SIRIUS HEAVY LAUNCHER

OPERATIONS

MANUAL

Revision A.0 Phase 0

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Introduction

This addon reproduces the current design study for a shuttle derived heavy launch vehicle (SDHLV) for launching heavy payloads for the NASA exploration program into Low Earth Orbit. This launcher is designed to lift lunar lander and earth departure stage (EDS) into LEO. The payload stack stays in parking orbit and waits for the manned CEV to dock with it.

Version history

0.1	09/18/2005	Initial development release. Autopilot until core stage separation, Status display on HUD, included test version of the Earth 2018 environment.
0.2	09/19/2005	Creation log file, improved autopilot values, improved TVC inputs

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Installation

If you agree to the terms of the license, just unzip the contents of the archive into the root folder your desired orbiter installation. If you don't know what the root folder of your orbiter installation is, search orbiter.exe – the folder which contains this file is the root folder of your installation.

Specifications

Description

The Sirius SDHLV consists of the following major components

- Two solid rocket boosters
- The Core stage
- The second stage
- The payload fairings

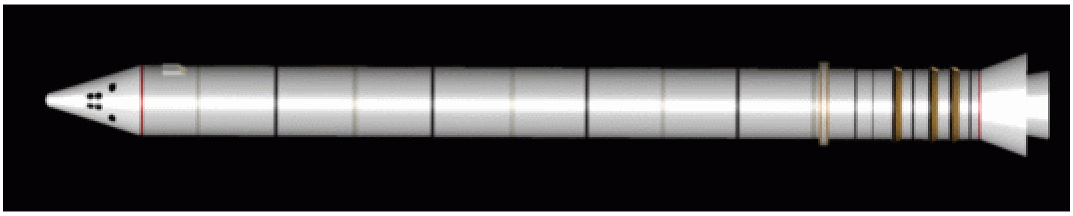
The launcher is optimized for launches from Pad 39B of the Kenndy Space Center.

Physical parameters

Total mass at liftoff	2,417,000 kg
Empty mass	349,000 kg
Maximum payload mass	110,000 kg @ 411 km LEO
Time to payload deployment	~3470 seconds

Solid Rocket Boosters

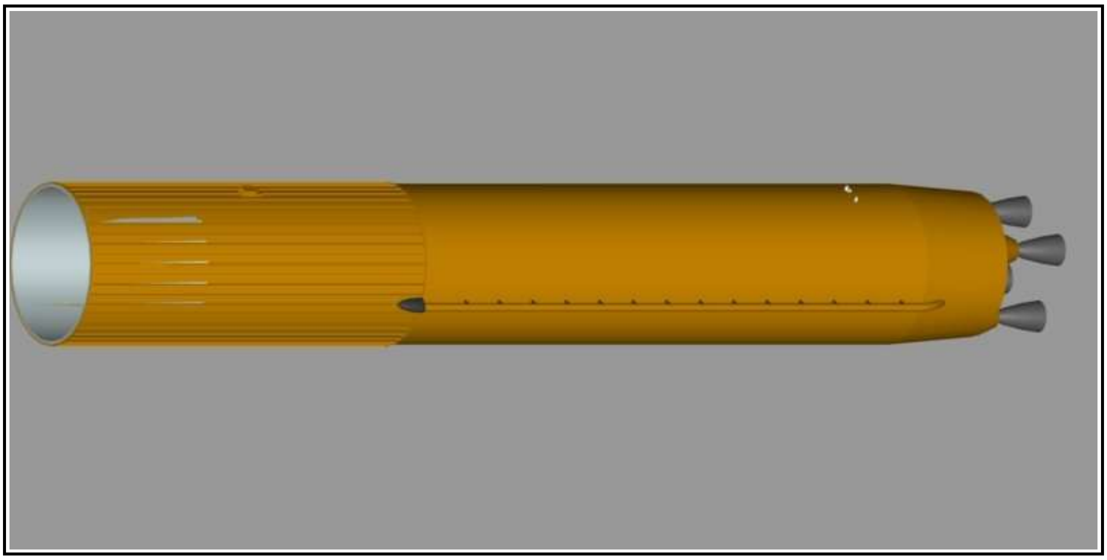
The solid rocket boosters of the Sirius SDHLV are similar to the common STS SRBs, but have an extra fuel segment, for higher thrust and burn time. These boosters have already performed the first successful test firings on the ground and can be considered proven technology.



Empty mass	87,000 kg each
Propellant mass	621,000 kg each
Burn time	128 seconds
Total Impulse	1,433.3 MNs
Sea level thrust	16,000 kN
Recovery	ocean landing by three main chutes

Core stage

The core stage is derived from the super lightweight external tank, flown by the STS since 1991. The most important changes are the interstage structure and modified LO2 tank for installing second stage and payload inline with the core and the aft section with its 4 expendable SSME engines.



The SSMEs on the core stage have been simplified for reducing the costs. The performance is assumed to be similar, but the 25x reuseability has been lost. The engines are now only able to fly one mission and their lifetime can be assumed to be only slightly above the 350 seconds burn time.

There are now two LOX feed lines instead of one on the ET for supplying four engines. This change has been suggested already in the ALS/NLS design documents.

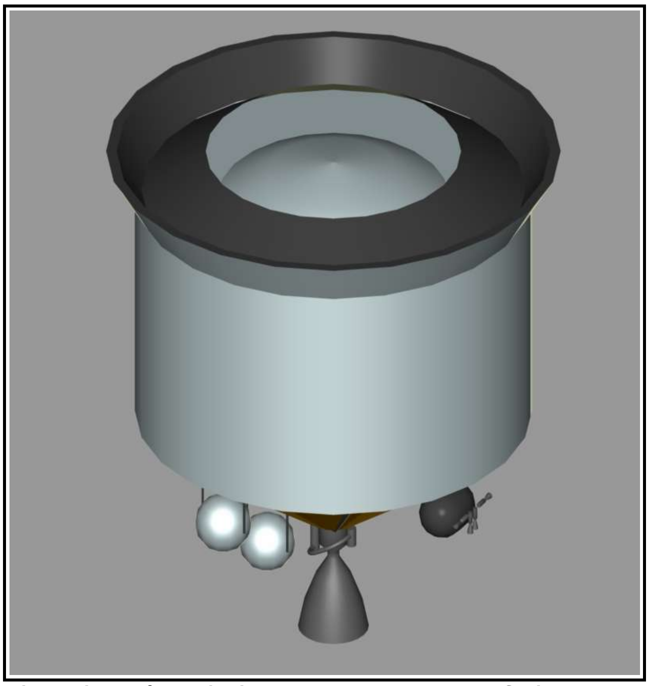
The LOX tank has been modified to use the same tooling as the LH2 tank and form the bottom part of the interstage structure.

The interstage structure already begins at the intertank section of the core stage and is strengthened to accept the loads from the second stage and the solid rocket boosters.

Empty mass	54,000 kg
Propellant mass	721,000 kg
Propellant type	LH2 + LO2
Burn time	350 seconds
Engines	4x expendable SSME

Second stage

The second stage is a new development, based on a J-2S engine, whose ancestors already flew to the moon inside the Saturn V.



The J-2S is simplified and replaced the gas generator of the original version with a expander cycle high pressure turbopump. It is capable of up to 2 restarts, the typical mission profile uses one restart.

Empty mass	9,069 kg
Propellant mass	105,000 kg
Propellant type	LO2 + LH2
RCS propellant	250 kg
RCS thrust	8x 2 kN
RCS propellant	Hydrazine
Main engines	1x J-2S

Mission Events

T-6.6	SSME ignition
T-0.3	SRB ignition
T+0.0	Liftoff
T+7.5	Pitchover and start of roll program.
T+62	MAXQ (Q~39.5 kPa)
T+132	SRB separation

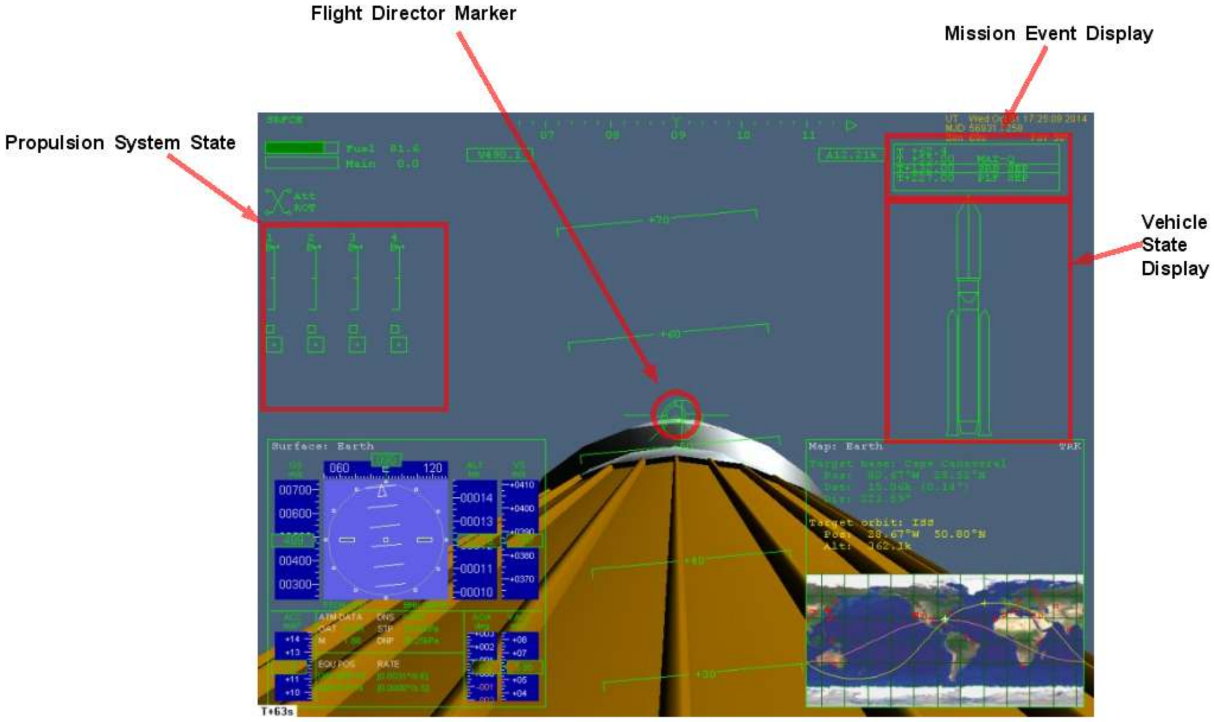
T+345	MECO
T+350	Core stage separation
T+728	SSECO1

User Interface

Keyboard

NUM-+ Initiate ignition sequence.

HUD



Flight Director Marker

Displays the target for the autopilot during core stage operation. Does not display useful information after core stage separation. The wings indicate bank error, the circle the pitch and yaw errors.

Mission Event Display

Displays the Mission Elapsed Time and the events around the current MET. The first line shows the MET in T-Time (T+0 = Takeoff). The second line displays the last event during launch.The third line is the next event during this mission, the last line shows the following event.

Propulsion System State

Shows the propulsion system data for the core stage and the second stage.

During core stage operation, the display shows the parameters of the SSMEs 1-4. From top to bottom, the displayed parameters for each engine are:

Main combustion chamber pressure / commanded thrust level.

Engine good/bad indicator

TVC deflection indicator

The MCC pressure indicator is the big triangle on the left side of the slide indicator. The top position equals 21 MPa or ~3100 PSI MCC pressure, the bottom position is zero. The indicator to the right displays the commanded thrust level from 0% to 109% . When the pressure is below or above the flight limits, the MCC pressure indicator starts to blink.

The Engine good/bad indicator is the small square below the pressure indicator. When it blinks, the engine is considered in an unstable operation state. This happens usually during startup.

The TVC deflection indicator shows the deflection of the noozle for each engine from the neutral position. When centered, the thrust vector points straight to the CoG. When the deflection exceeds 4◦ from the center position, the indicator circle starts to blink.

Vehicle State Display

The vehicle state display shows the current configuration of the launcher. It is planned for a later version to signal warnings and failures by highlighting the source subsystem by letting it blink on this display.

Scenario File

TBD

Launch

Depress '+' on the numerical keyboard to initiate the ignition sequence at T-6.6 seconds. The autopilot puts you into a suborbital trajectory at T+350 seconds. After separation of the core stage, you need to pilot the second stage yourself into the desired orbit (This will get replaced by a full second stage autopilot in a later version)

Making Scenarios

Example for adding a Sirius launcher to a scenario:

```
Sirius-1:SDLV\Sirius
  STATUS Landed Earth
  POS -80.6232502 28.6197341
  HEADING 0
  NAVFREQ 0 0
  PRPLEVEL 0:1.000 1:1.000 2:1.000 3:1.000 4:1.000
  STRUCT_STATE 0
  FAIRING LONG
END
```

Example for adding a payload to the Sirius:

```
Carina:Carina
  STATUS Orbiting Earth
  ATTACHED 0:0,Sirius-1
END
Sirius-1:SDLV\Sirius
  STATUS Landed Earth
  POS -80.6232502 28.6197341
  HEADING 0
  NAVFREQ 0 0
  PRPLEVEL 0:1.000 1:1.000 2:1.000 3:1.000 4:1.000
  STRUCT_STATE 0
  FAIRING LONG
  PAYLOAD_MASS 5000.0
END
```

Planned features for the next versions

Communication between payloads and launcher

Second stage autopilot

Animated launch pad

Prelaunch processing

SRB recovery

More payload fairing types.

Failure simulation

Development milestones

Milestone	Features
M0	Payload deployment, full autopilot until payload separation.
M1	SRB recovery, Core stage destruction, Second stage disposal
M2	Prelaunch Processing, animated launch pad, launch termination
M3	Failure simulation, flight aborts
M16	Integration in VAB

Credits

Core stage mesh: Dennis 'Urwumpe' Krenz

Second stage Mesh: Dennis 'Urwumpe' Krenz

PLF meshes: Dennis 'Urwumpe' Krenz

5 Segment SRB Meshes: David 'Orbiter Fan' Sundstrom

Vessel Modules: Dennis 'Urwumpe' Krenz

References

[1] „National Launch System cycle I loads and models data book", NASA-TM-103560

[2] „Cycle 0 (CY1991) NLS trade studies and analyses report – Book I: Structures and core vehicle", NASA-CR-184471

[3] „Cycle 0 (CY1991) NLS trade studies and analyses report – Book II, Part 2: Propulsion", NASA-CR-184472

[4] „Reliability and crew safety assessment for Solid Rocket Booster / J-2S based launch vehicle", Joseph R Fragola, SAIC

Appendix A: Filelist

Config/sdlv/

RSRB5L.cfg

RSRB5R.cfg

Sirius.cfg

SDLV_Core.cfg

sdlv_fair_ll.cfg

sdlv_fair_lr.cfg

doc/sdlv/

Sirius License.txt

Sirius Operations Manual.pdf

meshes/sdlv/

sdlv_fair_ll.msh

sdlv_fair_lr.msh

sdlv_rsrb5l.msh

sdlv_rsrb5l_body.msh

sdlv_rsrb5l_frstm.msh

sdlv_rsrb5l_nose.msh

sdlv_rsrb5r.msh

sdlv_rsrb5r_body.msh

sdlv_rsrb5r_frstm.msh

sdlv_rsrb5r_ne.msh

sdlv_rsrb5r_nose.msh

sdlv_stage1.msh

sdlv_stage2.msh

modules/

sdlv_sirius.dll

sdlv_rsrb5.dll

orbitersdk/samples/sdlv110/

BasicEngine.cpp

PIDLOOP.cpp

RSRB5.cpp

RSRB5_Interface.cpp

SDLV110.cpp
SDLV_RSRB5.cpp
SSME.cpp
SDLV110.dsp
SDLV_RSRB5.dsp
SDLV110.dsw
RSRB5.h
SDLV110.h
SDLV_Engines.h
Vessel2X.h

scenarios/Earth 2018/

Sirius-1 launch.cfg

textures/sdlv/

5segSRB_frustrum.dds
5segSRB_leftcasing.dds
5segSRB_misctex.dds
5segSRB_rightcasing.dds

Appendix B: Scenario file parameters

PAYLOAD_MASS

Defines the mass of an attached payload – if no payloads are attached, this parameter gets zeroed.

Syntax:

PAYLOAD_MASS mass [kg]

FAIRING

Defines the fairing type used

Syntax:

FAIRING type

type	Description
NONE	No fairing, but fairing adapter is still attached
LONG	35m x 10 long fairing installed
SHORT	18m x 10 Short fairing installed
LONG_OPEN	Long fairing installed with 6m diameter opening at the top.
SHORT_OPEN	Short fairing with 6m opening at the top