Vikings -> PathFinder -> MER rovers -> Phoenix -> MSL-Curiosity -> Insight -> Mars2020 ->…

Futuros Possíveis – A caminho de Marte

[Possible futures - On the way to Mars]

Ivair Gontijo, Systems Engineer [313F], JPL

Talk presented at Firjan – Possible Futures Meeting, Rio de Janeiro, Dec 7th, 2019

Jet Propulsion Laboratory
California Institute of Technology

Opiniões expressas são minhas e não representam o JPL, Caltech ou NASA

[Opinions expressed are my own and do not represent JPL, Caltech or NASA].

O TRÂNSITO DE VÊNUS DE 1882

Dez/1874 – Dez/1882 – Jun/2004 – Jun/2012 – Dez/2117 – 8/Dez/2125, 13:15h

8 122 8 105 8

We are now on the eve of the second transit of a pair, after which there will be no other till the twenty-first centrury of our era has dawned upon the earth, and the June flowers are blooming in distant year of 2004! When the last transit season occurred the intellectual world was awakening from the slumber of ages, and that wondrous scientific activity which has led to our present advanced knowledge was just beginning. What will the state of science when the next transit season arrives God only knows. Not even our children's children will live to take part in the astronomy of that day...

Estamos às vésperas do segundo trânsito de Vênus e depois deste não haverá outro até que o século 21 tenha chegado à terra e os jardins estejam florindo no distante ano de 2004! Quando o último par de trânsitos occorreu, o mundo intelectual estava acordando do sono das eras e a atividade científica que levou ao nosso avançado conhecimento atual estava ainda começando. Só Deus sabe qual será o estado da Ciência quando o próximo trânsito de Venus chegar. Nem mesmo os filhos dos nossos filhos vão viver para fazer parte da Astronomia daquela época...

US Naval Observatory astronomer William Harkness (1837–1903)

Futuros possíveis

Existem dois futuros, o futuro do desejo e o futuro do destino e a razão humana nunca aprendeu a separar os dois. Desejo, a coisa mais poderosa nesse mundo, é todo futuro ...

[There are two futures, the future of desire and the future of fate, and man's reason has never learnt to separate them. Desire, the strongest thing in the world, is itself all future …]

JD Bernal, in "The World, the Flesh & the Devil – An Enquiry into the Future of the Three Enemies of the Rational Soul", 1929.

E se … a gerra entre Atenas e Esparta não tivesse acontecido? *[what if … the war between Athens and Sparta had not happened?]*

…=> ~~Alexandre da Macedonia~~ => ~~Império romano e idade media?~~ => 25 séculos de acelerado desenvolvimento científico e tecnológico? => Estaríamos falando um dialeto grego? => Espaçonaves Helênicas entre o Sistema solar e Alfa Centauri?
[…=> No Alexandre of Macedonia => No roman empire or middle ages? => 25 centuries of accelerated science and technology development? => Would we be speaking a greek dialect? => Helenic spacecraft between solar system and alpha centauri?]

O futuro tem de ser construído! Isso vale tanto para o futuro individual, quanto o futuro de países ou da humanidade inteira. *[the future has to be built. This is true for the future of individual, nations or mankind as a whole.]*

JPL

Como você foi parar na NASA? *[how did you end up at NASA?]*

Inventando um futuro pessoal… [inventing a personal future]

Curiosity – Mars Yard

JPL

Ivair Gontijo
A
CAMINHO
de MARTE
A incrível jornada
de um cientista
brasileiro até a NASA
SEXTANTE

Um relato fascinante da exploração espacial
e da viagem do Curiosity ao planeta vermelho
Ivair Gontijo
A
CAMINHO
de MARTE
A incrível jornada
de um cientista
brasileiro até a NASA

Humanos em Marte nas próximas décadas?

[Humans on Mars in the next decades?]

Muito provável, mas antes disso, podemos “ajudar o futuro acontecer”:

[Very probable, but befor ethat we can “help make future happen”]

See translation for the rest in the next slide→

1. Podemos estudar Marte com veículos robotizados e descobrir porque o planeta se diferenciou tanto da terra.
2. Estudar compostos orgânicos genuinamente marcianos.
3. Precisamos resolver os gigantescos problemas tecnológicos:
    - Como produzir Oxigênio durante a viagem e na superfície
    - Como produzir comida durante a viagem e na superfície
    - Como sobreviver à viagem (saúde em geral, emergências médicas a bordo, tonus muscular, isolamento, problemas psicológicos)
    - Como sobreviver à radiação na superfície
    - Como levar combustível e entrar com ele na atmosfera marciana
    - Como voltar para a terra

[Humans on Mars in the next decades?]

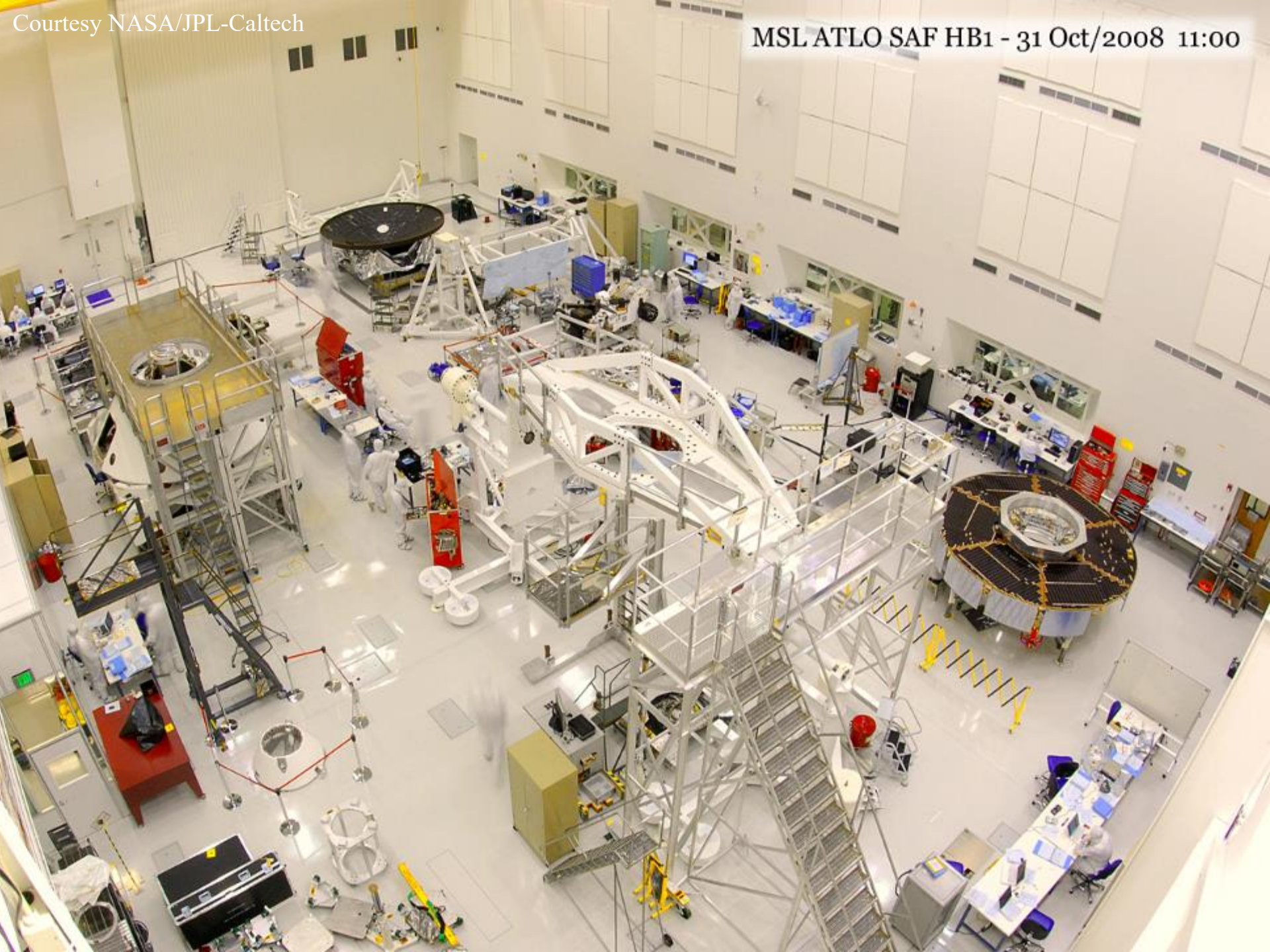
[Very probable, but befor ethat we can “help make future happen”]

1. We can study Mars with robotic vehicles and discover why the planet differentiated so much from Earth.
2. Study organic compound genuinely Martian
3. We need to solve the giant technological problems:
    - How to produce Oxygen during the trip and on the surface.
    - How to produce food during the trip and on the surface.
    - How to survive the trip (Health in general, medical emergencies aboard, muscular strength, isolation, psychological problems)
    - How to survive with the surface radiation.
    - How to carry fuel and enter with it in the martian atmosphere.
    - How to return to Earth

Os 10 centros da NASA

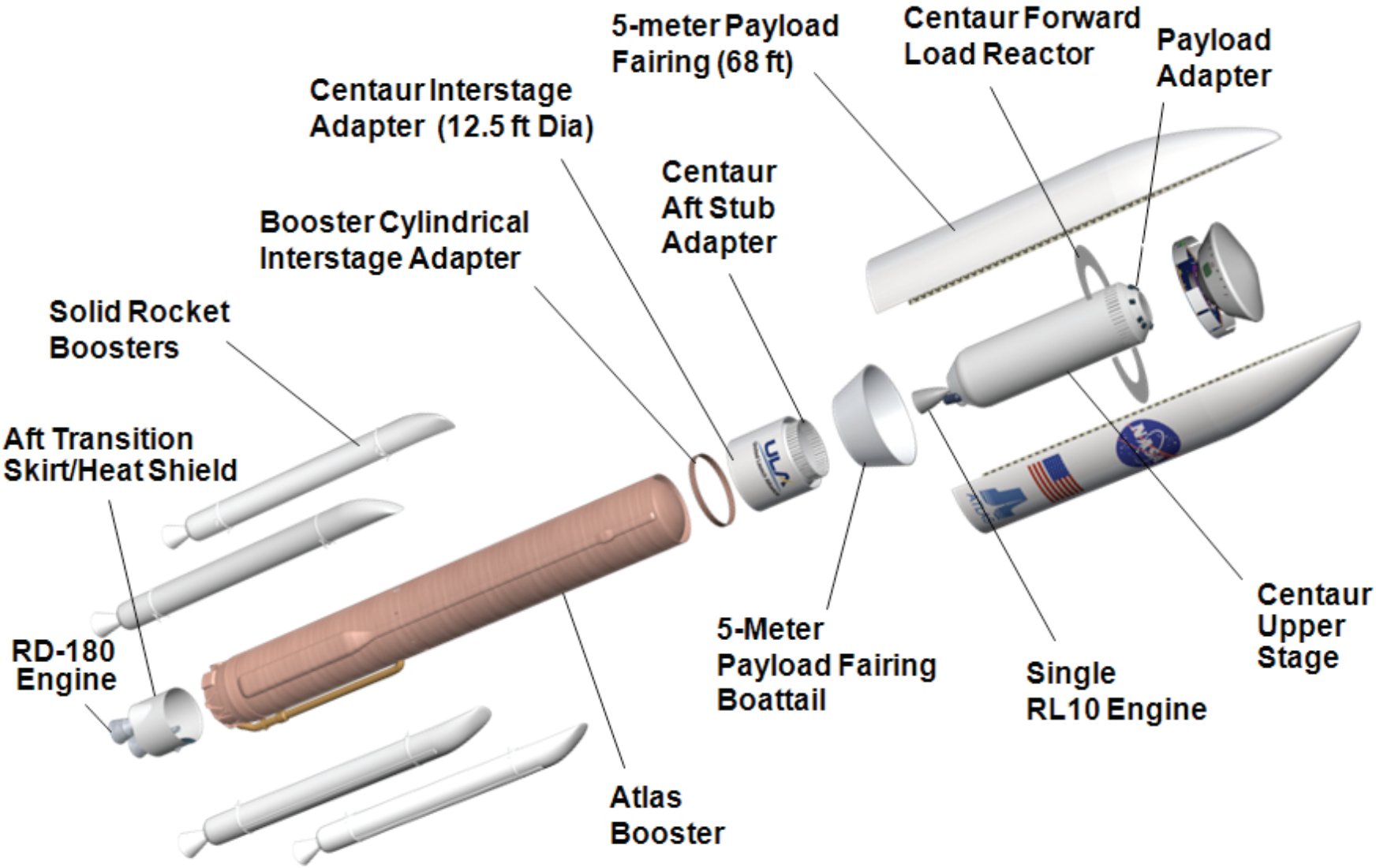
[the 10 NASA centers]

Courtesy NASA/JPL-Caltech

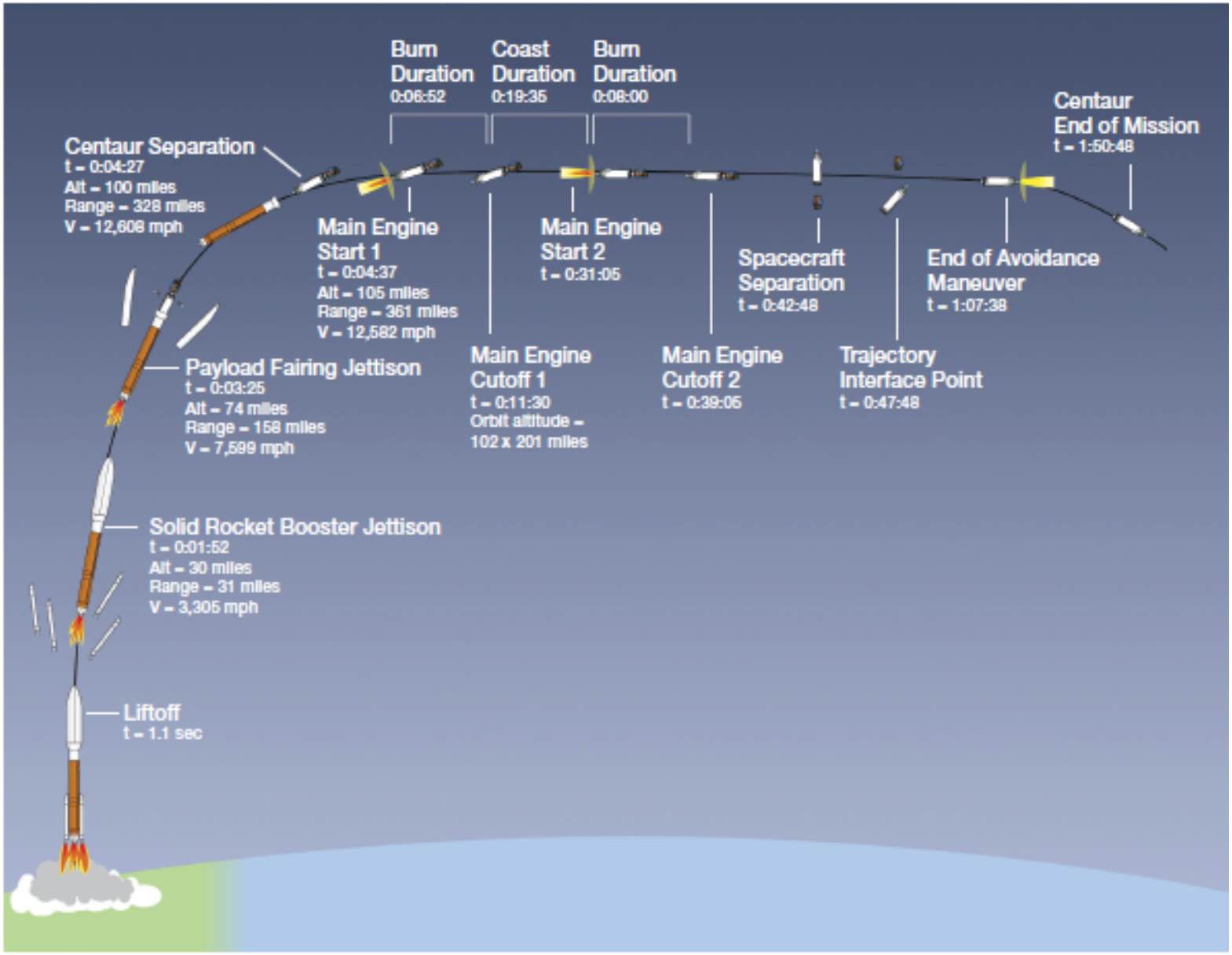


MSL – The rocket Atlas 541:

- 4 auxiliary rockets of solid fuel
- 2 liquid stages



MSL – launch sequence:

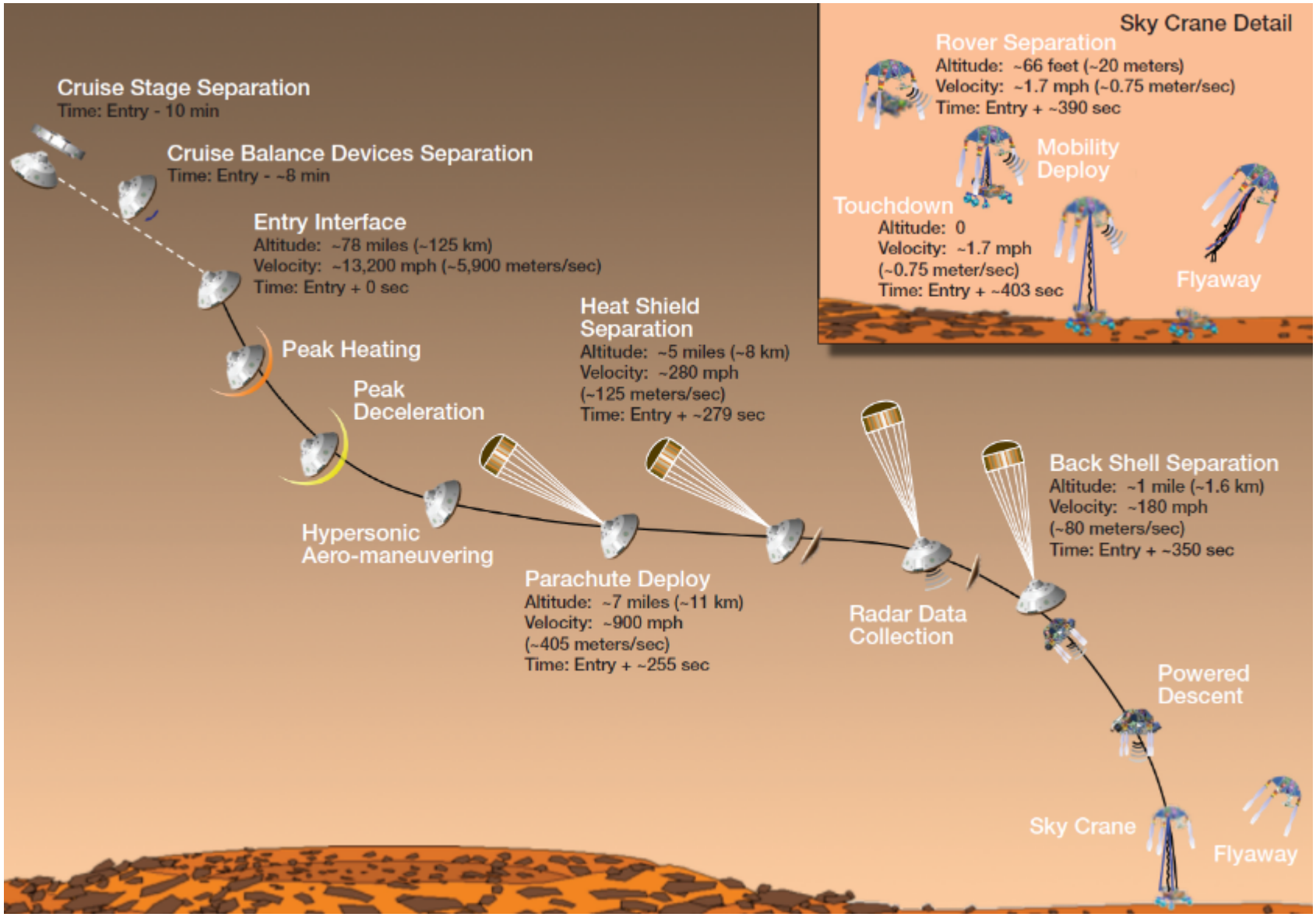


MSL – launch:

- Vídeo do Lançamento: 26 de Novembro de 2011, 7:02 Pacific Time, 13:02 Hora de Brasília.

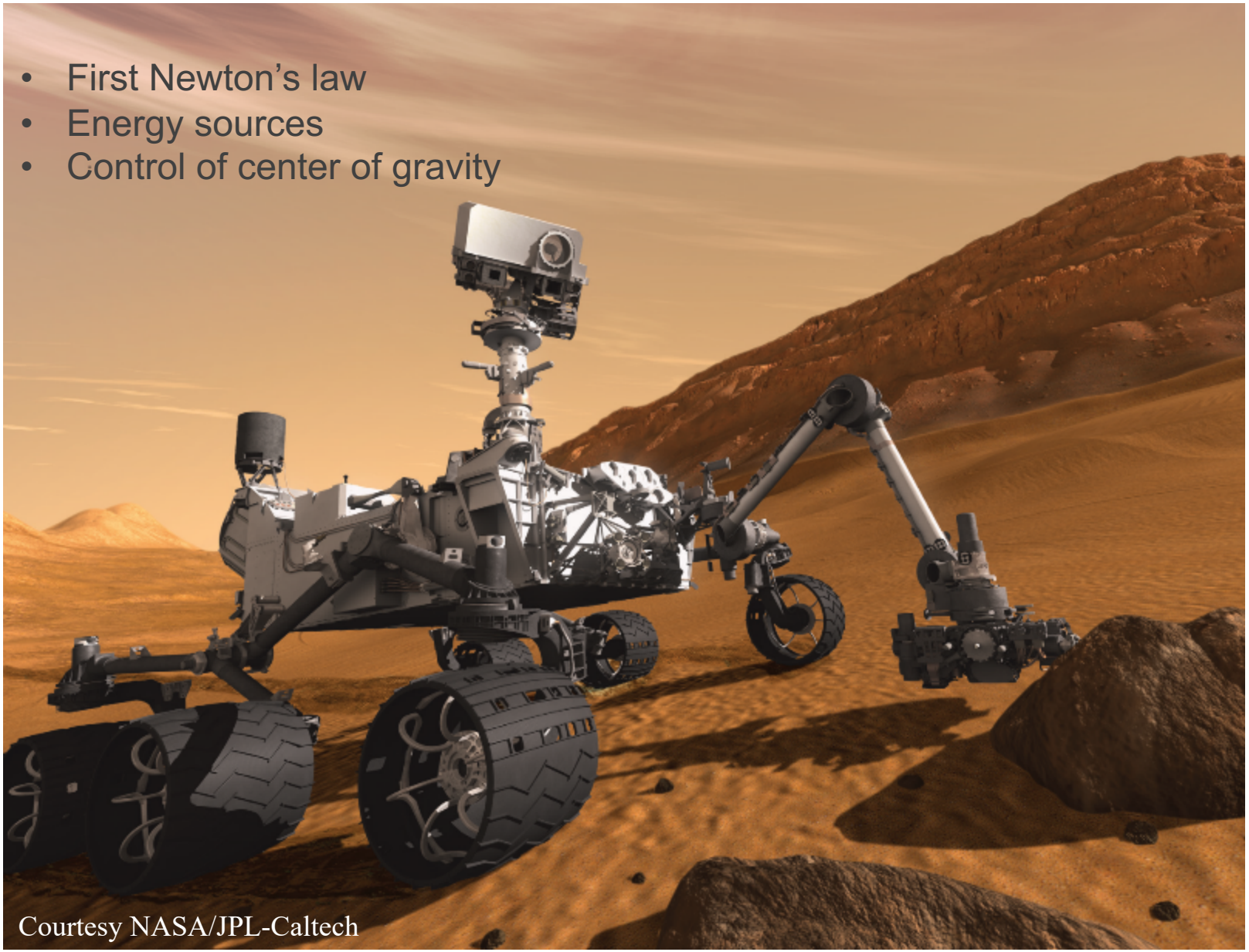
[this is the MSL launch video, available in the internet, here: https://www.youtube.com/watch?v=emqMhQcG3ho]

EDL – Entry, Descent and Landing:

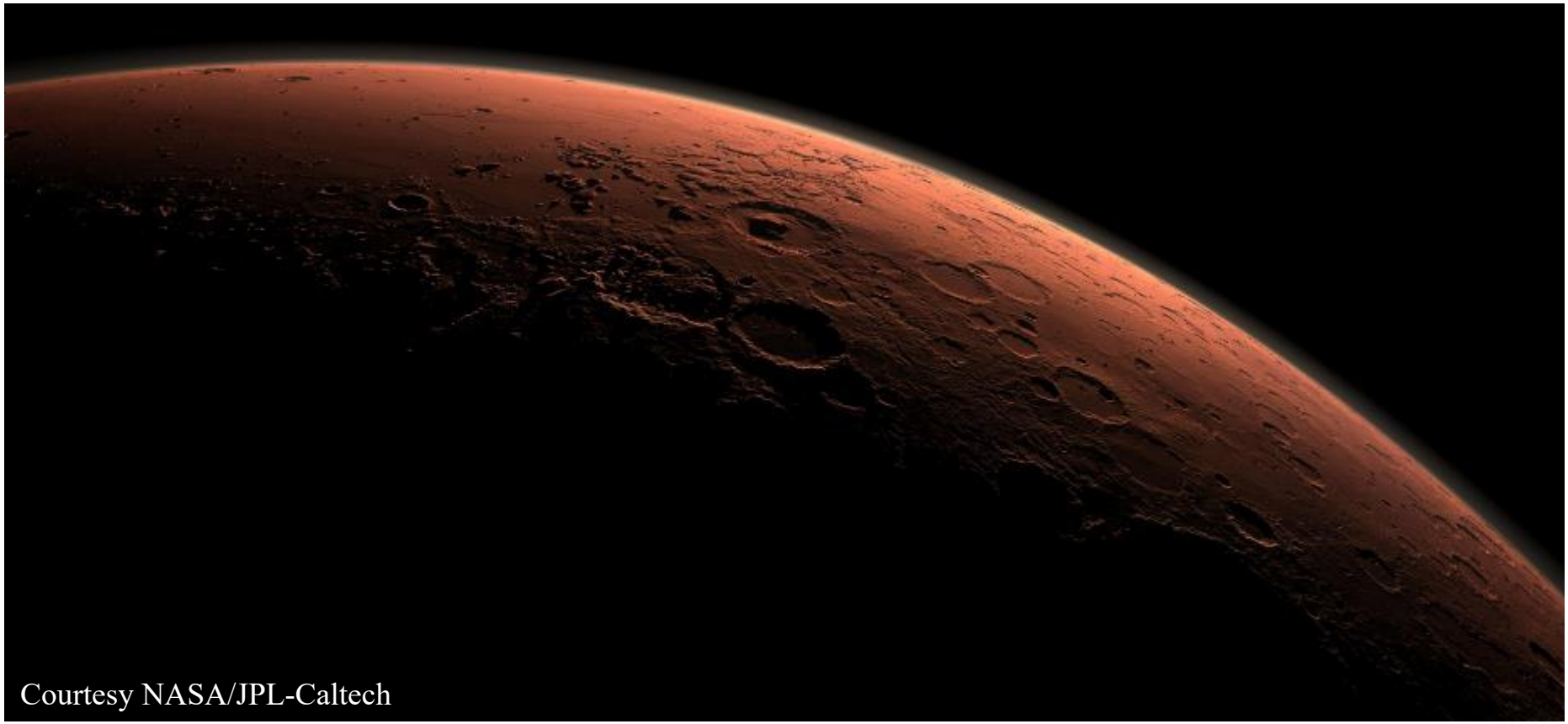


Simulation: From Earth orbit to Gale Crater!

[video simulation available here: https://www.youtube.com/watch?v=924O-cnkvr0]

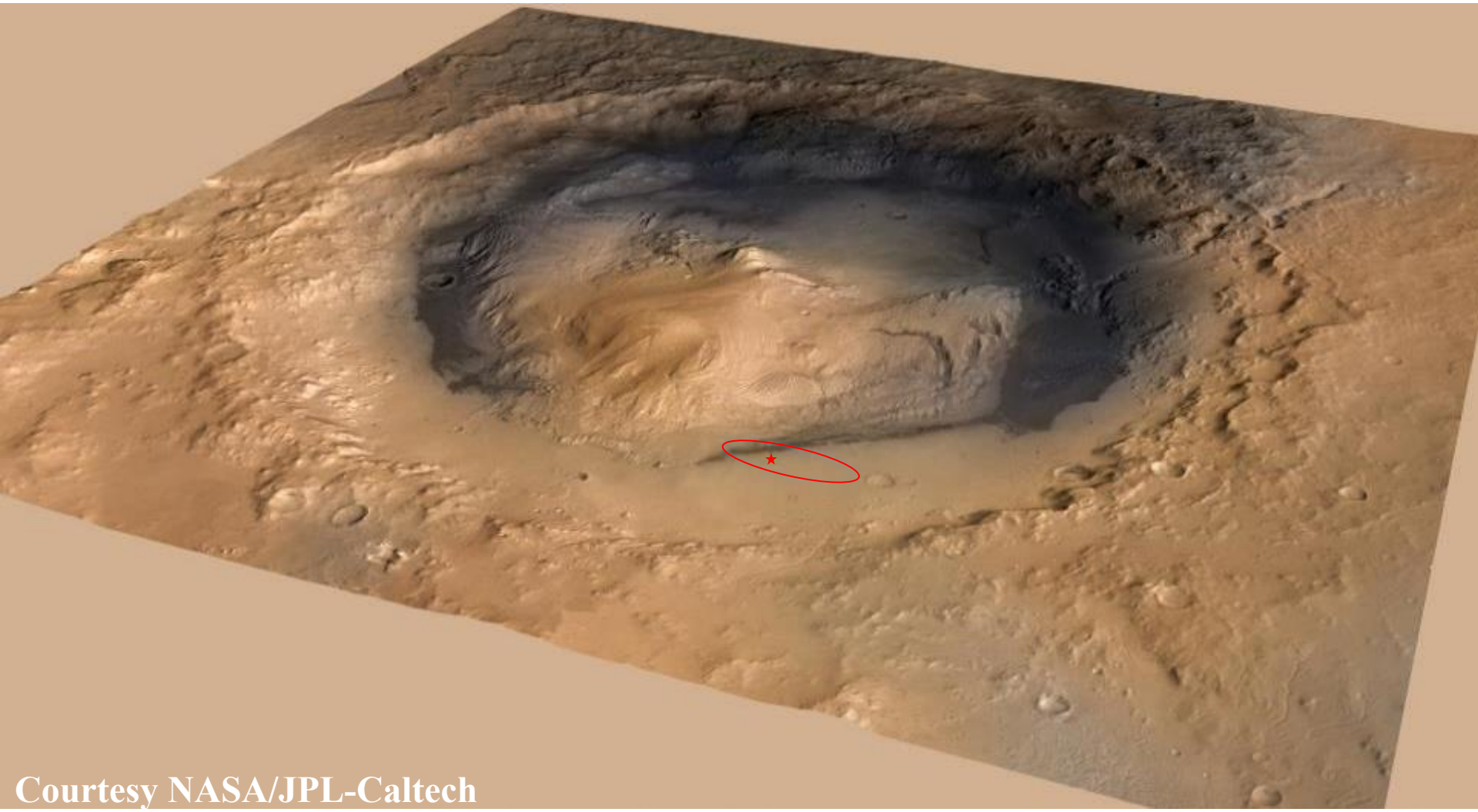


Dawn at Gale crater

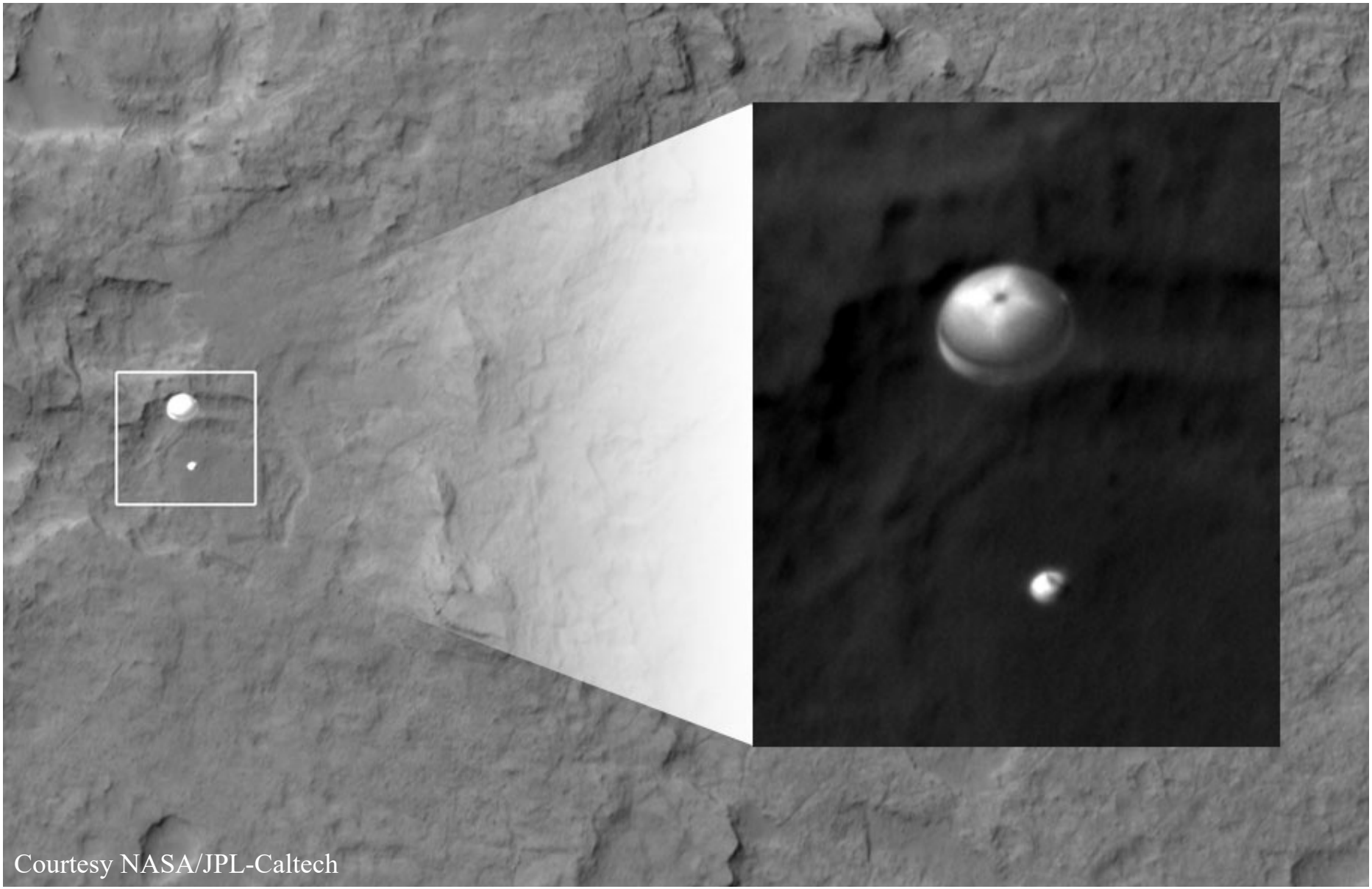


Gale crater photographed by MRO

Landing elippse (90% probability): 20 km x 7 km



MSL arriving, seen by MRO



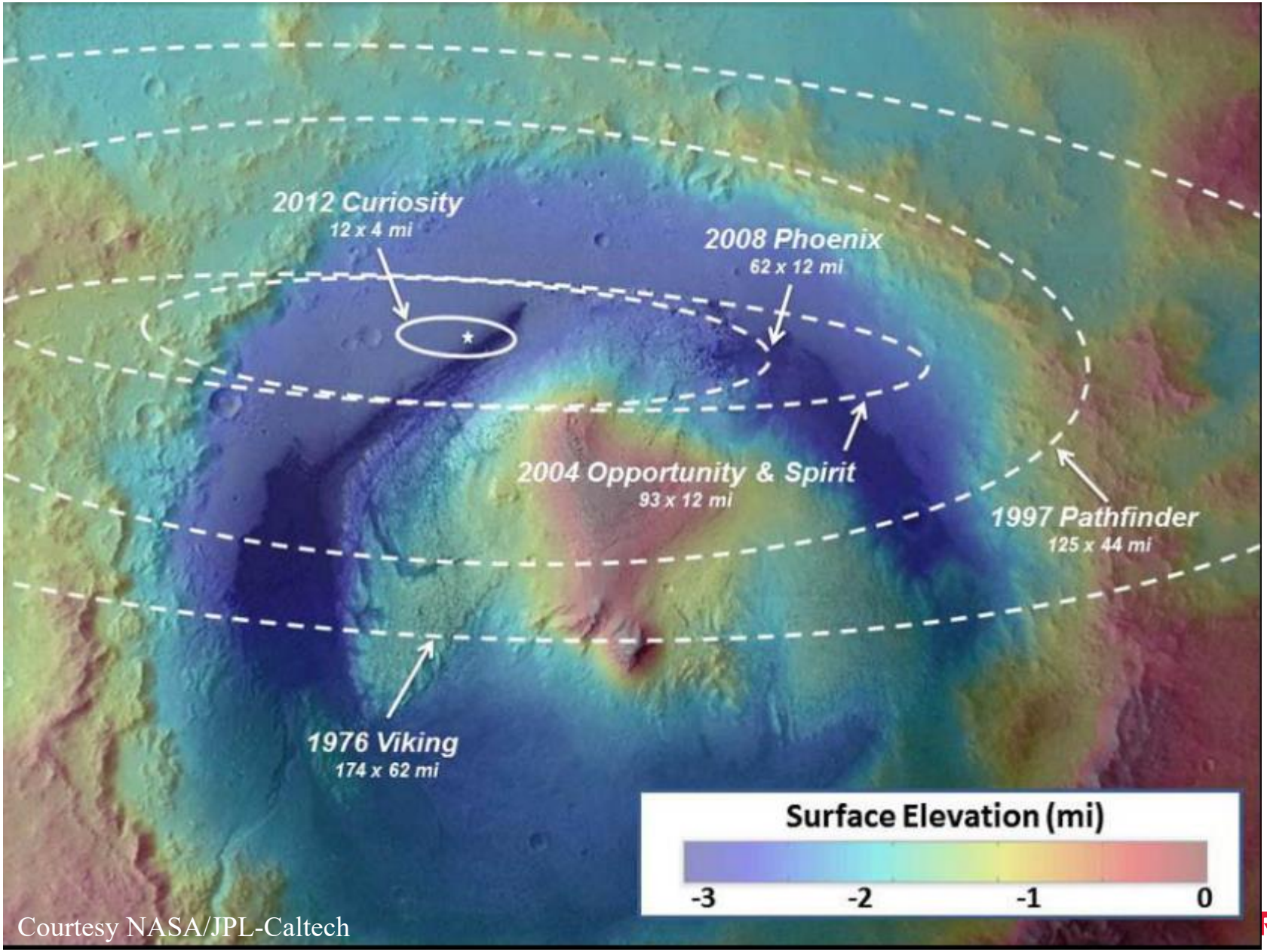
- Descent and landing on Mars:

(TANGO DELTA NOMINAL!)

[Video “dropping in on Mars”, available here:
https://www.youtube.com/watch?v=e1ebHThBdlY]

[Video “where were you when MSL landed”, available here:
https://www.youtube.com/watch?v=zervvVw2dnU]

Landing elippses – several missions.



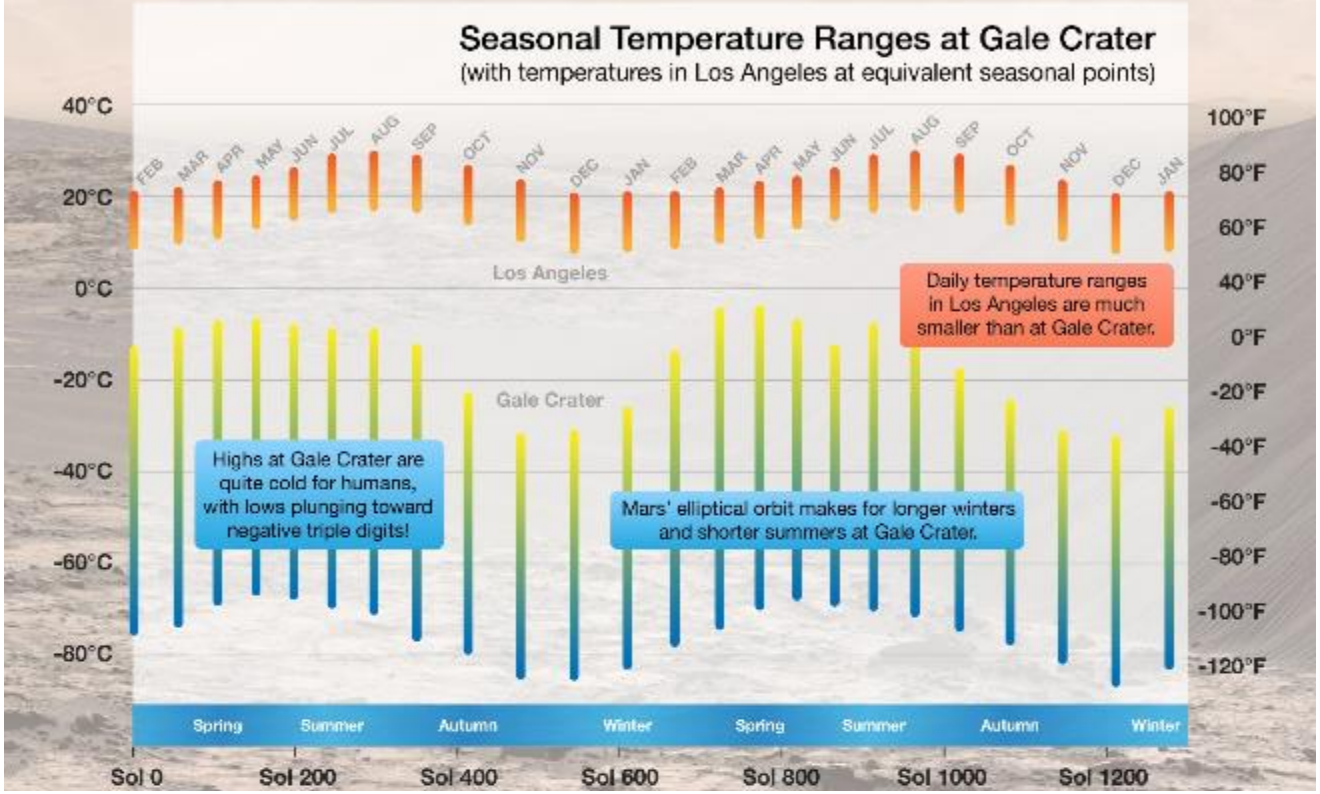
Courtesy NASA/JPL-Caltech

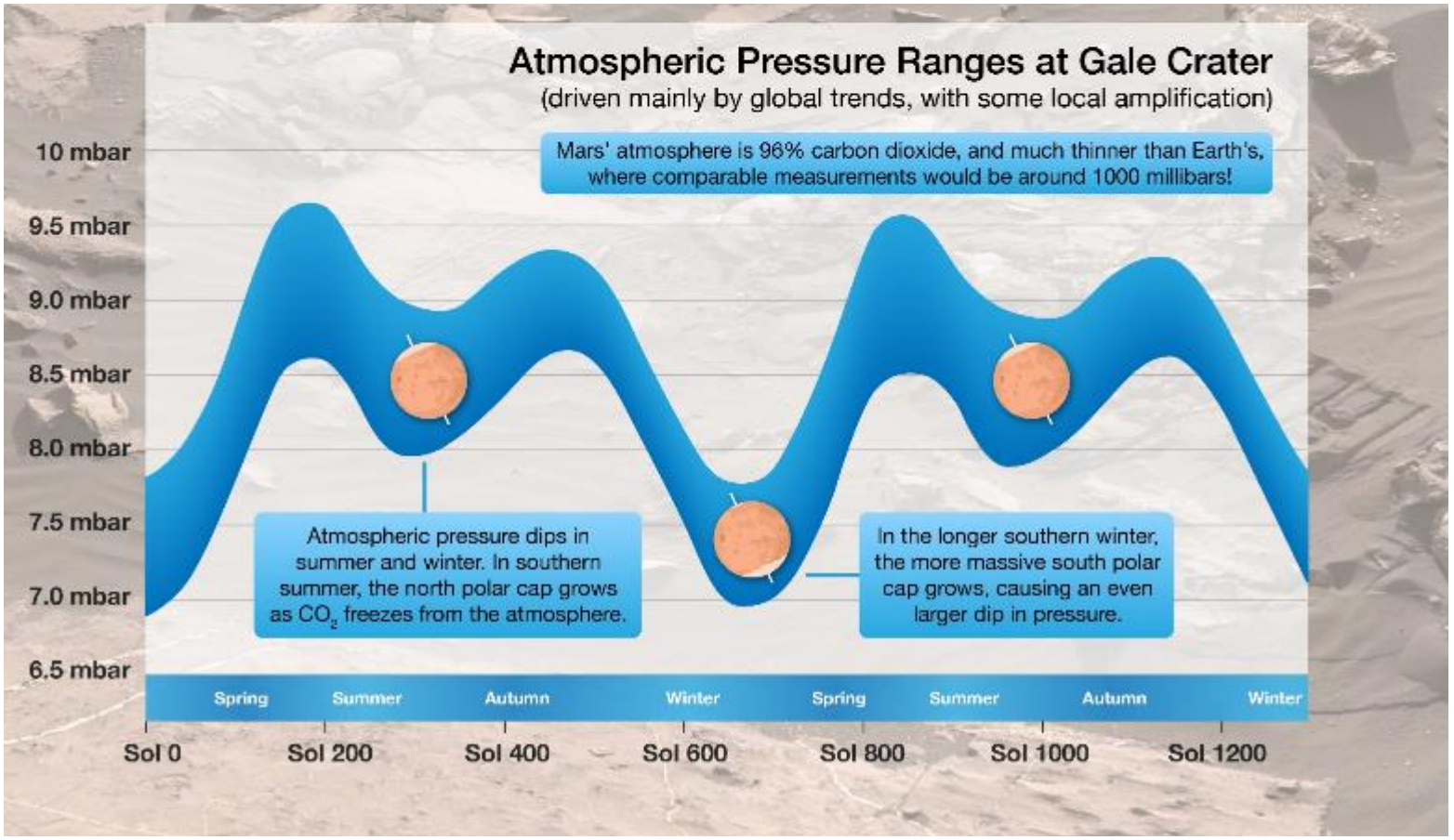
New Curiosity results

WHAT'S MARS REALLY LIKE?

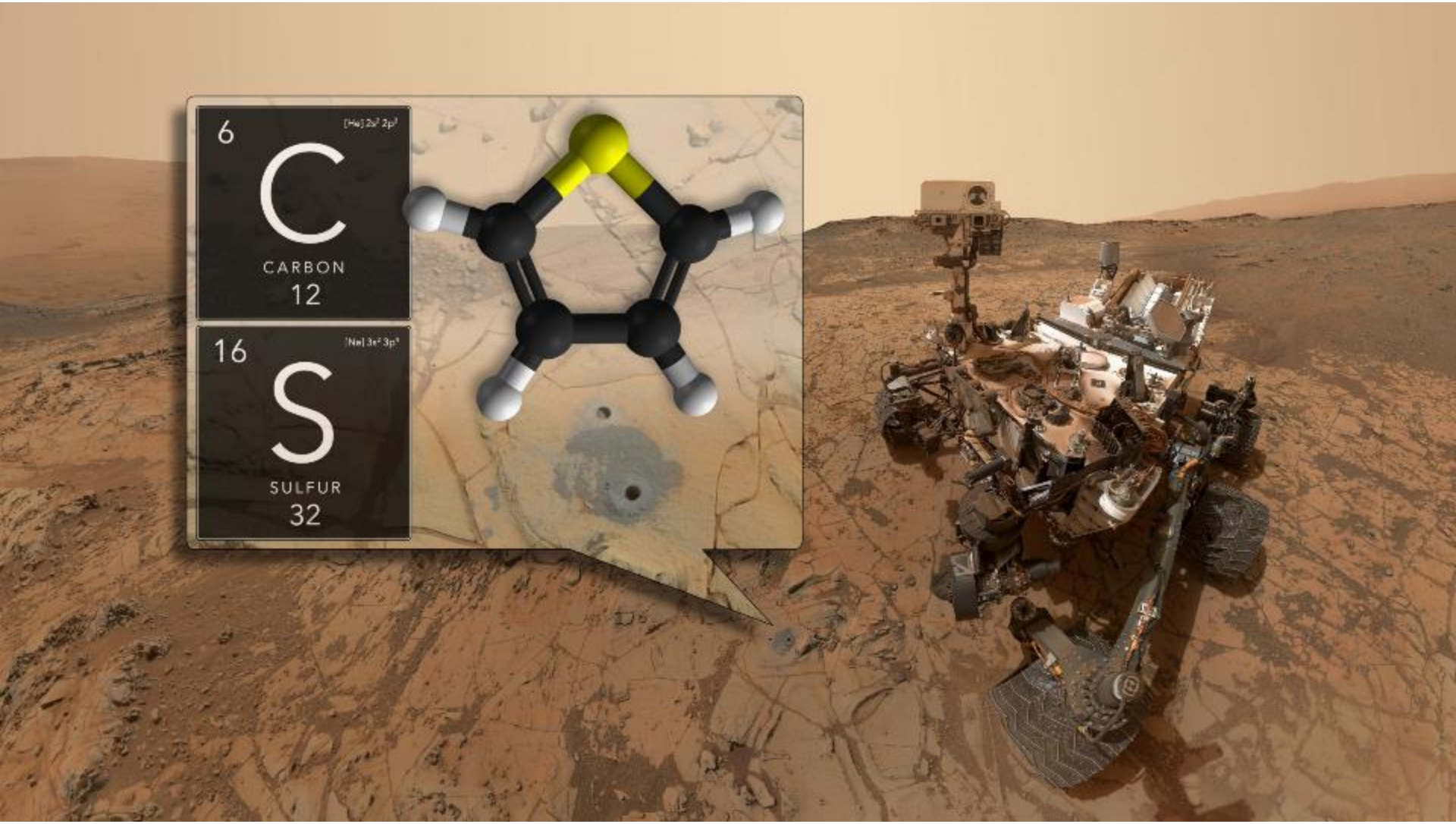
Seasonal Cycles at Gale Crater

as measured by NASA's Mars rover Curiosity

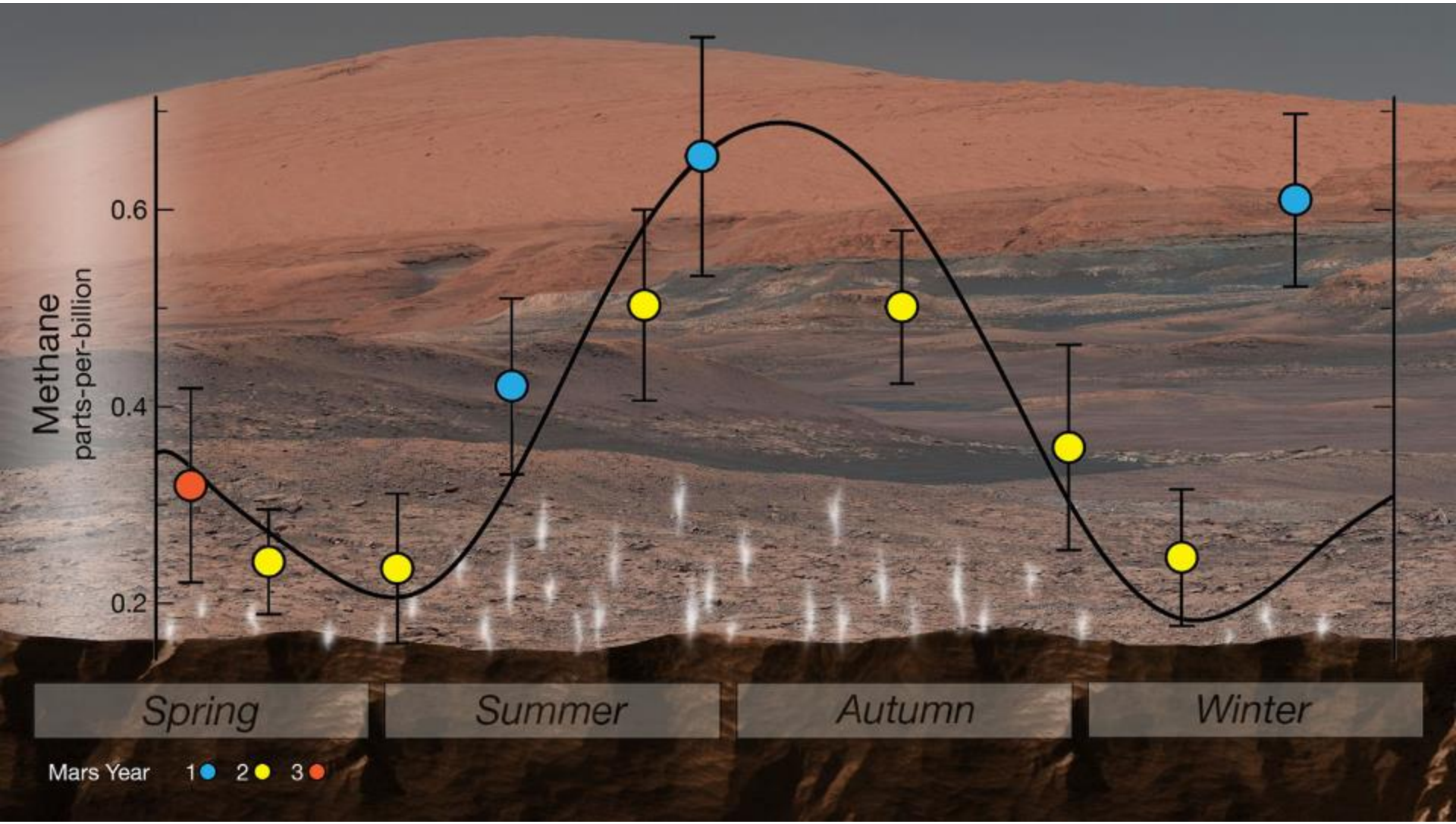



Atmospheric Pressure Ranges at Gale Crater
(driven mainly by global trends, with some local amplification)
Mars' atmosphere is 96% carbon dioxide, and much thinner than Earth's, where comparable measurements would be around 1000 millibars!
10 mbar
9.5 mbar
9.0 mbar
8.5 mbar
8.0 mbar
7.5 mbar
7.0 mbar
6.5 mbar
Atmospheric pressure dips in summer and winter. In southern summer, the north polar cap grows as CO_2 freezes from the atmosphere.
In the longer southern winter, the more massive south polar cap grows, causing an even larger dip in pressure.
Spring
Summer
Autumn
Winter
Spring
Summer
Autumn
Winter
Sol 0
Sol 200
Sol 400
Sol 600
Sol 800
Sol 1000
Sol 1200

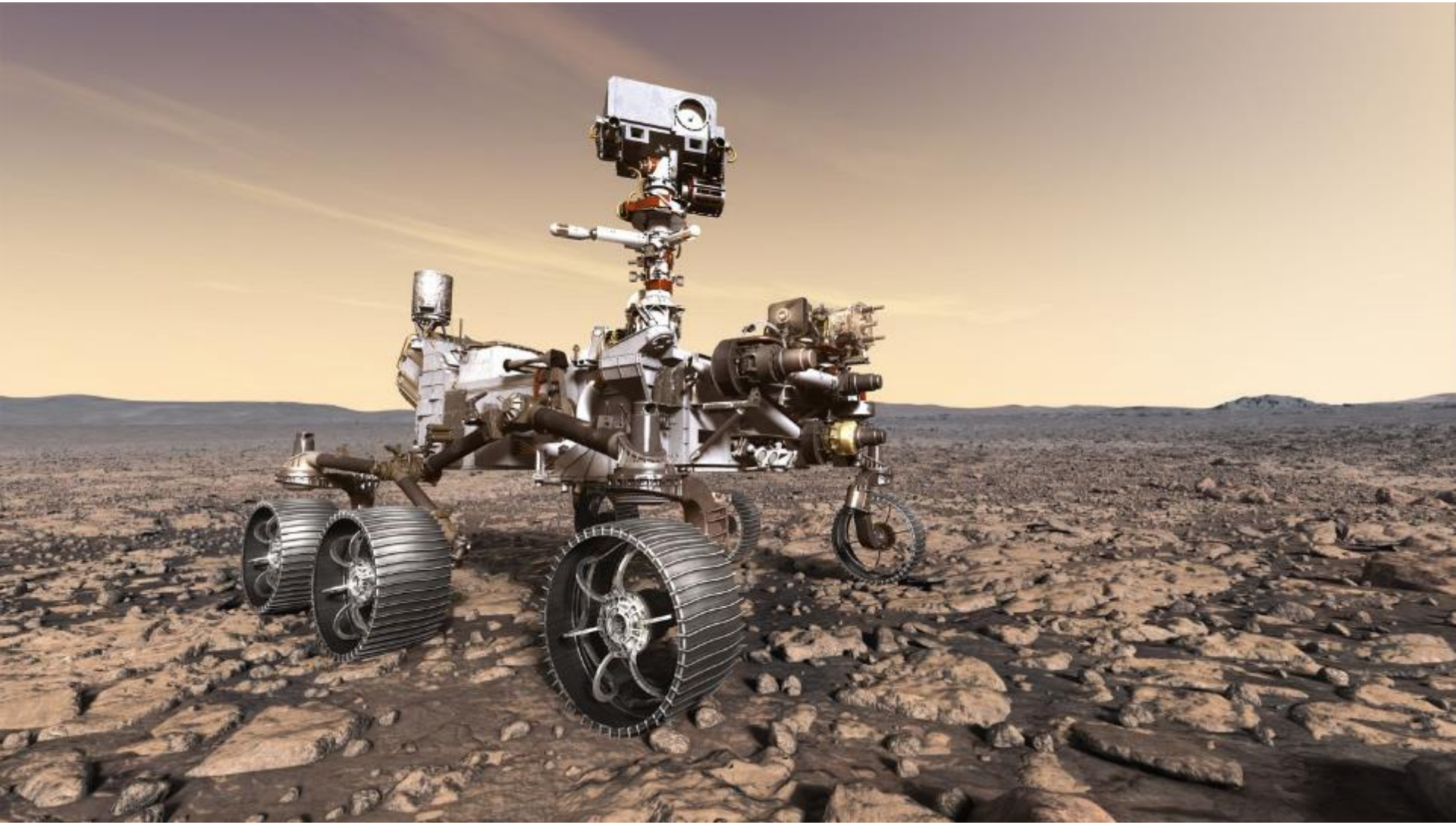
Complex organic molecules



Methane

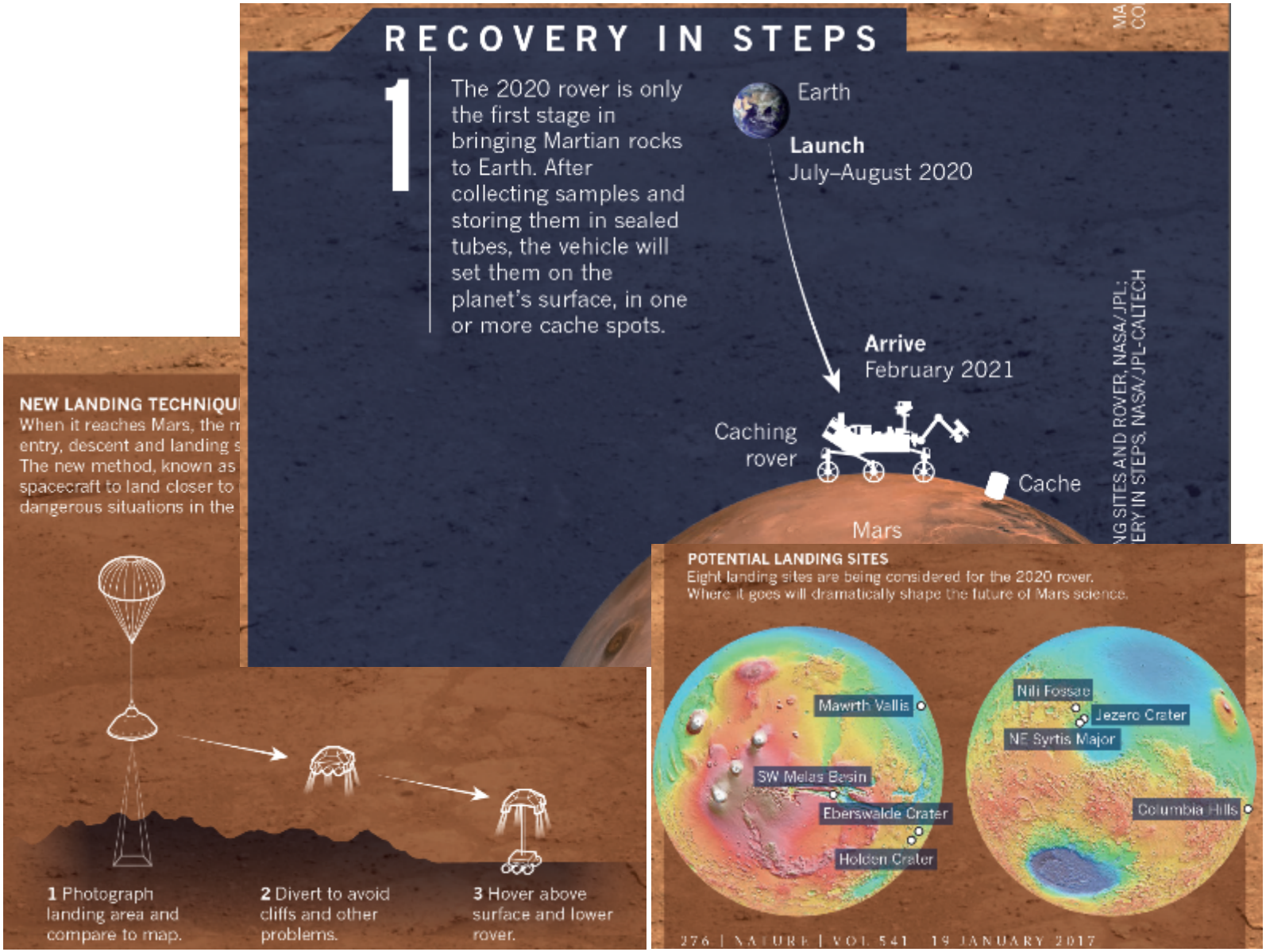

Methane
parts-per-billion
0.6
0.4
0.2
Spring
Summer
Autumn
Winter
Mars Year 1 2 3

Next steps on Mars exploration



JPL

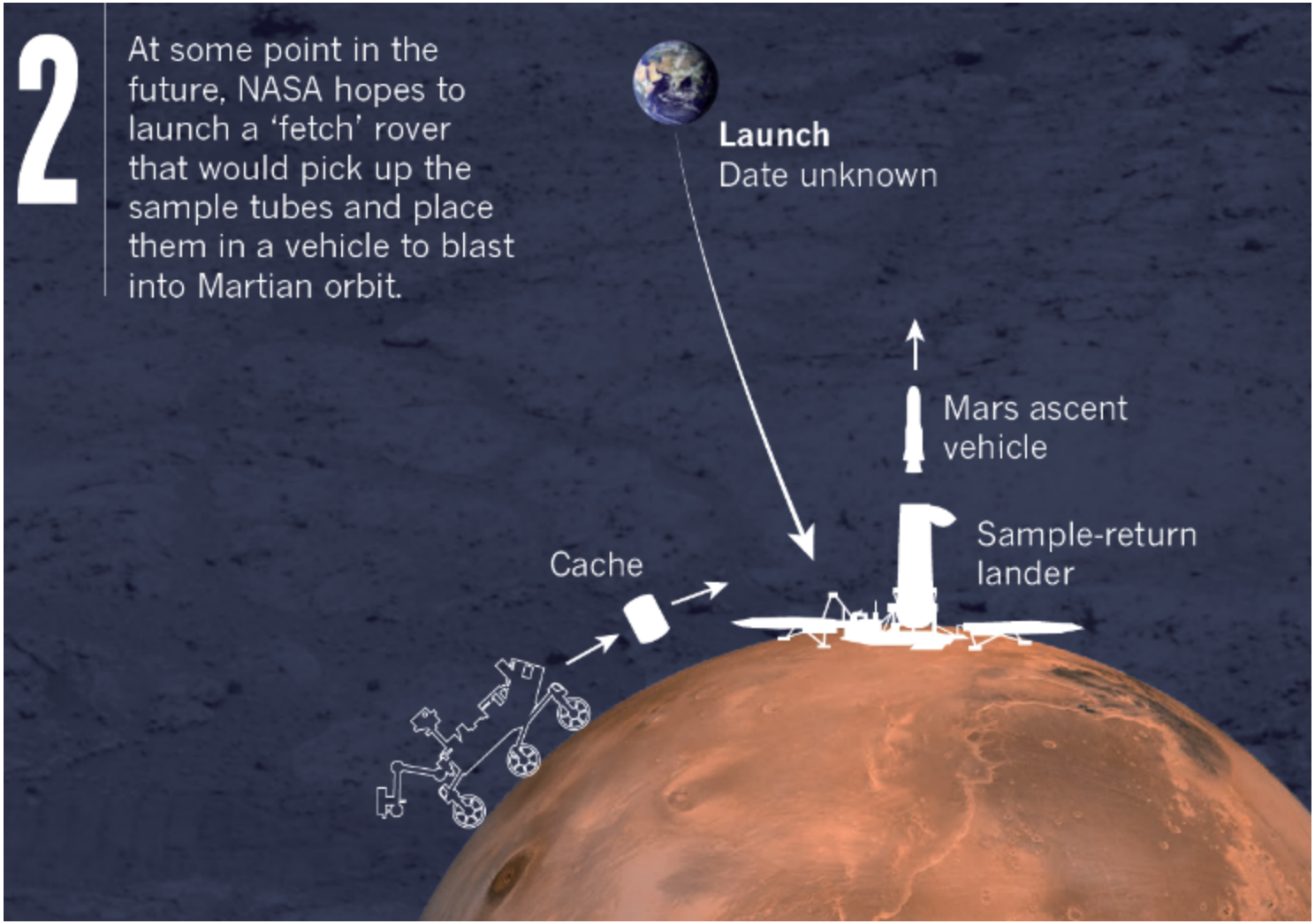
Potential Mars Sample Return



From: Alexandra Witze, "Next stop, Mars", Nature, vol 541, 274-278, 19 Jan 2017.

Pre-Decisional Information – For Planning and Discussion Purposes Only

Potential Mars Sample Return



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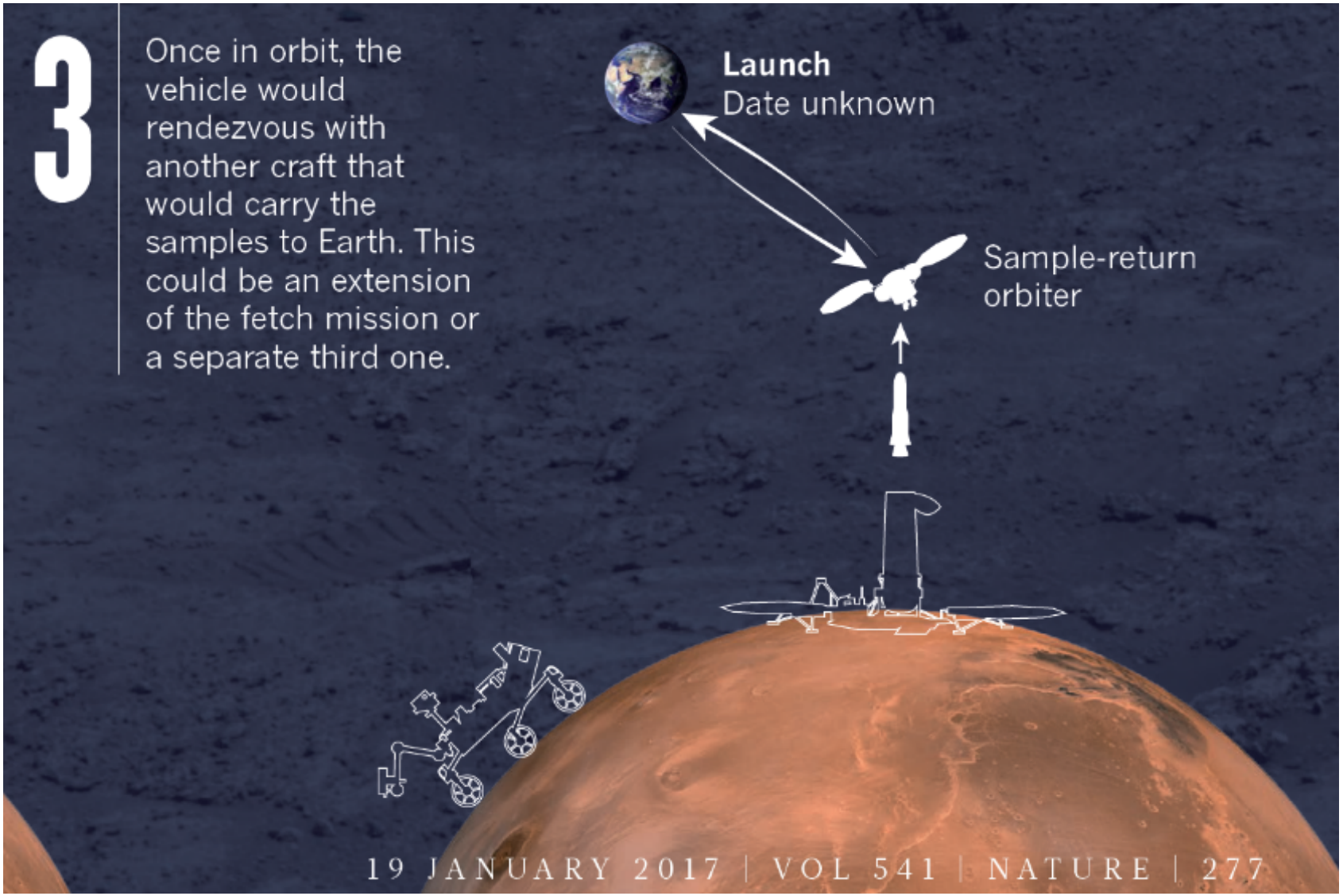
Pre-Decisional Information – For Planning and Discussion Purposes Only

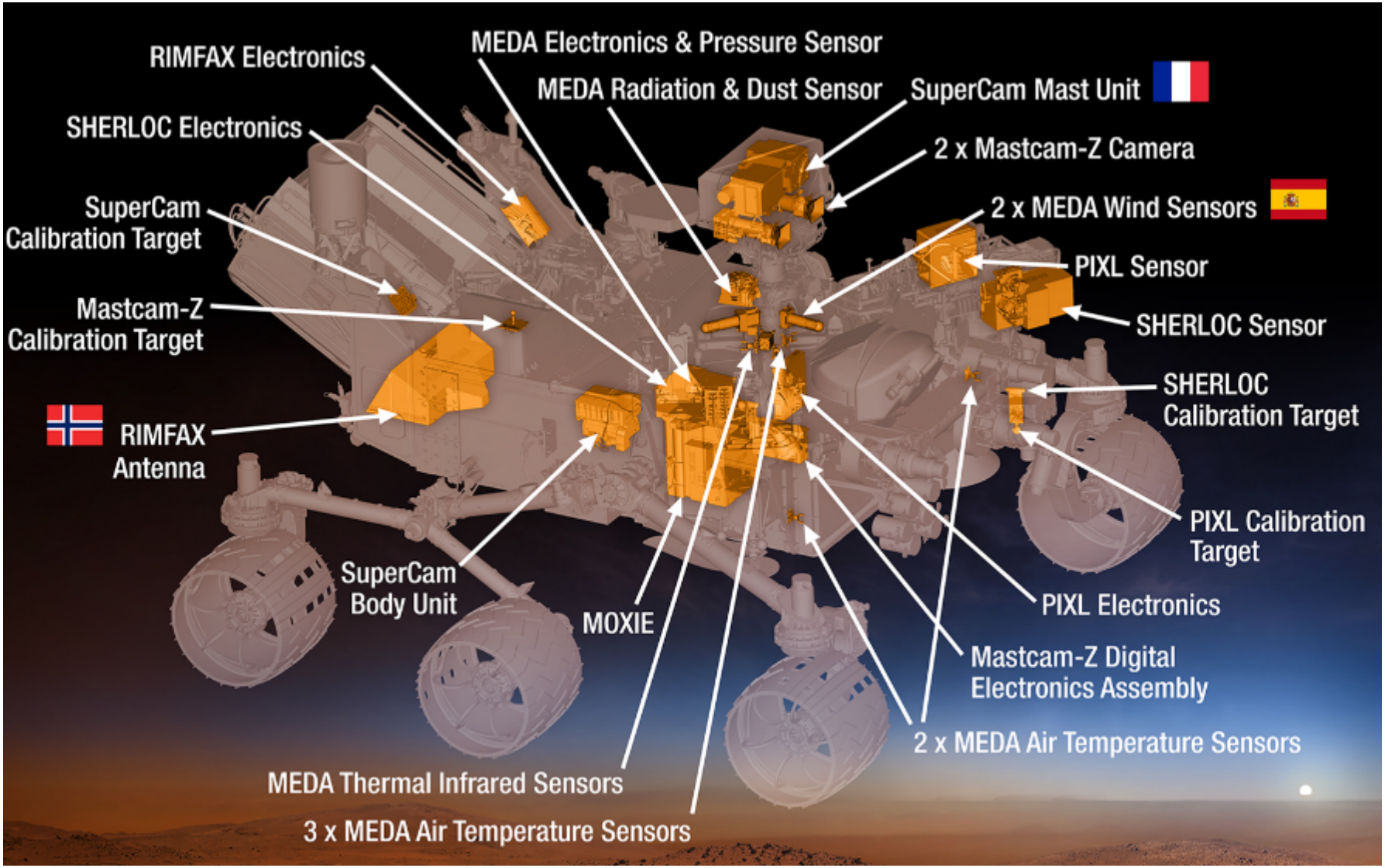
Potential Mars Sample Return



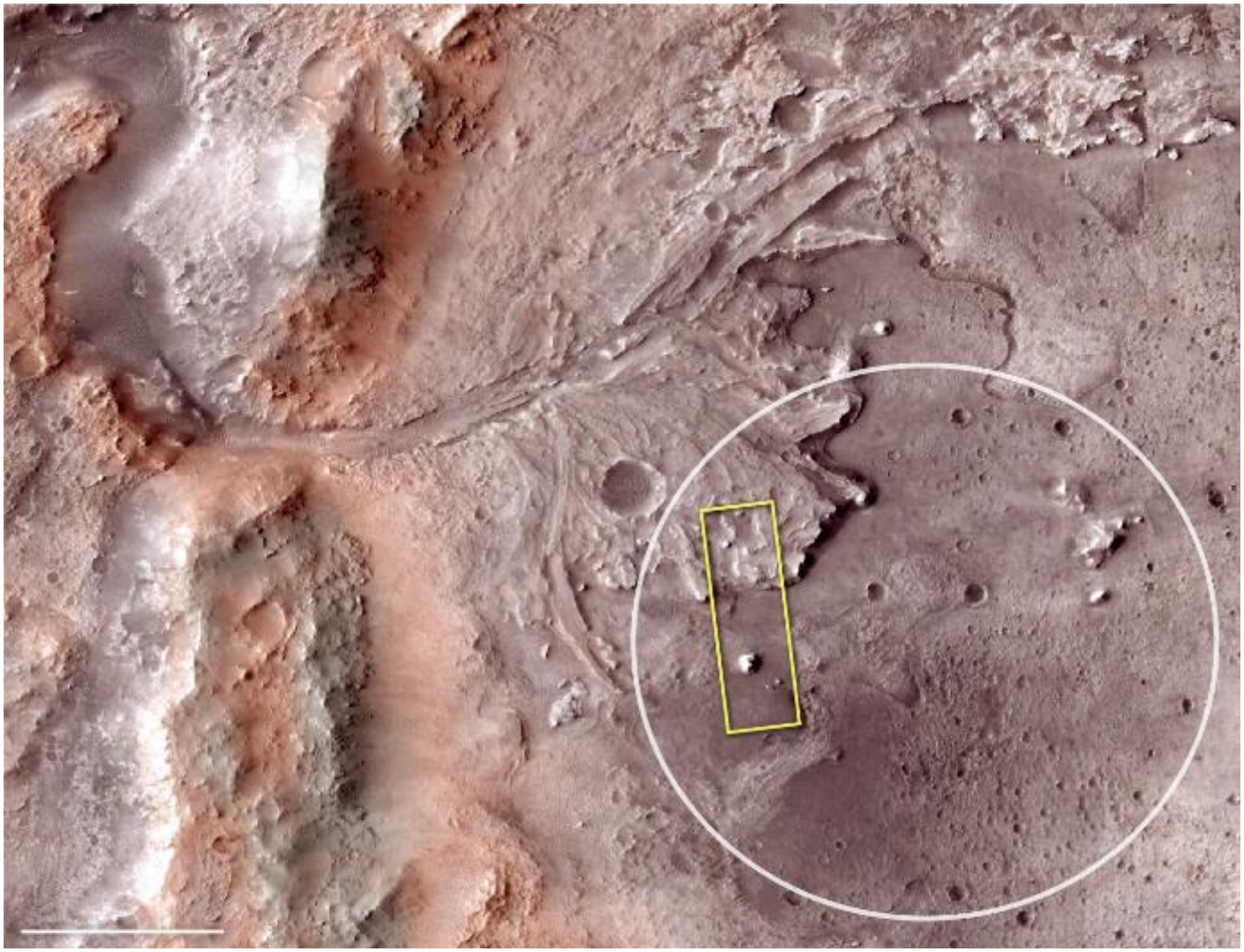
From: Alexandra Witze, "Next stop, Mars", Nature, vol 541, 274-278, 19 Jan 2017.

Pre-Decisional Information – For Planning and Discussion Purposes Only

MARS 2020 – instrumentos



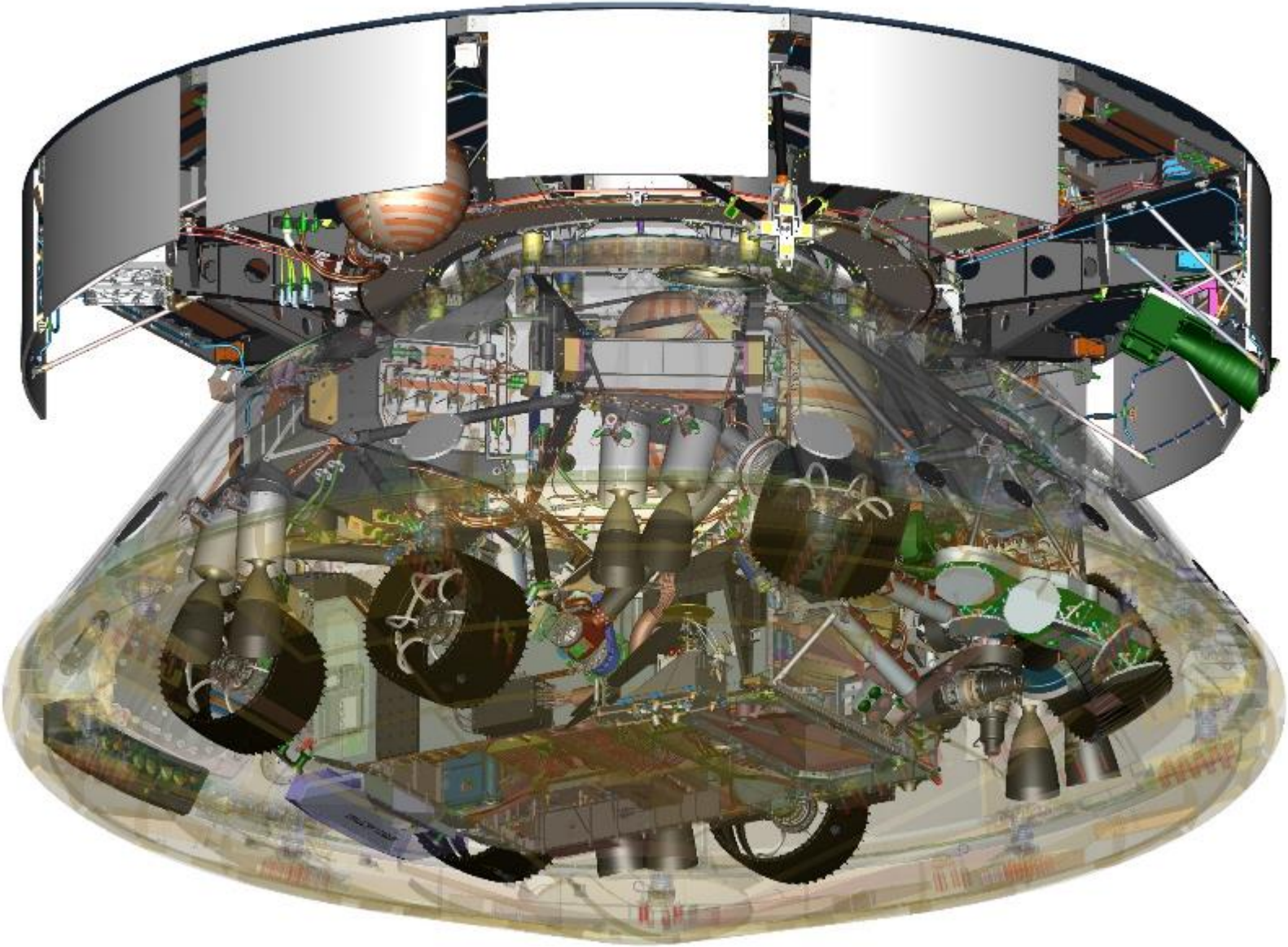
Jezero crater – river & lake



Jezero crater – river & lake

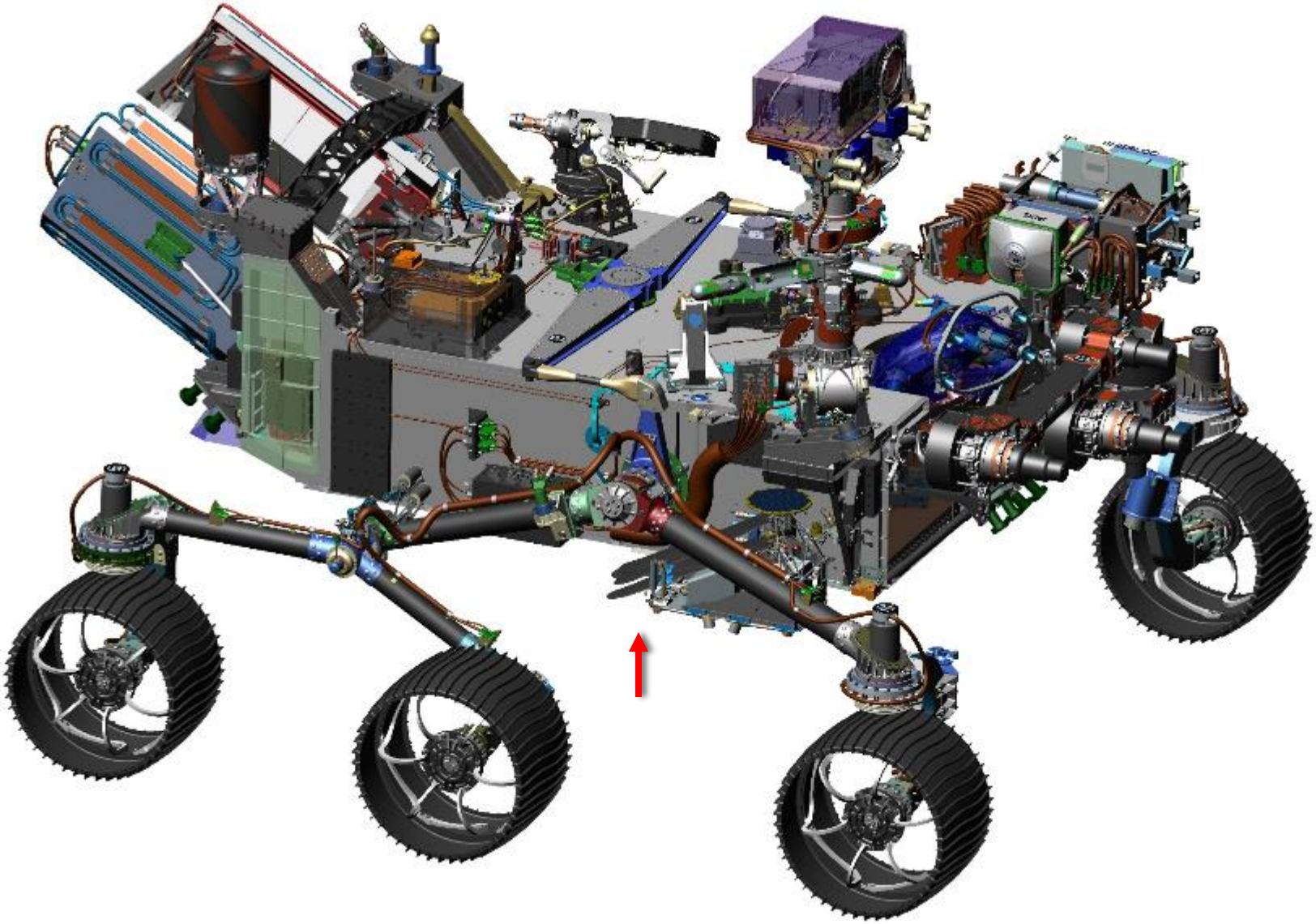
MARS 2020 – Mars sample collector

- Mars2020 uses hardware similar to Curiosity.



MARS 2020 – Mars sample collector

- New instruments and sample cache system



Space Simulator Chamber

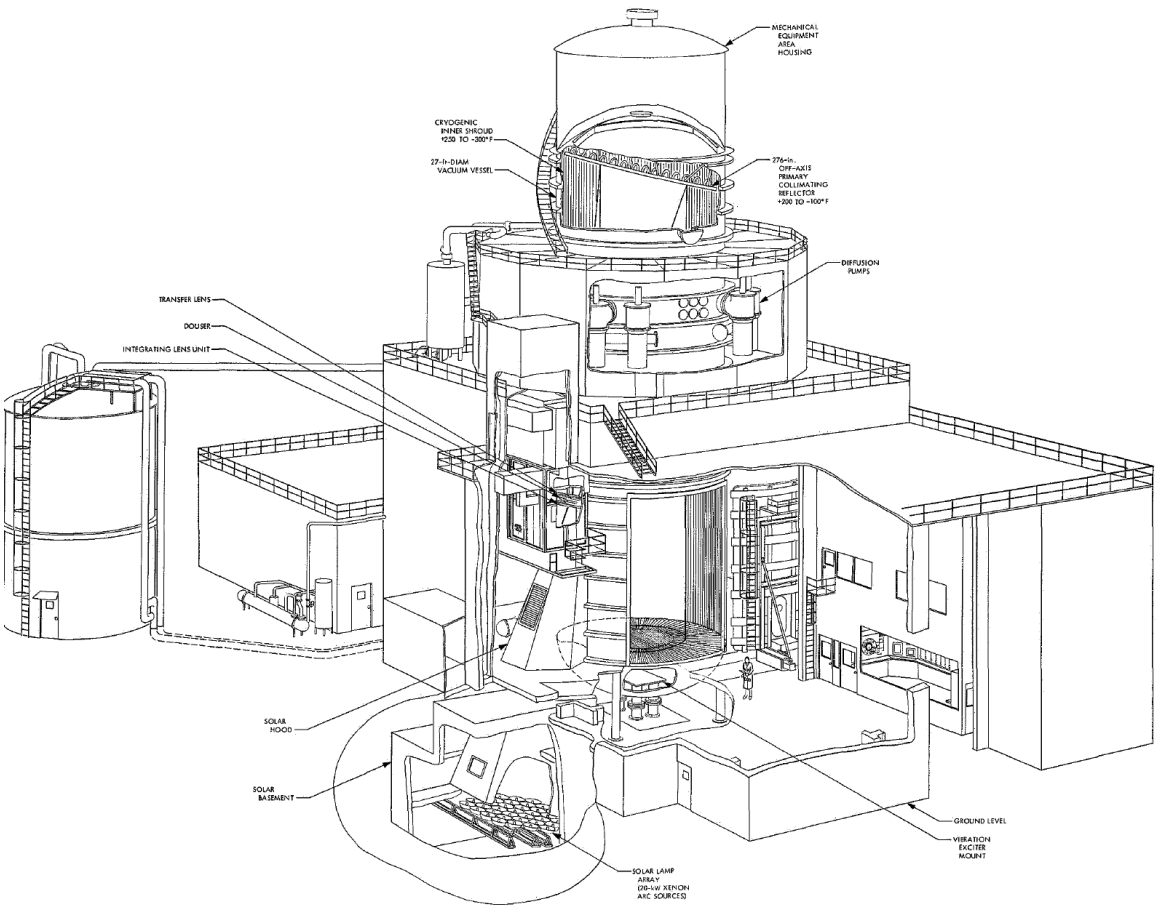
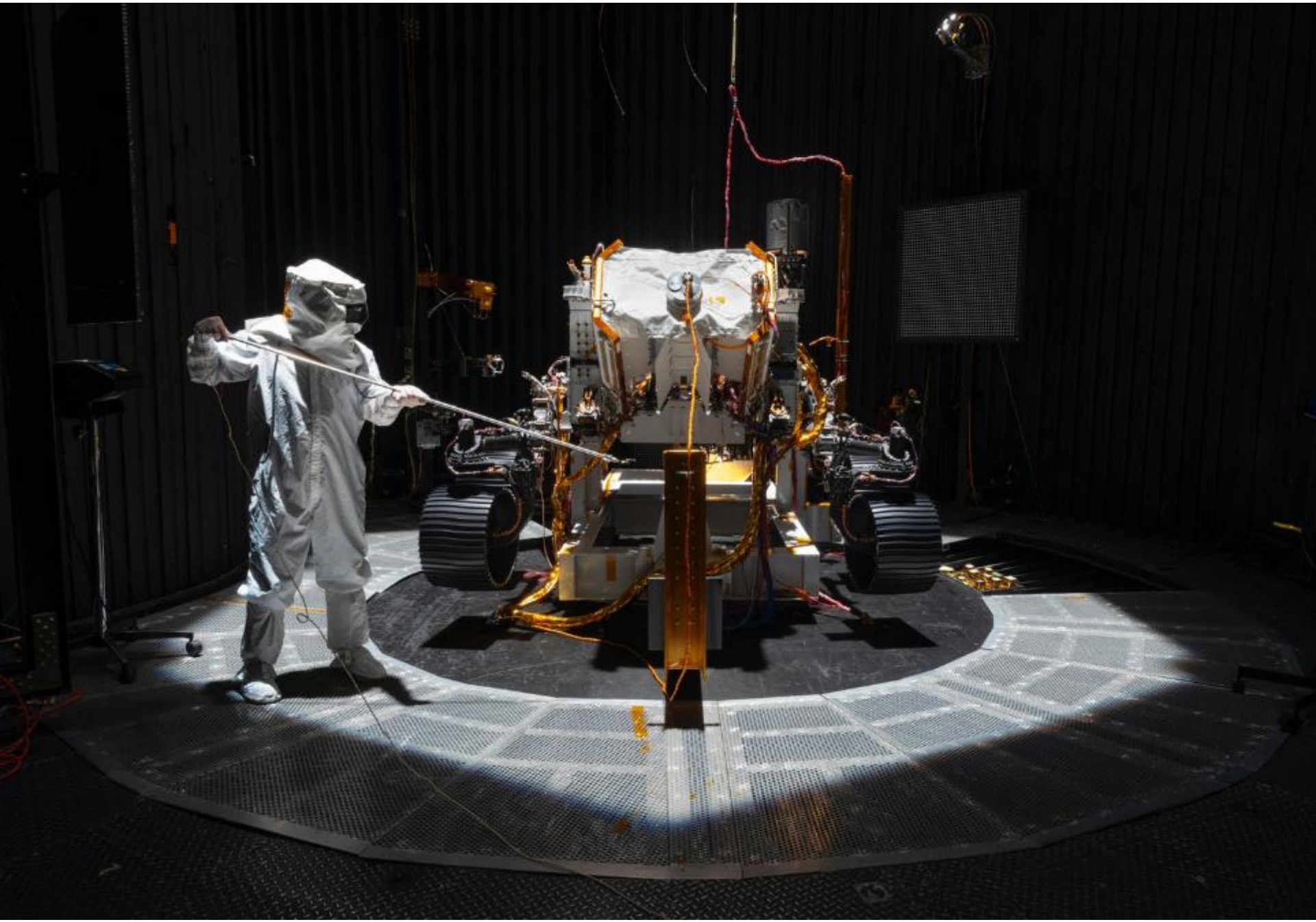


Fig. 2. JPL 25-ft space simulator

Images from:
technical report 32-1415, "The 25-ft space simulator at the Jet Propulsion Laboratory", 1969
https://www.space.com/nasa-mars-2020-tested-vacuum-chamber.html

Staff

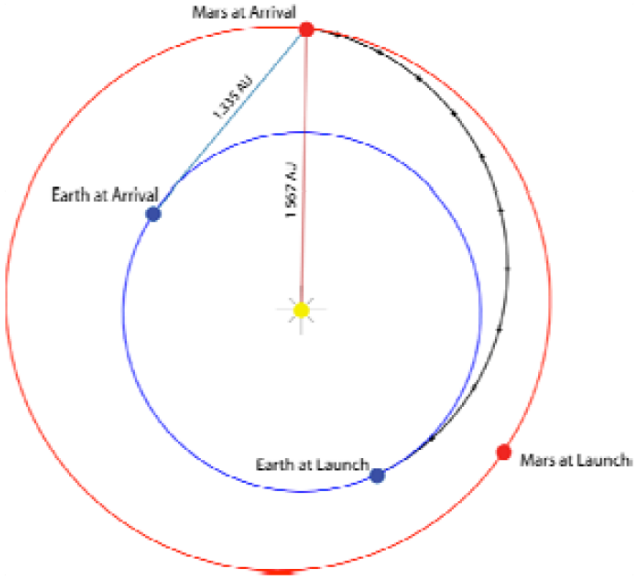
- Carol Bruegge, Calibration scientist
- Ivair Gontijo, M2020 Supercam Instr. Eng.
- Kaustabh Singh, M2020 Thermal Engineer
- Justin Maki, M2020 Imaging Scientist
- Brad Kinter, ETL Chamber Operator
- Ted Sharp, ETL Chamber Operator

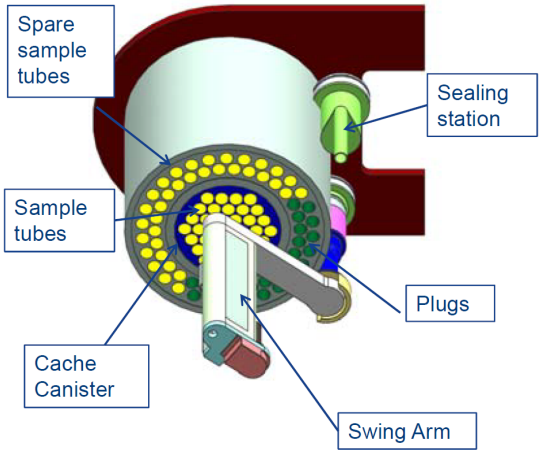


Leonardo, the helicopter

Next steps for the Mars 2020 mission [Translation in the next slide]

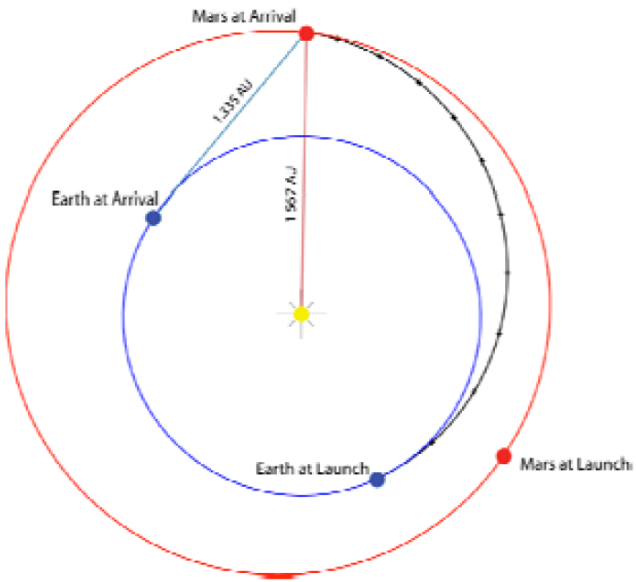
1. O veículo Mars2020, o estágio de descida e estágio de cruzeiro estão nos testes finais. Serão mandados para a Florida no início do ano de 2020.
2. Lançamento à partir do dia 17 de Julho de 2020.
3. Pouso em Marte no dia 18 de Fevereiro de 2021.
4. Vamos “seguir o carbono”. Procurar os melhores minerais marcianos contendo compostos orgânicos. Coletar amostras para serem trazidas para estudos na terra.
5. Preparar para a futura chegada dos humanos! O instrumento MOXIE vai produzir Oxigênio em Marte.



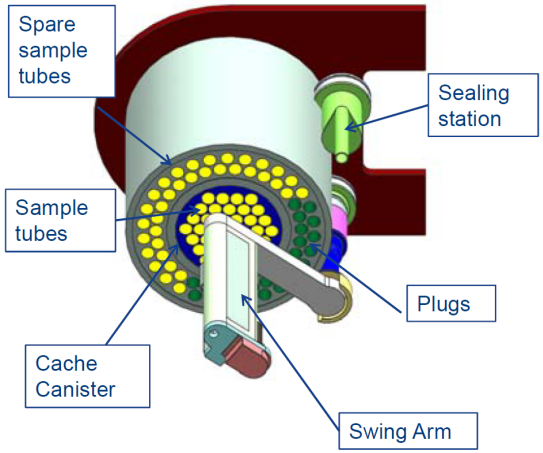


Images from 3_Mars_2020_Mission_Concept.pdf

Next steps for the Mars 2020 mission



1. The vehicle, descent and cruise stages are in final tests. Will go to Florida at the beginning of 2020.
2. Launch from 17th July 2020.
3. Landing on Mars on 18th Feb 2021.
4. We will “follow the carbon”. Search for the best minerals containing organic compounds. Collect samples and bring them back to Earth.
5. Prepare for humans! The MOXIE instrument will produce Oxygen on Mars.



Images from 3_Mars_2020_Mission_Concept.pdf

JPL

Jet Propulsion Laboratory

California Institute of Technology