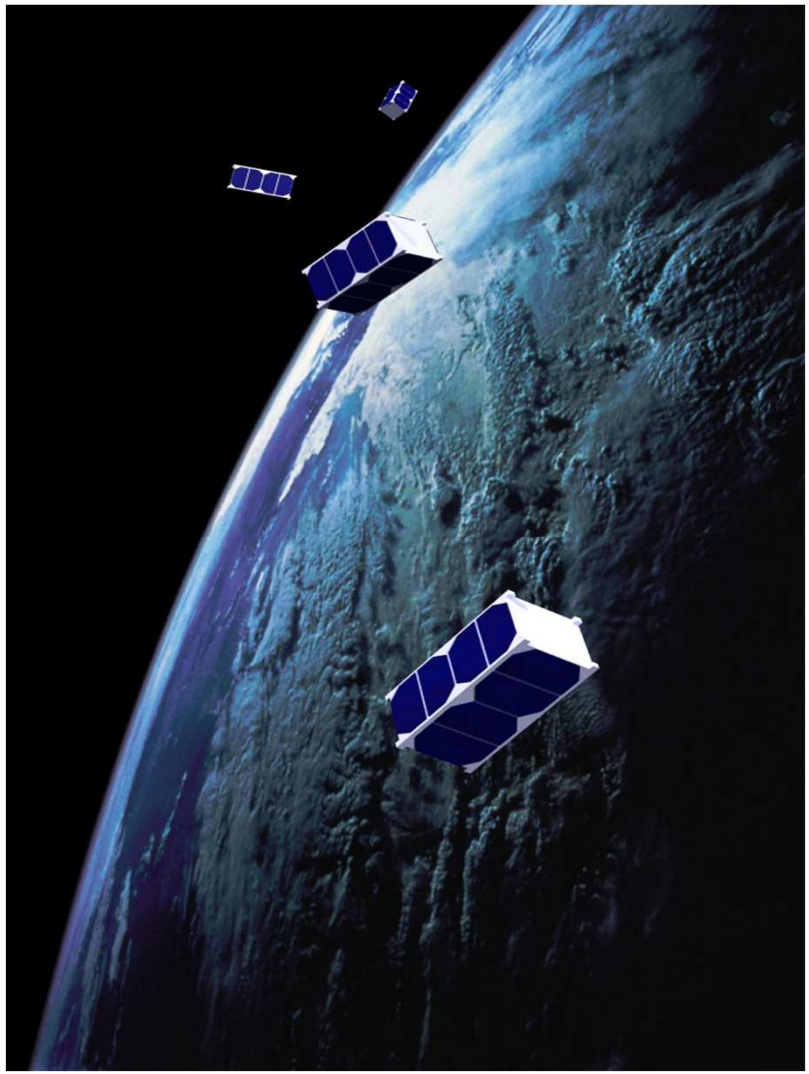
QB50

Deployment System



C. Bernal
ISIS

6th QB50 Workshop
6 June 2013
VKI, Belgium

Contents

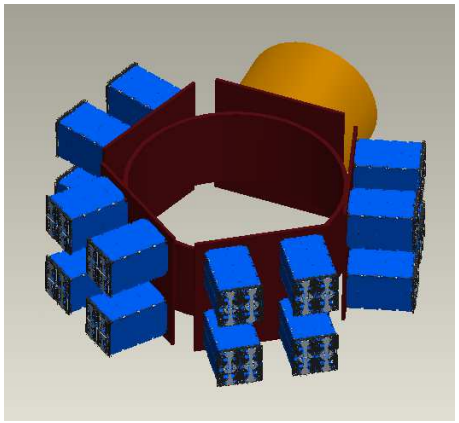
- **QB50 Deployment System Design**
- QuadPack PDR results
- ICD Update

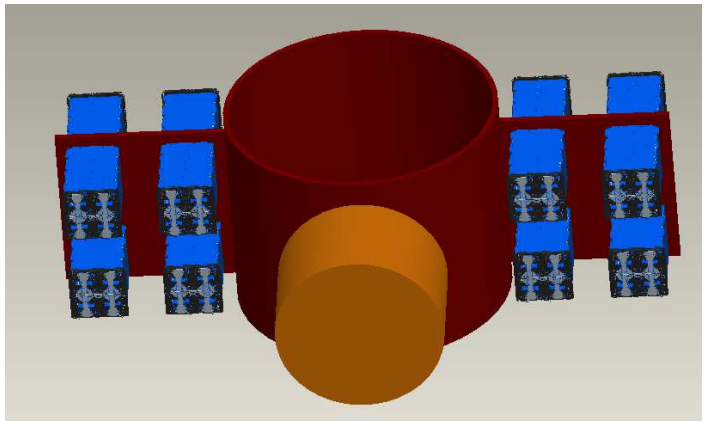
Objectives

- Deploy 50 CubeSats (40 x 2U 10 x 3U)
- Provide interface for Gossamer-1
- Allow flexible
  - choice of launch vehicle
  - deployment sequence
  - deployment direction

Cluster Concept

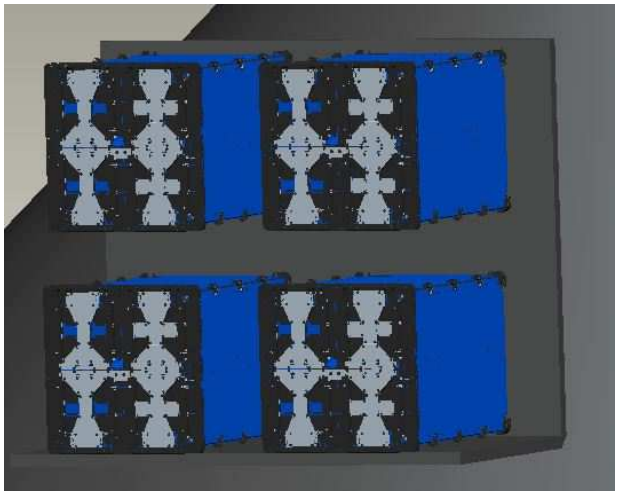
- Uses several QuadPacks
- Will gain flight heritage after precursor campaign
- Minimize risk of new technology
- Very flexible with respect to launch vehicle, deployment direction and deployment sequence
- Allows a scenario with several launches without re-development

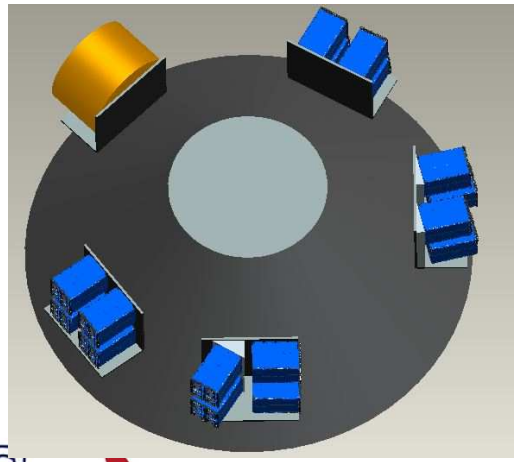


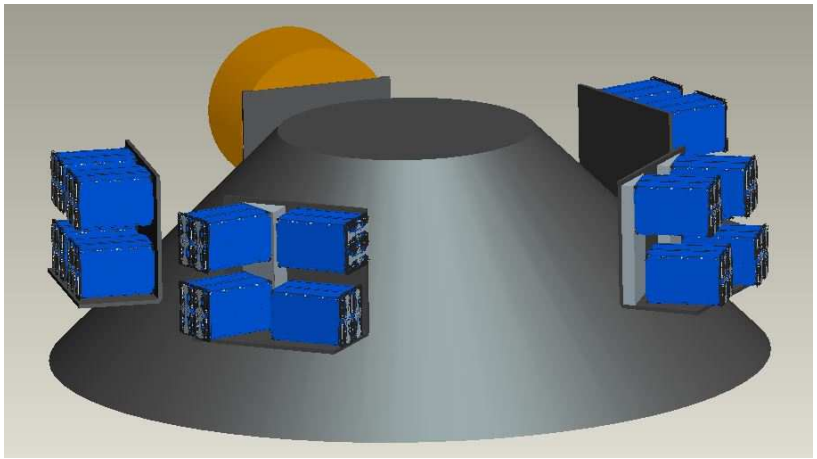


Cyclone-4 Concept

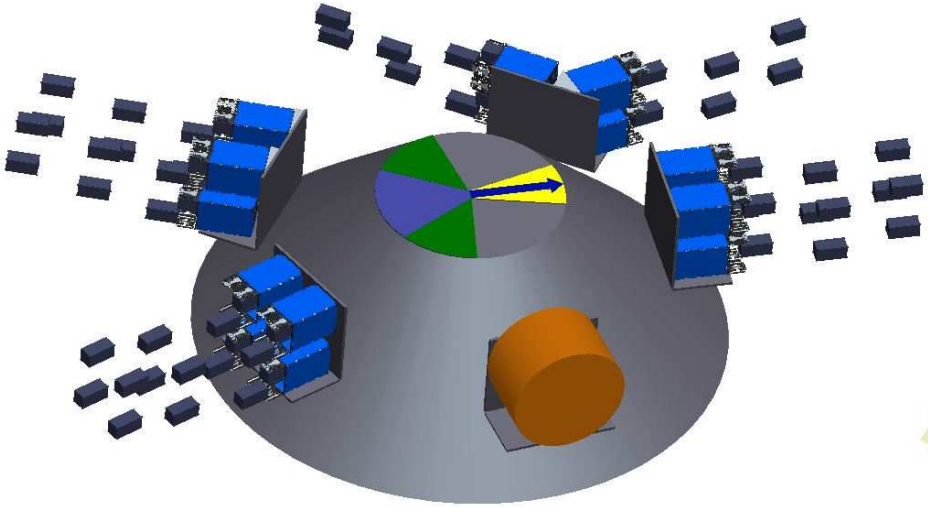
- Cyclone-4
- All QB50 CubeSats fits
- 2U flexible deployment angle
- Gossamer check compatibility

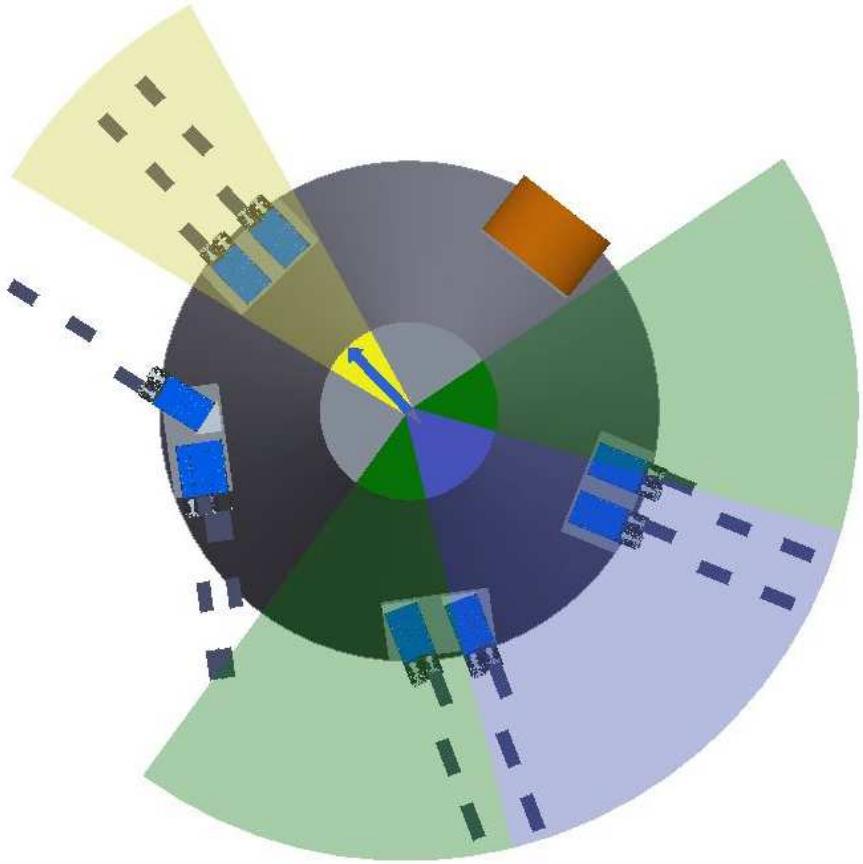






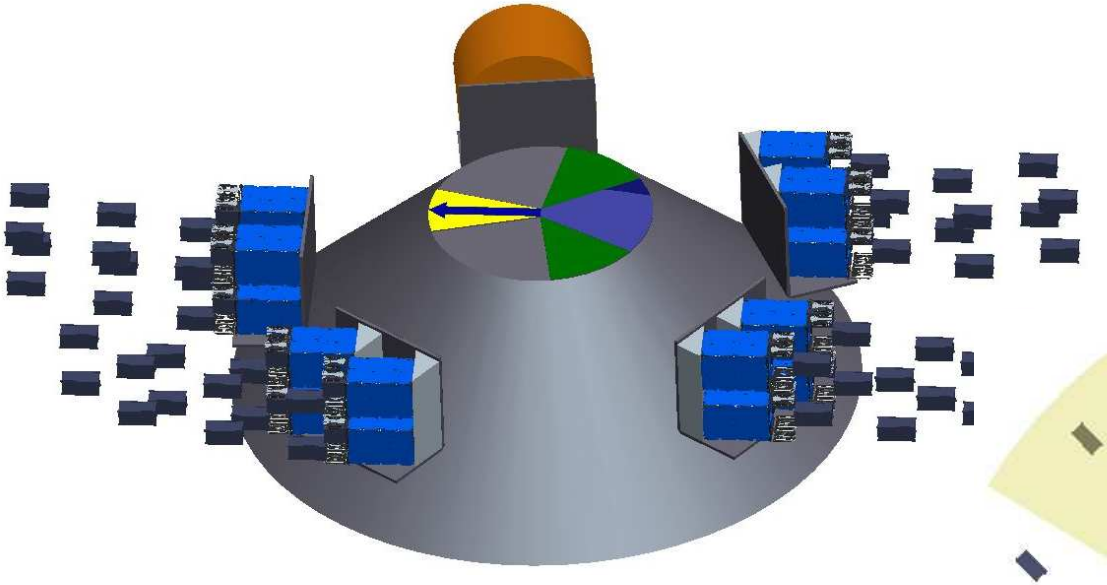
Cyclone-4 Concept

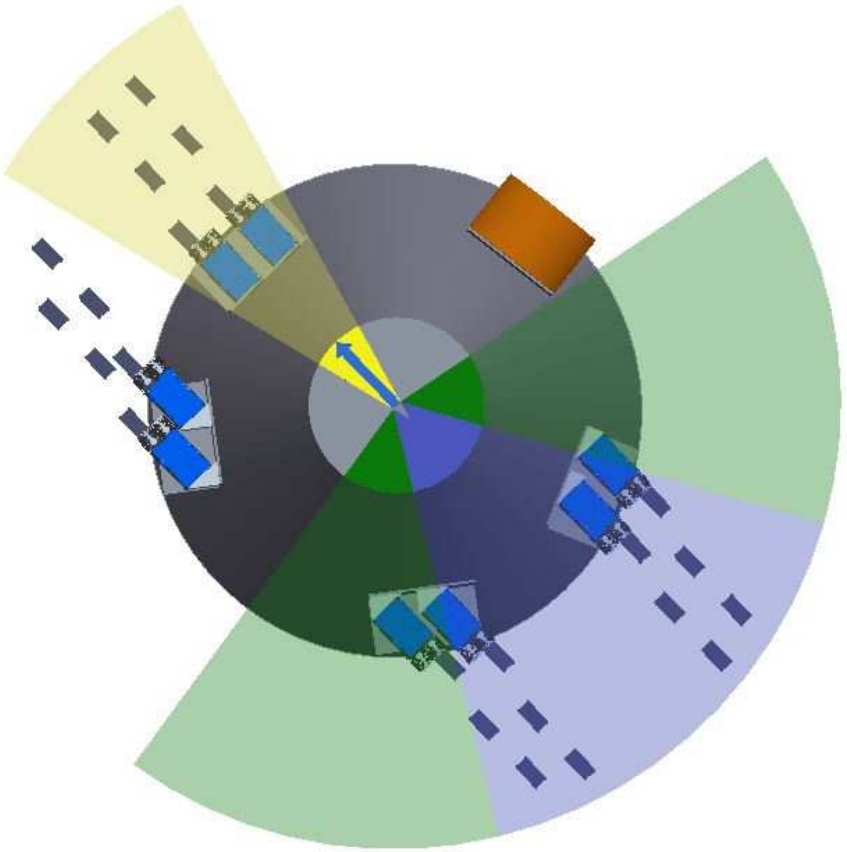




Two opposite cones

Cyclone-4 Concept

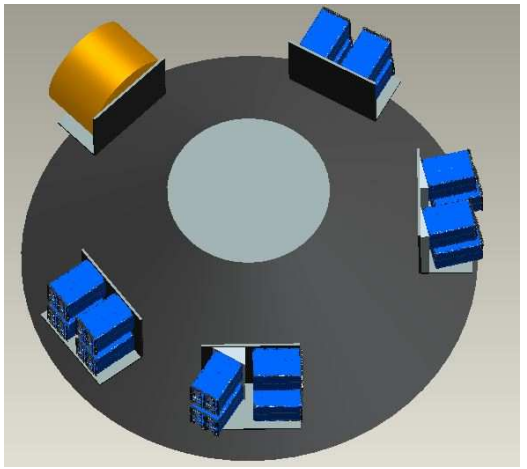




Two opposite directions

Open Points

- Launch vehicle
- Available volume
- Obstacles in deployment direction



- Upper stage attitude control available for us to utilize
- Actual mechanical interface

Action Items

- Finish work on QuadPack
- As more information on launch vehicle, volume, attitude control and mechanical interface become available identify lower level requirements
- Check compatibility of Gossamer and the available volume on the proposed Cyclone-4

Contents

- QB50 Deployment System Design
- **QuadPack PDR results**
- ICD Update

Requirements

List of Requirements and compliancy status

- Functional
- Interface
- Environmental
- Physical
- Operational
- Human
- Logistics
- PA
- Configuration
- Design

Main Requirements

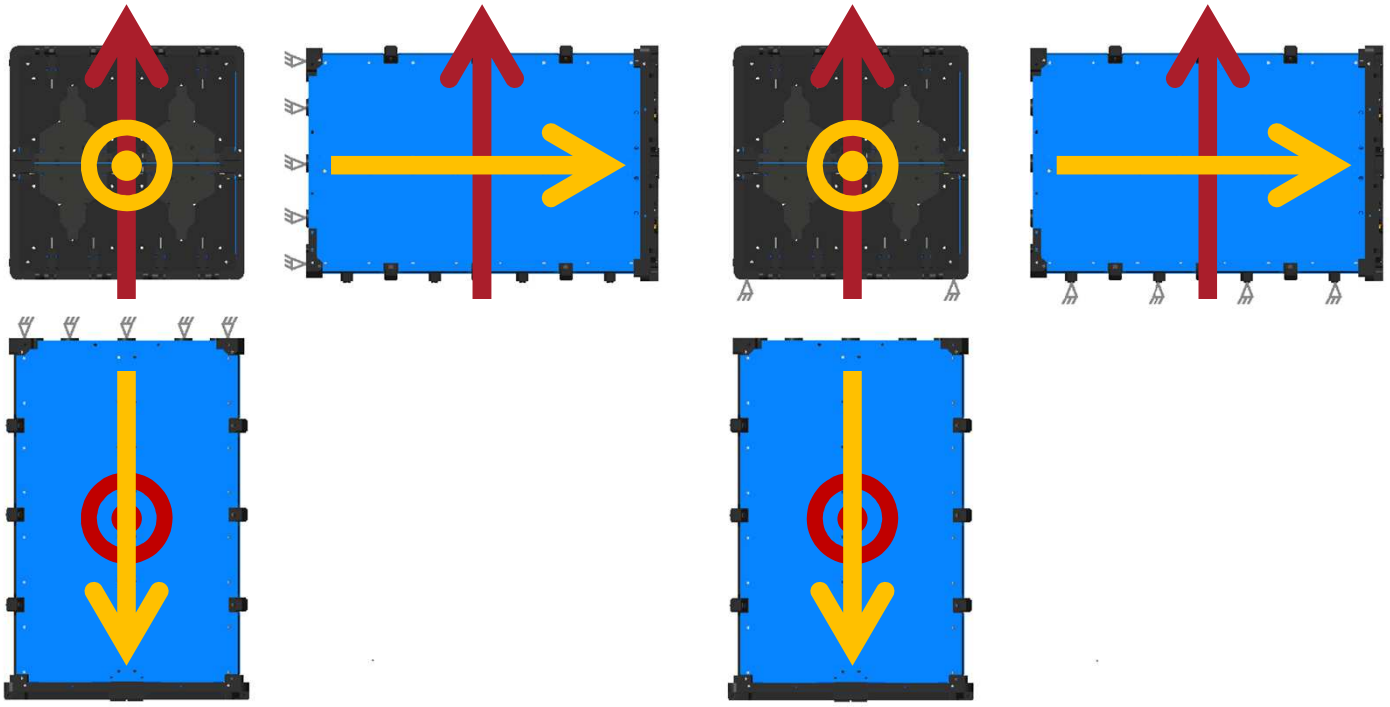
- 3U and 2U CubeSats & Gossamer-1
- Compatible with set of alternative Launchers (Precursor & QB50)
  - Dnepr
  - Tsyclon-4
  - PSLV
  - Rockot
  - Soyuz
  - Vega [TBC]





Technical Budgets

- Back Plate and Lateral Sides mounting patterns
- Vertical and horizontal launch

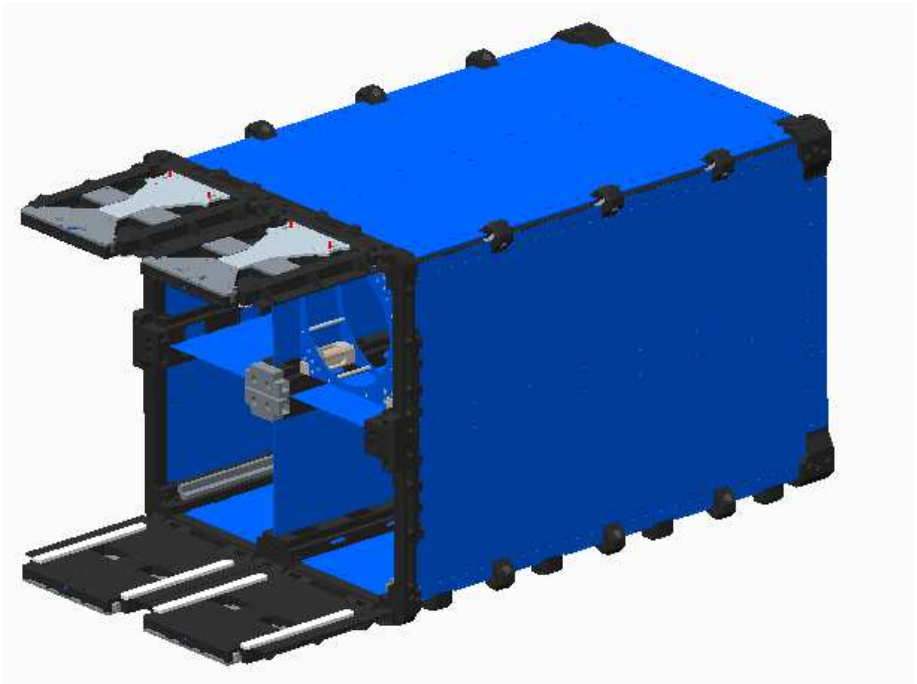


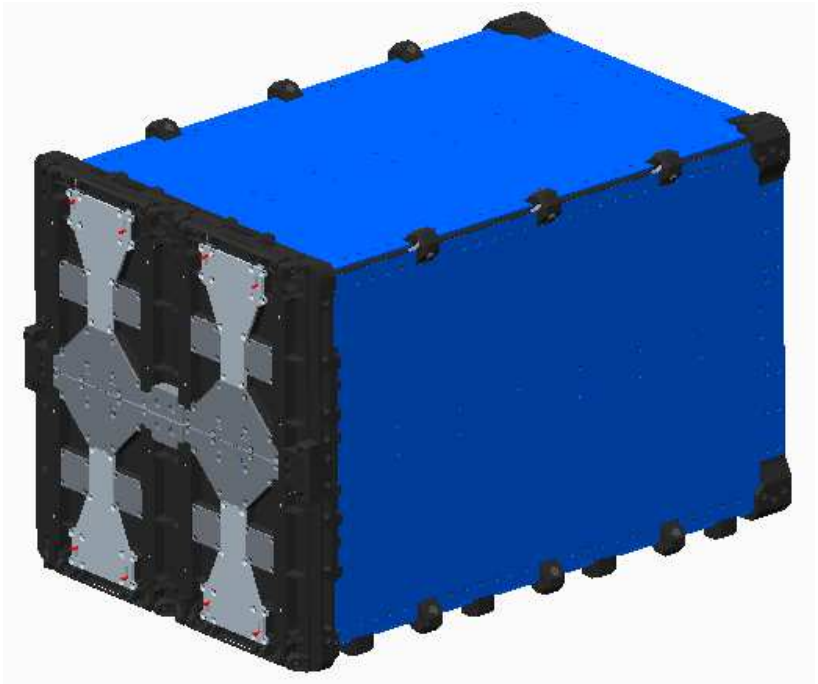
Technical Budgets

- Mass
  - 2U = 6kg
  - 3U = 7kg
- Volume
  - 2U = 22l
  - 3U = 31l

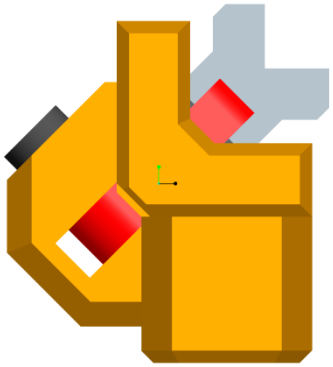
Preliminary Design

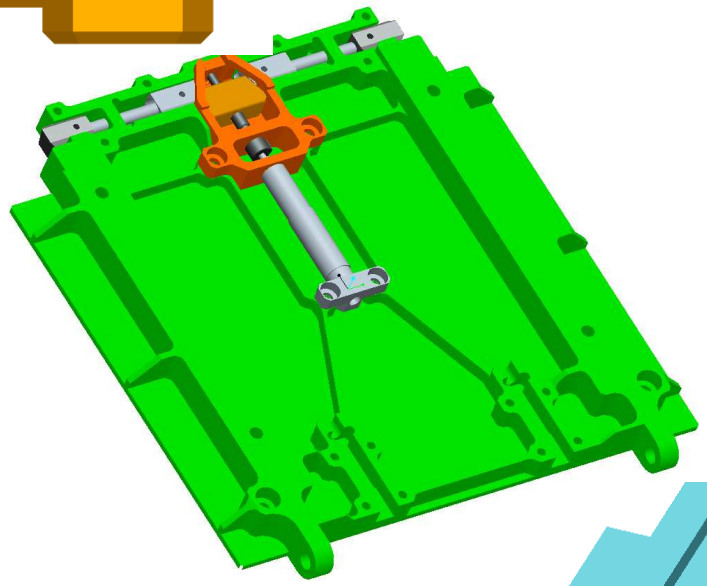
QuadPack Design Views

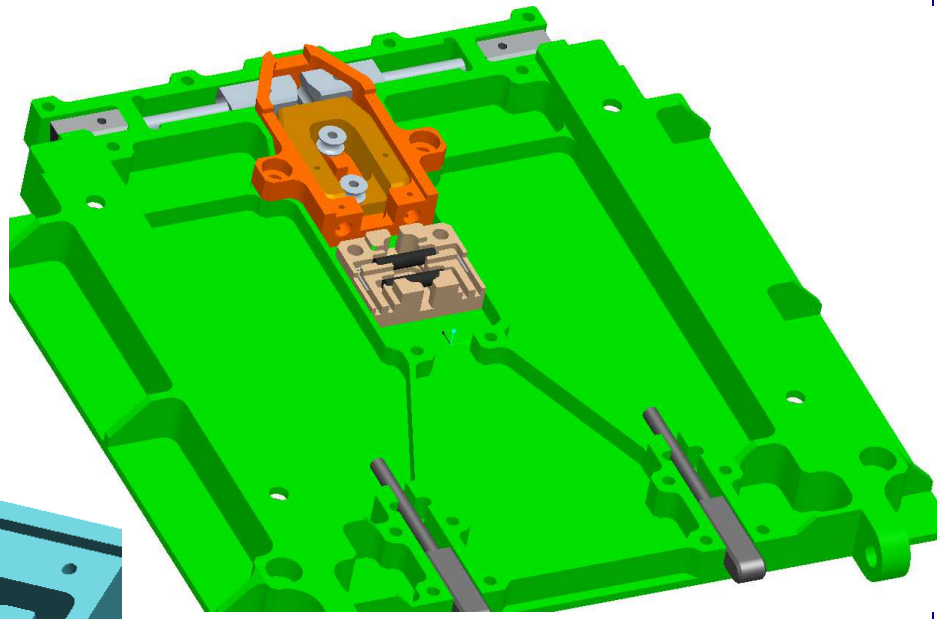


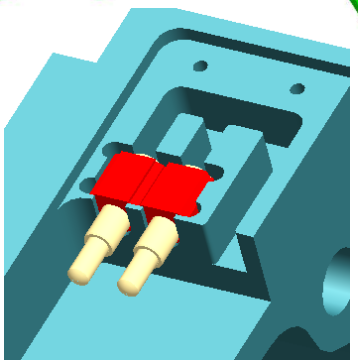


Preliminary Design









Preliminary Design

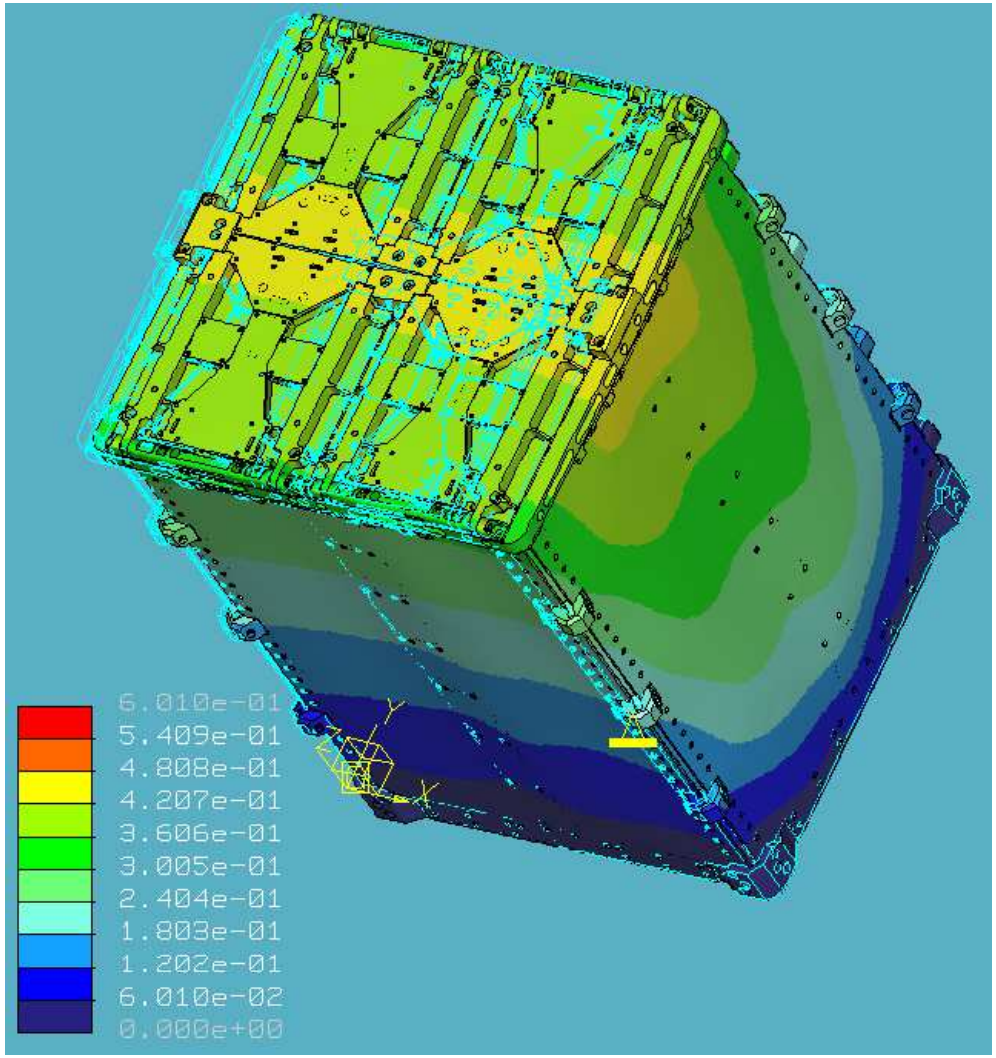
Analysis

50g

fn > 100Hz

σ_{Max} < 250MPa

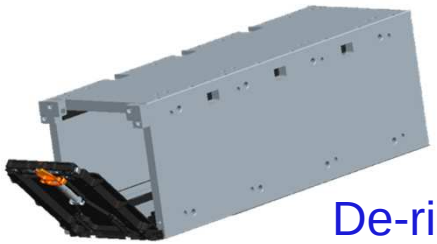
δ_{Max} < 0.6mm



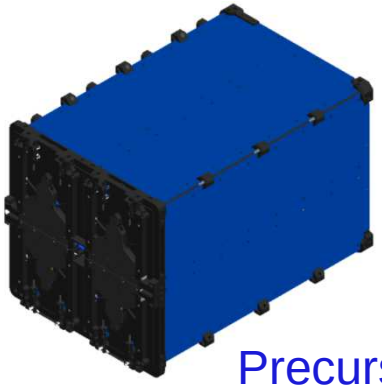
Model Philosophy

Foreseen Hardware production

- 1xPrototype (De-risk)
- 1xFM (Precursor Flight)
- 13xFM (QB50 Flight)



De-risk Prototype

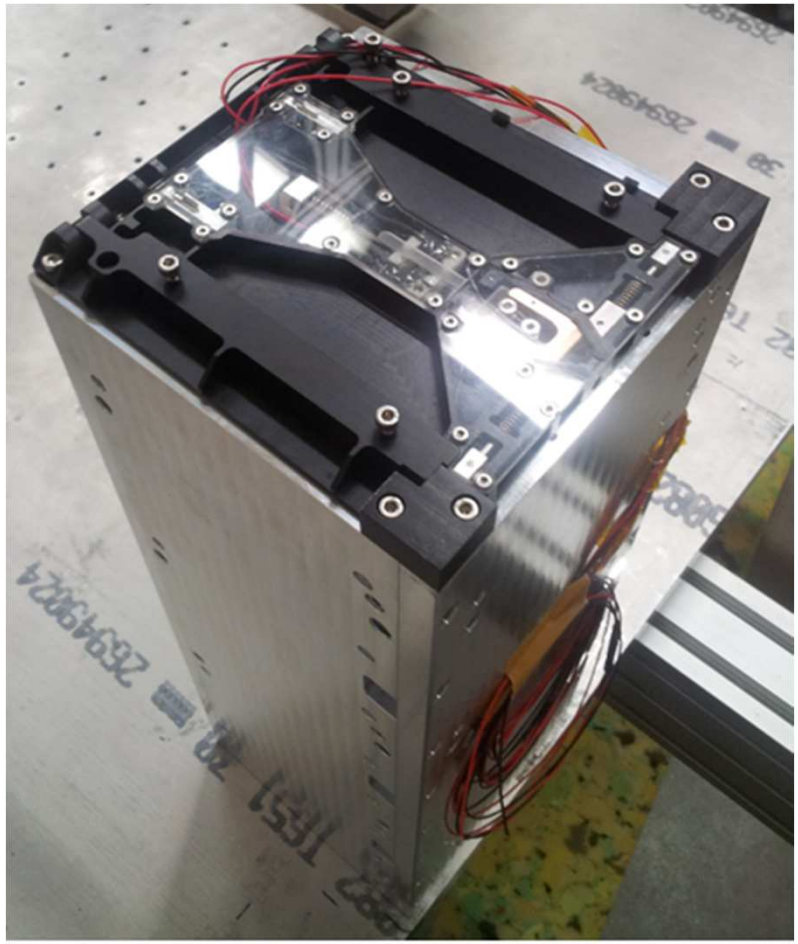


Precursor Flight

QB50

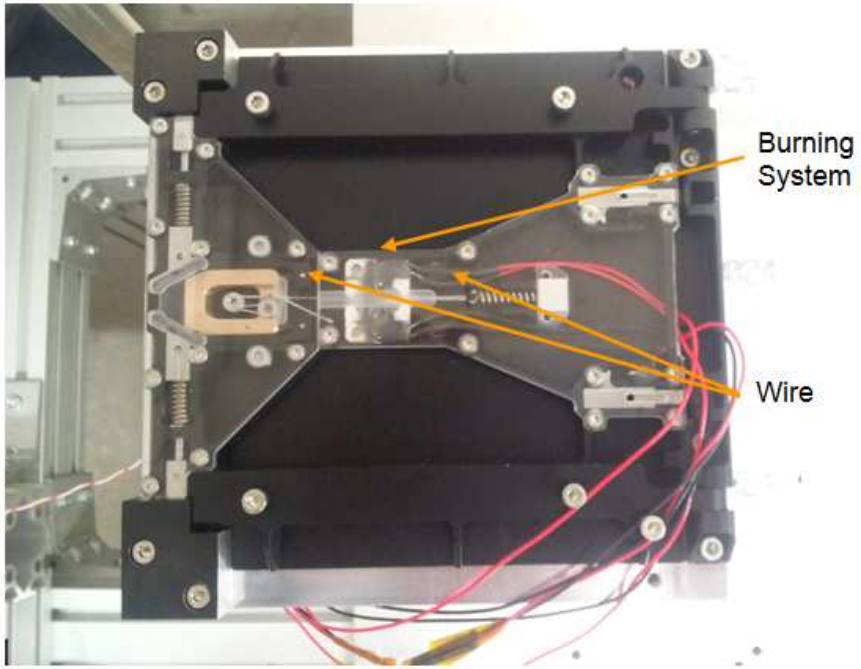
Model Philosophy

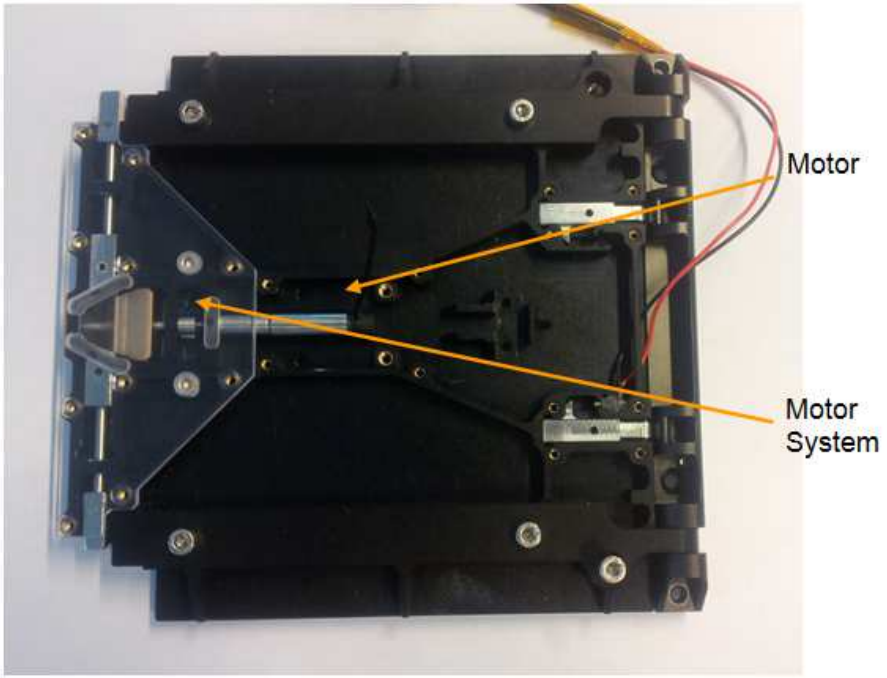
QuadPack Prototype Hardware



Model Philosophy

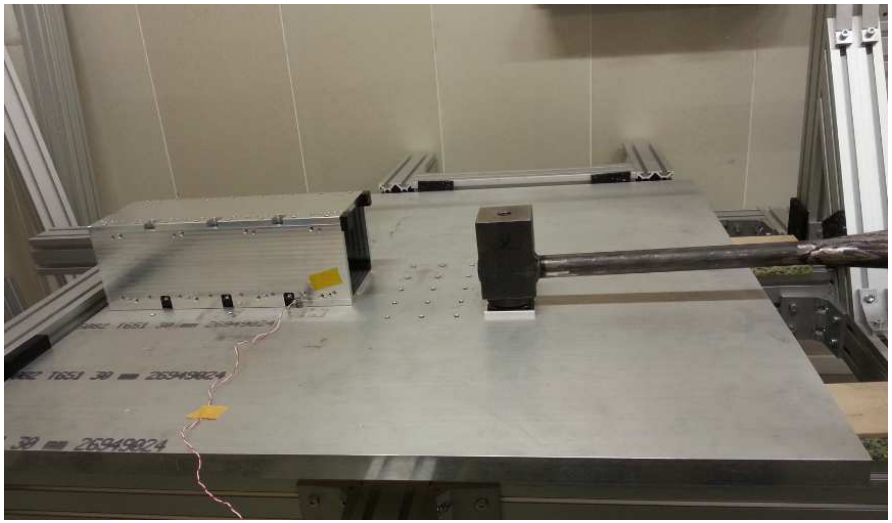
QuadPack Prototype Doors

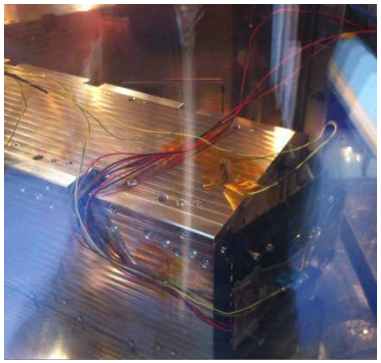




Model Philosophy

QuadPack Prototype Tests





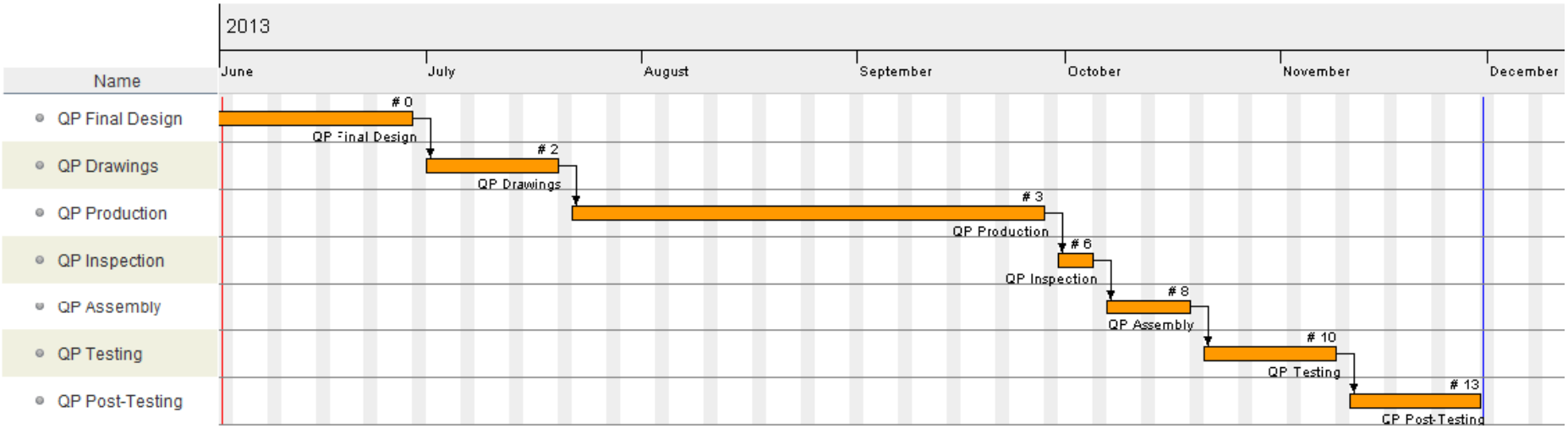
Open Points And AI

Final Launcher = Interfaces (mechanical, electrical, environmental, etc.) → Flexibility

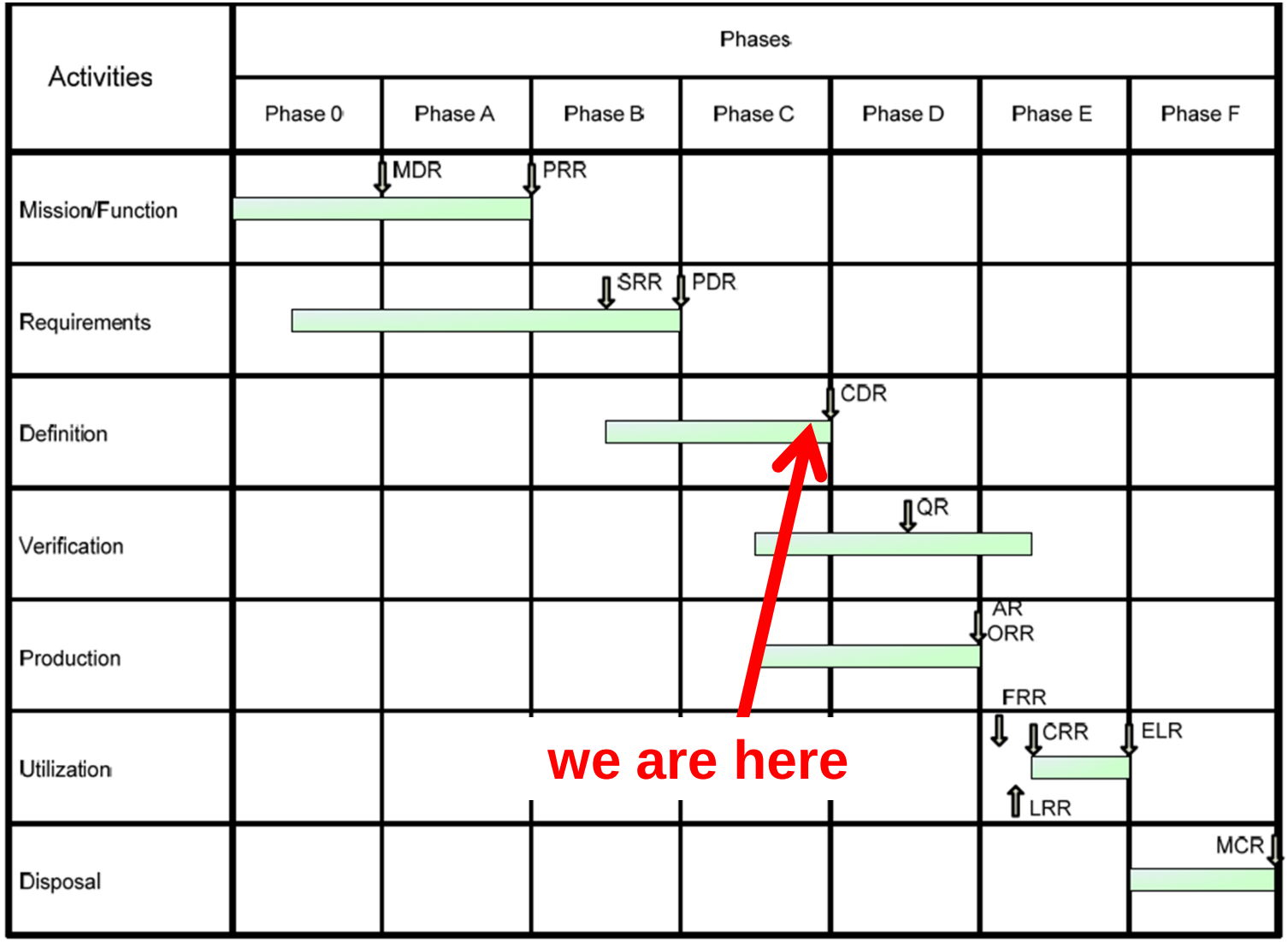
New technical solutions de-risk → Prototype production and testing

Schedule

Flight Model by end of 2013



Schedule


Activities
Phases
Phase 0
Phase A
Phase B
Phase C
Phase D
Phase E
Phase F
Mission/Function
MDR
PRR
Requirements
SRR
PDR
Definition
CDR
Verification
QR
Production
AR
ORR
FRR
Utilization
CRR
ELR
LRR
Disposal
MCR
we are here

Contents

- QB50 Deployment System Design
- QuadPack PDR results
- **ICD Update**

Acceleration

Characteristic	Unit	Qualification	Acceptance
Reference Frame		{BRF}	
Directions		X, Y, Z	
Amplitude	[g]	10.8	

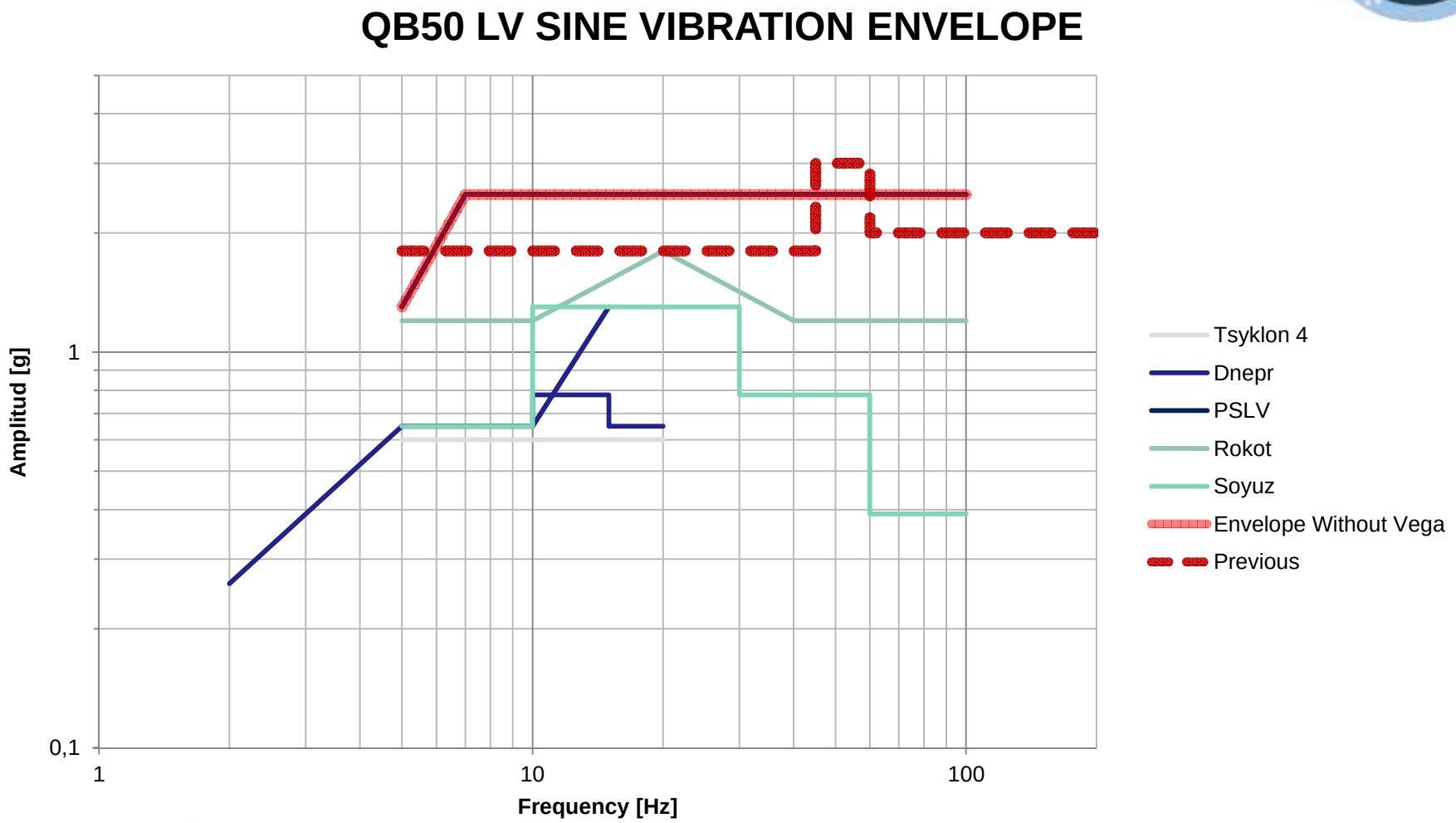
Resonance Survey

Characteristic	Unit	Qualification		Acceptance	
Reference Frame		{BRF}			
Directions		X, Y, Z			
Type		Harmonic			
Sweep Rate	[oct/min]	2			
Profile		Frequency [Hz]	Amplitude [g]	Frequency [Hz]	Amplitude [g]
		5	0.15*	5	0.15*
		100	0.15*	100	0.15*

Sine Vibration

Characteristic	Unit	Qualification		Acceptance	
Reference Frame		{BRF}			
Directions		X, Y, Z			
Sweep Rate	[oct/min]	2		4	
Profile		Frequency [Hz]	Amplitude [g]	Frequency [Hz]	Amplitude [g]
		5	1,3	5	1
		8	2,5	8	2
		100	2,5	100	2

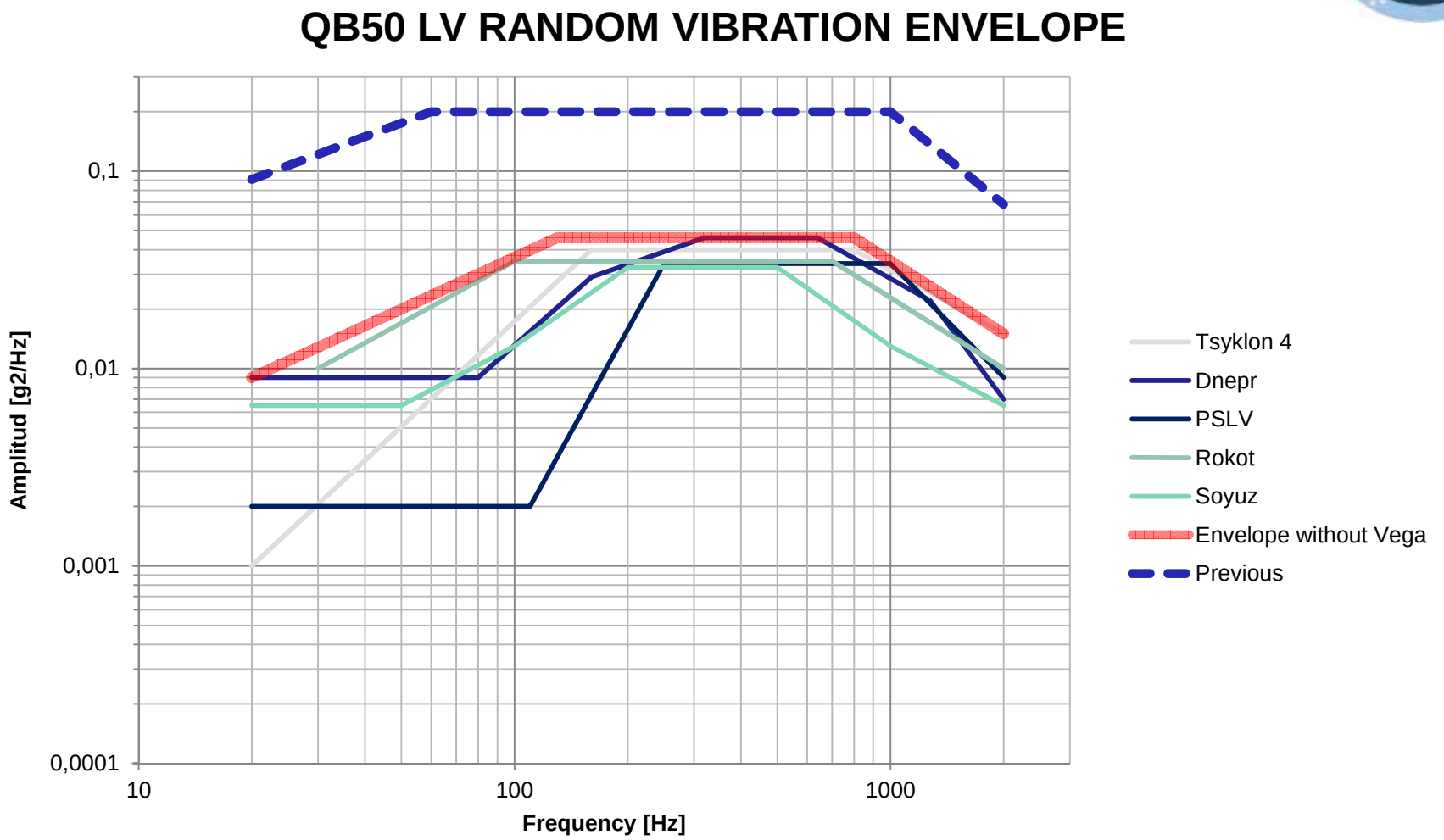
Sine Vibration



Random

Characteristic	Unit	Qualification		Acceptance	
Reference Frame		{BRF}			
Directions		X, Y, Z			
RMS acceleration	[g]	8.03		6.5	
Duration	[s]	120		60	
Profile		Frequency [Hz]	Amplitude [g2/Hz]	Frequency [Hz]	Amplitude [g2/Hz]
		20	0,009	20	0,007
		130	0,046	50	0,007
		800	0,046	200	0,035
		2000	0,015	640	0,035
				2000	0,010

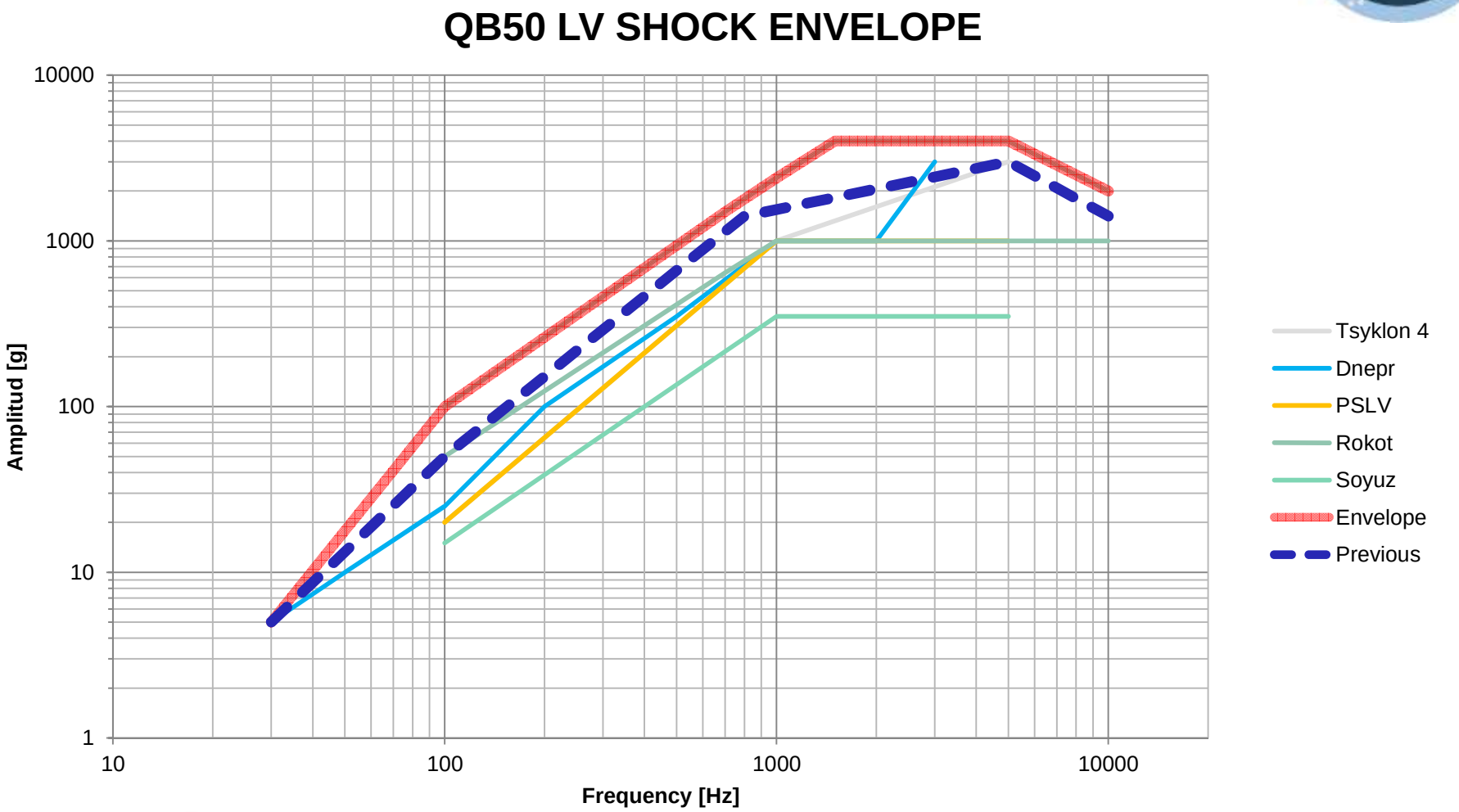
Random


QB50 LV RANDOM VIBRATION ENVELOPE
Amplitud [g2/Hz]
0,1
0,01
0,001
0,0001
10
100
1000
Frequency [Hz]
Tsyklon 4
Dnepr
PSLV
Rokot
Soyuz
Envelope without Vega
Previous

Shock

Characteristic	Unit	Qualification		Acceptance	
Reference Frame		{BRF}			
Directions		X, Y, Z			
Q-factor		10			
Number of shocks		2			
Profile		Frequency [Hz]	Spectrum [g]	Frequency [Hz]	Spectrum [g]
		30	5		
		100	100		
		700	1500		
		1000	2400		
		1500	4000		
		5000	4000		
		10000	2000		

Shock


QB50 LV SHOCK ENVELOPE
10000
1000
100
10
1
Amplitud [g]
10
100
1000
10000
Frequency [Hz]
Tsyklon 4
Dnepr
PSLV
Rokot
Soyuz
Envelope
Previous

Thanks for you attention!

Questions?