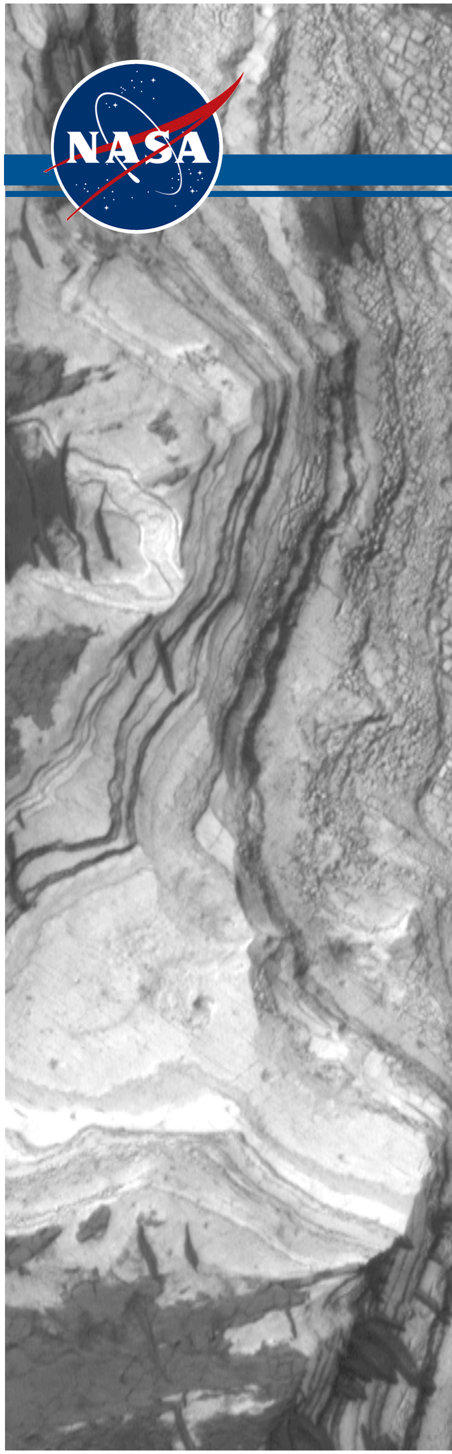


Mars 2018 Mission Status and Sample Acquisition Issues

Presentation to the Planetary Protection Subcommittee

Charles Whetsel – Manager, Advanced Studies and Program Architecture Office
Christopher G. Salvo – Mars 2018 Formulation Lead

January 20, 2011

Project Context

- Mars 2018 is 2nd mission of new NASA-ESA Joint Mars Exploration Program
  - ESA to provide orbiter engineering bus for Joint Trace Gas Science Payload & ESA Entry, Descent, & Landing (EDL) Demonstration carrier in 2016
  - NASA to provide launch/cruise/EDL for both NASA & ESA Rovers in 2018
    - Current concept would make extensive use of MSL-heritage Launch, Cruise, and EDL systems
  - NASA provides launch for both missions
    - *Note 1: Primary division of responsibilities established June 2009 at NASA-ESA Bilateral discussions in Plymouth, UK.*
  - Responsibilities for subsequent missions in the joint program are yet to be determined, but both agencies agree on the ultimate importance of Mars Sample Return (MSR)

- NASA Mars 2018 Project is currently in Pre-Phase A
  - Working towards conduct of Mission Concept Review & issuance of Formulation Authorization Document, in conjunction with Key Decision Point A (KDP-A) later in 2011 or early 2012 (pending funding/progress)
    - *Note 2: ESA Rover has been under development for > 4 years. The ESA ExoMars Project considers the rover maturity to be at Preliminary Design Review (PDR) (Phase B->C transition) level*

Excerpt of “Working-version” NASA Program-Level Requirements (of relevant interest)

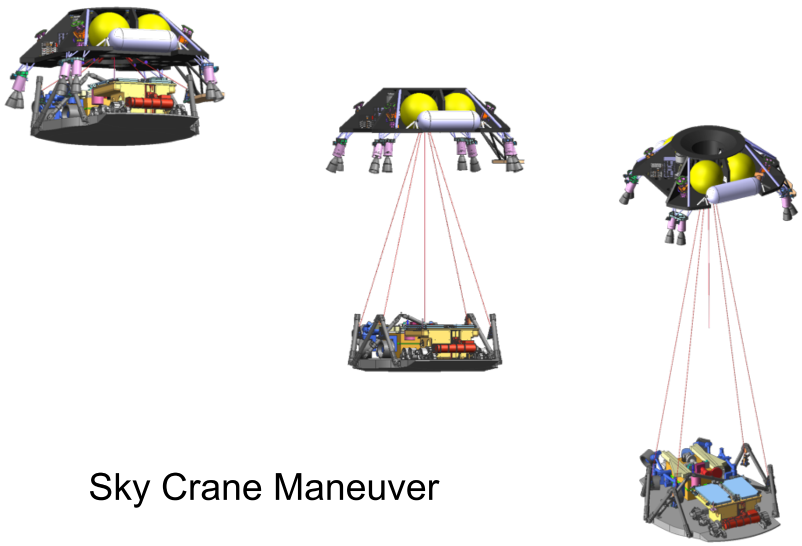
- Launch to Mars in 2018 opportunity
- Deliver to Mars the proposed NASA 2018 Rover
- Deliver to Mars the ESA ExoMars Rover

- Be capable of landing/operating at sites as far north as [25° N] and as far south as [5° S] latitude.
  - *5° S adopted from ExoMars rover constraint. For NASA rover 15° S is roughly equivalent to 25° N.*

- Go to a site such that regions of scientific interest would be reachable within traverse capabilities of the rovers—i.e. land at sites similar to Mars Science Laboratory (MSL) sites – EDL capable of handling similar rocks and slopes - to put science targets within reach.
  - *NOTE: Flight system implementation assumes large inheritance of MSL hardware systems for all elements prior to touchdown – see following*

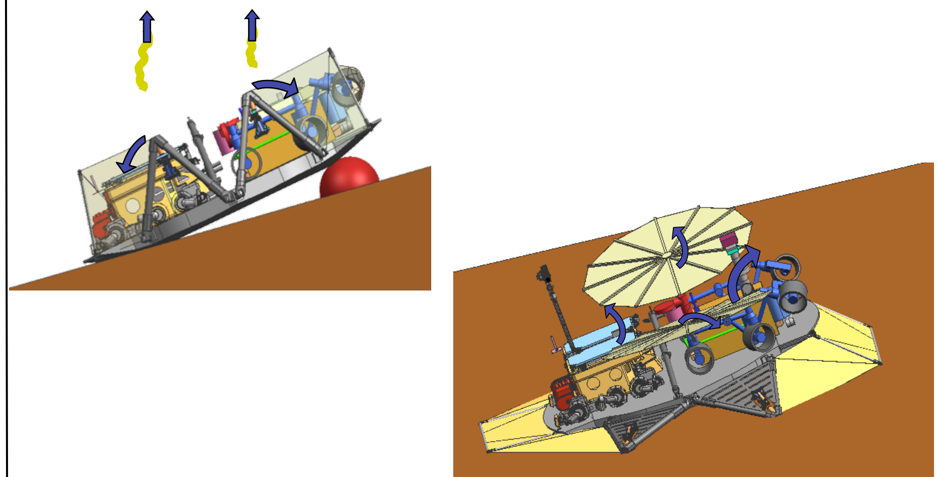
- NASA Rover would be able to select, acquire, and cache [1 or 2] caches of at least [19 - 31] cores of [10 g] each, [TBD number potentially hermetically sealed]
  - *NOTE, this may not be the full returned sample mass; regolith/dust/compressed atmospheric sample may be acquired by subsequent MSR-L.*
  - *If two caches flown, may be duplicates of each other; for robustness against failures in later campaign steps (fill either in parallel [identical contents] or serially [early mission cache, later mission cache]*

Flight System Concept: 2-Rover Touchdown Platform Delivered by MSL-based Cruise/Entry/Descent Stage

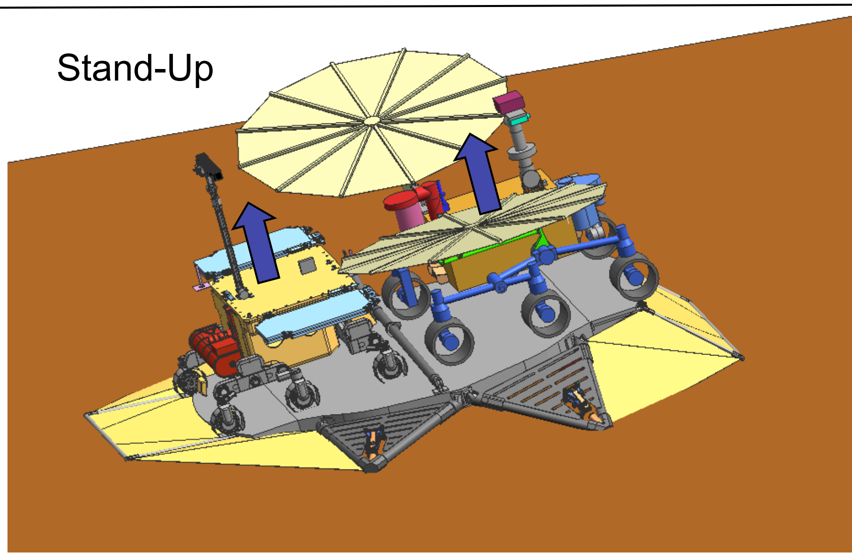


Sky Crane Maneuver

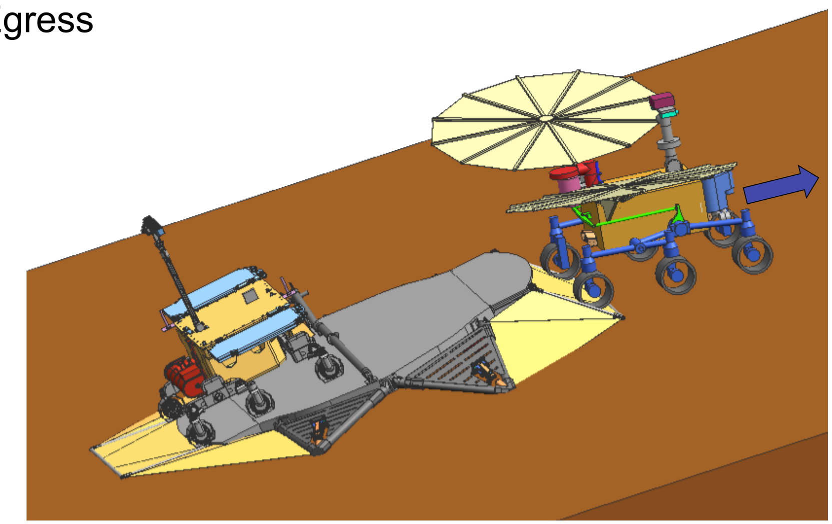
Touchdown Through Initial Deployments



Stand-Up



Egress



Planetary Protection (PP) and Contamination Control Expectations

- Joint mission moving forward assuming eventual overall Planetary Protection Categorization would be V (Restricted Earth Return – Outbound Phase/Leg) driven by NASA mission objectives, recognizing that ESA ExoMars objectives, taken alone, likely warrant Category IVb (Investigations of extant Life)

- Overall Planetary Protection and Organic Cleanliness Considerations are expected to be a major factor in the design and implementation processes for both rovers as well as the common shared delivery system hardware (largely inherited from MSL-based designs)

Current Thinking Regarding PP Approach

Considering 4 Main Classes of PP-Related Concerns:

1. Traditional <u>Forward PP</u> (contamination of the martian landing site, and its potential for propagation to the rest of Mars)

MSL-based approach expected: Similar mass delivered to Mars surface, but likely larger surface area for 2-rovers + platform

2. Protection from contamination of samples delivered to the *<u>in situ</u>* <u>experiments</u> on the ExoMars rover (general rover environment on Mars, internal sample acquisition/transfer pathways)

3. Protection from contamination of <u>samples for return</u> delivered to the NASA rover caching assembly (general rover environment on Mars, internal sample acquisition/transfer pathways)

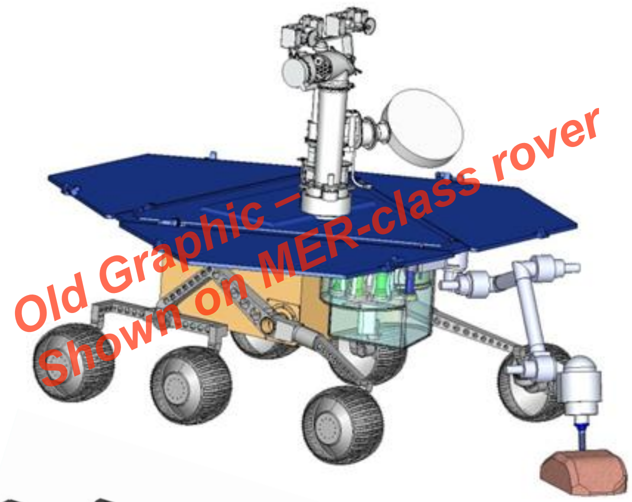
Planned approach is for each rover (ESA/NASA) to take appropriate precautions to safeguard the sample acquisition/delivery pathways, and deliver “clean rovers” to the integration flow; NASA to lead development of approach to maintain cleanliness during ground handling and in flight through touch-down/egress on Mars.

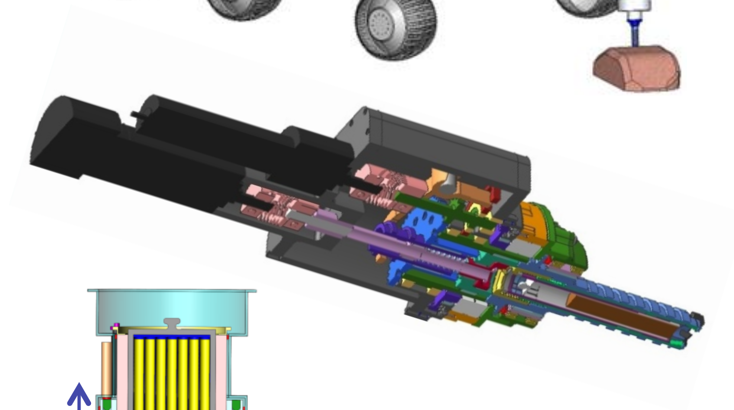
4. Satisfaction of anticipated specific “<u>Back</u>-<u>PP</u>” requirements on containment assurance of martian material returned to the earth’s biosphere

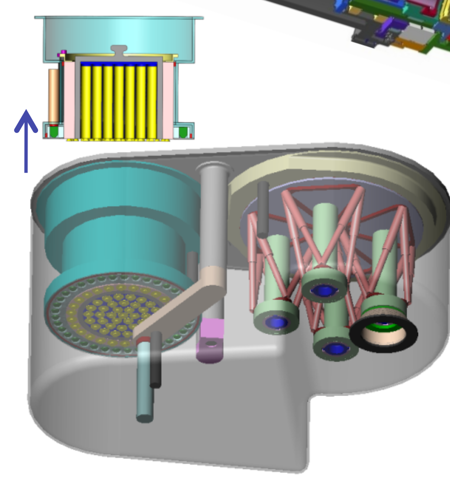
Currently assumed to be primarily met by systems/hardware on later elements of a Mars Sample Return (MSR) Campaign, e.g. Earth Entry Vehicle, Orbiter, or OS. “Due-diligence” to examine potential design implications for 2018

Sample Acquisition and Caching Architecture

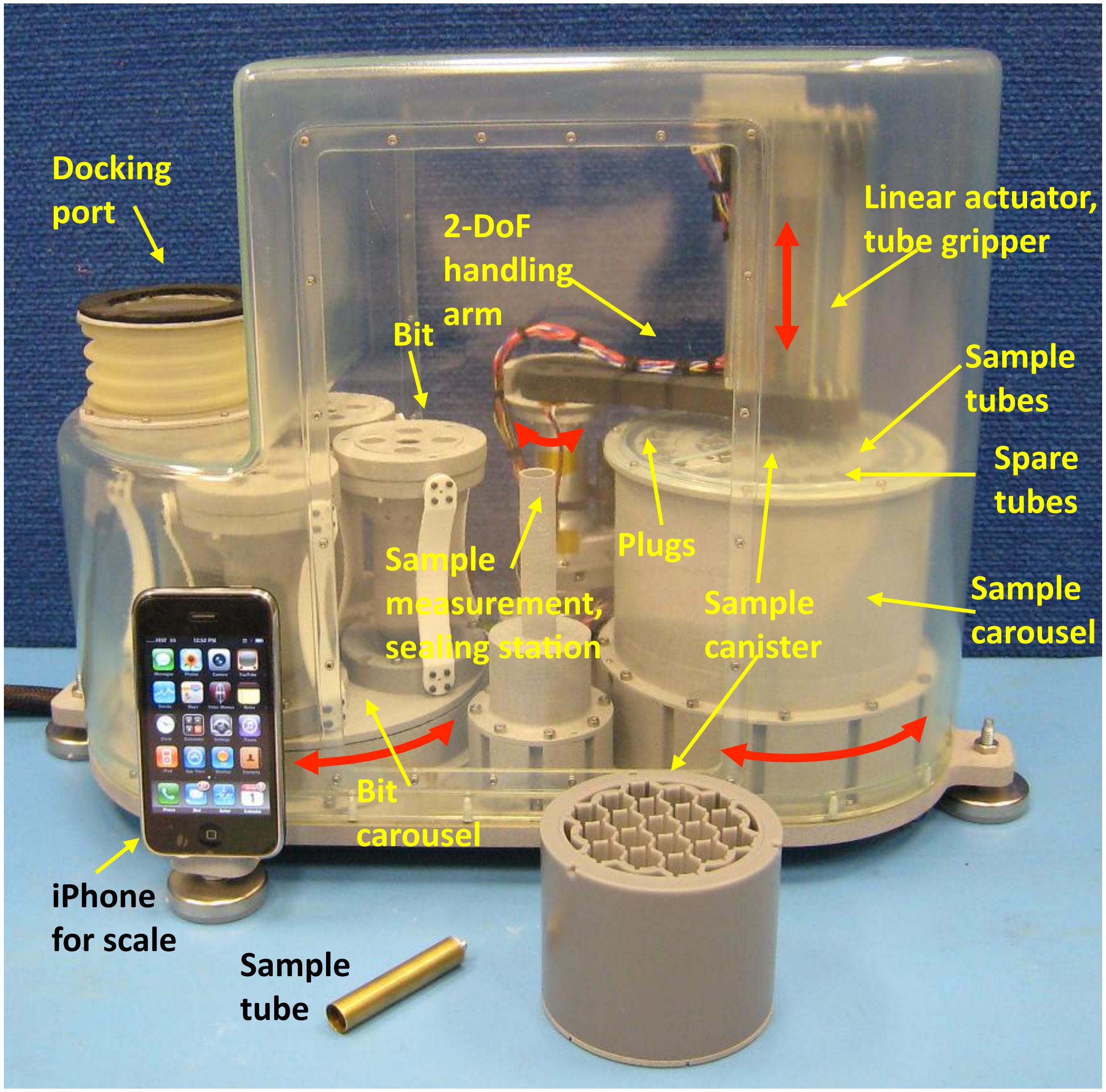
- **Tool Deployment Device:**
  - **Design:** 5 degree of freedom (DoF) arm
  - **Functions:** tool deployment, alignment and linear feed; place canister on the ground.
- **Coring Tool:**
  - **Technique:** Rotary percussion;
  - **Functions:** Core, breakoff, retention, bit change out, linear spring for preload and vibration isolation.
- **Caching Subsystem:**
  - **Sample Encapsulation:** Acquire sample *directly into its sample tube* in the bit.
  - **Sample Transfer**: Use bit changeout to transfer sample to caching subsystem (sample in tube in bit).
  - **Functions**: Transfer sample tube in/out of bit, bit changeout, tube sealing, store tubes in canister.







Prototype Caching Subsystem – Development Concept



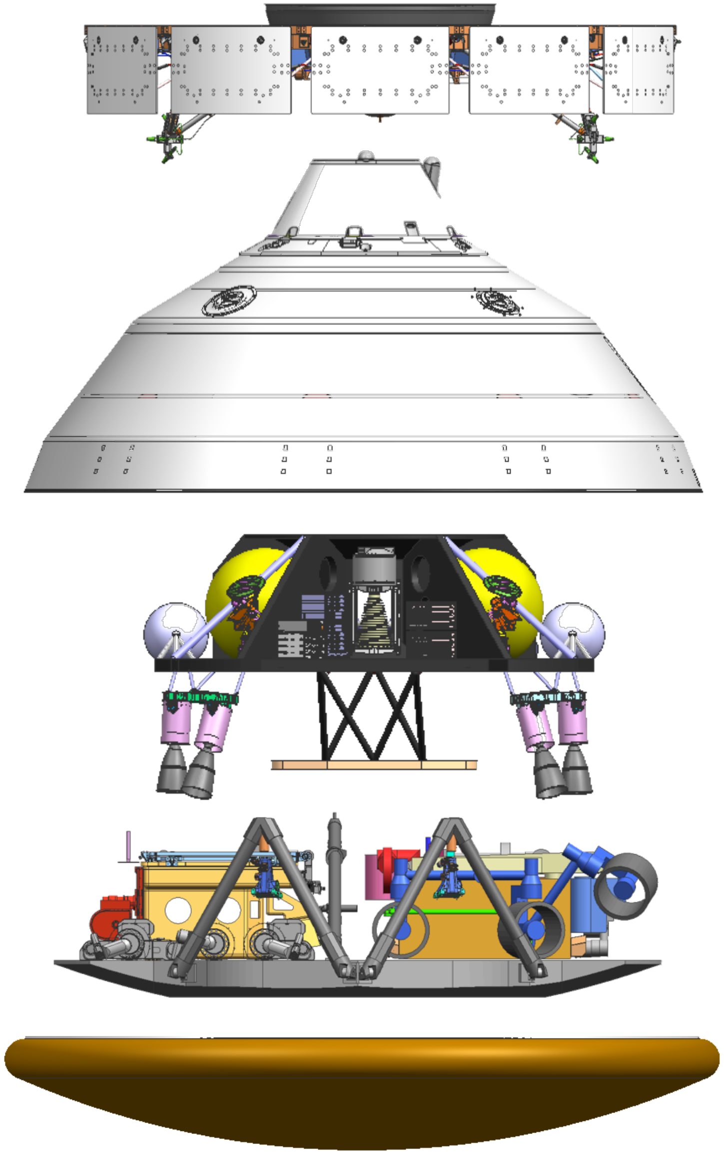
Mars 2018 Formulation Status (2 of 2)

- Integrated timeline of pre-launch flight hardware flow, handling activities/events and facilities still in development, so inputs related to contamination threat and assay/re-cleaning opportunities are timely (a planned agenda topic at next face-to-face interchange planned week of February 7th)
- NASA 2018 Formulation activities anticipate substantial R&D/ Technology Development efforts in 2012/2013 (in preparation for 2014 Project-level PDR), focused not only on Sample Acquisition/Encapsulation but also PP/Organic Cleanliness Techniques and Approaches to assure system compliance with requirements, including MSR round-trip considerations
  - Planning and scoping for these efforts getting underway in 2011

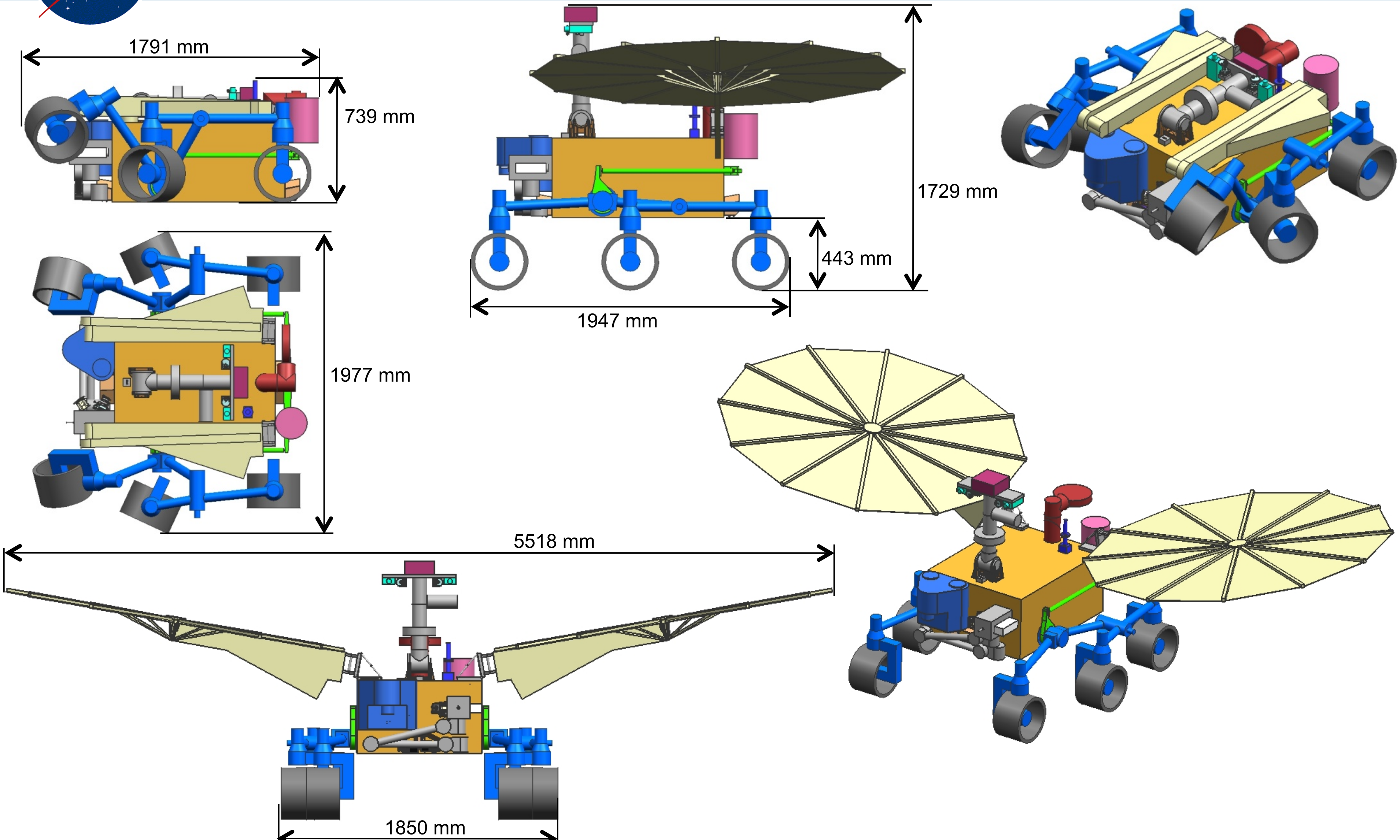
Additional Slides

BACKUP MATERIAL

Full Spacecraft Expanded View

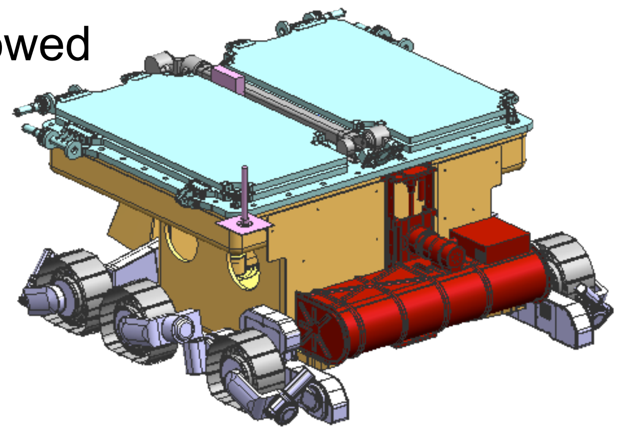


NASA Rover Dimensions

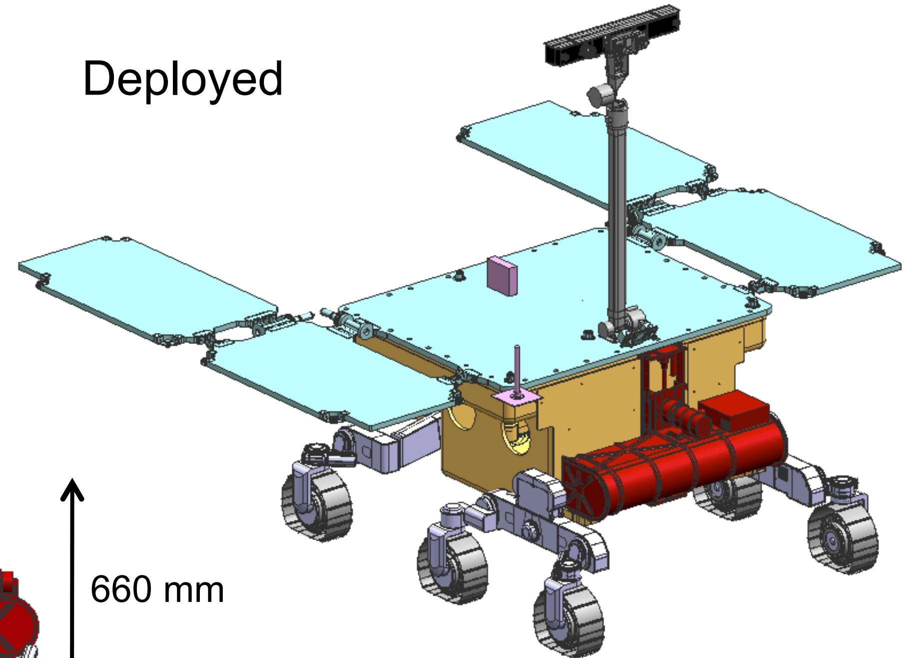


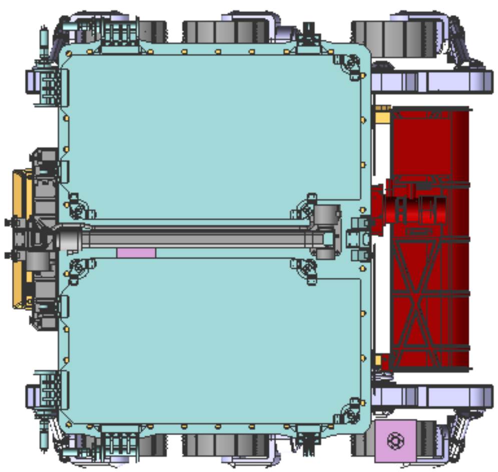
ESA ExoMars Rover

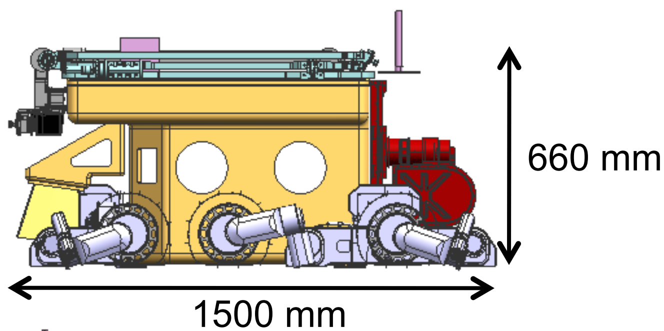
Stowed

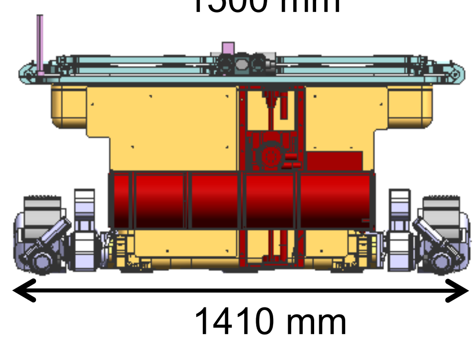


Deployed



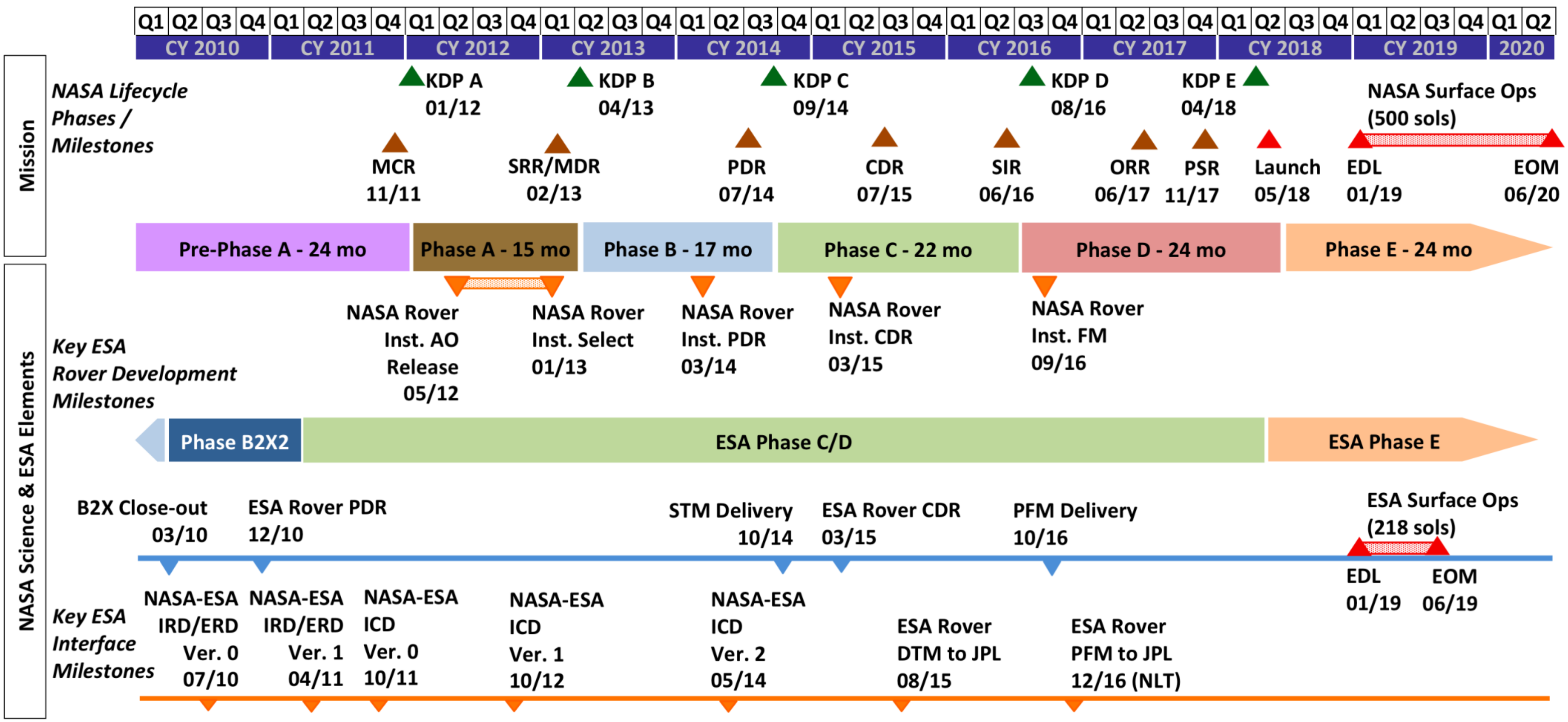






Current Working Mars 2018 Schedule

(based on 2010 PPBE budget request)



Full Lifecycle, Phase A-D: 78 months

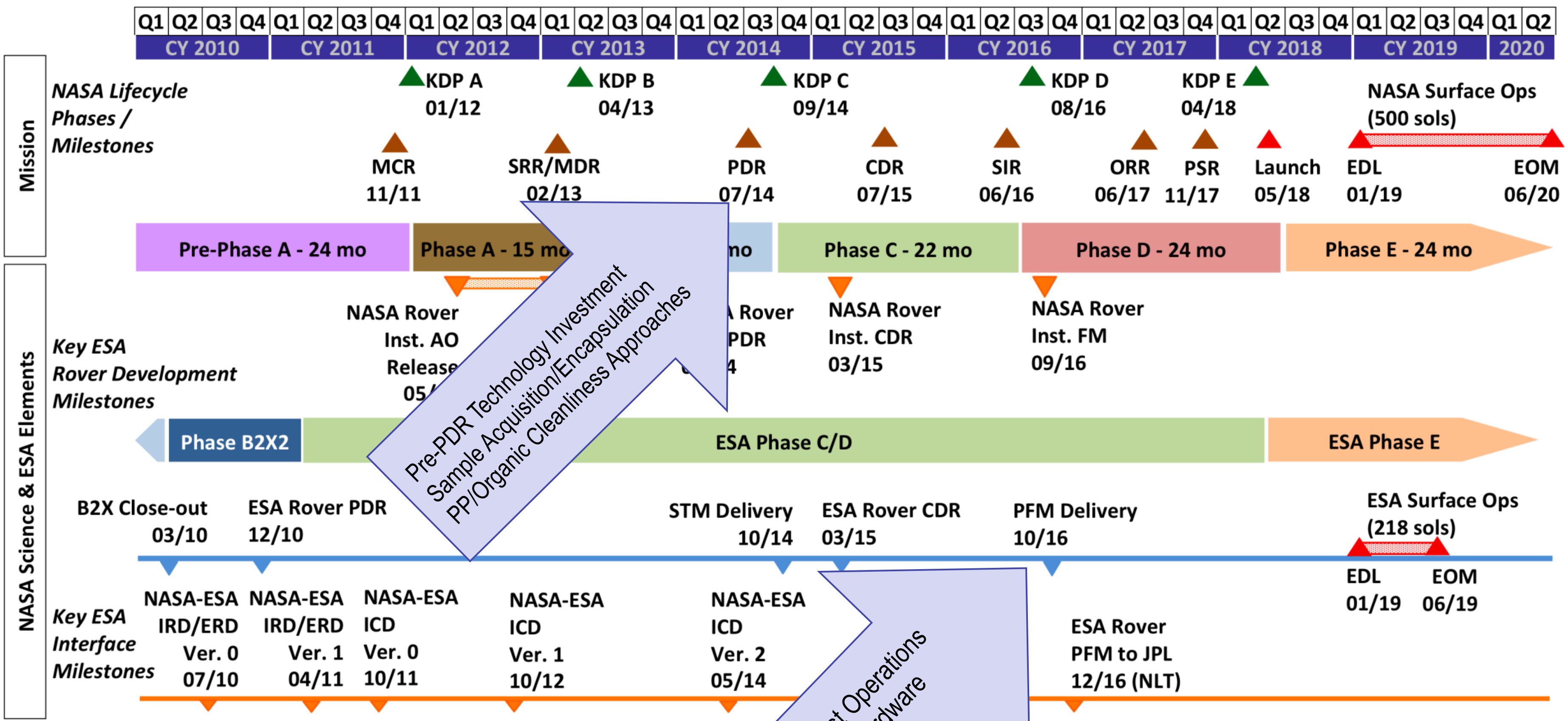
Note: Post-design review separation

From KDP milestones subject to revision

Pre-decisional - For Planning and Discussion Purposes Only

Current Working Mars 2018 Schedule

(based on 2010 PPBE budget request)



Full Lifecycle ... D: 78 months

Note: P... ew separation

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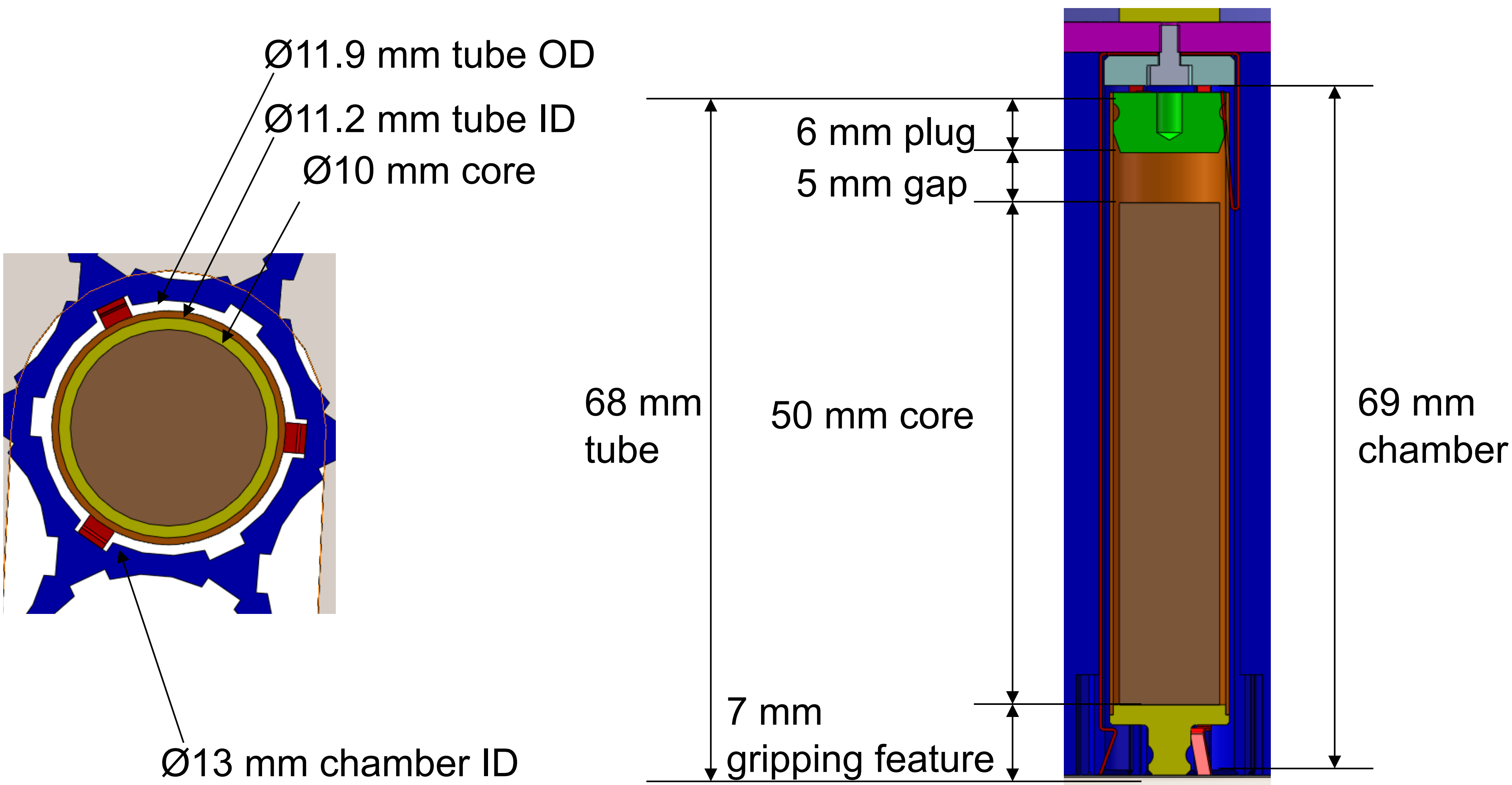
Sample Tube



From P. Younse