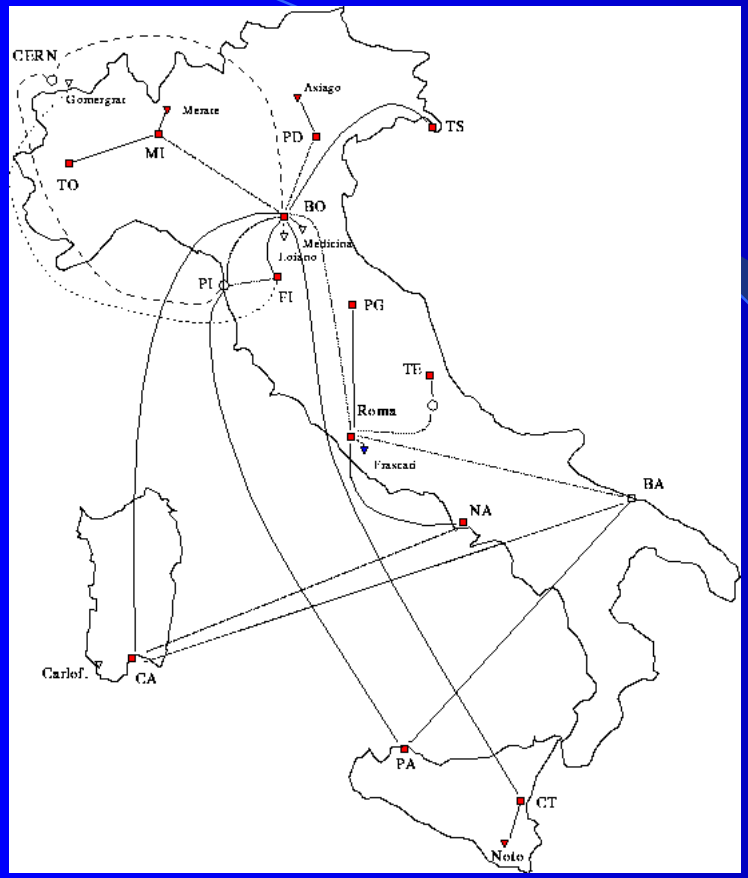








# Astronomy and Networks




**Astronomy is in the network Development task from the beginning (Span, Italian Astronet)**

**Second step in Italy (Garr)**

**In the '80 Astronomy is, maybe, the First "All digital Science"**

**Nowadays GRID**

# An "All digital Science"

## End to End cycle on the network:

- Observation preparation,
- Remote observing,
- Data Reduction and Analysis,
- Archiving,
- Data mining (virtual observatories),
- Modelling (theoretical astronomy),
- Literature,
- New ideas for new observation, theory etc.

# That is : ready for the Grid !

- Network allowed strong communication
- The Web allowed documentation sharing
- Is the Grid a change of metaphor ? (sharing the work!)

# First steps for the Grid

**We are working on Astrophysical applications within the framework of the Italian Grid for Science**

**(funded by MIUR: 2003-2006)**

**3 main poles engaged : Padova Trieste, Napoli**

**7 poles forecasted for the end of the year**

**Main objective is to determine "astrophysical" requirements for the Grid itself**

# Applications: Case study I

**Database and Astrophysical Archives (Planck, TNG, GSCII)**

**TNG at Canarias**

# Applications: Case study II

**Image reduction and Analysis of the VST survey**

**VST is a 2 m. Telescope with a 32.000 x CCD**

**A "pilot fish" For the 4 VLT giants**

VLT at Paranal

ESO PR Photo 43a/99 (8 December 1999)

© European Southern Observatory

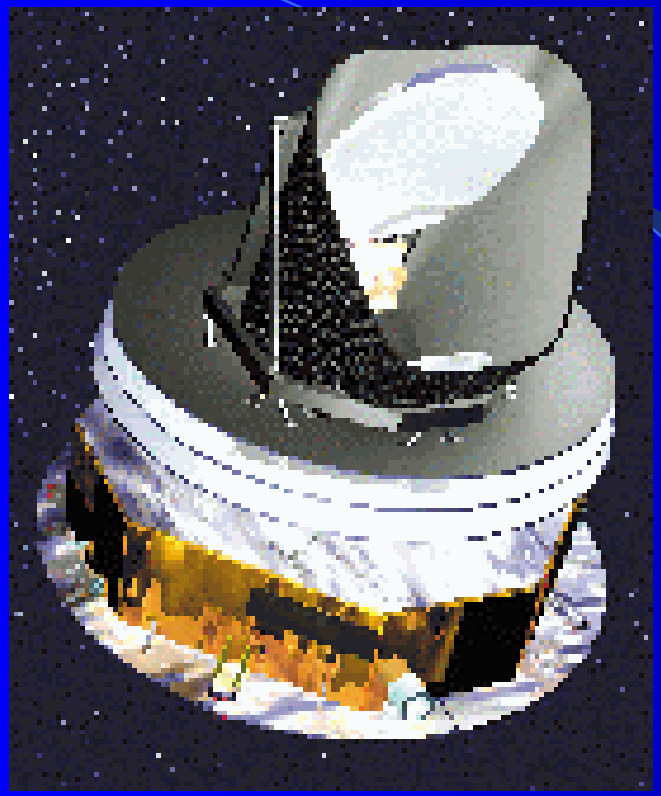
# Applications: Case study III

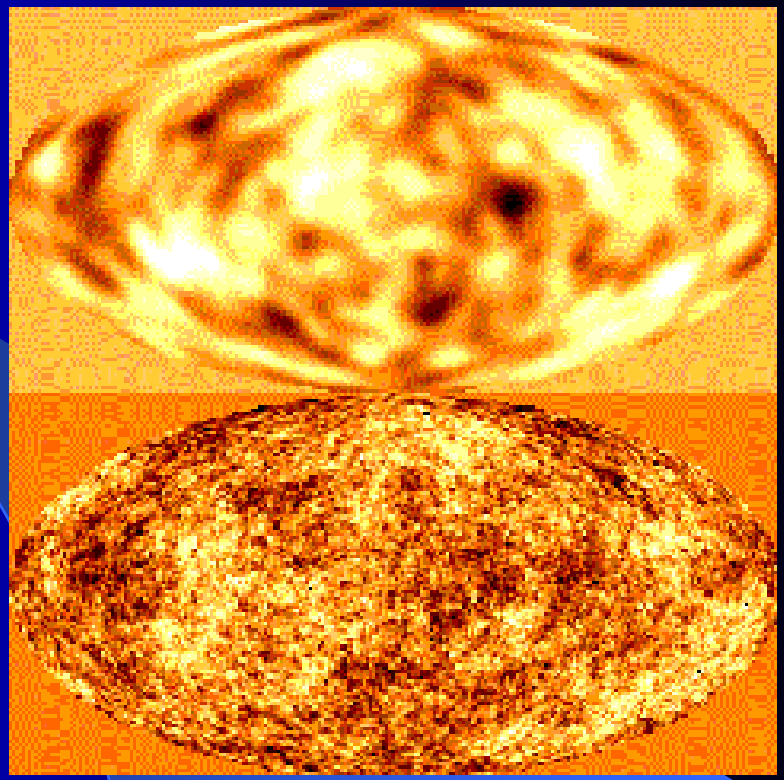
**Telescopes and the Grid : to distribute remote observing**

**Before grid**

**After grid**

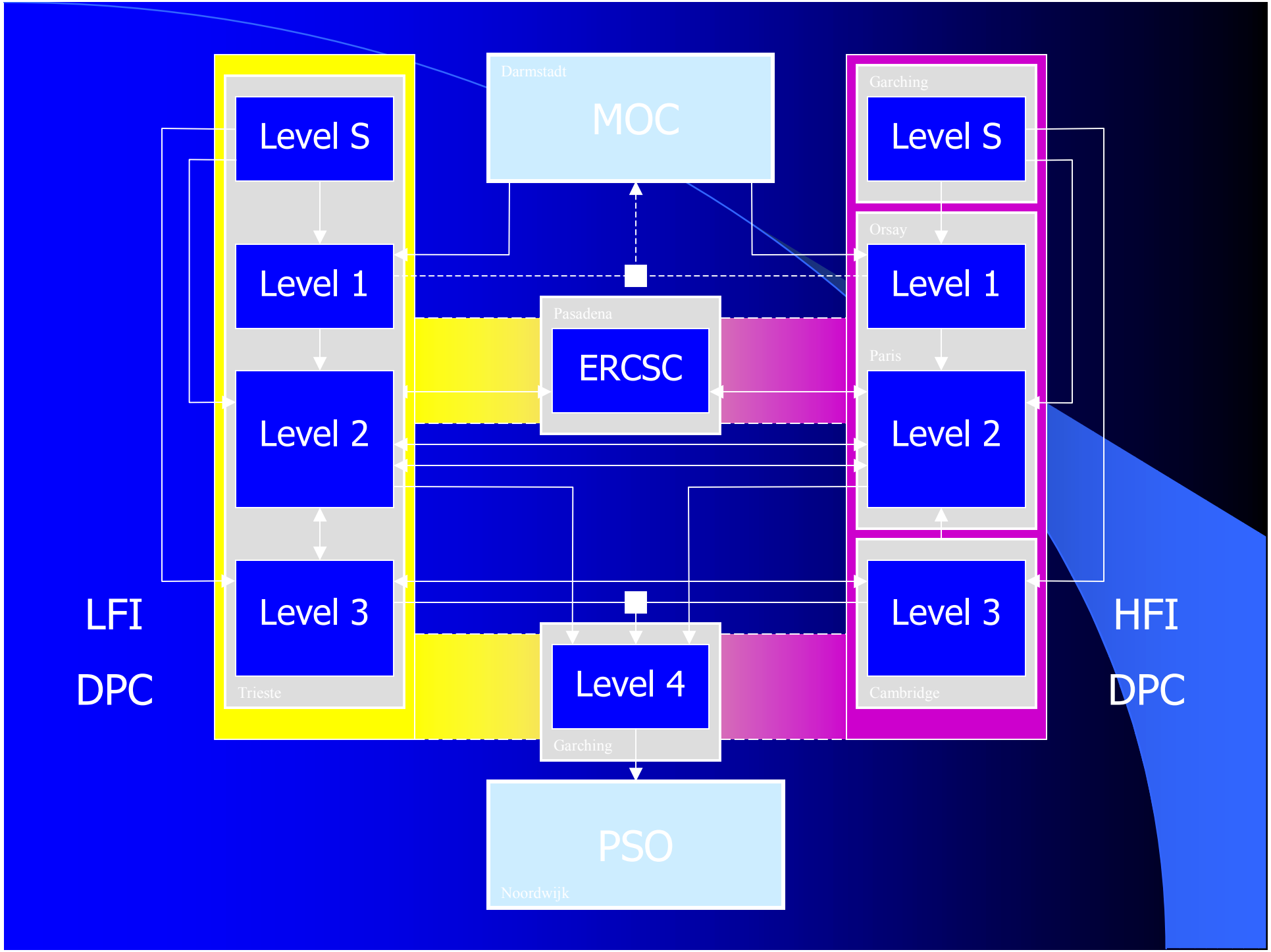
# Planck 2007: mapping the microwave Universe



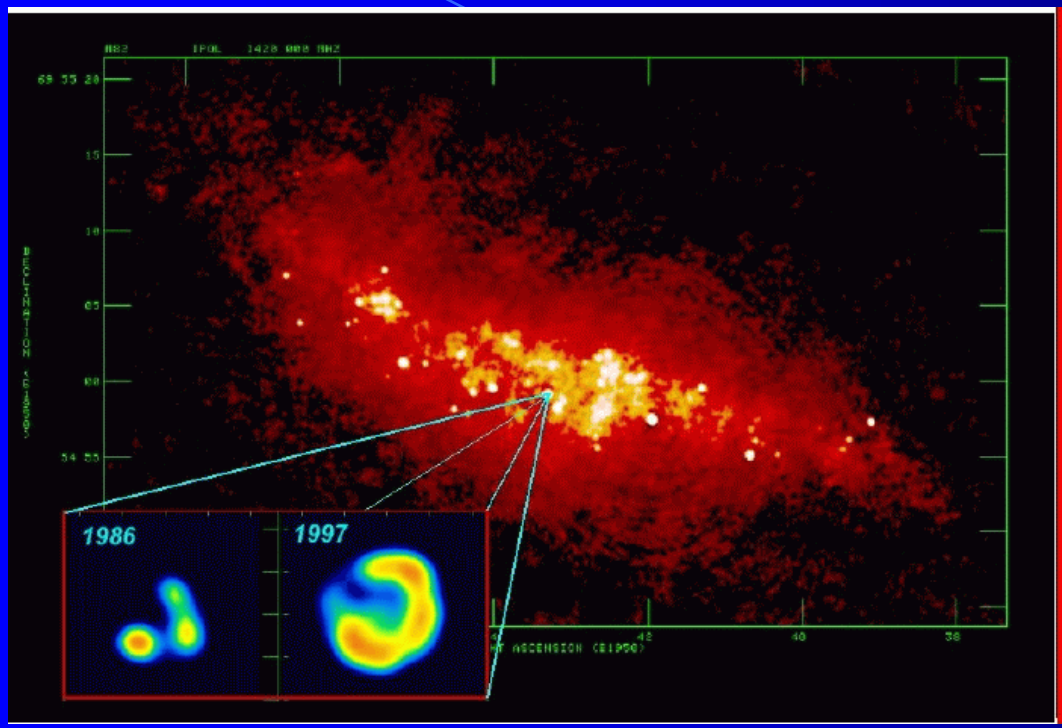


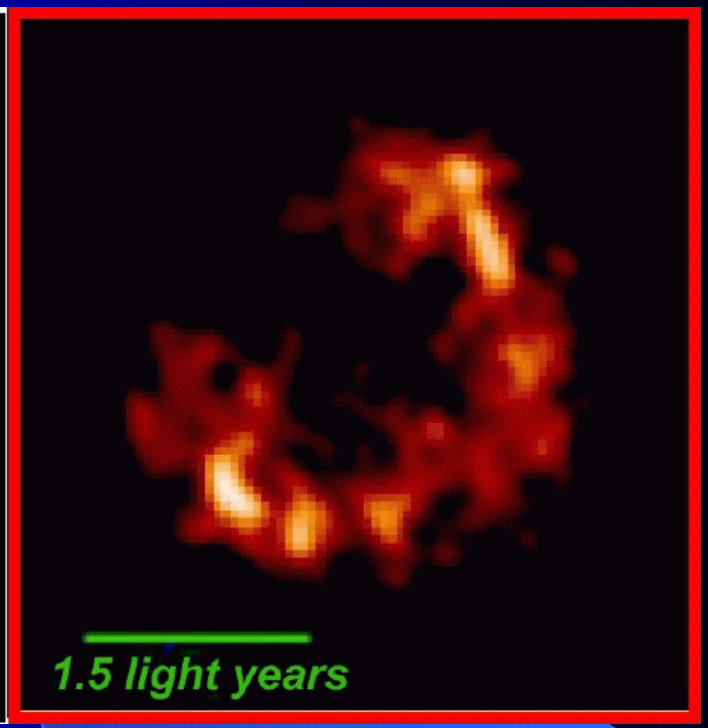
# Data Processing for ESA/Planck

- Highly distributed environment (9 sites)
- Collaborative development – inputs to data processing pipeline coming from over 30 institutes in over a dozen countries, in Europe and North America)
- Each of the DPC "Levels" perform well-specified tasks (simulations, handling of telemetry, production of frequency maps, separation of astrophysical components, preparation of final products)
- Need to share efficiently data (raw and at different levels of processing), information, documents, procedures, software
- Grid technology likely to be used (EU FP6 SSA proposal to support feasibility study)


Darmstadt
MOC
Level S
Level 1
Level 2
Level 3
Trieste
Pasadena
ERCSC
Level 4
Garching
PSO
Noordwijk
Garching
Level S
Orsay
Level 1
Paris
Level 2
Level 3
Cambridge
LFI
DPC
HFI
DPC

# Network, Grid, (Radio) telescopes




**Observing the heavenly bodies at radio frequency**

# Network, Grid, (Radio) telescopes

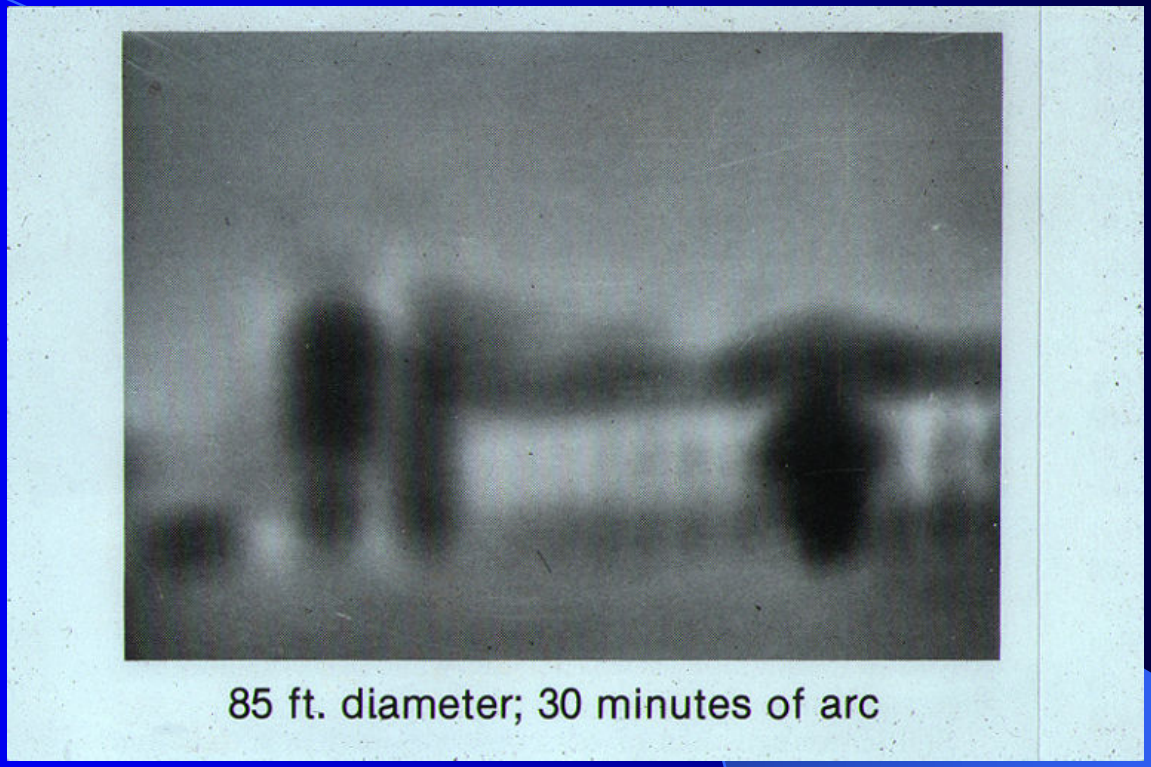
**4.5 cm binocular**

**Resolution is the key point (distance between antennas)**

# Network, Grid, (Radio) telescopes

**If a desert Is available Resolution is better.**

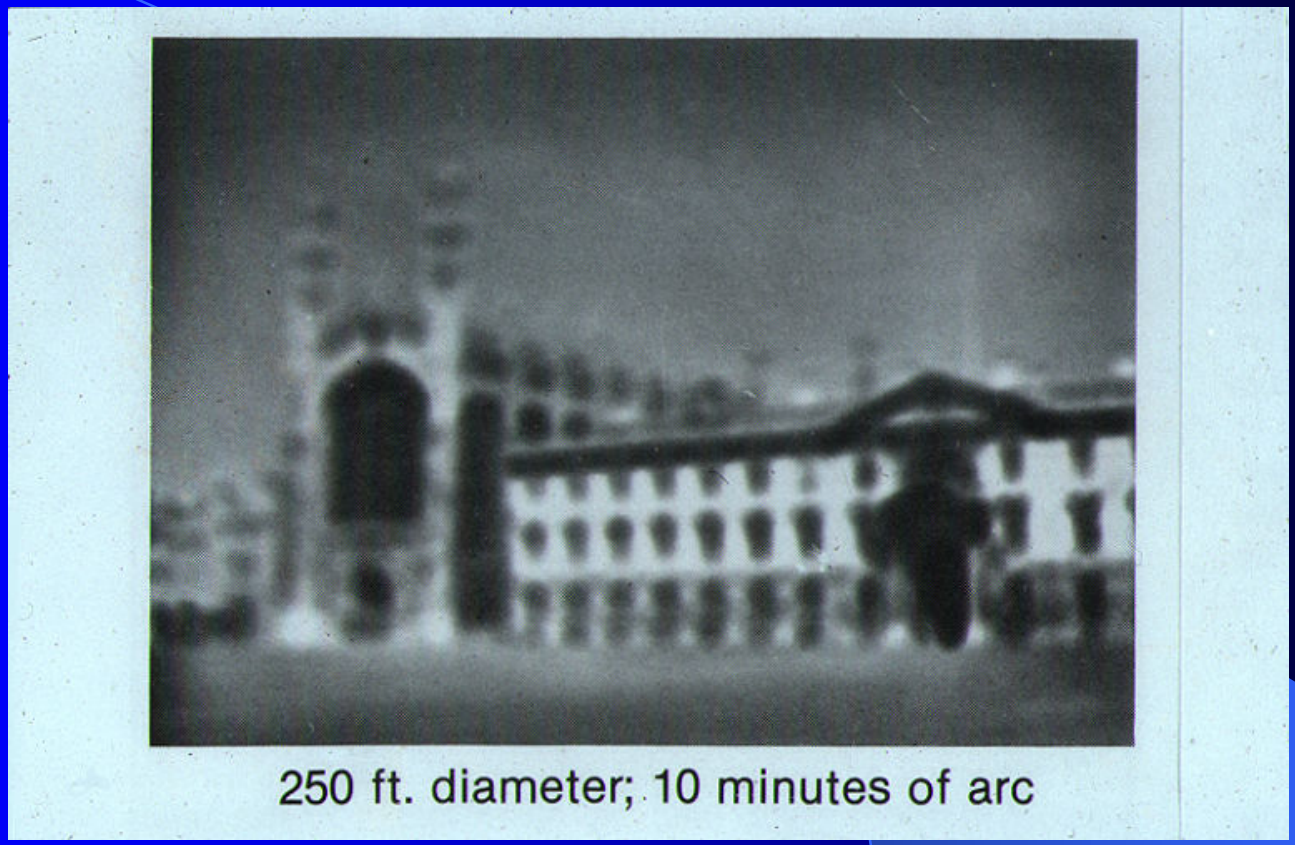
# Network, Grid, (Radio) telescopes



85 ft. diameter; 30 minutes of arc

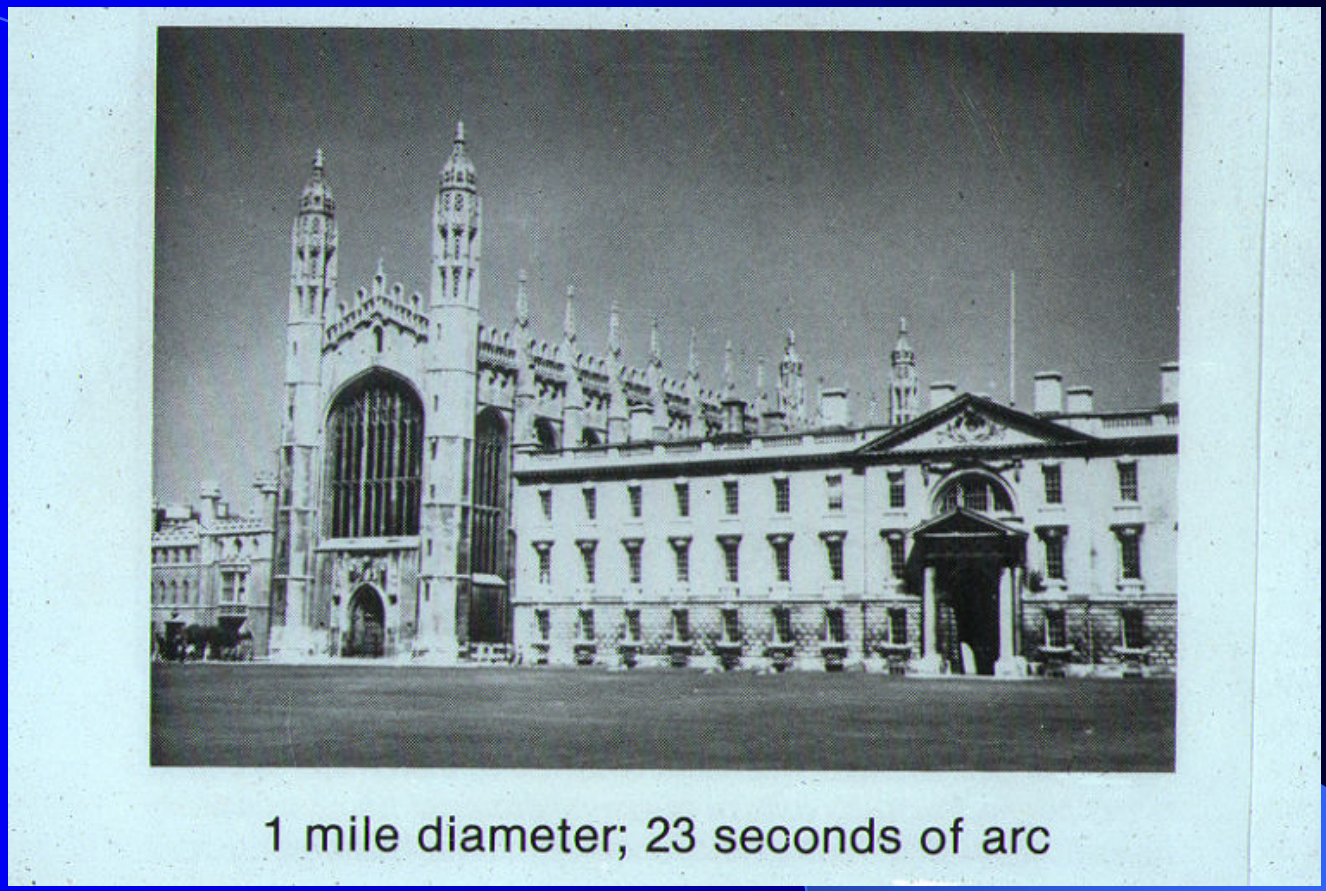
**Low resolution**

# Network, Grid, (Radio) telescopes




**better resolution**

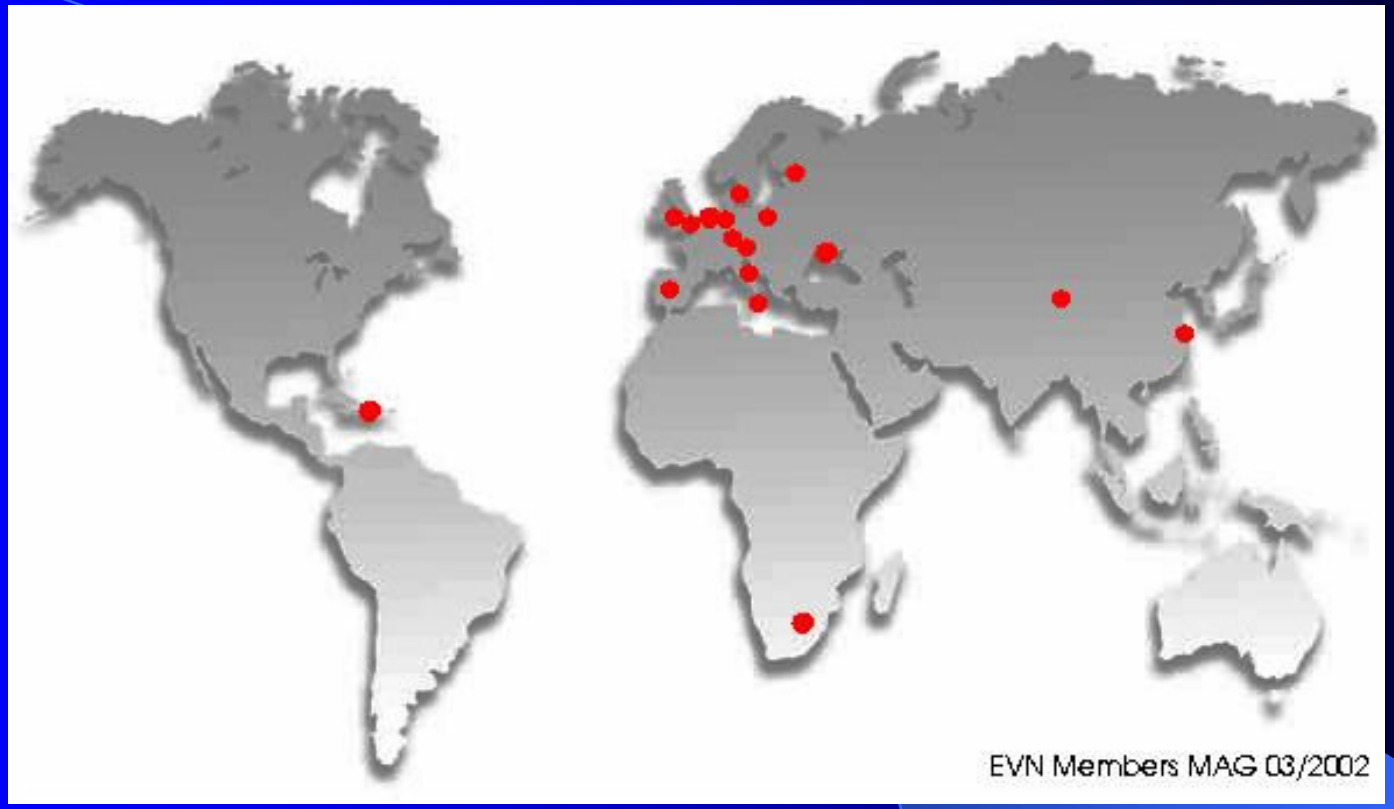
# Network, Grid, (Radio) telescopes



1 mile diameter; 23 seconds of arc

**and even better**

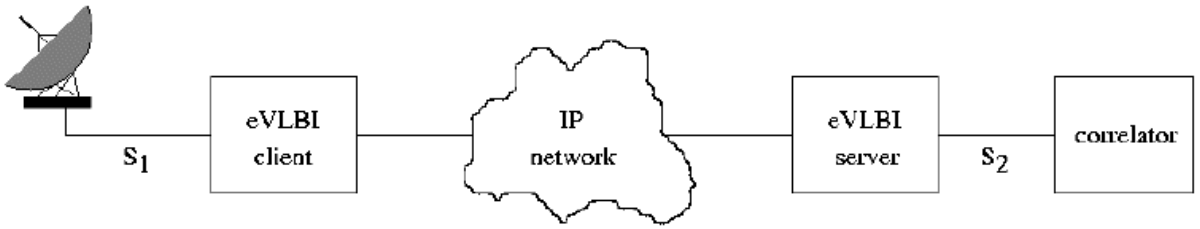
# Network, Grid, (Radio) telescopes




**using different distant telescope is the idea**
**Very Large Base interferometry**

# Network, Grid, (Radio) telescopes

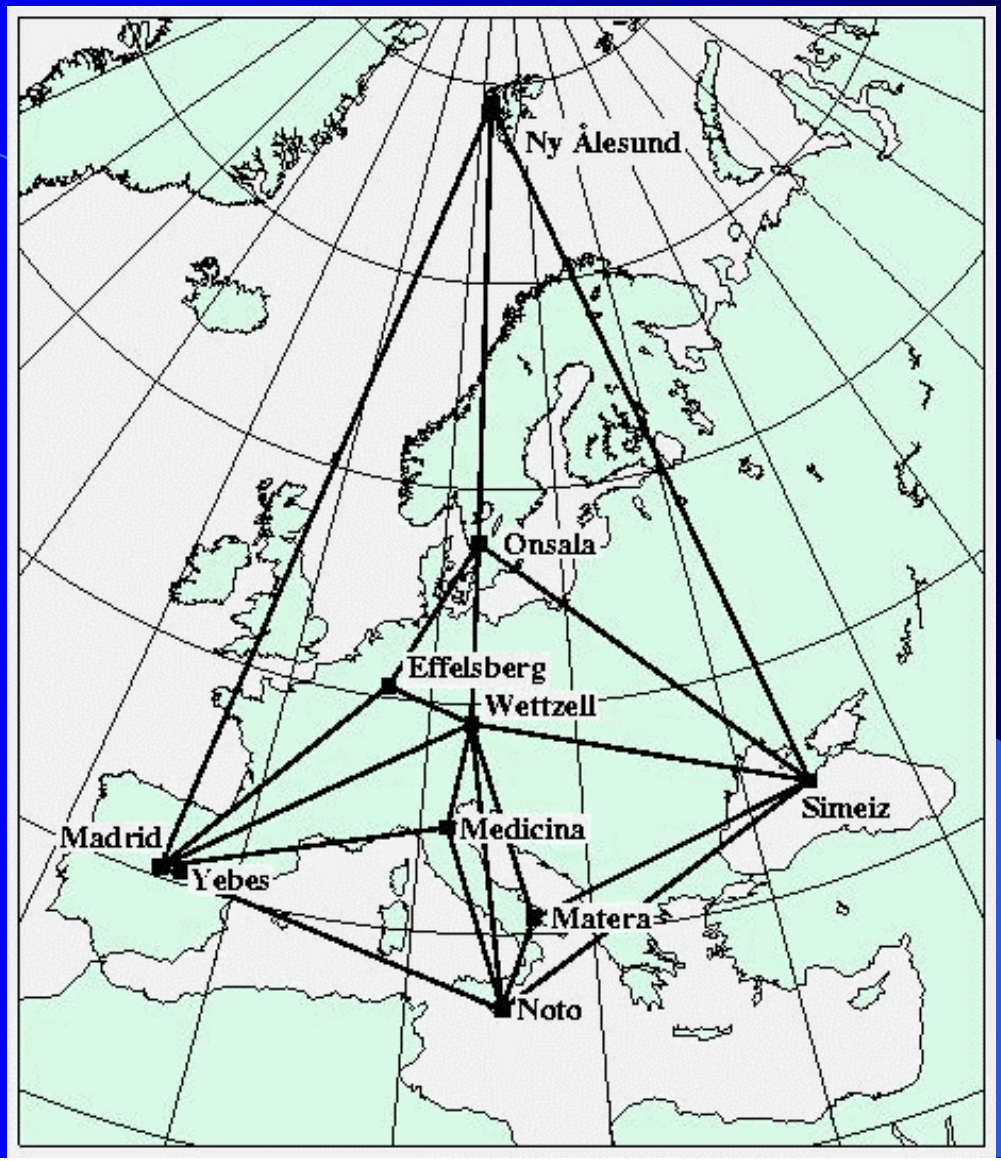
## Required Data Transmission Characteristics for eVLBI




- **S1:**
  - continuous (many minutes) and fixed rate
  - 32x10^6 samples/sec x 32 bits/sample ~ 1 Gbps
  - uncompressable
  - framed or unframed
- **S2:**
  - S1 + delta t
  - < 1% drop rate
- **Network:**
  - datagrams can be dropped
  - datagrams can arrive out of order
  - datagrams can be duplicated
  - datagrams can be delayed

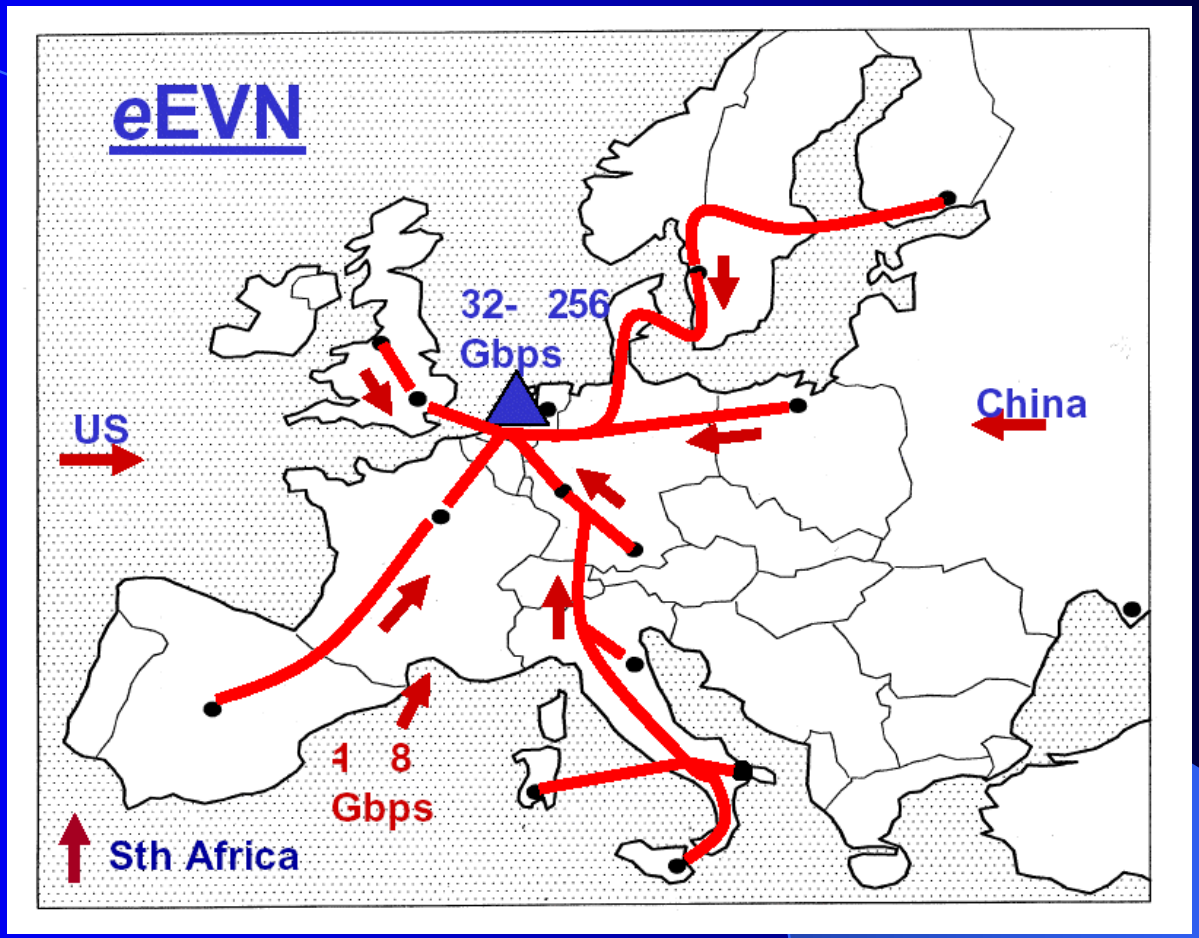
**Correlation of events is critical and require very-broad-band**

European VLBI Network



# Geant and

European VLBI Network



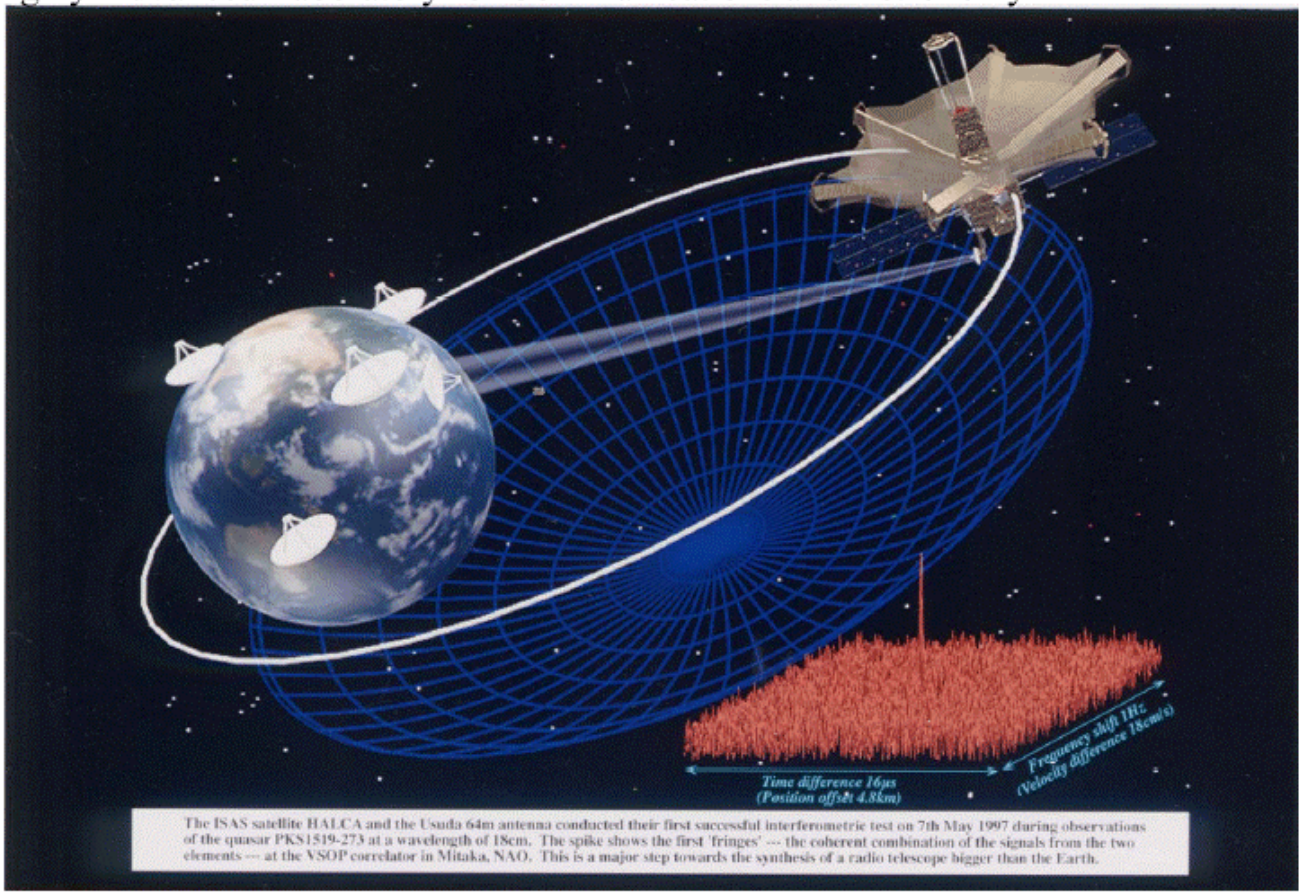

**seems enough strong**

# Next Step: going farther

VLBI Space Observatory Programme

## HALCA and VSOP

Highly Advanced Laboratory for Communications and Astronomy




The ISAS satellite HALCA and the Usuda 64m antenna conducted their first successful interferometric test on 7th May 1997 during observations of the quasar PKS1519-273 at a wavelength of 18cm. The spike shows the first 'fringes' — the coherent combination of the signals from the two elements — at the VSOP correlator in Mitaka, NAO. This is a major step towards the synthesis of a radio telescope bigger than the Earth.

# We are in pool position because…

**The Universe is a GRID !**