Euclid Assessment study

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Why an Assessment Study ?

- Selection is a multistage process.....
  - Better definition before selection to avoid BC effect!
  - Involve potential institutes and National Agencies before the final down-selection (Catch 22)
- Compare disparate missions and have some certainty that a mission is feasible
- Process aims to ensure all missions studied to the same level of detail
- Cost schedule and technical feasibility

History

- *CAT* was completing the mission concept as we were preparing for the study, and some other missions had started
- CDF used rapidly to identify a starting point for industry study
- Phase 1 had a number of open issues (continual scanning versus step and stare , how to fill gaps, what sort of optics satisfies WL and spectroscopy)
- Baseline concept was not concluded on schedule (January 2009)
- IDECS was investigated with NASA as a reference design to include most of Euclid requirements, and work on Euclid continued but to address likely IDECS directions
- Curtailed and had to restart work in April in order to conclude CV selection – provided industry and consortia an optics solution by ESA
- Industry & consortia thus had limited time
- Final concept in July; summer to estimate cost and initial AIV schedule

Mission Introduction -Requirements

Science Requirements

Wide Extragalactic Survey

- |b| > 30°
- 20 000 °²

PSF Quality

- Ellipticity < 20%
- Ellipticity stable <0.02% rms
- FWHM stable < 0.1% rms

VIS, NIP and NIS instruments

Same FOV & Dithered

System Requirements

L2 orbit

4.5 yrs Science mission

Step and Stare observation strategy

850Gbit/day = K band Cebreros

Pointing Stability

- RPE < 25mas (500seconds)
- APE < 10 as
- AME < 100mas

36 CCDs and 26 NIR arrays

Different flavours

- Each industry and the consortia free to arrange optical design with different folding
- Telescope technology / material drives other interface decisions (temperature, photometric budget etc.)
- With limited time was not possible to iterate the design solutions between industry and consortia
- However essentially all designs closed in on a common “functioning point”
- Following talks will highlight the design choices….

Technology readiness

The nominal request is to reach TRL 5 for the whole spacecraft, including payload, before entering the Implementation Phase (B2/C/D). However, it is acknowledged this can hardly be formally achieved for science missions, which generally require a new dedicated spacecraft and often brand new instruments

The objective of the review was to assess the technology readiness in terms of development risk.

Four development risk levels are defined:

Level	Development risk
1	**None or very low**
2	**Low**
3	**Medium**
4	**High**

Technology Readiness

Item status	Formal TRL	Development risk	Comments & examples
Built and space qualified under representative environment (temperature range, operation constraints, radiation etc)	≥ 6	None or very low (Level 1)	"I have done it". Make sure the environmental conditions are covering the Mission needs. Examples: existing star tracker, detector, computer etc
Prototyped and space qualified under representative environment	≥ 5	Low (Level2)	"I have done and verified all critical elements"
Not built, but relying on existing toolbox or technologies,	TBD < 5	Medium (Level 3)	"I can do it using exactly existing tools or demonstrated techniques" Make sure the toolbox / previous developments are fully covering the Mission environmental conditions and the requirements. Examples: Specific structure, mirror to be polished of comparable difficulty, science instrument, CCD to be built using E2V toolbox, mechanism relying on existing actuator
Not built, new development or specific verification requested	TBD < 5	High or very high (Level 4)	"I believe I can do it, but I am not sure of the success within schedule" or "I do not know"

Heritage & TRL

- From GAIA and Herschel missions the satellite Service Module designs have lots of heritage
- JWST provides some experience, but cryo lenses, mechanisms and detectors need some development.
- Fine Guidance sensor and AOCS actuators (cold gas or magnetic reaction wheels) need some specific development
- DMD was given an early start to see if it would be "qualifiable" – temperature, cycles new operating mode. Delays in the test programme and criticality to finish the system study means it has not been able properly to assess the system implications

Some classical difficulties and common mistakes (1)

- *The mass budget is tight, but some margin may be recovered by a mass saving exercise*

  Wishful thinking. An acceptable mass margin for entering the Definition Phase is 20% at equipment level + 20% at system level…assuming the initial mass figures are correct!! The board has critically reviewed the initial mass figures, and challenged many sub-systems

- *There is a technical risk, but a back-up solution is proposed in case of failure*

  Valid approach only if 1) the back-up implementation schedule is properly analysed with a clear decision process, 2) the back-up is relying on existing technologies or is safely removing the risk, and 3) the impact on science performance is properly evaluated and is acceptable.

- *There is a technical difficulty, but it is expected to be solved during the Definition Phase*

  This is an evidence of the non-maturity of the design potentially leading to a major failure. The Board was requested to 1) identify such cases, 2) critically review the recovery schemes and their chances of success and 3) make recommendations or propose alternatives.

Some classical difficulties and common mistakes (2)

- *The spacecraft/instrument is being studied since a long time, therefore the design should be sound, mature and with low development risk*

  The robustness of a spacecraft design and the development risk are not measured by the number of industrial contracts or the volume of engineering hours. The bottom line questions are: Are the requirements well defined? How does the proposed design compare to previously built spacecraft? Is the design relying on existing technologies?

- *A similar development was made in the two last decades: we have improved, therefore we can re-do faster and cheaper*

  Wishful thinking. No fundamental technology breakthrough occurred in the last decades for building spacecrafts and rockets. Furthermore, the current geo-return situation of D/SRE will limit the efficiency of the industrial work distribution.

- *The equipment is nearly identical, we can take recurring prices*

  Recurring prices must be limited to items that are strictly identical to the original item. Recurring items must be ordered quasi-simultaneously with the original development or explicitly foreseen and negotiated in the mother contract. "Minor changes" generally lead to the full non-recurring prices.

Technical Points

- Optical requirements very challenging, interfaces not optimised for AIV and testing
- The Attitude control performance is also challenging
- High thermo-elastic stability determined to be essential for ensuring performance, and constant SAA effect on mission duration / sky coverage ?
- The mass budget is assessed to be critical in several sub-systems and hence w.r.t. Soyuz capability seen as a technical risk;
- PAYLOAD TRL:Technology development for the instruments is critical and needs further scrutiny, and early credible funding by national Agencies.
- The critical mass budget can be looked at with other technical points: telescope mounting principle (level of iso-staticity and thermoelastic distortion compensation), the focal plane configuration (common optical bench or distributed optics and instruments) and the optics material (SiC vs. Zerodur/CFRP), centralised vs distributed data processing constitute the main Payload module technical risk and need to be solved by a more in-depth trade-off.
- This trade shall also involve science requirements, e.g. possible reduction of telescope diameter and sky coverage requirements, in order to re-gain margins

Schedule and Programmatics

- Schedules have been essentially designed to fit a constraint of 2018 launch. Implies instruments development < 4 years to PFM DRB.
- Despite this lean model philosophy the schedule is tight .This is viewed as a High Programmatic Risk;
- For a comparison with GAIA, a substantial funding for Euclid instrument detector procurement and optics development would be needed *before* the final down selection.
- NIR detector production rate is very ambitious cf. NIRSPEC and NIRCAM examples.
- Cost impact for lengthier schedule and additional development models would have to be considered – but can't allow Euclid to be very late cf. other missions ……..

The Technology Research Programme

- **Draft Technology Research Plan submitted to IPC – includes**
  - K-band transponder items,
  - CVD coating/polish of SiC,
  - Cryo lens characterisation,
  - detector development,
  - detector radiation testing,
  - magnetic reaction wheels,
  - cold gas regulator qualification
- **A mixture of TRP, GSTP and National Agency funding required to achieve the necessary TRL**

Prepare for success !

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- Boards completing the harmonisation across missions
- Present Review conclusions to SPC (19/11) & start identifying National contributions so no surprises before SPC selection
- Dec 1st present the YB "feasible design"
- Advisory Groups will ask questions between mid-Dec and mid-Jan – study team and consortia reply to technical and programmatic points
- ITT being prepared but we need to make significant progress in the interface definition in time for SPC deadline
- Potentially updated by Phase A kick-off in case science requirements have to be revisited
- Programmatic problem to balance the interests of National Agencies – (*cost and interest if the scope changes*), scientific judgement to make a reasonable recommendation in face of any requested descopes & coordinate instruments activity in intervening period