

DSL AND PATHFINDER : A CONCEPT OF LOW FREQUENCY RADIO TELESCOPE IN LUNAR ORBIT

Jingye Yan¹, Jinxiu Zhang²
and DSL team

1.National Space Science Center (NSSC/CAS), China

2.Harbin Institute of Technology (HIT), China

Outline

- Background
- DSL concept
- DSL pathfinder (DSL-P) in CE-4 mission
- Summary

Proposal for CAS-ESA Joint Scientific Space Mission

Discovering the
A Sky at
I U Longest
A L U wavelengths
F W
R I
O S
A

DSL: the joint Sino-European team



1. *HONG Xiaoyu, AN Tao, Willem Baan et al.*, ShAO/CAS, **China**
2. *YAN Jingye, ZHENG Jianhua, CHEN Ding et al.*, NSSC/CAS, **China**
3. *WU Xiangping, CHEN Xuelel, LI Di, YAN Yihua, HUANG Maohai, CHEN Linjie et al.*, NAOC/CAS, **China**
4. *Albert-Jan Boonstra, Michael Garrett et al.*, ASTRON, **NL**
5. *Leonid Gurvits*, JIVE & TU Delft, **NL**
6. *Heino Falcke, Marc Klein-Wolt et al.*, Radboud University, **NL**
7. *Leon Koopmans*, Groningen University, **NL**
8. *Mark Bentum*, Twente University, **NL**
9. *Baptiste Cecconi, Philippe Zarka*, Observatoire de Paris, **France**
10. *Reza Ansari*, Université Paris Sud & LAL, **France**
11. *Andrea Ferrara*, SNS, Pisa, **Italy**
12. *Hanna Rothkaehl*, Space Research Center, **Poland**
13. *Jan Bergman*, Institute of Space Physics, Uppsala, **Sweden**
14. *Graham Woan*, University of Glasgow, **UK**



plus supporting scientists and engineers (100+) from 17 countries

DSL objectives

- **Prime**: pioneering studies in the hitherto unexplored window of the cosmic EM spectrum
 - Full sky continuum survey of discrete sources:
 - *Ultra-steep spectrum extragalactic sources*
 - *Pulsars*
 - *Transients (galactic and extragalactic)*
 - Full sky map of (galactic) continuum diffuse emission
 - Search for signatures of Dark Ages
 - Recombination radio lines (of “macro-atoms”)?
 - Search for “exo-Jupiters”
 - Solar-terrestrial physics
 - Radio-showers from high-energy particles (and neutrinos) interacting with Moon
- **Above all**, a lesson of science history:
 - Discovery of unknown

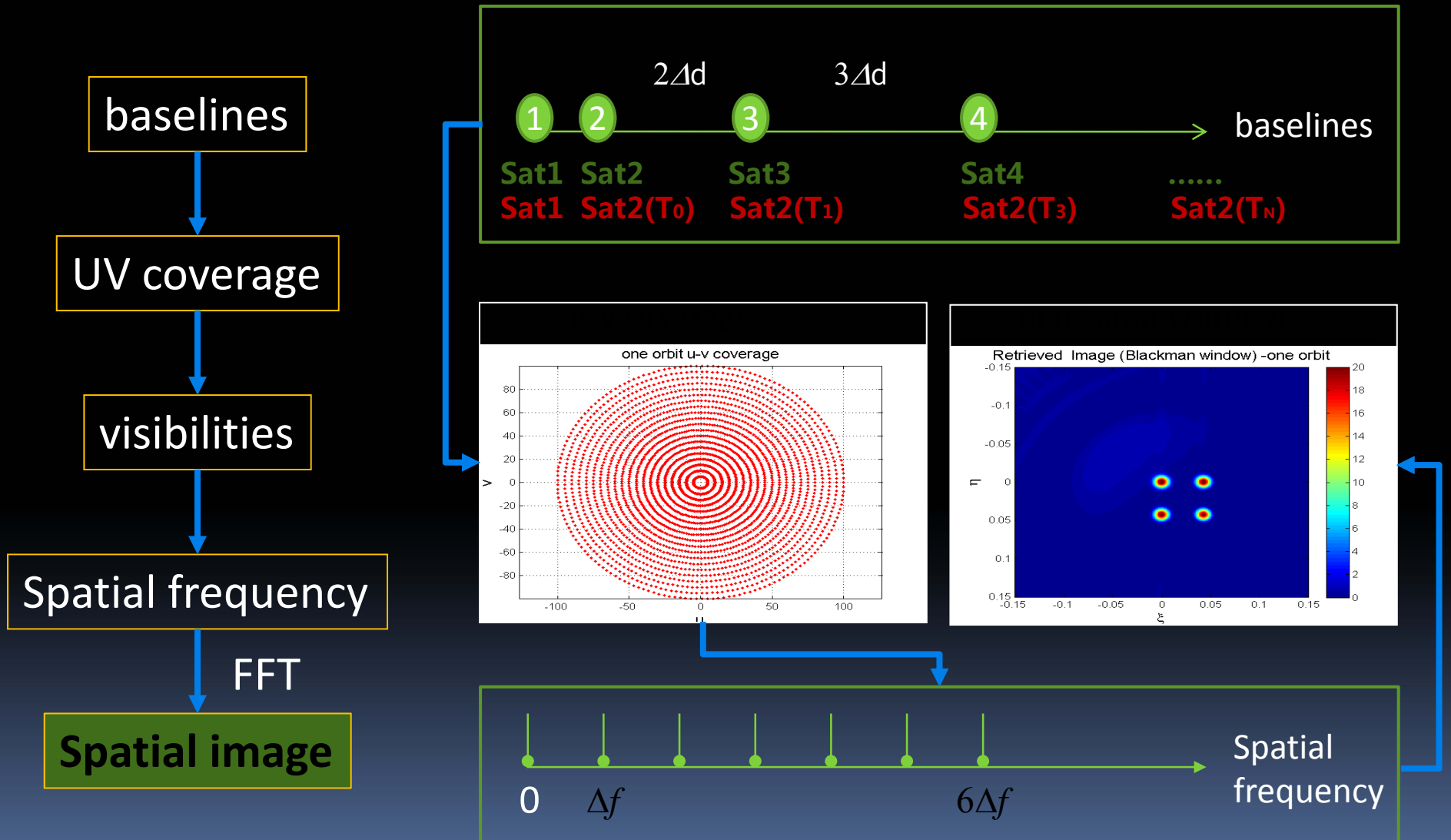
DSL major specifications

- Wavelength/frequency range:
 - *mandatory:* 300 – 10 m 1 – 30 MHz
 - *desirable:* 1 km – 10 m 300 kHz – 30 MHz
 - *optional:* 3 km – <10 m 100 kHz – >30 MHz
- Imaging capability:
 - *angular resolution:* 12" @30MHz
 - *mandatory:* Dynamic Range (DR) 300:1
 - *desirable:* DR 1000:1 (or confusion-limited)
 - *optional:* DR>3000:1 (or confusion-limited)
- Spectral resolution, $f/\Delta f \geq 250$

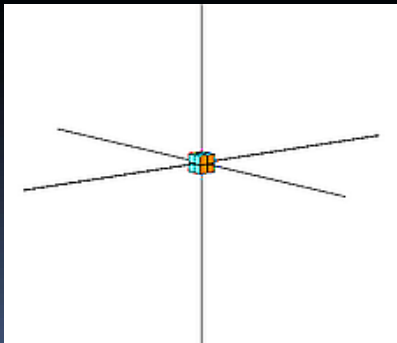
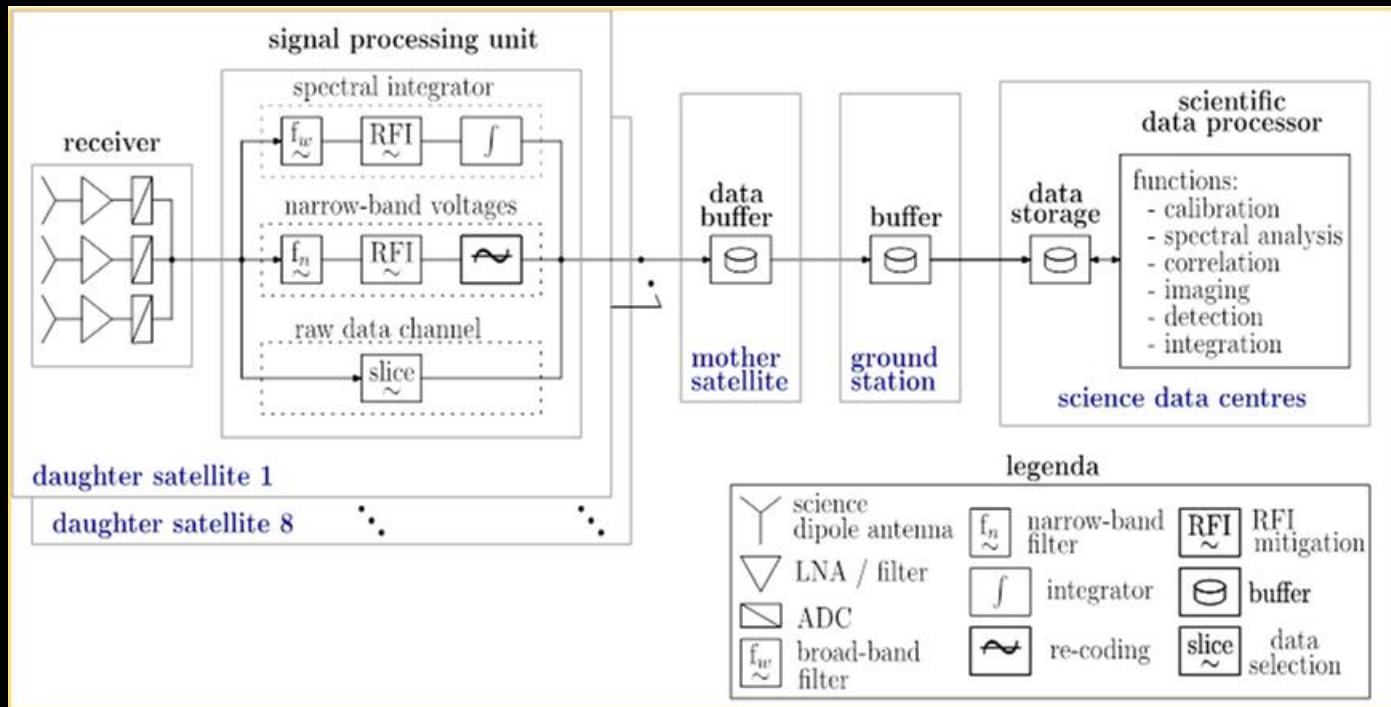
Outline

- Background
- DSL concept
- DSL pathfinder (DSL-P) in CE-4 mission
- Summary

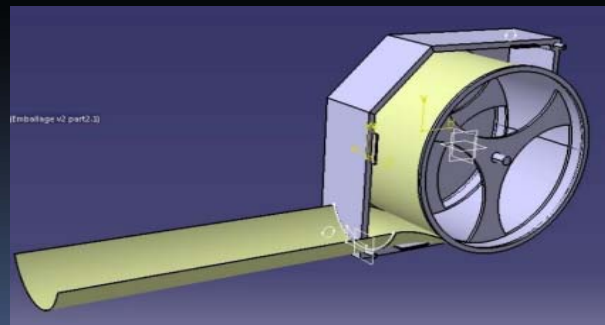
Interferometric Principle



Payload



3 dipole antenna



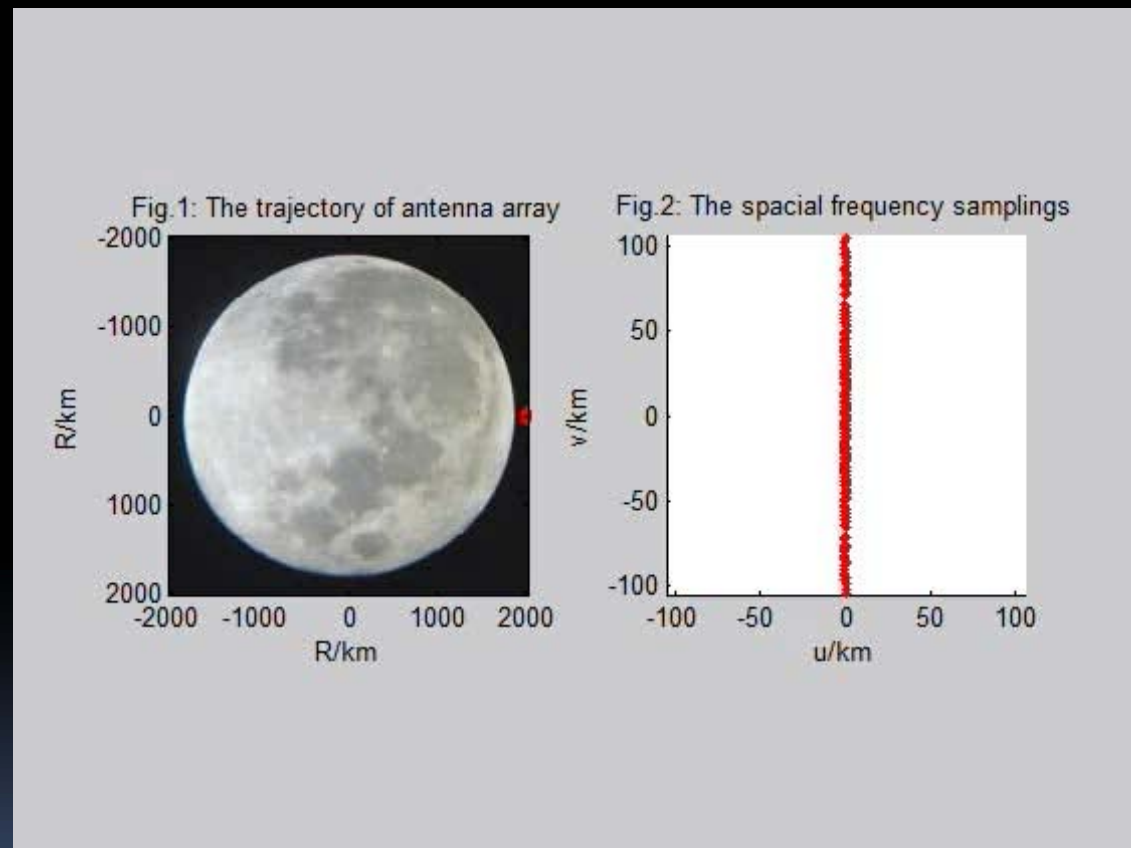
Antenna mechanism



antenna for RELEC satellite

DSL array design

- Linear array in lunar orbit
- 2D UV coverage every $\frac{1}{2}$ orbit
- Quicker aperture filling with maneuver
- Reconfigurable baseline
- Simple deployment and maintenance

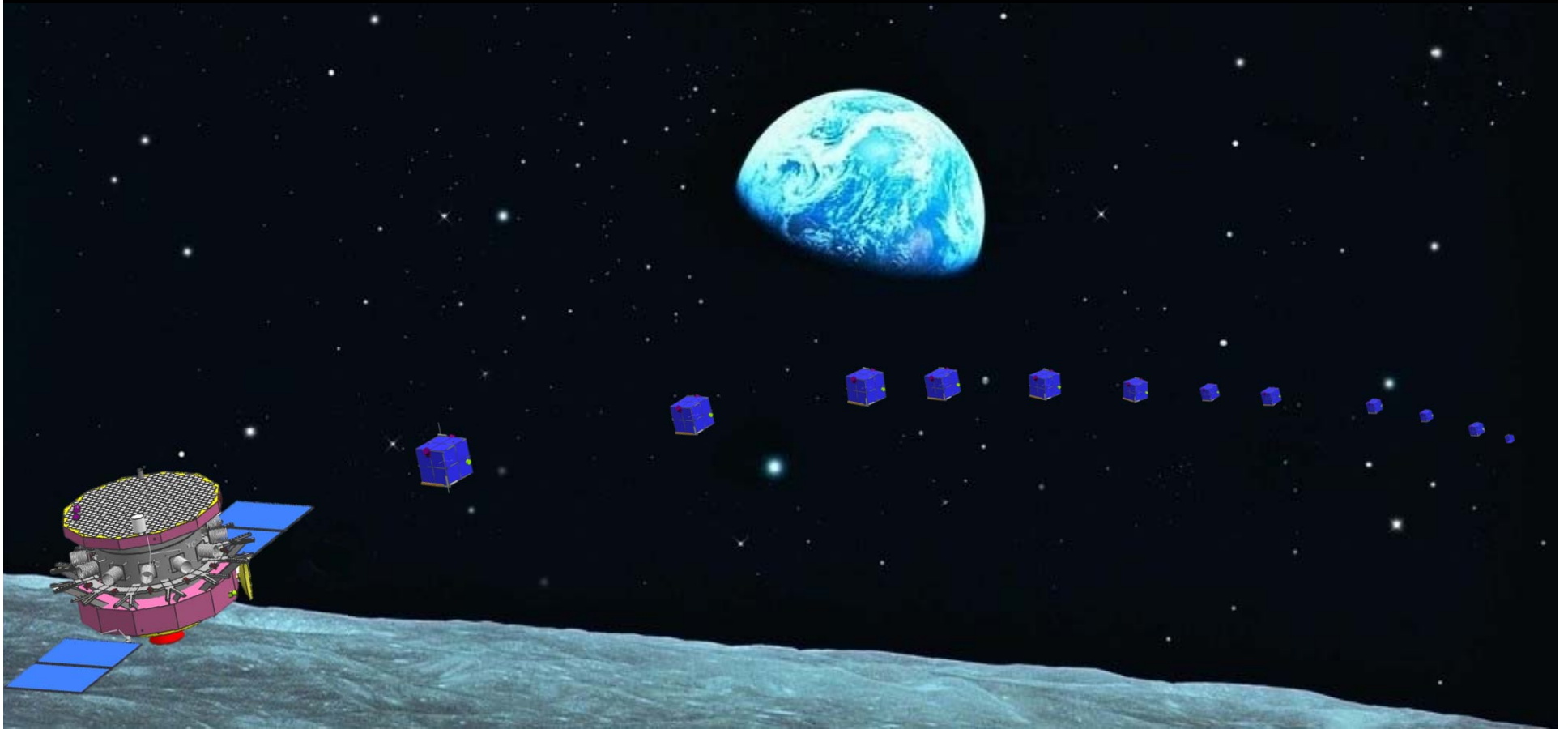


Sample array: 1 4 10 22 24 35 39 52 63 71 74 78 79 km

3D dense coverage with orbit precession



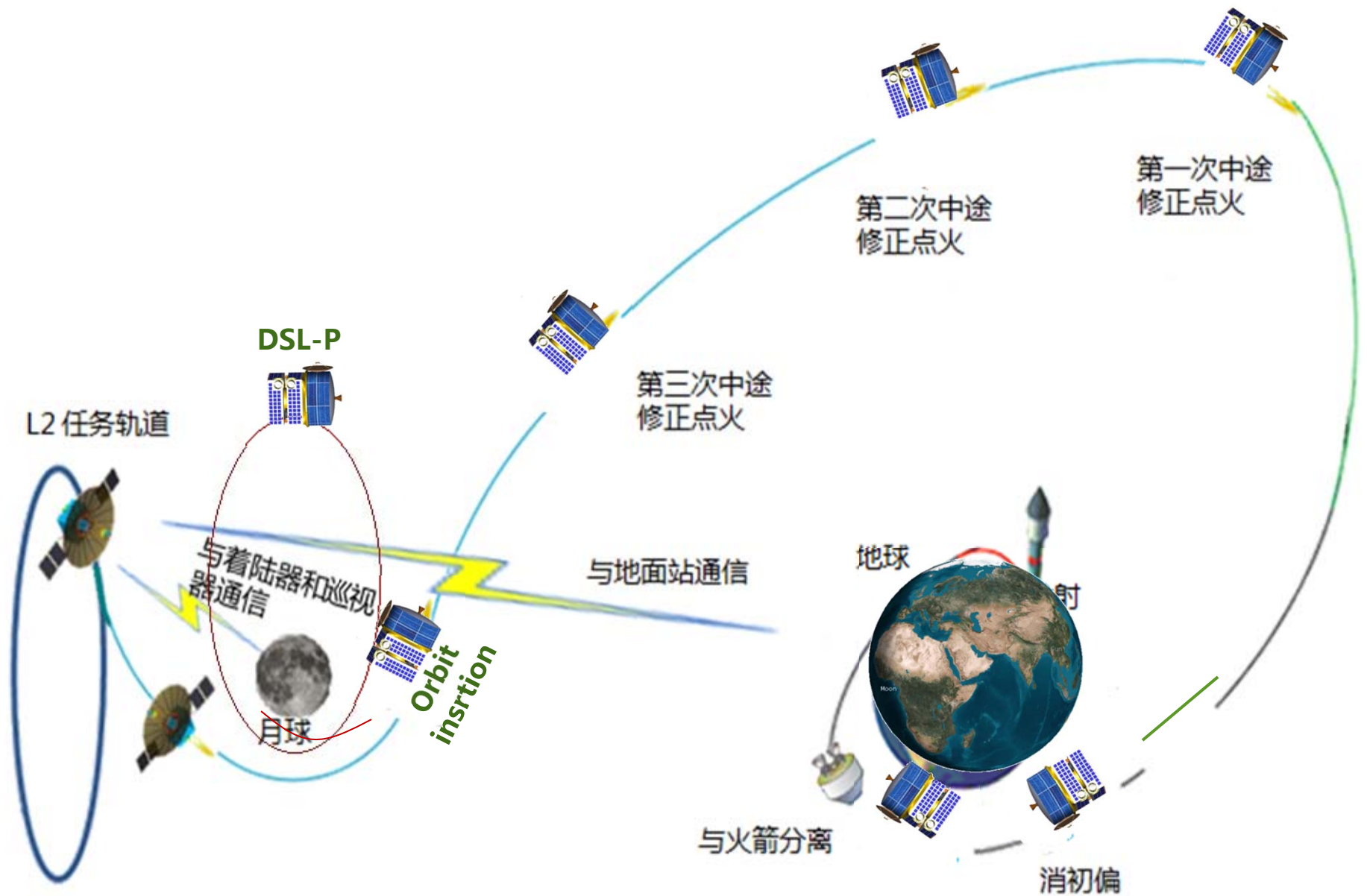
Artistic impression of a lunar orbiting DSL concept



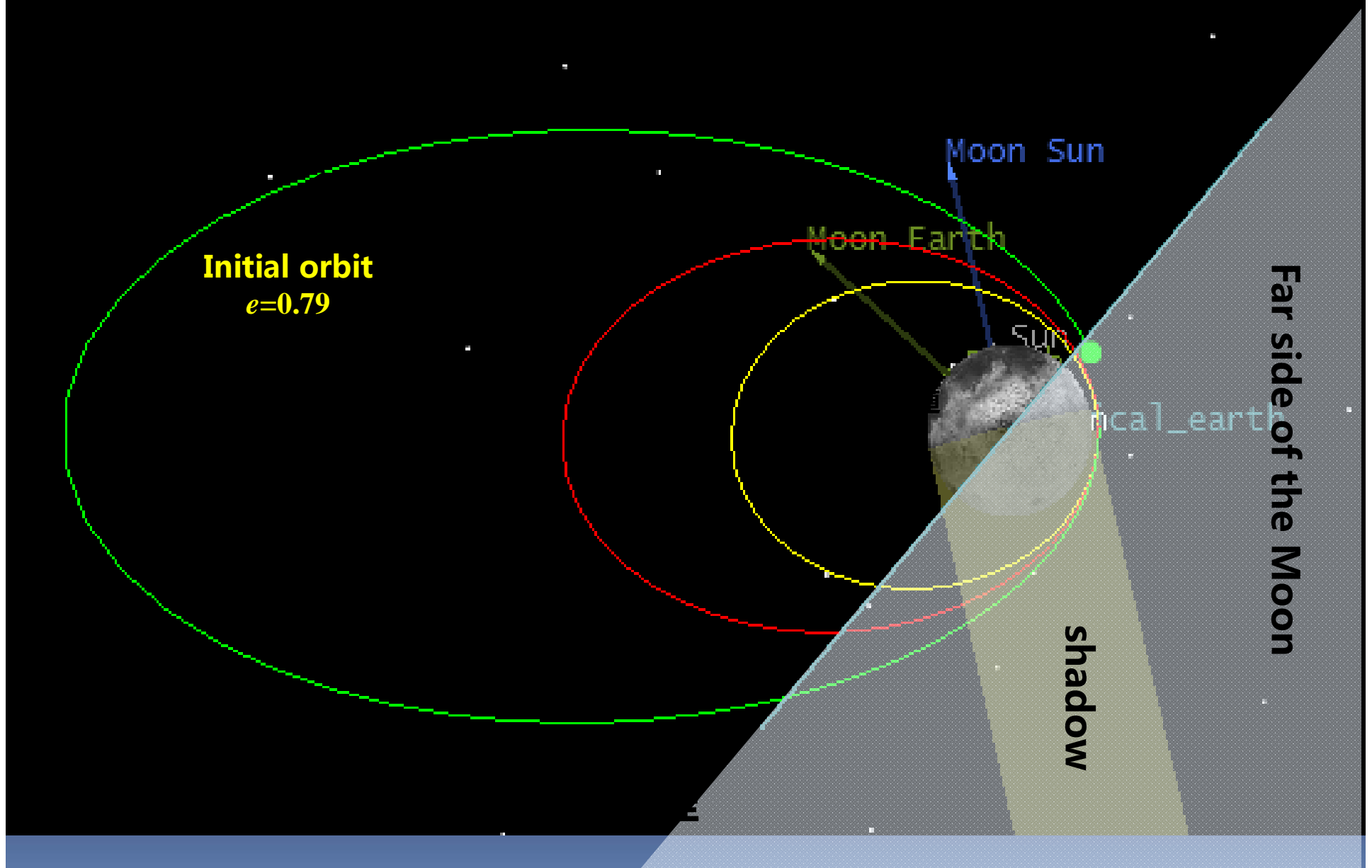
Outline

- Background
- DSL concept
- DSL pathfinder (DSL-P) in CE-4 mission
- Summary

Transfer orbit



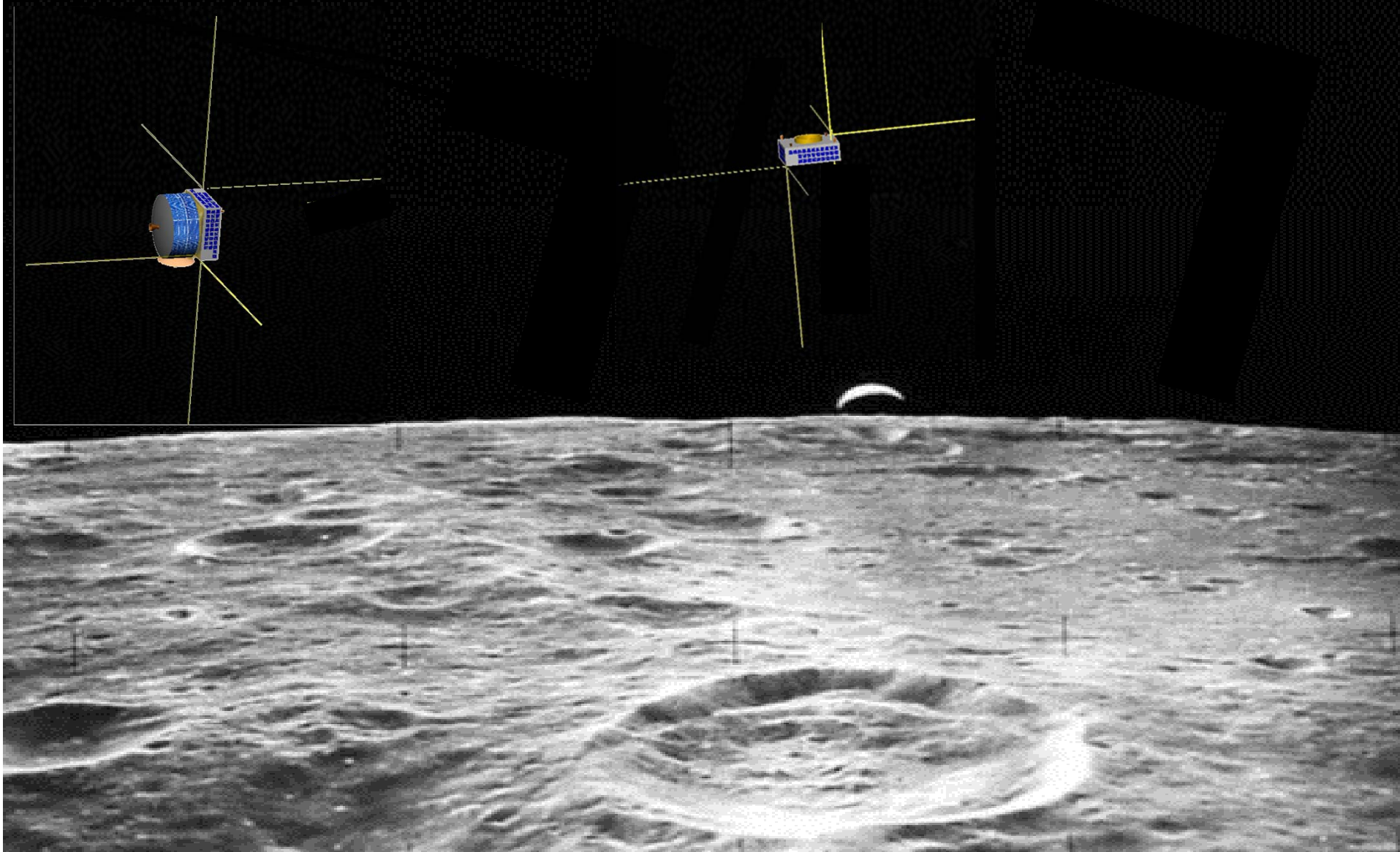
Target orbit



Preliminary specifications

- orbit: Perigee 300km ,
Apogee 4100km
- Orbit inclination : 23 °
- Number of satellite: ~2
- Reconfigurable baseline: 100m to 10km
- Relative positioning : 5m
- Life time: 12 months
- frequency : 1~30 MHz
- antenna : 3 dipoles , 1m

Micro satellites and reconfigurable baseline



Mass Budget

module	Mother (kg)	Daughter (kg)	comment
Service	26	8.7	
Conventional	10	8	Structure, AOCS, power, TC
Propulsion	15	0.5	Transfer and orbit insertion
Relative position	1	0.2	Camera, LED
Payload	7	6	
Science payload	5	5	Antenna, receiver, signal processor
ISL and timing	3	1	Synchronization, ISL, ranging
subtotal	34	14.7	
margin	1.3		
total	50		

◆ **Participants in China**

Harbin Institute of Technology (HIT)

National Space Science Center (NSSC)

Shanghai Astronomical Observatory (SHAO)

National Astronomical Observatories (NAO)

... to be included

◆ **Development schedule**

Jun. 2016 , detailed design

Jan. 2017 , QM

Apr. 2018 , FM, ready for launch

Open to international collaboration

- ◆ DSL concept was built up by international team
- ◆ “Piggybacking science experiments subsystem” of CE-4 is composed of DSL-P by HIT and NSSC, and payload on communication satellite by NSO
- ◆ Cooperation opportunity
 - System design and specifications
 - Payload module
 - Signal processing
 - Data sharing (corresponding to involvements)

Summary

- DSL will deliver pioneering science (never before!) at affordable cost, opening up the last unexplored window in Universe, Offers significant discovery potential
- Pathfinder in CE-4 will demonstrate feasibility, consolidate system design, improve TRL , and enable future large array
- DSL-P provides unique opportunity for international community

Thanks for your attention

contact point: yanjingye@mirslab.cn

