



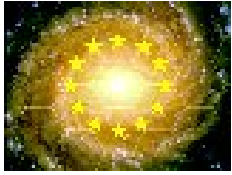
Update on the ELT Science Case and Science Requirements

ESO/OPTICON SWG Activity
and DS WP 02000

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& Piero Salinari

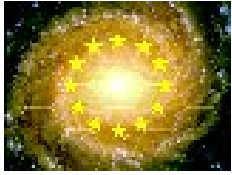
ELT Design Study – Contract No 011863

A technology development programme funded by the European Community under its Framework Programme 6



1st iteration requirements document

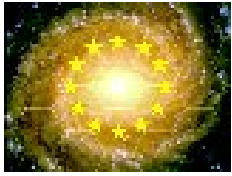
- Based on SWG report April 2006
 - Strong dependence on **optical and near-IR** wavelengths.
 - Almost all the cases require **AO** of some type
 - Several cases require **AO at visible wavelengths** ($<1 \mu\text{m}$). Should be an upgrade option.
 - **Simulations** are required to understand requirements in several areas.
 - **Hemisphere** of the site: most cases do not have a strong preference - those that do generally prefer a Southern site.
 - Most of the required instrumentation capabilities have been studied as part of the ELT design study and/or the OWL instrumentation studies. One notable exception is **moderate/high resolution optical spectroscopy**.



Requirements report- wavelength range

	Visible	Vis+NIR	NIR	NIR+TIR
	320-1100 nm	320-2500 nm	1100-2500nm	1100 >2500 nm
Planets and Stars				
All Science cases	2	5	4	1
PROMINENT Science cases	1	3		1
Galaxies and Cosmology				
All Science cases	8	7		
PROMINENT Science cases	3	1		
Galaxies and Cosmology				
All Science cases	6	10		
PROMINENT Science cases	2	4		
Total (all 43 observations)	16	22	4	1
Total (15 prominent obs.)	6	8	0	1

Note: Without optical only 5/43 cases could be done

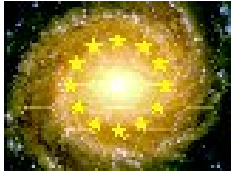


Requirements report – AO modes

	None or not defined	NGS AO or LTAO	GLAO	MCAO	Total
AO modes in SWG report	10	17	14	2	43
Re-assessed AO Mode	5	14	4	20	43

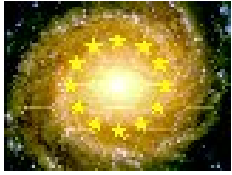
- Most cases (33/43) mentioned AO of some sort
- In many cases the AO mode did not match requirements
- Very few cases mentioned MCAO – but the IQ specifications require it (or MOAO)
- Is this because MCAO was not an option in the ETC?
- In some cases AO would help reduce instrument size

Case	Cases requiring “optical” AO	Wavelength range (μm)	AO mode in SWG report	Re-assessed AO mode
S3	Extra solar planets	0.8-2	NGS extreme AO	NGS extreme AO
S4	free-floating planets	0.7-2.4	LTAO-GLAO	MCAO
S5	Stellar clusters (incl. galactic centre)	0.7- 5	GLAO	MCAO
S9	Circumstellar disks	0.7 (or 2) – 20	NGSAO-LTAO	NGSAO-LTAO
S10	Stellar remnants	optical – NIR	NGSAO-LTAO	NGSAO-LTAO
G1	Intracluster population	0.5-1	LTAO	MCAO
G2	Planetary nebulae and galaxies	0.3-1	LTAO	MCAO
G3	Stellar clusters and the evolution of galaxies	0.4-5	LTAO	MCAO
G4	Resolved stellar populations - colour-magnitude diagram - abundances + kinematics	0.8(0.6)-3 0.45-0.75	LTAO ??	MCAO LTAO
G5	Spectral observations of star clusters	0.4-2.5	GLAO	GLAO
G6	Young, massive star clusters	0.4-0.6	GLAO	MCAO
G7	The IMF throughout the Local Group	0.8-1.6	MCAO	MCAO
G8	Star formation history through SNe	0.6-2.5	GLAO+LTAO	GLAO+LTAO
C1	Dark Energy: Type Ia SNe	0.8-2.5	MCAO+LTAO	MCAO+LTAO
C4	First Light- the highest redshift galaxies	0.9-2	GLAO	MCAO
C5	Galaxies and AGN at the end of reionisation	0.9-2	GLAO	MCAO
C7	Metallicity of the low-density IGM	0.55-0.7	NA	LTAO
C8	IGM tomography	0.4-0.7	GLAO	GLAO
C9	Galaxy formation and evolution	0.6-2.5	LTAO?	LTAO?
C11	Gravitational Lensing	0.4-2.5	??	MCAO
C12	Deep galaxy studies at z=2.5	0.4-2.5		MCAO (GLAO?)



Requirements report - Hemisphere

	Science cases with specified targets	Target location	North/South
S1	Solar System Comets	Ecliptic	Either
S2	Extra solar system comets	$-60 < d < +10$	South
S5	Stellar clusters (inc galactic centre)	Galactic centre, $d = -29$	South
S7	Origin of massive stars	Galactic plane	Either
S8	LMC field star population	LMC/SMC, $d = -70$	South
G1	Intracluster population	$-50 < d < +20$	South
G7	The IMF throughout the Local Group	Local Group	Either



Requirements report – top level requirements

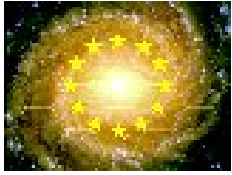
Parameter	Requirement	Goal
Telescope Diameter	TBD (*)	
Wavelength Short Long	0.4 μm 5 μm	0.38 μm (*) (note a) 20 μm
AO modes	LTAO, GLAO, MCAO	MOAO, Visible AO
Field of View	5' x 5'	10' x 10' (*) (note b)

*= Requires more work

(a) From Asteroseismology and PNe– justification not given

(b) From highest-z galaxies – justification not completely clear

– recoverable to some extent with multiple pointings

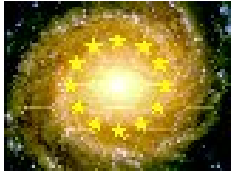


Questions arising from the April 2006 science case document

- Need to review the AO modes required for each science case
- First Galaxies and Physics of galaxies cases: What is the optimal AO mode for detecting and studying them (depends on spatial profile)?
- What is the expected image quality of the telescope without AO? (will it be seeing limited, or worse?) This will have an effect on whether AO should be used for cases such as CODEX.
- Resolved Stellar populations: In LTAO mode the PSF variation will be significant even over an imaging field of only ~ 1 arcsec. This should be simulated in order to decide whether MCAO would be better suited to this case.
- Is case S5 considering individual BDs or clusters?
- What is the justification for the short wavelength requirements from the asteroseismology and planetary nebulae cases?
- What is the justification for the FOV from the “first galaxies” case?

FP6 design study WP 02000 Milestones

Current Status, May 2007



- Q1 2005 KO Meeting - Done
- Q2 2005 Initial Report - Done (delivered doc Q3 2005)
 - Based on OPTICON case for 50-100m
- Q1 2006 Iteration #1 - Done (delivered doc Q1 2007)
 - Delay due to re-baselining activity
- Q2 2007 Iteration #2 - Status report on DRM
 - Due ~ now
- Q1 2008 Final release

Exo-planets

- **Direct detection**
- Radial velocity detection
 - Detection of new Earths
 - Rocky planets in the HZ of low-mass stars and brown dwarfs
 - Characterisation of transiting planets

Raphael Rebolo Proposal

Stephane Udry Abstract

Maria Osario (Rafael Rebolo) Abstract

Didier Queloz Abstract

Circumstellar disks

- 10-20 micron imaging
- CO fundamental spectroscopy

Mark McCaughrean Abstract

Mark McCaughrean Abstract

The Initial Mass Function in Clusters

- I - Characterizing the lowest mass freely floating objects
- II - The centers of massive star clusters (?)
- III - The Low-mass IMF at the Magellanic Clouds
- IV - Giant-planet Mass objects in the LMC

Fernando Comeron Proposal

Hans Zinnecker ?

Fernando Comeron Proposal

Fernando Comeron Proposal

Resolved Stellar Populations

- **Colour magnitude diagrams**
- Abundances and kinematics (low R)
- Detailed abundances (high R)

Eline Tolstoy Proposal

Eline Tolstoy ?

Vanessa Hill Abstract

Black Holes

- Spatially resolved spectroscopy
- RV test of GR in LMXBs

Wolfram Freudling Proposal

Rafael Rebolo Abstract

The physics of galaxies

- **The physics and Mass Assembly of galaxies to $z = 6$**
- High Resolution imaging of high-redshift galaxies
- Integrated spectroscopy of early-type galaxies at $z > 1$

Piero Rosati Proposal

Marijn Franx Proposal

Andrea Cimatti Proposal

The highest redshift galaxies at $z > 6$

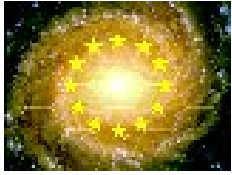
Marijn Franx Proposal

Metallicity of the low-density IGM

Jacqueline Bergeron Proposal

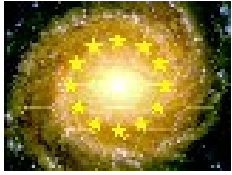
Dynamical measurement of Expansion

Luca Pasquini (Martin Haehnelt) Proposal



Science case and DRM next steps

- May 07 Complete one iteration of 3 demo cases
- May 07 Complete proposals for 9 prominent cases
 - 12 proposals written
 - Now need to prioritise simulations
- 2007–09 Use DRM to aid design choices
- (2008/09 possibly FP7 DRM activity)
- Q2 2009 community call for proposals
- Q2 2009 community workshop
- End 2009 Updated science case with simulations



THE END