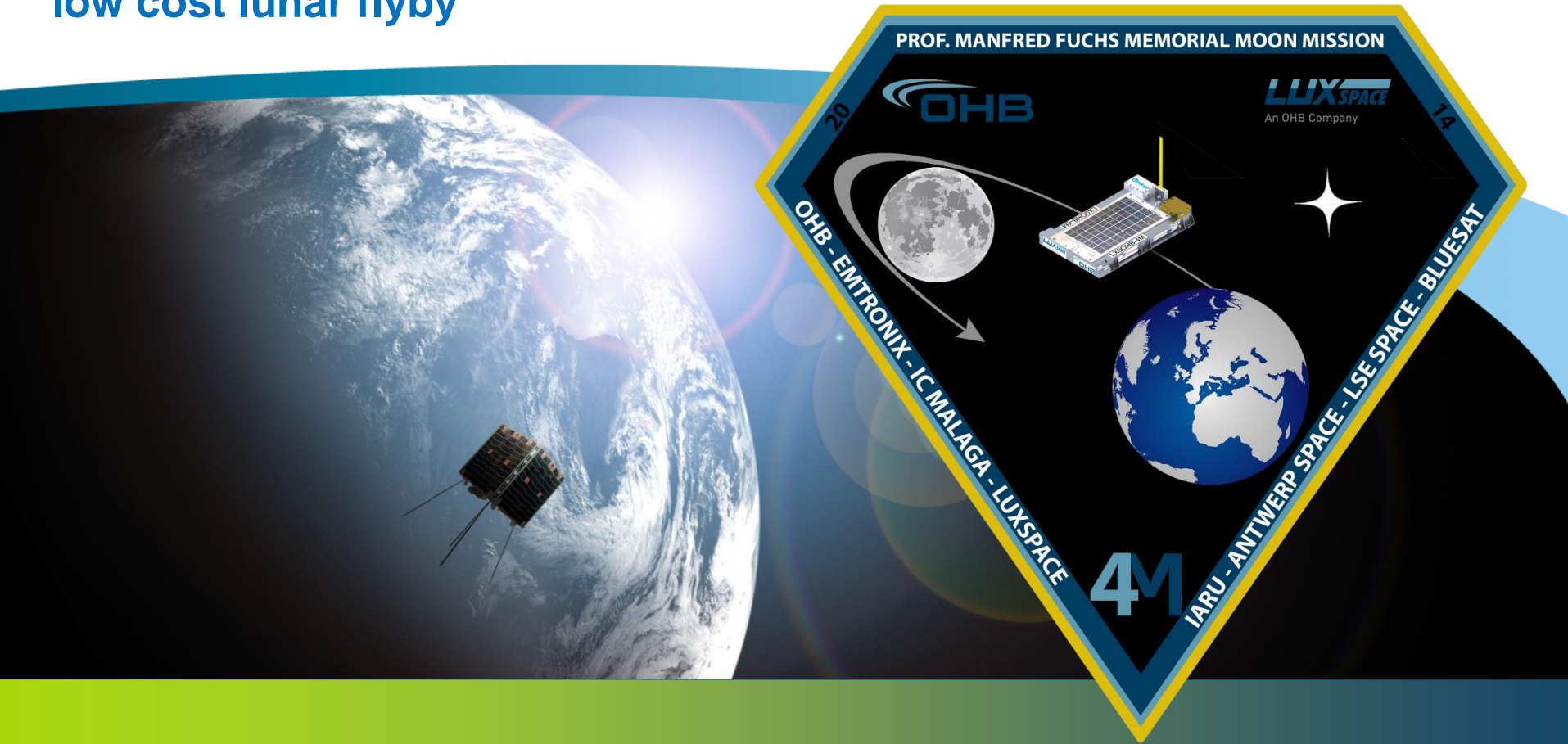


Manfred Memorial Moon Mission (4M): development, operations and results of a privately funded low cost lunar flyby

LUXSPACE

An OHB Company



Moser, H. A., Ruy, G., Schwarzenbarth, K., Frappé, J.-B., Baessler, K., Van Schie, B.

LuxSpace Sàrl

SBC - Rue Pierre Werner 9, 6832 Betzdorf, Grand-Duché de Luxembourg

29th Annual AIAA/USU Conference on Small Satellites 2015

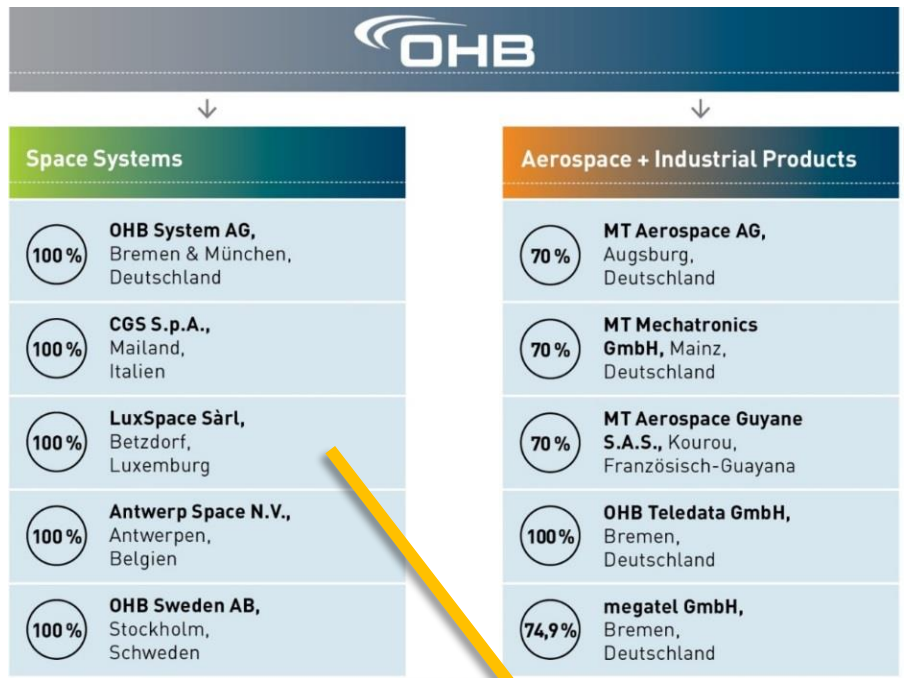
Memorial

Prof. Dott.-Ing. h.c. Manfred Fuchs
Founder of OHB SE (and LuxSpace)
Pioneer in small space business
†26.04.2014

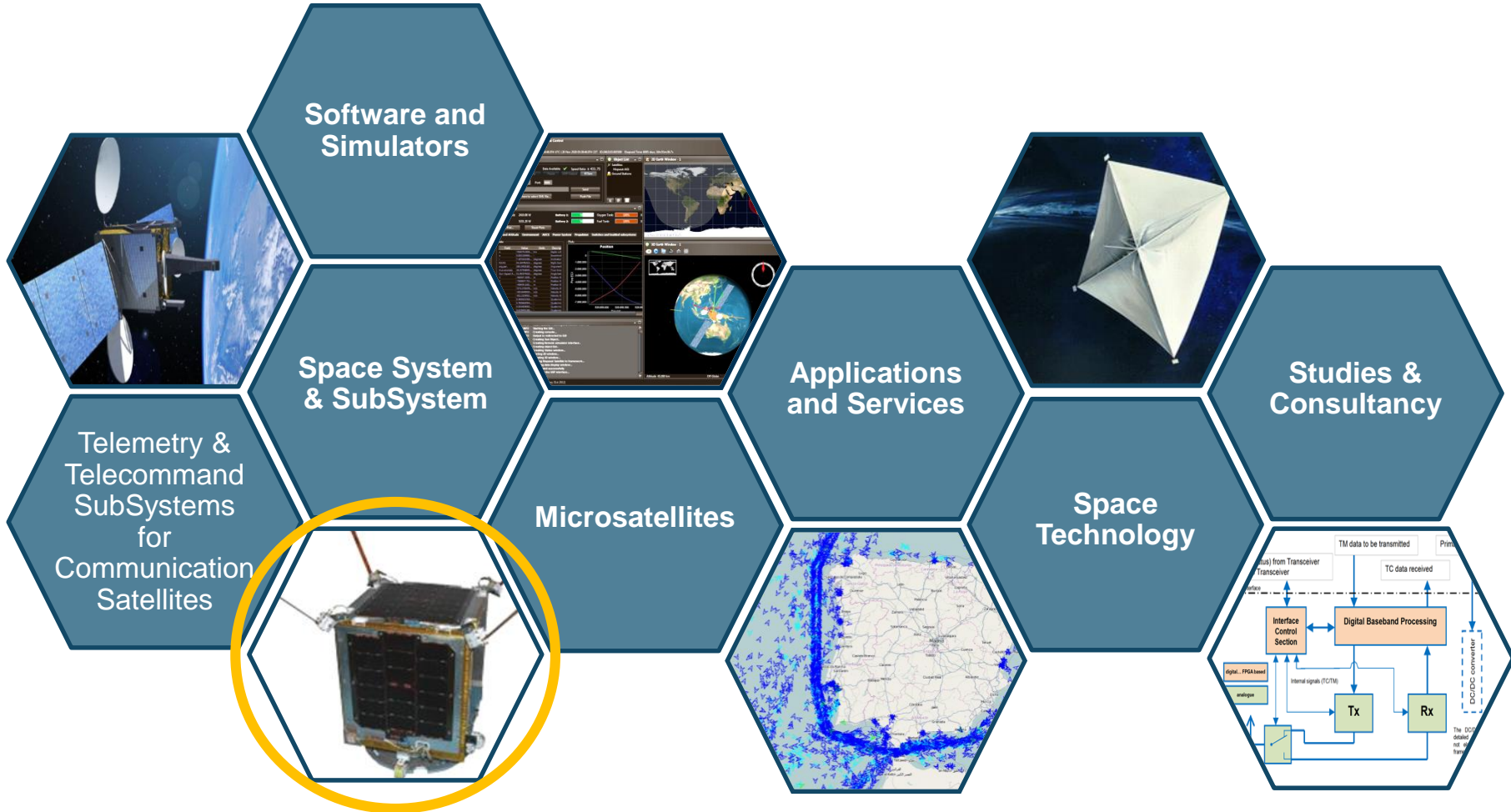


LuxSpace

- Founded in November 2004
- 40 staff from 12 different countries
- Turnover approx. 10M€

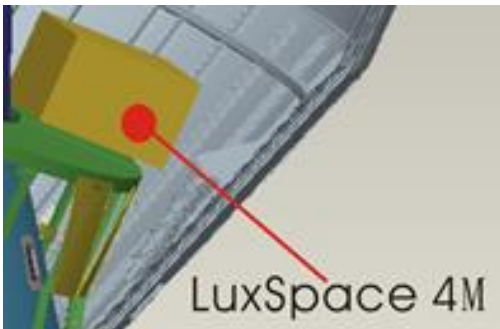


LuxSpace



Chinese Lunar Exploration Program (CLEP)

- Chang'e 1: Orbiter (2007)
- Final phase of CLEP
- Chang'e 5 T1: Test key technologies for Chang'e 5
- Hitchhike: 530x370x350 mm³
- Be ready: Q4/2014



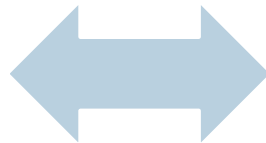
Credits: CNSA, CASC, CCTV

Mission objectives

- to honour Prof. Manfred Fuchs
- to increase public's interest in space exploration and space missions,
- to promote our approach to do space missions
- to demonstrate that privately funded missions to moon are feasible
- to demonstrate crowd-based navigation for deep space missions
- to measure the radiation dose on the way to the moon and back



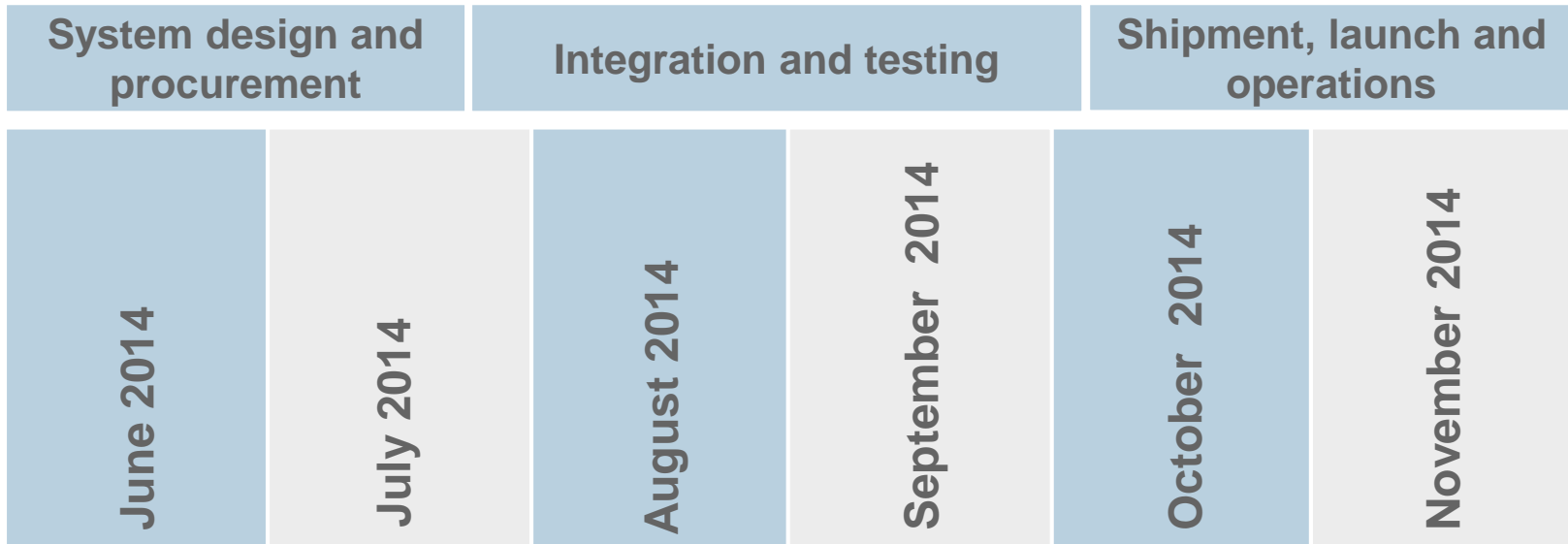
SkyLark



TRITON

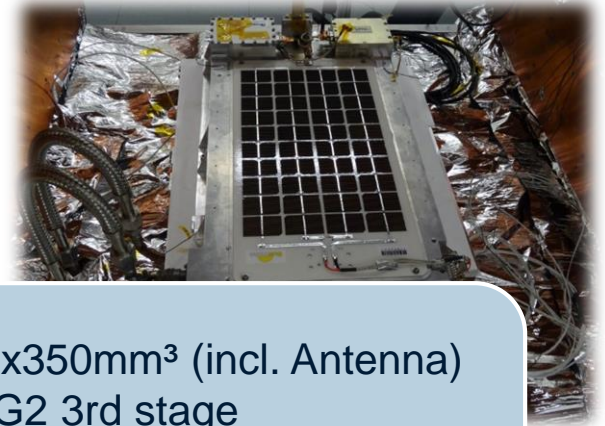
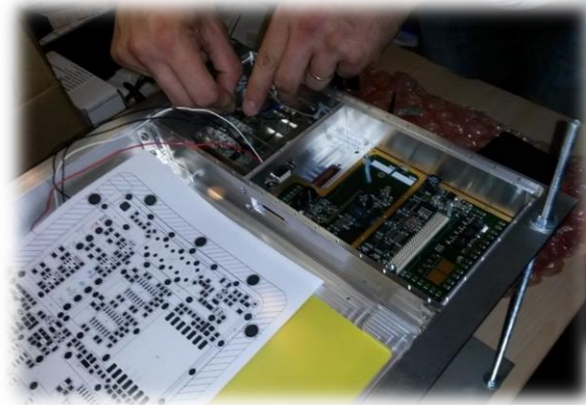


The approach



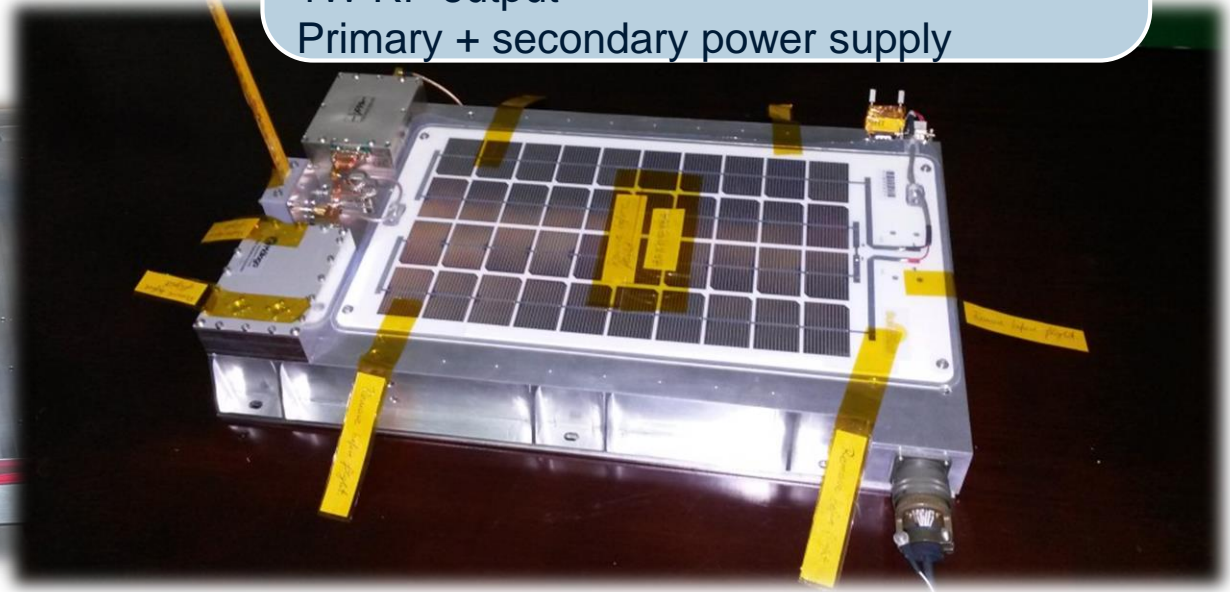
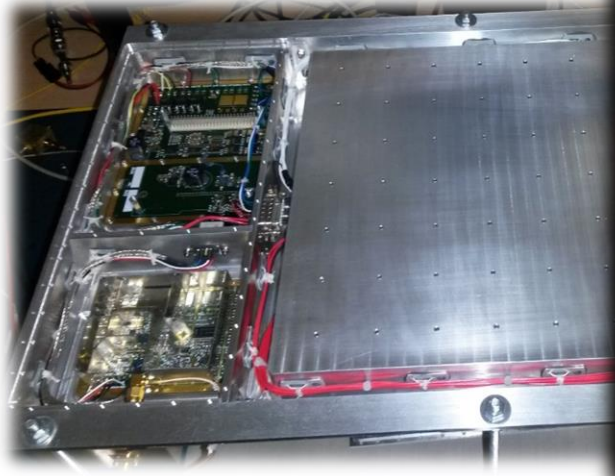
- Small multi-disciplinary team
- Conservative assumptions
- Design to reduce launch site operations
- Close trust-based supplier relationship
- Reduced documentation

The spacecraft



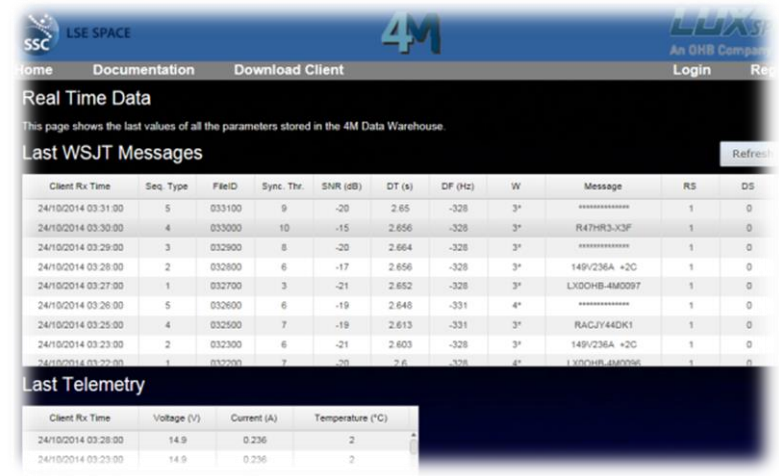
Mass: 12 kg
Volume: 530x370x350mm³ (incl. Antenna)
Bolted to LM-3C/G2 3rd stage
Downlink: 146 MHz
1W RF output
Primary + secondary power supply

LX00HB-4M



Preparations

- Data Warehouse (LSE Space)
- JT65B coded signals decoded with WSJT software (K1JT)
- Global Ground stations (incl. LuxSpace)
- Global community
- Mission website, social media



Real Time Data
This page shows the last values of all the parameters stored in the 4M Data Warehouse.

Last WSJT Messages

Client Rx Time	Seq. Type	FileID	Sync. Thr.	SNR (dB)	DT (s)	DF (Hz)	W	Message	RS	DS
24/10/2014 03:31:00	5	033100	9	-20	2.65	-328	3*	*****	1	0
24/10/2014 03:30:00	4	033000	10	-15	2.656	-328	3*	R47HR3-X3F	1	0
24/10/2014 03:29:00	3	032900	8	-20	2.664	-328	3*	*****	1	0
24/10/2014 03:28:00	2	032800	6	-17	2.656	-328	3*	149V236A +2C	1	0
24/10/2014 03:27:00	1	032700	3	-21	2.652	-328	3*	LX00HB-4M0097	1	0
24/10/2014 03:26:00	5	032600	6	-19	2.648	-331	4*	*****	1	0
24/10/2014 03:25:00	4	032500	7	-19	2.613	-331	3*	RACJY44DK1	1	0
24/10/2014 03:23:00	2	032300	6	-21	2.603	-328	3*	149V236A +2C	1	0
24/10/2014 03:22:00	1	032200	7	-20	2.6	-328	3*	LX00HB-4M0097	1	0

Last Telemetry

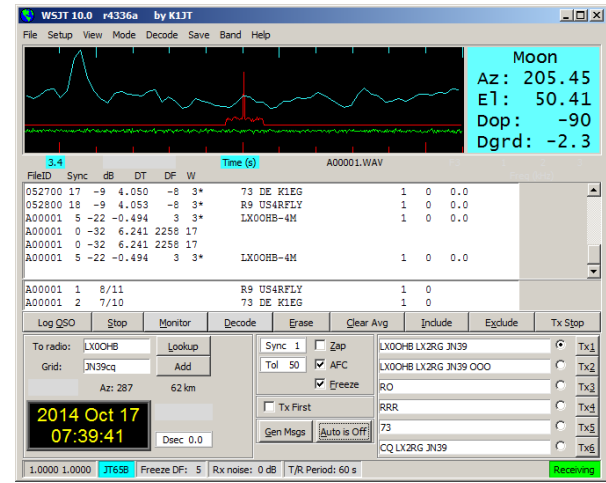
Client Rx Time	Voltage (V)	Current (A)	Temperature (°C)
24/10/2014 03:28:00	14.9	0.236	2
24/10/2014 03:23:00	14.9	0.236	2

LuxSpace Sári
Published by 4M Manfred Memorial Moon Mission [?] · October 21, 2014 ·

New post (Receiving 4M – The quick & dirty guide) has been published on Manfred Memorial Moon Mission (4M)



Receiving 4M – The quick & dirty guide
"Receiving 4M – The quick & dirty guide" The launch of 4M is planned for the 23th of October, 17:59 UTC! We have a very detailed instruction on our website how to receive 4M signals with all necessary information available: <http://moon.luxspace...>



WSJT 10.0 #4336a by K1JT

File: Setup View Mode Decode Save Band Help

3.4 Moon
Az: 205.45
El: 50.41
Dop: -90
Dgrd: -2.3

FileID	Sync	dB	DT	DF	W	Time (s)	A00001.WAV
052700	17	-9	4.050	-8	3*	73 DE K1EG	1 0 0.0
052800	18	-9	4.063	-8	3*	R9 US4RFLY	1 0 0.0
A00001	5	-22	-0.494	3	3*	LX00HB-4M	1 0 0.0
A00001	0	-32	6.241	2258	17		
A00001	0	-32	6.241	2258	17		
A00001	5	-22	-0.494	3	3*	LX00HB-4M	1 0 0.0
A00001	1	8/11				R9 US4RFLY	1 0
A00001	2	7/10				73 DE K1EG	1 0

To radio: LX00HB Lookup
Grid: JN39cq Add
Az: 287 62 km
2014 Oct 17 07:39:41
Disec 0.0
Log QSO Stop Monitor Decode Erase Clear Avg Include Exclude Tx Stop
Sync 1 Zap LX00HB LX2RG JN39 Tx1
Tol 50 AFC LX00HB LX2RG JN39 OOO Tx2
Freeze RRR Tx3
Tx First Tx4
Gen Msgs Auto Off 73 Tx5
CQ LX2RG JN39 Tx6
1.0000 1.0000 JT68 Freeze DF: 5 Rx noise: 0 dB T/R Period: 60 s Receiving

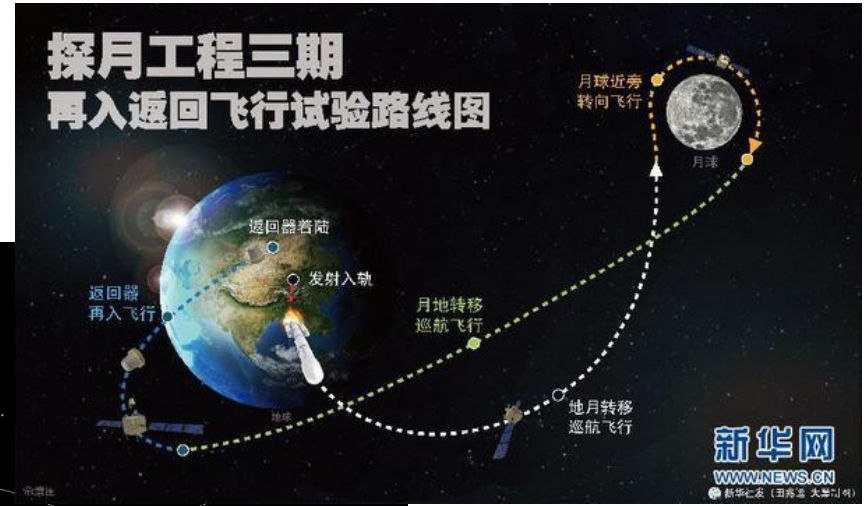
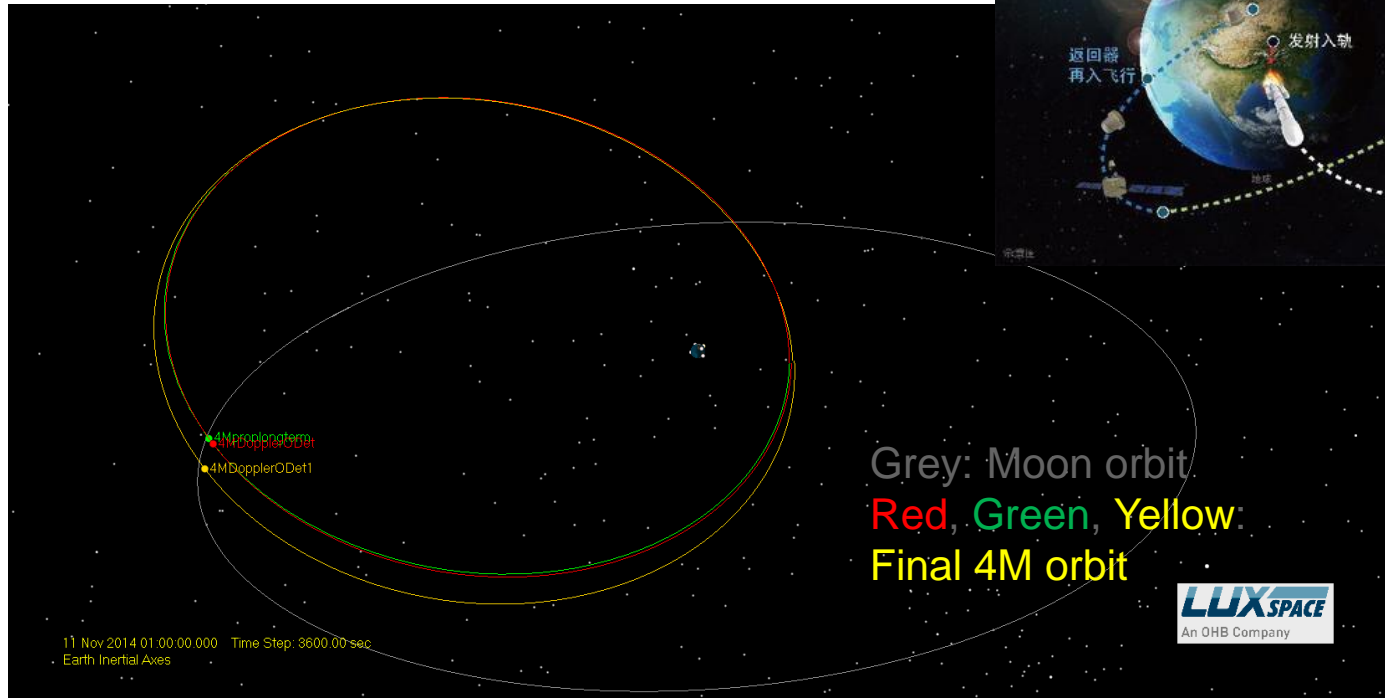


Preparations

- Shipment
- Pre-launch tests
- Launch



Final orbit



Credits: Xinhua

Apogee: 400 000 km, Perigee: 95 000 km, inclination: 57°

Messages and global reception

- 1st message received in Brazil (closest to S/C after activation)
- Various G/S types
- Global coverage (ham radios)

141100	21	0	0.332	-5	3*	MINIS BAUSTEL	1		
141200	20	-5	0.334	-5	3*	LX00HB-4M0526	1		
141300	20	-5	0.334	-5	3*	160V269A +18C	1		
141400	20	-4	0.336	-5	3*	LEAVEISCOMING	1	0	0.0
141500	21	-1	0.336	-5	3*	R3. 2P4LMWX	1	0	0.0
141600	20	-4	0.338	-5	3*	ESGEHTEINSATZ	1	0	0.0
141700	21	-5	0.338	-5	3*	LX00HB-4M0527	1	0	0.0
141800	20	-6	0.339	-5	1*	160V269A +18C	1	0	0.0
141900	20	-5	0.340	-5	3*	AUFREISENUNDD	1	0	0.0
142000	20	-5	0.340	-5	3*	R9Z. -4T5V0	1	0	0.0
142100	21	-2	0.343	-5	3*	OMMTZURUECKVO	1	0	0.0
142200	20	-1	0.343	-5	1*	LX00HB-4M0528	1	0	0.0
142300	20	-6	0.344	-5	1*	160V269A +18C	1	0	0.0
142400	20	0	0.345	-5	0*	MMOOND	1	0	0.0
142500	20	-6	0.346	-5	1*	R3. 2?4LMWX	1	0	0.0
142600	20	-2	0.348	-5	1*	GANZ LIEBE GR	1	0	0.0
142700	20	-4	0.349	-5	2*	LX00HB-4M0529	1		
142800	20	0	0.350	-5	1*	160V270A +18C	1		
142900	20	-5	0.351	-5	1*	UESSEANGABIUN	1		
143000	20	-1	0.352	-5	1*	R9Z. -4T5V7	1		
143100	20	-7	0.354	-5	1*	DOTTOVOMMOND	1		
143200	20	-6	0.354	-5	1*	LX00HB-4M0530	1		
143300	20	-6	0.355	-5	2*	160V269A +18C	1		
143400	20	-5	0.357	-5	1*	DAMITALLEMENS	1		
143500	20	-6	0.357	-5	2*	R3. 2?4LMWX	1	0	0.0
143600	20	-5	0.359	-5	2*	CHENAUFDERWEL	1	0	0.0
143700	20	-6	0.360	-5	1*	LX00HB-4M0531	1	0	0.0
143800	20	-6	0.361	-5	2*	160V269A +18C	1	0	0.0
143900	20	-4	0.363	-5	1*	TINFRIEDENZUS	1	0	0.0
144000	19	-3	0.364	-5	1*	R9 084T5VF	1	0	0.0
144100	19	-1	0.364	-5	0*	AMMENLEBEN	1	0	0.0



Mission

Accomplished?

Honour Prof. Manfred Fuchs and send messages from the moon	All uploaded messages were sent and received several times.
Lifetime (100h)	438h @ lower temperature than expected.
Include and rely on radioamateurs	> 75 registered ground stations in 29 countries for data reception and trouble-shooting.
Perform radiation measurement	215h (details at NSREC 2015)
Crowd-based navigation	Not via foreseen multi-lateration, but via Doppler shift measurement.
Public outreach	Various articles in international media (journals, news, newspapers, social media).

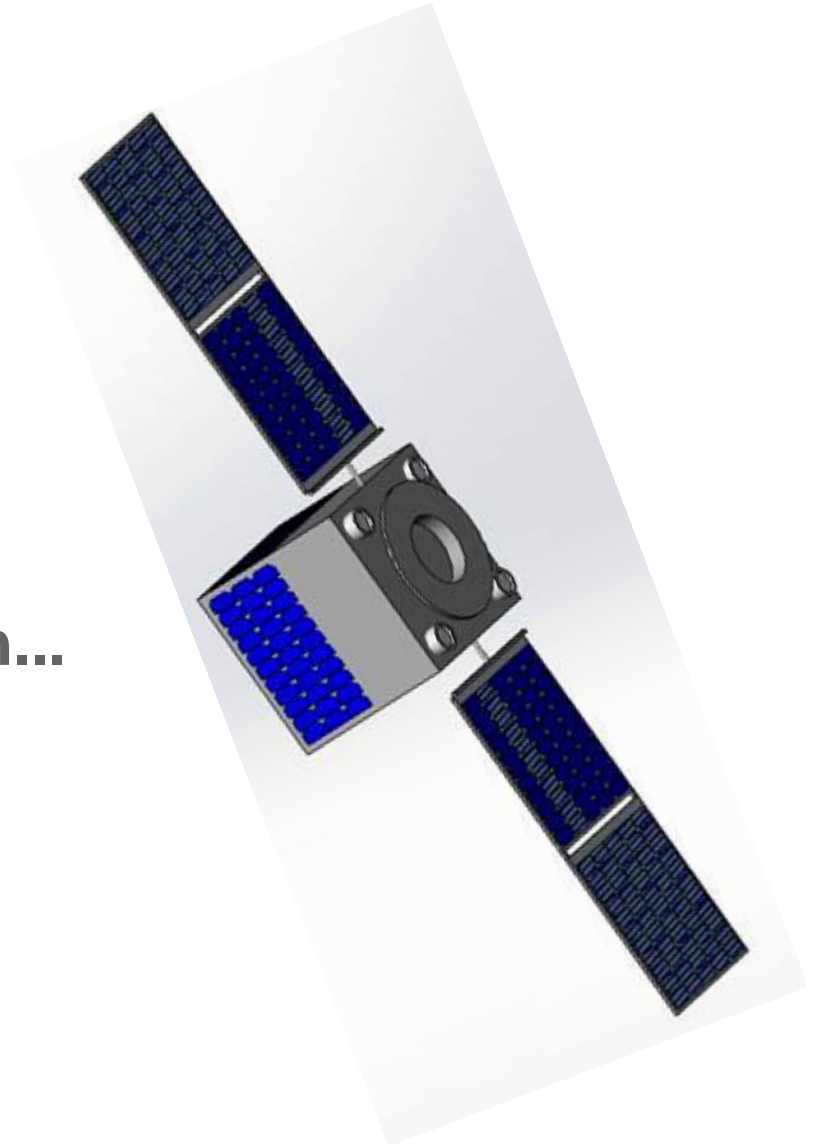
What's next?

2018

Based on our Triton-2 platform (<70 kg)

Goal: Privately funded moon orbiter,...

→ You are welcome to join with...
ideas, experiments, support,...



THANK YOU FOR YOUR ATTENTION !



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moon.luxspace.lu

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moon@luxspace.lu

4M partners:

