S25 GSTP Program

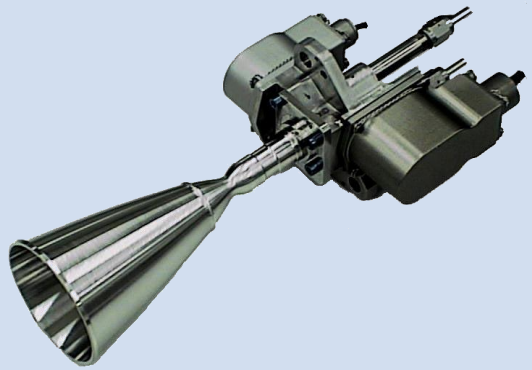
ESA Contract No. 4000133839/21/NL/GLC/va "Assessments to Prepare and De-Risk Technology Developments: 22N Thruster"

Final Presentation July 20th, 2021

Doc No: 22N-ASLLAM-RP-0002

Starting Point: S22 Heritage Versions

Status End 2003, see also AIAA-2003-4777

S22-01 (Solenoid valve)	S22-02 (Torque motor valve)	S22-03 (Titanium Lightweigt valve)
		
Clamped injector / Chamber Two COTS double seat solenoid FCV‘s	Full welded Injector / Chamber Modified Standard 10N double seat FCV	Clamped injector / Chamber Development double seat FCV
Test Program: ▪ SSF Performance Mapping ▪ PMF Performance Mapping ▪ PMF Thermal Stability	Test Program: ▪ SSF Performance Mapping ▪ SSF Margin Tests ▪ SSF Long Duration Runs ▪ PMF Performance Mapping ▪ PMF Thermal Stability	Test Program: ▪ SSF Performance Mapping ▪ PMF Performance Mapping ▪ PMF Thermal Stability

S22-02 Design including lessons learned (DOC No: TP42-TN-02-016) is Baseline for 2021 Revitalization

S25 Design

Design Considerations for 2021 GSTP Project are based on actual Customer Needs

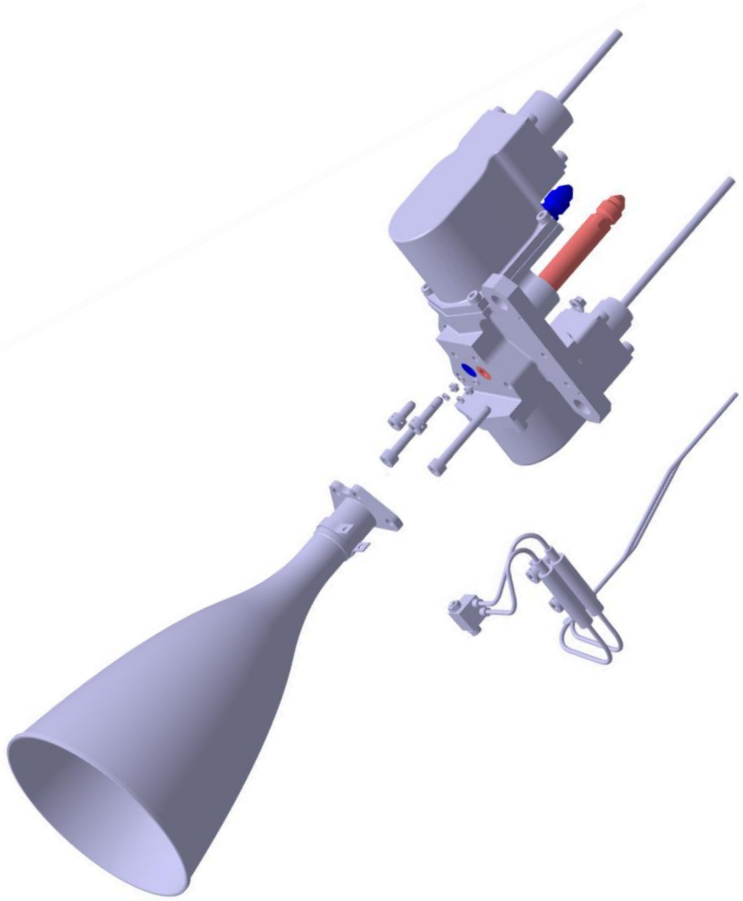
Heritage

S4/S10/S22/S400 biprop engines

- S22 low cost engine
- S10 ARTES program wrt material obsolescence
- S4 ARTES low impulse injector tech demonstrator

Components

- Maximised communalities with the established S10 engines (valve and peripheral thermal equipment; test equipment; procedures, procurement; etc.)
- Built-in trimming orifices
- Coax. vortex injection
- Uncoated Platinum alloy chamber
- Super-alloy heat barrier and nozzle extension



Valve

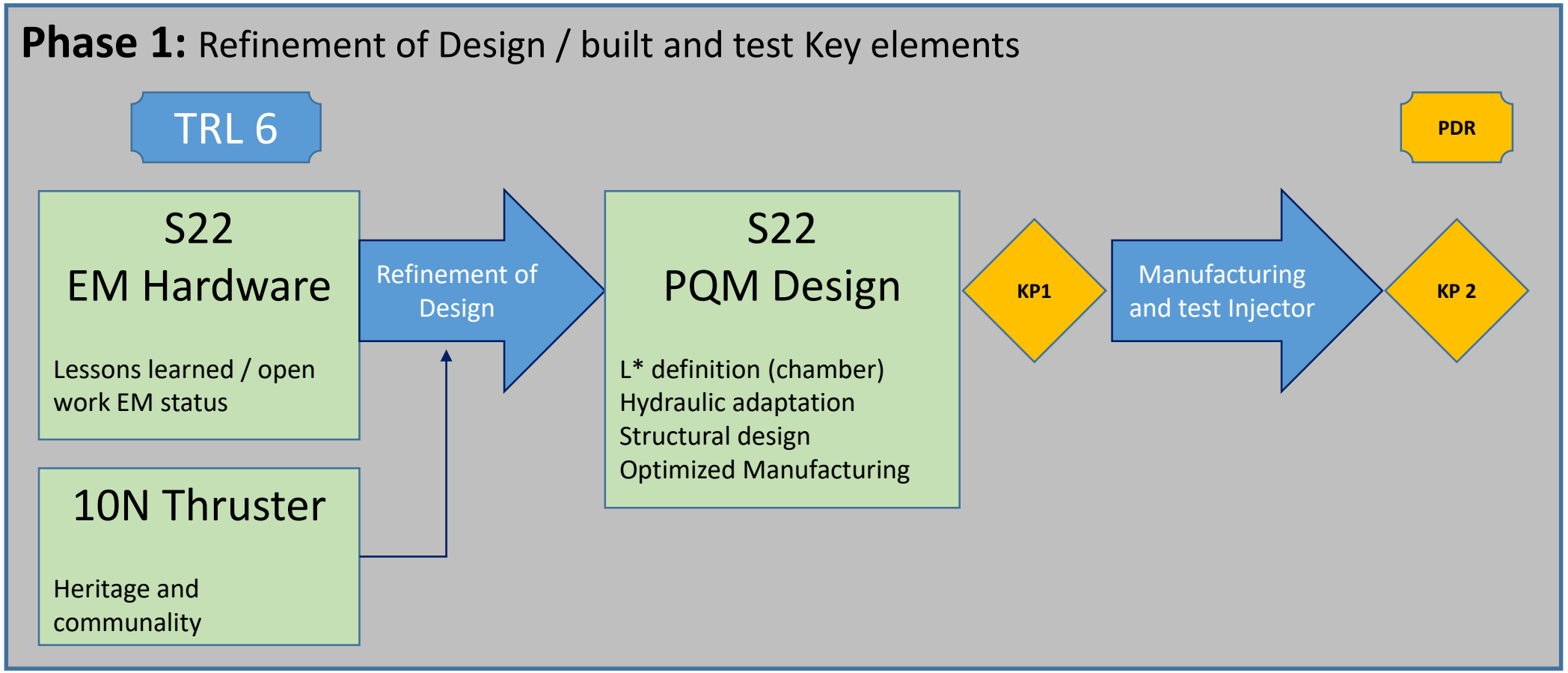
- Valve portfolio is shared with S4 and S10: dual seat torque motor valve with nominal 28; 42 ;51VDC supply voltage
- Optional single seat version
- Hydraulic interface screwed AN2 or weld ¼" Ti interface
- structural interface via 3 alignment studs

Temperature sensors / heaters

- Flight sensor: PT1000 primary and redundant chamber sensor (option)
- Optional additional thermistors (flange / valve cap) and heaters

S25 GSTP Program (Phase 1)

Actual Work Content



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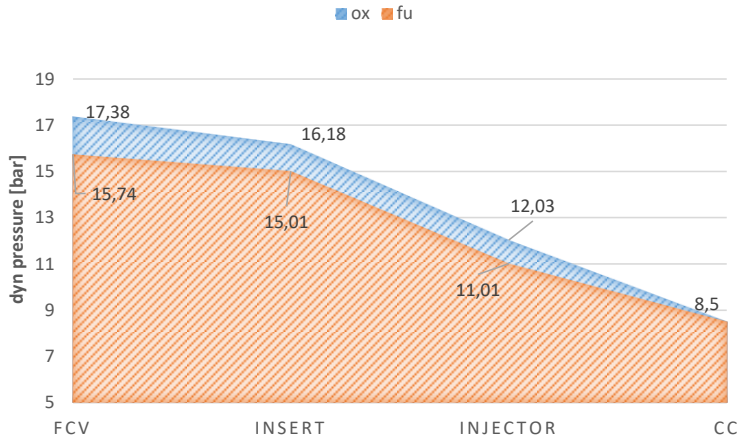
Injector Design

Injector Design

- Global ∆p Requirement for injector defined based on pressure drop cascade



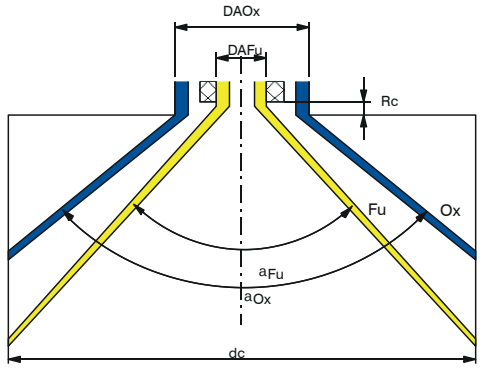
- Injector pessure drop based on necessary
  - Atomization, functional working of injector
  - decoupling from feed system (experience: ∆p ≥ pc/3)

Injector Design Parameters

- Pressure drop requirements

	dp_{Ox} [bar]	dp_{Fu} [bar]
Injector min	3,00	3,00
Injector max	4,62 max	6,02 max

- Injector Design Parameters (double swirl)



OX nozzle outlet diameter	DA_{Ox}
FU nozzle outlet diameter	DA_{Fu}
OX spray angle	a_{Ox}
FU spray angle	a_{Fu}
Recess	Rc

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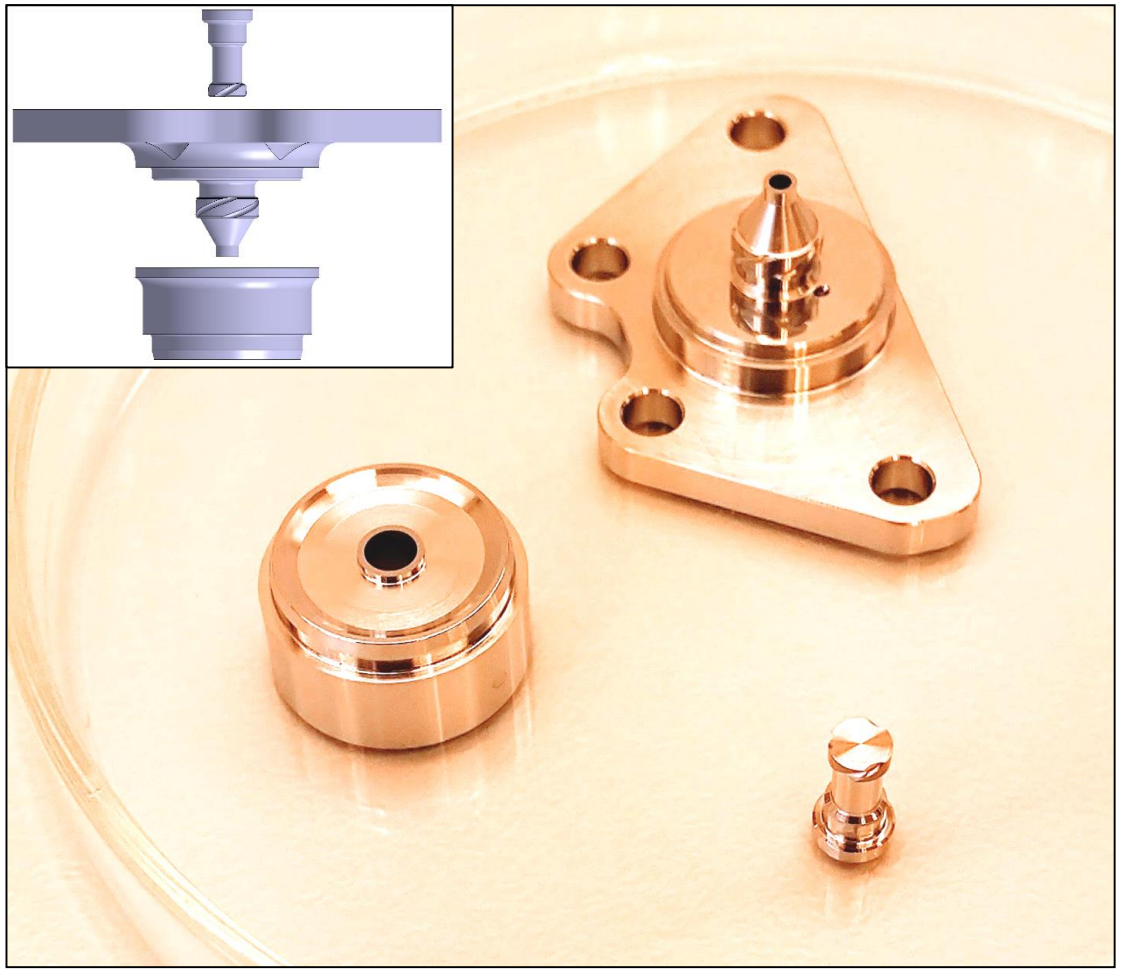
Injector Design Variations

Parameter Variations

- Number of Slots (Channels)
- Slot manufacturing method (morphology / tools used)
- Sealing / tolerance concept (gaps)
- Recess

	Int. level	Item	Model	dp	spray	atomisation	population	note
Part 1	3	Fu 3 channels	MK1	x		x	10	With channel morphology variation
	3	Ox 5 channels	MK1	x		x	2	With channel morphology variation
	3	Ox 4 channels	MK2	x		x	10	With channel morphology variation
	3	Ox 3 channels	MK3	x		x	2	With channel morphology variation
Part 2	2	Radial gap var.	PQM	x	x	x	3	
	1	Recess var.	PQM	x	x	x	3	
Part 3	1	Hot fire demo	PQM	x			1	Forecast GSTP phase 2



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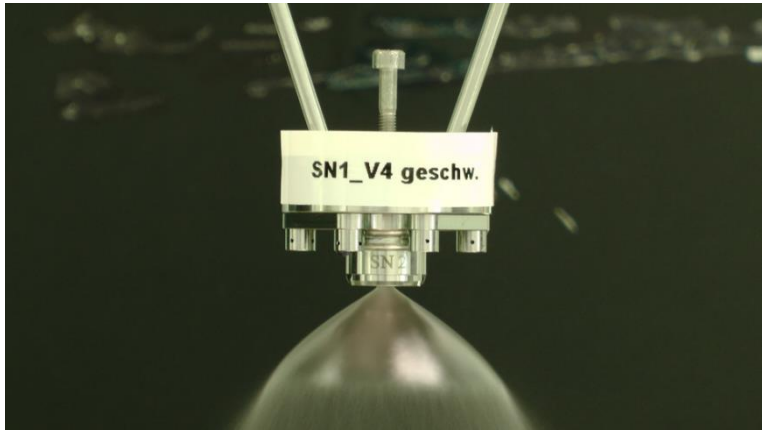
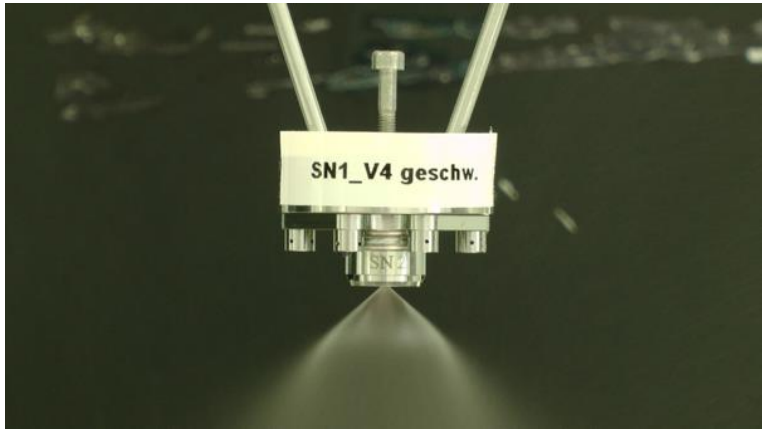
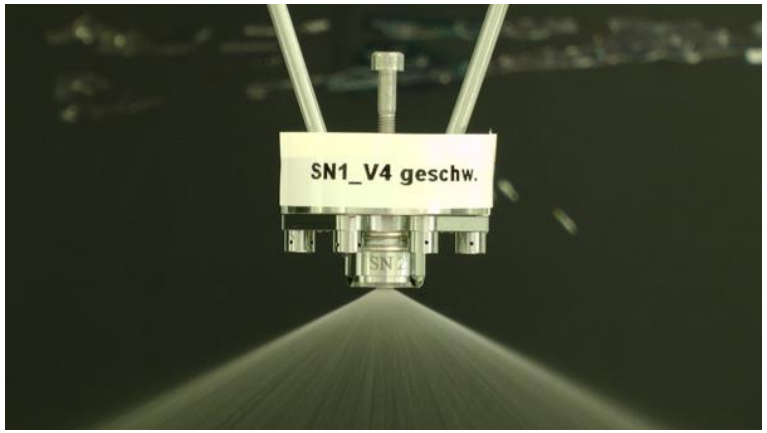
Injector Test Results – Pressure drop, spray angle and propellant distribution measurement



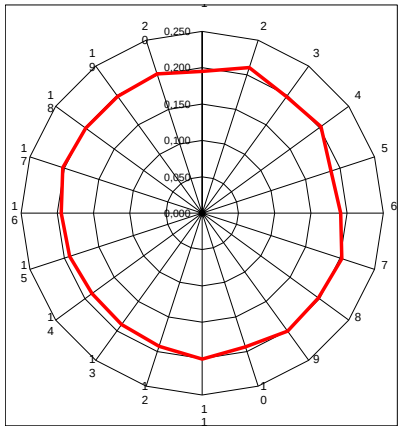
OX alone MK3 SN1V4

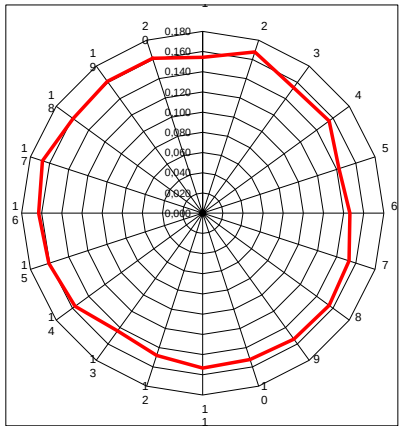


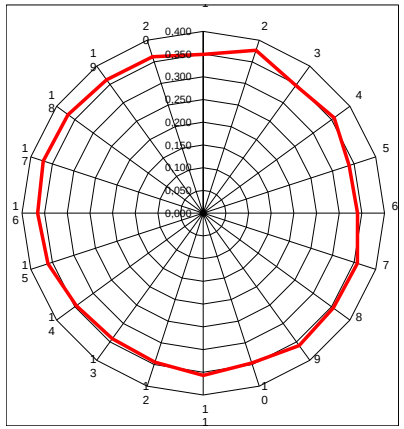
FU alone MK3 SN1V4



OX + FU combined MK3 SN1V4







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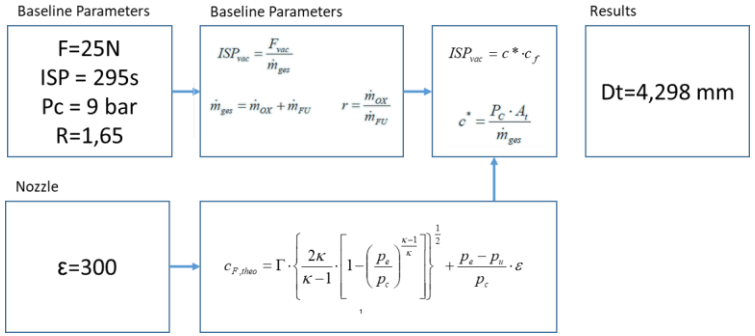
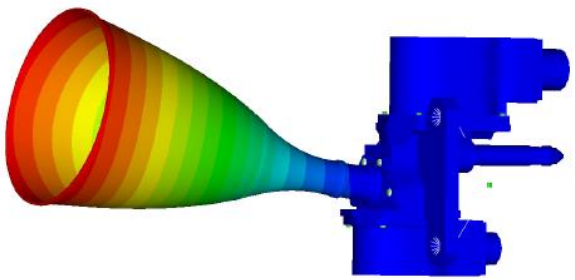
PQM Design

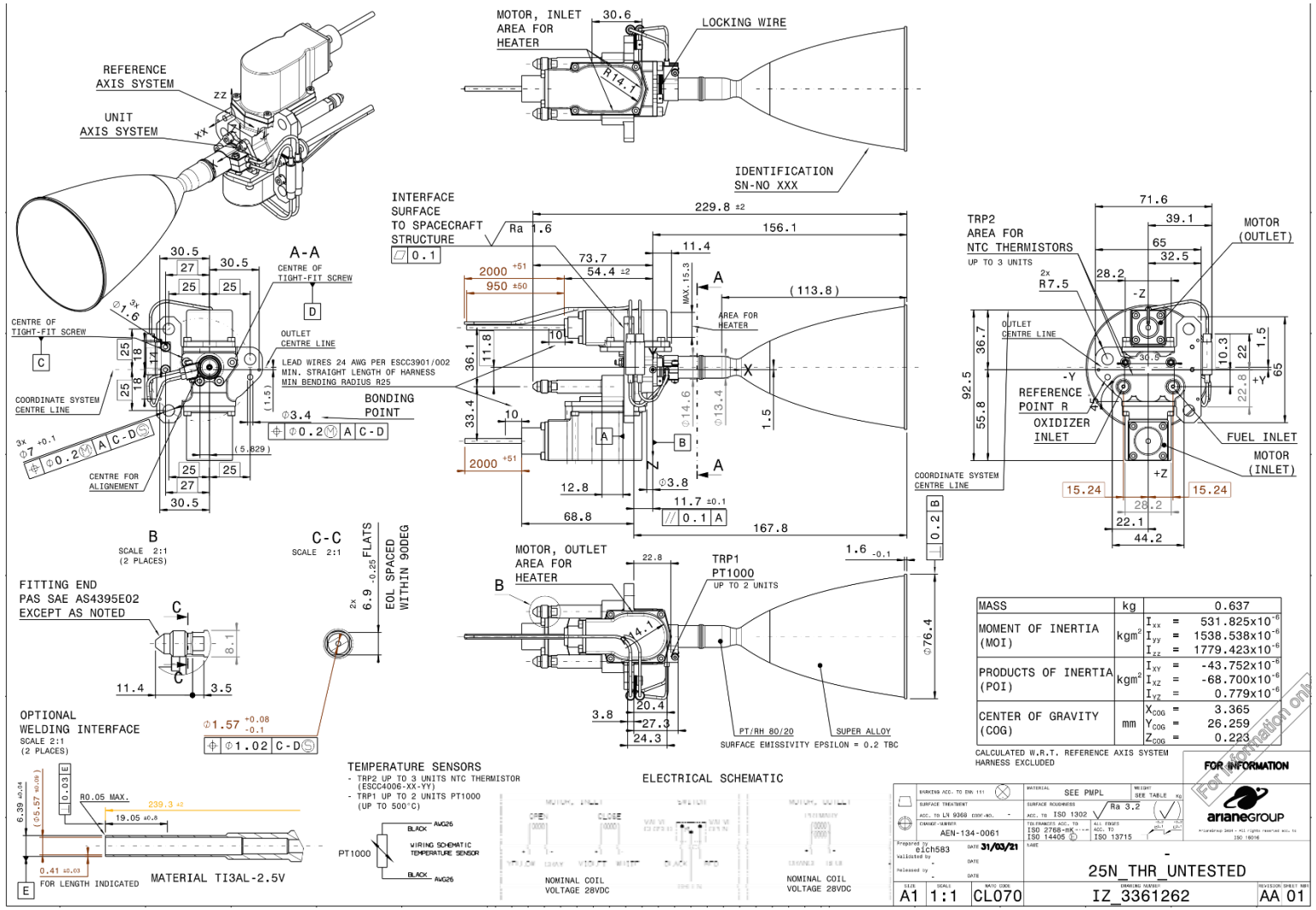
PQM Thruster sizing was performed





388 Hz Bending Mode y

Bendin



S25 GSTP Program (Proposal for Phase II)

Phase II is not part of the actual activity