



4M, A MOON FLYBY MISSION

Opportunity mission for
experiments

4M: what is it ?



- 4M is a mission that popped up as a combination of occasion and memory of late Pr. Manfred Fuchs, founder and chairman of OHB group, Bremen.
- 4M is a short duration mission that will perform a flyby around the Moon and come back to Earth. Total duration is around 196 Hours
- Launch will occur in a window end of October.
- 4M stands for Manfred Memory Moon Mission

4M, what does it?



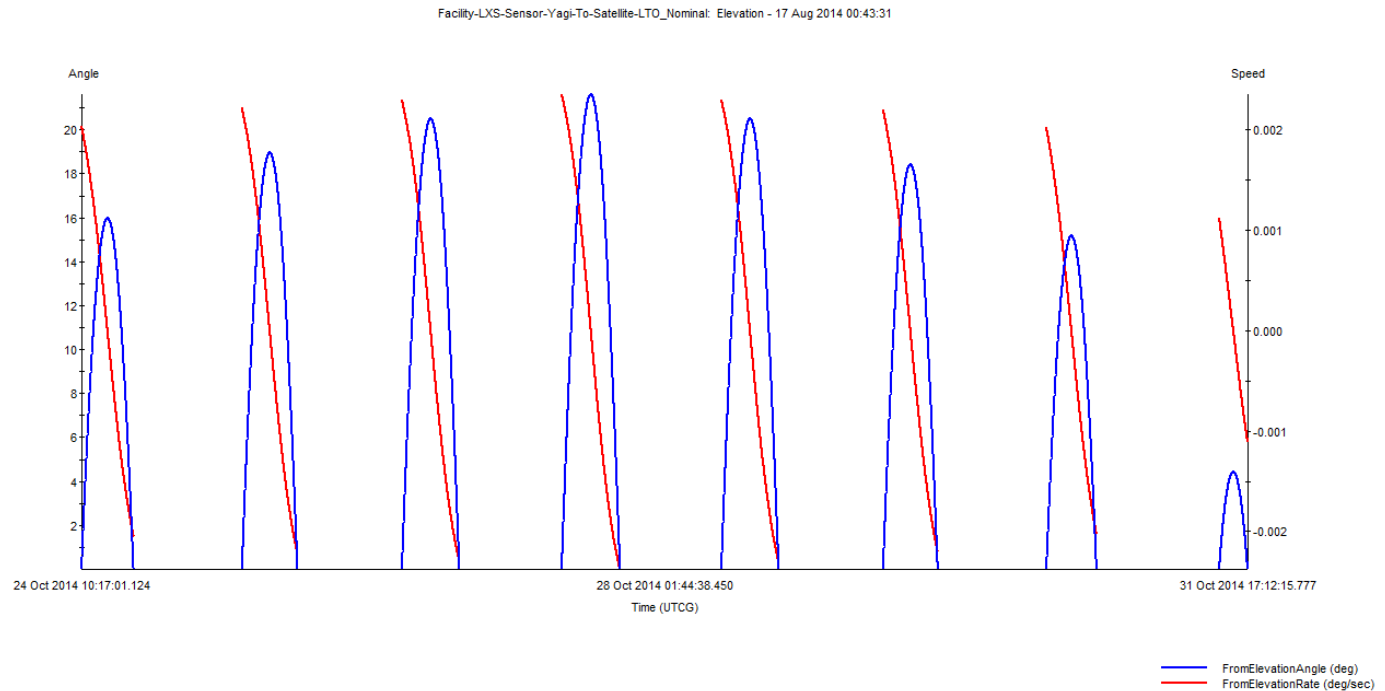
- 4M is a simple spacecraft that does nothing much more than transmit its callsign, a basic telemetry, the result of an experiment and some welcome messages
- Nevertheless, it can bring back some very interesting results:
 - Radiation experiment: sizing of appropriate radiation shielding for the next Moon mission (orbiter)
 - Multilateration: first basic trial for spacecraft navigation of next Moon mission
 - Direct, effective and efficient communication with a lunar rover without the need of big scale antennas, kind of network centric C2.

4M: Trajectory



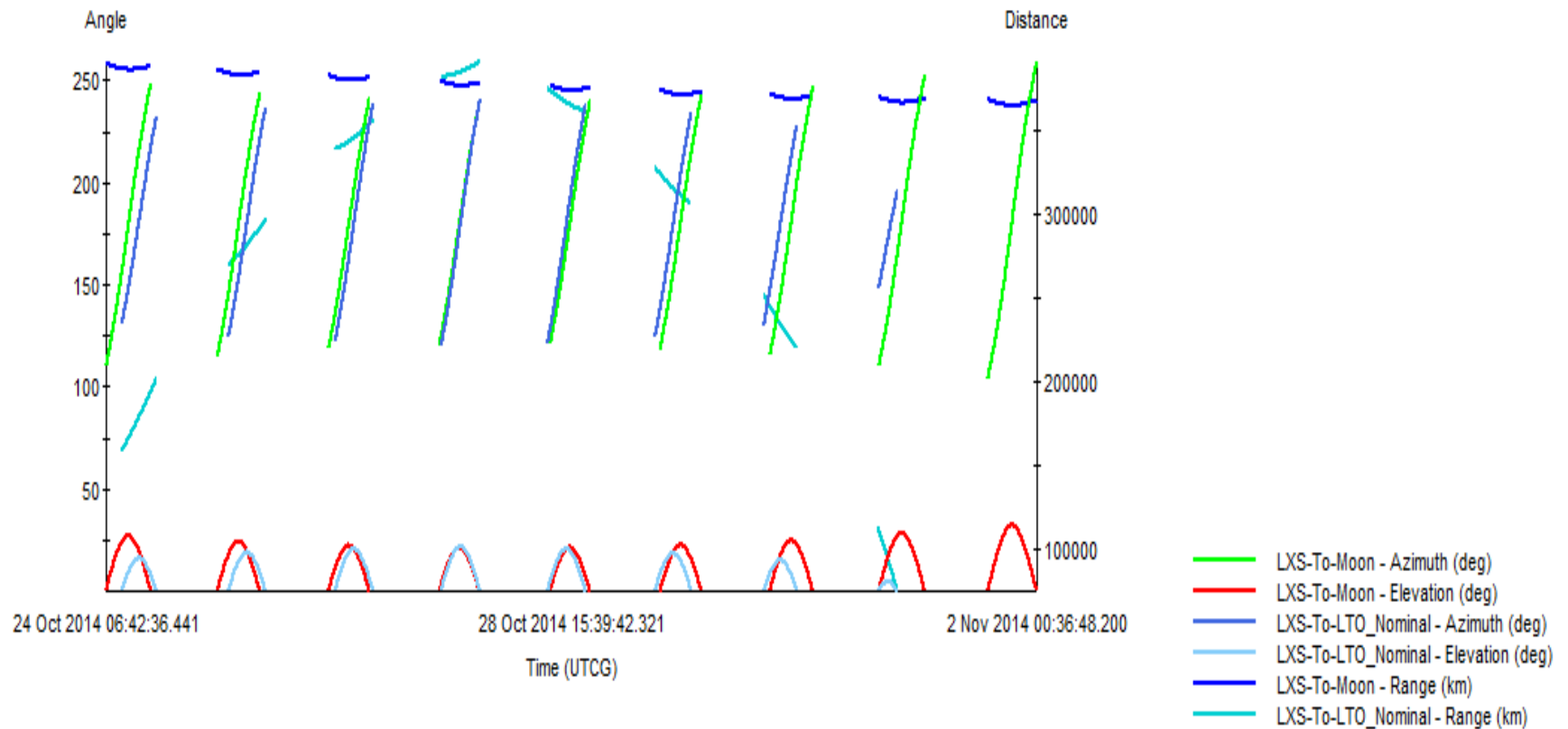
- Moon will be at lowest declination, trajectory will favour southern hemisphere stations.
- 4M tracking elevation from 50°N latitude will not be very high, 20° during flyby.

4M Elevation from 50°Lat North

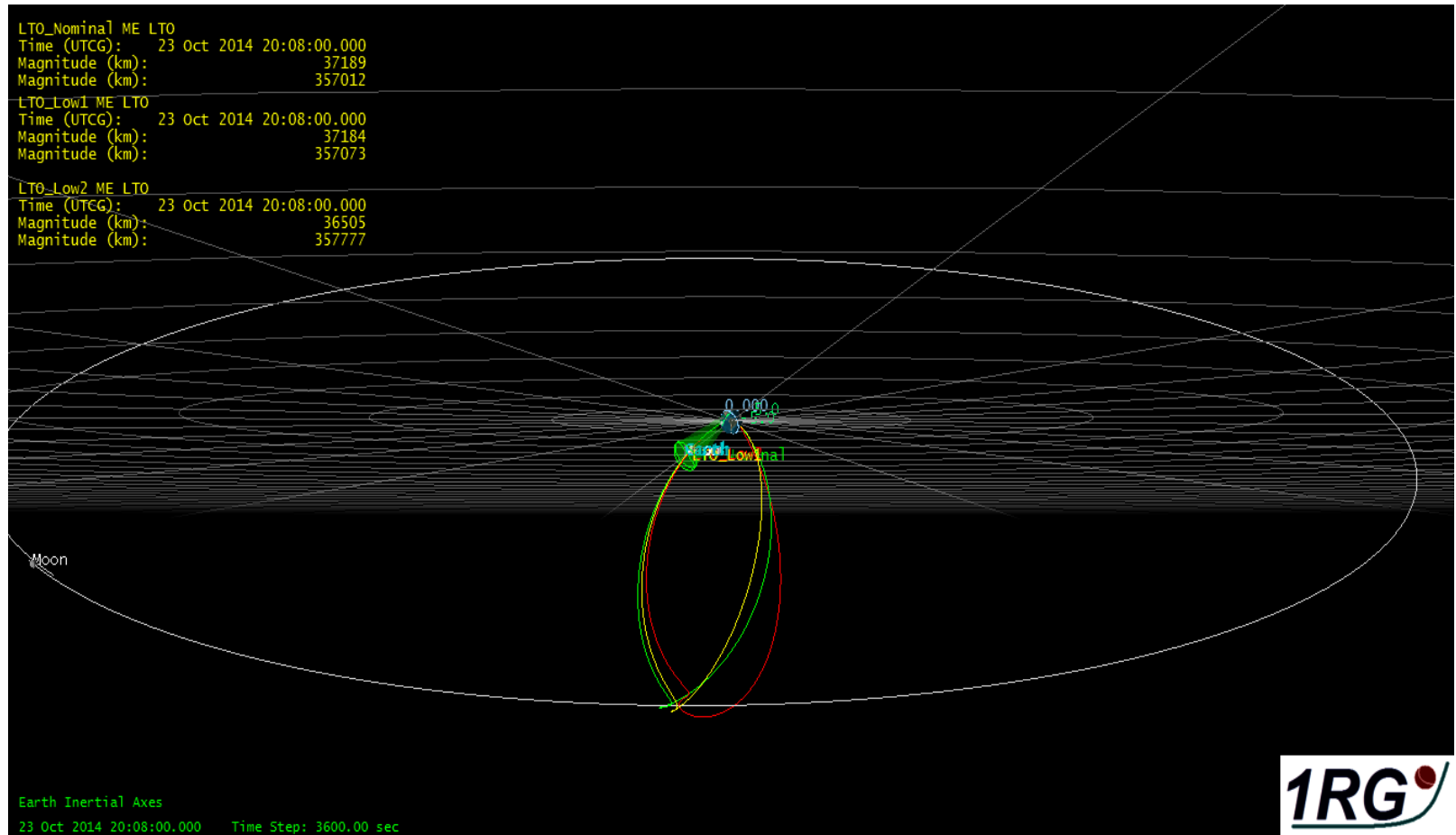


4M + Moon Elevation from 50°Lat North

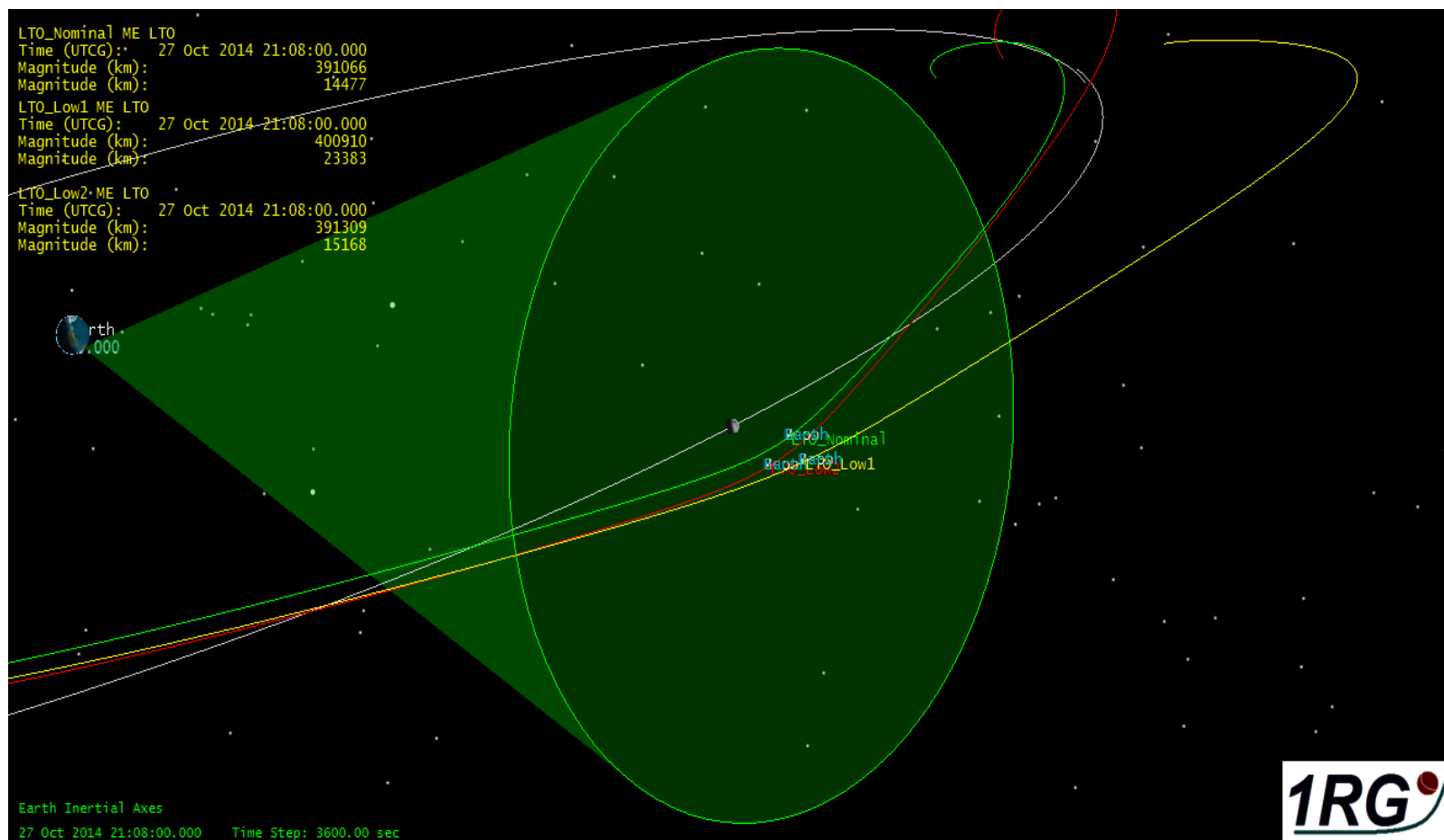
Facility-LXS-To-Planet-Moon, Satellite-LTO_Nominal: AER - 25 Aug 2014 10:18:44



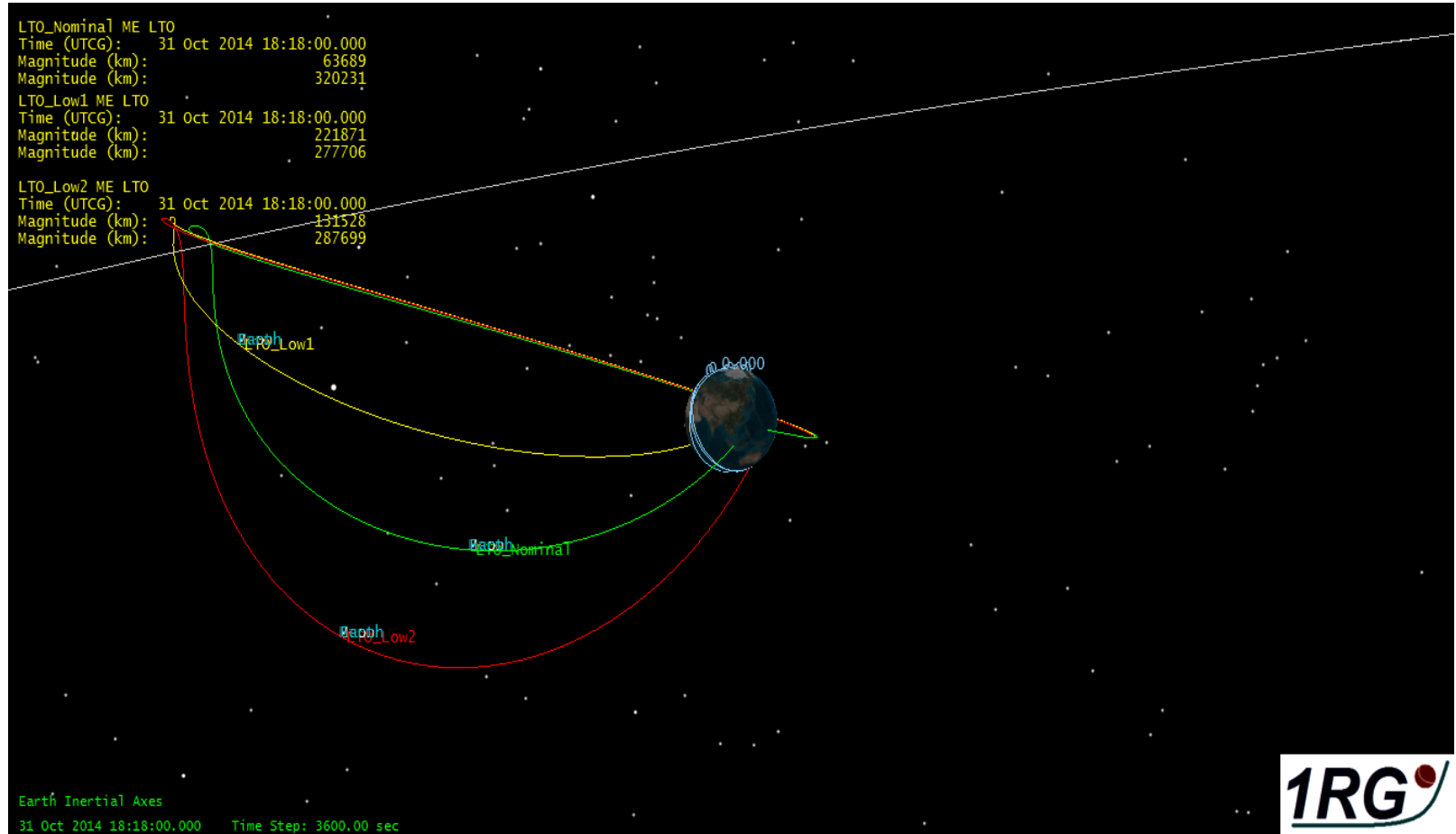
4M: trajectory



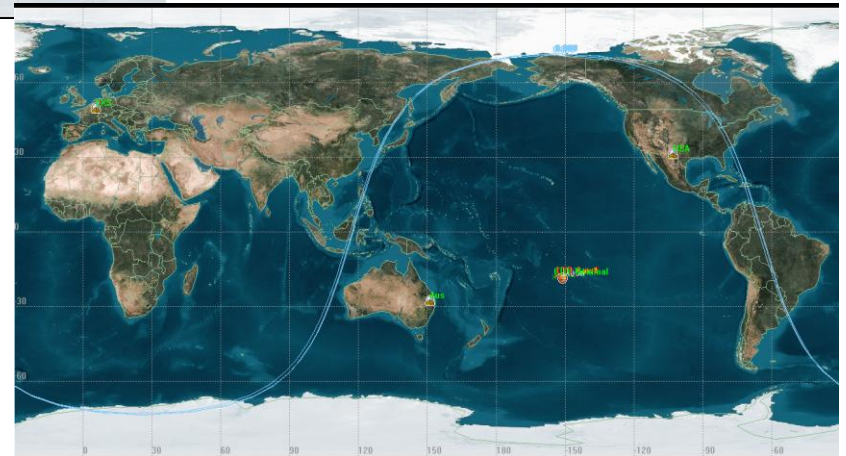
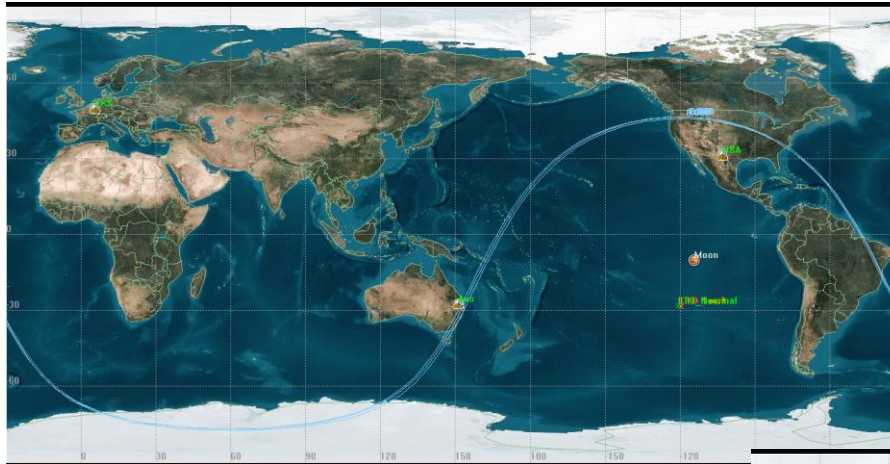
4M: trajectory during flyby



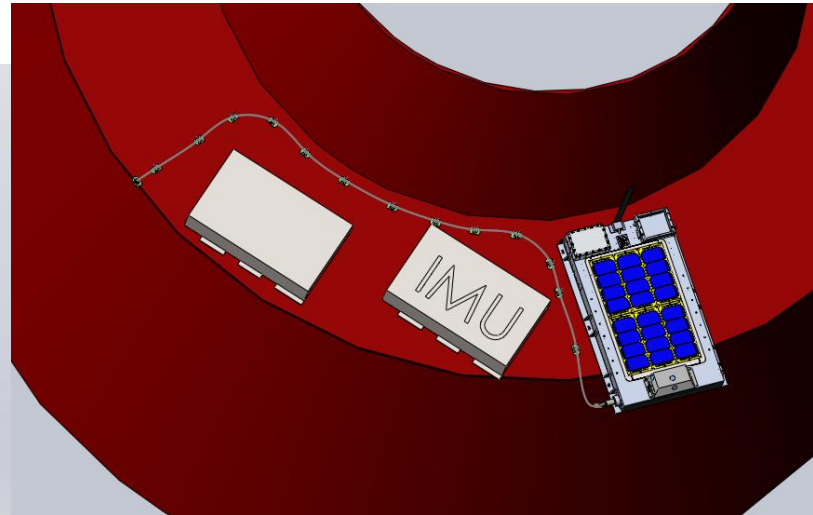
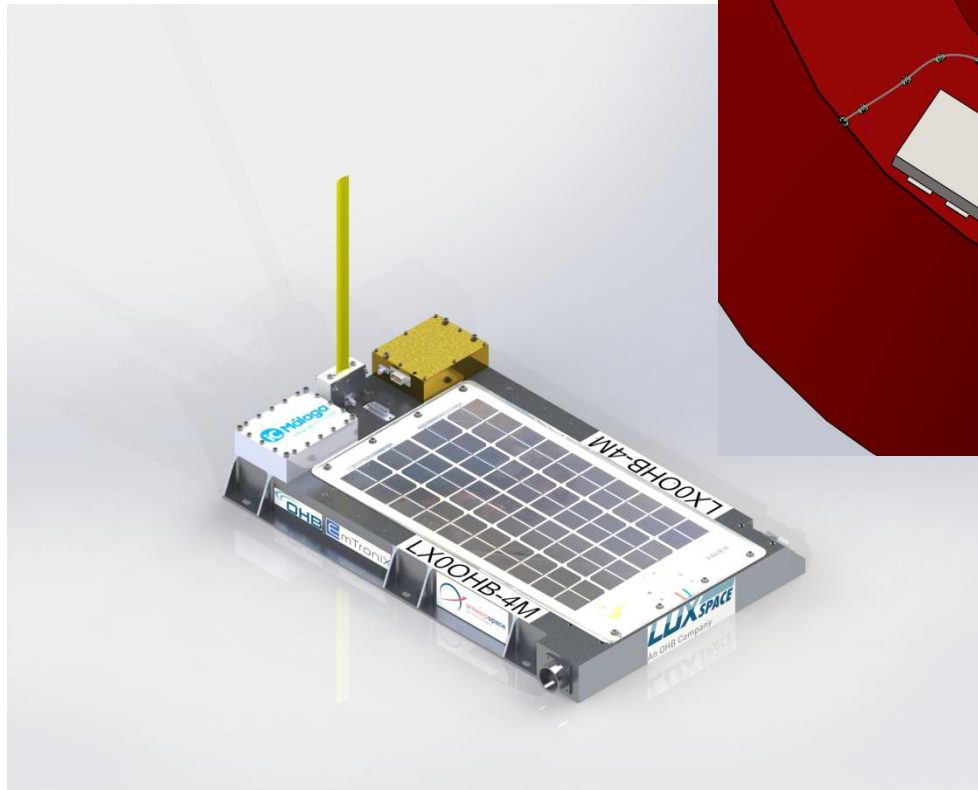
4M: trajectory after flyby



4M: Visibility at injection and during fly-by



4M: View of the spacecraft



4M Description summary



- Callsign: LX0OHB-4M
- Antenna: $\lambda/4$ monopole, as an exciter of the whole structure
- TX power: 1.0W
- Frequency: 145.980MHz +/- 2.9kHz (-40°C to +125°C), Doppler max: -2200Hz, +1000Hz
- JT65B modulation
 - Cycle of 5 minutes based on 1 minute sequence
 - JT65B sequence completed with analog telemetry to fill in a minute

4M under the hood



- Onboard computer:
 - FM430 based on MSP430 from TI
 - Controls all functions
 - Generates IQ signals, JT65b encoding
- Interface board
 - Interfaces with RAD experiment
 - Controls modules through HiRel MOS switches
 - Provides +5.5V regulated to point of load LDO's
- IQ modulator, -5dBm to +9dBm (based on diode ring and gain block with autocenter function)
- RFPA, 1.0W, two stages, nominal gain +30dB, stable and compensated from -40°C to +110°C continuous duty
- RAD experiment
- 28 x LSH20HTS as primary power source, 29 to 35W.h nominal each cell.
- 4 x MSP160165 and solar array as secondary power source
- Power coupling board: mainly diodes ! Overvoltage protection of batteries

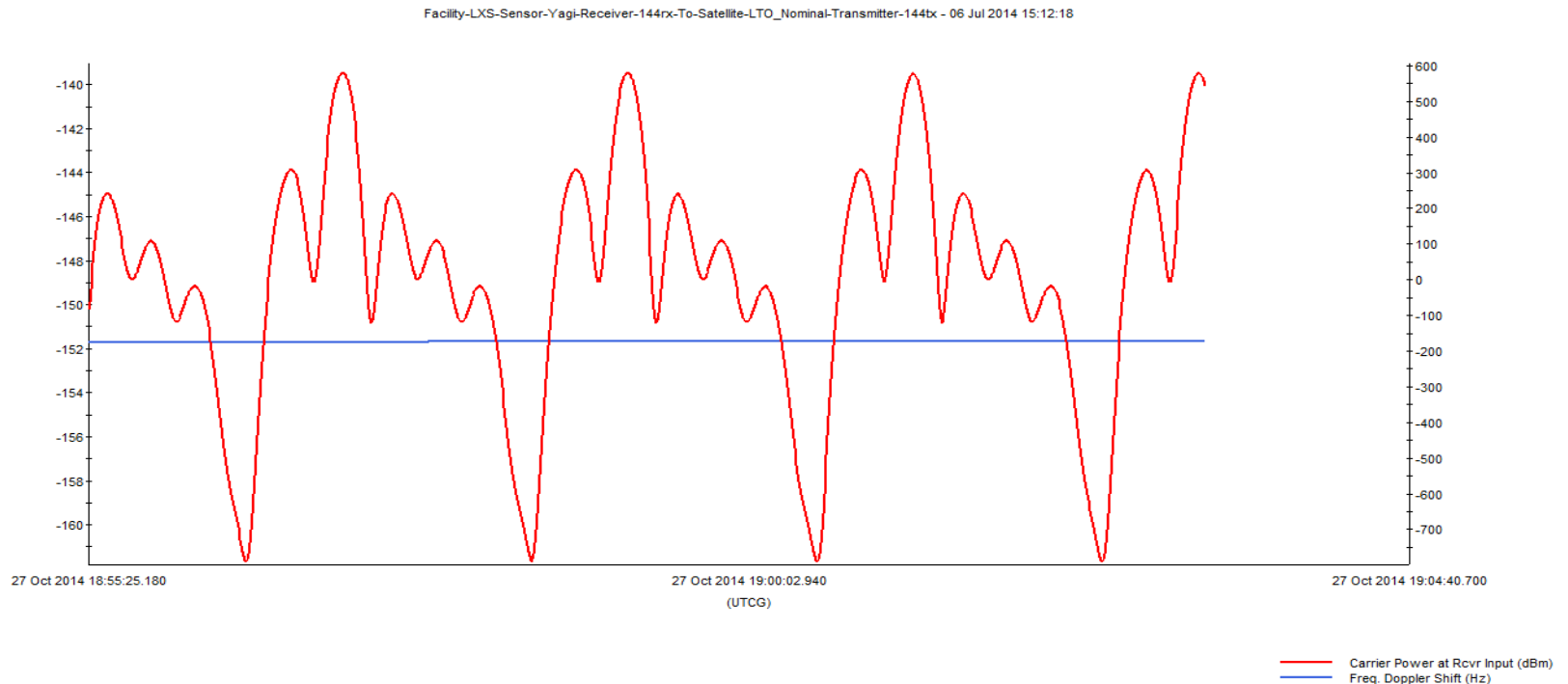
4M Received signals

- Based on minimal station:
 - 12dBic antenna gain (8 elts crossed Yagi RHCP)
 - 0.5dB coupler + cable losses
 - 1dB NF LNA
 - Integrated noise (sky+ground)
 - No man made noise accounted for
- We have signals in this range:

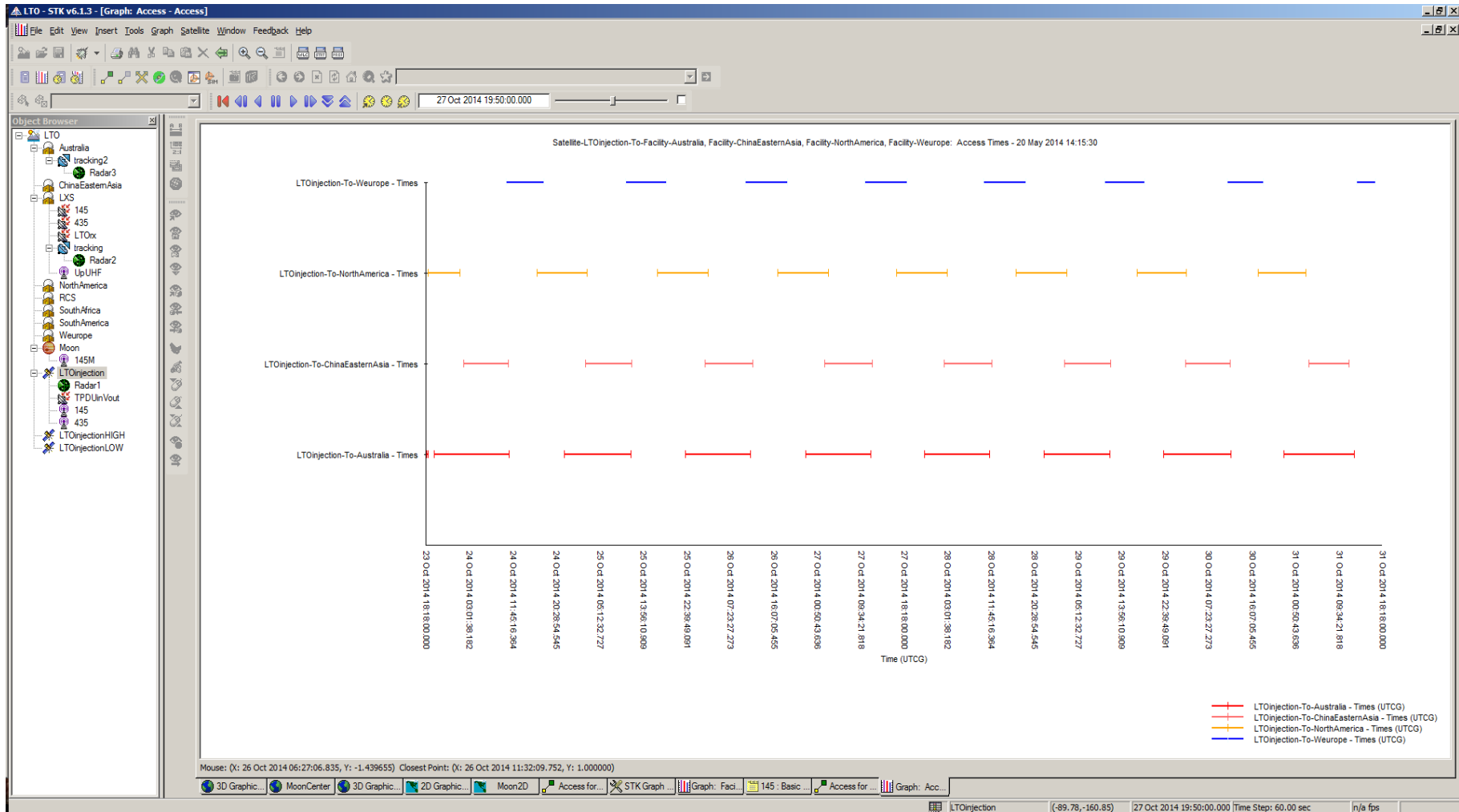
	Equivalent S/N in 2.4kHz bandwidth as displayed in WSJT assuming: 12dBic Antenna, 0.5dB cable loss, 1dB NF LNA, ground and sky noise integrated in the antenna pattern, man made noise not included	
Rec. Power (dBm)	SNR (eqv WSJT / 2400Hz)	
-135.00		1.70
-138.00		-1.30
-141.00		-4.30
-144.00		-7.30
-147.00		-10.30
-150.00		-13.30
-153.00		-16.30
-156.00		-19.30
-159.00		-22.30
-162.00		-25.30
-165.00		-28.30

4M signals

- During flyby, from Luxembourg (average case):



4M Visibility

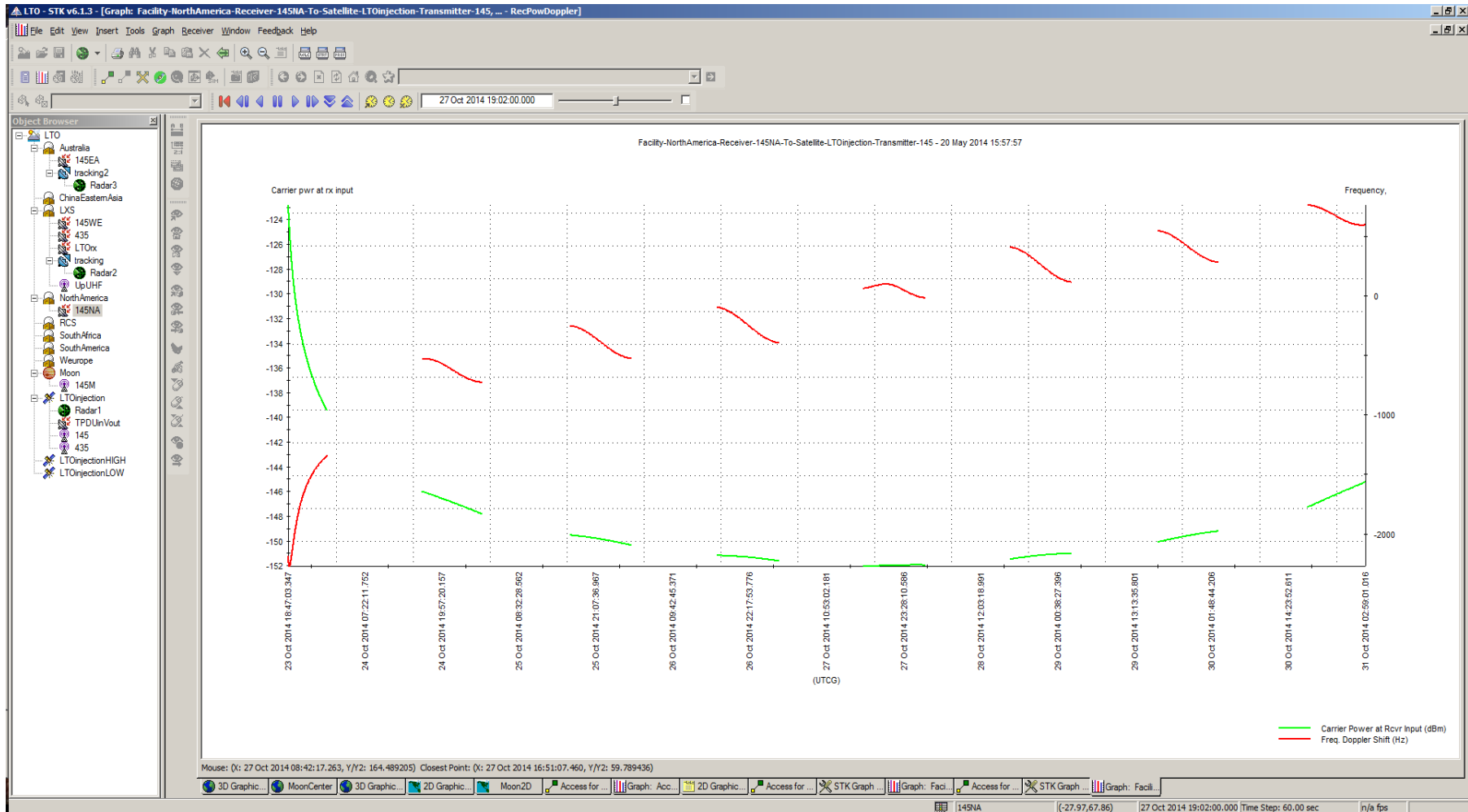


26/08/2014

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4M signals / Doppler



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4M Sequence description



Sequence number / start	Description	Experiment
1 / UTC + 0 m 00s	JT65B Callsign xxxx	RAD experiment is turned ON, xxxx Elapsed mission time, 4 Characters
1 / UTC + 0 m 02s	(at the latest)	RAD experiment sends Boot message (not transmitted)
2 / UTC + 1 m 00s	Telemetry of 4M: V, I, T, y	y mission parameter, 1 Character
3 / UTC + 2 m 00s	JT65B Global MSG transmission	13 Characters max.
3 / UTC + 2 m 58s	(at the latest)	RAD experiment sends its data and is turned OFF
4/ UTC + 3m 00s	JT65B RAD experiment data transmission	
5/ UTC + 4m 00s	JT65B Global MSG transmission	13 Characters

CAUTION: Onboard clock may drift by several seconds, UTC synchronisation is not guaranteed and manual sync' is likely to be required

4M Sequence description

Time	Sequence	Purpose
UTC minute 0s	Unique tone 4	Describes the JT65B data sequence that follows
+1.2s	Start of JT65B	Data sequence of 72 bits
+ 48s	End of JT65B/Start of analog sequence	Analog sequence is made of unique tones of frequency proportional to the measured value: Voltage, Current, OBC temperature
+ 58s	End of analog sequence	Transmitter OFF
+ 60s	End of OFF time	Transmitter ON, beginning of next sequence

CAUTION: Onboard clock may drift by several seconds, UTC synchronisation is not guaranteed and manual sync' is likely to be required

4M sequence description (ALL.txt and decoded.txt)



UTC Date: 2014 Aug 14										UTC Date: 2014 Aug 14									
-----										-----									
210100	3	-16	-0.297	0	3*	LX00HB-4M0001	1	0		210100	3	-16	-0.297	0	3*	LX00HB-4M0001			
210100	2	1/1				LX00HB-4M0001	1	0		210200	12	-16	-0.282	0	3*	164V380A020C0			
210200	12	-16	-0.282	0	3*	164V380A020C0	1	0		210300	13	-16	-0.274	0	3*	HELLO WORLD 1			
210200	1	1/1				164V380A020C0	1	0		210400	14	-16	-0.283	0	3*	R4OK?4.MUH			
210200	2	1/1				LX00HB-4M0001	1	0		210500	17	-16	-0.282	0	3*	NI HAO XINHUA			
210300	13	-16	-0.274	0	3*	HELLO WORLD 1	1	0											
210300	1	1/1				164V380A020C0	1	0		210600	14	-16	-0.291	0	3*	LX00HB-4M0002			
210300	2	2/2				HELLO WORLD 1	1	0		210700	11	-18	1.710	51	3*	163V380A021C1			
210400	14	-16	-0.283	0	3*	R4OK?4.MUH	1	0		210800	10	-18	1.701	51	3*	HELLO WORLD2			
210400	1	2/2				164V380A020C0	1	0		210900	12	-18	1.695	51	3*	R4OK?4.MUI			
210400	2	2/2				HELLO WORLD 1	1	0		211000	20	-13	1.688	51	4*	TIP PE ARMEL			
210500	17	-16	-0.282	0	3*	NI HAO XINHUA	1	0											
210500	1	2/2				164V380A020C0	1	0		211100	18	-14	1.712	51	3*	LX00HB-4M0003			
210500	2	3/3				NI HAO XINHUA	1	0		211200	17	-13	1.701	51	3*	162V379A022CD			
210600	14	-16	-0.291	0	3*	LX00HB-4M0002	1	0		211300	13	-13	1.697	51	3*	LX2RG ON1RG			
210600	2	3/3				NI HAO XINHUA	1	0		211400	17	-13	1.700	51	3*	R4OK?4.MUJ			
210700	11	-18	1.710	51	3*	163V380A021C1	1	0		211500	19	-12	1.705	51	3*	GOOD WE AMDG			
210800	10	-18	1.701	51	3*	HELLO WORLD2	1	0											
210900	12	-18	1.695	51	3*	R4OK?4.MUI	1	0											
211000	20	-13	1.688	51	4*	TIP PE ARMEL	1	0											
211000	1	5/5				TIP PE ARMEL	1	0											
211100	18	-14	1.712	51	3*	LX00HB-4M0003	1	0											
211100	1	5/5				TIP PE ARMEL	1	0											
211100	2	6/6				LX00HB-4M0003	1	0											
211200	17	-13	1.701	51	3*	162V379A022CD	1	0											
211200	1	6/6				162V379A022CD	1	0											
211200	2	6/6				LX00HB-4M0003	1	0											
211300	13	-13	1.697	51	3*	LX2RG ON1RG	1	0											
211300	1	6/6				162V379A022CD	1	0											
211300	2	7/7				LX00HB-4M0003	1	0											
211400	17	-13	1.700	51	3*	R4OK?4.MUJ	1	0											
211400	1	7/7				R4OK?4.MUJ	1	0											
211400	2	7/7				LX00HB-4M0003	1	0											
211500	19	-12	1.705	51	3*	GOOD WE AMDG	1	0											
211500	1	7/7				R4OK?4.MUJ	1	0											
211600	20	-13	1.694	51	3*	LX00HB-4M0003	1	0											
211600	1	8/8				LX00HB-4M0003	1	0											

4M Sequence description



- Decoding the RAD experiment:

- A sample message would be "R4OK?4.MUH"
- The first 4 chars ("4OK?"), contain the reference frequency (17 bits) the number of recharges (2 bits) and the number of the active sensor during this measurement (0 or 1)
- Preference<<Recharges<<ActiveSensor
- The following 5 chars ("4.MUH"), contain the temperature value (8 bits) and the sensor frequency (17 bits)
- Temp<<Fsensor
- **Data decoding example:**
- From the example message "R4OK?4.MUH"
- Preference, Recharges and ActiveSensor decoding:
- "4OK?" ASCII coded 4 24 → 20 41 base42 Coded
- 4 24 20 41 base42 Coded → 0x52E71 Hex Coded
- LSB = **ActiveSensor = 1d**
- next 2 bits = **Recharges = 0d**
- Next 17 bits = **Preference = 42446d**
- Temperature, Fsensor decoding:
- "4.MUH" ASCII coded → 4 39 22 30 17 base42 Coded
- 4 39 22 30 17 base42 Coded → 0xEA9FAD Hex Coded
- 17 LSBs = **Fsensor = 40877d**
- 7 MSBs = **Temperature = 117d**

4M: why do we need you ?



- Collect continuous data during all the mission
 - Radiation experiment
 - Comm availability
 - Multilateration
 - Network trial test
 - LSH20HTS: will be used on EXOMARS, ESA mission
- Have reference stations, preferably with a very good time synchronisation to have accurately timestamped .wav files

4M: what can you expect ?



- Ultimate DX on first amateur S/C around the Moon
- An exciting team contest all around the world: team obviously comprised of OM's on all continent to ensure continuity
- Real time display of incoming data on our webserver.

4M Web Client



4M Warehouse - Mozilla Firefox

4M Warehouse

127.0.0.1:5555/warehouse/home

SSC LSE SPACE

Home Login Register

Register a new user

Callsign/Username:

Email:

Password:

Confirm Password:

First Name:

Last Name:

QTH Locator:

Country:

Register

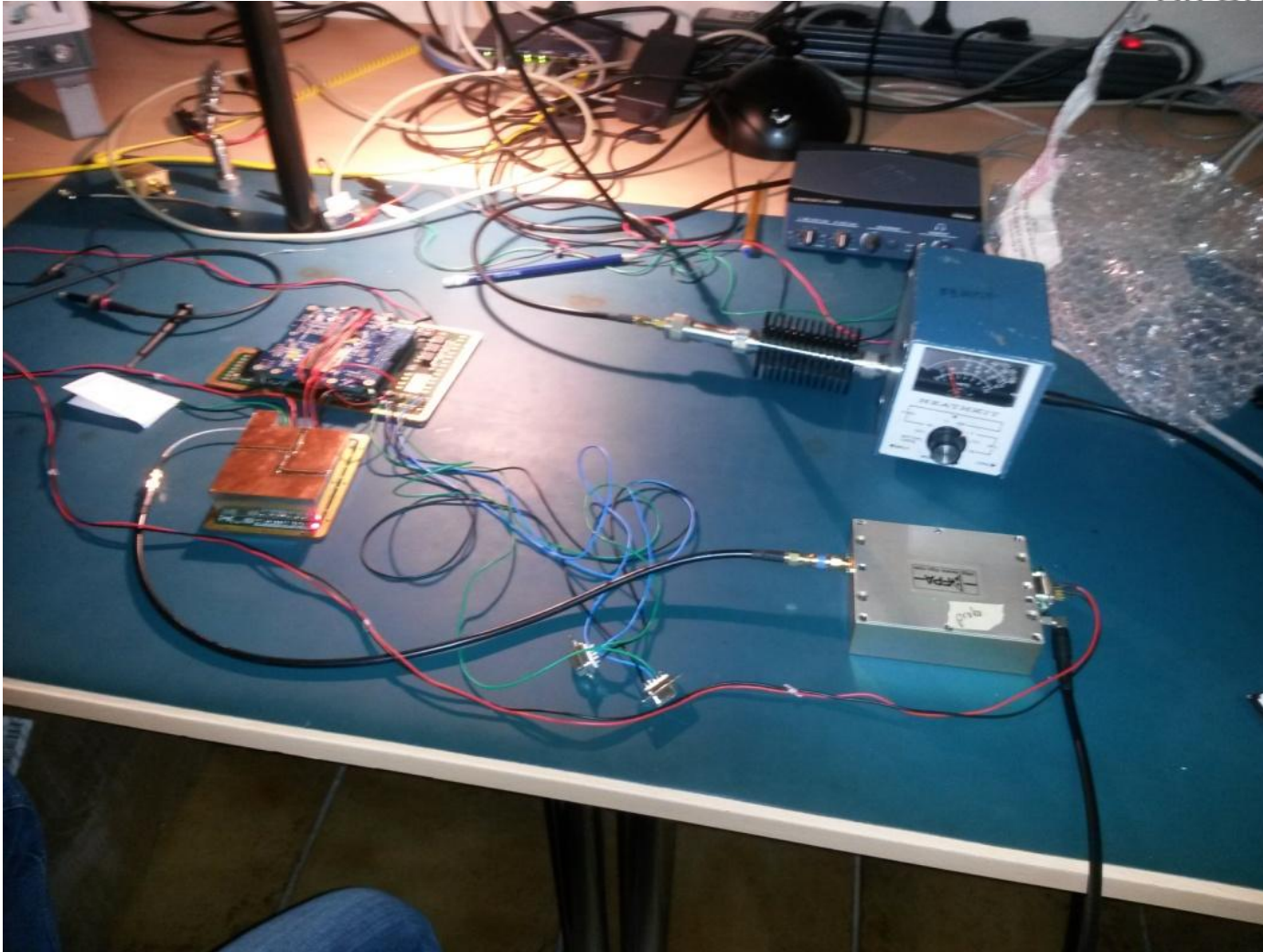
4M Data Warehouse v0.9. Copyright ©2014 LSE Space GmbH. All rights reserved.

4M Web Client

The screenshot displays the '4M Data Delivery Client' application running on a Windows desktop. The interface includes several key components:

- UTC/Offset/Local Time:** UTC is 2014-08-22 14:03:19, Offset is 105 ms, and Local is 2014-08-22 16:03:19.
- Configuration/Communication Tab:** Shows server connection status (Thread ready), audio delivery status (Thread not running), and JT65B delivery status (Waiting for new packet).
- JT65B packet details:** WSJT string: 140200 6 -11 -0.5 -237 1 * RX4CD IK1NPP R-11 1 0. Packet is valid. Timestamp: 2014-08-22 14:02:00. Accuracy: DEGRADED. Message: RX4CD IK1NPP R-11.
- Log Window:** A table of messages showing the sequence of events, including waiting for packets, timestamp matches, and decoding attempts.
- Spectrum Plot (K1JT):** A waterfall plot showing frequency (657 to 2500 Hz) and signal strength. A prominent signal is visible around 1400 Hz.
- Log QSO Table:** A table listing received QSOs with columns for frequency, mode, signal, and call sign.
- Controls:** Includes buttons for 'Connect', 'Disconnect', 'Select File', 'Send', 'Monitor', 'Decode', 'Erase', 'Clear Avg', 'Include', 'Exclude', 'Tx Stop', 'To radio', 'Grid', 'Lookup', 'Add', 'Sync', 'Zap', 'Tol', 'AFC', 'Freeze', 'Tx First', 'TxDF = 0', 'Gen Msgs', and 'Auto is Off'.

4M Some HW pictures



4M Some HW pictures

