Japanese 1st Moon Lander SELENE-2 as SELENE Follow-on

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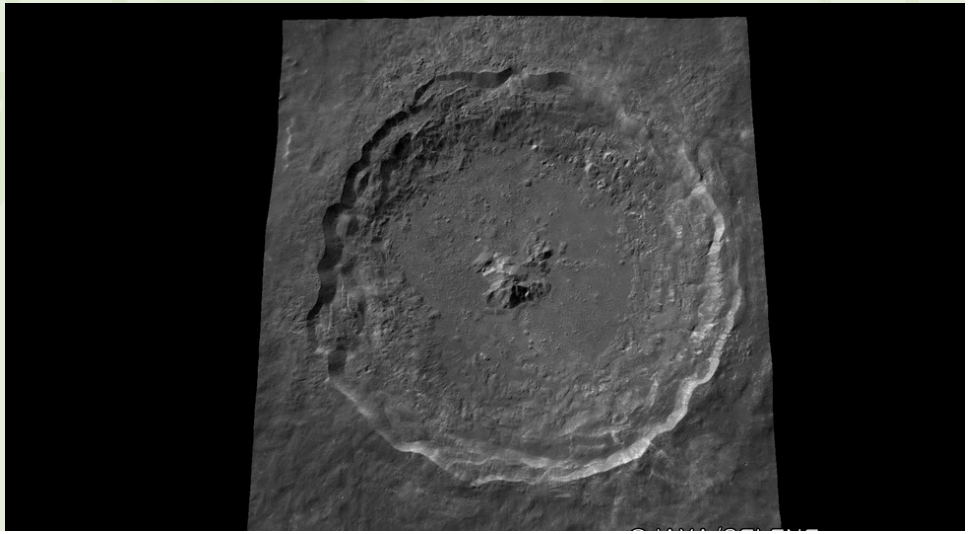
ILEWG/LEAG/SRR-2008 2008.10.31

SELENE (KAGUYA) as the 1st step

- **Objectives**
  - Science for lunar origin and evolution
  - Tech. development for the future lunar exploration
- **Major Outputs**
  - 1st HDTV, Rising Earth
  - 3D lunar pictures
  - “Science”



SELENE-2 1st step to Human Moon Exploration

- Report of Lunar Exploration WG for SAC Long-Term Vision
  - in addition to Space Science WG
  - Lander before the middle of the 2010s
    - For Japanese space exploration.
    - Part of science

- Key-technologies for exploration.
  - Safe and precise **landing** technologies
  - Surface **mobility** : robotic rover
  - Long mission life : **Night** survival technologies
- In-situ activities for science and lunar utilization.
  - Detailed **geology** & **Geophysics** for Lunar interior structure
  - Measure **dust, radiation, soil** environment
- Contribution to international lunar activity and public interest.
  - **International** payload (TBD)
  - **Outreach** payload (TBD)

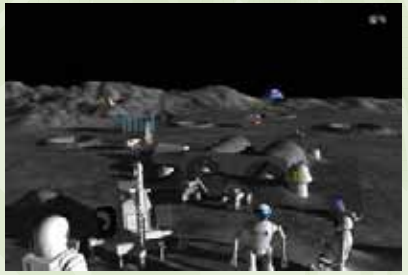
Scenario for Human Lunar Exploration

08 10 15 20 25

▽U.S. Human mission

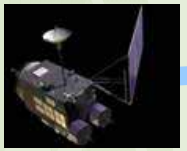
Human Exploration

Activities with ISS and HTV,

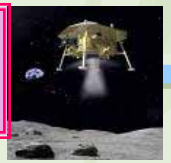


Robotic Precursor

KAGUYA Orbiter



SELENE-2 Lander



SELENE-X Advanced Lander

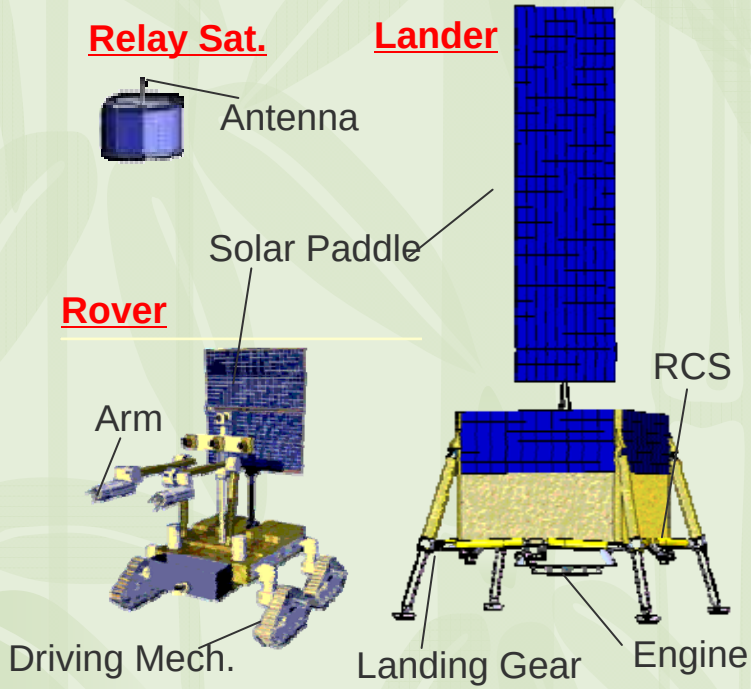
Science & utilization by Japanese astronauts.

Technology	**Lunar orbiter**	**Safe landing Surface mobility Long-mission life**	**Candidates of Advanced lander**
Science	**Surface material Gravity field**	**In-situ geology and geophysics**	***Construction demo. *Sample return *Lunar observ.**
Utilization	**Environment Resource**	**In-situ Environ. & ISRU**	
Int'l & Outreach	**Data exchange HDTV**	**Payload: Code Share HDTV, Univ.?**	

- **In-situ activity**

SELENE-2 at MDR

- Infrastructure for Exploration
  - Landing
    - Eternal light region at polar
  - Rover
- Lunar Science & Technology
  - Origin and evolution of Moon
  - Moon night survival without RTG
- Environmental study for future utilization
- Int. collaboration and cooperation
- Launch: H-2A @ 2010s'
  - 1000kg (Dry) 200 ~ 400kg Payload



Landing area : Quasi- eternal sun-light area in polar region or some other locations

Mission life : One month at least.

SELENE-2 Phase-A study

- JAXA Long Term Vision 2005
- JSPEC established Apr. 2007
- SAC Luner Exploration WG
  - SAC space development long term plan
- Space Basic Law Apr. 2008

ILC2008

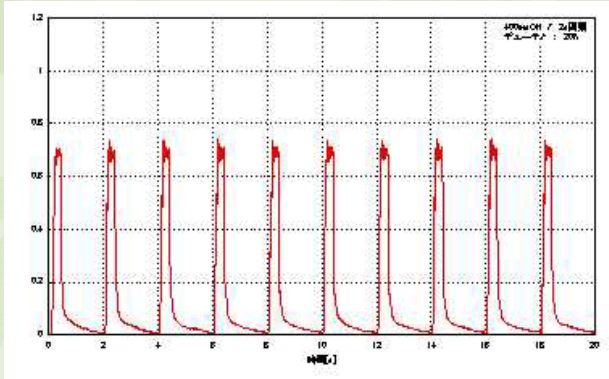
- MDR completed June, 2007.
- Pre-Project Team authorized July, 2007 with discretionary budget
- Phase-A started
  - Science advisory team started
  - Engineering team from JSPEC & ISAS
- SELENE-2 research budget authorized Apr. 2008
- SRR is planed within 2008.
- SDR is expected in early 2009.
- Launch before mid of 2010's

SELENE-2 Phase-A study

- Technology
  - Safe & Precise Landing
  - Surface mobility
  - Long mission life
- Mission
  - Science
    - Utilization Moon itself
  - Precursor for Human Exploration
  - International Cooperation
    - ILN, . . .
- Subjects
  - Payload : weight vs variety
  - Landing site : safe vs strategy

Technology : Safe & Precise Landing (1/2)

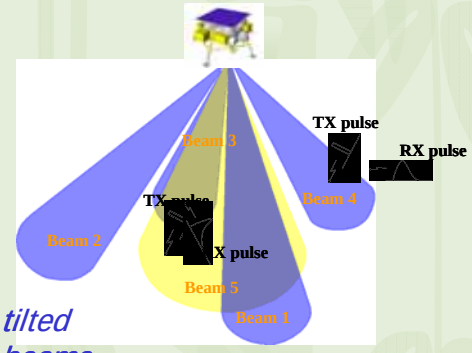
- Powered Descent :
  - Guidance, Navigation and Control
    - Use of a laser altimeter and navigation cameras
- Vertical Descent :
  - Propulsion
    - Large thrust and precise control
- Touch Down
  - Safe landing
    - Landing radar
    - Hazard avoidance
      - Optical : Mid latitude
      - LRF : Polar region
- Thruster :
  - Pulse firing
  - 500N
  - 9 Cluster



Technology : Safe & Precise Landing (2/2)

- **Landing radar : field testing**
  - **One beam altimeter**
  - **Four beams speed meter**

Type	Pulse radar
Altitude range	30m(TBD) ~ 3.5km
Velocity range	0 ~ 50m/s
Altitude accuracy	5% or 0.1m
Velocity accuracy	5% or 0.1m/s
Output data rate	1Hz

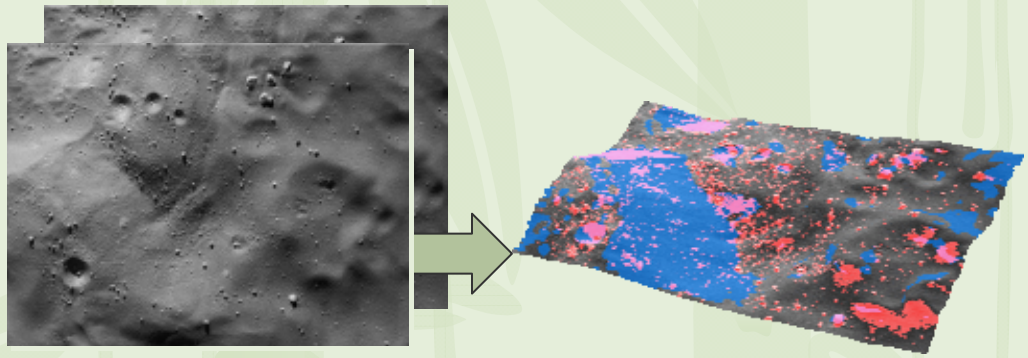


tilted beams for velocity

vertical beam for altitude

- **Optical obstacle detection:**
  - **Monocular-view system**
  - **Stereo-view system**

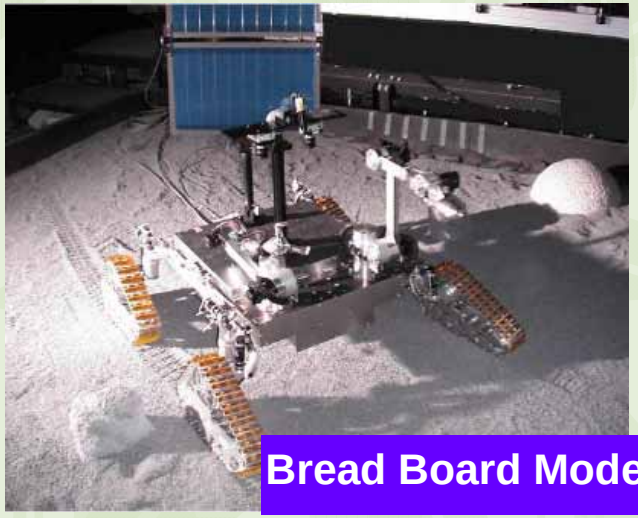
Combined algorithm



3D view of Detected obstacles

Landing site selection for 1st moon lander

Technology : Surface Mobility



Bread Board Model

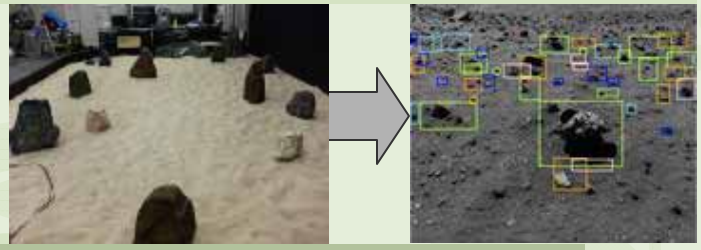
◆ **Slipping on lunar regolith**

- ● Apollo LRV & Lunokhod
- ➢ Mobile mech.
  - ➢ Crawler
  - ➢ Low pressure wheel
  - ➢ Hard wheel

◆ **Regolith seal mech. test**

◆ **Sensor: Camera and LRF**

- ✓ Hazard avoidance, Path finding
- ✓ Ground Based Teleoperation



◆ **Manipulator & Sampler**

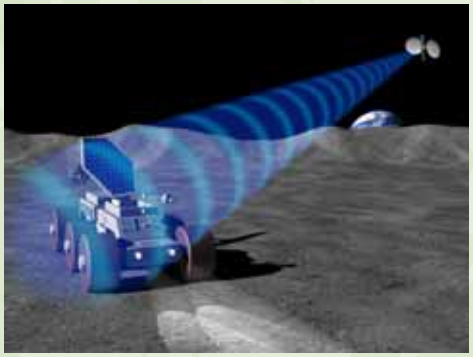
Rover Night Survival

Technology:Long mission life–Night Survival

- **6 possible power resources**
  - **Solar power at ELR**
  - **Chemical Rechargeable battery**
  - **Regenerative Fuel Cell**
  - **Solar power satellite**
  - **Hibernation**
  - **Nuclear**

➢**Fuel Cell**

➢**90kg 100w&354h**



➢**LSPS**

➢**ELR tower**

➢**5m ~ 20m**

➢**Lithium Ion Battery**

➢ ~120 Wh/kg

➢**Hibernation**

➢Verification Test

➢**RHU / RTG**

⇒**Hard to get public support**

✓**Possibility : hibernation with battery**

✓**Lithium ion battery**

✓**Fuel cell : Promissing candidate**

Concluding Remarks

- **SELENE-2 Phase-A : major subjects**
  - **Landing site as 1st moon lander**
  - **Rover night survival**
  - **Mission Life : Possible hibernation with battery**
- **SELENE-2 in next few months**
  - **SRR** **before end of 2008.**
  - **SDR** **in early 2009**
  - **Phase-B** **expected after Apr. 2009**
- **Coming**
  - **International payload** **(ILN & . . .)**
  - **Launch** **before mid of 2010's**

Thank you & Question ?