



LEROS 4

High Thrust Apogee Engine

An overview of development model testing

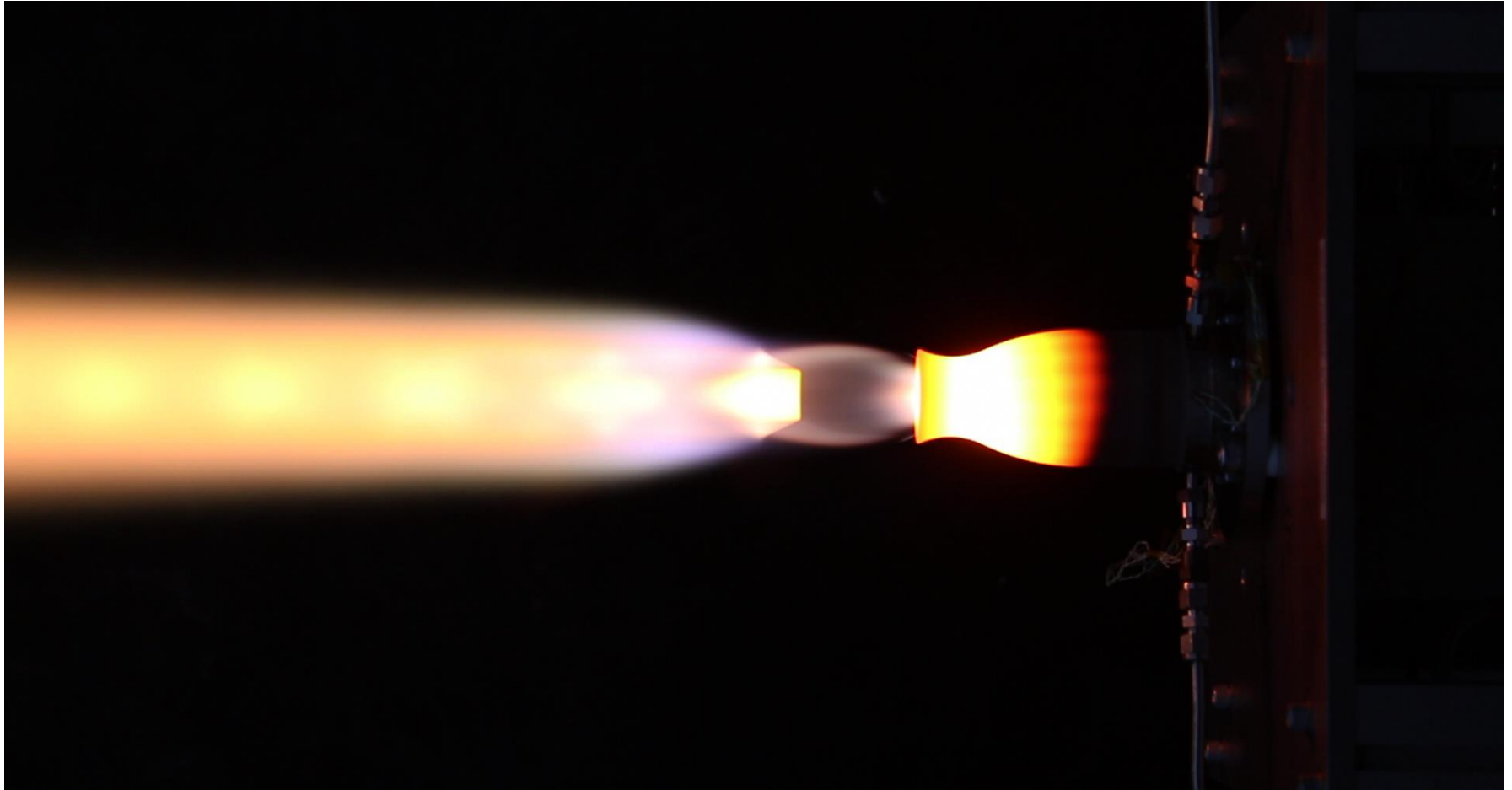
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Paper No. 2969298
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How we got to this point.

Approx. 0.5 m



Phase 1B sea-level firing #33 of 704 conducted at Moog Westcott Operations UK

Overview

Concept design

Materials investigation

Engine design and build

Test facility build

Engine testing

Summary

Concept design

Materials investigation

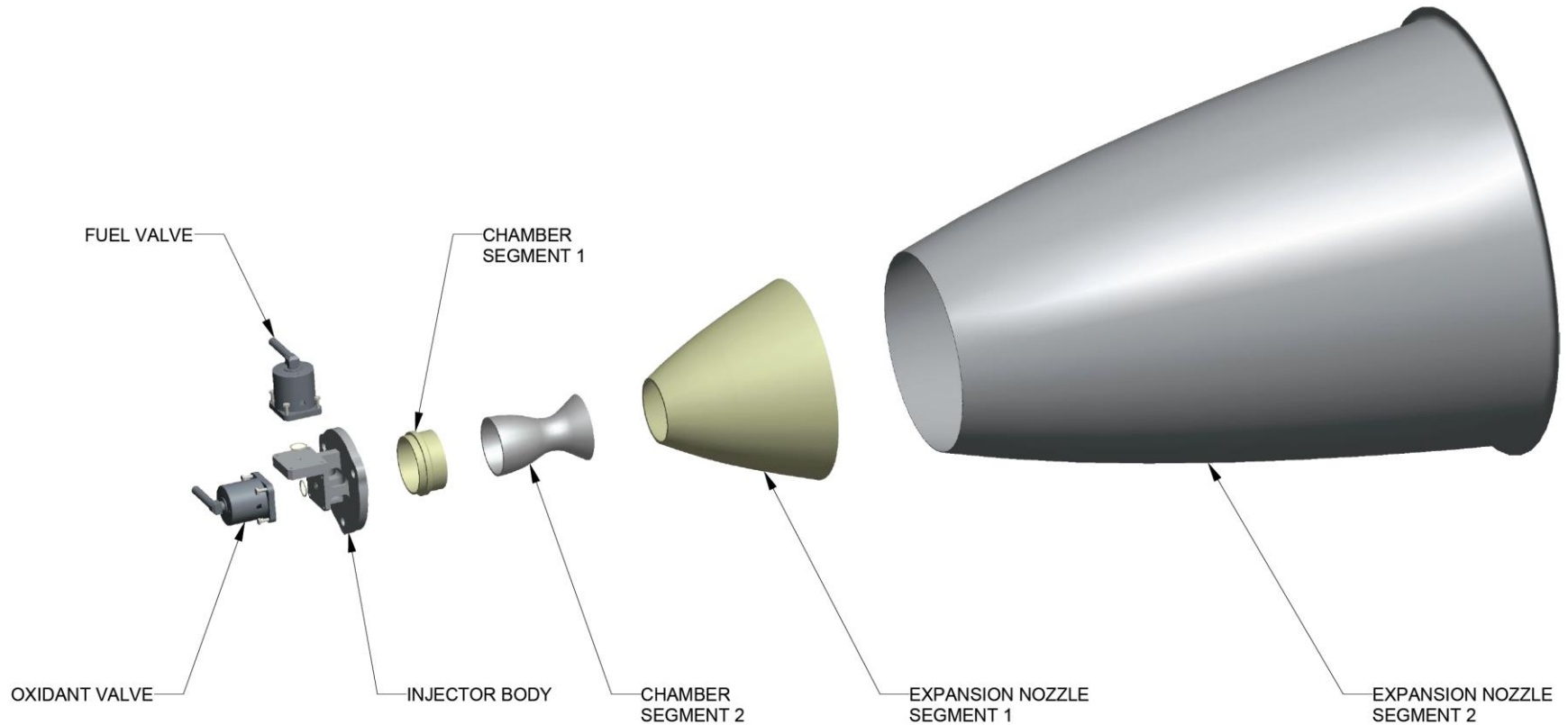
Engine design and build

Test facility build

Engine testing

Summary

Flight engine design concept



LEROS 4 flight engine concept at the end of Phase 1B

Concept design

Materials investigation

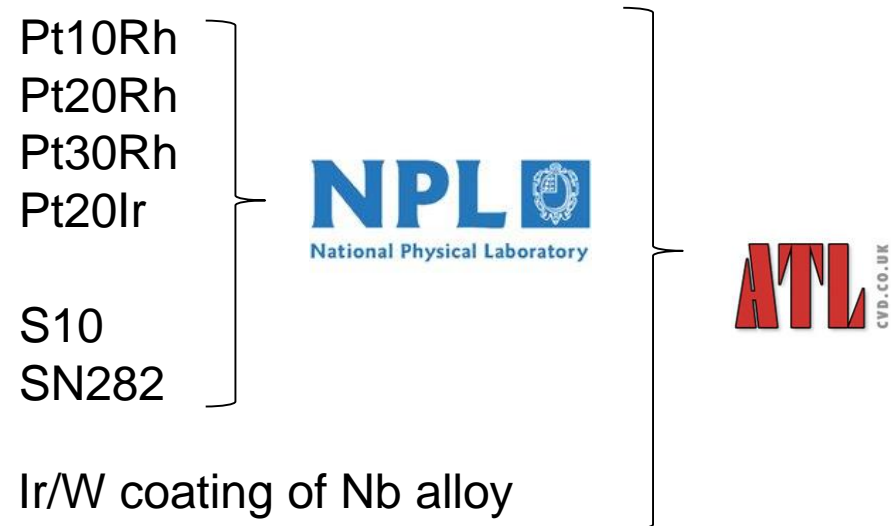
Engine design and build

Test facility build

Engine testing

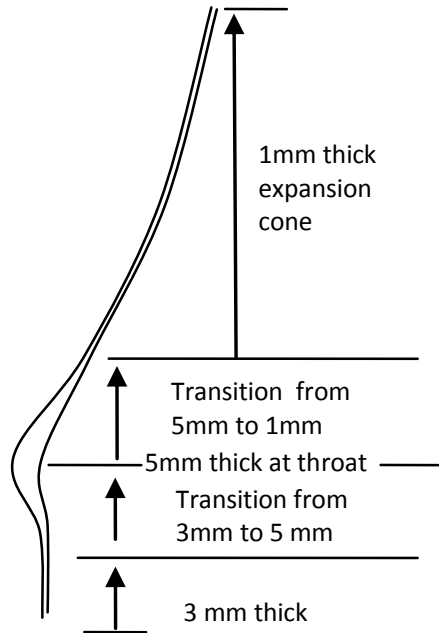
Summary

Materials investigation

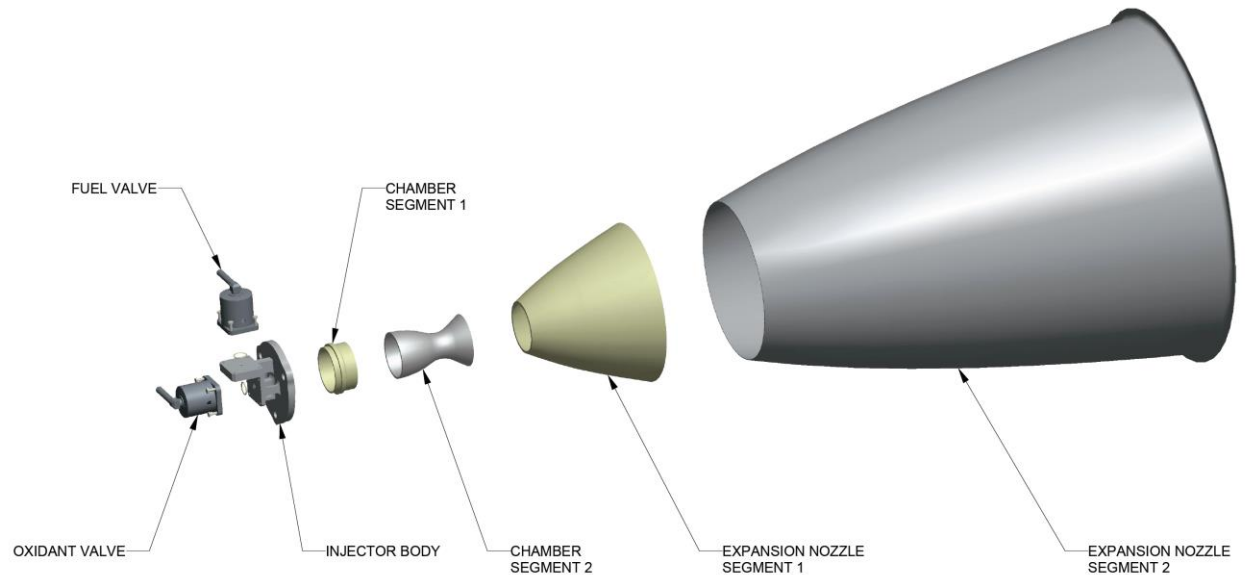


Materials tested to inform structural-thermal models

Flight engine design concept

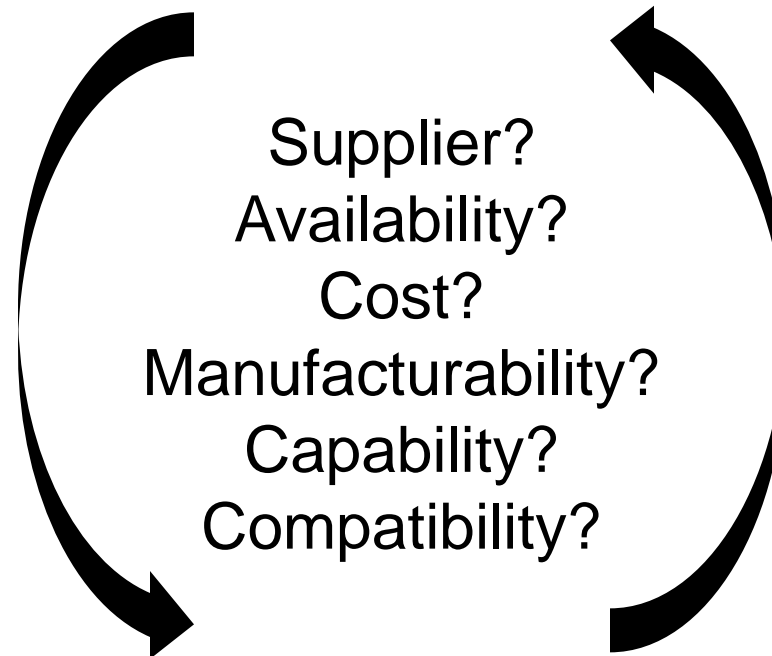


Geometry 2: Thick throat



Structural-thermal analysis of the LEROS 4 flight engine concept

Materials investigation



Concept design

Materials investigation

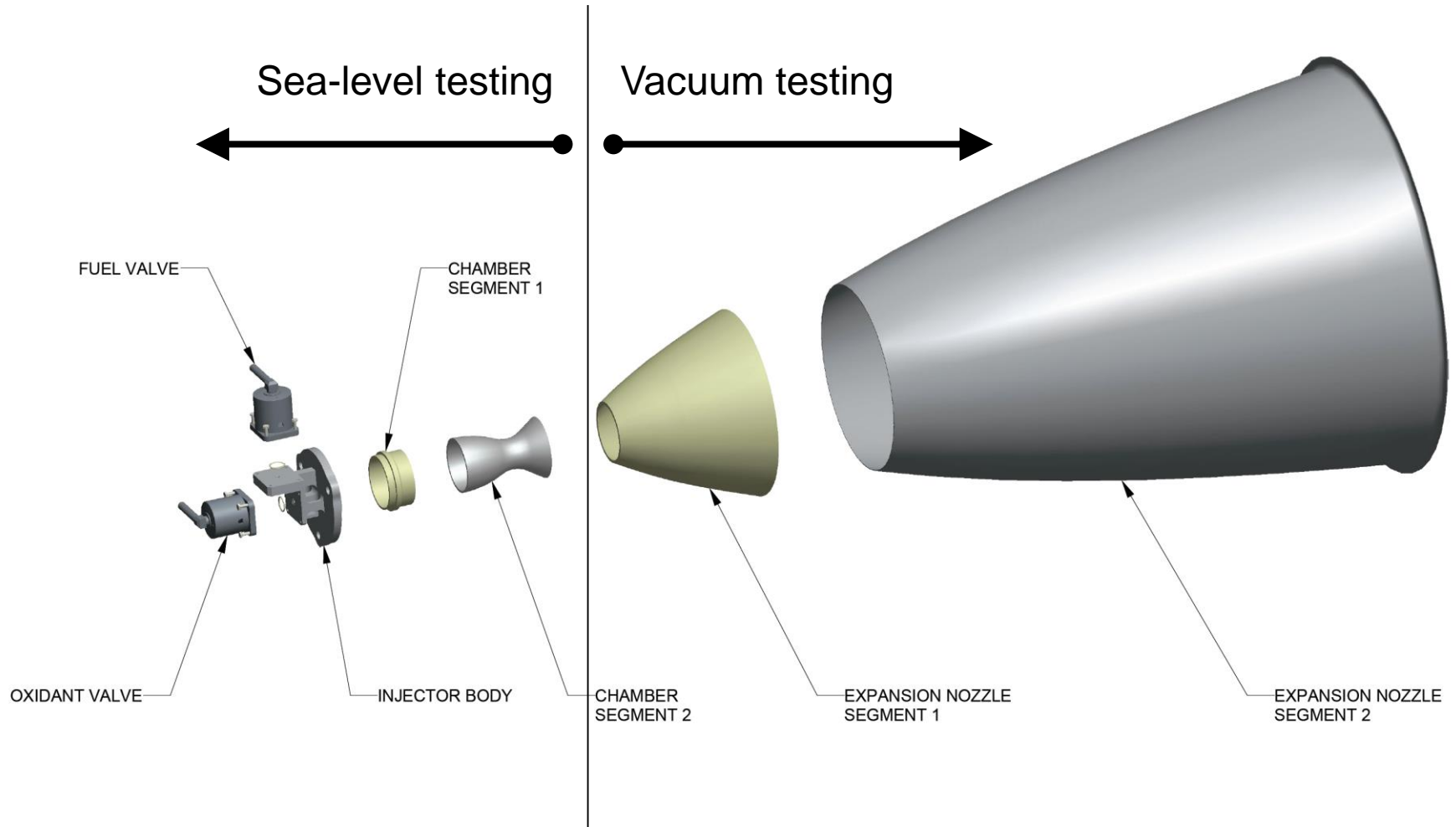
Engine design and build

Test facility build

Engine testing

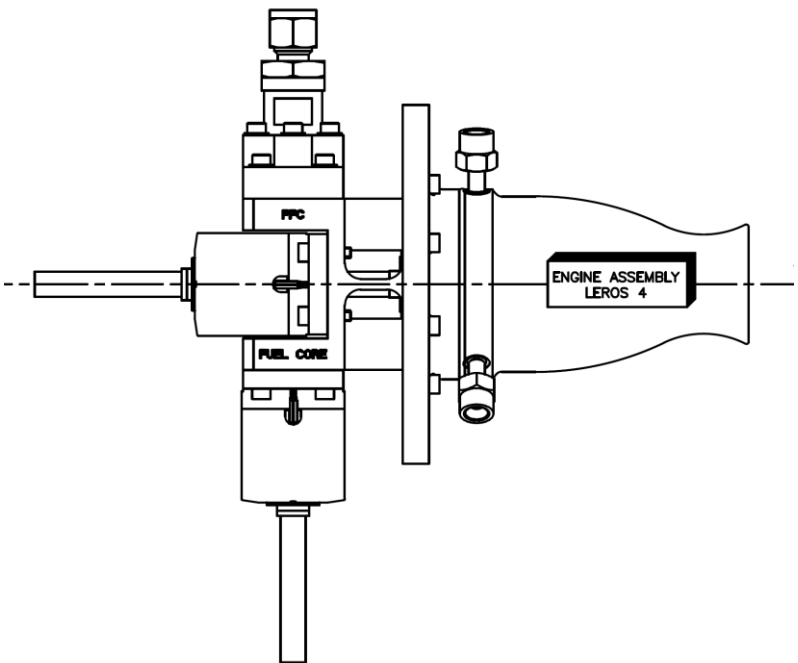
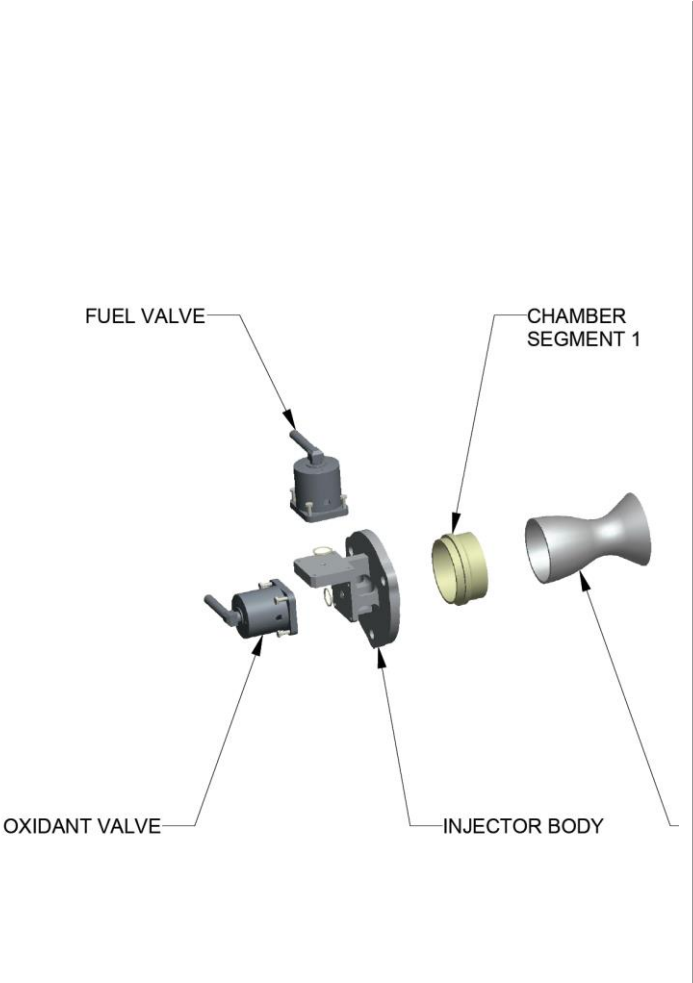
Summary

Flight engine concept



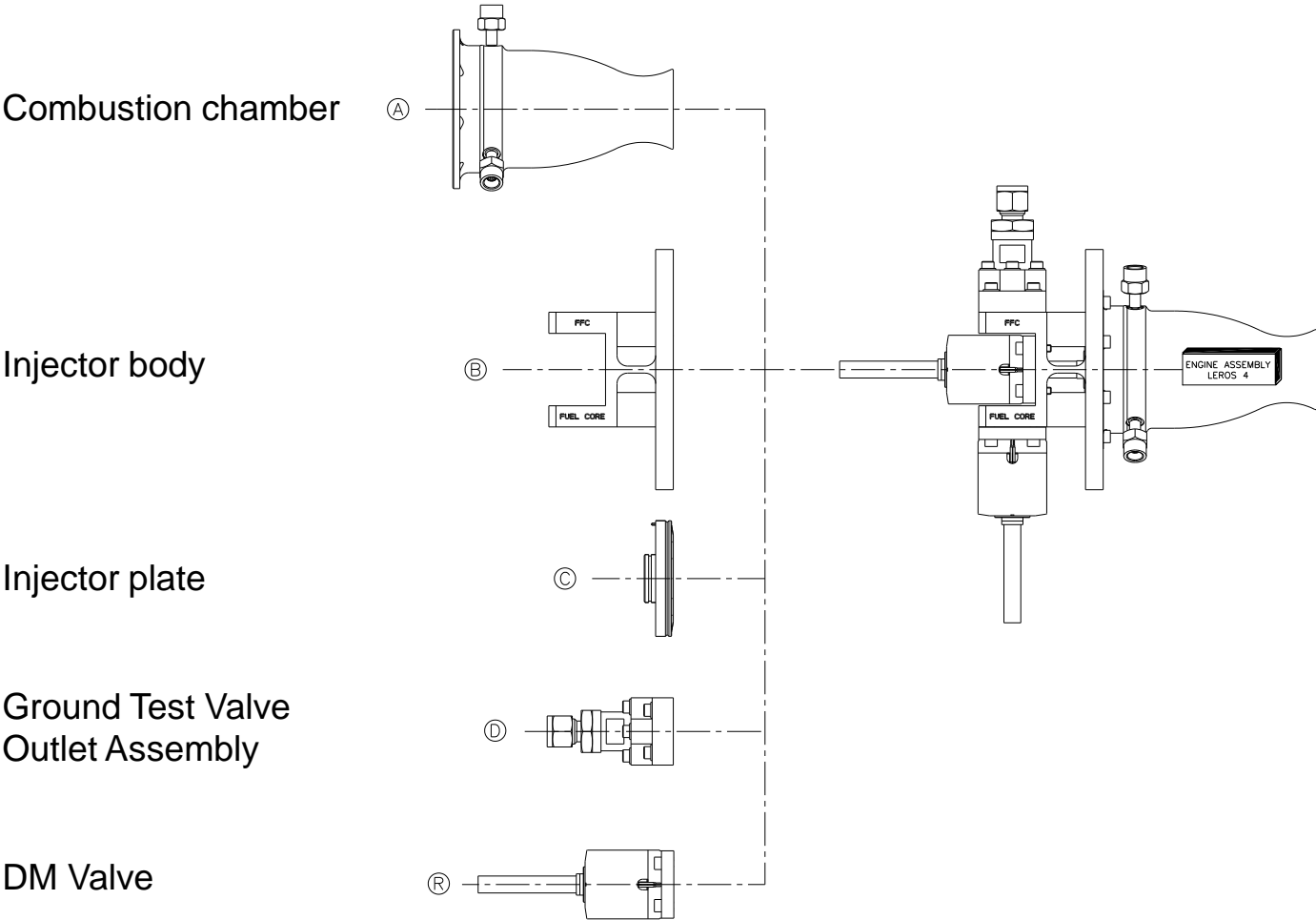
Phase 1B sea-level testing excluded the expansion nozzle

Development model



Flight engine vs Development Model (DM) engine

Development model



Main components used in a typical configuration of the DM engine

Concept design

Materials investigation

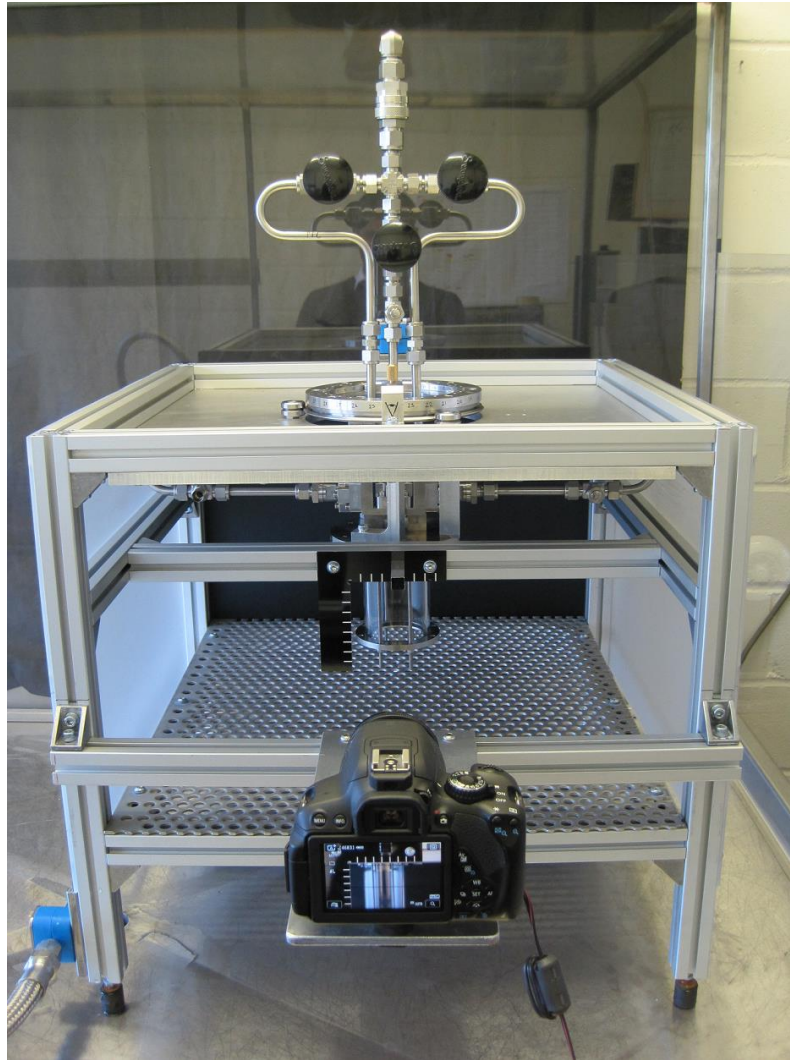
Engine design and build

Test facility build

Engine testing

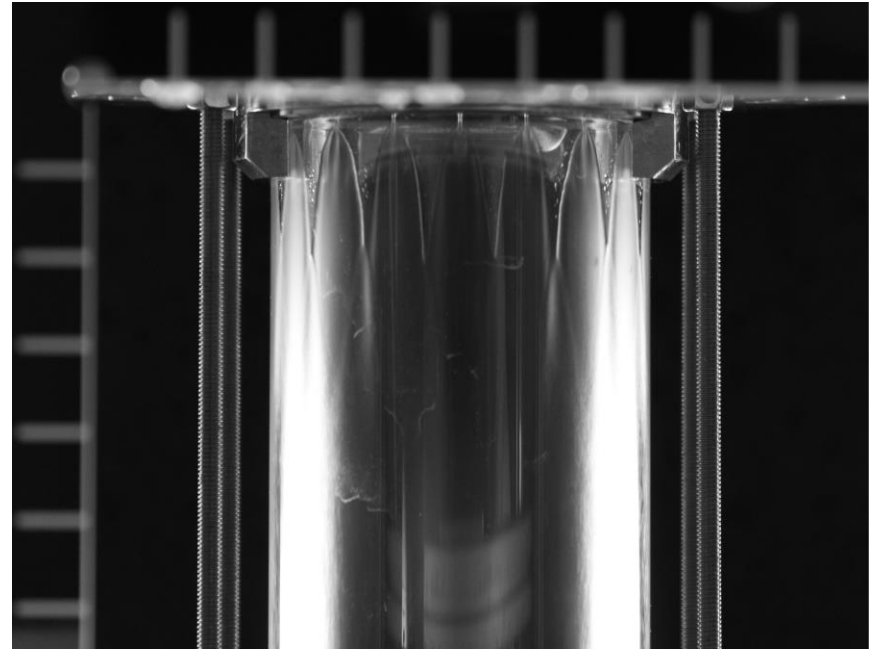
Summary

Cold-flow testing



Cold-flow test rig for characterisation of propellant injectors

Cold-flow testing



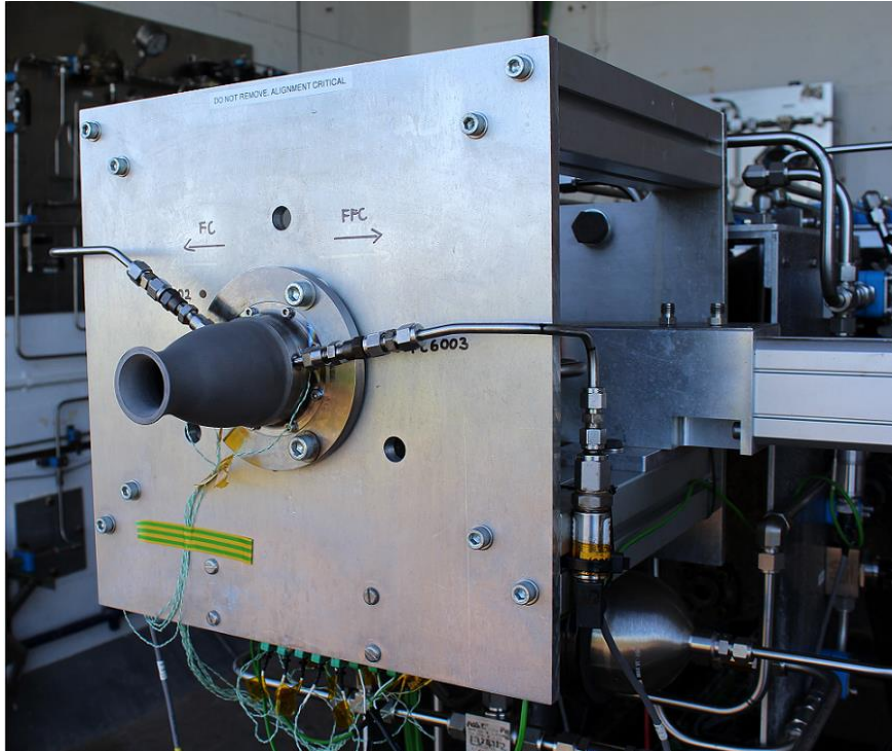
Typical cold-flow testing images obtained

Sea-level hot-fire testing



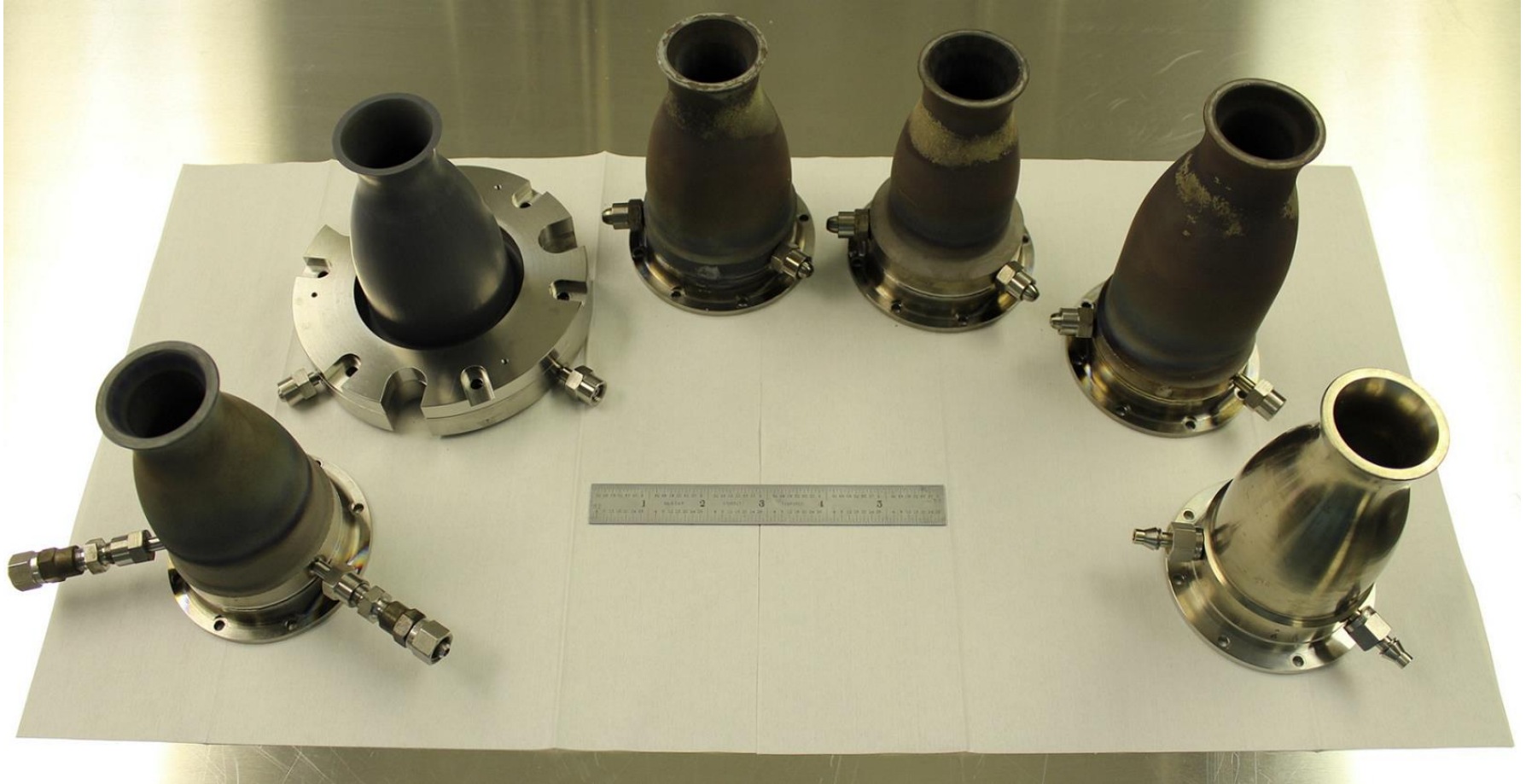
Sea-level hot-fire test facility at Moog Westcott Operations UK

Sea-level hot-fire testing



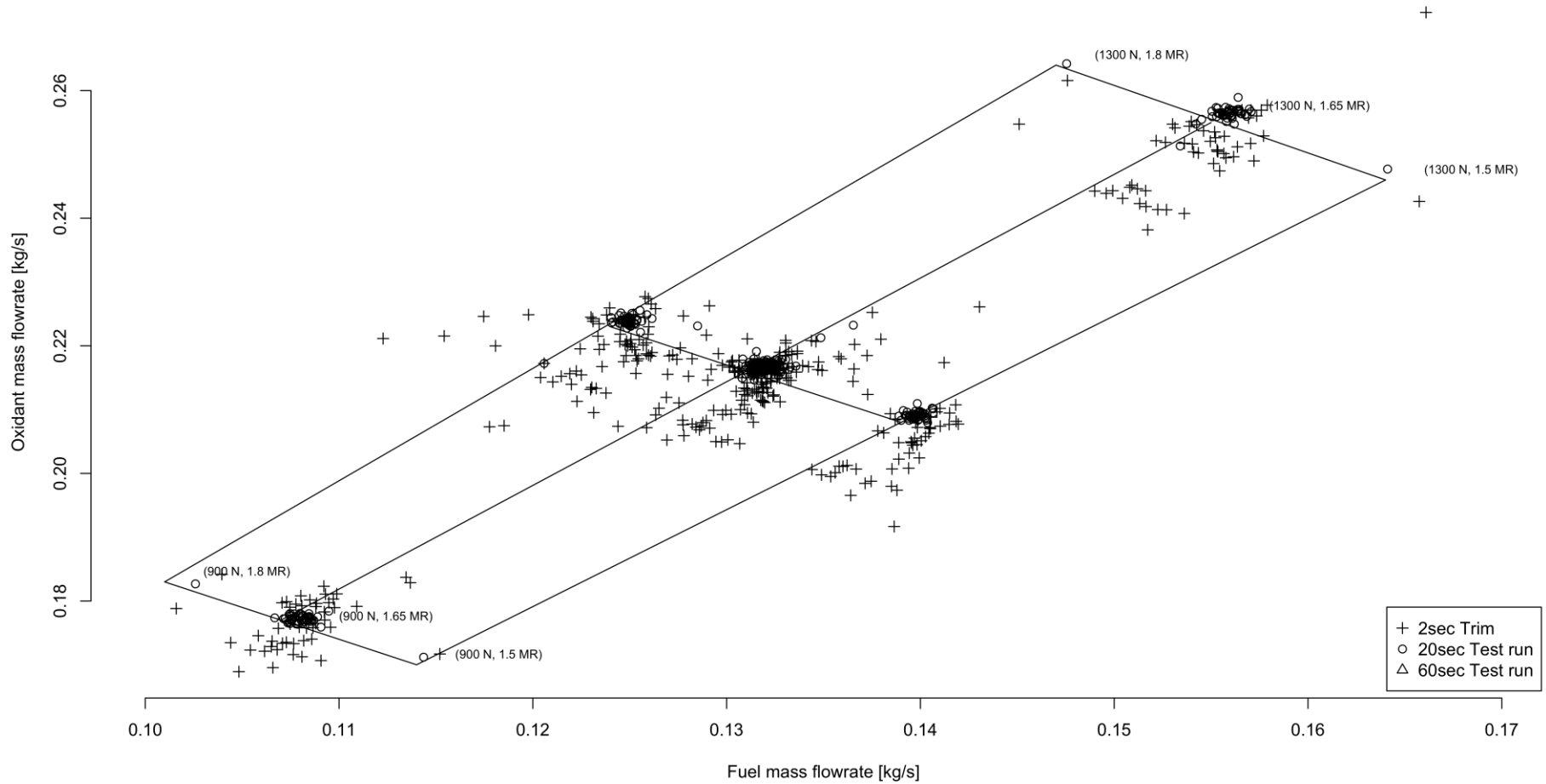
DM engine mounted on the test stand along with DM valves

Sea-level hot-fire testing



Range of combustion chambers hot-fire tested in Phase 1B

Sea-level hot-fire testing



Performance box investigated in Phase 1B. Over 700 firings plotted.

Concept design

Materials investigation

Engine design and build

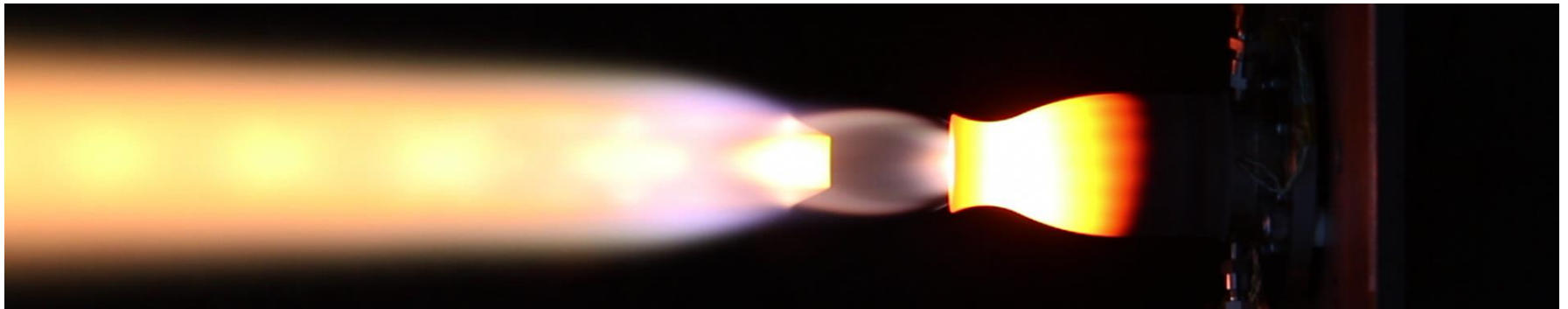
Test facility build

Engine testing

Summary

Summary

- Iterated flight engine design
- Tested candidate materials
- Built development model valves
- Built an SN282 chamber (with JAXA/MHI)
- Built a development model engine (39 injectors, 6 chambers)
- Upgraded test facilities
- Cold-flow and hot-fire tested hardware (over 700 firings)
- Next phase is DM engine optimisation with off-nominal propellants.



SP2014 papers

Test facility : I. Coxhill et al., "The design, construction and operational experiences of a 0.5 to 15 kN sea level rocket engine test facility",

Structural-thermal : M. Poucet et al., "Material and geometry trade-off of the LEROS 4 1100 N high thrust apogee engine"

Valve : M. Houston et al., "A high flow rate apogee engine solenoid valve for the next generation of ESA planetary missions"

This paper : L. Naicker, R. Wall and D. Perigo, " An overview of development model testing for the LEROS 4 High Thrust Apogee Engine"

