International Lunar Observatory (& Power Station): A Dish on the Moon

Presented by Steve Durst,
Lunar Enterprise Corporation / Space Age Publishing Company,
Hawaii Island / Palo Alto, CA, USA
International Lunar Conference 2005 and the International Lunar Observatory

- ILC 2005 is a Renaissance event for North America
- International / National / Commercial Space Awakening – New Era of the Space Age
- ILO is a “toehold,” lunar catalyst
- Distinguished by its low cost (US$35-50M)
- Early lunar access; business timeline – before 2008 Olympics
Why Astronomy from the Moon?

- Mechanical stability / stable platform – can point and track precisely
- High vacuum, no atmospheric absorption or scattering
- Farside free of Radio Frequency Interference
- Constant, uninhibited observation (except for Sun and Earth)
- Extremely long life – no expendable gases, gyro wear, etc.
- Real time control possible - light travel <3 second round trip
- A lunar observatory is expandable (interferometry)
- Low mission cost now possible thru private space enterprise
- Infinite single point observation at Poles, depth unmatched
- And much more

Many advantages of astronomy from the Moon are well known. There are no fundamental or engineering problems in sending a robotic mission to the Moon. It has been done many times before using much older technology!
Why Is Hawaii Important to Space Exploration? – Geographic Advantages:

- Center of Pacific Hemisphere
- Southern-most site in USA / equatorial proximity
- Mid-Pacific islands bi-directional launch capacity (equatorial or polar)
- Mauna Kea – highest point in Pacific

And Aloha
International Lunar (Dish) Observatory
• Bridges Earth-based astronomy with lunar-based astronomy
• Aims to see humans on the Moon within the decade
Lunar Astrophysics Center
Lunar South Pole
(Clementine photo)
Shackleton Crater Location

Fig. 1: Top View of the First part of the Scenario

Graphic: Paul van Susante
Indian Astronomical Observatory

- Mt. Saraswati, Hanle, India – 4,500-m elevation
- The Indian Institute of Astrophysics’ high altitude station
- 2-meter Himalayan Chandra Telescope is world’s highest optical / infrared observatory
- Several other telescopes onsite with ongoing construction on additional facilities
Square Kilometer Array (SKA) prototype now being constructed as “National Megascience Project” in Guiyang, Guizhou Province, China
National Radio Astronomy Observatory (USA), European Southern Observatory and National Astronomical Observatory of Japan project broke ground Nov 2004 at Atacama Desert’s 5,000 meter elevation Llano de Chajnantor in Chile.
Space Age Publishing Company – Hawaii Space Tours Headquarters
Waimea, Hawaii Island

- Central Island, upcountry location, close proximity to Mauna Kea summit and observatory support facilities
Lava Fields, Mauna Loa

Past - Used to train Apollo astronauts

Future - Used to train lunar observatory service technician astronauts
Lava Fields

International Lunar Conference “From Hawaii to the Moon” tour 19 November 2003. Apollo 16 Moonwalker Captain John Young (right) accompanied tour.
Mauna Kea Summit Observatories

- 13,796 feet elevation – tallest mountain in Pacific Ocean
- Global center of Earth-based astronomy
- 12 nations represented – USA, Hawaii, Argentina, Australia, Brazil, Canada, Chile, France, Japan, The Netherlands, Taiwan / China, United Kingdom
Very Long Baseline Array / National Radio Astronomy Observatory
Caltech Submillimeter Observatory
Caltech SM Observatory,
James Clerk Maxwell Telescope &
Submillimeter Avenue
Smithsonian Submillimeter Array
Subaru / National Astronomical Observatory of Japan (NAOJ)
Keck 1 & 2 Observatories
Keck Interferometry
Gemini Ridge
Canada France Hawaii Telescope
Gemini North Telescope
Submillimeter Valley, Subaru, Keck 1 & 2, NASA Infrared Telescopes
SpaceDev CEO Jim Benson tests out Hawaii Space Tours
SpaceDev Core Competencies Overview

**Microsatellites**
- Mission Analysis & Design
- Spacecraft & Subsystem Design
- Microsatellite Mission Control and Operations

**Hybrid Propulsion**
- **MoTV** (Maneuvering and orbital Transfer Vehicle)
- **Hybrid** Rocket Propulsion System
- Supplied Engines for X Prize Winner SpaceShipOne
Observatory Design

Observatory includes:

- Dish and pedestals
- All spacecraft avionics
- Fixed landing legs
- Mono-propellant motor
- Attitude control thrusters
- Uses some SpaceDev hardware and software from CHIPSat mission
Conceptual Vehicle Design

- Designed to fit inside the launch vehicle payload envelope
- LDO Stack consists of
  - Observatory (by SpaceDev)
  - SpaceDev Hybrid motor
  - Solid motor

(Thermal management not shown on motors)
Flight Configuration

Launch and LEO

Phasing orbits up to velocity zeroing 4 km above Lunar surface

Lunar descent and surface operations
Phasing Orbits and Lunar Insertion

2-D Representation of Trajectory in Earth-Sun rotating Frame
Lunar Orbit Insertion and Descent

3-D Representation of Trajectory in Moon Centered Inertial Frame
Lunar Descent

• Actuators
  – Use mono-propellant motor
  – Reaction control thrusters

• Navigation
  – Inertial Navigation Unit used for navigation
  – Three beam FM CW Doppler Radar

• Radar used under 4 km for range and velocity data

• Can cut off motor several meters above ground to avoid contamination
Lunar Landing Sites

- Low latitude sites are not attractive due to 14.5 day long sunlight and 14.5 day long eclipse
- Lunar polar location might have **Peaks of Eternal Light (PEL)** locations where sunlight is available 95% of the time
- PEL are estimated to be
  - On the rims of the large craters
    - Very high in altitude – 12 km high
    - Very rough terrain
  - Very small in surface area
  - No specific locations are known
  - SMART-1 mission will attempt to locate them

**Landing on PEL will be the most difficult aspect of the mission!**
Phase B Focus: Navigation & Landing System

• First study demonstrated the concept from launch to landing
  – Concept was maintained for this study
• The challenge for this study was to determine how to be able to begin the descent (~4 km altitude above target) and land precisely on a target that may be ~100 square meters
• No deep space mission has ever required or achieved this level of accuracy
• Past missions achieved accuracy which is orders of magnitude lower than this mission
ILO Advisory Committee Workshop
17-20 November 2005
Hawaii Island, HI, USA

Focus 1: ILO Users and Sponsors

Focus 2: ILO Mission Technology Definition

Focus 3: Financing & Organizational Operations
ILO Primary Users:

- Hawaii – People / State, University of Hawaii Institute For Astronomy
- Stanford University community
- National Astronomical Observatories - China, CNSA
- India Institute of Astrophysics, ISRO
- Canada-France-Hawaii Telescope, CSA
- National Astronomical Observatory – Japan, JAXA
- European Southern Observatory, ESA
- Russia Academy of Sciences, RKA
- Pakistan – SUPARCO
- Malaysia – Angkasa
- Ukraine – NSAU
- Others: Australia, South Africa, Chile, Brazil, Argentina

ILO Secondary Users:
- Private, Commercial (Communications, Broadcasting)
ILO Mission Technology Definition

- ILO Instrument, Wavelength and Object Definition
- Related Technologies of Robotic Village
- ILO Spacecraft Design, Launch, Operations; Lunar Orbit and Landing Technologies
- ILO Siting and Emplacement; Follow-On, Build-Out Considerations
- Human Service Mission to the ILOs (2010-2015)
Primary and Secondary ILO Mission Objectives Must Be Defined, Prioritized

- Initial landing site observation, local surveillance
- Search for Earth-like planets
- Analyze interstellar molecules to determine origin of solar system
- Search for dangerous NEOs
- Image galactic center
- Earth observations: geocorona, etc
- Solar observations, solar storm warnings
- Search for extra-terrestrial intelligence (SETI)
- Observe signs of life on Mars, Europa, Titan, etc
- More
ILO Sponsors?

International space agencies, astrophysical / science centers, philanthropy and private enterprise

Global Effort!
ALOHA!

For more information about the International Lunar Observatory, contact:

Space Age Publishing Company / LEC
65-1230 Mamalahoa Highway, D-20
Kamuela, HI 96743

Phone 808-885-3473
Fax 808-885-3475

Email news@spaceagepub.com
Web http://www.spaceagepub.com