http://www.arcetri.astro.it/~salinari/ELT/Florence/Status of Design Requirements_F.ppt

Status of design requirements for the European ELT

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Section A: Straw man requirements

The following 6 slides are from my presentation at the first EELT Steering Committee meeting (Munich, August 2004)

They represent only my understanding of some science cases discussed at Marseille.

I will now go through them quickly
BUT
I would like to discuss each of the slides in greater detail in the separate sessions
(if the chairs agree and give me the time)

Top level requirements:

A) Terrestrial Planets in Extra-Solar Systems

- **AO requirements:**
  - **NIR+visual**
  - **Actuator density (on incoming WF) up to order $10^2/m^2$**
  - **Adaptive control of differential segment piston (piston sensitive wavefront sensing, segmented corrector)**
  - **Control of scintillation ?? (single or double conjugate AO ??)**
- **Telescope optimisation:**
  - **Control of diffraction pattern (pupil and segment shape)**
  - **Control of scattering (minimal number of surfaces)**
- **Site selection priorities:**
  - **Coherence time**
  - **Coherence length**
  - **Low scintillation**
- **Instrument(s):**
  - **Control of speckle-noise**

Top level requirements:

B) Stellar populations across the Universe

- **AO requirements:**
  - **NIR+Visual**
  - **Actuator density (on incoming WF) ≥ $10^1/m^2$**
  - **Multiconjugate AO (field ~ 30 arcsec @ Strehl ≥ 0.3 in visual)**
- **Telescope optimisation:**
  - **Control of diffraction pattern (pupil and segment shape)**
- **Site selection priorities:**
  - **Coherence length**
  - **Isoplanatic angle**
  - **Coherence time**

Top level requirements

C) The Physics of Galaxies from z=2 to z=5

- **AO requirements:**
  - **NIR (+visual?)**
  - **Actuator density (on incoming WF) ~ $10^1/m^2$**
  - **Ground Layer AO (field ≥ 2 arcmin @ FWHM 0.2-0.3 arcsec)**
- **Telescope optimisation:**
  - **Adaptive telescope mirror conjugated to GL**
- **Site selection priorities:**
  - **Modest turbulence in high layers**

Top level requirements:

D) The First Objects and Re-ionisation structure of the Universe

- **AO requirements:**
  - **NIR**
  - **Actuator density (on incoming WF) ≤ $10^1/m^2$**
  - **Multiconjugate / GL AO**

  (field ≥ 1 arcmin @ Strehl ≥ 0.3) / (≥ 2 arcmin @ FWHM 0.2-0.3 arcsec)
- **Telescope optimisation:**
  - **Adaptive telescope mirror conjugated to GL**
- **Site selection priorities:**
  - **Modest turbulence in high layers**

Top level requirements:
Summary

Of the high priority science areas identified at Marseille for a 50-100 m telescope

ALL require

AO (SC, MC, GL) + extreme ADC

(that we still do not know how to do for an ELT)

and a very good site

SOME [A,B] require

an optimized telescope configuration

(that doesn't penalize other applications)

Section B

How to translate
Science drivers
in to
top level design requirements

or:
reducing the risk that
an idiot can miss
all your great ideas

A difficult job, in any case . . .

- **Because I believe that technology drives science (not vice versa) . . .**
  unfortunately our job definition is the opposite: finding science drivers for technology

- **Because most of the scientific drivers are unavoidably rather vague . . .**
  by definition: we don't know exactly what we are looking for, what we will find

- **Because the amount of work done on the subject is not enough . . .**
  plenty of nice talks on what we may want to observe, not much detailed work on writing down numbers for specific observations

- **Because we are ambitious . . .**
  (from ~10 to 50-100 m telescopes, from elementary to advanced AO in one step)

Design requirements: Our first attempt (using documents of Leiden 2001)

Mode A: Read the documents, extract requirements for some basic parameters

Derived Parameters

1- FoV
2- Spatial Resolution
3- Spectral Resolution
4- lambda
5- Observation
6- Target density
7- Special requirements

Table 1 ELT performance requirements

	FOV [arcmin]	Spatial Resolution [arcsec]	Spectral Resolution	Lambda [microns]	Observation	Target density	Special Requirements
Extrasolar Planets							
Terrestrial exoplanets: Detection	0.01	High Strehl AO	5 imaging	0.7-1.4	imaging	-	Coronagraphy
Terrestrial exoplanets: Characterization	0.01	High Strehl AO	? 1000	0.5-1.6	Spectra of Absorption bands	-	Coronagraphy
Earth-like moons in HZ	0.01	High Strehl AO	~$2x10^4$	? 0.7-1.4	Radial velocity modulation	-	Coronagraphy
Orbiting Jovian planets (of all ages)	0.01	High Strehl AO	? (up to very high)	0.5-10	Spectra	-	Coronagraphy
Free-floating planets	? >1	? diff. limited	? (up to very high)	Near and thermal IR	various	?	
Our Solar System							
Master Atlas	? ~<0.5	Diff. limited	Up to extremely high	0.3 to >20	various	-	
Surface and atmospheric changes							

Result:

Does not work!

Authors should provide more details!

Next (current) iteration

Template @ http://www-astro.physics.ox.ac.uk/~imh/ELT/sci_req_template.txt

Mode B: forcing contributors to answer
- quantitative questions
- on more parameters (~ 12, **4 new**) (will we ever succeed?)

TEMPLATE PARAMETERS

1- FOV
2- Spatial Resolution
3- Spectral Resolution
4- Wavelength (range) of interest
5- Observation type (e.g. absorption line spectroscopy)
6- Target density
7- Special Requirements (e.g. coronography, IFU)
8- Dynamic range constraint (if any)
9- Comparison of 30m,50m,100m & JWST
10- Observing time needed (assuming 100m)
11- Date constraint
(if program is dependent on other facilities, or will be done better by a future facility)
12- Comments

Possible Template improvements: An example

Still, I believe, in the template there are dangerous “hidden” assumptions.
For instance in:

10- Observing time needed (assuming 100m)

Not only we assume 100 m, but ***we exclude “multiple smaller telescopes***”.
(VLT, Gemini . . . are the results of long studies of a 16 m telescope!)

By splitting “Observing Time” in more parameters, e.g. :
xx- Number of sources needed for statistical significance
xx- Typical location on sky (e.g. everywhere, High GL, in a specific field)
xx- Typical surface brigthness
xx- etc.
We can make “Observing Time” less dependent from explicit
(FOV, target density) and implicit (single telescope, AO mode . .) assumptions

A very different approach?

Mode C: Prepare specific "imaginary proposals"
(Yes, an imaginary application for a big programme, with imaginary coordinates, imaginary "observing bloks" of imaginary instruments of an imaginary telescope (or more than one) of imaginary size.

The interesting aspect of this approach would be that, for each science case, the potential observer could feel free of choosing the telescope(s)/instrument(s) configuration he would consider most appropriate.

Of course we need to introduce some constraints, based on known physical limits, such as:

- Max diffraction limited field at Lambda = X (for any telescope size)
- Max ground layer corrected field at Lambda =Y (for any telescope size)
- etc.

Section C

Top level requirements
and
ELT study reformulation
priorities

GREAT!

We got 8 M€ from EU!
WE got even larger National supports!
We will soon start the ELT design study!
We are on the right track to a giant telescope. . .
Aren't we?

Uhm . . . which is the right track?
. . . let see where we really are . . .

My own views on priorities of work packages

The following slides are part of my original presentation
for the August 04 SC meeting
but have NOT been shown at Munich
on request of Roberto Gilmozzi

I agreed not to show these slides to the SC
to avoid giving space in that meeting for a
"minimal funding" option,
but the entire Study Group knows them

These are my criteria,
for evaluating the results of the "reformulation"
based on my current understanding of top level requirements

Reality: 22 M€ ⇒ 8 M€

Forces us to go back from

“extensive ELT study”

to

“Demonstration of key ELT technology”

⇒ **Concentrate funds on key technology**

Aiming to the most demanding application

so that even a partial success will be sufficient for less critical applications

⇒ S**timulate voluntary funding**

on aspects that cannot be covered by ELT studies

(more resources than simple “*matching EU funds*” from partners,

EU “*seed money*” for coordination of work groups, workshops, networking)

ELT Study Priorities

Highest priorities: most of the budget !

- **Development of necessary NEW technology**
  - AO (including part of active "wavefront control")
    - Atmospheric dispersion compensation (at mas level, for instruments and AO WFS)
    - **Identification of cost-effective technology**
      - Primary mirror segments: production (aspheric, lightweight, thin?), support and coating
        - Enclosure
        - **Characterization of sites**

Not a top priority (but important): voluntary partner contribution?

- **Studies of**
  - Instruments
    - Telescope mechanics
      - Numerical modelling
        - Observatory operations

My list of crucial work packages:

I selected **8/46** Work Packages
(involving **16/39** partners)
of the ELT Proposal
containing the key technology developments or key missing information

k€

WP Number	WP Coordinator	WP name	Total Budget	Requested From EU
04600	ESO	APE	3,369	**1,786**
05100	ESO	Silicon carbide prototypes	3,252	**1,645**
05200	UCL	Optical finishing and edge control	1,029	**536**
07100	ESO	APE Control System	1,177	**588**
08100	Grantecan	Enclosure concepts	948	**457**
09100	INAF	100m-Layer WFS experiment	2,117	**895**
09300	ESO	Large format, high density DMs R&D	5,011	**1,819**
11300*	UKATC	Atmospheric Dispersion Compensation	49	**26**
Total			16,903	**7,728**
*	**May be severely underestimated**			

And its implications

If these SUBJECTS are not funded at a sufficient level
(say in average ~3/4 of requested amount,
~ 6 M€ from EU contribution)
There is no reason to study the rest!

What remains (~2M € from EU) should cover other acivities:
Site characterization
Novel instrument concepts
Coordination of voluntary contributions

Section D

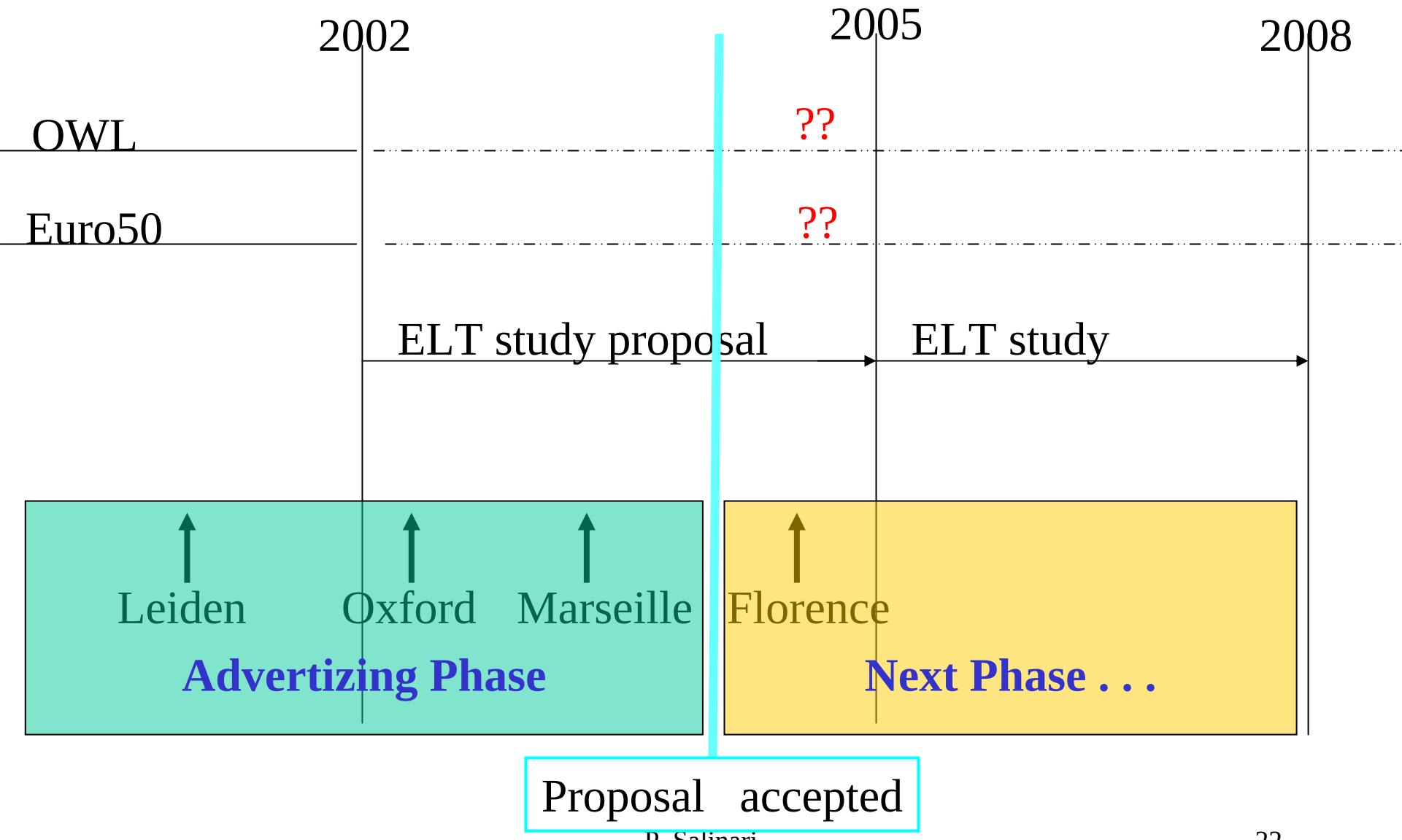
End of “advertizing” phase?

or

can we start discussing in public and in depth
questions we have previously avoided

for getting the 50-100 m ELT proposal through?

Phases . . .


2002
2005
2008
OWL
??
Euro50
??
ELT study proposal
ELT study
Leiden
Oxford
Marseille
Florence
Advertizing Phase
Next Phase . . .
Proposal accepted

My simple doubts . . .

My own doubts are simple:

1. *Why our American colleagues keep going for 20-30 m elts?*
2. *What makes us believe we can do MUCH better?*
3. *What is the minimum elt worth doing (~ compettitive in the 20')?*
4. *What technology development can be done in three years with ~ 20 M€ ?*

*In a single question: are we **really** on the right trak???*

The answers to these questions will affect:

1. *The result of the EELT study, therefore:*
   - *The rediness for a real EELT project, therefore*
     - *Its timescale and cost, therefore*
       - ***The competitivity of European Astronomy in the future***
2. *Our work on science cases and top level requirements . . .*
   (I mention this only to find an excuse to touch such important strategic issues)

Some simple (provisional) answers

Why our American colleagues keep going for 20-30 m elts?

To the best of my knowledge:

- Because they are not sure it is technically safe to go much beyond ("wavefront control" in the wind is the problem. Their published results are only (marginally) compatible with a few m/s wind speed within a dome)
- Because they think telescopes of this class are worth doing (in some cases even with modest or initially absent AO)
- Because they want these telescopes SOON

(I tend to agree with them, except for starting with modest AO)

What makes us believe we can do MUCH better?

- Sorry, I do not have the recipe for a 100 m telescope in my pocket
- I asked OWL people (more than once in the last two years) for calculations or simulations on the wind-telescope interaction (and other similar technicalities) *but I had no answer yet*.

So, I don’t know. . .

What technology development can be done in three years with ~ 20 M€ ?

Let me rephrase the question in the logics of the previous one
(just in case the "secret" is not there):

- *Can we develop **quick, new, brigtht tricks for a 100 m** in the ELT study?*

- **Money can be concentrated on key developments**
  but I heard very negative rumors last Friday . . .
- **Three years is something.**
  But lost time is lost for ever
  We have started loosing time in late 2002,
  We largely missed the JRA1 proposal opportunity in late 2003
  I do not see any hot enthusiasm around . . . for matte technical stuff

I believe that the original set of key developments will be seriously de-scoped.

We either trust those who really know or we better start de-scoping the telescope!

Are we on the right track?