OPPORTUNITY CONCEPTS OF AEROSPACE TESTING AT ESRANGE SPACE CENTER

GUNNAR FLORIN, SSC

Aerospace Technology 2016

2016

MISSION

We help Earth benefit from space

SCIENCE SERVICES

Experiment Payloads
Sounding Rockets
Parabolic Flights
Balloons

Sounding Rockets
Programs and Systems

Balloons
Programs and Systems

Launch Services
Rockets and balloons
Flight tests

55 YEARS IN SPACE

1961	The first sounding rocket launch from Sweden
1966	First sounding rocket from Esrange
1974	First balloon from Esrange to the Ural mountains
1978	Satellite data reception at Esrange Landsat Station
1990	First sounding rocket over 700 km apogee

ESRANGE SPACE CENTER

AFTER 50 YEARS AT ESRANGE:

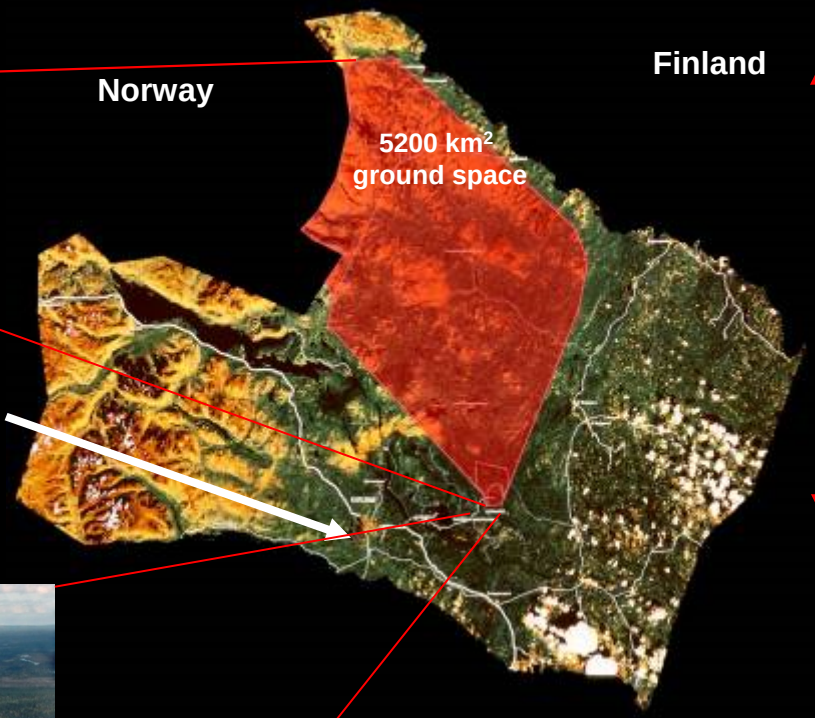
- 524 balloon missions
- 553 rocket launches

and still counting…

Why Esrange?

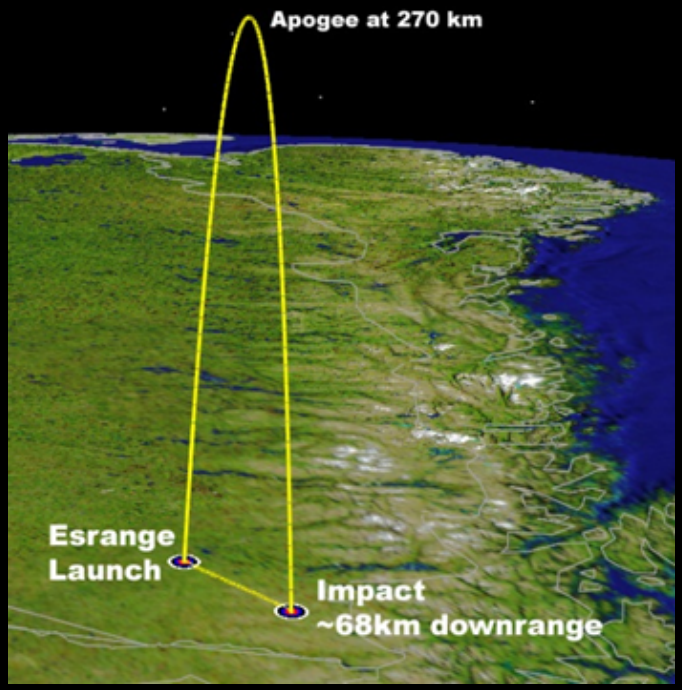
ESRANGE SPACE CENTER 67.9 N 21.1 E

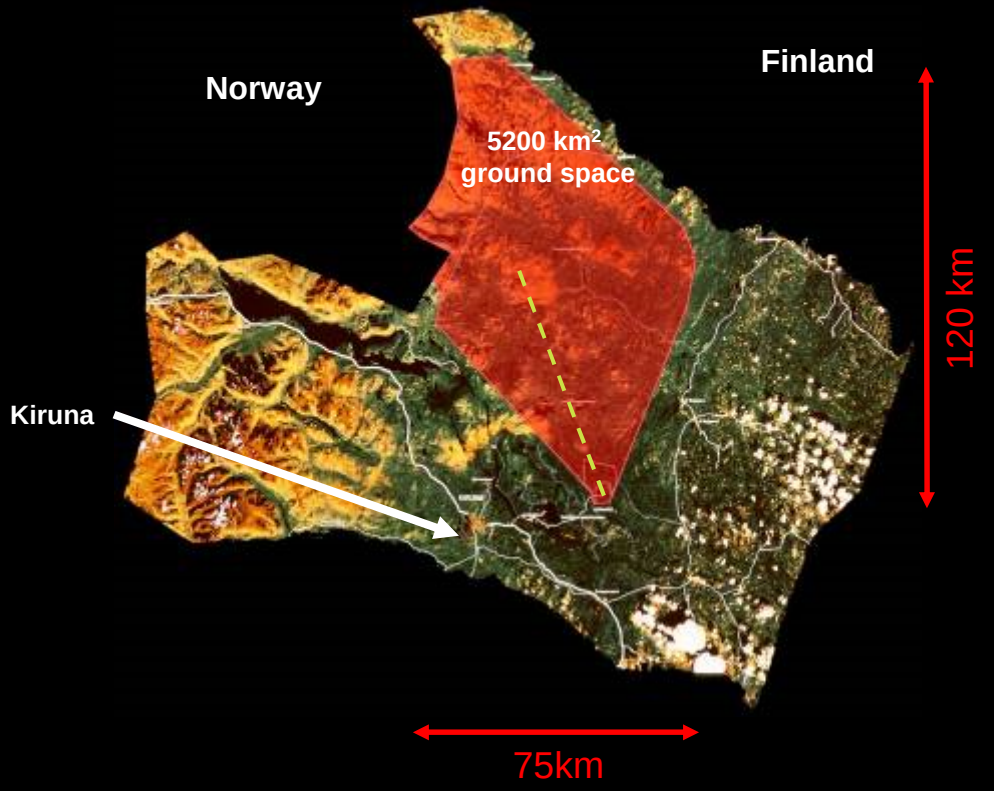
Esrange



Aerospace Technology, 2016
Space, 11-12 Oct 2016

ESRANGE SPACE CENTER 67.9 N 21.1 E






SSC
Aerospace Technology 2016
Solna 11-13 Oct 2016

ONE DAY OF AIRTRAFFIC


SSC
SOUNDING ROCKETS
553 ROCKETS LAUNCHED TO DATE

SOUNDING ROCKETS

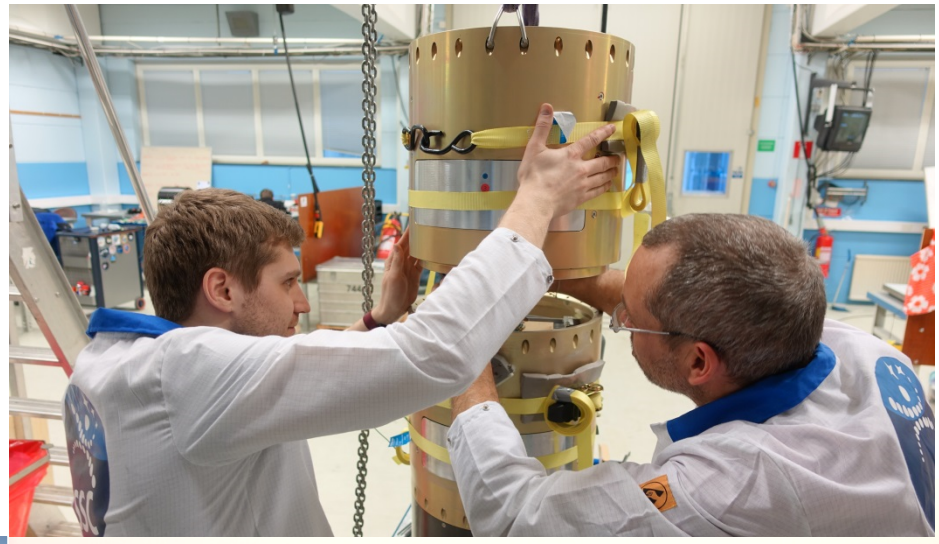
SOUNDING ROCKETS

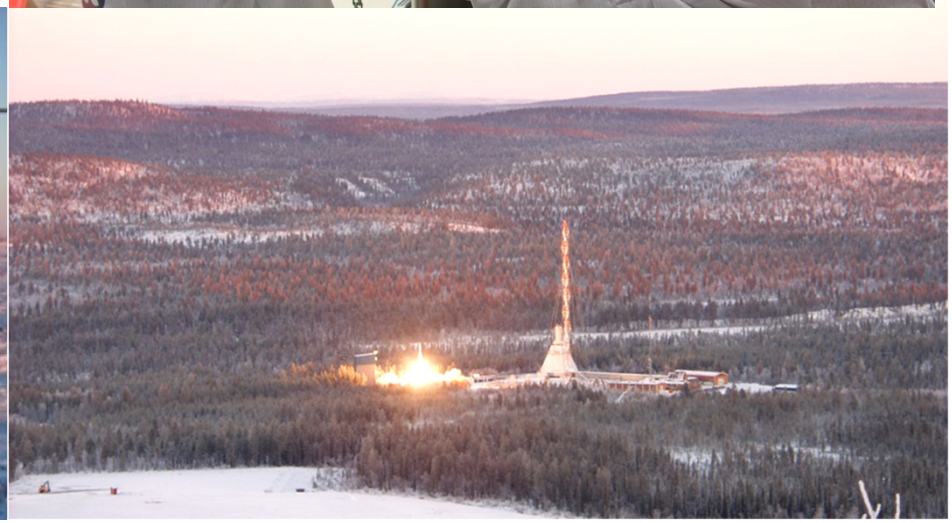
ROCKET LAUNCH AREA

SOUNDING ROCKETS

TYPE OF SCIENTIFIC MISSIONS

- Ionospheric physics
- Astronomy
- Aeronomy
- Meteorology
- Atmospheric physics
- Research in microgravity





MICROGRAVITY EXPERIMENT PAYLOADS

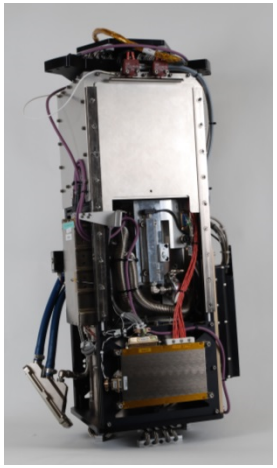
SSC has…

… developed 48 experiment modules flown on microgravity rockets since 1977

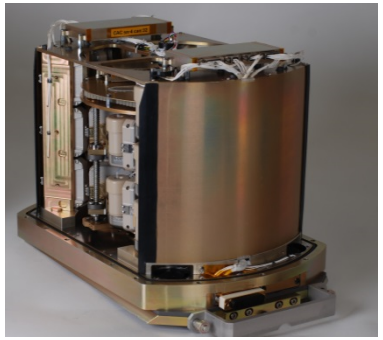
… participated with payloads on 21 parabolic flights

…flown 4 Get Away Special payloads on the Space Shuttle

BIOMICS blood cell experiment

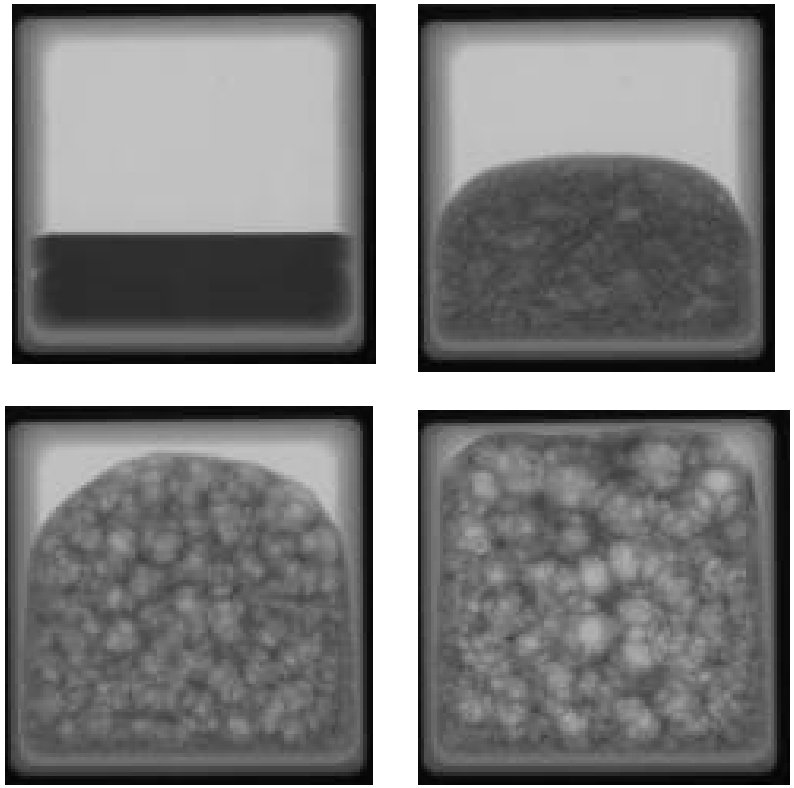


isothermal solidification exp. with furnace using X-ray as diagnostic tool



BIM-3 Cell biology experiment on MASER 13

EXAMPLE OF MATERIAL SCIENCE EXPERIMENT



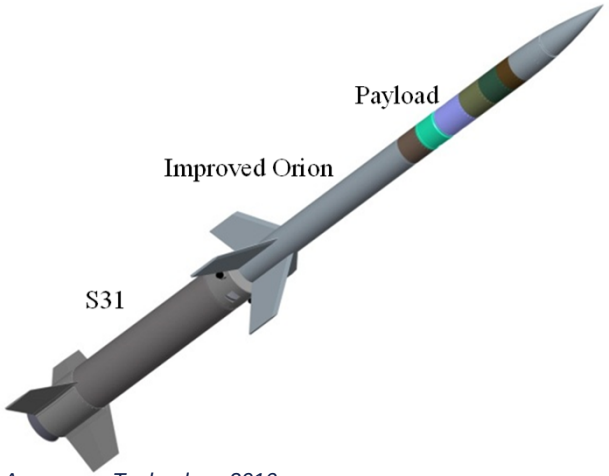
Metallic foam generation during 6 minutes of microgravity, MASER 11 flight

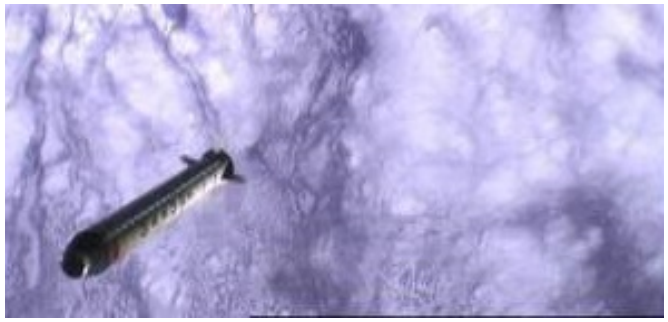
- "Growth kinetics and stability of Al-based metallic foams under microgravity, using X-ray radioscopy as diagnostic tool"
- Part of the Microgravity Application Promotion (MAP) program of the European Space Agency
- Output already applied in aerospace industry technology

ROCKET SYSTEMS

- Development of systems for sounding rocket programs

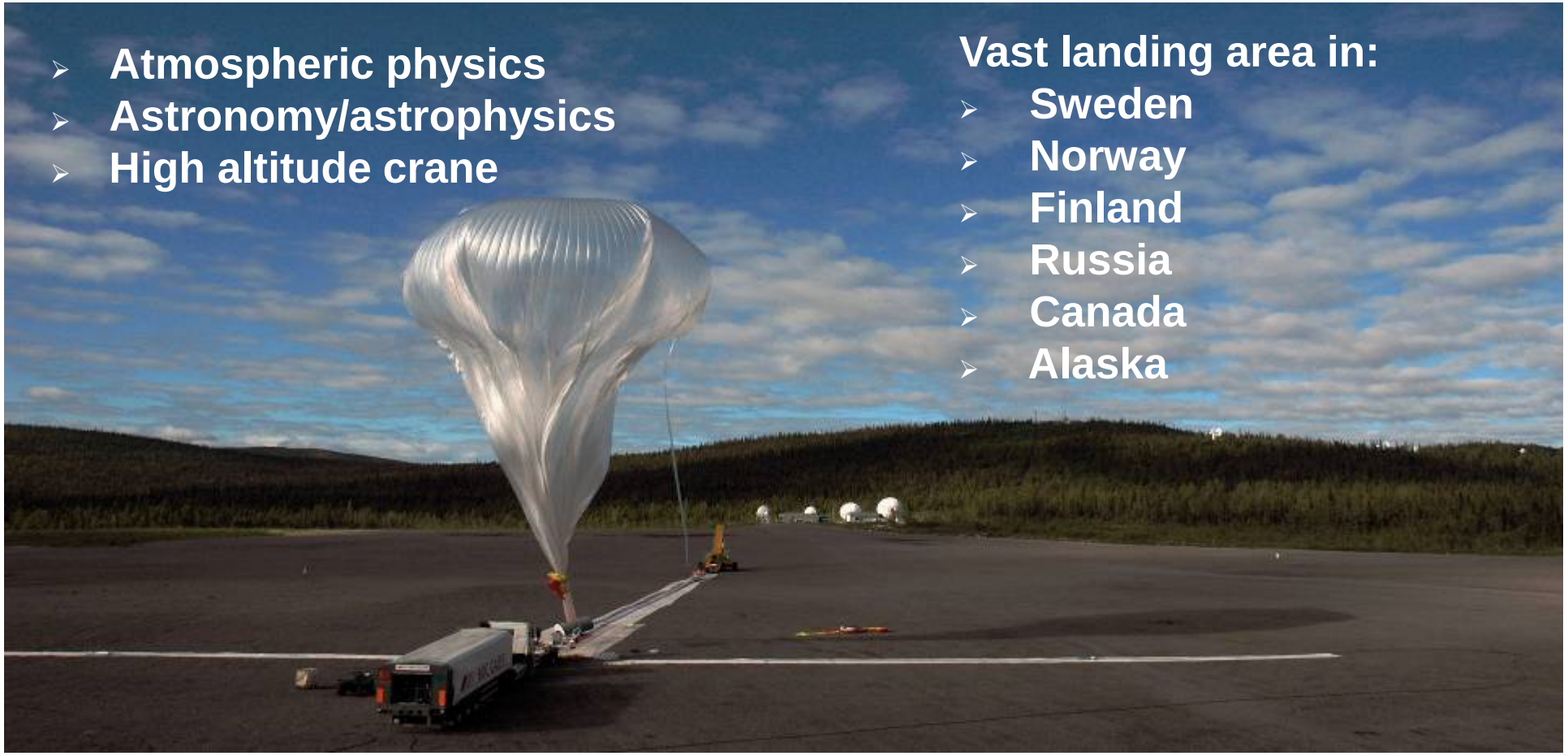
- Over 60 flights delivered
- MASER, MAXUS
- National rockets for SNSB






STRATOSPHERIC BALLOONS
524 BALLOONS LAUNCHED TO DATE

STRATOSPHERIC BALLOONS

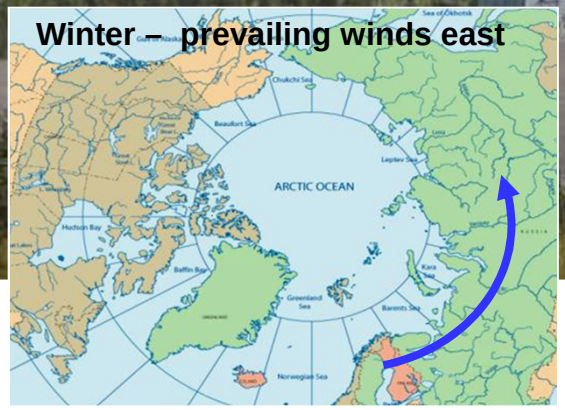


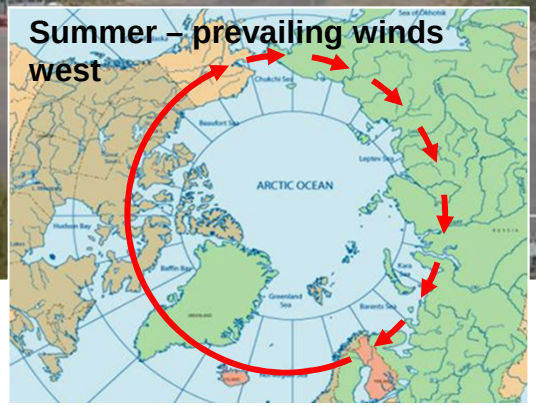
STRATOSPHERIC BALLOONS

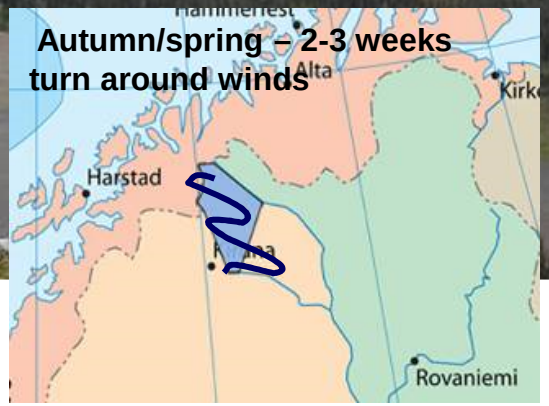
Balloons are essential for research within meteorology, environmental monitoring and climate change, as well as an excellent tool for technical tests of instruments, space vehicles and return systems for interplanetary missions – using the balloon as a very high crane.

Vast landing area in:

- **Sweden, Norway, Finland, Russia, Canada, Alaska**







DROP TESTS

LEGACY SINCE 1986

DROP TESTS

- **Stratospheric balloons** are used for drop tests of aerospace vehicles, re-entry bodies and parachute systems.
- Free falling objects up to 2 tonnes
- Drop altitude up to 42 km (3 mbar)
- Telemetry and tele-command during ascent and drop phase
- Recovery of object with helicopter

- **Sounding rockets** are used for drop tests of re-entry bodies and parachute systems.
- Free falling objects up to 50 kg on dedicated flights
- Release altitude up to 700 km
- Recovery of object with helicopter

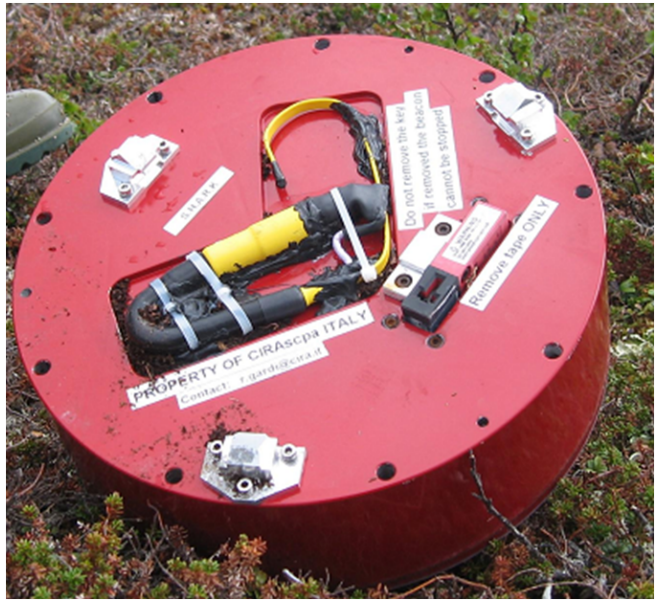
DROP TESTS MISSIONS FROM ESRANGE

Using balloons up to 42 km:		
Mikroba - micro gravity experiment in free flight	1986-92	DLR
Hugyens – drop test of moon probe	1995	CNES
HSFD - high speed flight demonstrator (HOPE-X Reusable Launch Vehicle)	2003	JAXA /CNES
D-SEND – Drop tests for non-symm. sonic boom	2011-15	JAXA
SHADT - Sub-scale high altitude parachute	2014	ESA
ERC – Earth re-entry capsule aerodynamic characterisation	2015	ESA
HADT – ExoMars parachute performance verification	2017	ESA
RLV landing	2018/19	
Using sounding rockets up to 720 km:		
SHARK - re-entering capsule UHT Ceramic 720 km	2010	ESA/CIRA
Super-MAX – super sonic parachute test 720 km	2017	ESA
Mini-Irene – Hypersonic Deployable Re-entry Demonstrator 260 km	2018	CIRA/ESA

EXAMPLE OF DROP TEST CAPSULKE: SHARK

Sounding Hypersonic
Atmospheric
Re-entry Kapsule

SHARK mounted to payload aft end



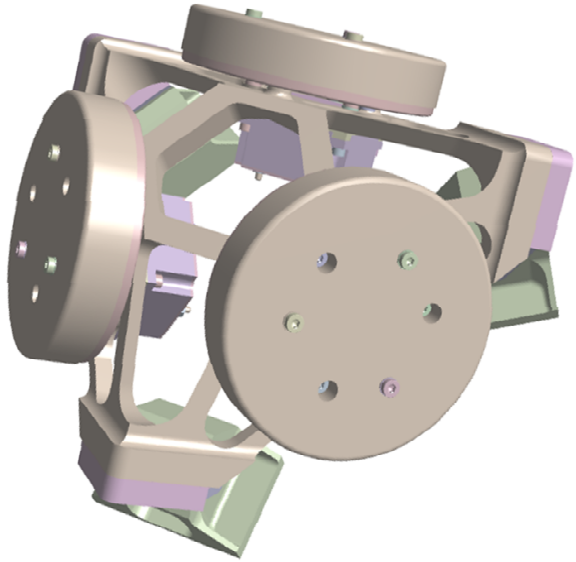
SHARK on ground after 720 km free fall

OTHER USED IN-FLIGHT OPPORTUNITIES

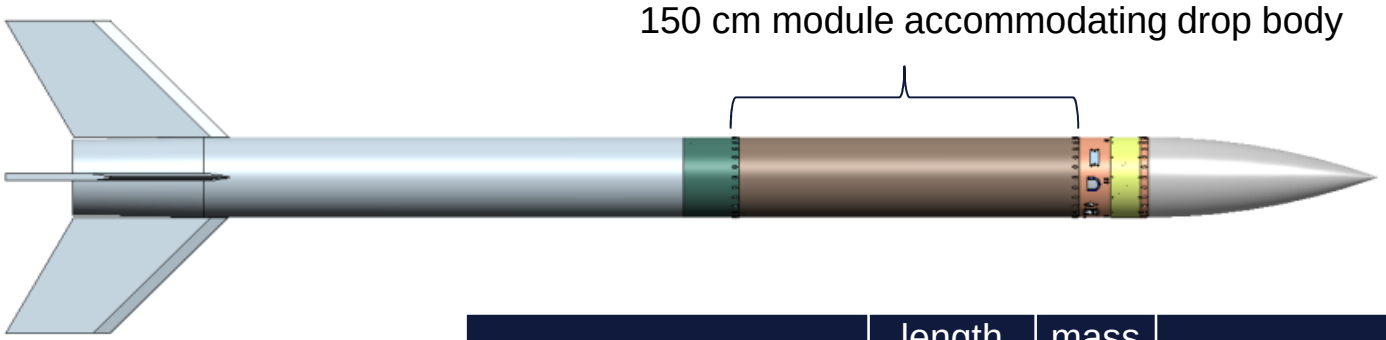
Examples of technology demonstrators flown on Sounding Rockets:

- **Payload data transmitter**
  demonstrating ability of enhanced data down-link bandwidth by SOQPSK modulation. 3 kg equipment with antenna system.

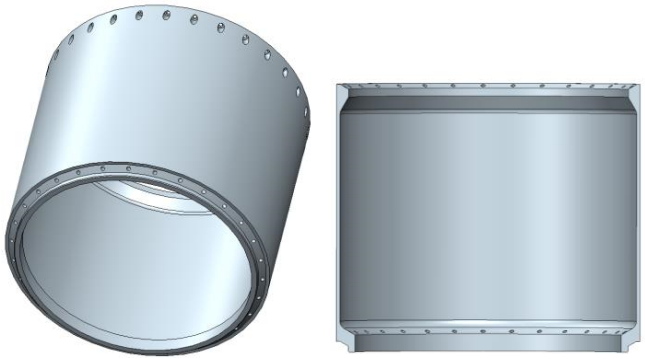
- **Inertial Measurement Unit Breadboard**, testing performance in representative launch, ascent and planetary descent/re-entry environment



SOUNDING ROCKET PLATFORM FOR DROP TESTS



	length (mm)	mass (kg)	diameter
Experiment payload:	1500	50	14 inch (356 mm)



Dedicated launches for releasing re-entry bodies from high altitudes, launched and recovered at Esrange Space Center.

Example of 14 inch diameter structures with radax joints,

OTHER FLIGHT TESTS

LEGACY SINCE 2001

OTHER FLIGHT TESTS

CHRONOLOGY

DATE	NAME	USER	VEHICLE	TYPE OF TEST
2001-08-14	HSFD test 1	CNES, NAL	Balloon	Parachute / Ops.
2001-08-16	HSFD test 2	CNES, NAL	Balloon	Parachute / Ops.
2003-06-05	HSFD	CNES, NAL	Balloon	RLV Aerodynamics
2004-05-08	*PHOENIX*	*EADS ST*	*Helicopter*	*Landing (Vidsel)*
2006-05-15	USV test 1	Carlo Gavazzi	Helicopter	Parachute
2006-05-18	USV test 2	Carlo Gavazzi	Helicopter	Parachute
2011-05-06	D-SEND #1	JAXA	Balloon	Aerodynamics
2012-09-26	VEXREDUS	DLR	Balloon	UAV Aerodynamics
2013-08-16	D-SEND #2	JAXA	Balloon	UAV Aerodynamics
2015-02-22	CRYOFENIX	ALAT, CNES	Rocket	LH2 fuel tank tech
2015-05-08	HABLEG	DLR	Balloon	UAV Aerodynamics
2015-07-24	D-SEND #2C	JAXA	Balloon	UAV Aerodynamics

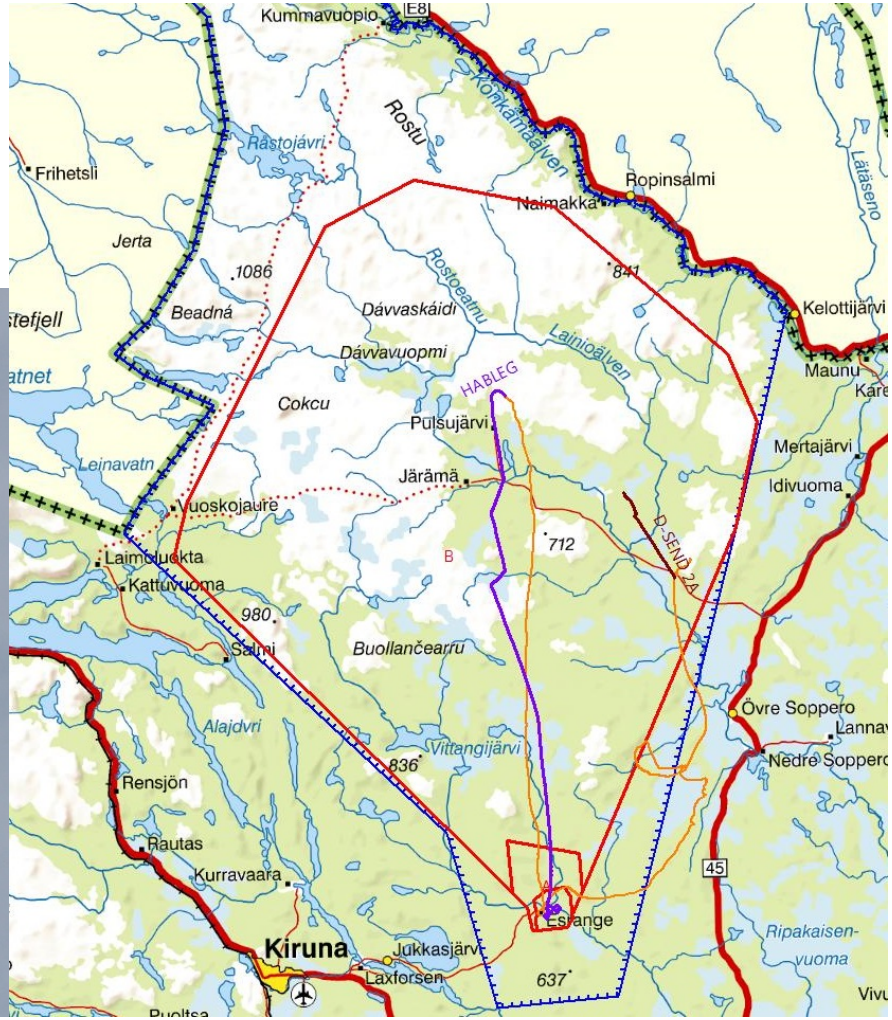
UAS TESTS, SMALL AND LARGE

- 6600 km^2 restricted airspace, ground→ unlimited
- Autonomous gliders:

➢ JAXA D-SEND #2
tracking by Giraffe, PS-90 surveillance radar

➢ DLR HABLEG
(aerodynamic tests, 75 km glide 20 → 0 km altitude)

➢ Rotorcraft – Univ. of Chalmers
(performance test, volcanic plume)



D-SEND #1, HERKULES

SUPERSONIC BOOM TEST – FALLING BODIES

D-SEND #2

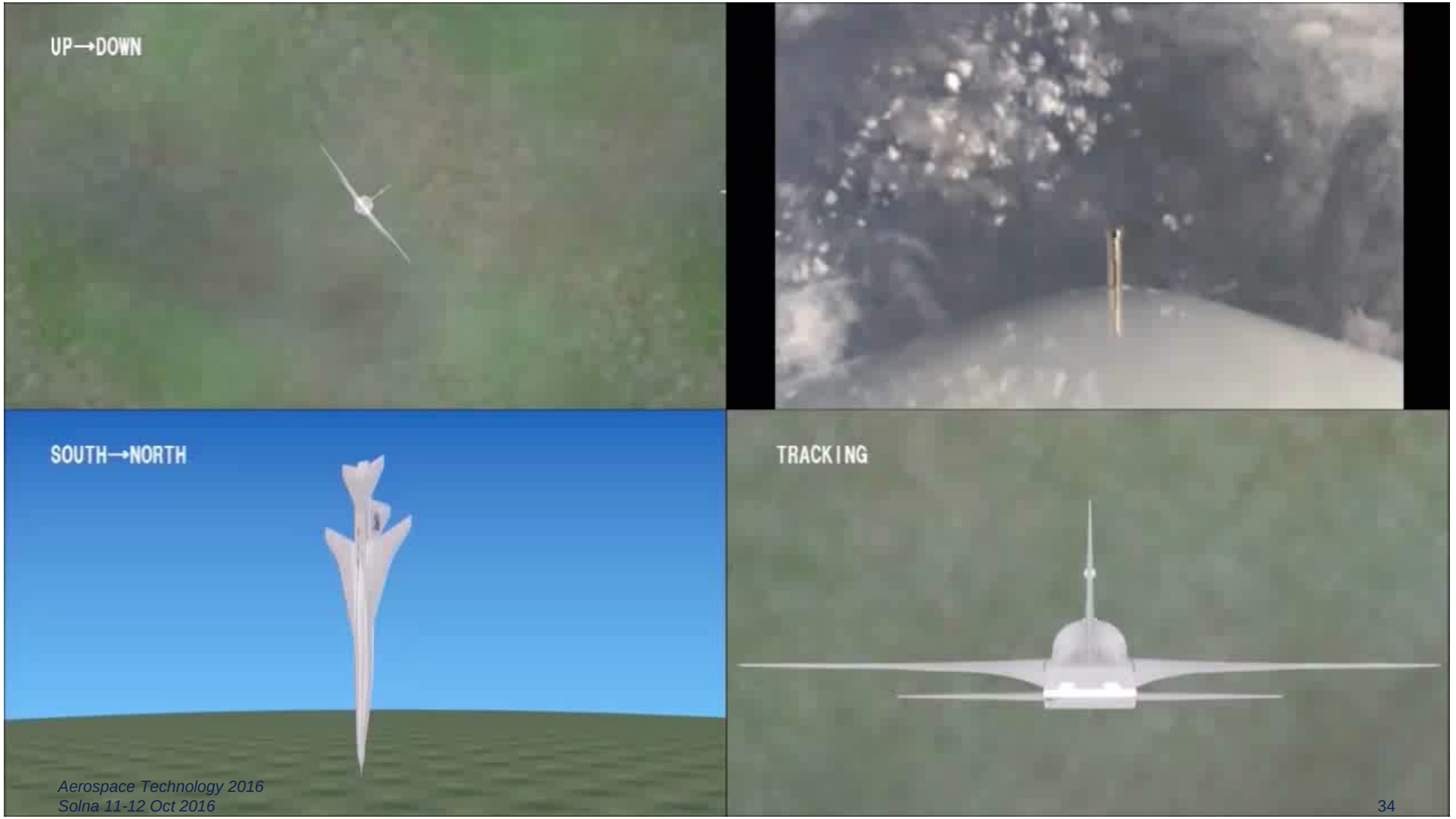
SUPERSONIC BOOM TEST - AIRCRAFT

D-SEND #2

VEHICLE RELEASE AT 30 KM

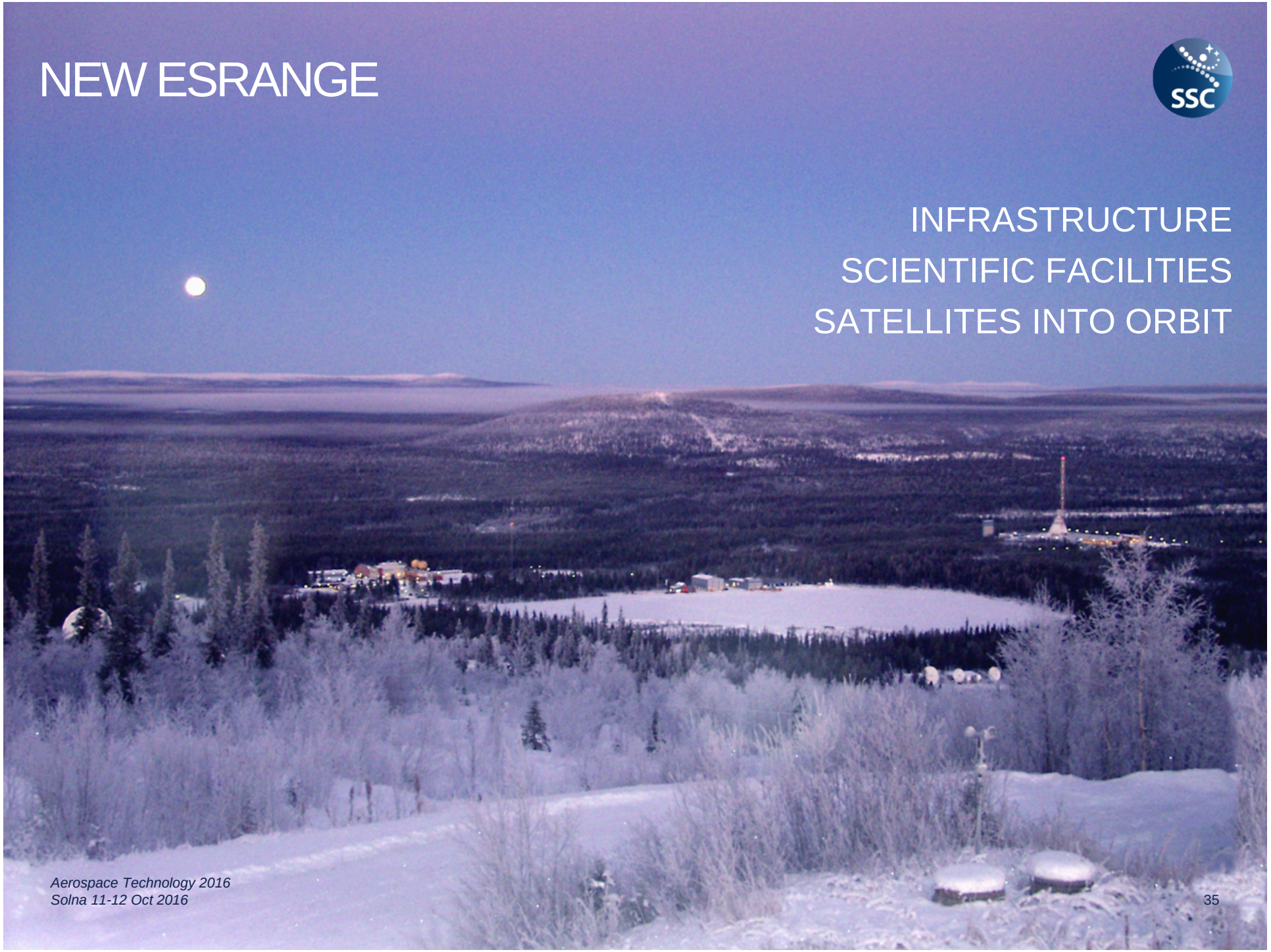
D-SEND #2

ON-BOARD CAMERA AND CORRESPONDING ANIMATION



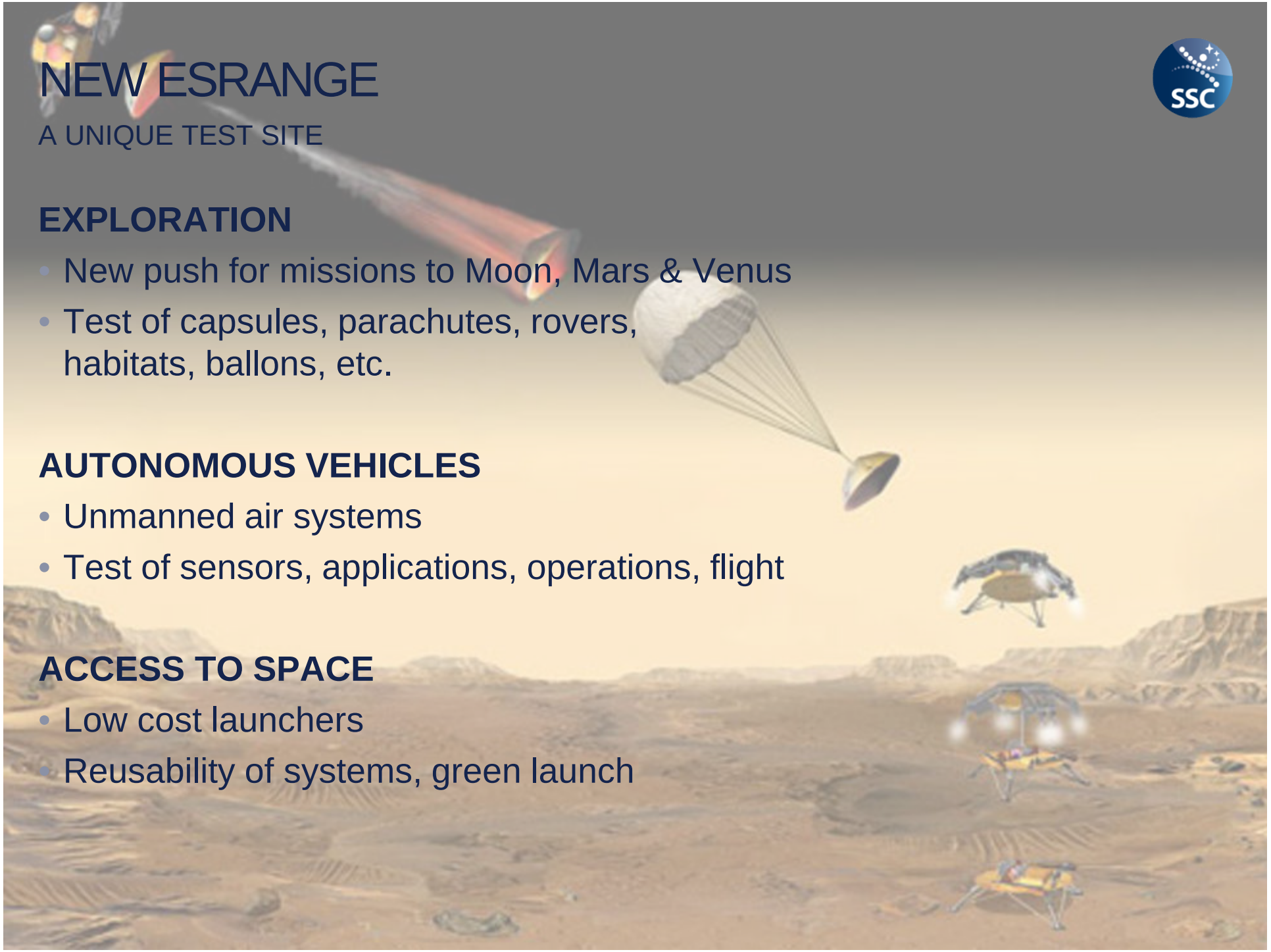
NEW ESRANGE

INFRASTRUCTURE
SCIENTIFIC FACILITIES
SATELLITES INTO ORBIT



NEW ESRANGE

A UNIQUE TEST SITE



EXPLORATION

- New push for missions to Moon, Mars & Venus
- Test of capsules, parachutes, rovers, habitats, ballons, etc.

AUTONOMOUS VEHICLES

- Unmanned air systems
- Test of sensors, applications, operations, flight

ACCESS TO SPACE

- Low cost launchers
- Reusability of systems, green launch

30 km in to Range Area

Rover proving ground

New Satellite Launch area

N

New Runway

Facility for landing and testing autonomous reentry and aerospace vehicles launched from stratospheric Balloons. Test site and landing pad for reusable rockets.

VITTANGIRIVER

Guard

MCC Main Building Area

Rocket Launch Area

Rocket and Igniter Storage

Balloon Launch Area

ESRAD

Multiple Small Antenna Parks w 20+ antennas each

SATTAJÄRVI

ESRANGE - MASTERPLAN 2026

0,5 KILOMETERS 1,0

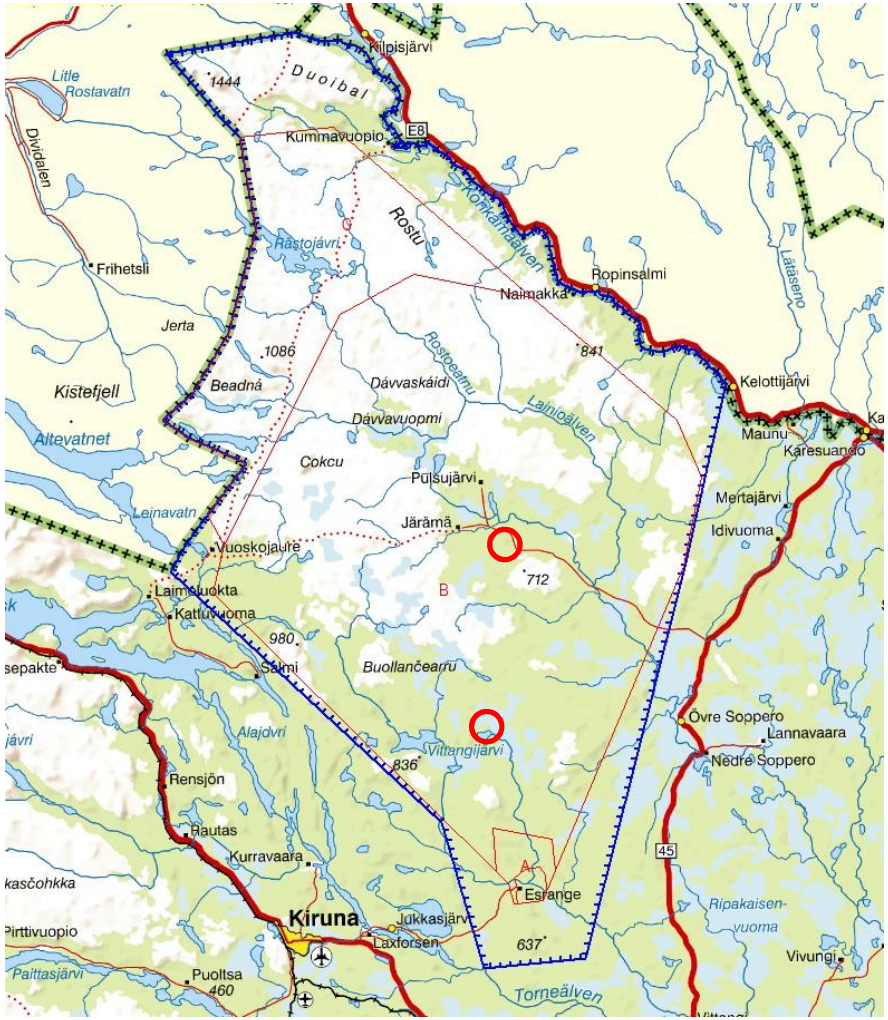
MAP SCALE = 1/9000

NEW ESRANGE

POSSIBLE OFF-BASE AREAS

- Sites for resusability tests
  - ➢Landing pads
  - ➢Autonomous proving ground

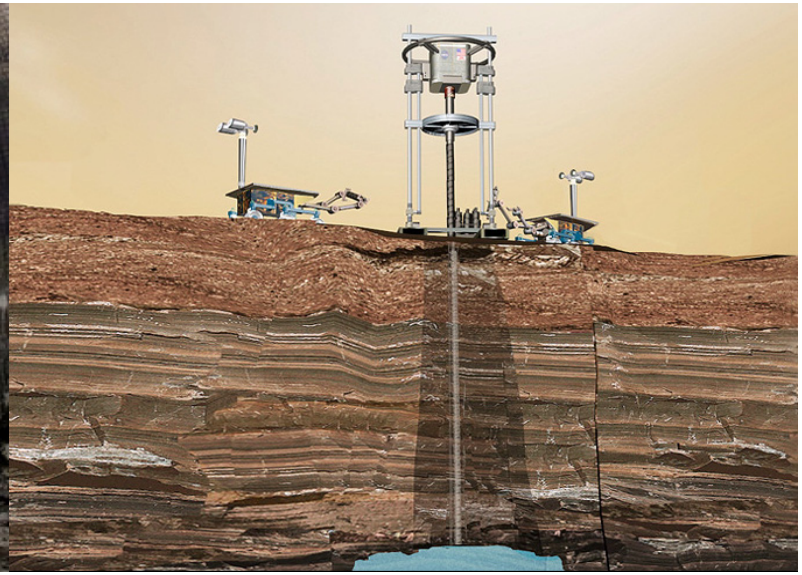
- Sites for ground instrumentation
  - ➢Areas free of light-pollution



MOON AND MARS EXPLORATION

- Explore lavatubes:
- Create habitats and radiation shielding
- Search for water on Mars by drilling:
- Explore past/present habitability.
- Find water for future manned missions.

Cooperation with mining company LKAB



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BENEFIT FROM SPACE

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