# Technical Constraints
# for
# CAS-ESA joint mission

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# ESA-CAS Joint Mission

The Call for joint mission will be issued towards end of 2014:

- Science driven mission
- Preliminary technical guidelines are provided for supporting the science community reflections
- The guidelines will be progressively matured up to the Call
- A relatively fast implementation is contemplated
    - Selection in 2015
    - Joint definition < 2 years
    - Space segment development < 4 years
    - Launch in 2021

# Mission work breakdown

Possible work breakdown

- Mission architect
- Platform
- Payload
- System integration and testing
- Launch services
- Spacecraft operations
- Receiving stations
- Science operations
- Science exploitation

Any of the mission elements can be provided by China, Europe, or jointly. The work share shall preserve clean and manageable interfaces.

The following elements are anticipated to be jointly achieved:

- Overall mission management
- Science management and exploitation

# Preliminary Technical Boundaries

Guidelines to be considered at this stage:

- Launch mass < ~ 250 kg
- Payload mass < ~ 60 kg
- Payload power ~ 50 watt average (typical)
- Operational life time of satellite 2-3 years
- Orbit and mission profile: no a priori limitation, provided compatible with envisaged launchers. A propulsion module can also be considered if mandatory (e.g. for orbit insertion)
- Launcher: To be defined, could be LM-2C (possibly passenger), LM-2D (possibly passenger), VEGA (possibly passenger), SOYUZ (passenger)

# Space segment

**The entire space segment shall be “ITAR free”**

**Science instrumentation**

- Can be a new development (with heritage)
- Must rely on available technologies (ISO TRL ≥ 6)
- European part to be provided by ESA Member States
- Development schedule < ~ 3-3.5 years

**Platform and other elements as relevant**

- Expected to be adapted from previous development
- Must rely on qualified equipment (ISO TRL ≥ 7)
- Shall comply with space debris regulations
- Development schedule < ~ 3-3.5 years

# Potential launchers

**LM-2C**, possibly as passenger and with CTS upper stage. In general for LEO and in particular SSO.

Example of capability: ~ 1650 kg @ SSO 700 km

**LM-2D** , possibly as passenger. Mainly for LEO and SSO

Example of capability: ~ 1200 kg @ SSO 700 km

**LM-2D with liquid upper stage**

Can deliver escape velocity for a 250 kg spacecraft

**Vega**, possibly as passenger

Example of capability: ~ 1500 kg @ SSO 700 km

**Soyuz**, only as passenger

Example of capability: ~ 4800 kg @ SSO 700 km,
~ 3000 kg in GEO, ~ 2100 kg @ L2

# More information

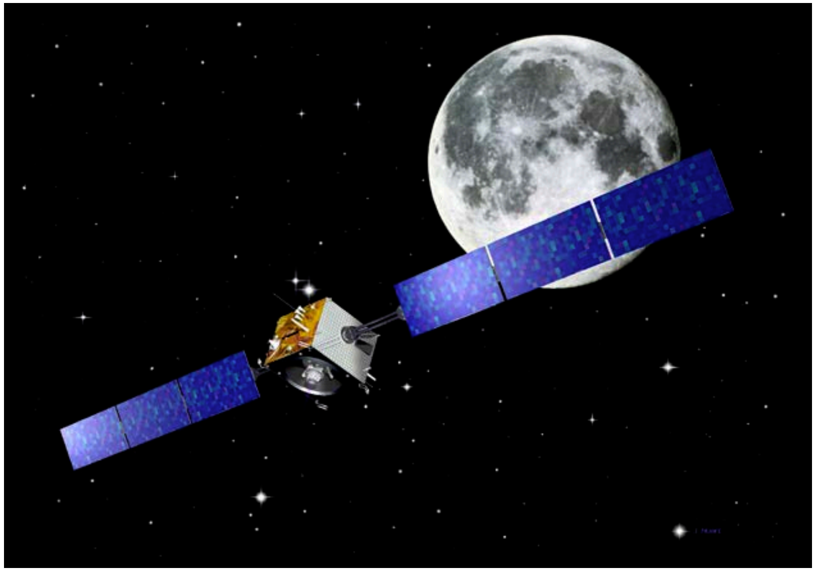
More on launchers and capabilities:

SOYUZ, VEGA: www.arianespace.com

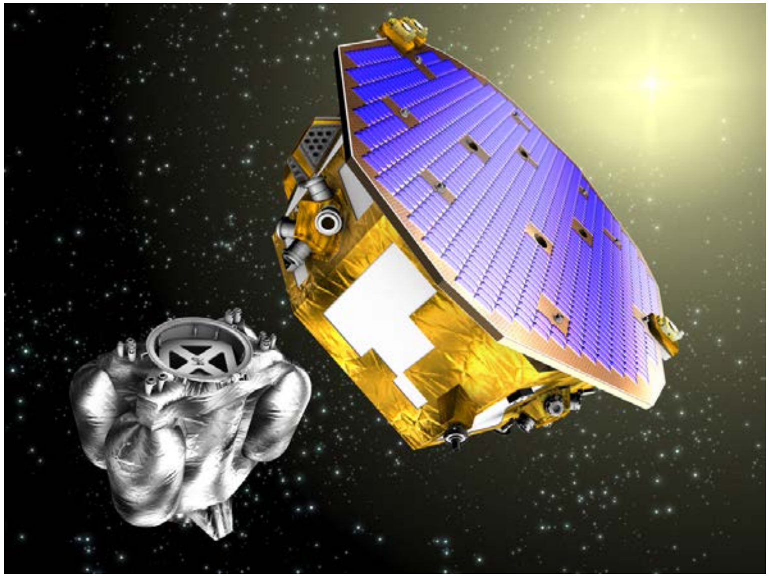
CZ LM-2C and LM-2-D: See Annex 1

More on ISO TRL: see table in Annex 2

# Illustrative examples



*SMART 1*
*Mission to the moon*
*using electric propulsion*
*283 kg dry mass, 1 m$^3$*
*Launched 2003*
*End of mission 2006*



*LISA Pathfinder*
*VEGA launcher with propulsion module*
*Orbit at L1 Lagrange point,*
*450 kg dry mass, 3.6 m$^3$*
*To be launched in 2015*

# Annex 1
# Capabilities of
# LM-2C and LD-2D launchers

# LM-2C Launcher

The two-stage LM-2C is mainly used for conducting LEO (h<500 km) missions.

CTS is a three-axis stabilized upper stage for LM-2C which is capable of delivering one or more satellites.

LM-2C/CTS is mainly for circular LEO (h>=500 km) and SSO missions.

LM-2C takes JSLC as its main launch site, and it can also be launched from XSLC and TSLC.

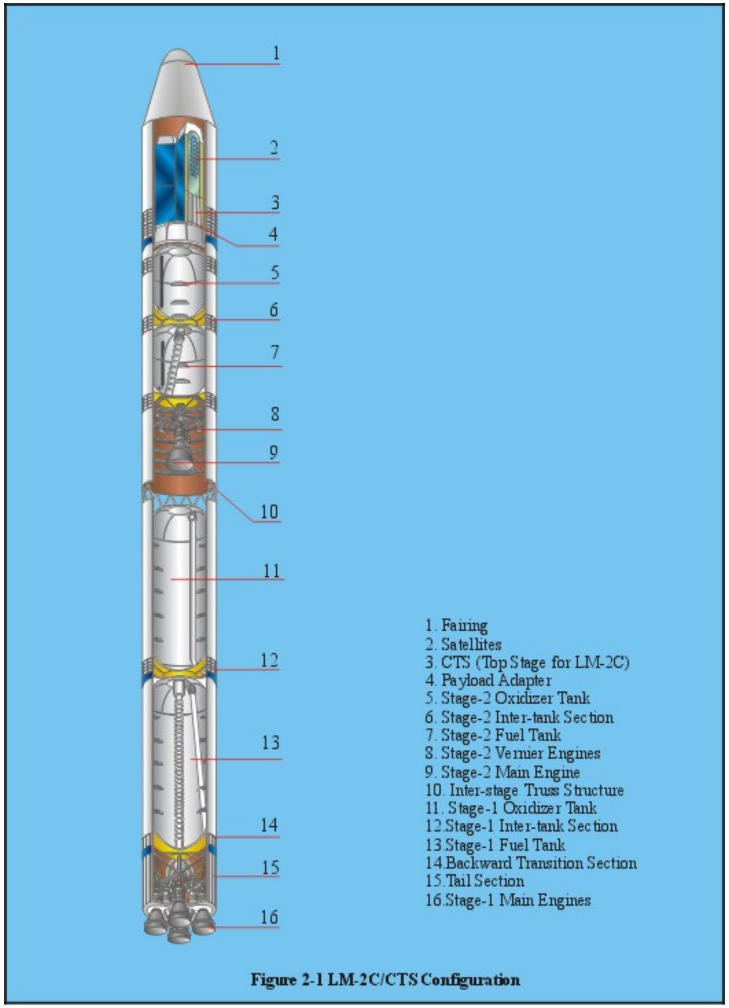
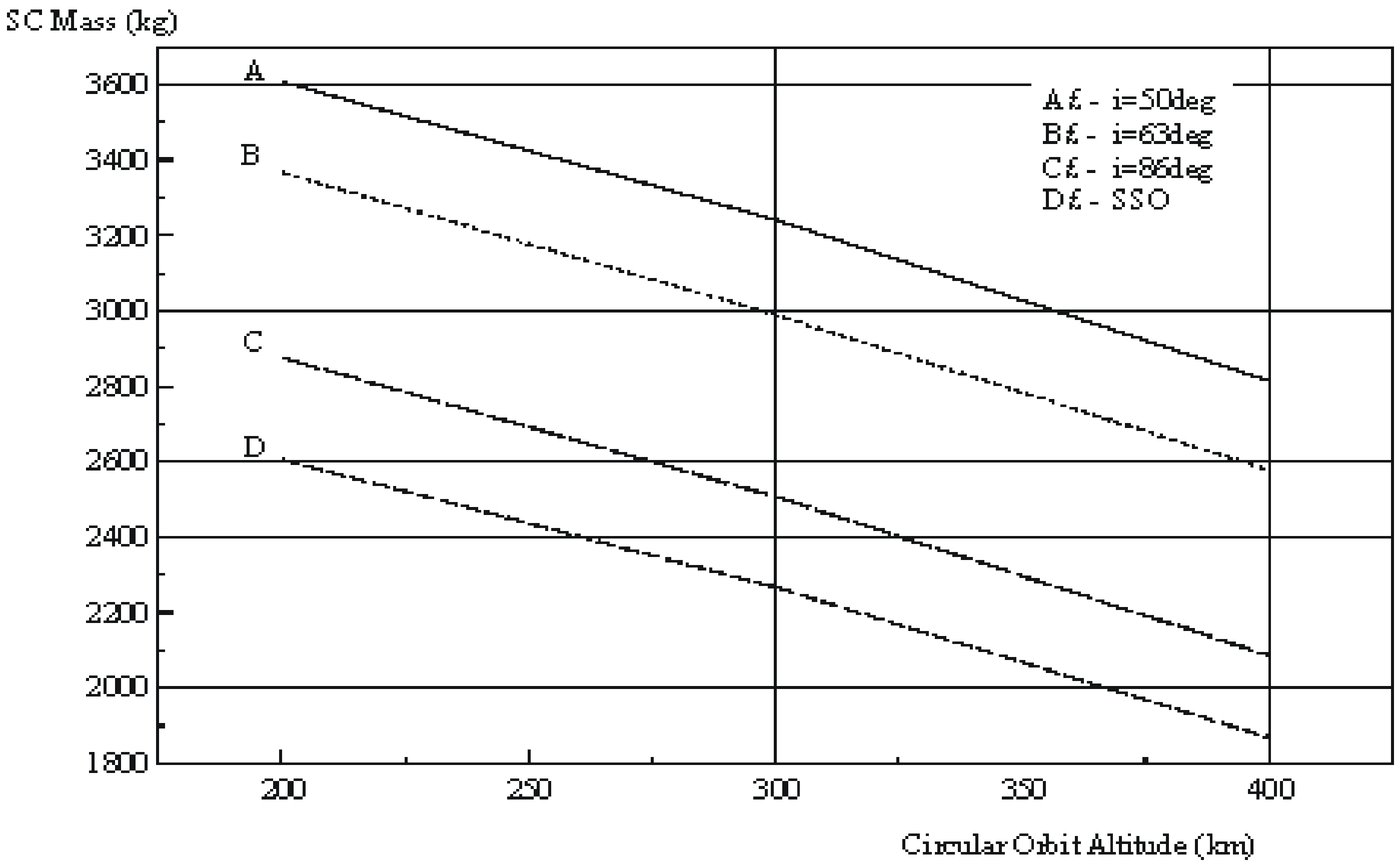



Figure 2-1 LM-2C/CTS Configuration

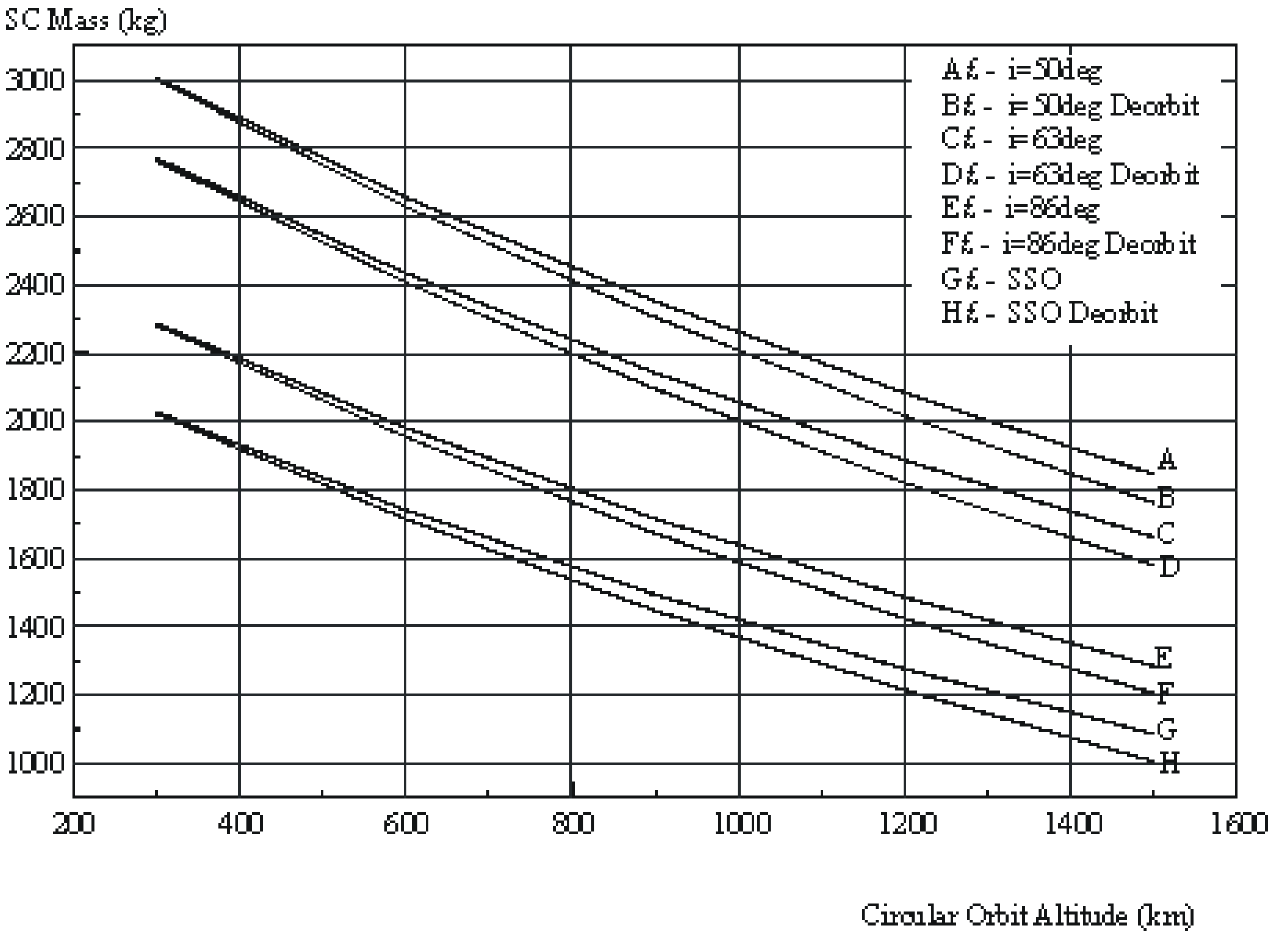
2-3

# LM-2C Launcher



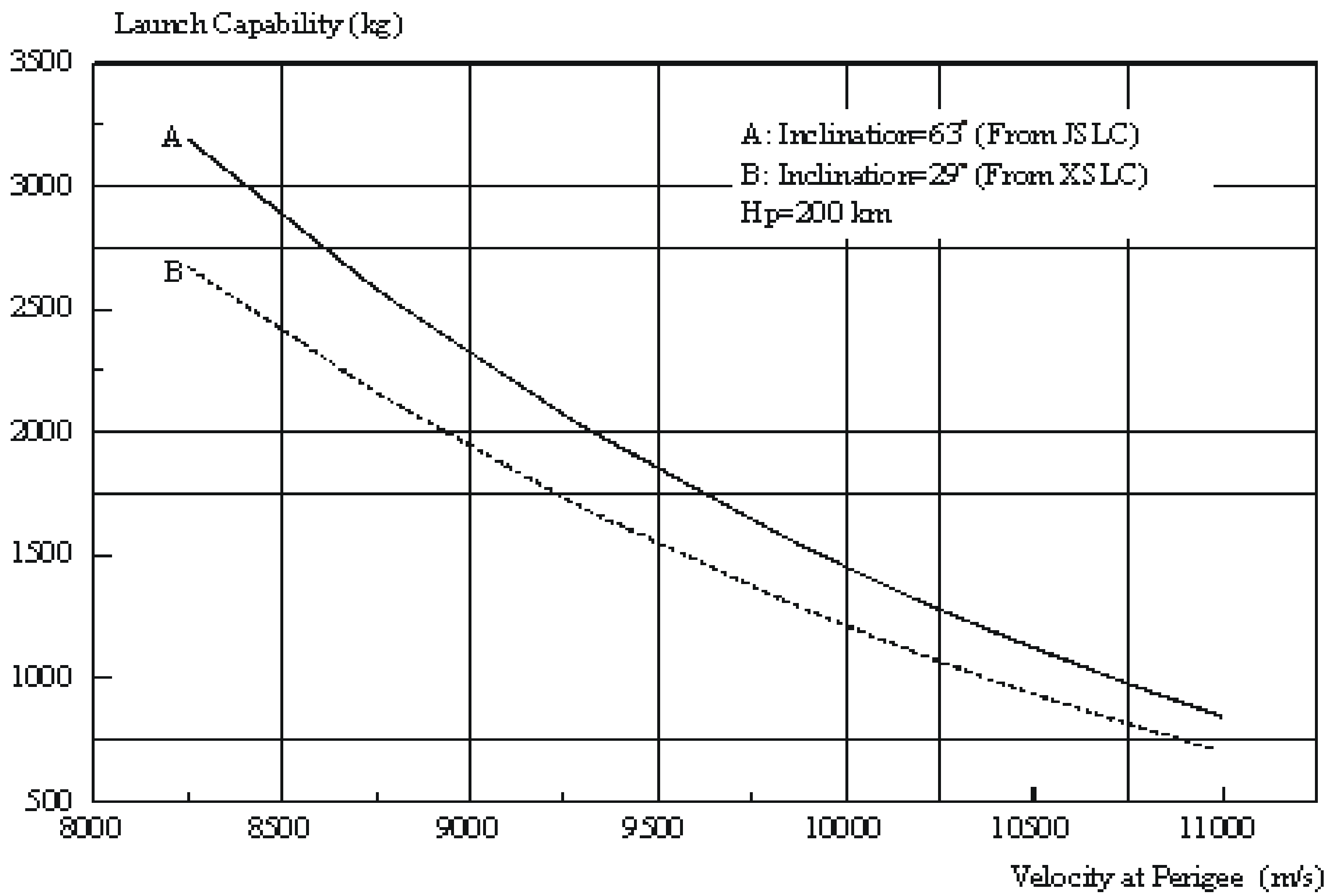

Two-stage LM-2C for circular orbits

# LM-2C Launcher




LM-2C with upper stage for circular orbits

# LM-2C Launcher




Two-stage LM-2C with upper stage for large elliptical orbits

# CZ-2C Launcher

| Symbol | Parameters | Deviation (1σ) |
|---|---|---|
| Δa | Semi-major Axis | 1.1 km |
| Δe | Eccentricity | 0.00022 |
| Δi | Inclination | 0.045 deg. |
| ΔΩ | Right Ascension of Ascending Node | 0.055 deg. |
| Δω | Perigee Argument | 1.67 deg. |

Two-stage LM-2C Injection Accuracy for LEO Mission (hp=200km, ha=400km)

# CZ-2C Launcher

| Symbol | Parameters | Deviation （1σ） |
|---|---|---|
| Δh | Orbital Altitude | 6 km |
| Δi | Inclination | 0.05 deg. |
| ΔΩ | Right Ascension of Ascending Node | 0.06 deg. |

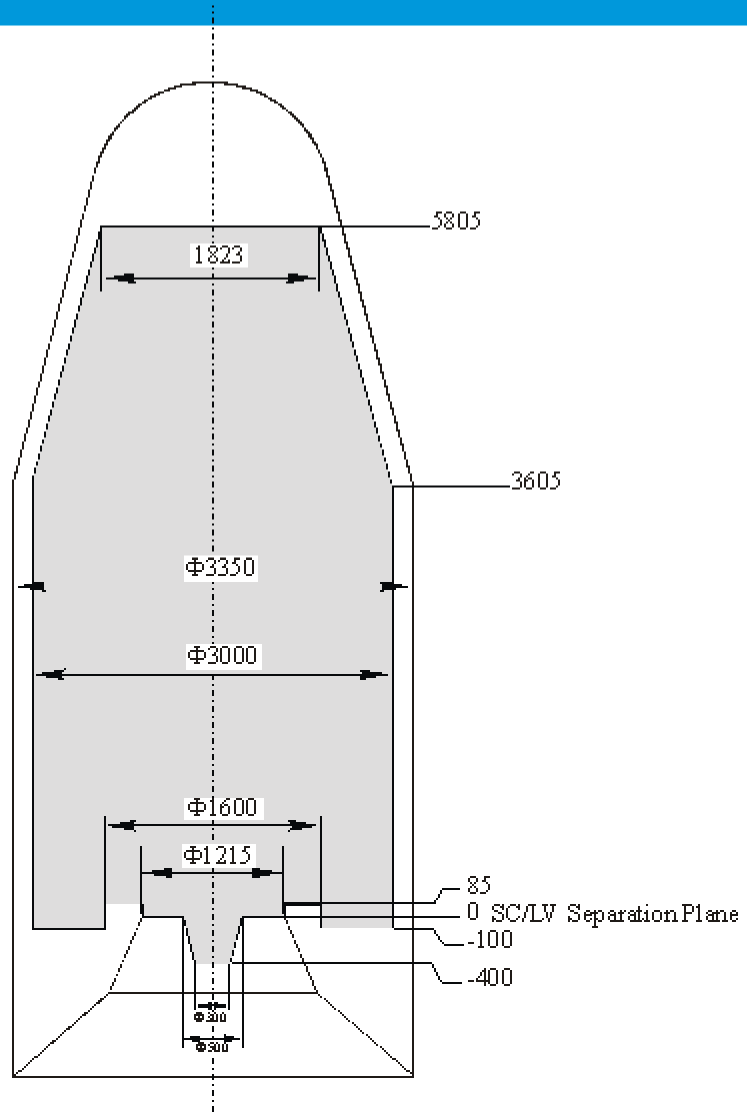
LM-2C/CTS Injection Accuracy for Circular Orbit Mission (h=630km)

# CZ-2C Launcher

➢Fairing Static Envelope: ø3000mm

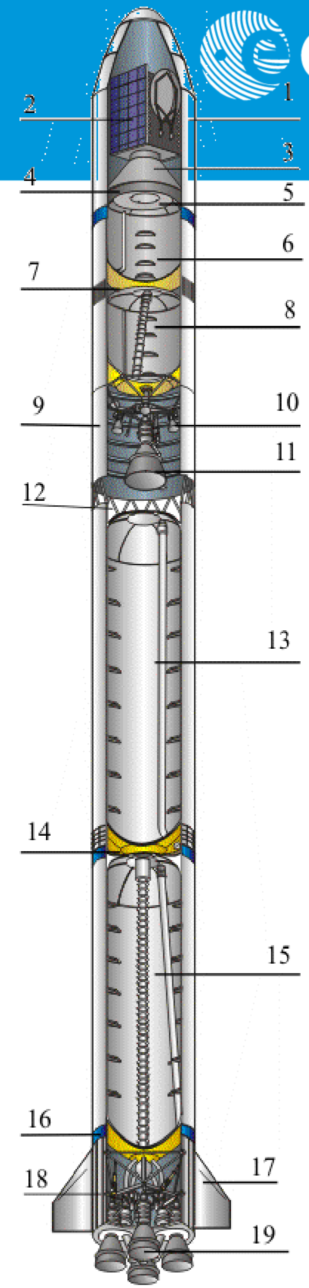
➢Payload Adapter :

- 1194A Interface
- 937B Interface

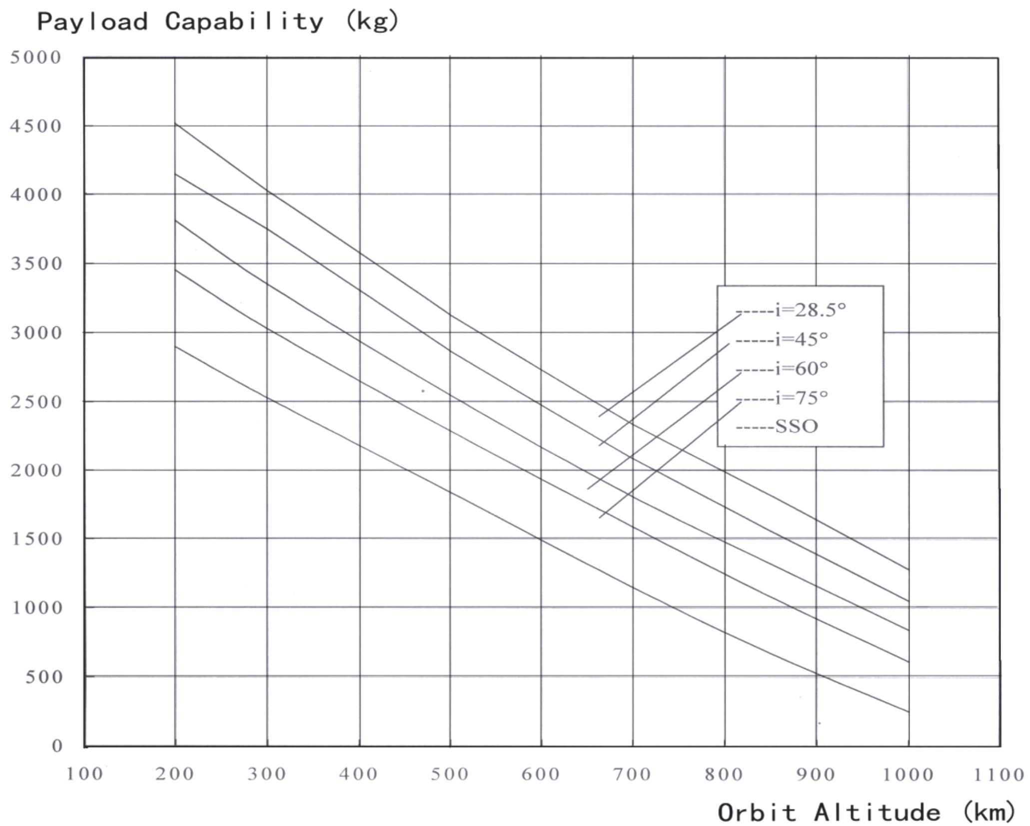


# CZ-2D Launcher

- LM-2D is another two-stage launcher mainly for circular LEO and SSO missions.
- LM-2D can carry out single satellite launch mission and dual satellite launch mission, parallel- or series-configured.
- It can also provide piggyback launch service for micro-satellites.
- LM-2D can work with a liquid upper stage to get more powerful launching capability.

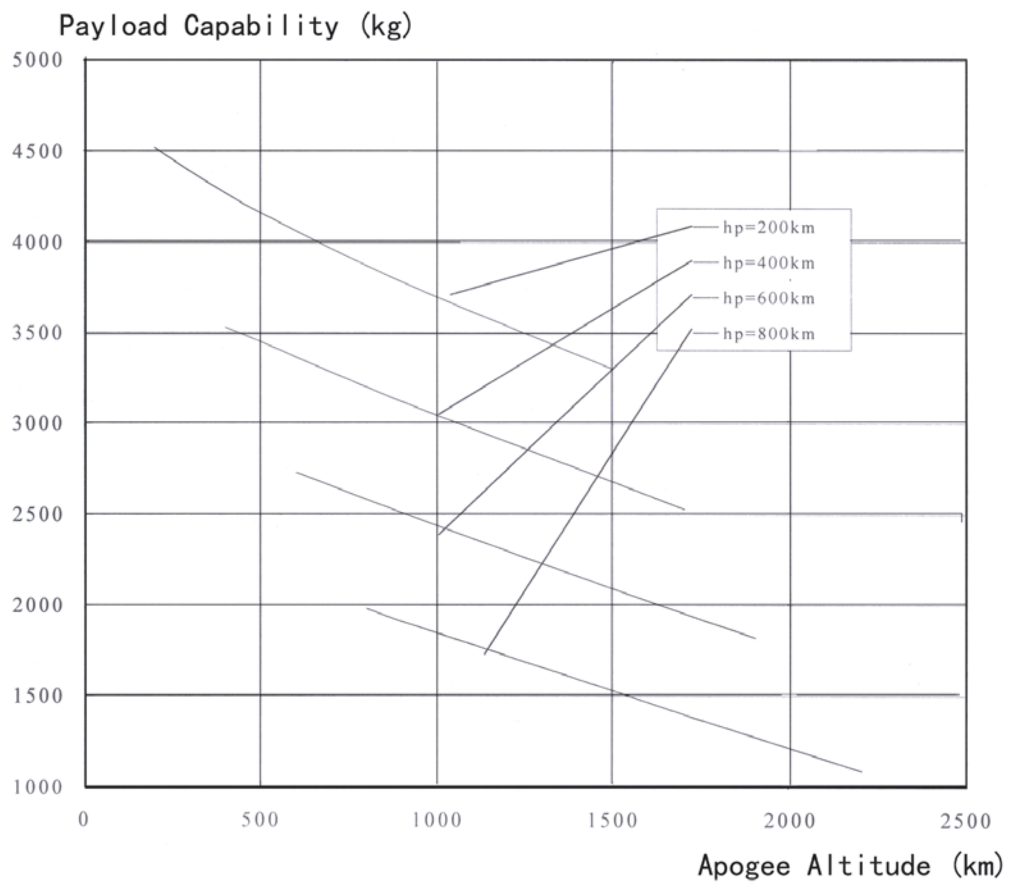


# CZ-2D Launcher



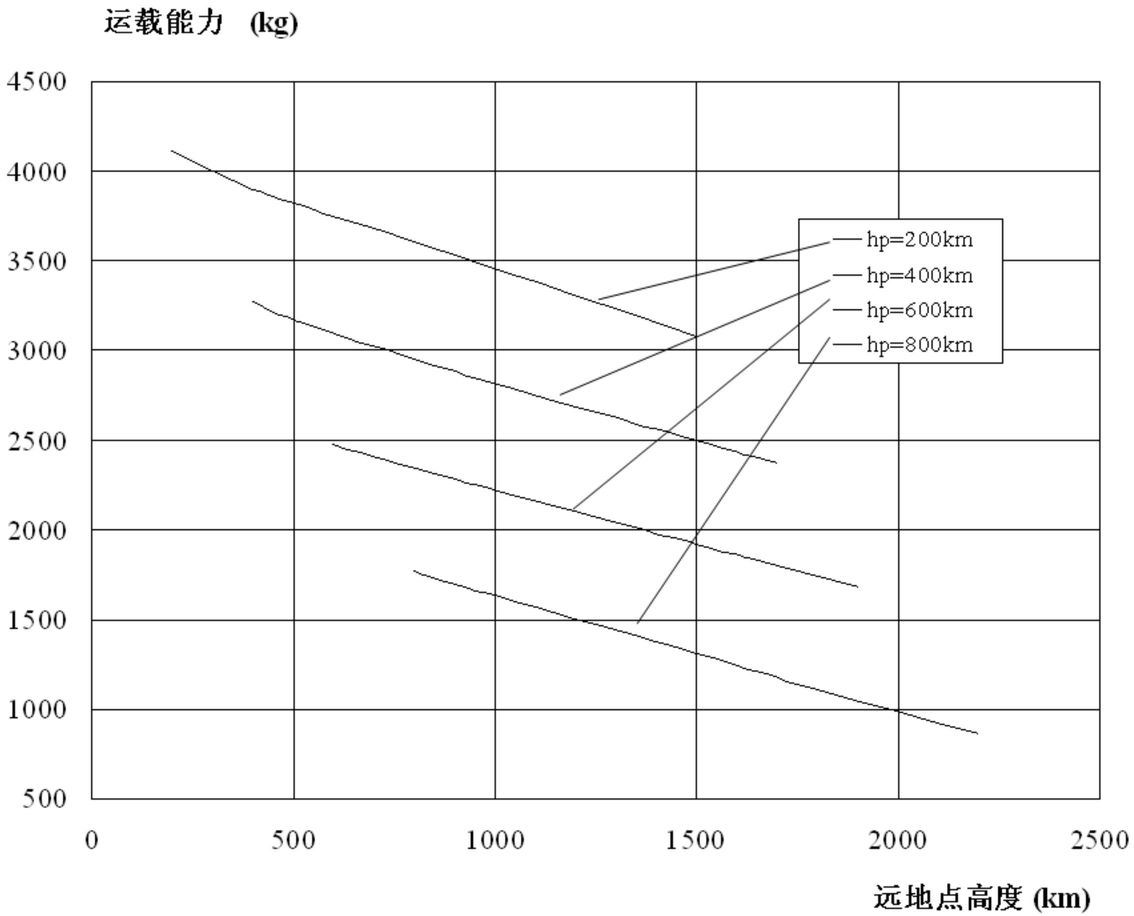

Two-stage LM-2D for  for Circular Orbits

# CZ-2D Launcher




Two-stage LM-2C for 28.5º Inclined Elliptical Orbits

# CZ-2D Launcher




Payload Capability for 45º Inclined Elliptical Orbits

# CZ-2D Launcher

## ➢CZ-2D with a Liquid Upper Stage

- CZ-2D can carry satellite and liquid upper stage into a 200km×800km elliptical orbit. In the perigee of orbit, the liquid upper stage works and Lets satellite(250kg) escaping from the earth with velocity of 11.07km/s.

# CZ-2D Launcher

| Symbol | Parameters | Deviation（3σ） |
| --- | --- | --- |
| Δa | Semi-major axis | 5 km |
| Δe | Eccentricity | 0.003 |
| Δι | Inclination | 0.1° |

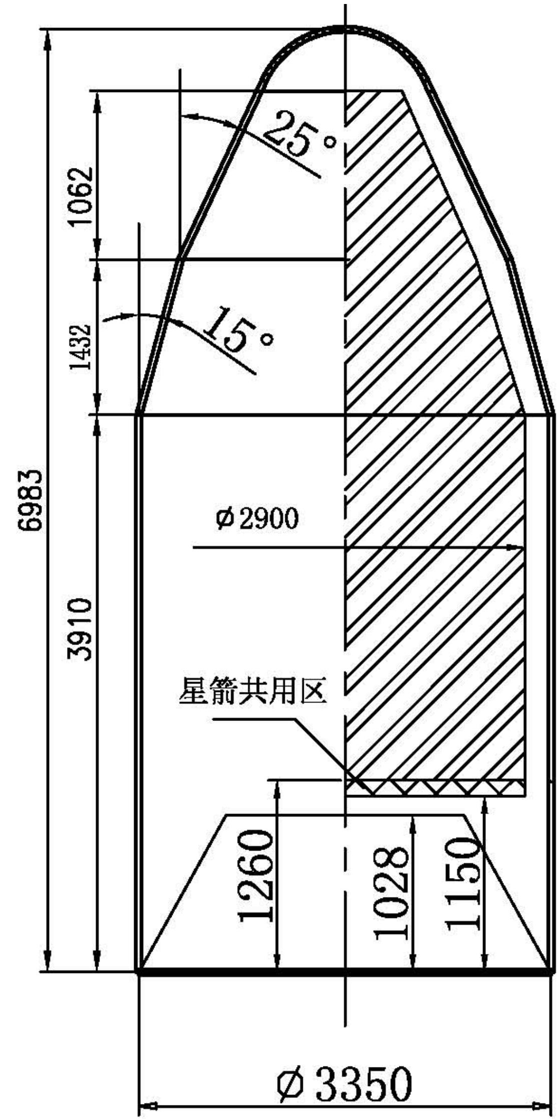
LM-2D Injection Accuracy

# CZ-2D Launcher

➢Fairing Static Envelope : ø2900mm

➢Payload Adapter :

- 1194A Interface
- 937B Interface



# Annex 2

# ISO TRL table

From ISO-16290, Definition of the Technology Readiness Levels (TRLs) and their criteria of assessment

| Technology Readiness Level | Milestone achieved for the element | Work achievement (documented) |
|---|---|---|
| TRL 1: Basic principles observed and reported | Potential applications are identified following basic observations but element concept not yet formulated. | Expression of the basic principles intended for use.<br>Identification of potential applications. |
| TRL 2: Technology concept and/or application formulated | Formulation of potential applications and preliminary element concept. No proof of concept yet. | Formulation of potential applications.<br>Preliminary conceptual design of the element, providing understanding of how the basic principles would be used. |
| TRL 3: Analytical and experimental critical function and/or characteristic proof-of-concept | Element concept is elaborated and expected performance is demonstrated through analytical models supported by experimental data/characteristics. | Preliminary performance requirements (can target several missions) including definition of functional performance requirements.<br>Conceptual design of the element.<br>Experimental data inputs, laboratory-based experiment definition and results.<br>Element analytical models for the proof-of-concept. |
| TRL 4: Component and/or breadboard functional verification in laboratory environment | Element functional performance is demonstrated by breadboard testing in laboratory environment. | Preliminary performance requirements (can target several missions) with definition of functional performance requirements.<br>Conceptual design of the element.<br>Functional performance test plan.<br>Breadboard definition for the functional performance verification.<br>Breadboard test reports. |

| Technology Readiness Level | Milestone achieved for the element | Work achievement (documented) |
|---|---|---|
| TRL 5: Component and/or breadboard critical function verification in a relevant environment | Critical functions of the element are identified and the associated relevant environment is defined. Breadboards not full-scale are built for verifying the performance through testing in the relevant environment, subject to scaling effects. | Preliminary definition of performance requirements and of the relevant environment.<br>Identification and analysis of the element critical functions.<br>Preliminary design of the element, supported by appropriate models for the critical functions verification.<br>Critical function test plan. Analysis of scaling effects.<br>Breadboard definition for the critical function verification.<br>Breadboard test reports. |
| TRL 6: Model demonstrating the critical functions of the element in a relevant environment | Critical functions of the element are verified, performance is demonstrated in the relevant environment and representative model(s) in form, fit and function. | Definition of performance requirements and of the relevant environment.<br>Identification and analysis of the element critical functions.<br>Design of the element, supported by appropriate models for the critical functions verification.<br>Critical function test plan.<br>Model definition for the critical function verifications.<br>Model test reports. |
| TRL 7: Model demonstrating the element performance for the operational environment | Performance is demonstrated for the operational environment, on the ground or if necessary in space. A representative model, fully reflecting all aspects of the flight model design, is built and tested with adequate margins for demonstrating the performance in the operational environment. | Definition of performance requirements, including definition of the operational environment.<br>Model definition and realization.<br>Model test plan.<br>Model test results. |
| TRL 8: Actual system completed and accepted for flight ("flight qualified") | Flight model is qualified and integrated in the final system ready for flight. | Flight model is built and integrated into the final system.<br>Flight acceptance of the final system. |
| TRL 9: Actual system "flight proven" through successful mission operations | Technology is mature. The element is successfully in service for the assigned mission in the actual operational environment. | Commissioning in early operation phase.<br>In-orbit operation report. |

# Questions?