

## **ESTABLISHING A LAUNCH FACILITY FOR SMALL SATELLITES AT ESRANGE, SWEDEN**

**Anna Rathsman**

SSC, anna.rathsman@sscspace.com

**Anne Ytterskog**

SSC, anne.ytterskog@sscspace.com

### **ABSTRACT**

Small satellites, including Cubesats, are today mainly launched as piggyback payloads with very limited opportunities for choosing orbit. As the satellites and their applications get more sophisticated, the need to launch them into carefully designed orbits arise. There is already a queue of Cubesats looking for launch opportunities and a further increase is expected. Thus, there is a need for dedicated launchers which regularly launch into standardized orbits. To meet these needs, SSC has initiated SmallSat Express, a launch capability for small satellites from SSC's launching facility Esrange Space Center.

Esrange is located in the very north of Sweden, above the Arctic Circle (68°N, 21°E) and has access to a vast, unpopulated recovery area. The facility has been operated since 1966 and is presently used for sounding rocket and balloon launches. It also hosts one of the world's largest civilian satellite ground stations.

The launch service, "SmallSat Express" is intended for 1- ~150 kg satellites, CubeSats are the target payloads. The launch periods, one to three per year, will be fixed enabling a standardized, sun-synchronous, "dawn-dusk" orbit at 500 km altitude. A constellation of satellites can be established by using three consecutive launches.

A phase A study shows that it is technically feasible. A phase B1 study, recently finalized, aimed for political endorsement, mainly in Sweden as well as obtaining data for different launch vehicle options. The evaluation of the launch vehicle options resulted in choosing the Brazilian/German VLM launcher as the base case. However, the final decision is not taken and other alternatives will be considered. The next phase, B2 will commence in 2016 and includes, amongst other things, flight safety risk assessment and design of infrastructure at Esrange.

The goal is to launch the first satellite from the Esrange in 2020.

### **ESRANGE SPACE CENTER**

Esrange Space Center is located in the very north of Sweden, above the Arctic Circle (68°N, 21°E) and has access to a vast, unpopulated recovery area, 5200 km<sup>2</sup>. Esrange was founded in 1966 by the European organization ESRO, nowadays ESA. SSC has owned and operated Esrange since 1972. The facility is now undergoing a major upgrade to manifest its status as a Center of Excellence for space services to meet an increasing demand of access to space. As part of the modernization, SSC has initiated SmallSat Express, a launch capability for small satellites from Esrange. Esrange will be a "green" launch site meaning that Hydrazine will be banned.

The facility is presently used by the international scientific community, space agencies and commercial customers for launching sounding rockets for microgravity and atmospheric research as well as high altitude balloons for astronomy, atmospheric research and drop tests. It also hosts one of the world's largest civilian satellite ground stations, a hub in SSC's global satellite ground station network, SSC Universal Space Network, former PrioraNet.



**Exhibit 1:** The location of Esrange Space Center

### **THE INCREASING NEED FOR ACCESS TO SPACE**

Nano and microsatellites, including Cubesats and even minisatellites are today mainly launched as piggyback payloads with very limited opportunities for choosing orbit or even knowing in which orbit the satellite will be placed. As the satellites and their applications get more sophisticated, the need to launch them into carefully designed orbits has arisen. There is already a queue of Cubesats looking for launch opportunities and we can expect a further increase in the future. Thus, there is a need for dedicated launchers for small satellites which regularly launch into standardized orbits. Several initiatives are ongoing but very few are European.

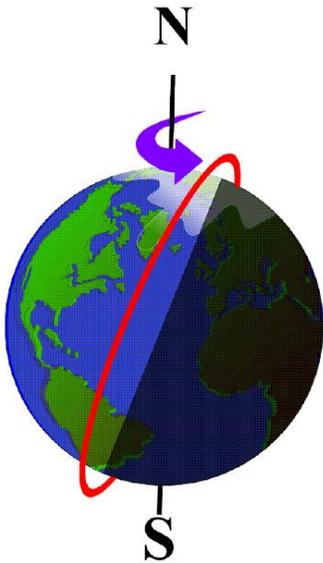
### **SMALLSAT EXPRESS – A LAUNCH SERVICE FOR SMALL SATELLITES**

SmallSat Express will launch satellites 1 - ~150 kg at pre-determined dates, one to four times per year and into a standard orbit. Cubesats are the main target payloads. The standard orbit is a sun-synchronous, “dawn-dusk” orbit at 500 km altitude and at the following local times of the ascending node: 2200, 0600 and 1400 (or 1000, 1800 and 0200).

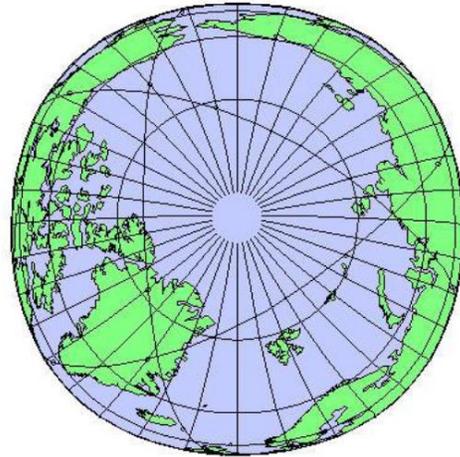
The 2200 Local Time orbit is very similar to those used by optical earth observation missions because satellites pass southbound over targets on the ground at about 10 a.m. local time – the optimum time of day for taking pictures of the ground. The 1400 Local Time orbit is very similar to those used by optical earth observation missions because satellites pass northbound over targets on the ground at about 2 p.m. local time – a local time used by weather satellites to get a close-up view of afternoon cloud cover to complement the 10 a.m. images. For satellites that desire a sun-synchronous orbit but are not engaged in optical imaging this is a perfectly viable alternative to the 10 a.m. orbit. The launch into the 0600 “dawn-dusk” orbit is proposed to occur in August giving eclipse-free conditions until the following spring – an advantage for power-starved missions.

If only one launch is made per year it occurs in August. If two launches are made they occur in April and August. Three launches per year occur in January, April and August. By using the launch service on three consecutive launches a constellation of satellites covering every local time can be established. Consecutive launches will enter orbits with local times in the following succession: 0600, 2200, and 1400. If the demand for

such constellation-building launches does not materialize the “dawn-dusk” orbit will be offered as the standard orbit with the 2200 Local Time orbit as the fall-back.



**Exhibit 2:** Dawn/dusk orbit



**Exhibit 3:** Three orbital planes

***Add-on services and products***

As a complement to the launch service, SSC can provide automated and standardized ground network services for frequent, high capacity satellite data download and satellite tasking, SSC Infinity. We also offer launch and early orbit phase (LEOP) support, frequency coordination, cubesat propulsion systems and a “green” orbit raiser, high performant avionics for small satellites as well as mission planning, satellite design and procurement support.



**Exhibit 4:** Unpacking of small antenna for SSC Infinity

### PROJECT STATUS SMALLSAT EXPRESS

A phase A study with the aim to investigate if a satellite launch service can be implemented at Esrange shows that it is technically feasible.

A phase B1 study has recently been finalized which aimed for political endorsement, mainly in Sweden as well as obtaining data for the different launch vehicle options. As a result, the Swedish government has appointed a coordinator with the task to, on behalf of the government, take the project one step further by evaluating the business conditions including financing of the launcher infrastructure needed. The assessment of the launch vehicle options resulted in choosing the Brazilian/German VLM launcher as the base case. However, the final decision has not yet been taken and other launcher alternatives will be considered. The launch vehicle should be able to carry a payload of 100 - ≈150 kg to a 500 – 600 km Solar Synchronous Orbit and not use toxic propellants such as Hydrazine. Since the launches will take place all around the year, the vehicle must withstand low temperatures (≈ -20°C) and have a track record of at least three successful launches. There are also some restrictions for the ascent, i.e. first stage impact, second stage ignition and impact and a “dog leg” capability. Air launchers are not an option at present since Esrange and the closest airport do not have the necessary infrastructure in place.

The B2 phase will commence in 2016 and will include flight safety risk assessment, design of infrastructure at Esrange and orbit raiser design (concept and main engine) if the need for an orbit raiser is verified. A preferable choice for an orbit raiser will be based on ECAPS’ High Performance Green Propulsion.

Esrange will be a “green” launch site meaning that Hydrazine will be banned. The goal is to launch the first satellite in 2020.

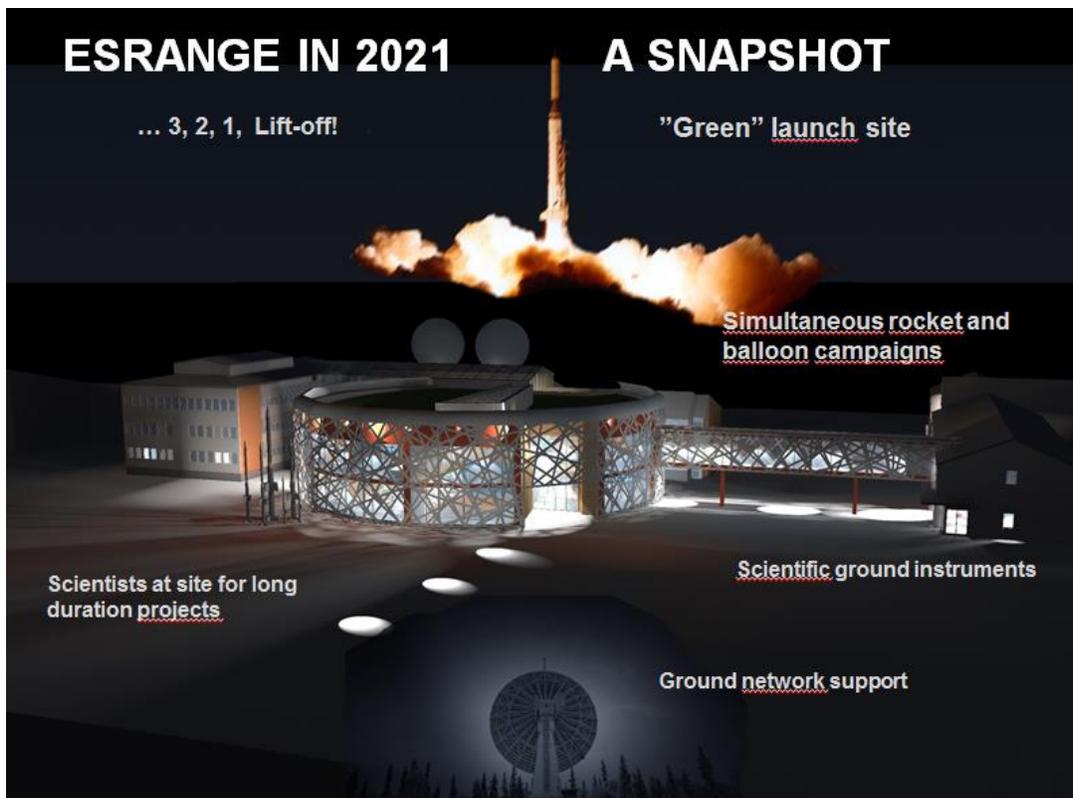


Exhibit 5: The vision for Esrange Space Center in 2021