



SUBORBITAL EXPRESS SERVICE DESCRIPTION

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SUBORBITAL EXPRESS YOUR TICKET TO SPACE!

SubOrbital Express provides frequent sub-orbital flight services on shared-ride basis to the international scientific community and commercial actors. Whether you want to fly alone or share the ride, we can provide you with several options dependent on your specific needs. We also offer different suborbital rocket platforms, depending on your specific mission requirements.

SubOrbital Express is run by an experienced engineering team that works in close contact with you to provide cost-effective solutions and superior service. The team is mastering disciplines of mechanics, electronic and power design, advanced software engineering, experiment system engineering, mission system engineering as well as integration and acceptance testing. The 24/7 on-site engineering support from the team at Esrange Space Center will ensure optimal results.

Read more about [SubOrbitalExpress.com](https://www.suborbitalexpress.com)

Enjoy the ride on a SubOrbital Express mission

<https://www.youtube.com/watch?v=hlwAeudKlXE>



FLIGHT TICKET PROCUREMENT PROCESS

The flight ticket procurement process, i.e. from launch reservation agreement until flight differs and is dependent on the type of flight ticket you choose. For booking requests, we kindly ask you to send an email to suborbitalexpress@sscspace.com. We will then ask you to fill in a payload description questionnaire for us to better understand your needs and requirements.



SubOrbital Express launch from Esrange

WHAT KIND OF FLIGHT TICKETS CAN I BOOK?

Fully customized flight ticket

This flight ticket is for you who:

- Have an experiment idea
- Need engineering support to design and develop the experiment equipment or payload system
- Needs engineering support to execute your experiment or payload system
- Have a payload mass or experiment requirements that require a mission of its own

Active passenger flight ticket

This flight ticket is for you who:

- Bring your own experiment, product or device. We can accommodate it in a standard compartment or a shared compartment with other users, provide power and telemetry
- May need additional systems, like video, data recording, experiment environment control, telecommand and many more

Passive passenger flight ticket

This flight ticket suits you with a payload that:

- Is fully autonomous
- Needs no interaction with the flight systems onboard SubOrbital Express
- Has smaller dimensions and can share a compartment with other users
- Needs a "last minute" ticket

Customized passenger flight ticket

This flight ticket is for you who like to:

- Perform a drop test
- Perform atmospheric re-entry test of your payload
- Fly a telescope or other optical equipment
- Expose solar cells or other equipment to space environment
- Increase Technology Readiness Level (TRL) of your system
- Perform an atmospheric or plasma physics research experiment, e.g. auro-
ra borealis, noctilucent clouds

WHEN CAN I FLY?

SSC's launch manifest includes suborbital microgravity rocket flights from Esrange Space Center every 18 months with the next launch opportunity scheduled for November 2020.

SSC can also offer other kinds of suborbital rocket flights with launch on short-time notice, down to as low as three months for simple and easily accommodated items.

FULLY CUSTOMIZED FLIGHT TICKET

From a bright idea to a ride on a rocket

A fully customized flight ticket will provide you with a tailored solution that meets your specific requirements. It might include everything from a feasibility study, to design, development and test of your experiment equipment/payload up to launch, flight operations and recovery. Whatever your needs are, we can support you.

SSC's highly skilled engineers have over the years developed more than 65 advanced experiments/payloads, all in in close co-operation with our customers and in the fields of material, life, fluid, physical and life science, physical chemistry, technical tests as well as atmospheric and plasma physics.

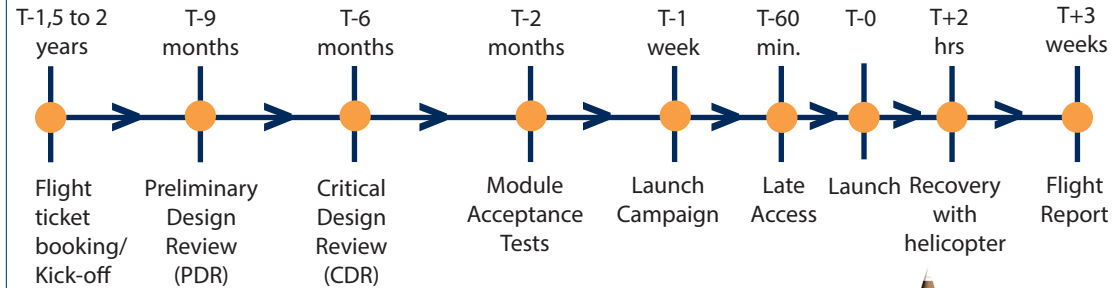
Our engineering skills cover advanced fluid handling and injection systems, high temperature furnace development with in-situ X-ray systems, advanced optics and

camera solutions, ejection mechanisms, openable hatches as well as cryogenics and many more. Also the miniaturization of complex laboratory, production and measurement equipment is within our expertise.

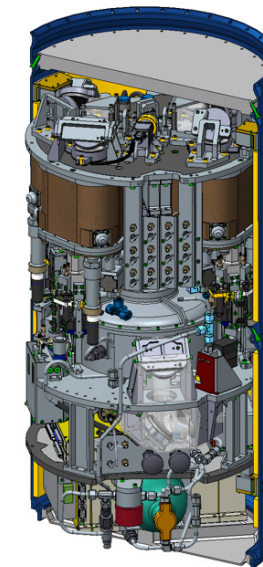
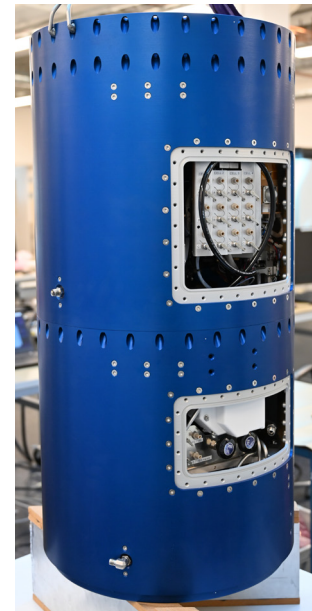
Last but not least our team of engineers is outstanding in developing reliable advanced electronics and computer systems with suitable software - for onboard as well as for ground monitoring and control - for all different kinds of payloads.



Typical timeline for a fully customized mission



The pictures below show the ARLES experiment payload module flown on SubOrbital Express M14 in June 2019 from Esrange. ARLES is a highly complex fluid microgravity experiment funded by ESA and developed by SSC on behalf of an European science consortium.



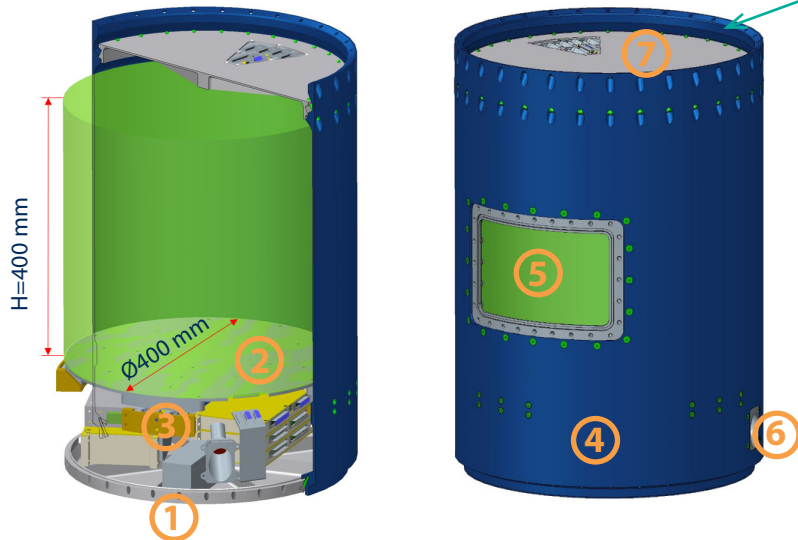
ACTIVE PASSENGER FLIGHT TICKET

What is an active passenger?

Active passengers are characterized by the need for support of power, data storage and data transmission to ground. Most of the scientific experiments are active passengers and a variety of different supporting systems are available for their execution.

This flight ticket includes a standard experiment compartment, accommodation of your experiment, launch, flight and recovery. The module has an insulated outer structure and is equipped with electronics for support of power, and data storage as well as a late access hatch. Additional systems are available dependent on the experiment requirements. A more comprehensive description of the standard interfaces and optional add-ons is found in the table on the next page.

Standard compartment with payload volume in green



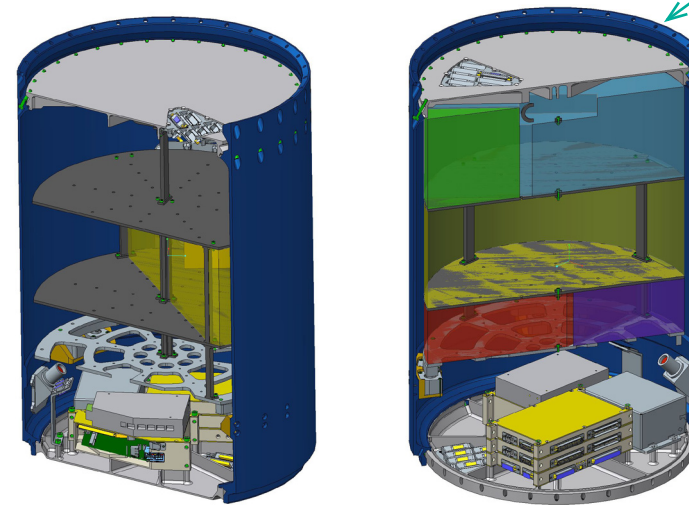
1. Pressure tight bottom lid with supporting electronics
2. Base plate with standard drilling pattern for experiment accommodation
3. Vibration damper with bracket
4. Pressure tight outer structure
5. Pressure tight late access hatch
6. Electric umbilical
7. Pressure tight top lid



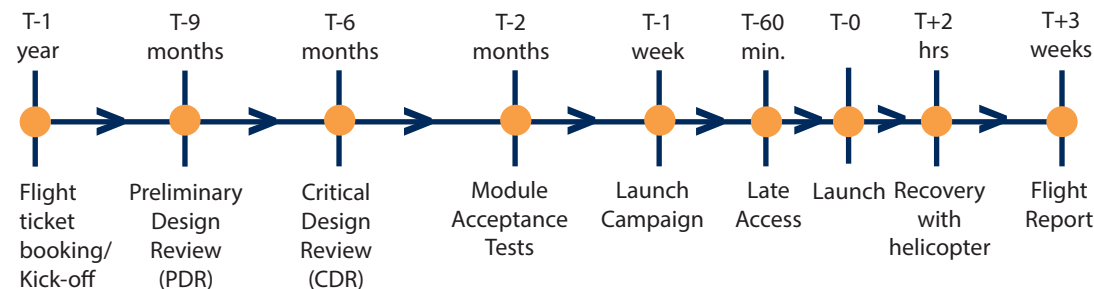
Small active passengers

Smaller active passengers with the need of power, data storage and data transmission to ground can be accommodated in compartments shared with other users.

Shared compartment with different payload volumes



Typical timeline for an active passenger mission



Standard module interfaces active passenger

| Standard module | Optional |
|--|---|
| Dimensions | |
| Diameter: 400 mm | Customized |
| Experiment height: <600 mm | Experiment height: <3,000 mm |
| Experiment mass: <25 kg | Experiment mass: <250 kg |
| Power | |
| 28 VDC ±4V, 4A, 75 Wh | 28 VDC ±4V, 8A, 150 Wh |
| Electrical interface | |
| Standard D-sub connector | Flexible advanced solutions |
| Mechanical interface | |
| Vibration damped base plate with standard drilling pattern | Flexible drilling pattern |
| Late access hatch: 250x250 mm | Several late access hatches in flexible sizes and positions |
| | Additional vibration damped base plates |
| | Customized fixtures and structural components |
| Software | |
| | Flexible advanced software solutions |
| | Experiment control during flight |
| | Remote control during flight |
| | Pre-programmed flight sequence |

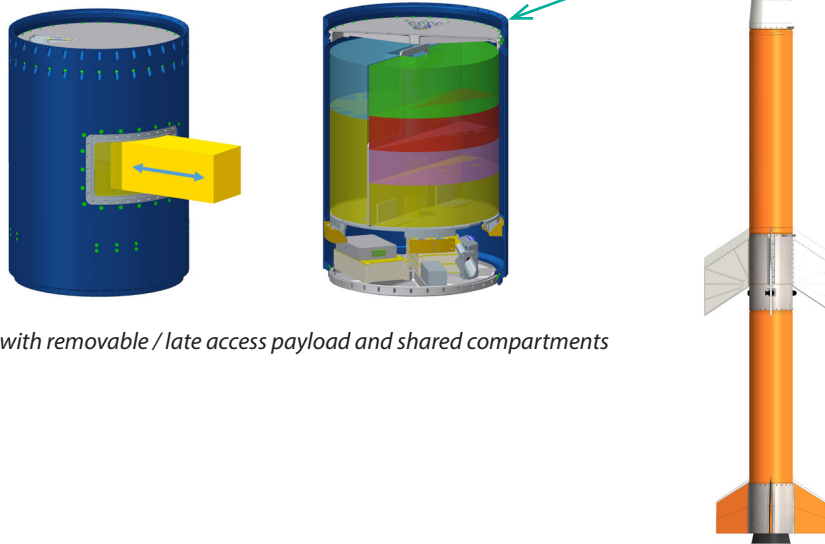
| Standard module | Optional |
|--|---|
| Data interface and storage | |
| Onboard data storage of experiment data | Highspeed onboard data storage of experiment data |
| Ethernet or RS422 experiment data interface | Highspeed data and telemetry downlink, telecommand options |
| Experiment environment | |
| | Controlled inert gas atmosphere (e.g. GN2, pressure, humidity) or ventilated to vacuum condition during flight |
| | Insulated outer structure and lids |
| Examples of optional supporting systems | |
| | Fluid management systems: <ul style="list-style-type: none"> • Fluid injection systems • Fluid handling • Cryogenic fluids |
| | Camera solutions with highspeed telemetry downlink |
| | Customized advanced optics and microscopy |
| | Interferometer |
| | High temperature furnace design and accommodation |
| | In situ X-ray imaging system |
| | Advanced temperature control with thermal decks powered via umbilicals by external liquid cooling and heating system |

PASSIVE PASSENGER FLIGHT TICKET

What is a passive passenger and what is included?

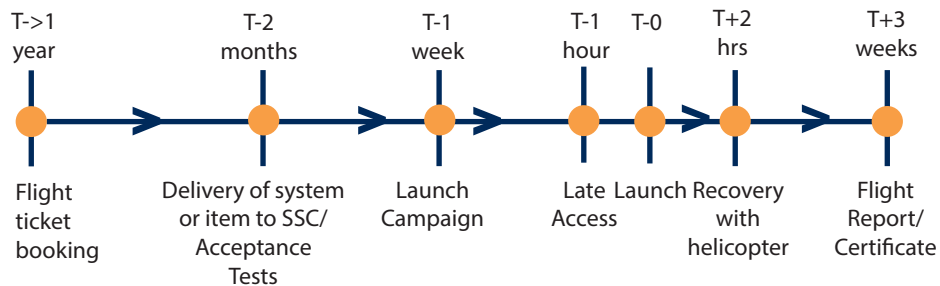
With a passive passenger ticket you can send a self-sustained experiment, instrument or items to space. Your system or item is accommodated in a compartment with a defined volume and a mechanical interface. Communication and power are not included but can be provided on request. The compartments are available in different sizes as shown on the image below.

The ticket includes accommodation, launch, flight and recovery of your item.



Module with removable / late access payload and shared compartments

Typical timeline for a passive passenger mission



CUSTOMIZED PASSENGER FLIGHT TICKET

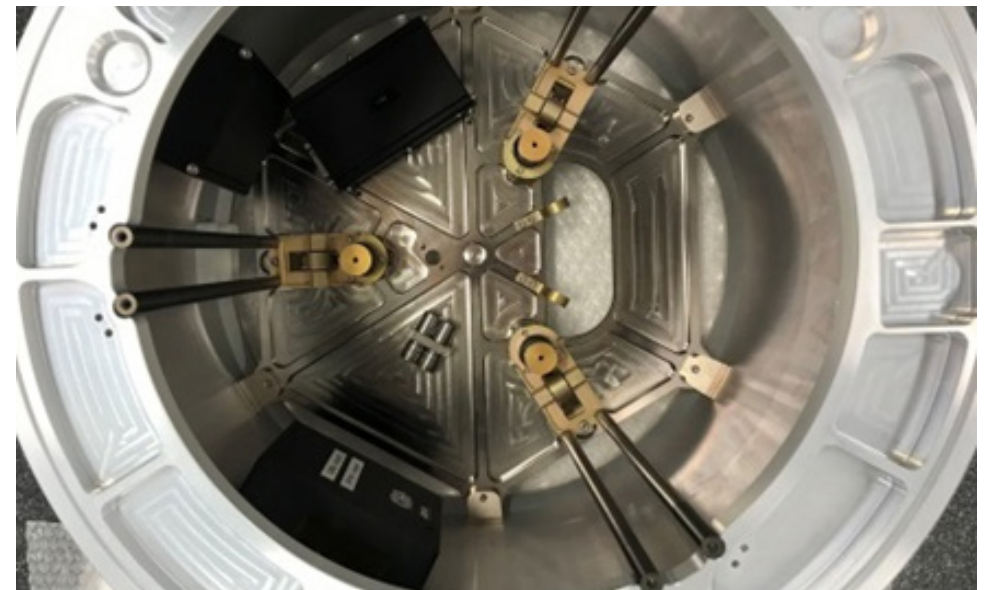
What else can I fly?

Suborbital rockets are most commonly used for microgravity experiments. However, there is a huge variety of other applications that can utilize suborbital rocket platforms.

Scientific and technical payloads

Some examples of applications:

- Drop tests of probes which are released at a specific altitude e.g atmospheric re-entry experiments or parachute developments
- Atmospheric or plasma physics research experiments, e.g. aurora borealis, noctilucent clouds
- Telescopes and optical equipment for deep space or Earth observation
- Exposure of equipment, solar cells or sensors to space environment
- Increasing Technology Readiness Levels (TRL)



SSC's aft-end separation system for drop tests

EXCELLENT FACILITIES AND INFRASTRUCTURE

SSC's Engineering Center

The SSC premises in Solna, 15 minutes from Stockholm city center have electronic laboratories for design, manufacturing, and test of electronics as well as integration rooms with handling equipment. The premises also accommodates a mechanical workshop with milling, turning, drilling, grinding and welding machines and environmental test facilities such as tanks for thermal vacuum and thermal cycling.

The ceiling height allows for integration of full-length suborbital rocket payloads.

Dedicated to suborbital rocket projects, there is a 6 m2 clean room. Two radiation proof facilities are at hand for evaluation and test of X-ray equipment, a lead-lined 6 m2 room and a 0.5 m2 mobile facility.

A few kilometres from SSC premises, the RISE (Research Institute of Sweden) environmental testing establishment provides extensive facilities for environmental qualification and acceptance test such as vibration and thermal tests and spin balancing of complete suborbital rocket payloads, satellites and subsystems.

Esrange Space Center

SSC's launch facility Esrange Space Center is located 40 km from the town of Kiruna in the very north of Sweden, above the Arctic Circle (68°N, 21°E) and has access to a vast, unpopulated impact and recovery land area of 5200 km2. Kiruna has a highly developed infrastructure and a domestic airport providing daily flights to Stockholm. The climate is typically continental with cold winters and relatively warm summers.

Esrange is equipped with large and modern facilities for rocket launches, preparation, integration and testing of payloads as well as clean room facilities, class 1 laboratories, workshops, offices and meeting rooms. It also houses its own hotel, restaurant and a multitude of indoors and outdoors recreation facilities.

Laboratories

Class 1 laboratories are available for advanced biological and chemical work. They are all equipped with gas, warm and cold water, fume hoods, laminar air flow cupboards - horizontal or vertical, refrigerators, deepfreezes, and lockable cupboards to store poisonous materials.

Science Center

The Science Center is the center for the scientific observations. Data from the scientific instruments are displayed during flight to enable the scientists to survey the scientific situation. Users can install their own instruments and data can be routed to the Science Center by means of a permanent cable network. Telemetry data from the payload are also displayed in the Science Center. Altogether, these facilities are vital to support critical launch decisions.

Restaurant & Accomodation

The restaurant is located in the main building and is open during normal working hours and during the launch operations. Special requirements regarding the opening hours, special dishes, etc, can normally be fulfilled.

The hotel Aurora is located close to the Main Building. It houses 79 rooms (out of which 20 are double rooms) conference rooms, gym, sauna and kitchens.



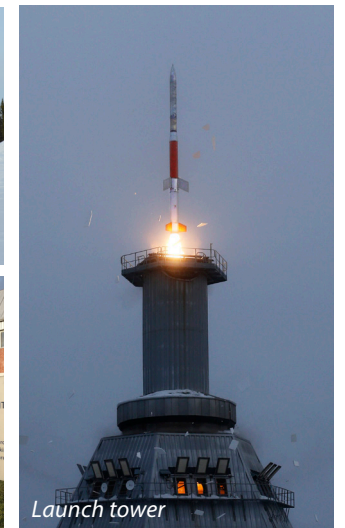
Esrange suborbital launch area



Solna integration hall



Recovery helicopter



Launch tower



Hotel Aurora



Esrange main building



Science Center

GENERAL TECHNICAL DESCRIPTION PAYLOADS

SSC can offer various types of suborbital rocket flights dependent on your mission needs. Here we provide technical summary descriptions of two examples of suborbital rocket flights and their respective payload.

TYPICAL SUBORBITAL MICROGRAVITY ROCKET FLIGHT

The microgravity flights can accommodate experiments using microgravity as research tool as well as free falling objects for re-entry or drop tests and small promotional items.

| | |
|---|---|
| Experiment payload mass: | up to 300 kg |
| Payload module diameter: | 17 inches |
| Microgravity: | up to 6-7 minutes of high quality microgravity, down to 10^{-6} g |
| Apogee/altitude: | up to 300 km, dependent on payload mass |
| Number of active passengers: | normally 3-5, each experiment can typically weigh 2-70 kg |
| Rocket systems: | two-stage solid propellant rocket motor |
| Guidance system: | optional |
| Telemetry speed: | up to 4 x 5 Mbit/s |
| Telecommand: | up to 38 kbits/s, command update rate from 18 Hz to 228 Hz |
| Digital video system: | optional |
| Separation systems for free falling objects: | optional |
| Recovery system: | parachute system with GPS and beacon for positioning, landing speed less than 10 m/s, helicopter recovery, recovery operations ~2 hours, early retrieval of biological samples about 1 hour |

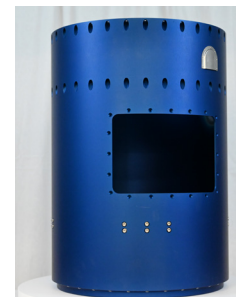
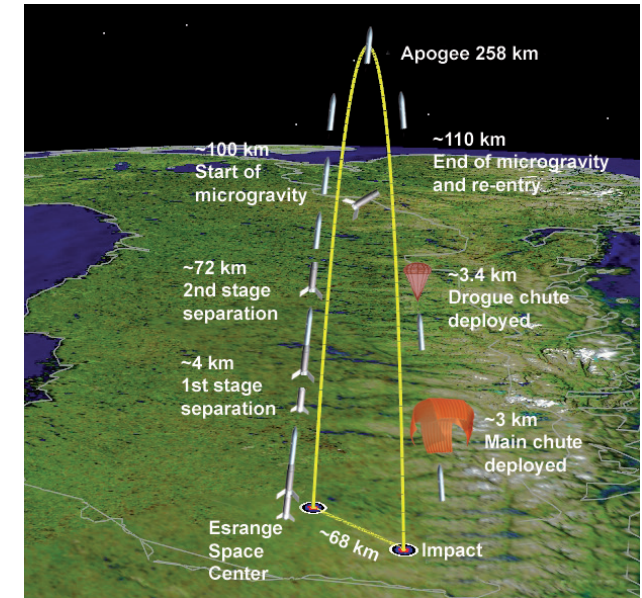
TYPICAL FLIGHT EVENTS OF A MICROGRAVITY MISSION

Start of microgravity:
~1m 10s after lift-off

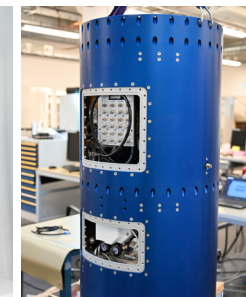
End of microgravity:
~7m 20s after lift-off

Total microgravity time: 6 minutes

Total flight time:
~15 minutes



Dedicated payload module



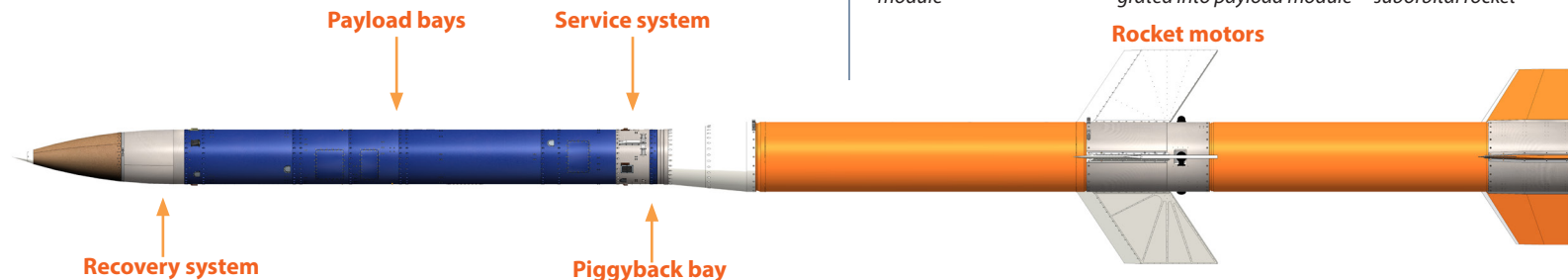
Experiment system integrated into payload module



Launch of a two-stage suborbital rocket



Payload recovery Photo: M. Lindh



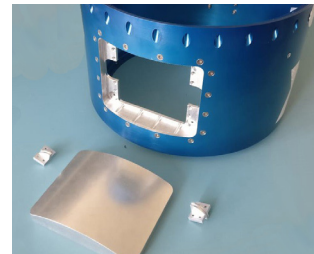
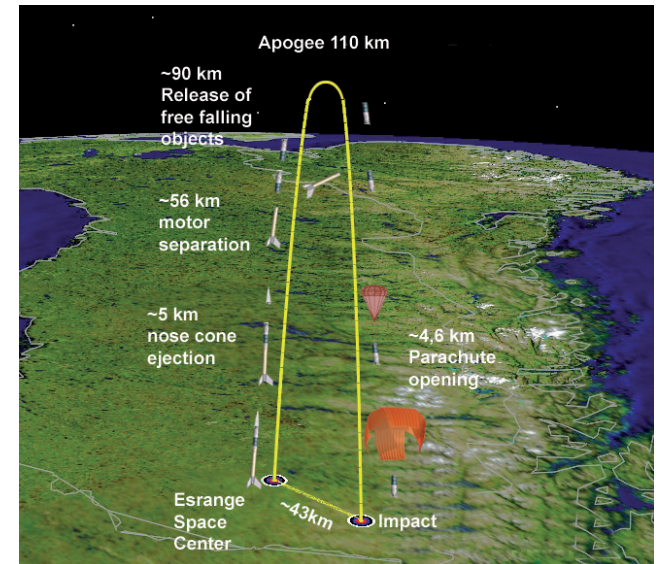
TYPICAL FLIGHT WITH SMALLER SUBORBITAL ROCKET PLATFORM

SSC also offers smaller suborbital rocket platforms that can accommodate experiments, free falling objects for re-entry or drop tests as well as promotional items.

| | |
|---|---|
| Experiment payload mass: | up to 40 kg |
| Payload module diameter: | 14 inches |
| Microgravity: | 2 minutes of microgravity (10 ⁻³ g) for microgravity missions |
| Apogee/altitude: | up to 110 km, dependent on payload mass |
| Number of Experiments: | normally 1-2 + ejection experiments/items which can be accommodated inside the nose cone |
| Rocket systems: | single-stage solid propellant rocket motor |
| Guidance system: | optional |
| Telemetry speed: | up to 4 x 5 Mbit/s |
| Telecommand: | optional, up to 38 kbits/s, command update rate from 18 Hz to 228 Hz |
| Digital video system: | optional |
| Separation systems for free falling objects: | optional |
| Recovery system: | parachute system with GPS and beacon for positioning, landing speed less than 10 m/s, helicopter recovery, operations 2 hours, early retrieval of biological samples about 1 hour |

TYPICAL FLIGHT EVENTS

Total flight time:
~13 minutes



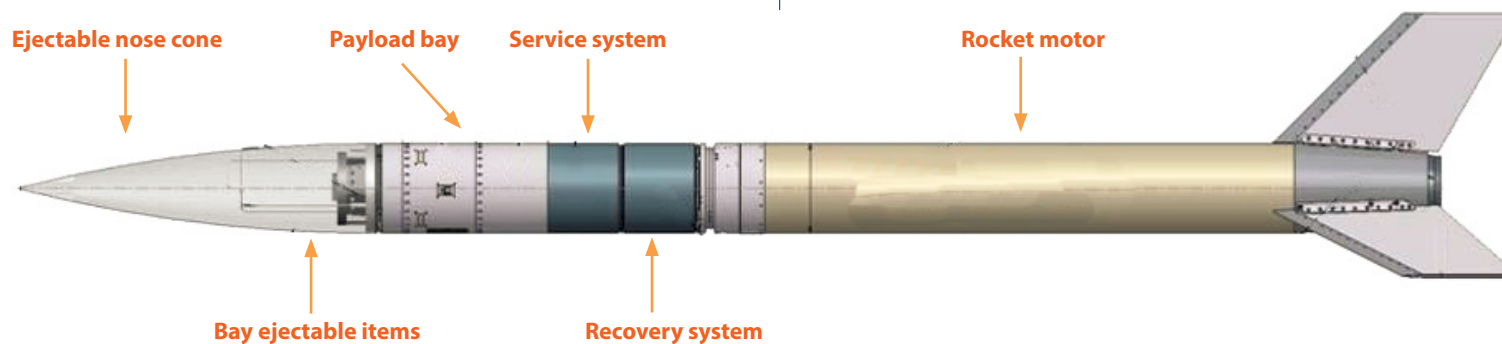
Dedicated payload module



Launch of a single-stage suborbital rocket



Payload recovery



BEAUTIFUL LAPLAND

The location of Esrange Space Center with its wild, beautiful and magnificent surroundings offers a wide selection of outdoor recreation activities. The mountain areas surrounding Kiruna is perfect for hiking and skiing. The lakes and rivers are an eldorado for fishing. In the summer you enter the world of the midnight sun, in the winter you may experience an incredible light show; the northern lights or Aurora Borealis. Sightings of wild animals such as reindeer and moose are commonplace.

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Photo: Dominique Daab

WELCOME TO SSC

SSC, a state-owned limited liability company, is a leading global provider of advanced space services. Starting with pioneering scientific rocket launches in northern Sweden, we have grown into a full-service supplier of state-of-the-art space engineering, satellite and launch services to commercial and institutional customers worldwide.

Launching suborbital rockets is one of our core businesses, up to date we have launched more than 560 rockets, developed over 65 suborbital rocket experiment modules for scientists and research institutes in the fields of material science, gas and fluid physics science, and biology, as well as for technical tests. We have also built over 60 suborbital rocket vehicle systems over three decades.

SSC operates its own launch site at Esrange Space Center and can provide you with services supporting all your mission needs, from design and development to accommodation, launch, flight and recovery. The flight service is provided jointly by SSC and DLR Moraba.



Contacts

Find out more about SubOrbital Express, including launch manifest: suborbitalexpress.com or send us an email suborbitalexpress@sscspace.com

Read more about SSC at sscspace.com.