SPACE
(SPectroscopic All-sky Cosmic Explorer)

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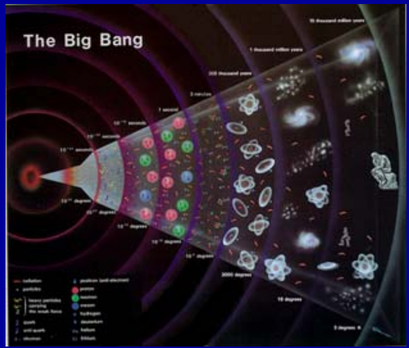
Outline

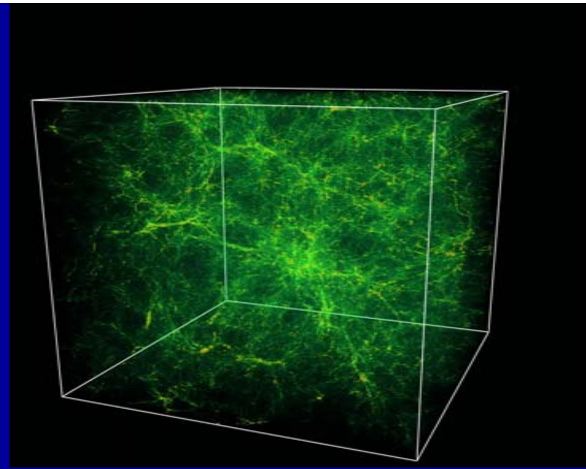
- Mission Concept
- Science goals
- Technology
- Consortium
- Potential spanish participation

Mission Concept

- Medium-size mission: non-cryogenic 1.5 m diameter telescope at geosynchronous or geostationary orbit equipped with HgCdTe detectors.
- First all-sky spectroscopic survey of the Universe
- Resolution ≈ 400 in the near IR
  - Background 1000 times lower than from ground
- Identify and analyze 1 billion galaxies brighter than AB=23 at 0.6-1.8 μm
  - Determine locations with precision better than 1 arcsec
  - Determine redshifts with precission of 0.001



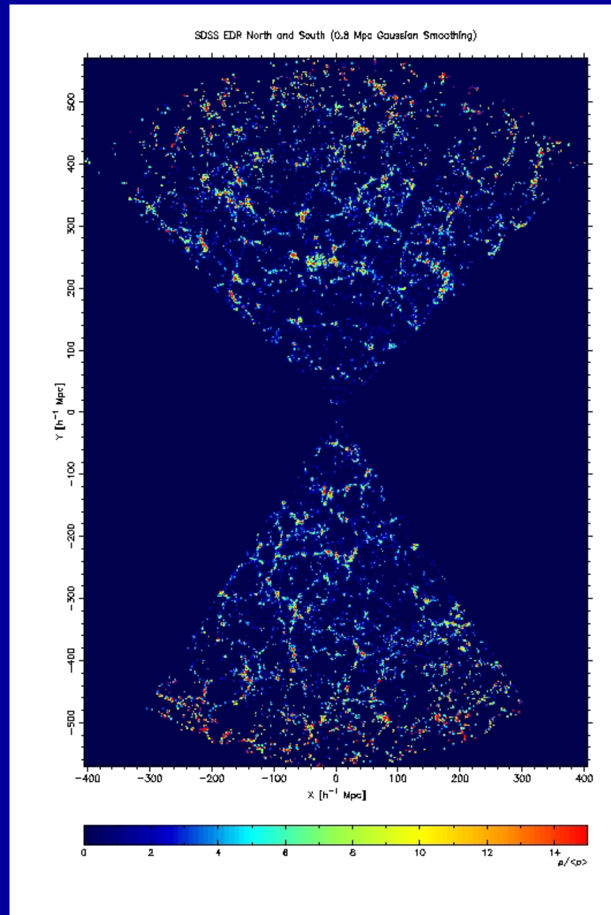
Science goals



- To place the most accurate constraints on the Baryonic Acoustic Ocillations and the nature of Dark Energy using spectroscopic redshifts

- To obtain the first 3-D all-sky map of the Universe up to $z \approx 2$, reveal the large scale structure of baryons, its power spectrum and its evolution to an unprecedented accuracy

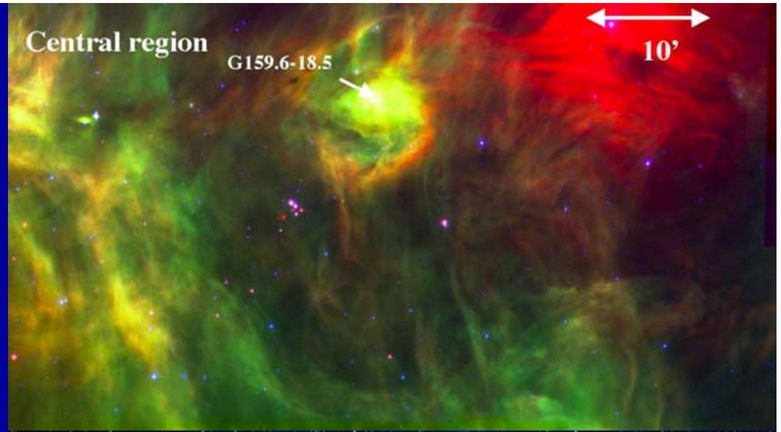
- To identify the most luminous primordial galaxies and super massive black holes up to $z \approx 14$ by using Ly alpha

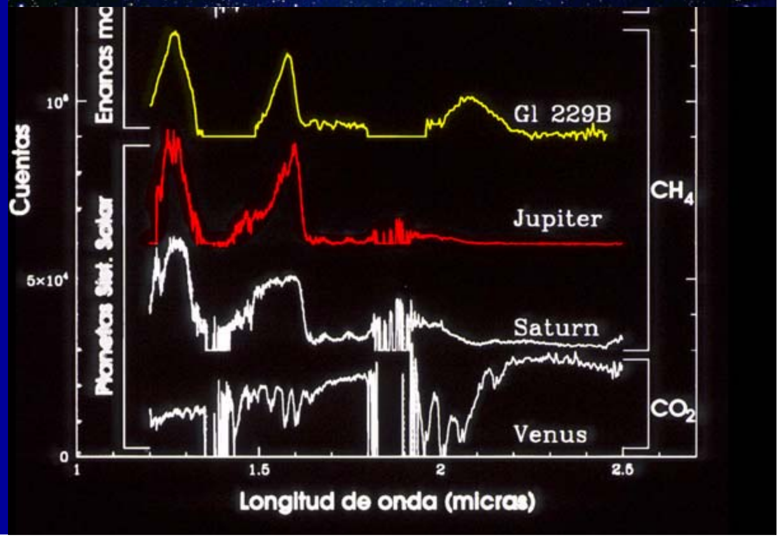


Science goals (II)

•To measure the bottom of the Initial mass function in star forming regions and clusters of our Galaxy and classify millions of stars whose distances will be measured by GAIA

•To explore the limits of the Solar System obtaining a nearly complete census of minor bodies and detect the faintest objects in the solar neighbourhood including possible low-mass substellar companions of the Sun





Technology

- Light-weight mirrors for space telescope are available

- It will use detectors similar to those developed for Hubble Space Telescope (WFC3) and JWST (4k x 4k pixel format)
  - Pixel size 1 arcsec, Field of view larger than 1 sq deg in a single pointing. 900 sec integration for 5 sigma detection of J(AB)=23.
  - Entire sky mapping in 18 months (impossible even with the next generation of Extremely Large Telescopes).

- Digital Micromirror Devices (DMDs) will allow rapid selection of target sources with flexibility and efficiency.
  - In “slit mode” 12000 spectra per DMD configuration will be obtained
  - Integral field spectroscopy of crowded fields by acting as coded masks

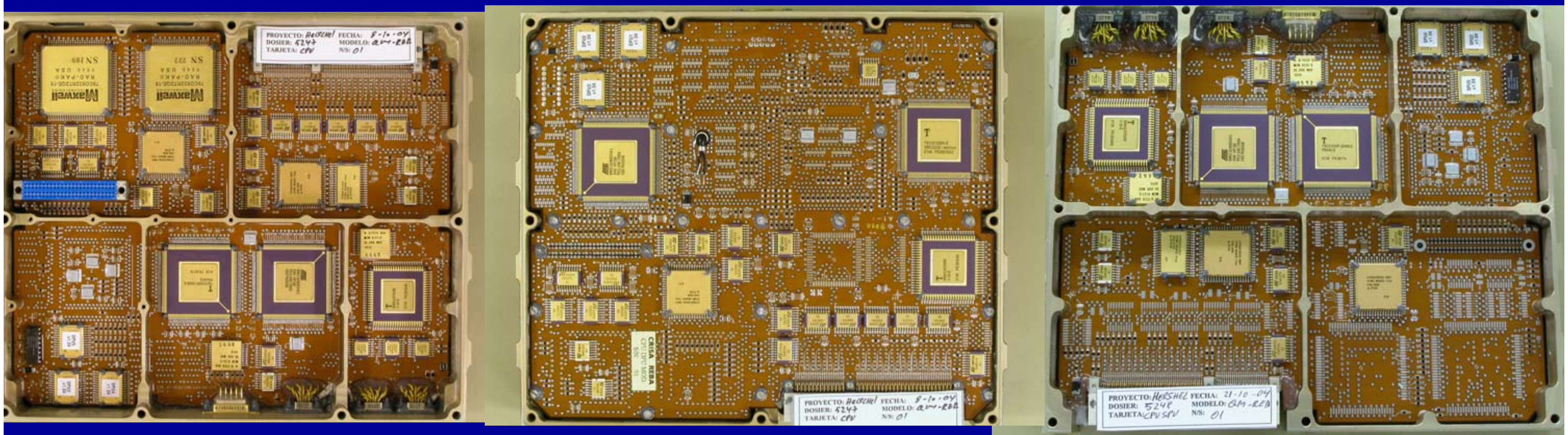
Consortium

- PI Andrea Cimatti (Univ. di Bologna)
- Co-PI Massimo Roberto (Space Telescope Science Institute)

- France (Marseille: Le Fevre; Paris: Lehnert, Daddi et al.)
- Germany (MPA: S. White, G. Kaufmann et al. MPIA: Schinner et al.; Bonn: Bertoldi)
- Italy (Bologna: A. Cimatti et al., Padova: Franceschini et al.; Brera: Guzzo et al.
- Spain (IAC: R. Rebolo, M.R. Zapatero-Osorio, M. Balcells et al.; UPCT: Perez- Garrido, Villo, Diaz-Sanchez)
- UK (Durham: C. Frenk, Shanks et al., Cambridge: Kennicut)
- USA (STScI: M. Roberto, Caltech: N. Reid et al.; Arizona: Meyer et al., Princeton: Strauss et al.)
- ESO (Rosati)

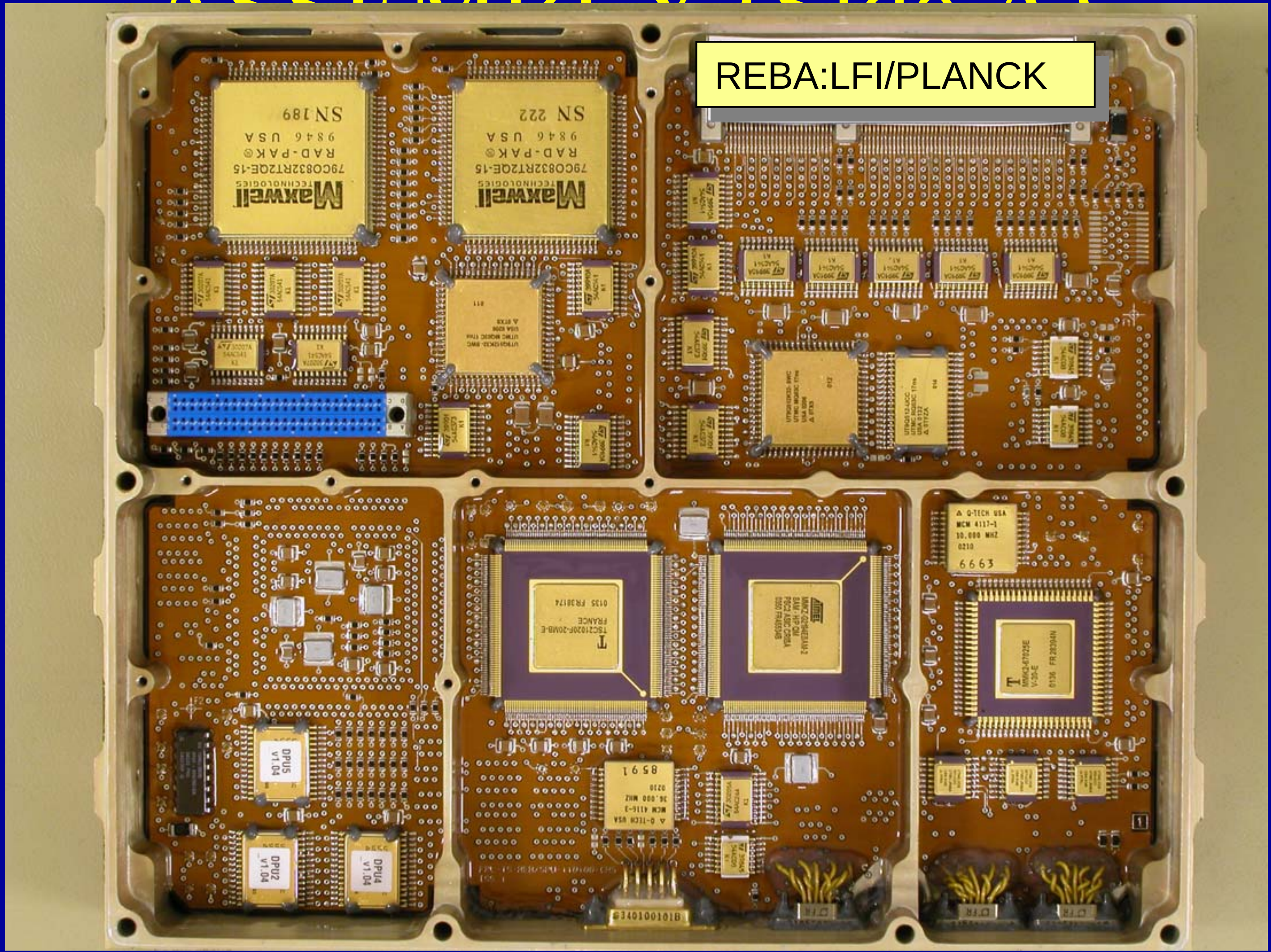
Spanish potential participation

- On-board data processing (hardware and software)
    - DPU and SPUs (DSP boards)



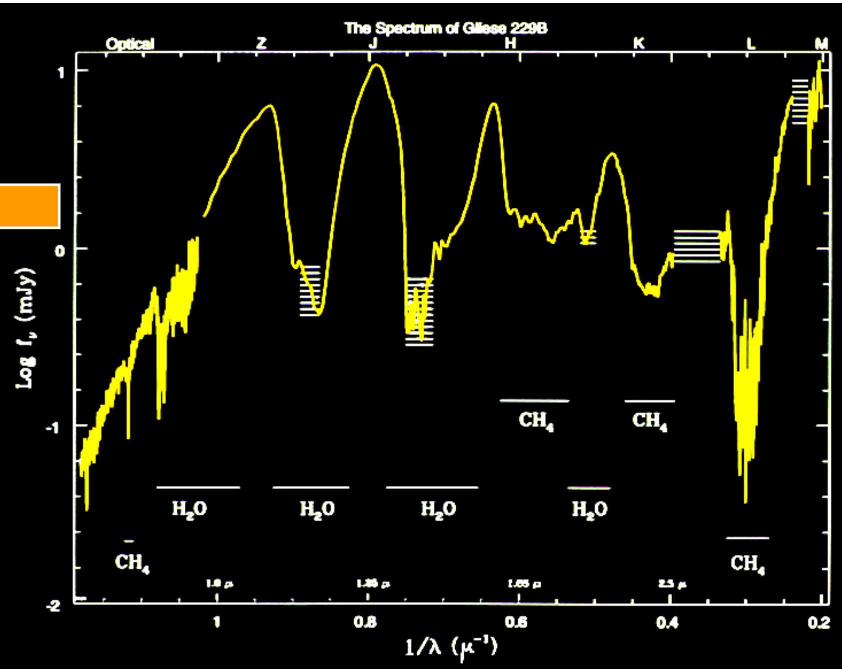
Planck REBA DPU and SPU (IAC-CRISA)

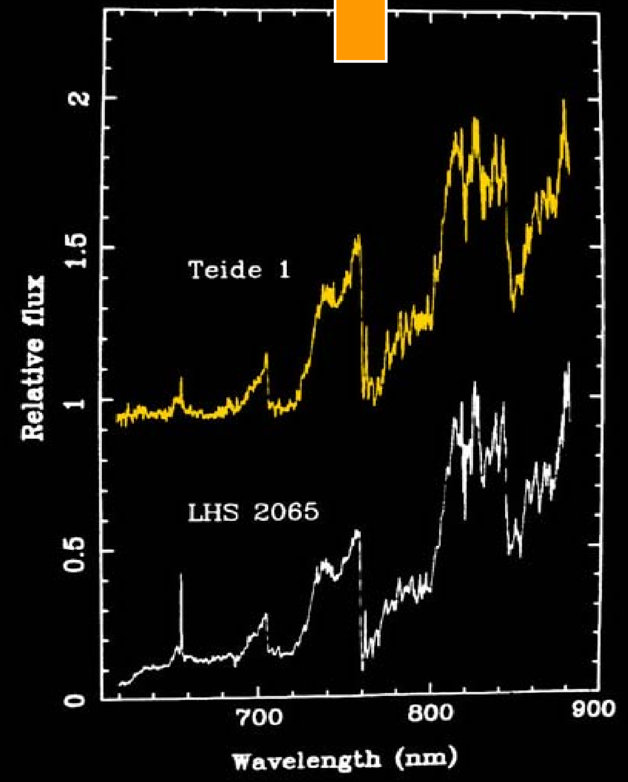
QM CPU DPU MODULE ASSEMBLY (Side A)

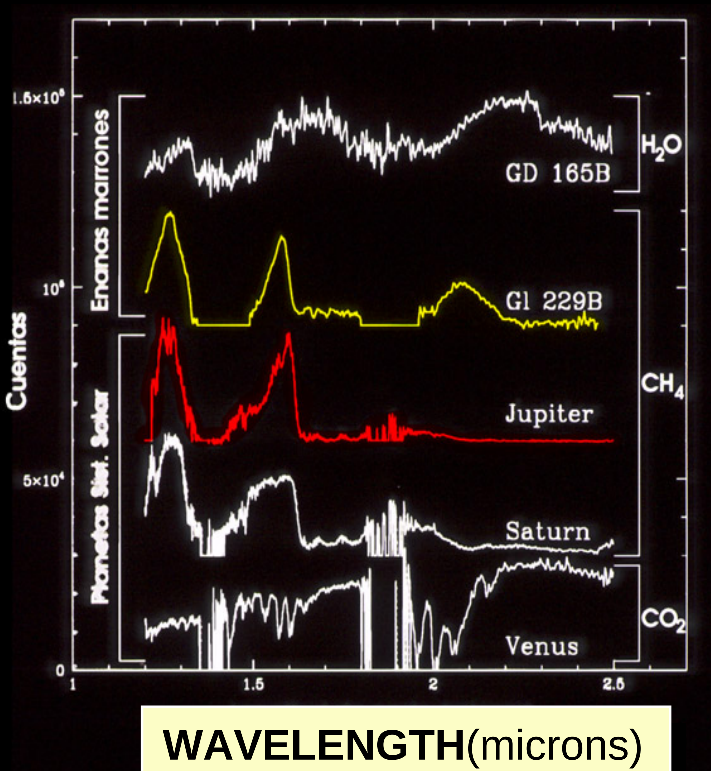


Old brown dwarf

Young brown dwarf







The Pleiades open cluster

d~130 pc

~120 Myr

[Fe/H]=0.1 dex

central B stars

~1000 stars

tidal radius=13.1 pc

notable proper motion

lithium test for brown dwarfs

(Rebolo et al. 1995; 1996; Martin et al. 1996; Zapatero Osorio 1997ab, 1999; Bouvier et al. 1998; Festin 1998, Stauffer et al. 1998; Martín et al. 2000; Moraux et al. 2001, 2003; Hambly & Deacon 2004, Biham et al. 2006)

OBJECTIVES:

Identify and Confirm Pleiades low-mass BDs ($M<0.040M_{Sol}$)

down to the planetary-mass domain:

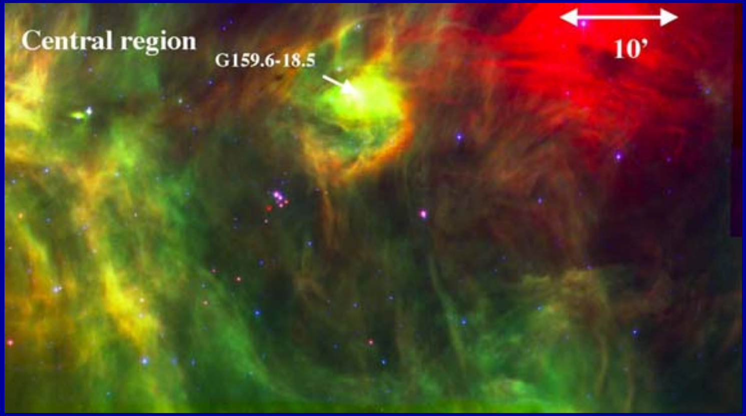
define the L and Tdwarf sequence

Compare to model predictions

Obtain the mass spectrum

How do stars form?

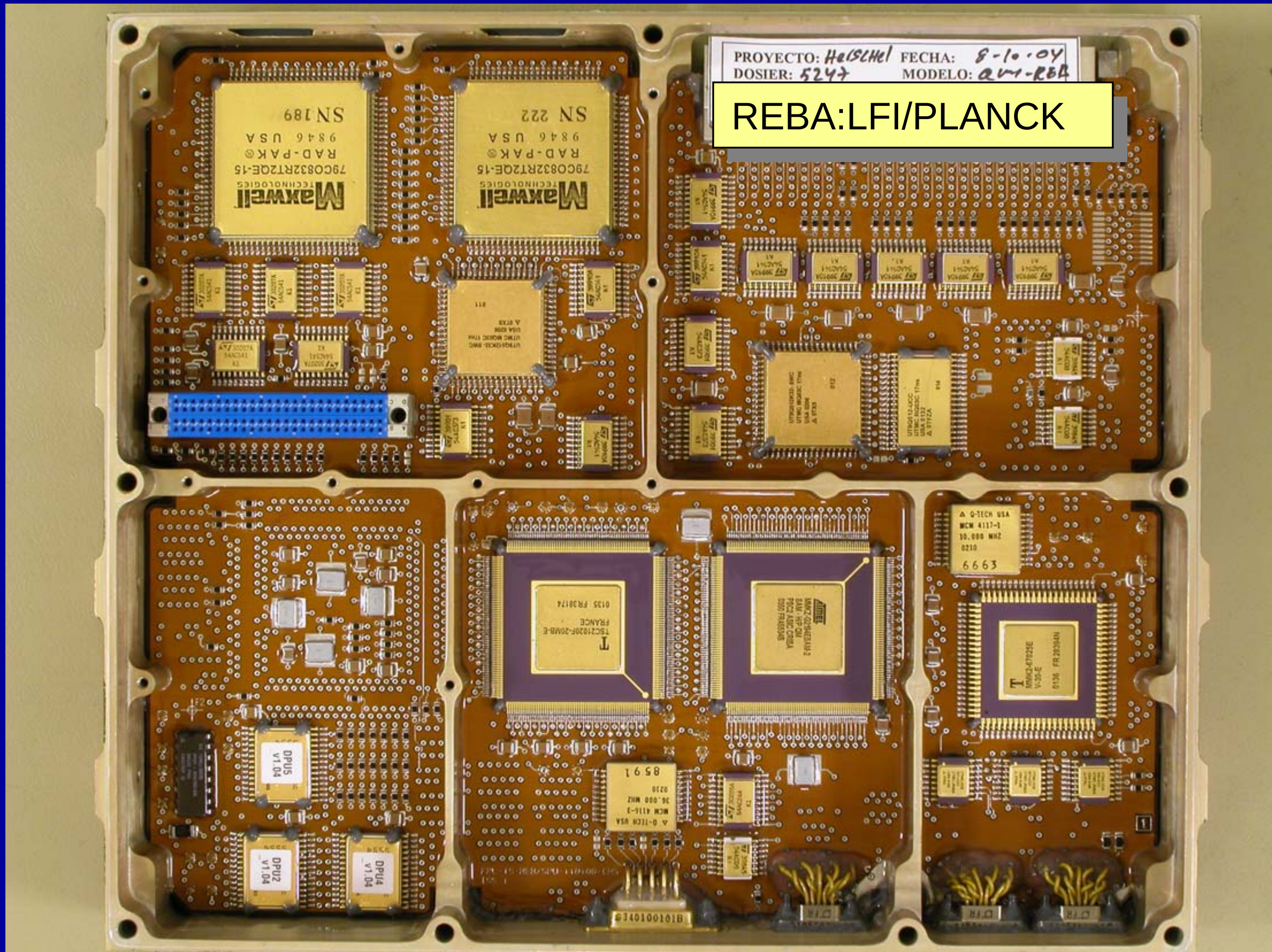
Is the initial mass function universal?



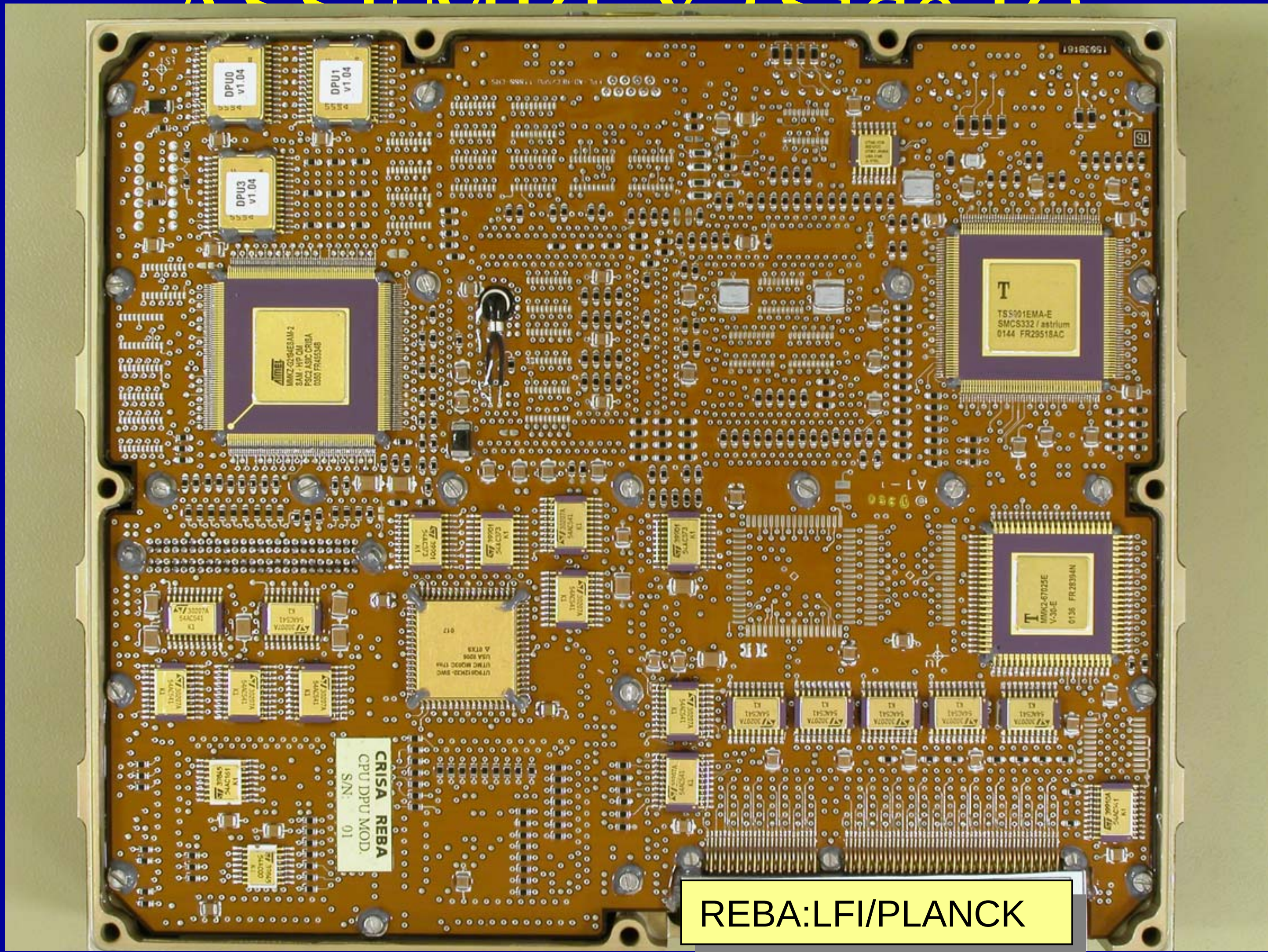
Tools:

- High angular resolution observations, near and mid IR, mm and radio => resolve dense clusters, understand the structure of protoclusters, extragalactic super star clusters. Herschel, ALMA, JWST. ELT, SKA, far IR space interferometer.
- UV imaging of starbursts: the violent star formation processes in galaxies, the interaction between stellar clusters and the interstellar medium, and the variation of the IMF.
- X-ray imaging: accretion phenomena of young stars (including Class 0).

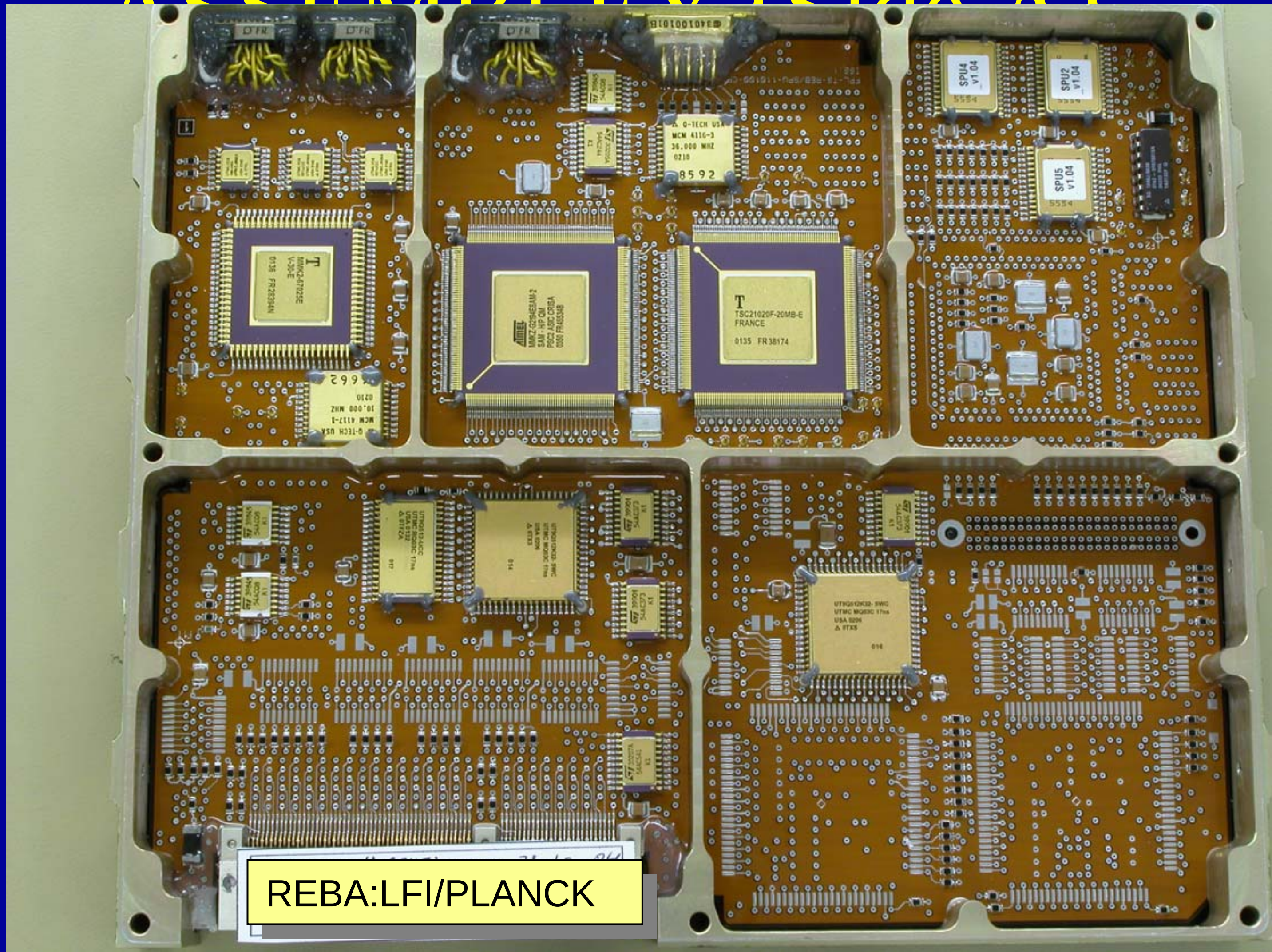
QM CPU DPU MODULE



QM CPU DPU MODULE ASSEMBLY (Side B)

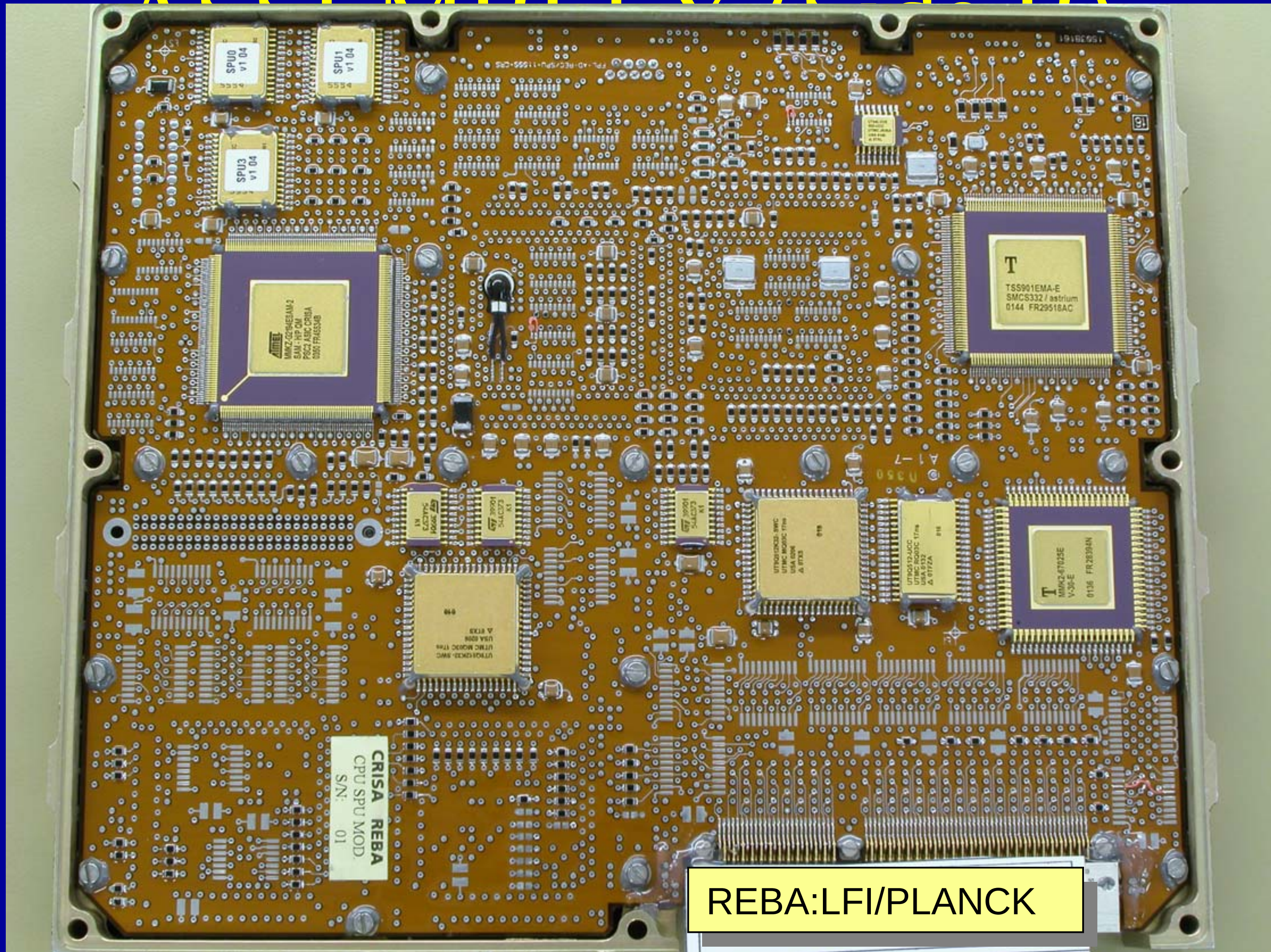


QM CPU SPU MODULE ASSEMBLEY (Side A)



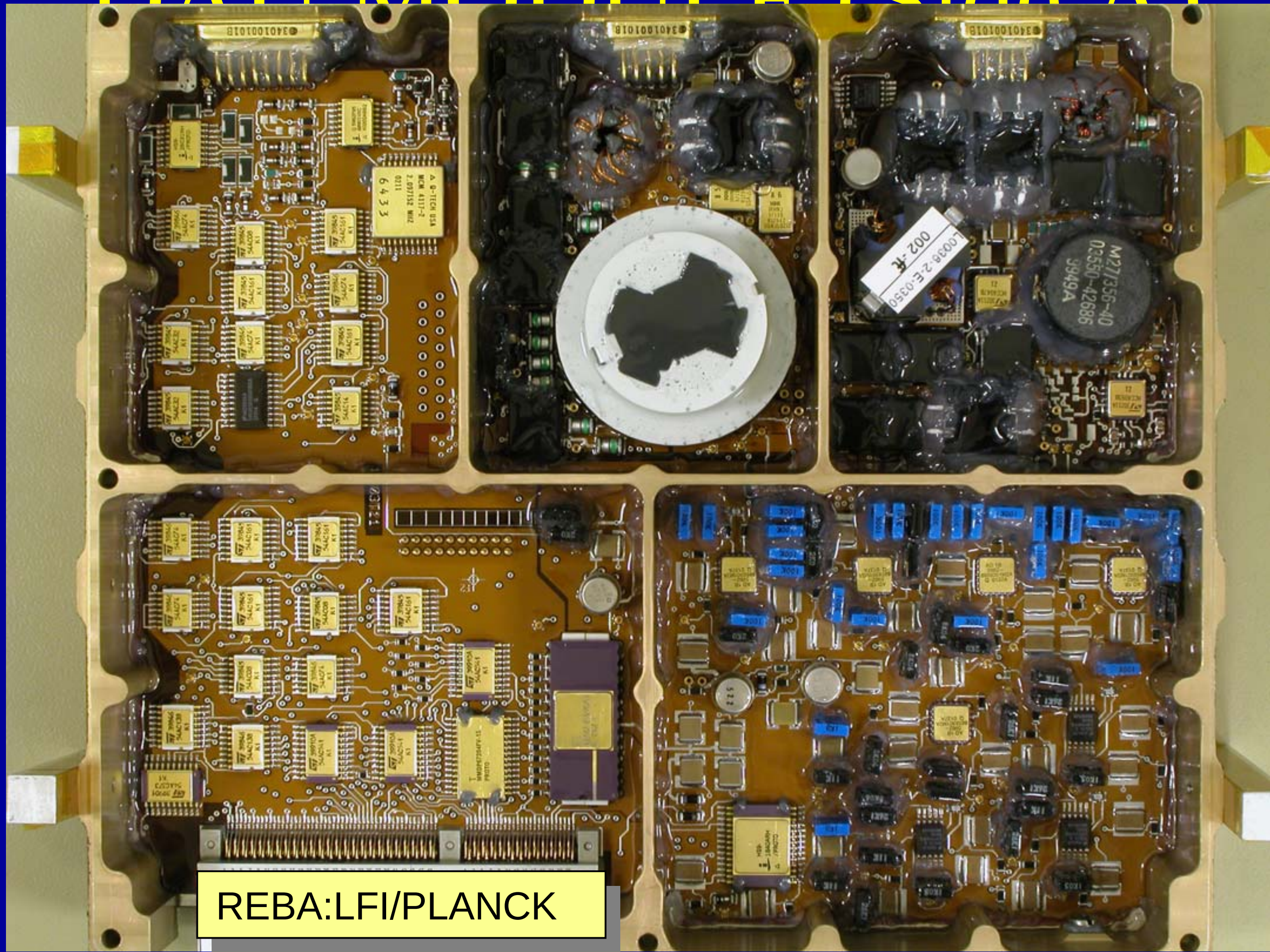
REBA:LFI/PLANCK

QM CPU SPU MODULE ASSEMBLEY (Side B)

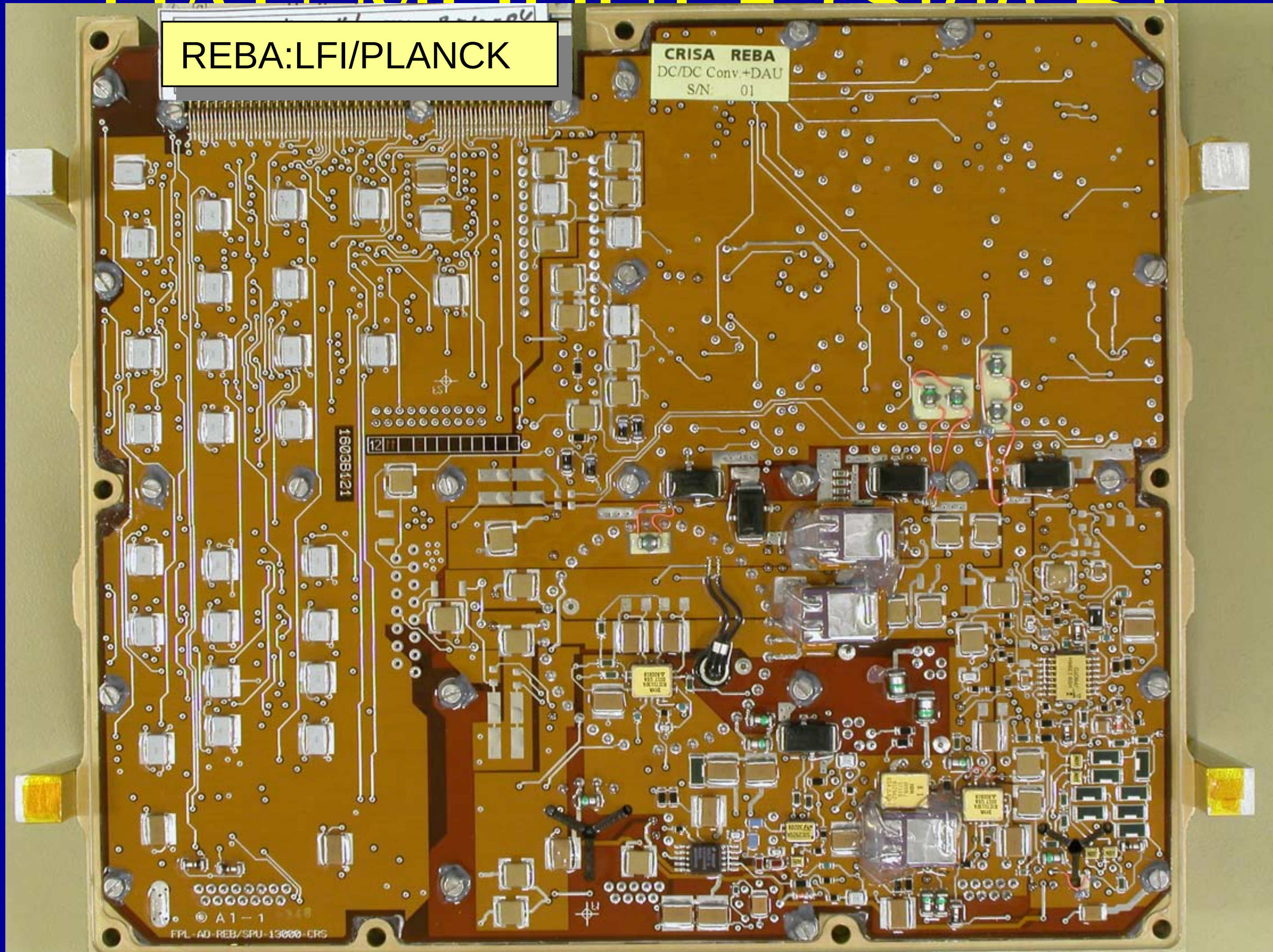


REBA:LFI/PLANCK

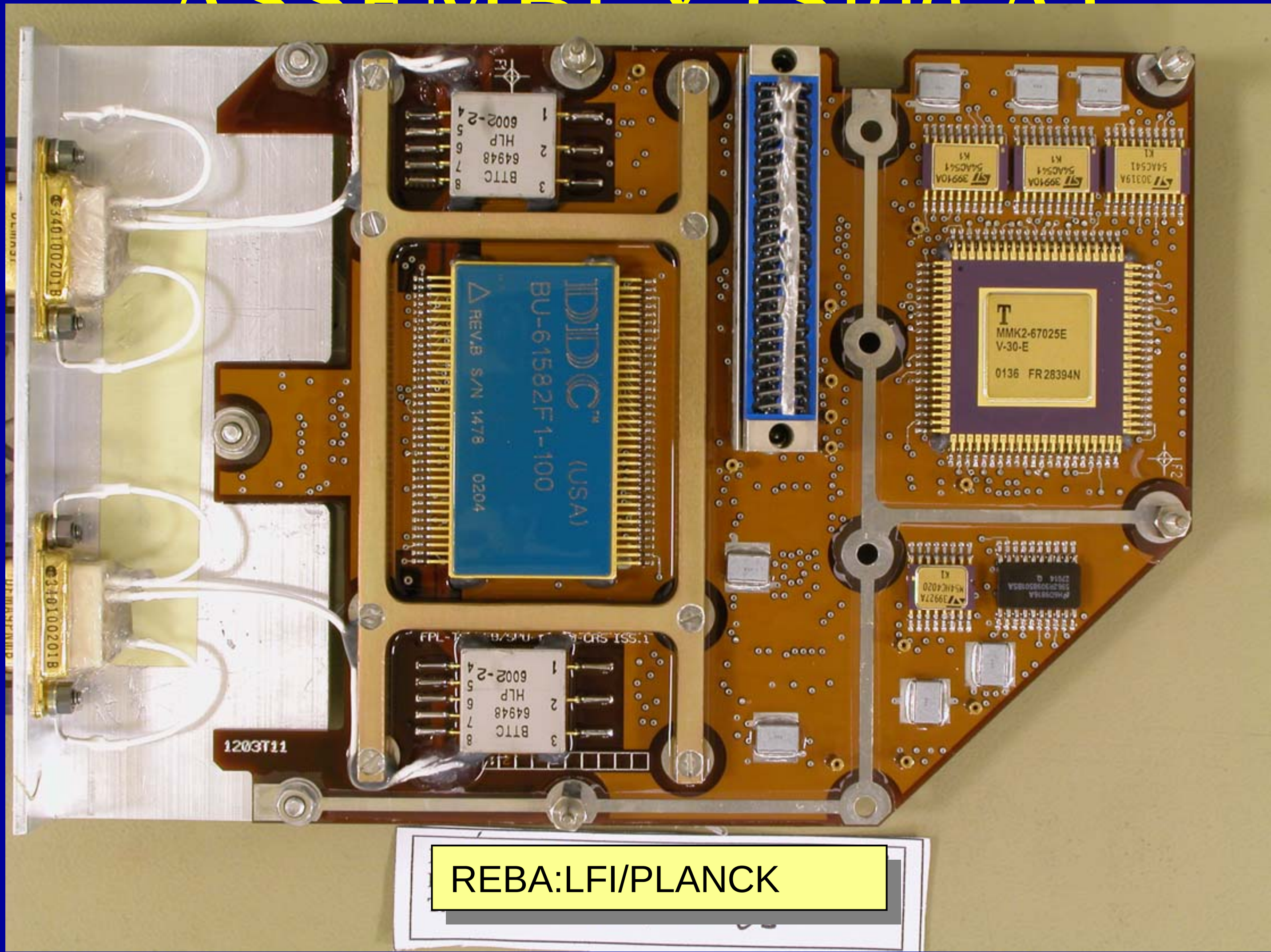
QM DC/DC CONVERTER & DAU MODULE (Side A)



QM DC-DC CONVERTER & DAU MODULE (Side B)

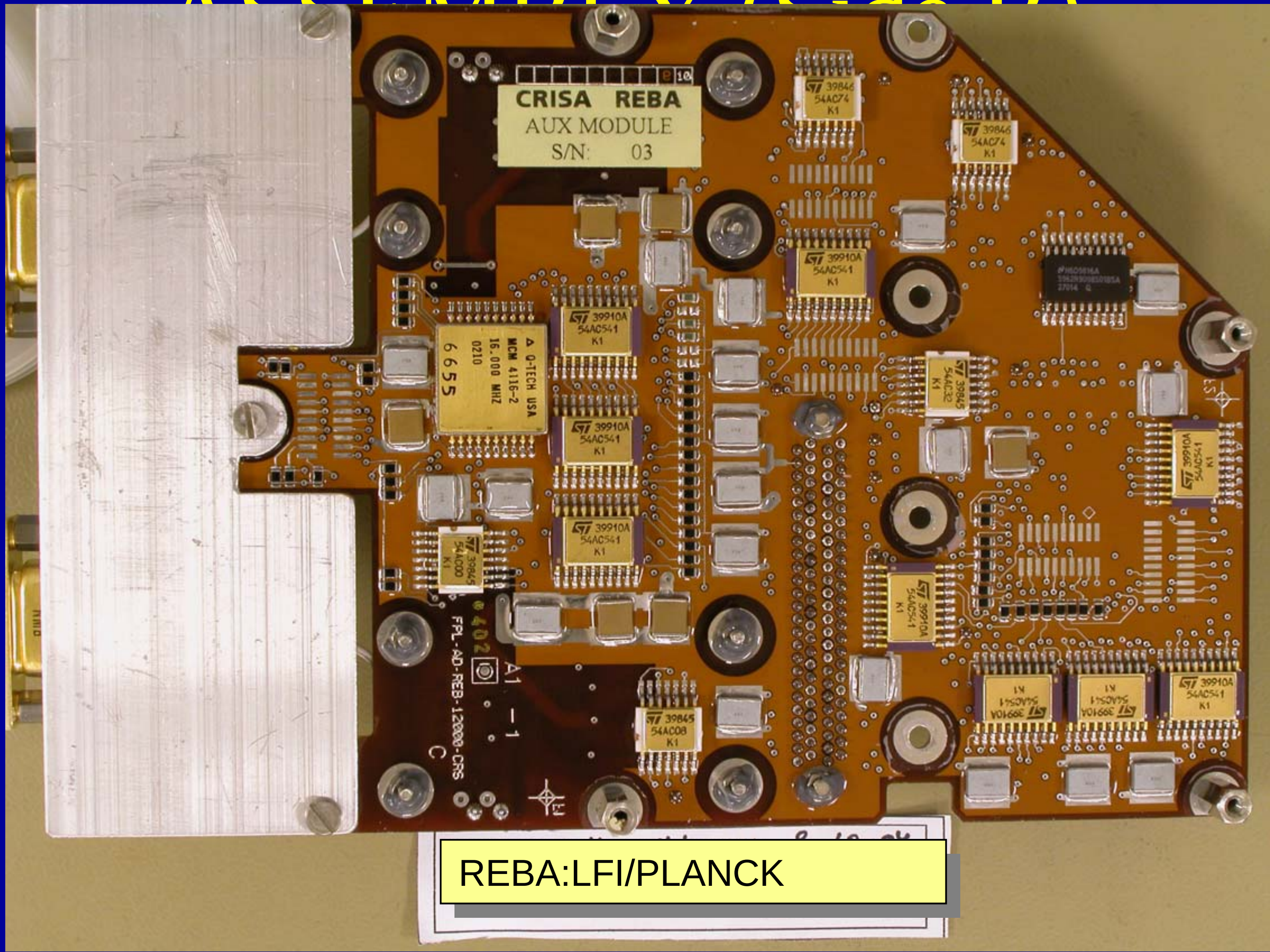


QM AUXILIARY MODULE ASSEMBLY (Side A)

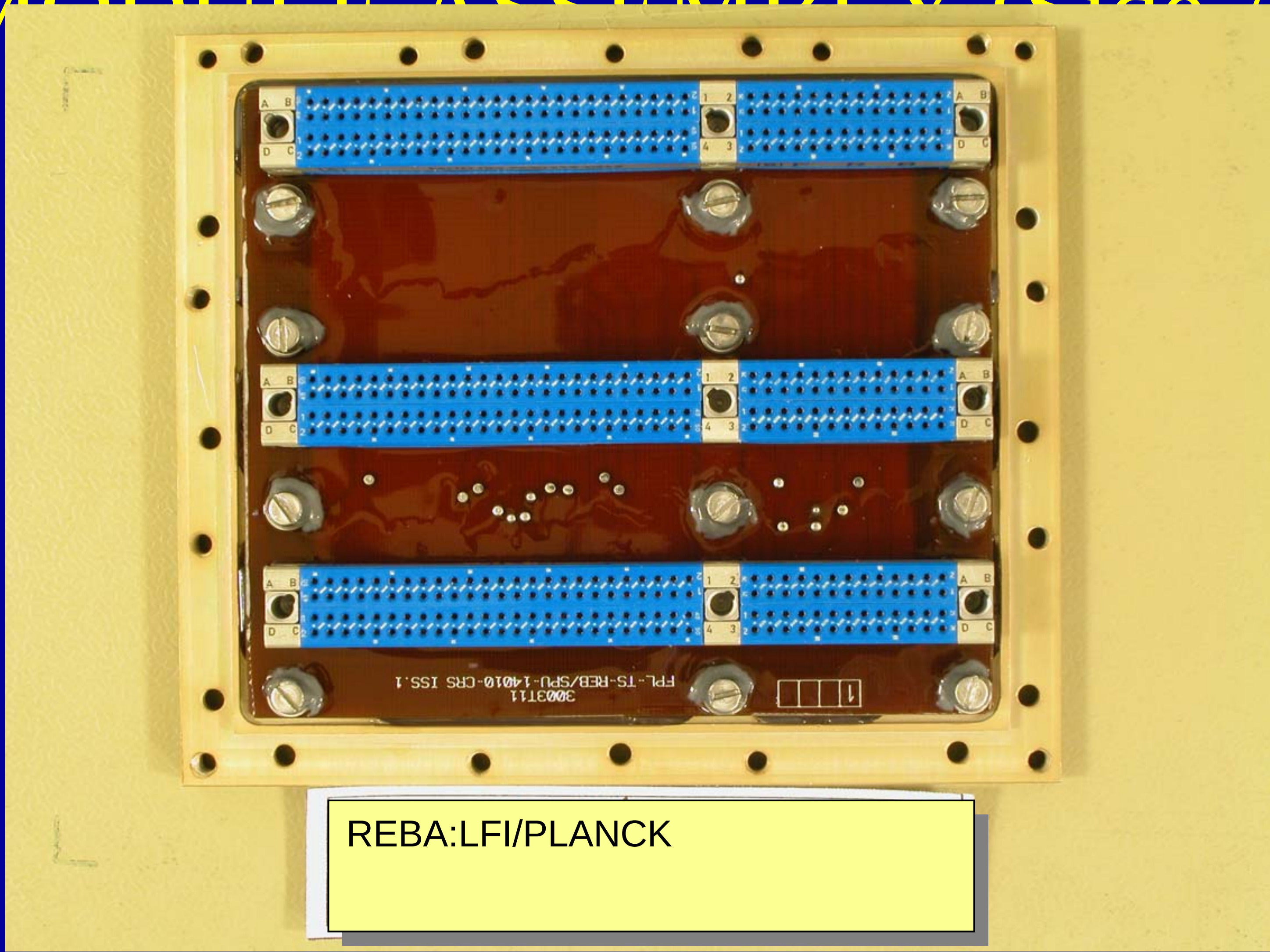


REBA:LFI/PLANCK

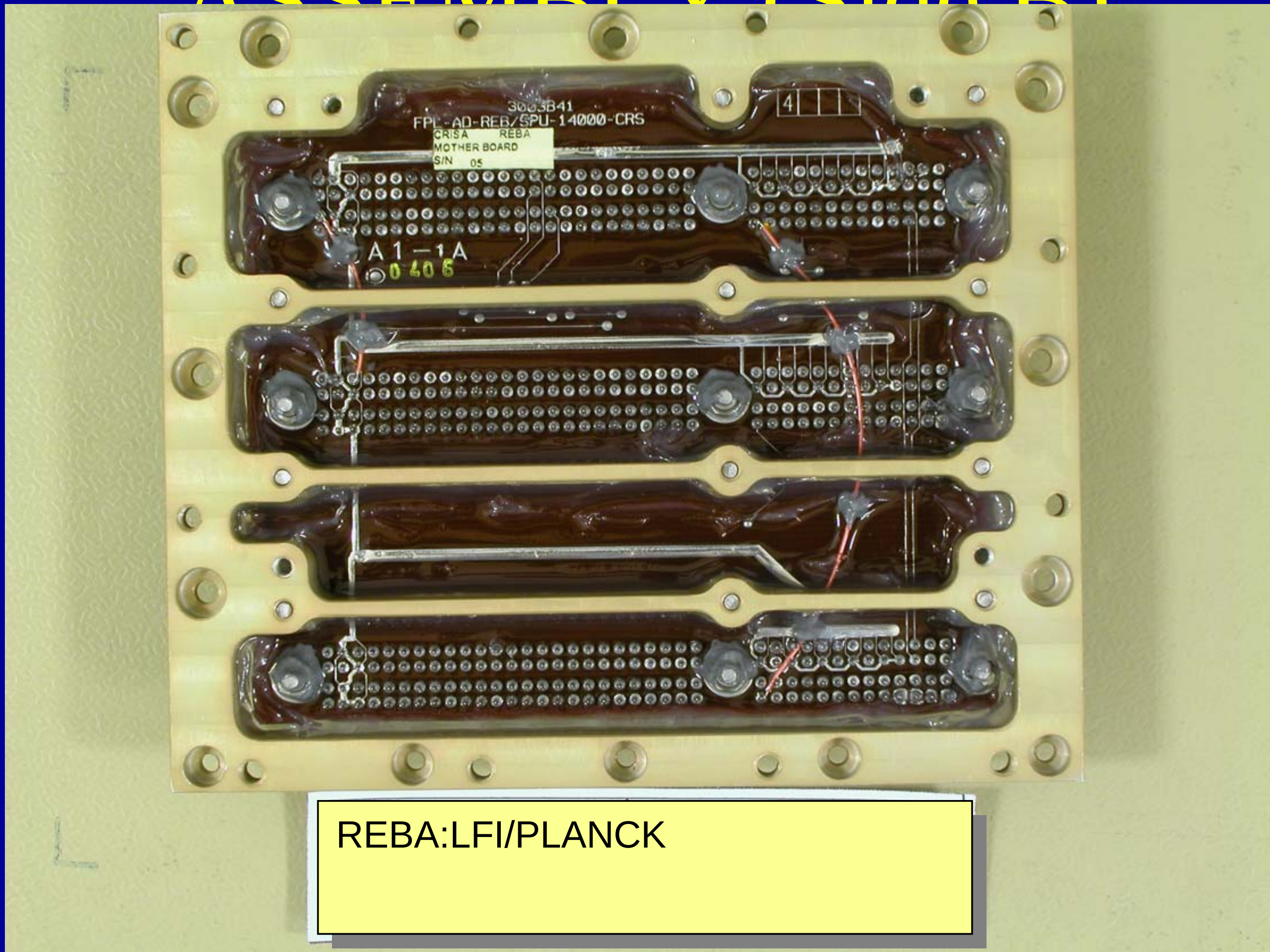
QM AUXILIARY MODULE ASSEMBLY (Side B)



QM MOTHER BOARD
MODULE ASSEMBLY (Side A)

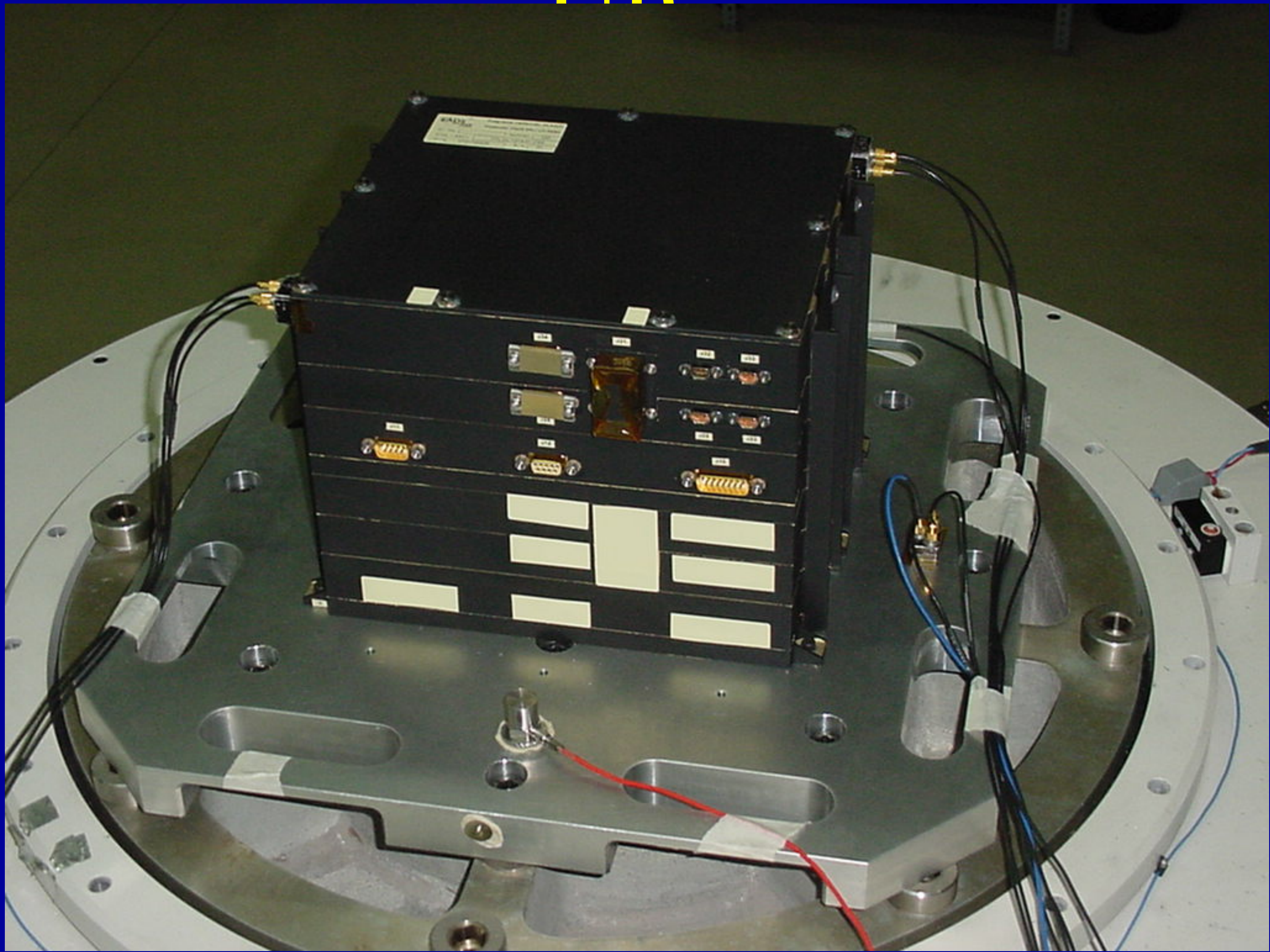


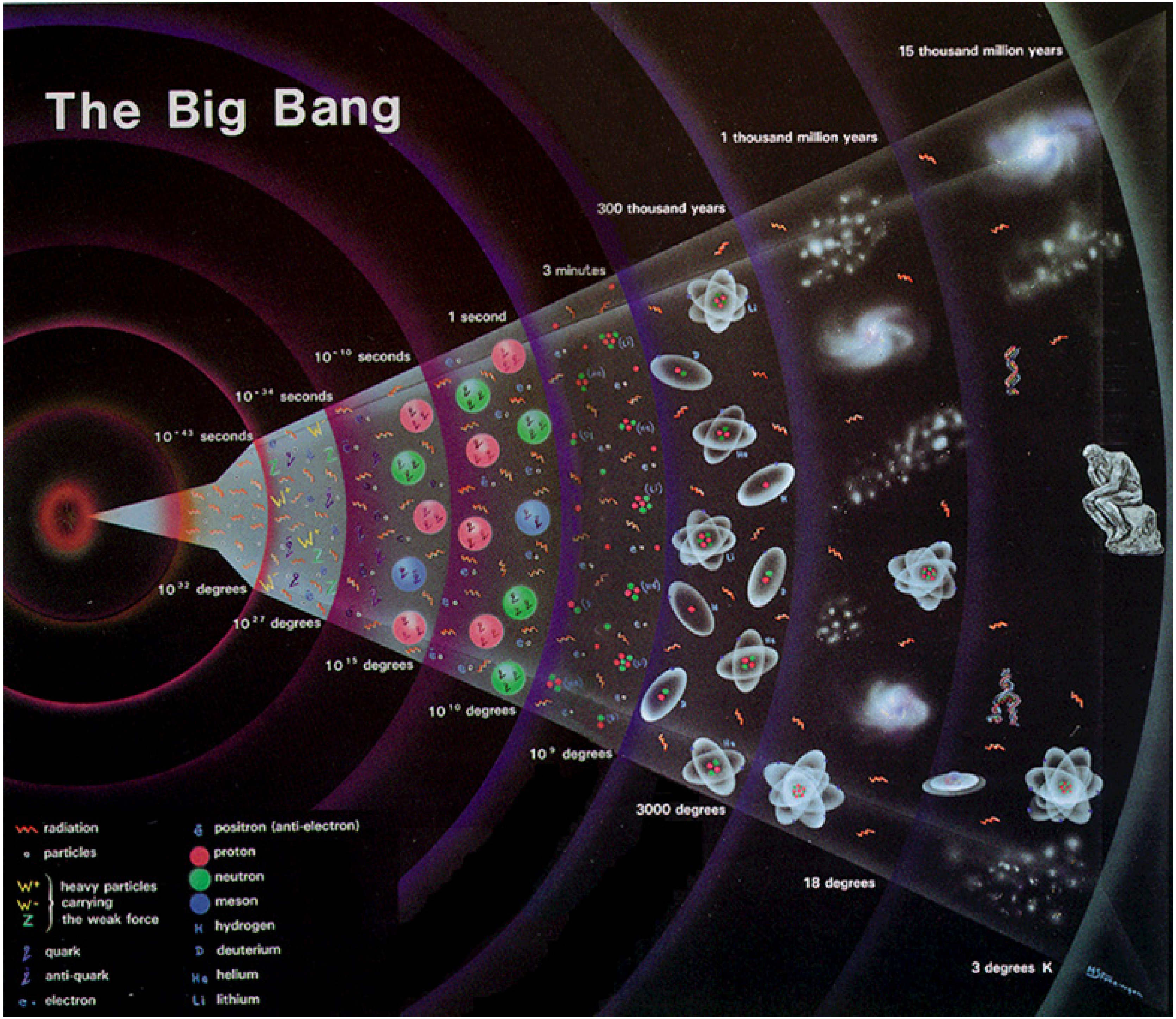
QM MOTHER BOARD MODULE ASSEMBLY (Side B)

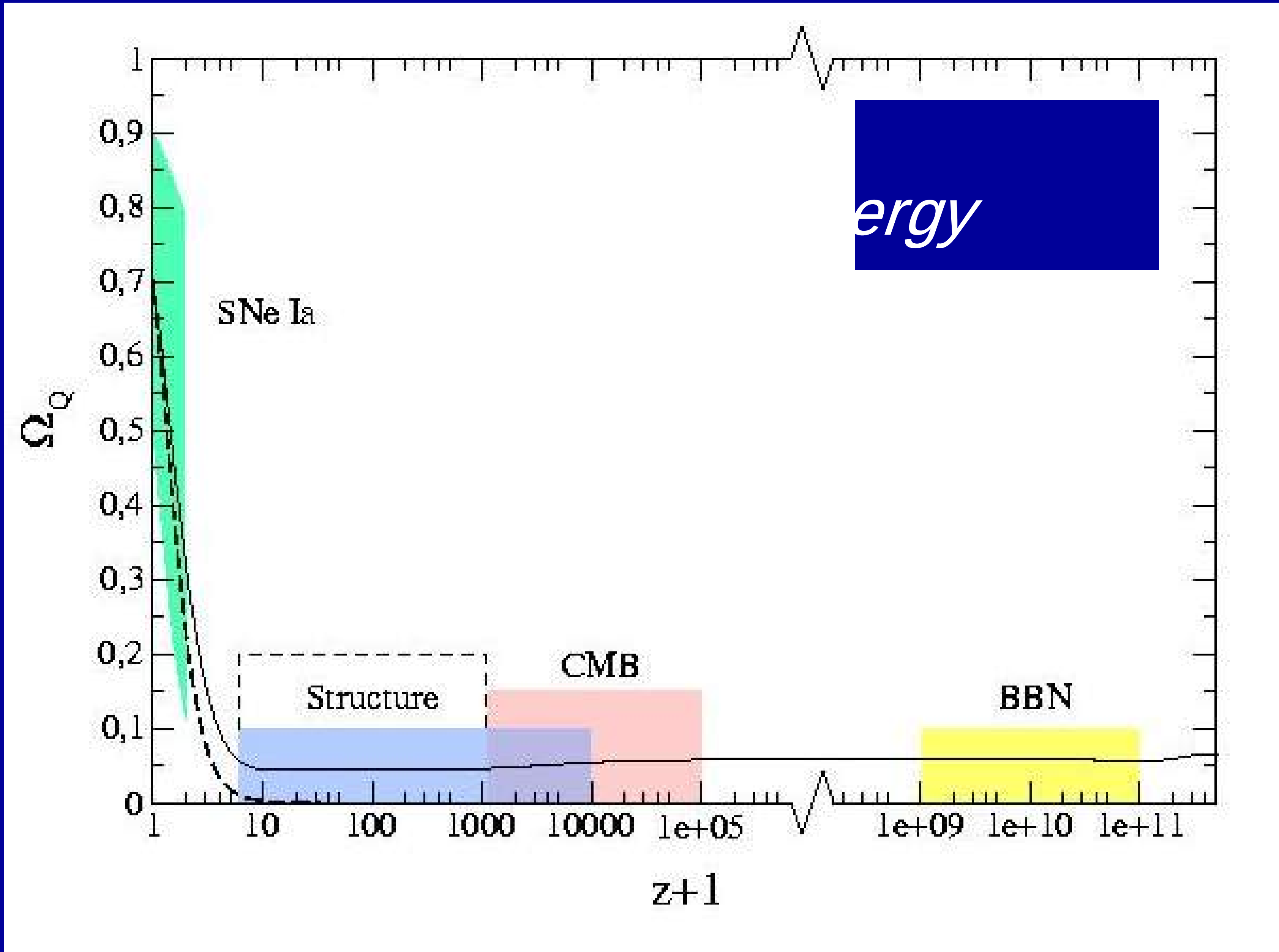


REBA:LFI/PLANCK

REBA QM VIBRATION SET-UP

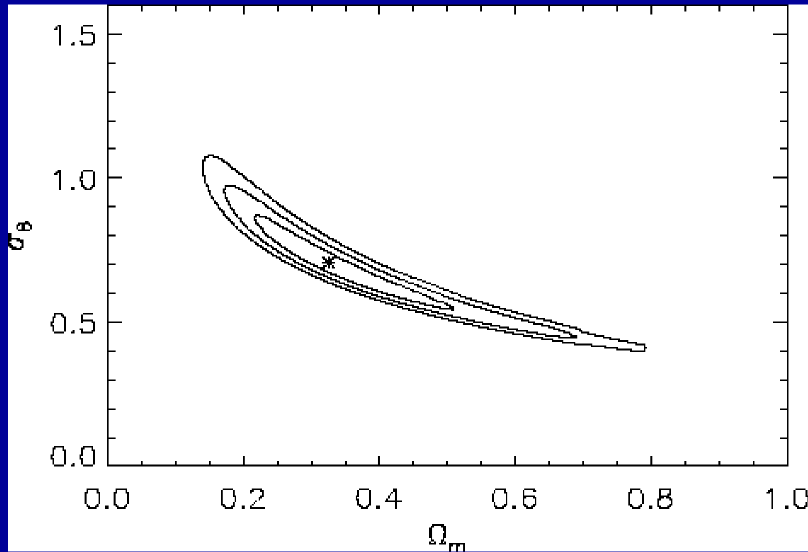


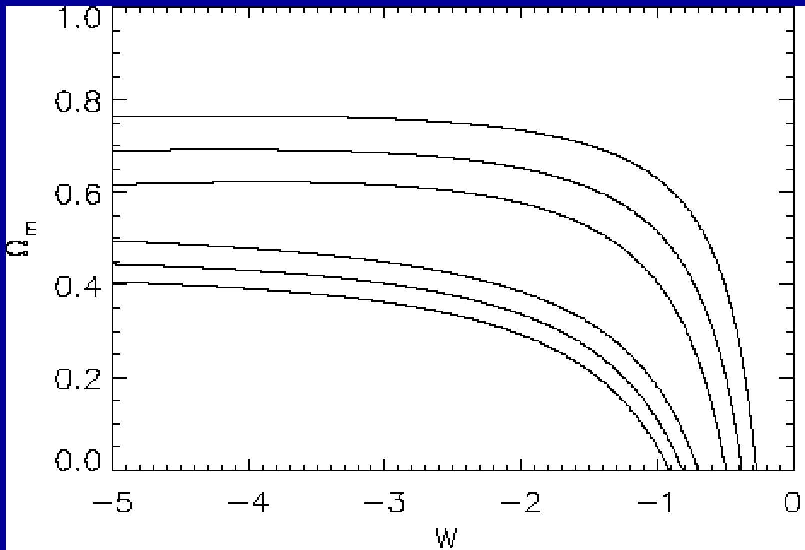

The Big Bang
15 thousand million years
1 thousand million years
300 thousand years
3 minutes
1 second
10^{-10} seconds
10^{-34} seconds
10^{-43} seconds
10^{32} degrees
10^{27} degrees
10^{15} degrees
10^{10} degrees
10^{9} degrees
3000 degrees
18 degrees
3 degrees K
radiation
particles
W^+ W^- Z heavy particles carrying the weak force
quark
anti-quark
electron
positron (anti-electron)
proton
neutron
meson
H hydrogen
D deuterium
He helium
Li lithium

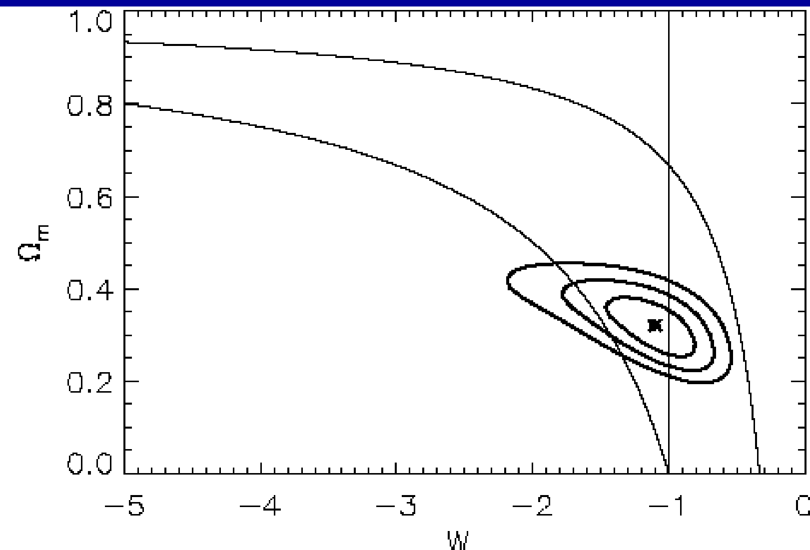


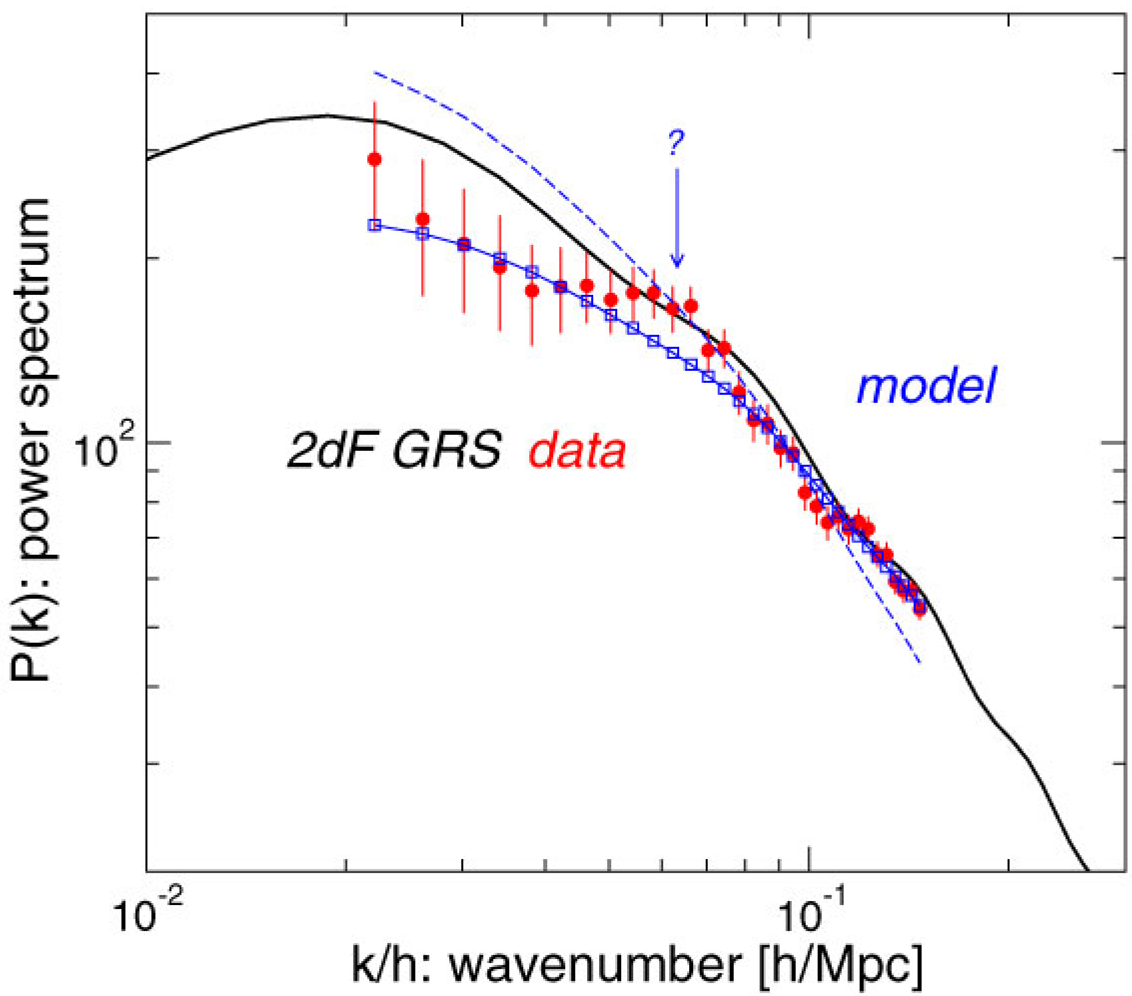
Doran & Wetterich 2002

REFLEX X-ray clusters + SNe,
Schuecker et al, (forthcoming, 2002)

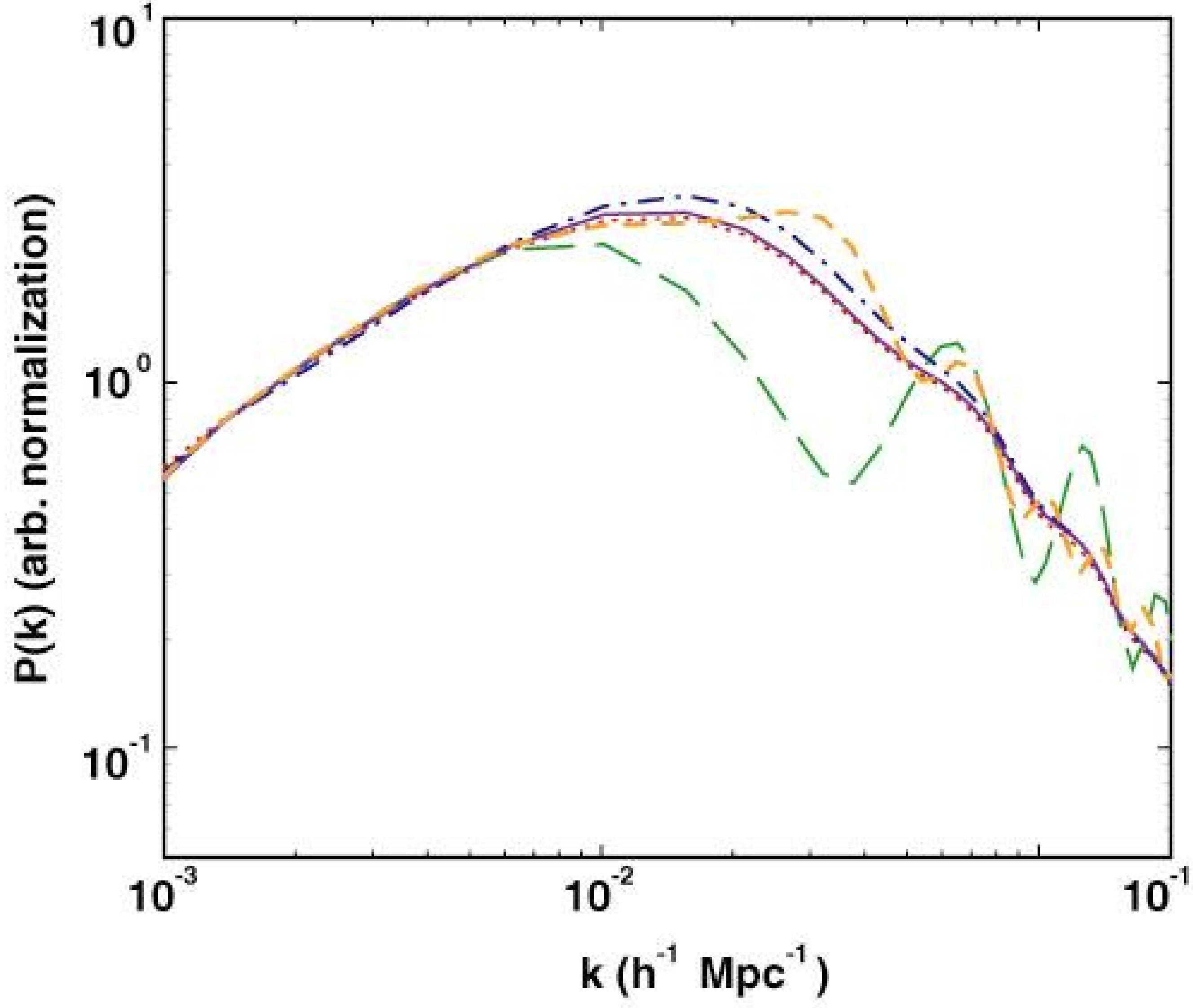






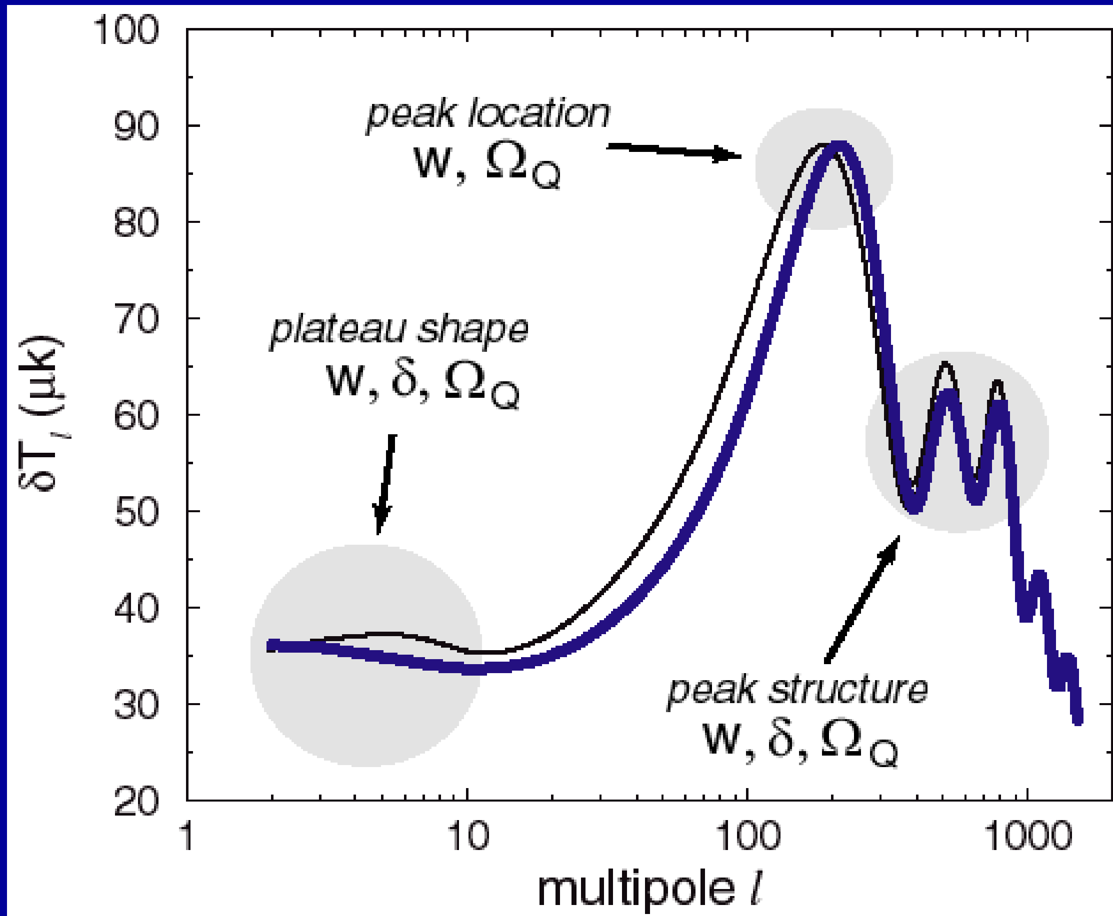


?
model
2dF GRS data
P(k): power spectrum
10^2
10^-2
10^-1
k/h: wavenumber [h/Mpc]

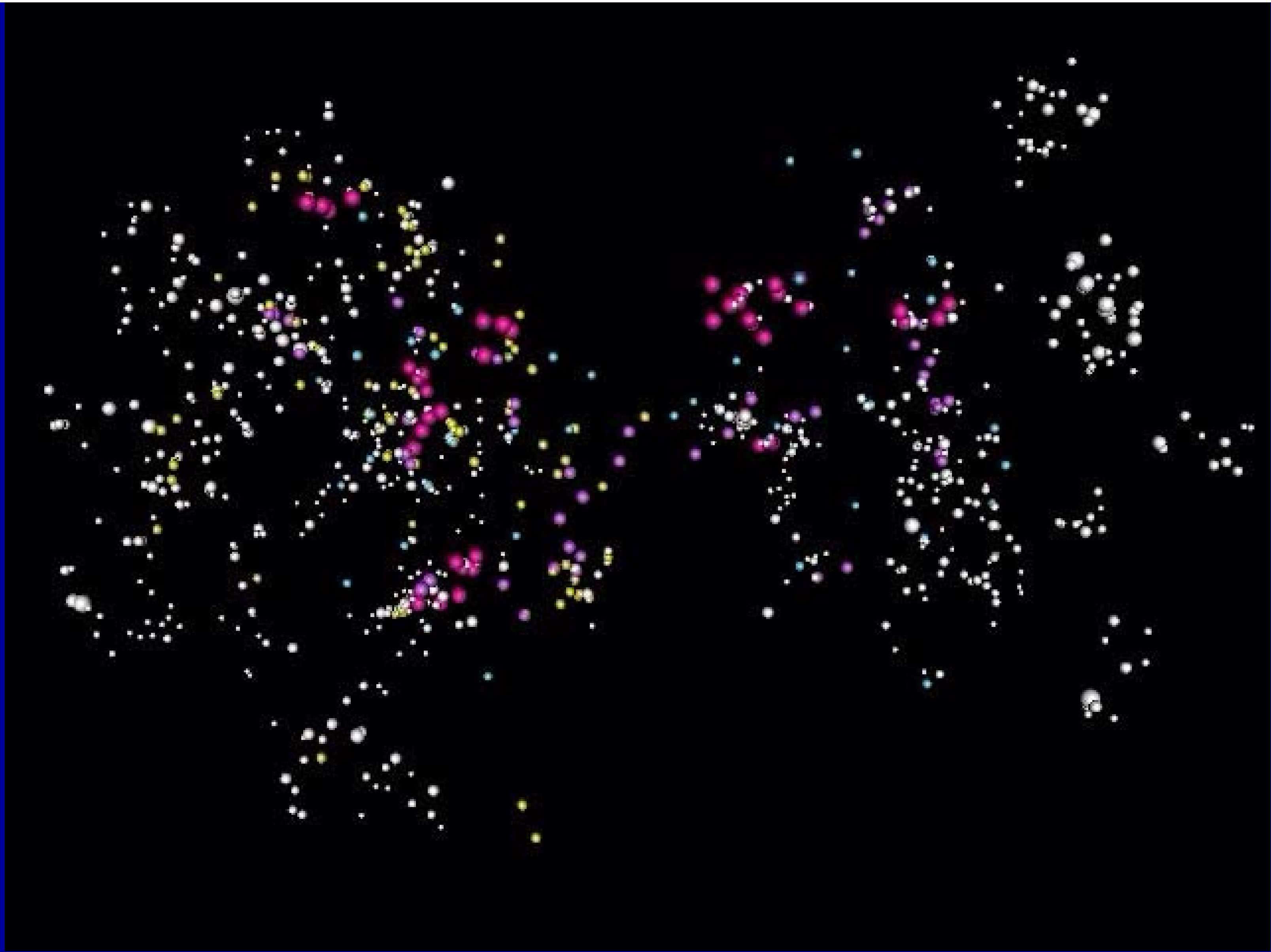


10^{1}
10^{0}
10^{-1}
P(k) (arb. normalization)
10^{-3}
10^{-2}
10^{-1}
k (h^{-1} Mpc^{-1})

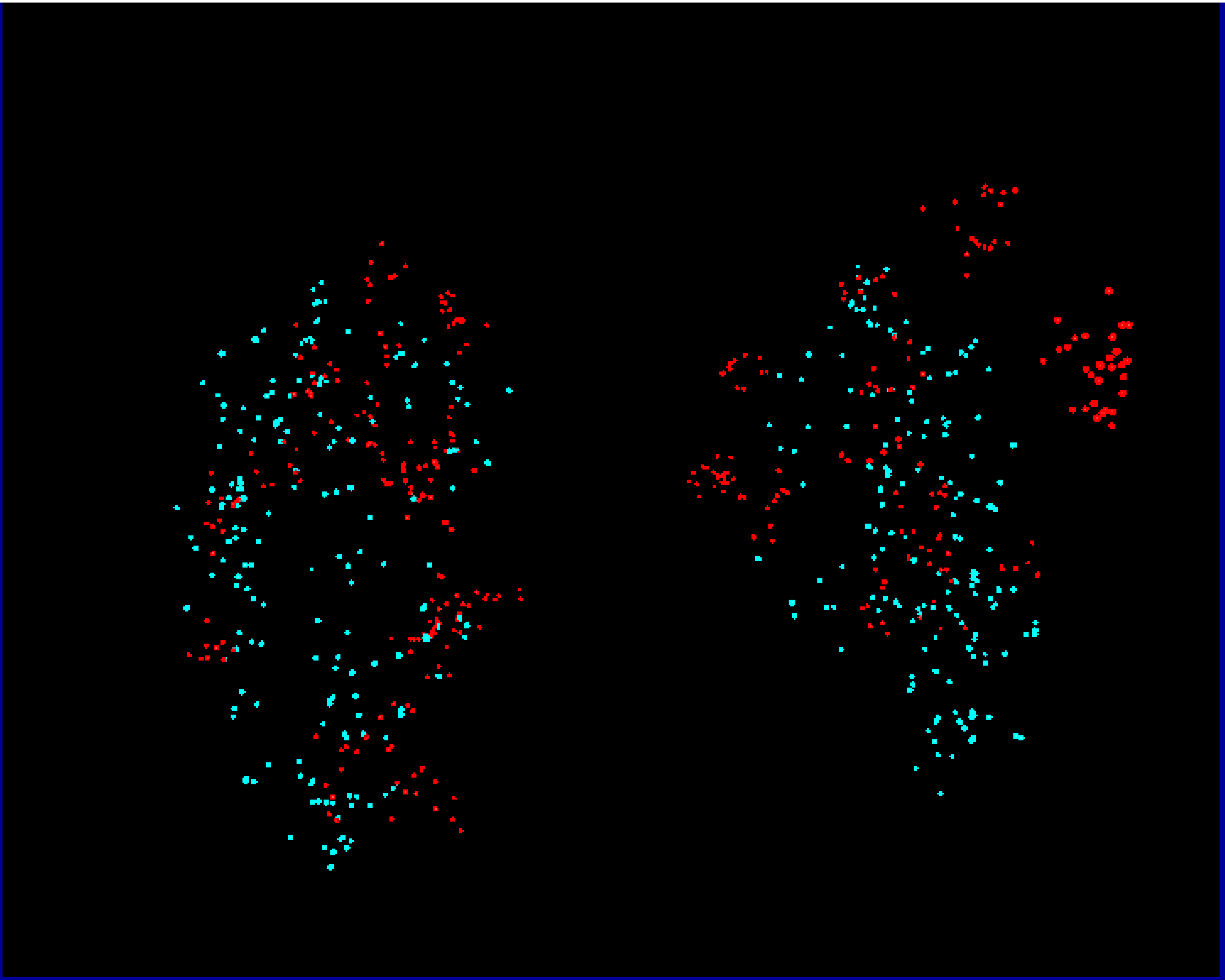
imprint



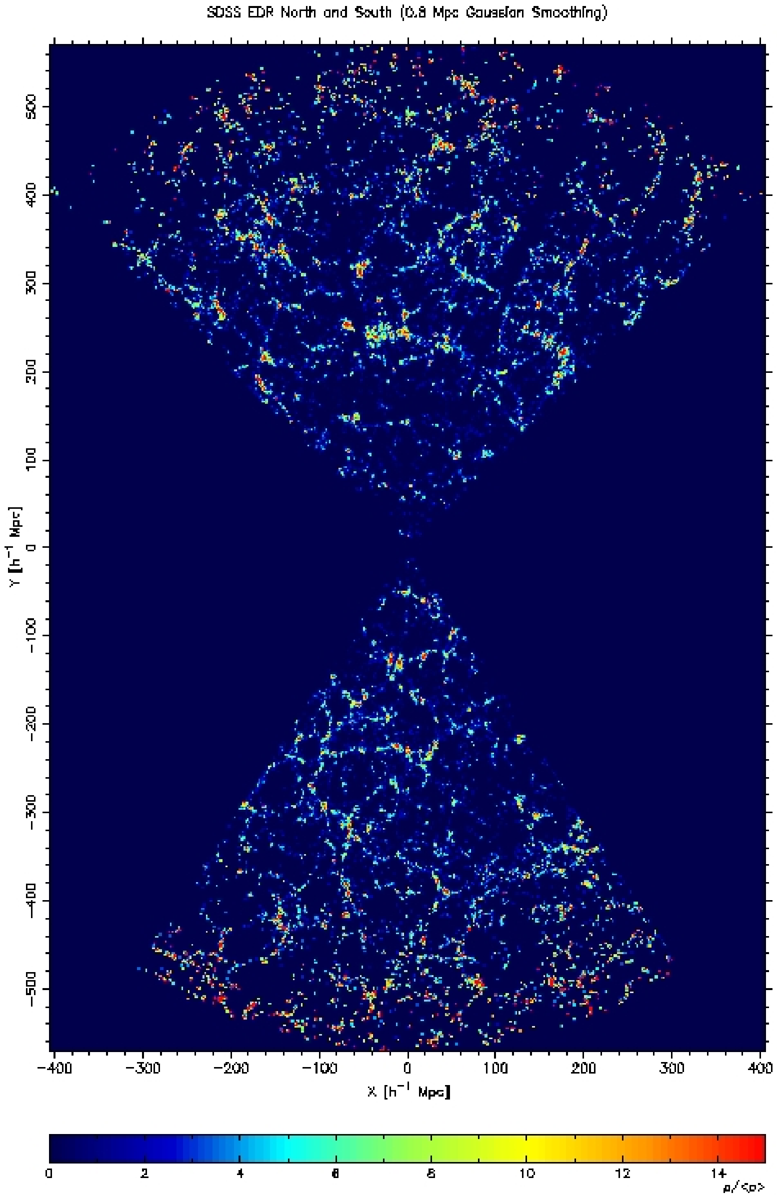
peak location
w, Ω_Q
plateau shape
w, δ, Ω_Q
peak structure
w, δ, Ω_Q
δT_l (μk)
100
90
80
70
60
50
40
30
20
1
10
100
1000
multipole l

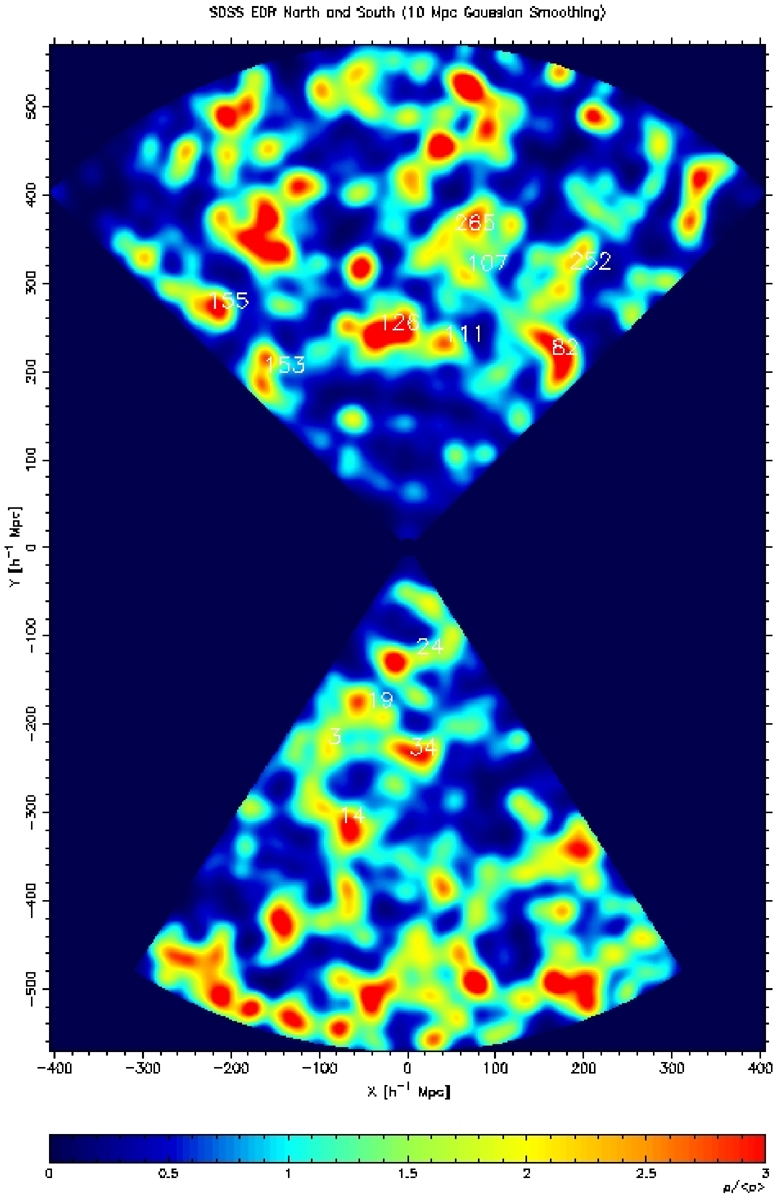


Distribution of Abell clusters (white) and X-ray clusters (red)



Abell clusters (red) and LCRS clusters (blue). Global structure
Better visible using 3-D Abell cluster data


SDSS EDR North and South (0.8 Mpc Gaussian Smoothing)
Y [h^{-1} Mpc]
X [h^{-1} Mpc]
ρ/<ρ>

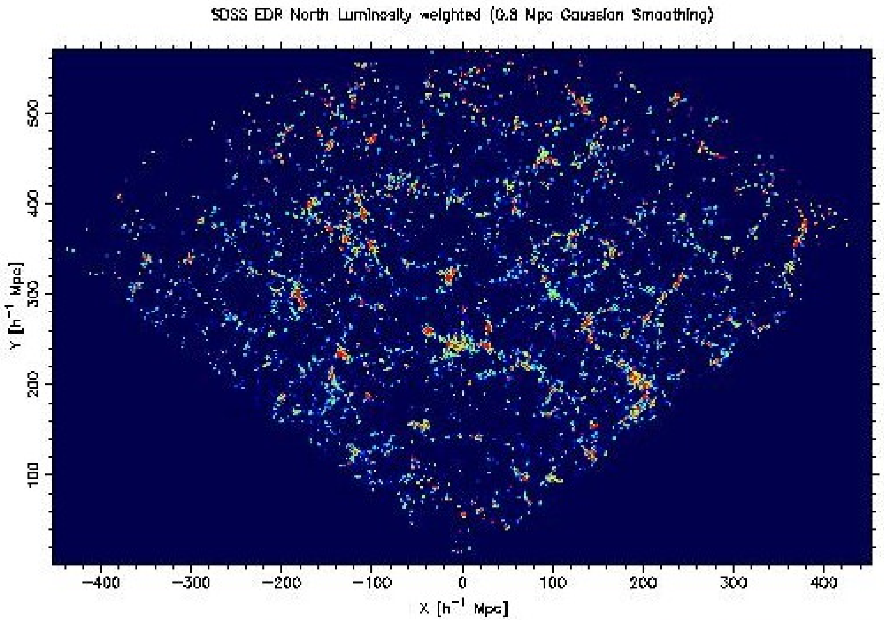

SDSS EDR North and South (10 Mpc Gaussian Smoothing)
265
107
252
155
128
111
82
153
24
19
3
34
14
Y [h^{-1} Mpc]
X [h^{-1} Mpc]
ρ/<ρ>

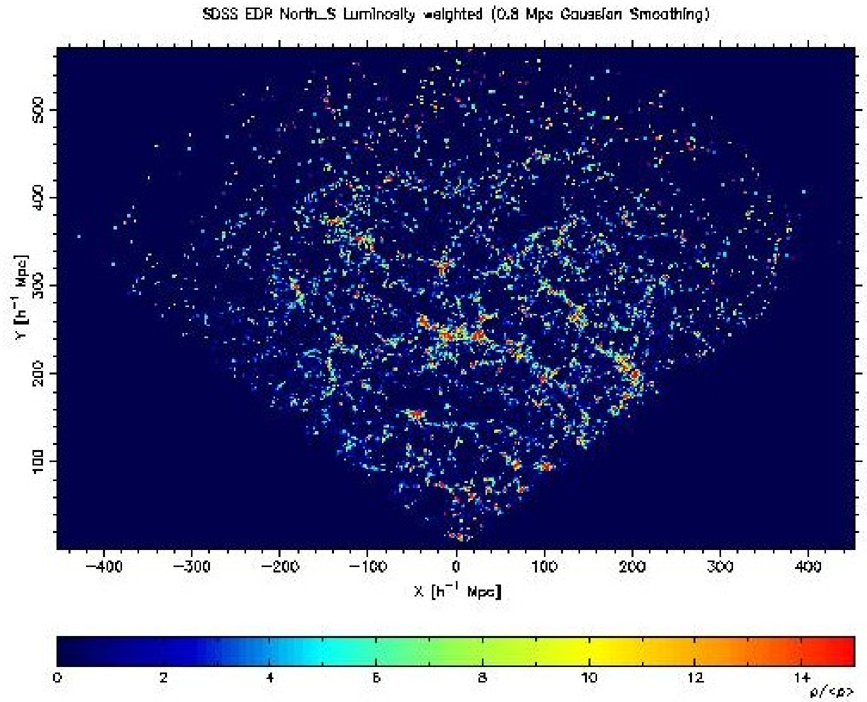
Density field for early and late type galaxies

Using color index early
 and late type galaxies
 can be separated.

Upper figure: density field for early galaxies

Lower figure: for late galaxies. There are more late type galaxies in low-density regions

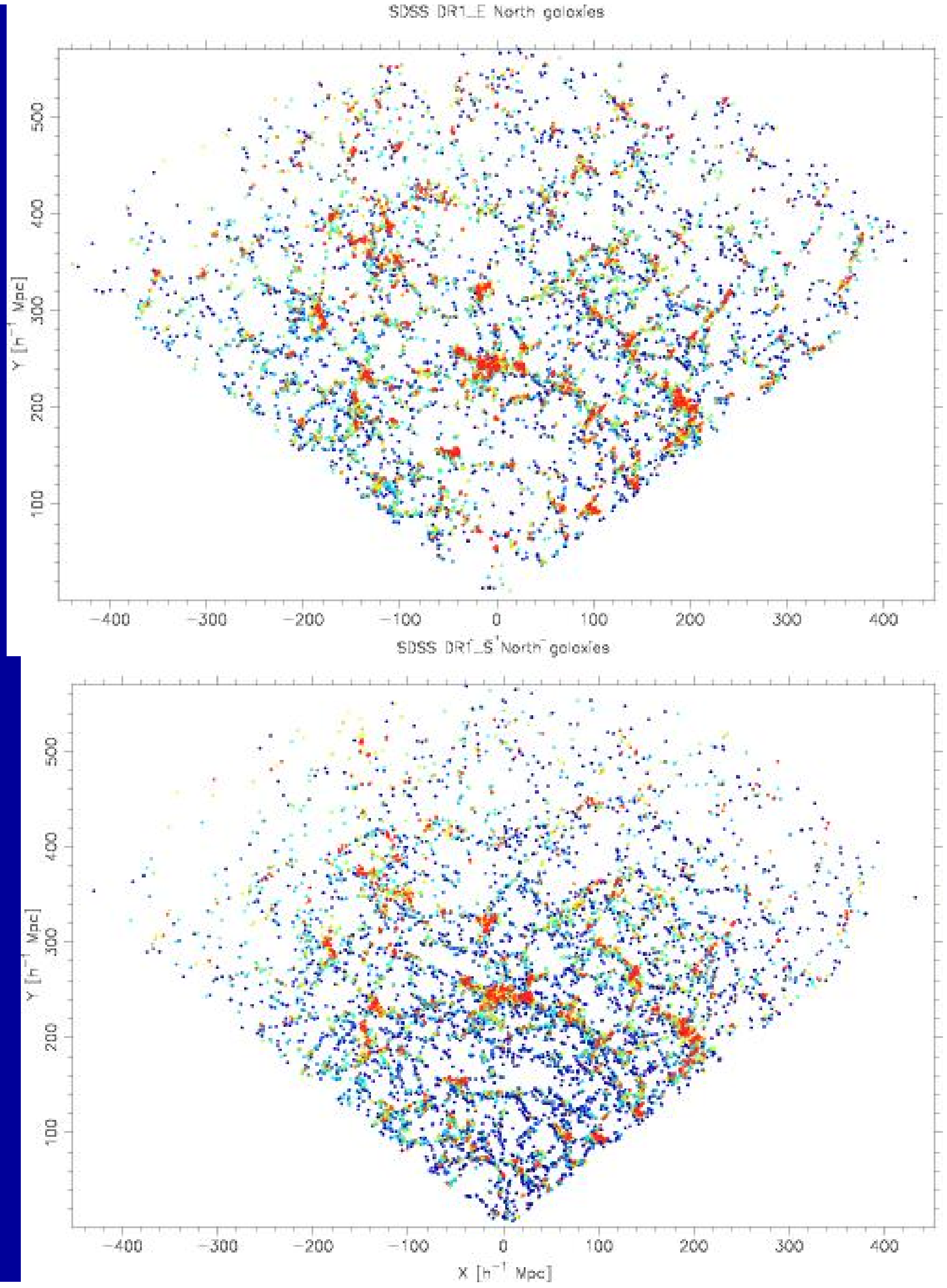




Distribution of early (top) and late (bottom) type galaxies in SDSS Northern equatorial strip.

Dark blue – galaxies in low-den environment

Red – galaxies in high-den environment



Superclusters with Abell clusters

Luminosity of superclusters as a function of the richness (the number of DF-clusters).
Filled circles - superclusters with Abell clusters
Open circles – superclusters without Abell clusters

Abell superclusters are richer