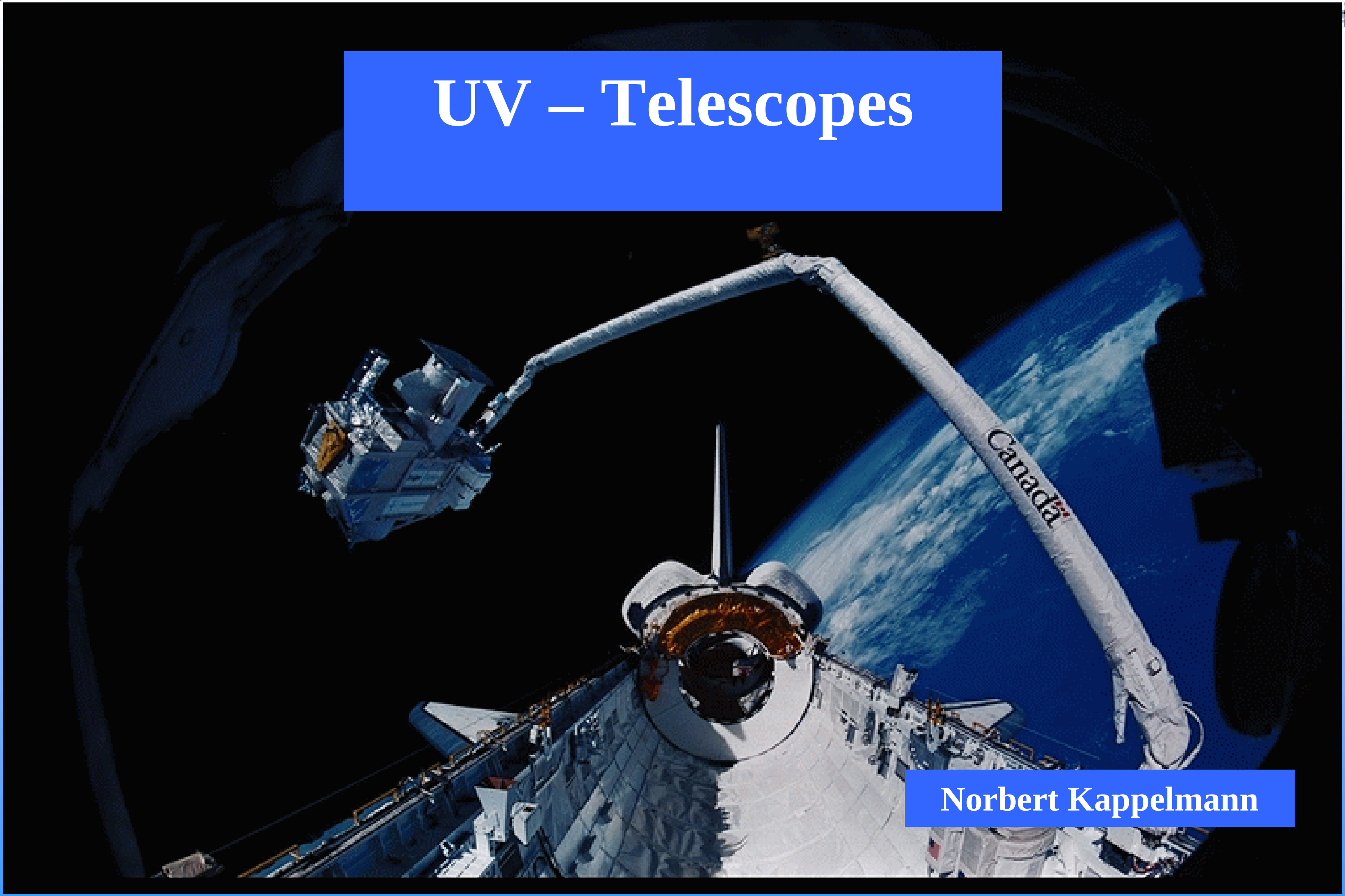
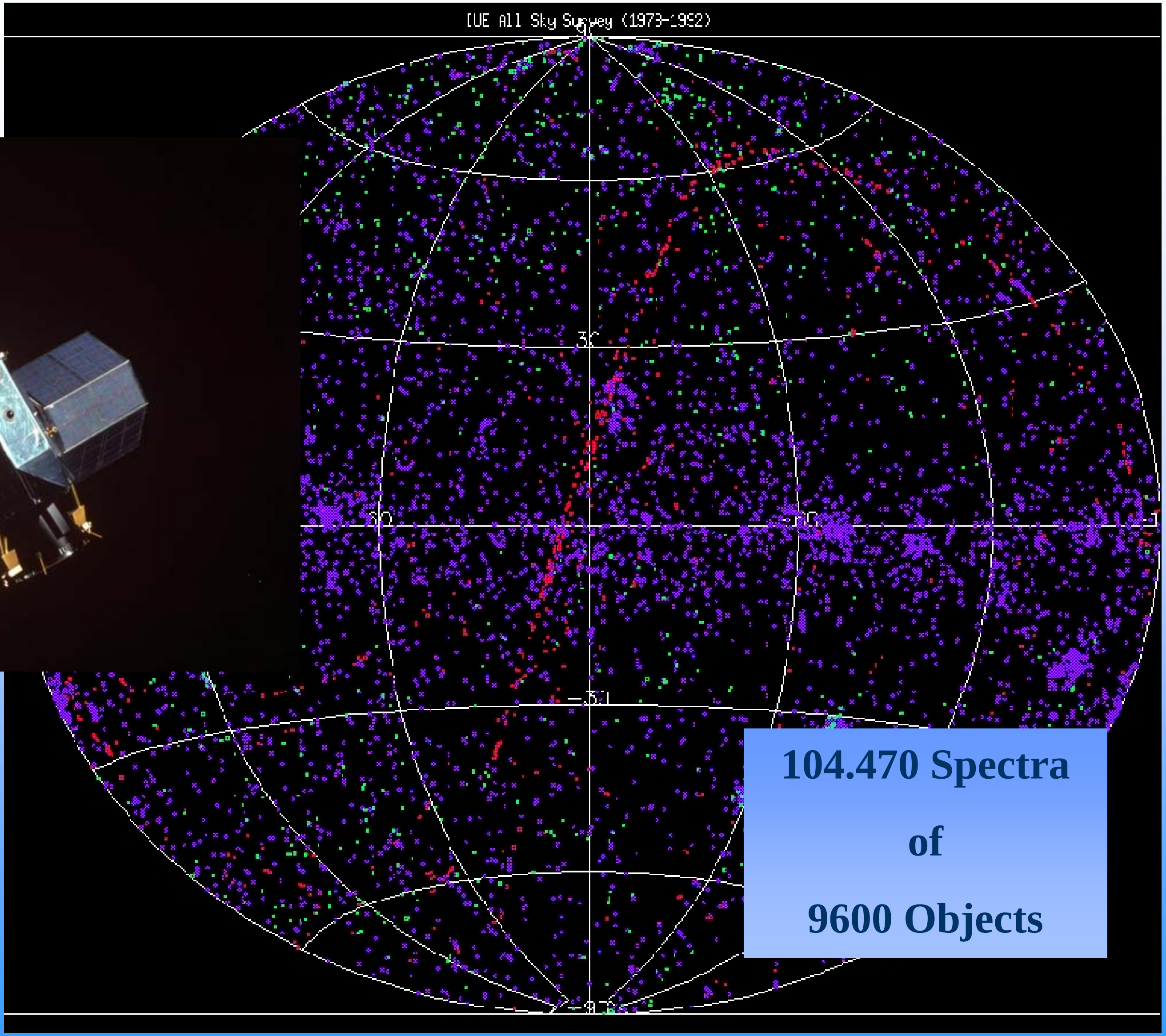
UV – Telescopes



Norbert Kappelmann

UV - Missions

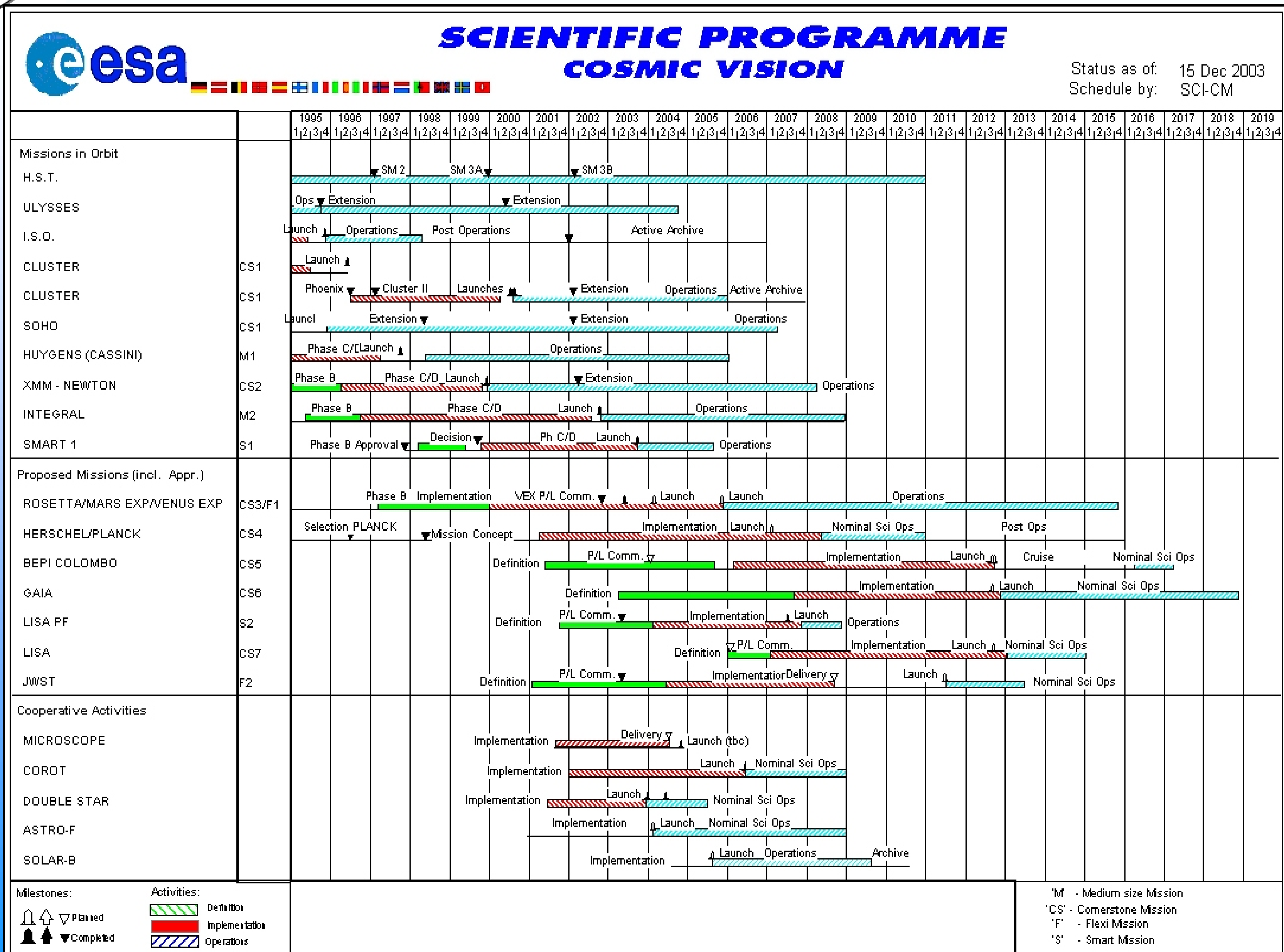
	50-90nm	90-120	120-200 nm	200 – 320 nm
Optic: Mission	special	special	normal	normal
1960 -			Rockets	Balloons
1968 -1975			OAO2,ANS TD1	OAO2,ANS TD1
1972 -1979		Copernicus	Copernicus	Copernicus
1978 -1996			IUE	IUE
1990 -			HST	HST
1992 - 2001	EUVE	ASTRO1 ASTRO2	ASTRO1 ASTRO2	
1993 - 1996		ORFEUS		
1999 -		FUSE		

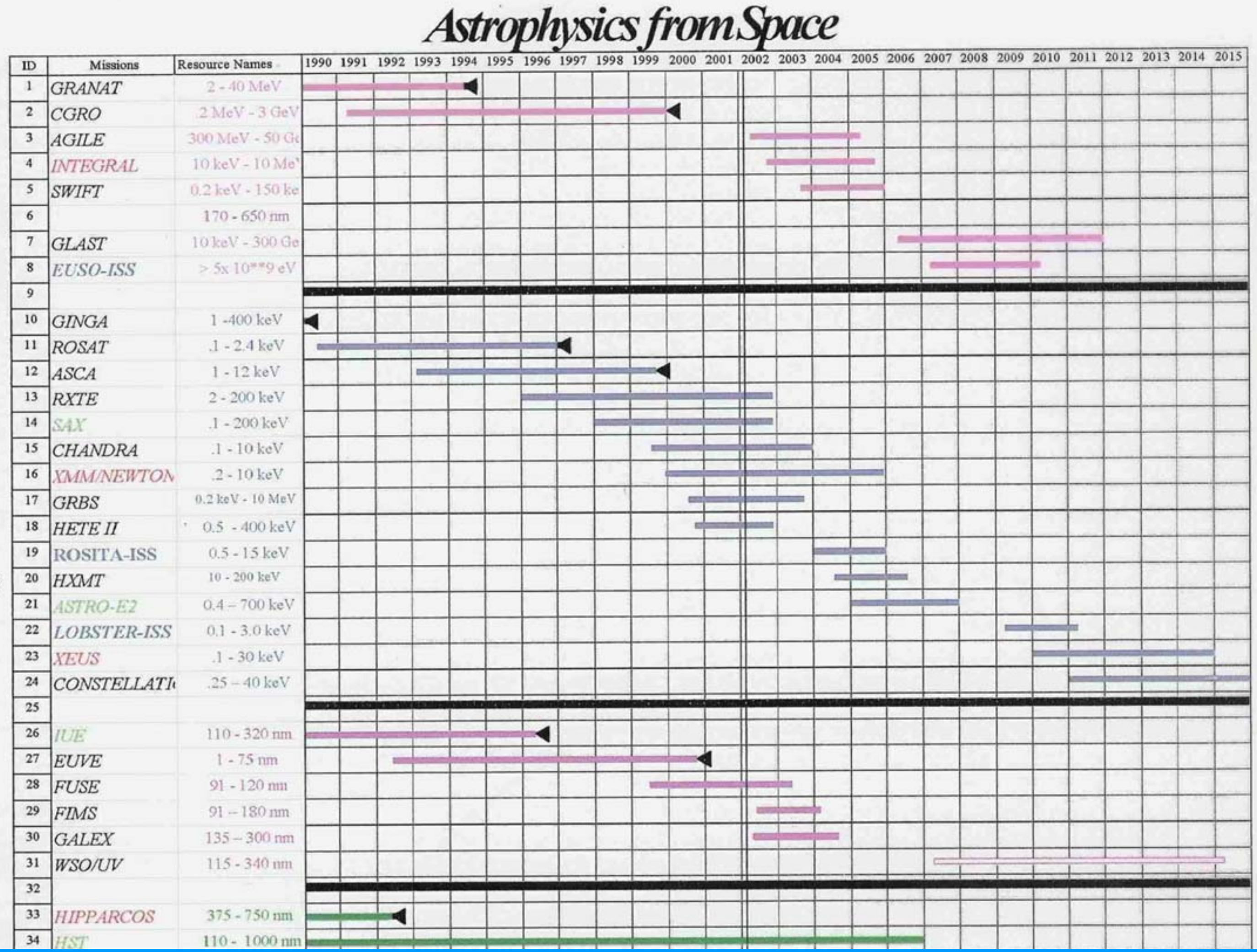


104.470 Spectra

of

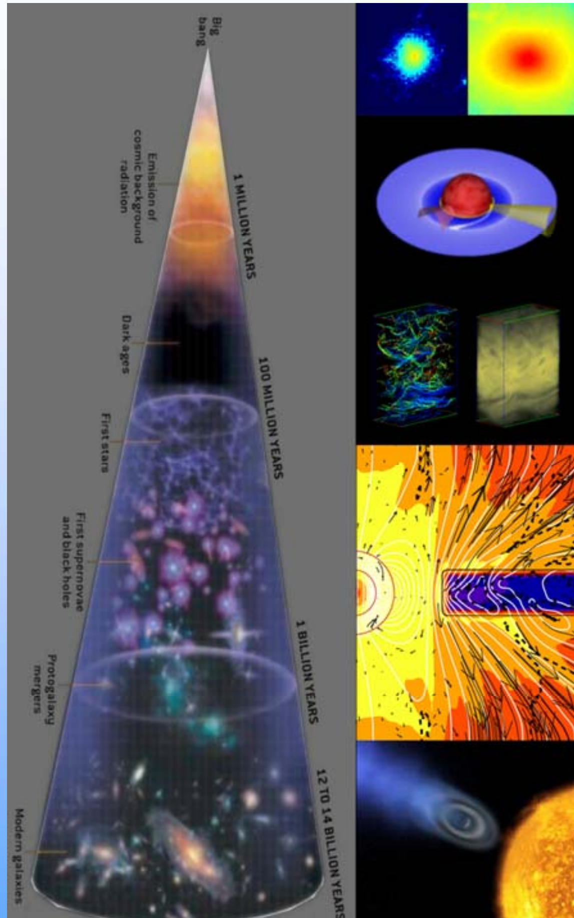
9600 Objects

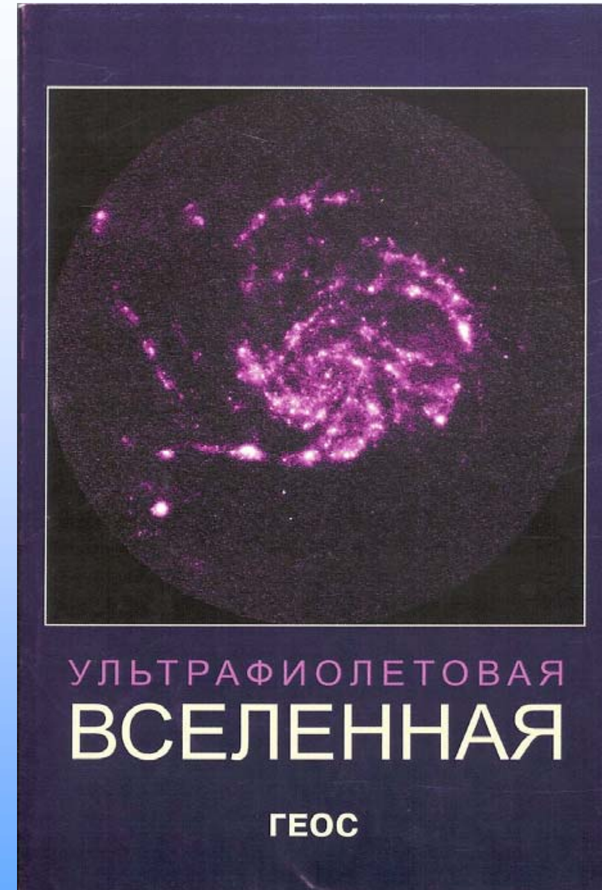

esa
SCIENTIFIC PROGRAMME
COSMIC VISION
Status as of: 15 Dec 2003
Schedule by: SCI-CM
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Missions in Orbit
H.S.T.
SM 2
SM 3A
SM 3B
ULYSSES
Ops
Extension
Extension
I.S.O.
Launch
Operations
Post Operations
Active Archive
CLUSTER CS1
Launch
CLUSTER CS1
Phoenix
Cluster II
Launches
Extension
Operations
Active Archive
SOHO CS1
Launch
Extension
Extension
Operations
HUYGENS (CASSINI) M1
Phase C/D
Launch
Operations
XMM - NEWTON CS2
Phase B
Phase C/D
Launch
Extension
Operations
INTEGRAL M2
Phase B
Phase C/D
Launch
Operations
SMART 1 S1
Phase B Approval
Decision
Ph C/D
Launch
Operations
Proposed Missions (incl. Appr.)
ROSETTA/MARS EXP/VENUS EXP CS3/F1
Phase B
Implementation
VEX P/L Comm.
Launch
Launch
Operations
HERSCHEL/PLANCK CS4
Selection PLANCK
Mission Concept
Implementation
Launch
Nominal Sci Ops
Post Ops
BEPI COLOMBO CS5
Definition
P/L Comm.
Implementation
Launch
Cruise
Nominal Sci Ops
GAIA CS6
Definition
Implementation
Launch
Nominal Sci Ops
LISA PF S2
Definition
P/L Comm.
Implementation
Launch
Operations
LISA CS7
Definition
P/L Comm.
Implementation
Launch
Nominal Sci Ops
JWST F2
Definition
P/L Comm.
Implementation
Delivery
Launch
Nominal Sci Ops
Cooperative Activities
MICROSCOPE
Implementation
Delivery
Launch (tbc)
COROT
Implementation
Launch
Nominal Sci Ops
DOUBLE STAR
Implementation
Launch
Nominal Sci Ops
ASTRO-F
Implementation
Launch
Nominal Sci Ops
SOLAR-B
Implementation
Launch
Operations
Archive
Milestones:
Planned
Completed
Activities:
Definition
Implementation
Operations
'M' - Medium size Mission
'CS' - Cornerstone Mission
'F' - Flexi Mission
'S' - Smart Mission


Astrophysics from Space
ID | Missions | Resource Names
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
1 GRANAT 2 - 40 MeV
2 CGRO .2 MeV - 3 GeV
3 AGILE 300 MeV - 50 G
4 INTEGRAL 10 keV - 10 Me
5 SWIFT 0.2 keV - 150 ke
6 170 - 650 nm
7 GLAST 10 keV - 300 Ge
8 EUSO-ISS > 5x 10**9 eV
9
10 GINGA 1 -400 keV
11 ROSAT .1 - 2.4 keV
12 ASCA 1 - 12 keV
13 RXTE 2 - 200 keV
14 SAX .1 - 200 keV
15 CHANDRA .1 - 10 keV
16 XMM/NEWTON .2 - 10 keV
17 GRBS 0.2 keV - 10 MeV
18 HETE II 0.5 - 400 keV
19 ROSITA-ISS 0.5 - 15 keV
20 HXMT 10 - 200 keV
21 ASTRO-E2 0.4 – 700 keV
22 LOBSTER-ISS 0.1 - 3.0 keV
23 XEUS .1 - 30 keV
24 CONSTELLATI .25 – 40 keV
25
26 IUE 110 - 320 nm
27 EUVE 1 - 75 nm
28 FUSE 91 - 120 nm
29 FIMS 91 – 180 nm
30 GALEX 135 – 300 nm
31 WSO/UV 115 - 340 nm
32
33 HIPPARCOS 375 - 750 nm
34 HST 110 - 1000 nm

year

1970	
1980	COPERNICUS IUE ASTRON
1990	HST
2000	FUSE GALEX
2010	**WSO/UV - Spectrum UV**
2020	





Fundamental Problems in Astrophysics:

Guidelines for Future UV observations, 2006

Astrophys. Space Sci 2006 303

Ultraviolet Universe, 2001

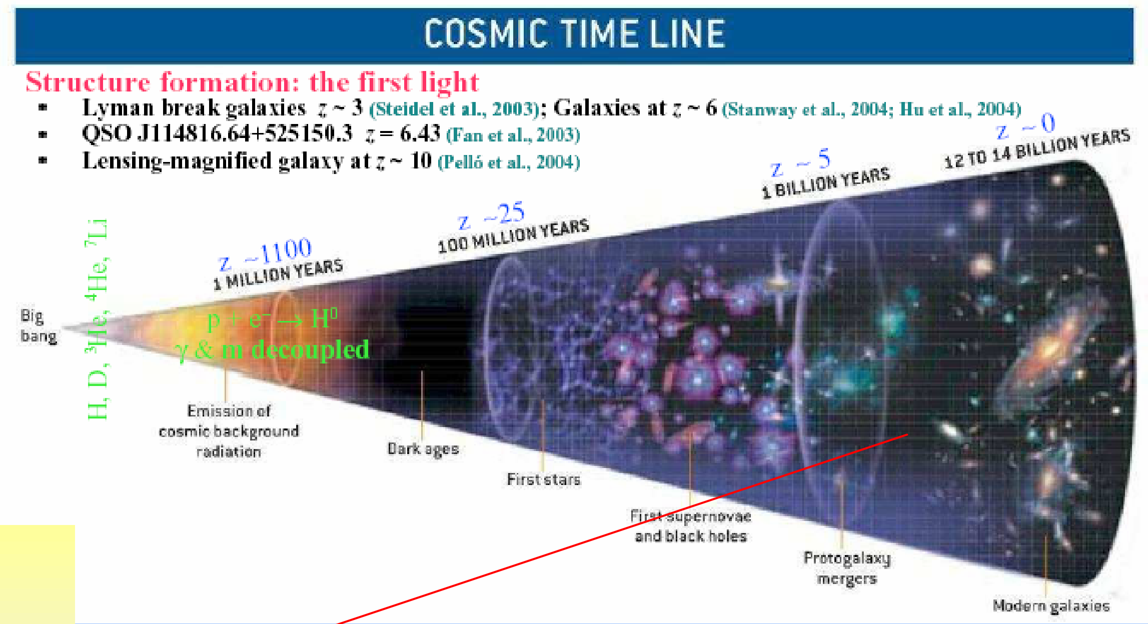
Why is the UV range is important?

- Richness of experimental data for the study of ***plasma with temperatures in between 3,000K and 300,000K***.
  - – unmatched by any other domain
- ***Electronic transitions of the most abundant molecules***, observed in this range
  - – e.g. $H_{2,}$ OH, or CO

- Most sensitive spectral tracers to ***diffuse baryonic matter***
  - – HI Lyα in the nearby Universe and HeII Lyα at $2<z<9$

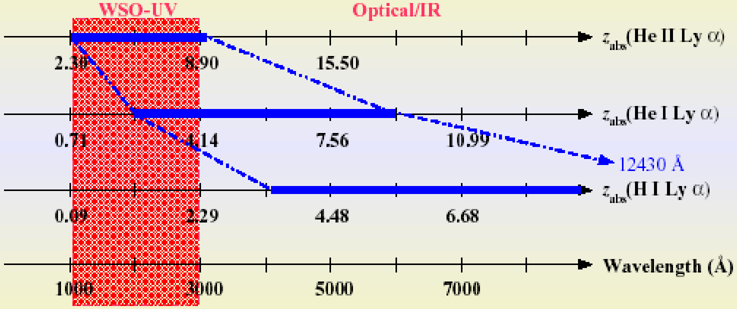
Determine baryonic number density of diffuse IGM & discrete clouds

Observe simultaneously, HI & HeII in the redshift range 2.1<z.<2.9

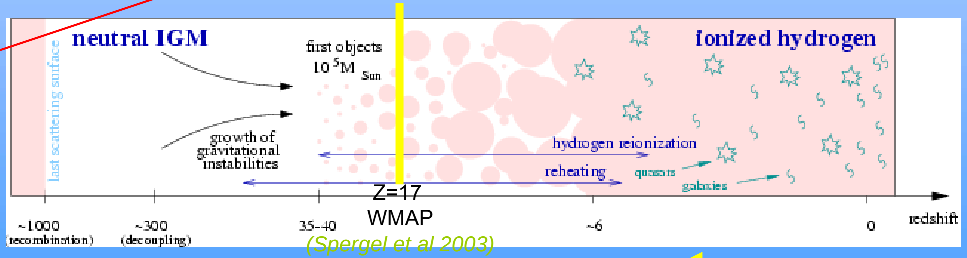


Absorption by H I, He I and He II

	H I	He I	He II
λ (Lyman limit) (Å)	912	504	228
α_B (10^{-13} cm^3 s^{-1})	2.6	2.7	13
λ (Ly α) (Å)	1215	584	303
λ (Ly β) (Å)	1026	537	256



η = <n(He II)>/<n(H I)> depends on both F_ν and density



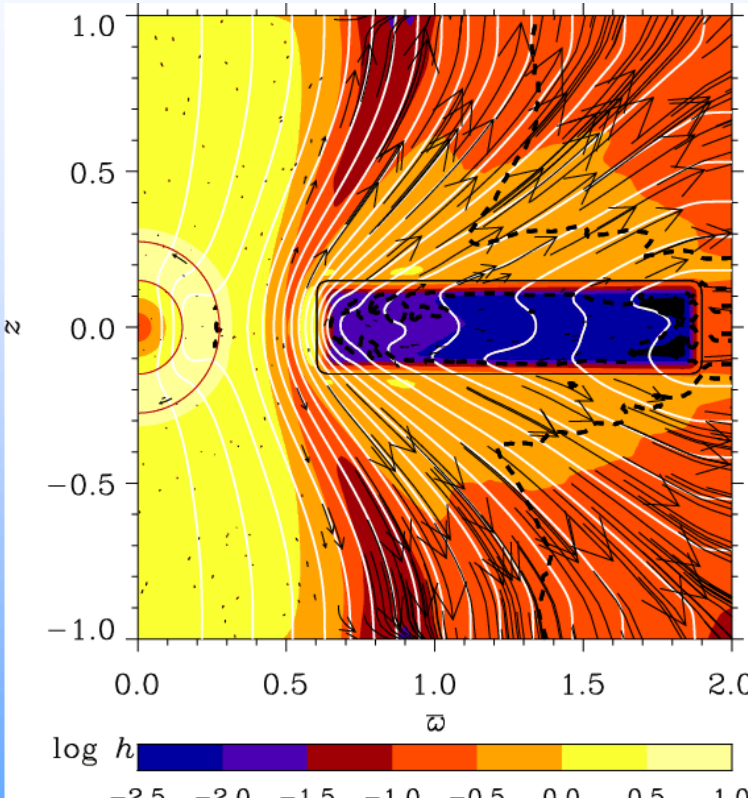
Surveys: SLOAN (10^5 QSOs z~2-4), GALEX(10^4 QSOs z~2)

He II reionization phase ends at z=2.9 (Reimers, 1997)

nk1 Observe simultaneously,
HI & HeII in the redshift range 2.1<z.<2.9

Abundances of O, Ne, S for z<2.1
Intrinsic wavelength of (OIII-OV, NeIII-NeVII, SIII-SVI) in EUV (300-900A).
Kappelmann; 23-11-2006

The Young Solar System

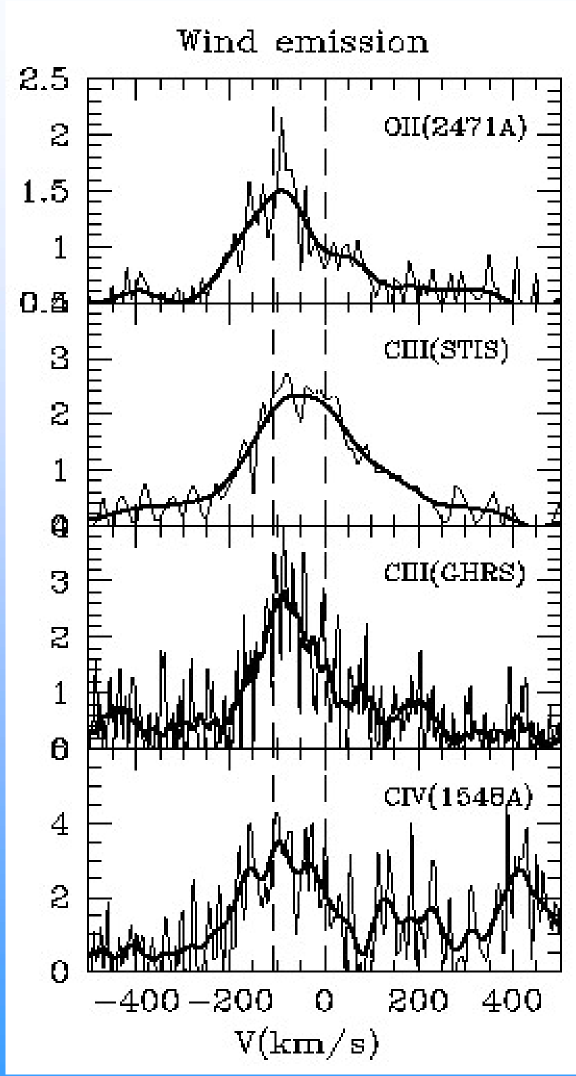


Young stars are surrounded by very hot plasma emitting at UV that interacts with the disk

Understand the source of high energy radiation at the early stages of the Solar evolution and its role in young planetary disks chemistry

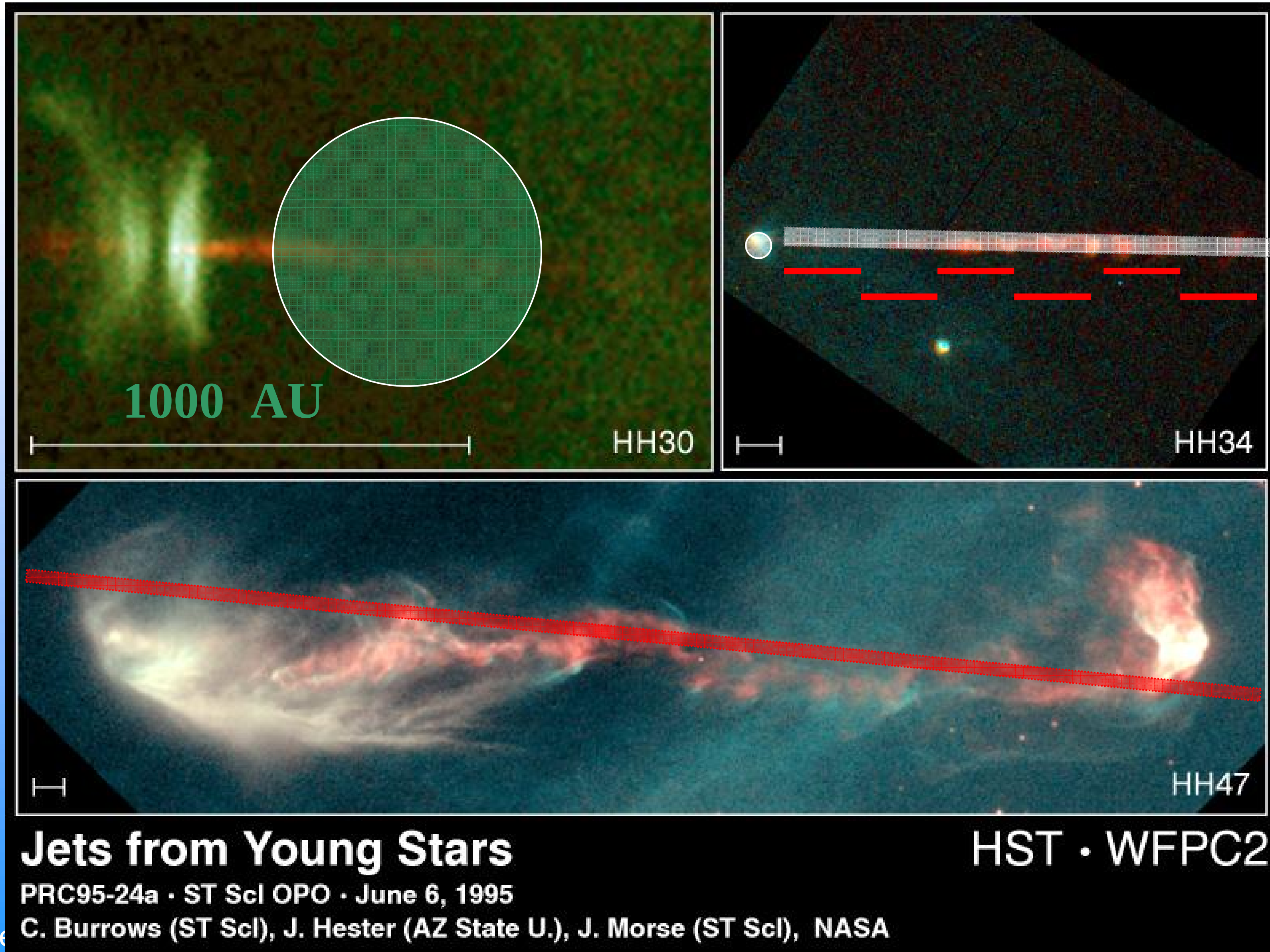
nk2

nk2 ...of magnetized accretion disk undergoing the MRI ...
Kappelmann; 23-11-2006



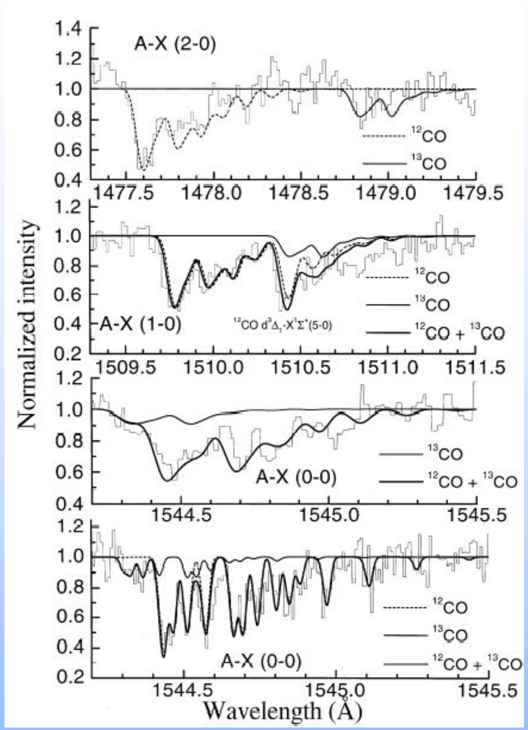
~100 T Tauri stars will be observed in the full UV range to determine the temperature, density and velocity of the whole System:
magnetosphere-disk-accretion flow-wind-jet

Target lines:
OIII],SiIII],CIII],CII],MgII,FeII,
MgI, CIV, Lyα, H_2 bands,
CO bands


1000 AU
HH30
HH34
HH47
Jets from Young Stars
HST • WFPC2
PRC95-24a • ST ScI OPO • June 6, 1995
C. Burrows (ST ScI), J. Hester (AZ State U.), J. Morse (ST ScI), NASA

Planetary Formation:

- UV radiation (above 150nm) is an important photochemical agent: accelerates formation of large organic molecules
- Evolution of embryonic planetary atmospheres
- Vertical structure of the disk and switch-off of MRI
- The planets-disk decoupling time



Determine the characteristics of young planetary systems (β-Pic like)

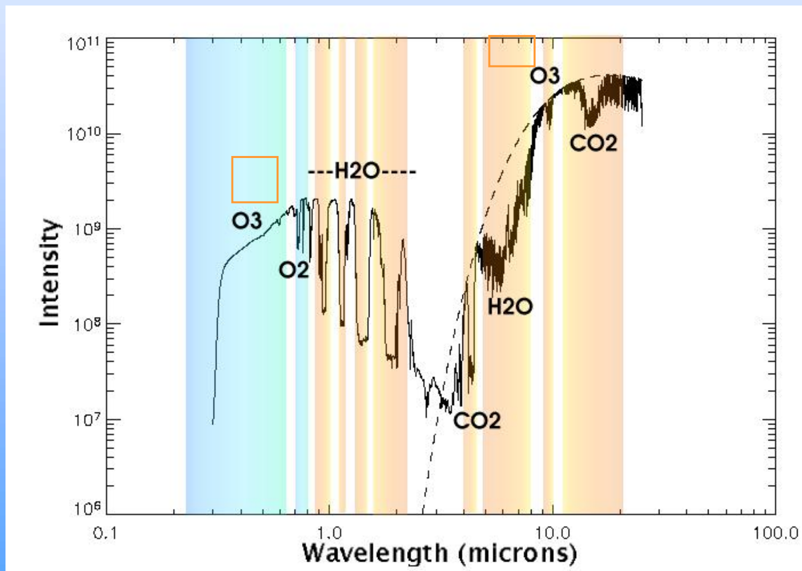
- Through the stellar wind/disk interaction.

CO from comets in the extrasolar system of Beta Pic (Jolly et al. 1998)

Atmospheres of exoplanets

Composition of atmosphere:

- Atmospheres out of equilibrium
  ex: O3 (life induced?)
- Relative abundances
  H, H2, O, C, CO, OH, etc.



Hartley bands of O3 are the main absorbers at 200-350 nm.

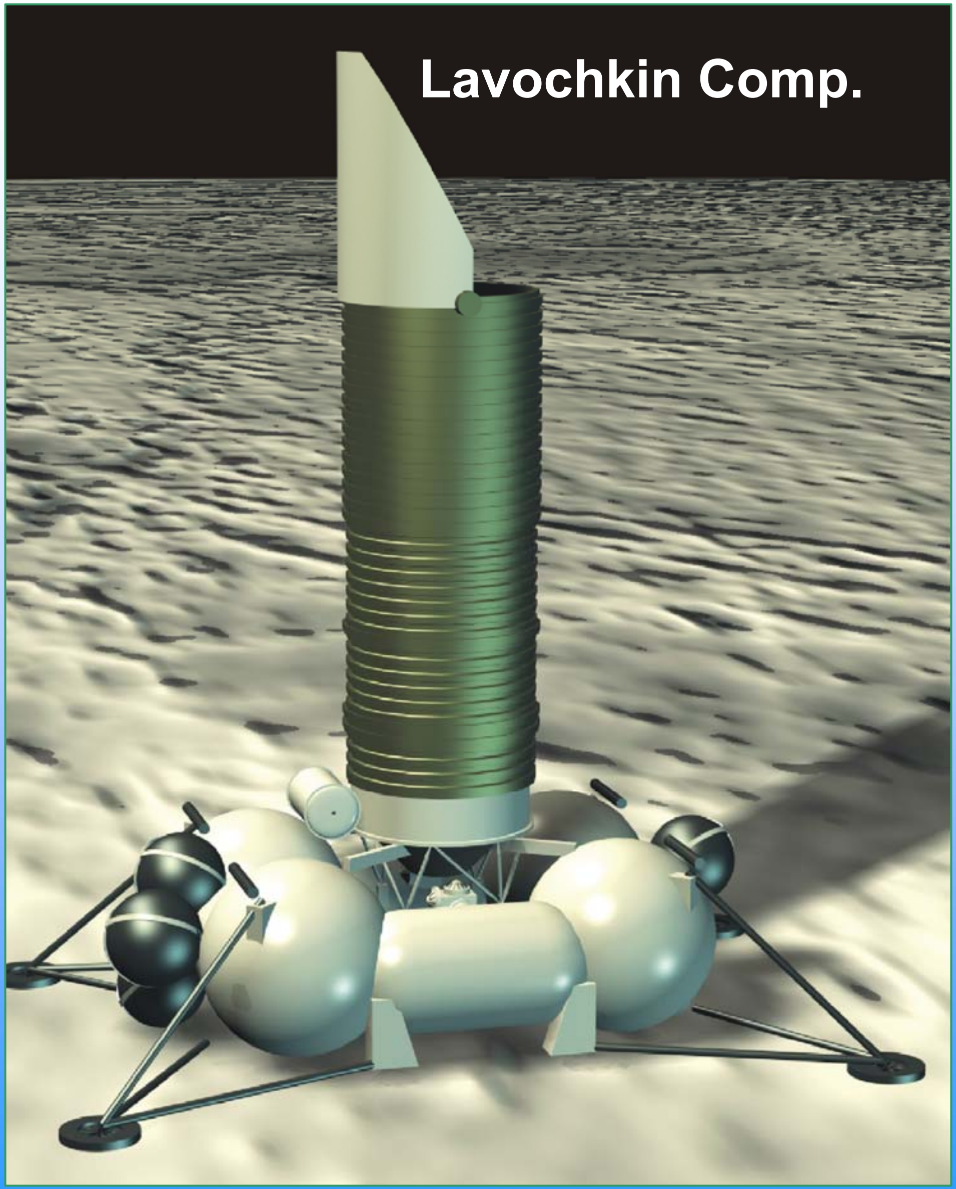
Escaping atmospheres of evaporating ocean from water rich planets detected in Lyα.

UV Programme

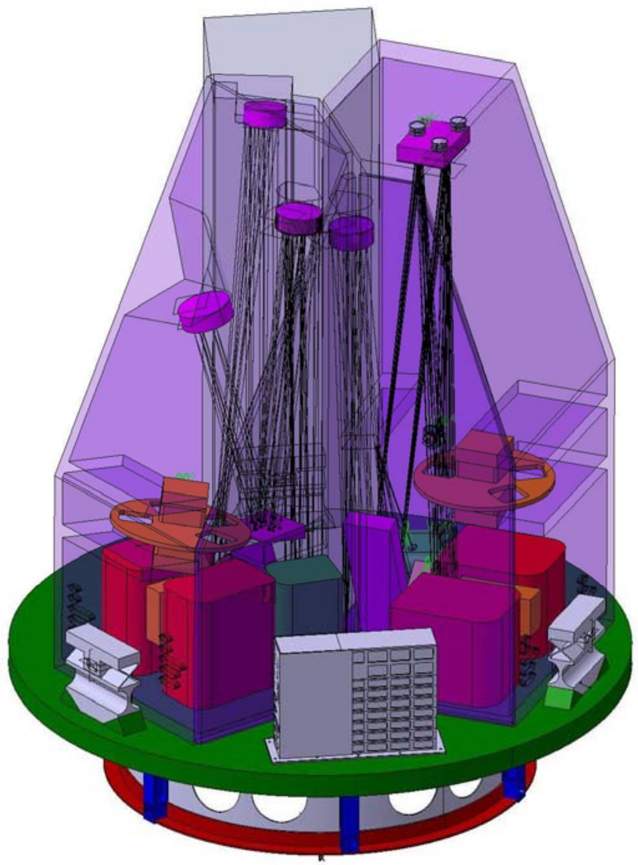
- ISM and Formation and Evolution of Stars:
  - Hot stars atmospheres (and abundance determination) from white dwarfs to hypergiants
  - Cool stars atmospheres and magnetic dissipation phenomena
  - Interacting binaries and accretion physics
  - Circumstellar material and shells in warm environments, jets, shocks and HH objects
  - Chemical abundances in supernovae remnants and in the early phases of supernovae explosions
  - The warm and hot components of the ISM

UV Programme

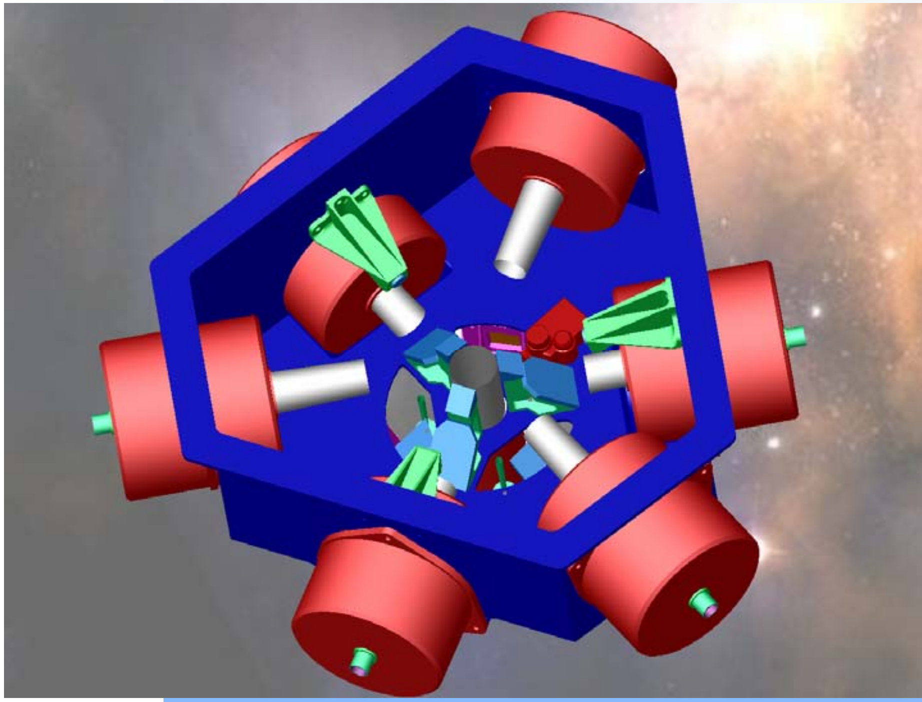
- AGN and Compact Objects:
  - Accretion physics and disk instabilities
  - Gas distribution around AGNs
- Universe, Galaxies and Galaxy Evolution:
  - Star formation rates
  - Galactic haloes
  - High velocity clouds, magnetic buoyancy in galactic disks and disk-halo interaction
- Fundamental Physics and Cosmology:
  - Variation of fundamental constants with the gravitational field and redshift



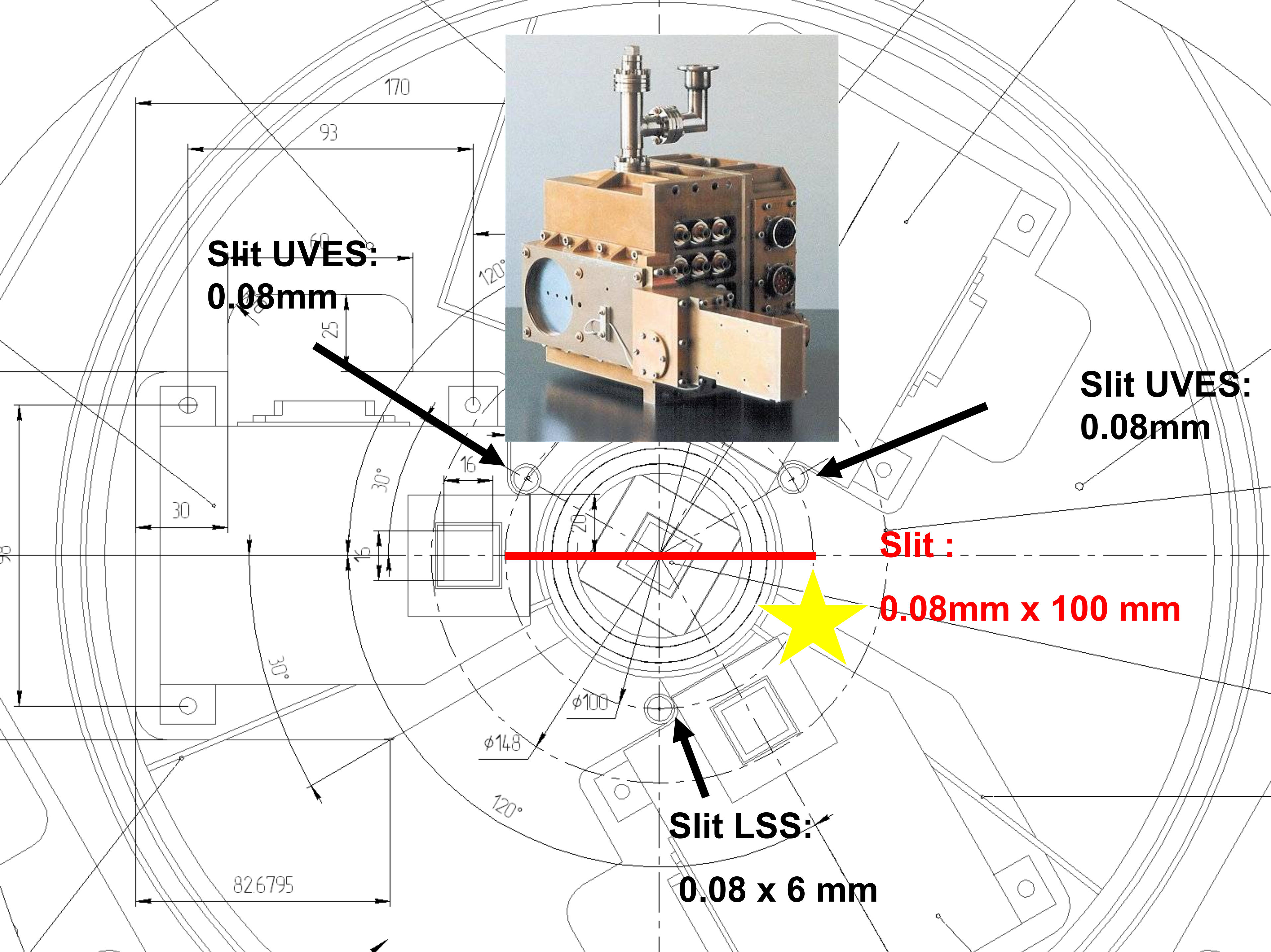
WSO/UV Telescope

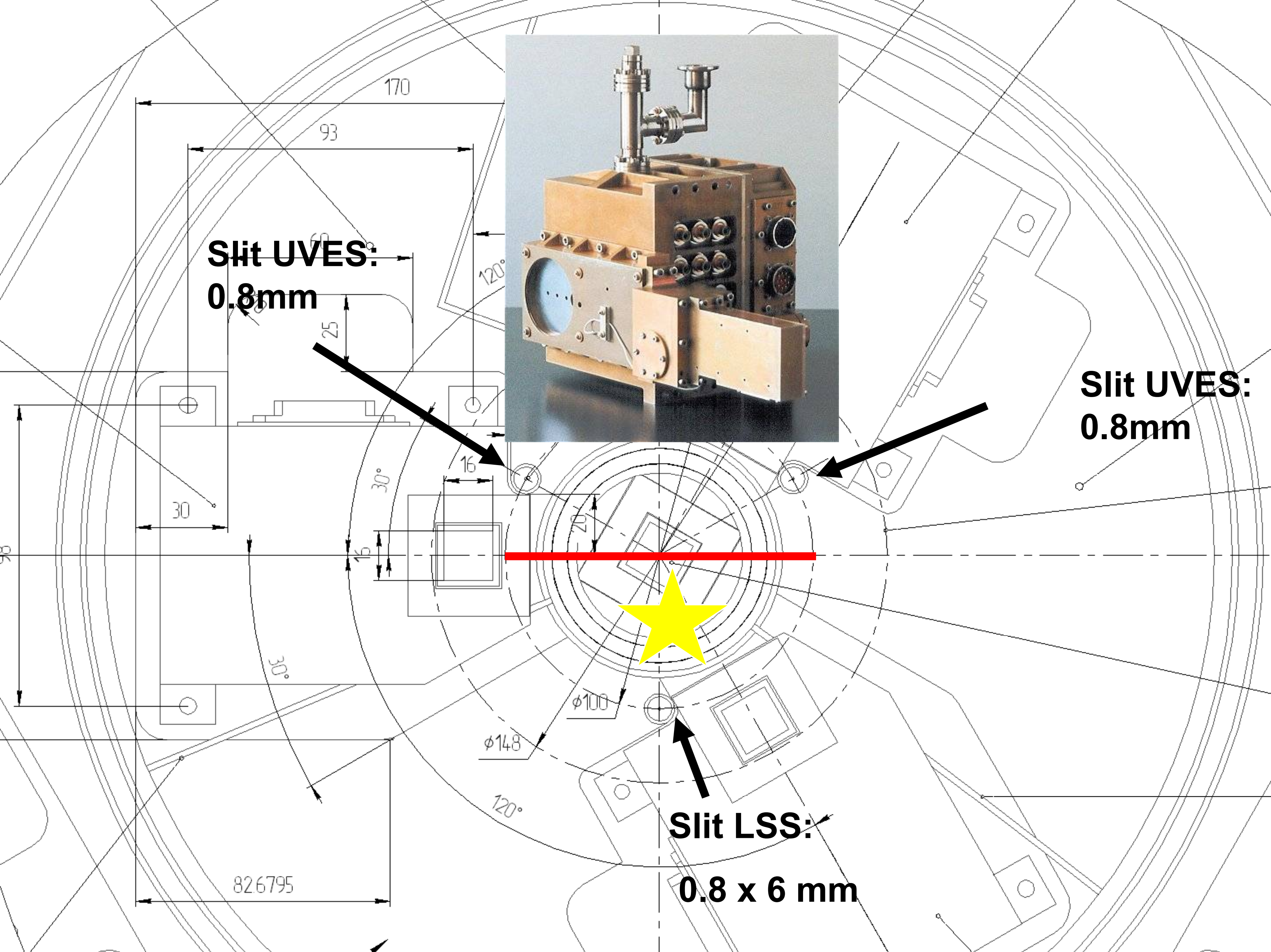


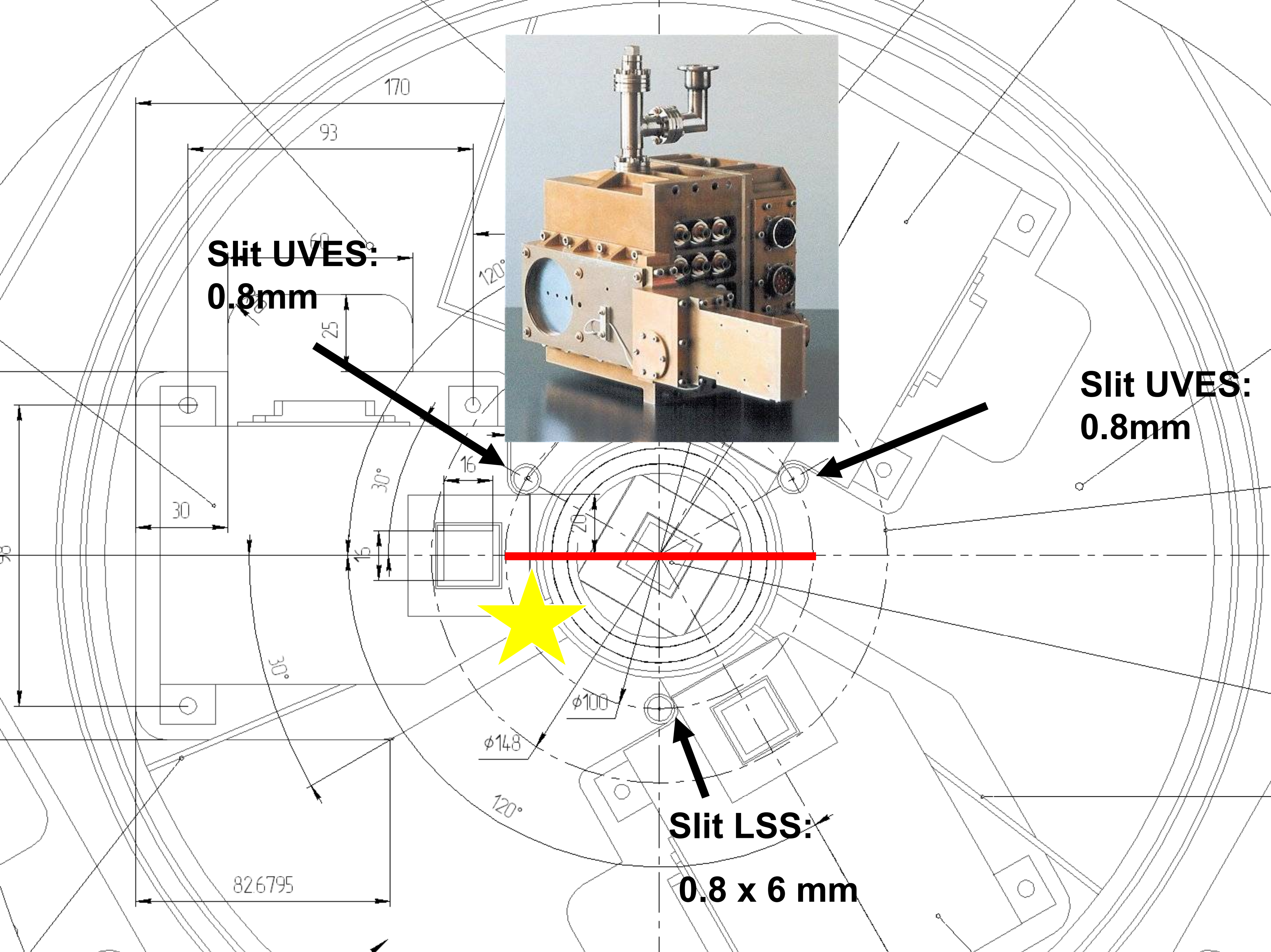
HIRDES



FP, Imagers


Slit UVES:
0.08mm
Slit UVES:
0.08mm
Slit :
0.08mm x 100 mm
Slit LSS:
0.08 x 6 mm


Slit UVES:
0.8mm
Slit UVES:
0.8mm
Slit LSS:
0.8 x 6 mm
170
93
25
30
16
20
30°
120°
ϕ100
ϕ148
82.6795

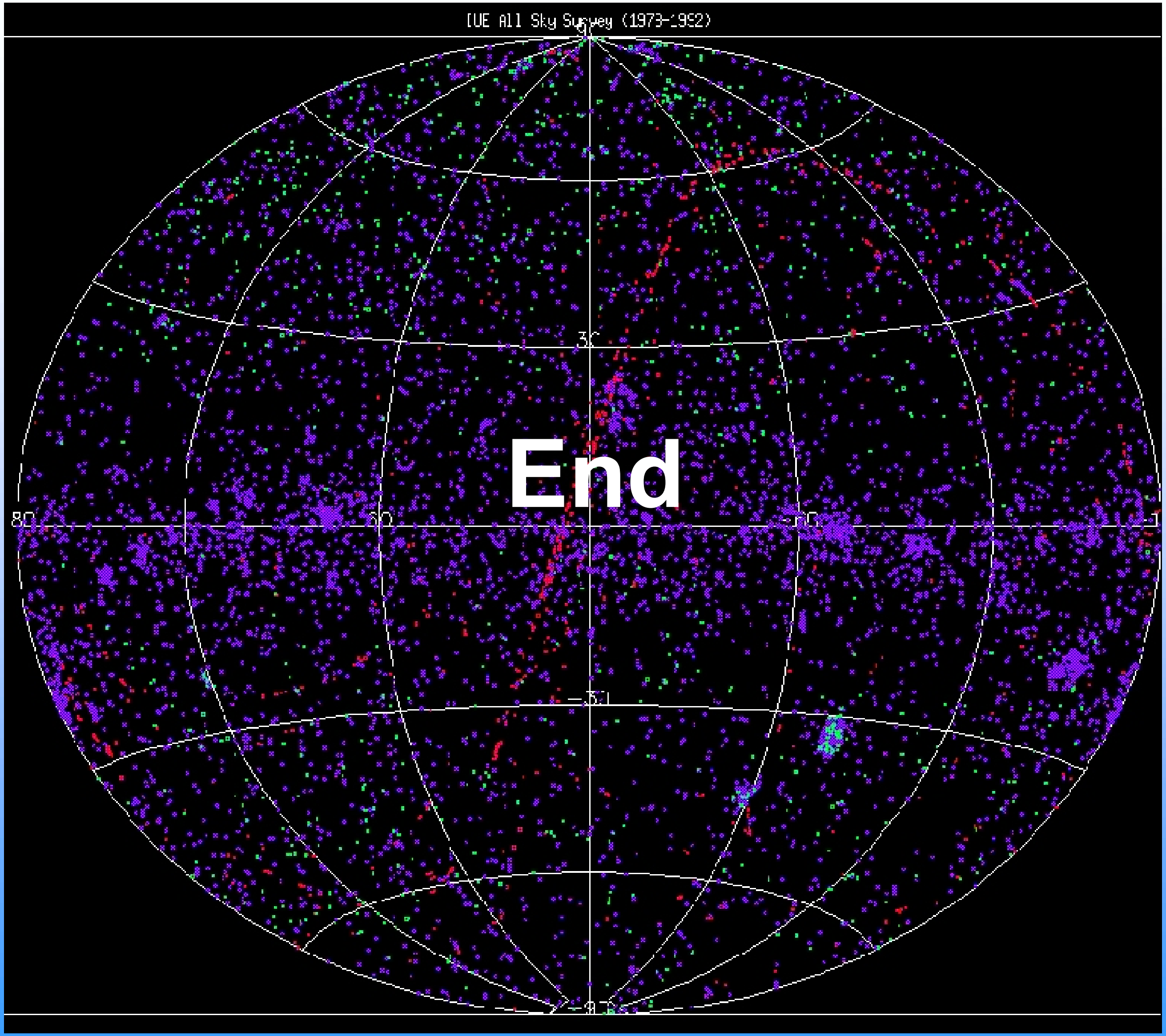


Slit UVES:
0.8mm
Slit UVES:
0.8mm
Slit LSS:
0.8 x 6 mm
170
93
25
30
16
20
16
30°
30°
120°
120°
φ100
φ148
82.6795

New grating technologies

- Better abberation control
- (minimization of optical elements)
- Low scatter
- Efficiency improvement

- Detectors
  - MCP-Detectors (Micro Channel Plate)
    - Different type of photokathods (GaN)
    - Different type of anodes (Cross strip) with faster readout systems
    - Silicon-MCPs (Photolithographic methods, uniform pore pattern)
    - Size of MCPs


IUE All Sky Survey (1973-1992)
End

- **Nature of intermediate mass planets**
  (5-20 Earth mass)
  Absorption by molecules, haze and atoms
  (Leger et al. 2004; Baraffe et al. 2005)

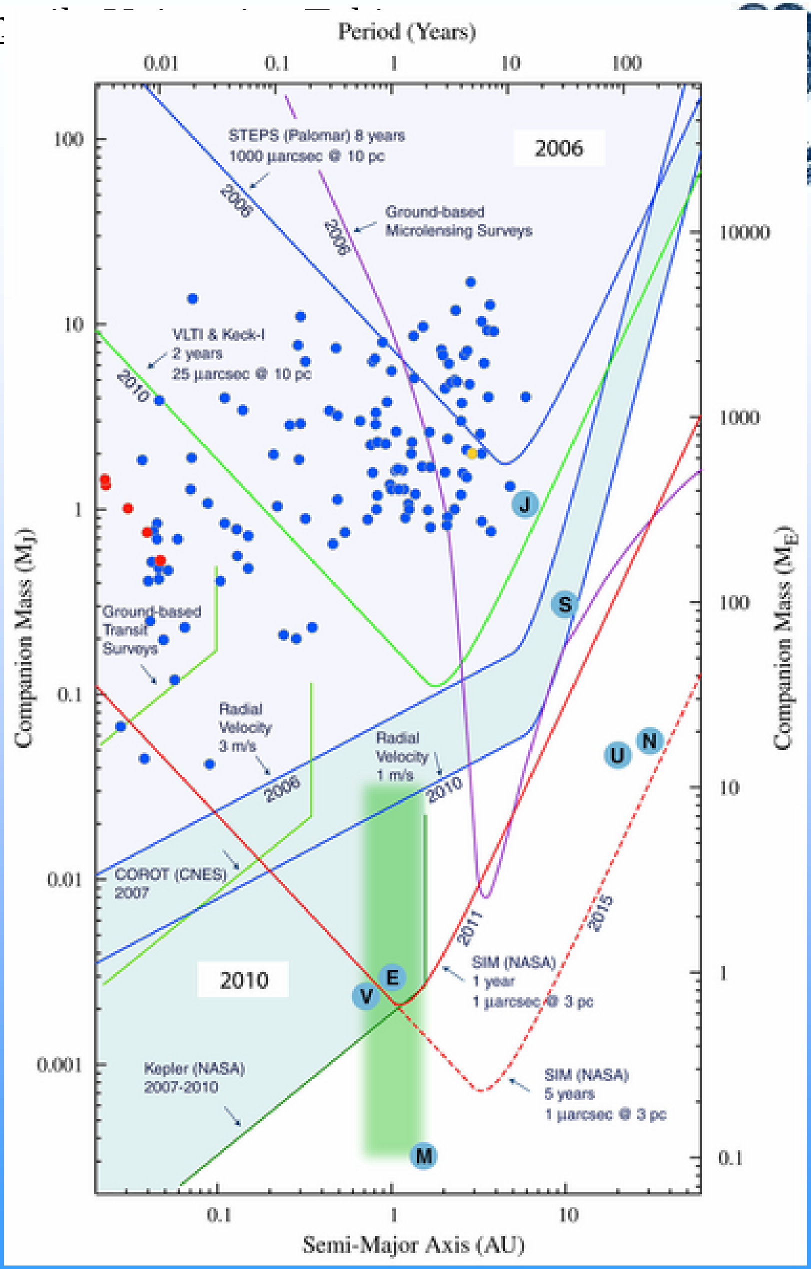
- **Atmospheric content of low density planets and satellites of giant planets**
  (Ocean planets; Titan-like satellite)
  Low density ➔ large absorptions in UV
  (Lecavelier & Ehrenreich 2005)

- **Evolution of water-rich planets**
  (evaporation of Venus-like planet in the early stage;
  evaporation of Earth-like planet in the last Gyr)
  Absorption of H2O dissociation products: HI in Lyman-alpha, O at 130nm
  (Jura 2005)

- **Evaporation of gaseous planets**
  Observation in Lyman-alpha, but also C, O, FeII, MgII, etc.
  (Lecavelier 2006)

CONTEXT

- **9 Transiting planets discovered today. Many more to come in near Future.**
  The HST observation of the first transiting planet led to 4 detection (H, C, O, Na)
- **Upper atmosphere of HD209458b evaporates.**
  Evaporation processes and consequences still to be understood (Vidal-Madjar et al. 2003, 2004)
- **Unknown nature of "Hot neptunes"**
  6 planets with 15-20 Earth mass
  1 planet with 7 Earth mass
- **Forthcoming surveys will discover a large number of transiting planet. New kind of planets are expected (Ocean-planets and unforeseen objects)**



The need:

Follow-up observations of transiting planets to be discovered by surveys