The European Lunar Lander Mission

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Objectives

Programme Objective
PREPARATION FOR FUTURE HUMAN EXPLORATION

Lunar Lander Mission Objective
ENABLE SUSTAINABLE EXPLORATION

- Soft Precision Landing with hazard avoidance
- Crew health
- Habitation
- Resources
- Preparations for human activities
• Constraints applying to the Lunar Lander mission
  – Launch: use of European launch capability
  – Cost: to be compatible with PreCursor-type mission
  – Timeframe: not later than 2018
  – Technology: will be challenging but must be feasible

• Key mission baseline choices

- **Launcher**: Soyuz
- **Thermal**: No RHUs
- **Landing Site**: South Polar
  - Reliant on Solar Power generation + conventional thermal control

* Belgian participation to be finalised
**Phase B1**

**Kick-off September 2010**

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**LUNAR LANDER PHASE B1a**

**LUNAR LANDER PHASE B1b**

**Breadboarding Activities**

**Part B1a:**

- Requirements review
- Analysis of South Pole illumination & comms conditions based on most recent data → power/thermal influence
- Establishment of mission architecture
- Preliminary system/sub-system design, focus on structure & propulsion

**POLAR LANDING REVIEW ~ T0 + 6 months**

**Ministerial Council 2012 Preparation**

Pre System Req. Review
**Phase B1**

**Kick-off September 2010**

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**LUNAR LANDER PHASE B1a**

**LUNAR LANDER PHASE B1b**

**Pre System Req. Review**

**Ministerial Council 2012 Preparation**

**POLAR LANDING REVIEW**

~ T0 + 6 months

**Breadboarding Activities**

**Part B1b:**
- Consolidated spacecraft system design
- Detailed sub-system design
- Modelling, Simulation and Analysis
- Payload accommodation
- Operations implementation
- Assembly, integration and verification

**Q 2010**

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**Kick-off September 2010**

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**Phase B1**

*Kick-off September 2010*

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**Breadboarding Activities**

**Breadboarding:**
- **Propulsion:**
  - Performance check of pulse-modulated thrusters
  - Flow interaction tests to investigate impact of clustering
  - Testing of flow regulator
- **Navigation:**
  - Validation of vision based navigation techniques
- **Additional activities foreseen:**
  - Avionics
Launch & Transfer

- Launcher: Soyuz 2-1b, with Fregat upper stage
- Launch site: CSG
- Launch date: no later than 2018

- **main mission constraint from launcher:** MASS
- **launch date compatible with favourable illumination/comms period at the landing site**

- **Transfer via HEO:**
  - Optimal solution under investigation in Phase B1
- **Injection in LTO followed by insertion in LLO** (typically 100 km altitude) performed by the spacecraft itself
LLO and Descent & Landing

- **LLO**
  - Coasting

- **Descent**
  - Coasting
  - Braking

- **Landing**
  - Approach
  - Terminal

**Propulsion:** use of non-throttleable engines
Combination of fixed thrust main engines & pulse modulated assist engines

1. Absolute navigation based on landmarks
2. Relative visual navigation
3. Hazard detection and avoidance (camera & LIDAR based)

*Note: the velocity, altitude, downrange, delta-V and time values are provided to give an order of magnitude*
Lunar Lander Challenges

- Technical feasibility assessment of Polar landing on-going, to be consolidated in Phase B1
- Lunar Lander challenges represent opportunities to federate development effort and to advance European space capabilities:
  - Propulsion system (no throttability)
  - Advanced GNC techniques and sensors for Polar landing: e.g. absolute landmark navigation, Lidar, hazard detection in shadow conditions
  - Avionics
  - Survivability to darkness periods without RHUs

Autonomous operations in a unique environment (landing & surface)
Deployment of robotics capabilities
Technologies & developments in support of surface operations
• ESA Programmes, incl. Aurora Core, plus nationally funded R&D activities are engaging the steps needed to develop necessary technologies

• Industries across Europe are already forging the next generation technologies needed to successfully land on the Lunar surface
Model Payload Objectives

• Definition Process:
  – Lunar Exploration Definition Team (LEDT) recommendations
    • Objectives & requirements
  – Consultations with Topical Teams and experts
  – Establishment of preliminary model payload for Phase B1

• Objectives
  – Analysing the structure and composition of lunar dust
  – Investigating the lunar EM and plasma environment, and its interaction with lunar dust
  – Characterising in-situ resources in the form of volatiles

• Phase B1 process shall allow reflection on the implications of addressing these objectives in terms of lander requirements

* Including 20% margin
Conclusions

Europe’s First Lunar Lander:

• is a key step in preparing the way for Human Exploration of the Moon

• will bring together the results of Europe’s technological investment and experience, particularly in landing, to achieve a first in lunar exploration: landing at the Moon’s south pole

• represents a focal point for using advances in autonomy and robotics to enable survival and operations in a harsh, but vital, environment for exploration