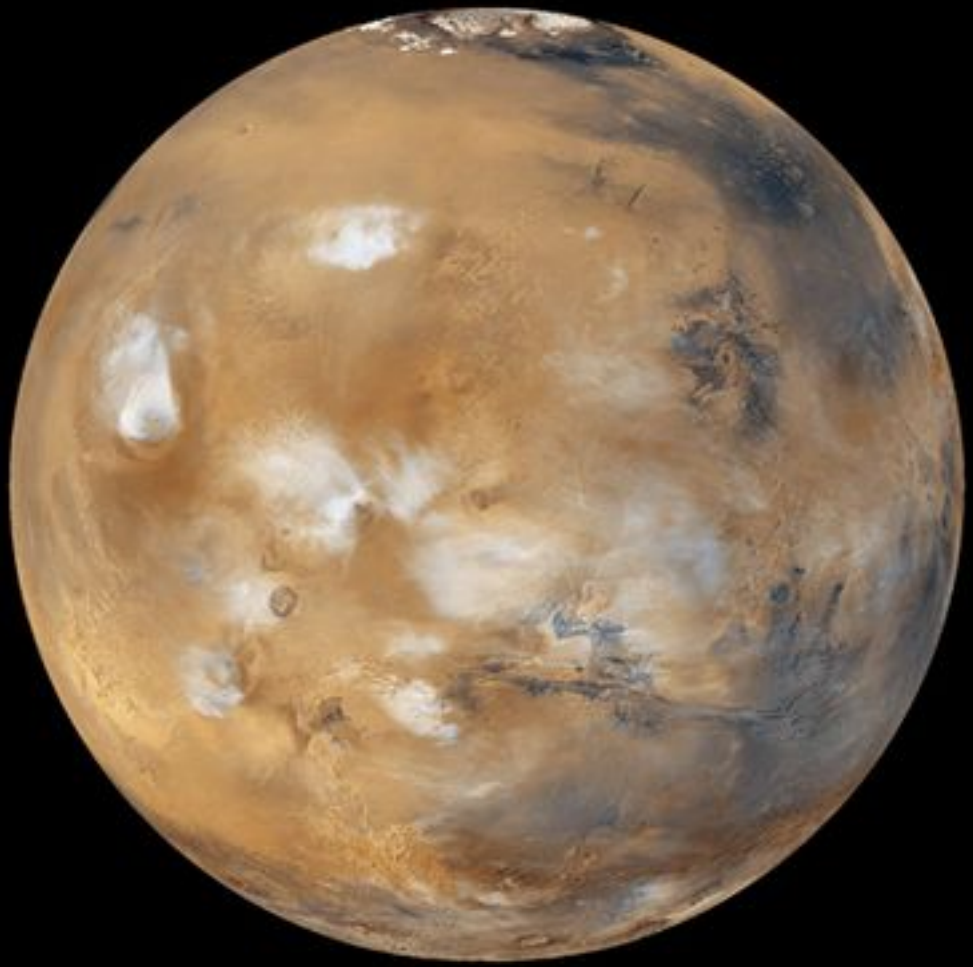
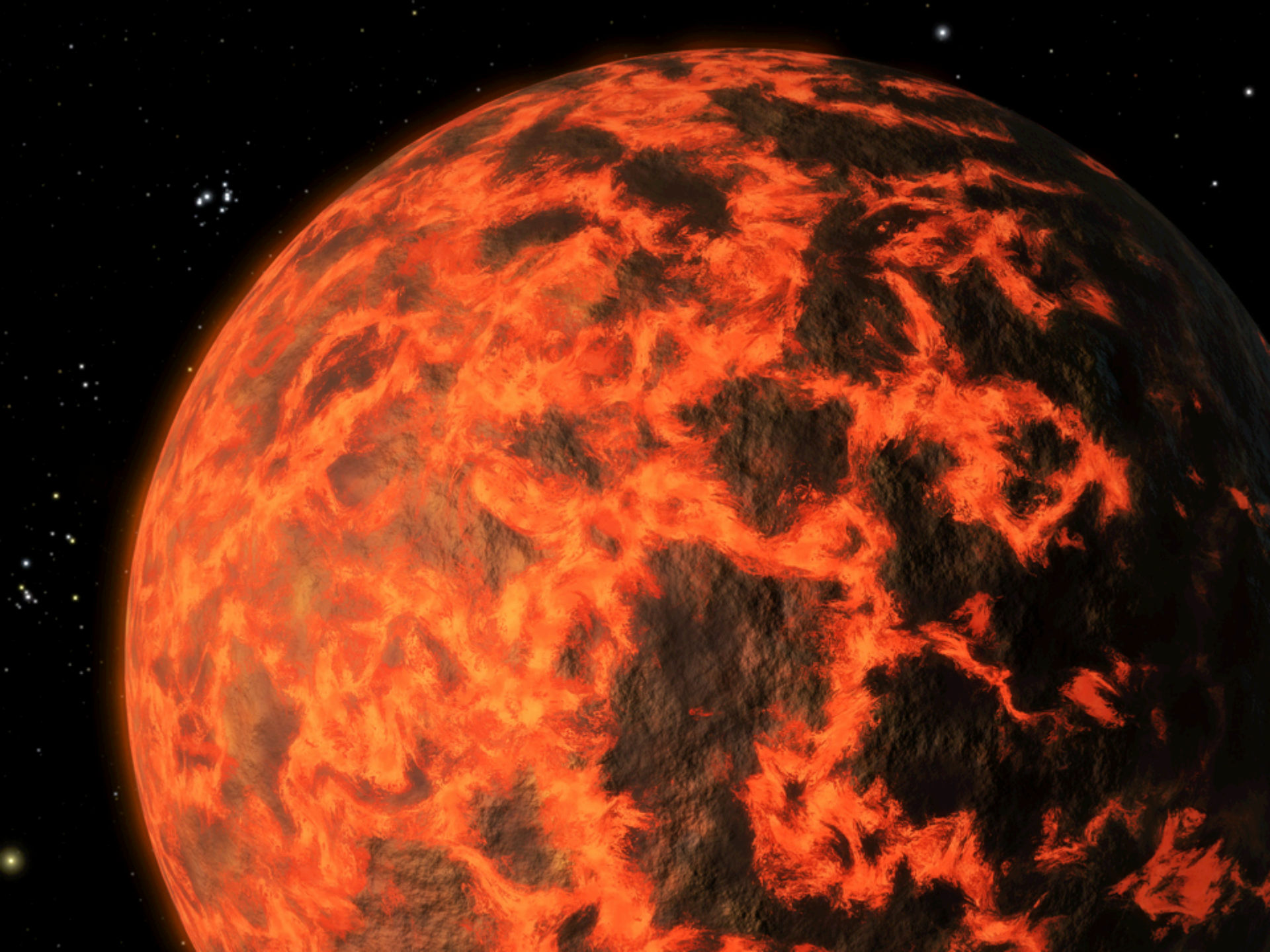
INSIGHT: Ausculter l'intérieur de Mars

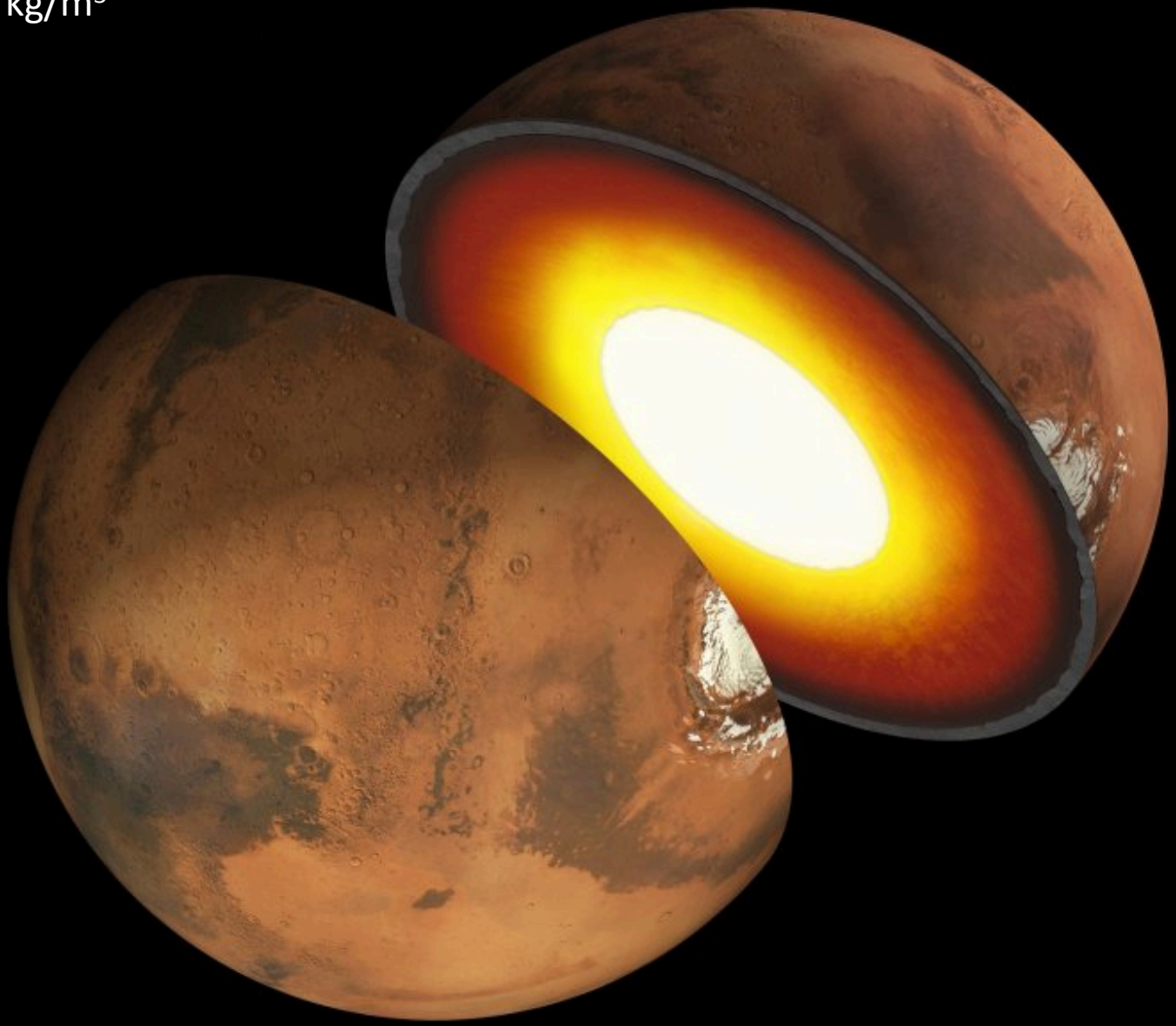
Lucile Fayon
IPGP

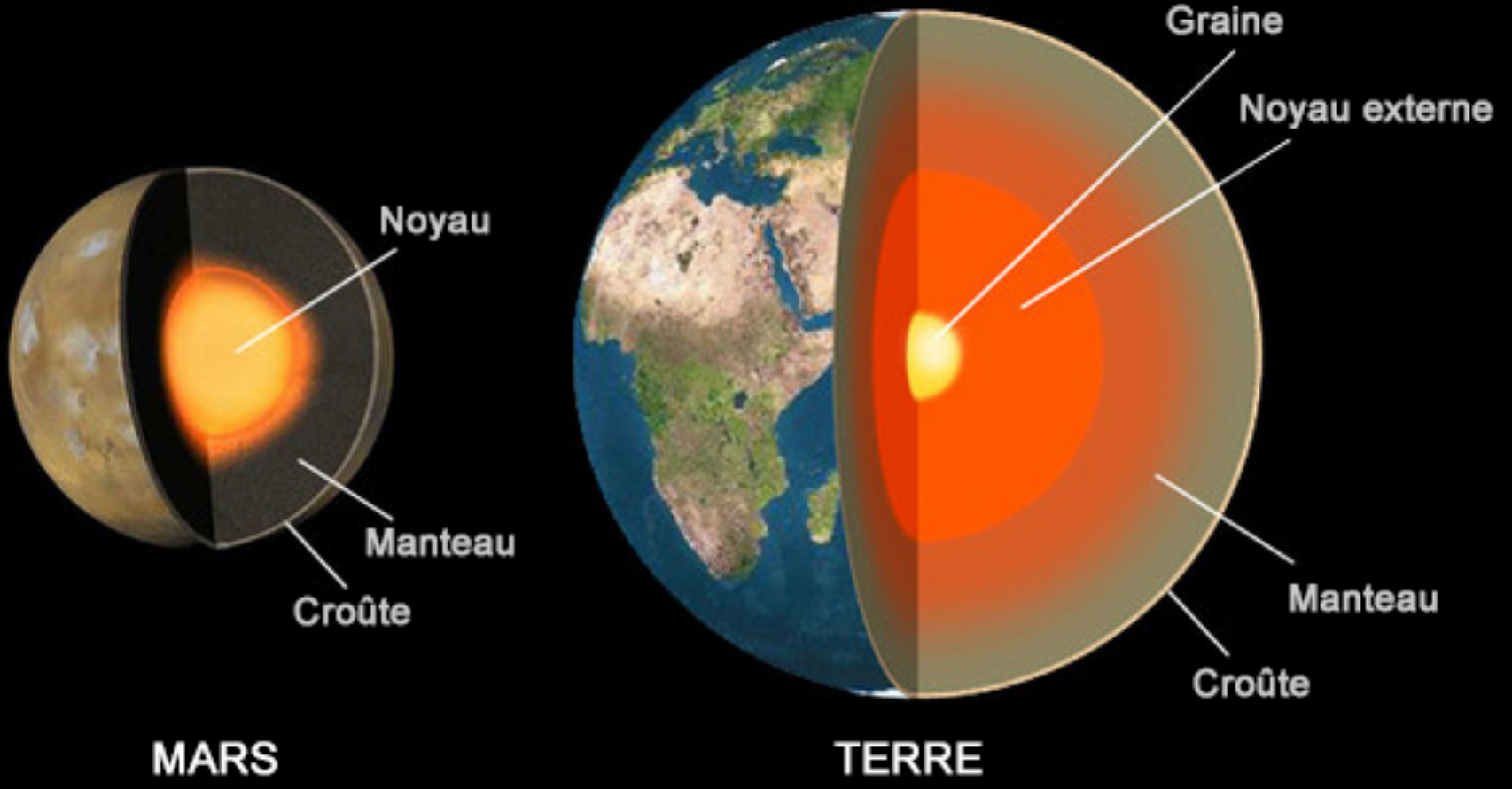
Sylvain Bouley
GEOPS



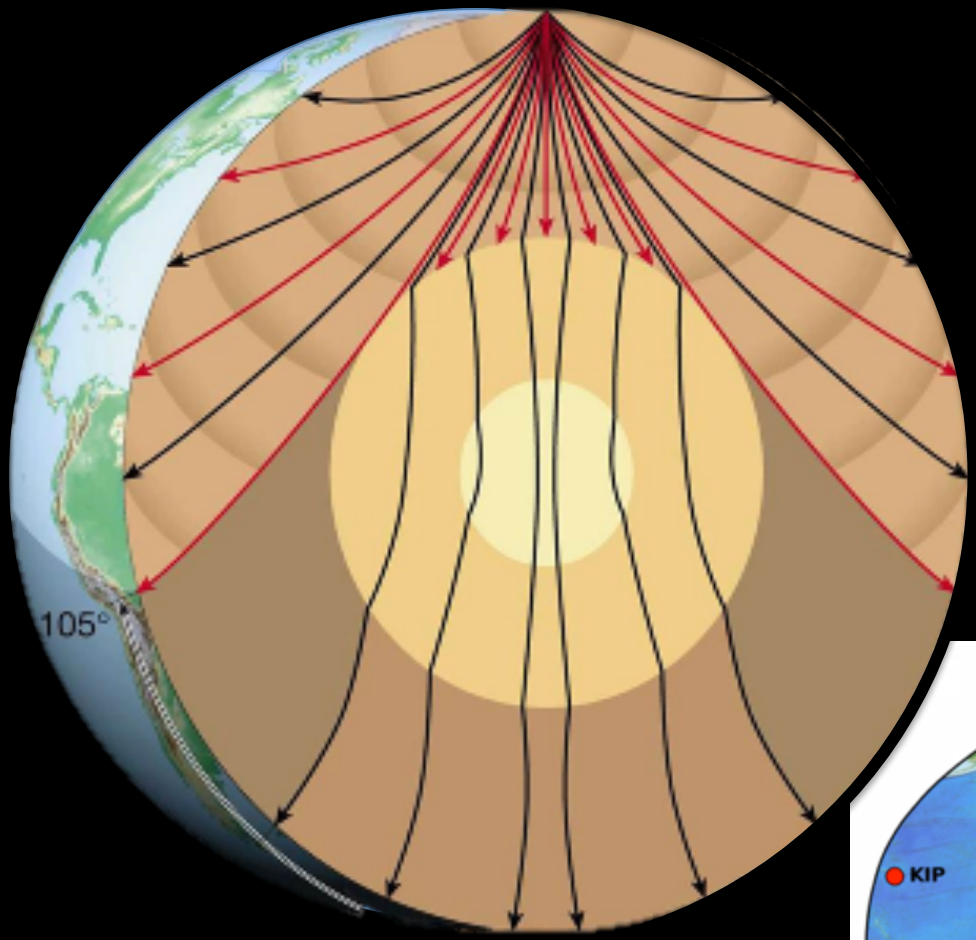


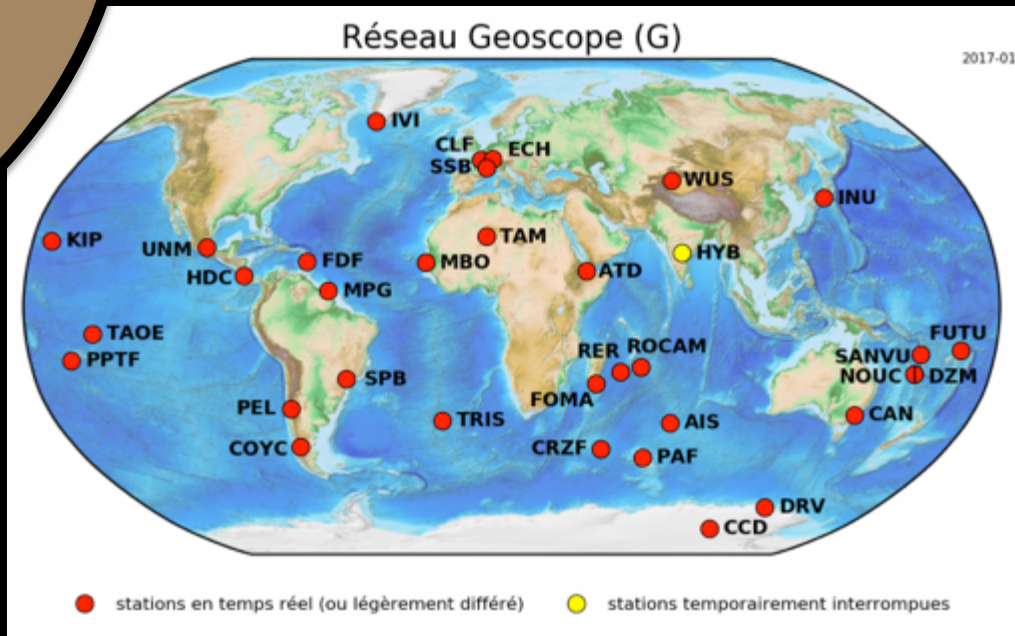
Mars: 3900 kg/m^3
Terre: 5510 kg/m^3




Noyau
Manteau
Croûte
MARS
Graine
Noyau externe
Manteau
Croûte
TERRE

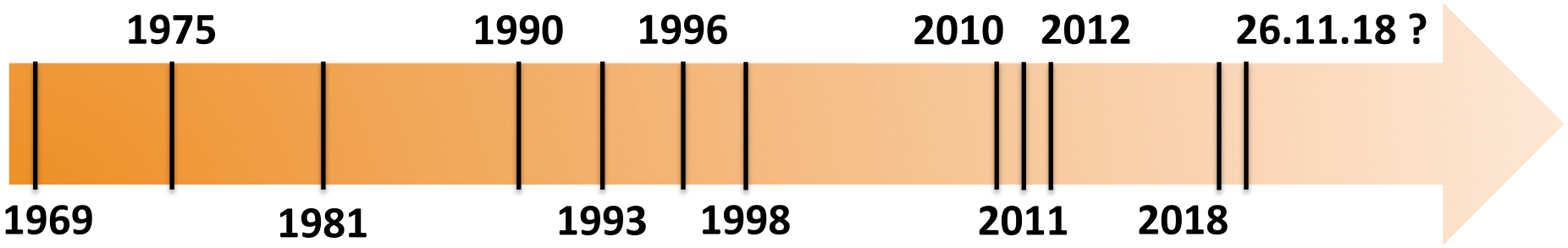
Séisme


105°

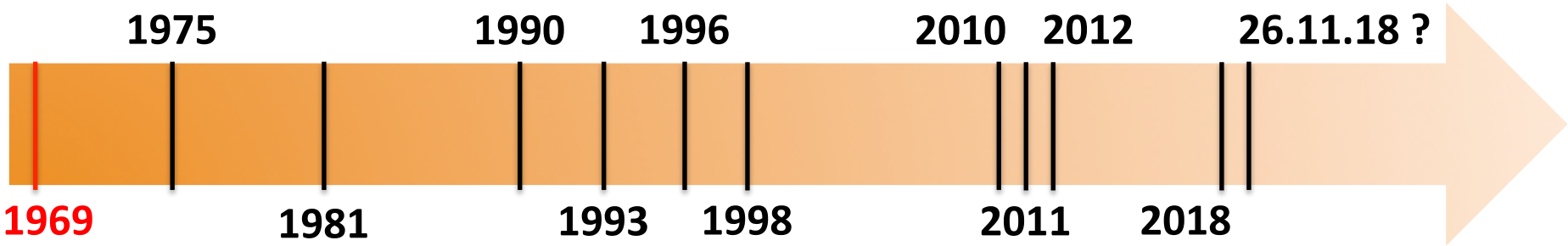

Réseau Geoscope (G)
2017-01-24
IVI
CLF
SSB
ECH
WUS
INU
KIP
UNM
HDC
FDF
MPG
MBO
TAM
ATD
HYB
TAOE
PPTF
SPB
PEL
COYC
TRIS
RER
ROCAM
FOMA
AIS
CRZF
PAF
SANVU
NOUC
DZM
FUTU
CAN
DRV
CCD
stations en temps réel (ou légèrement différé)
stations temporairement interrompues

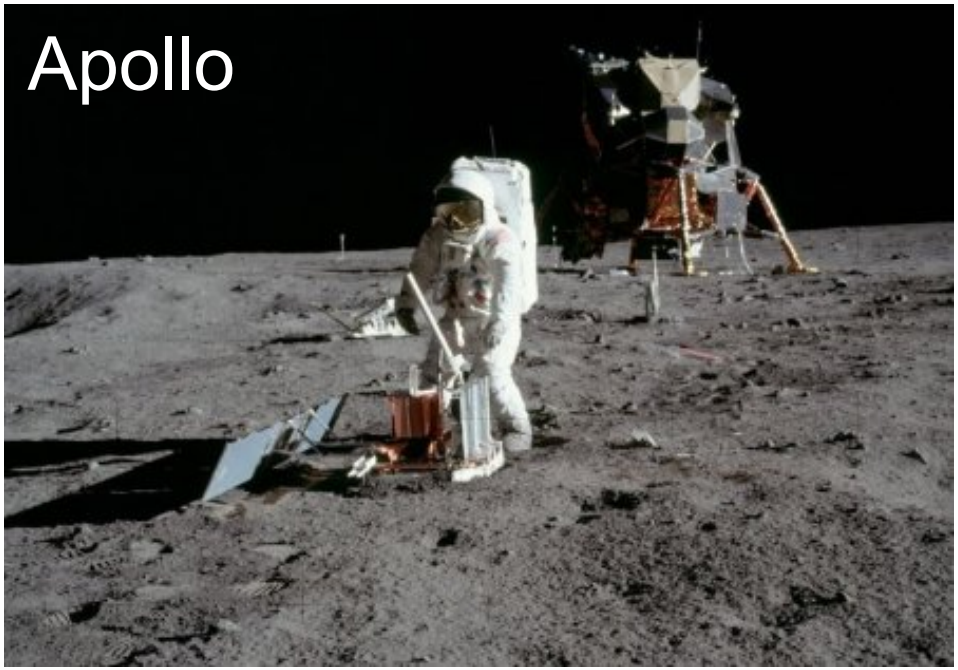
En route pour installer un sismomètre sur mars !

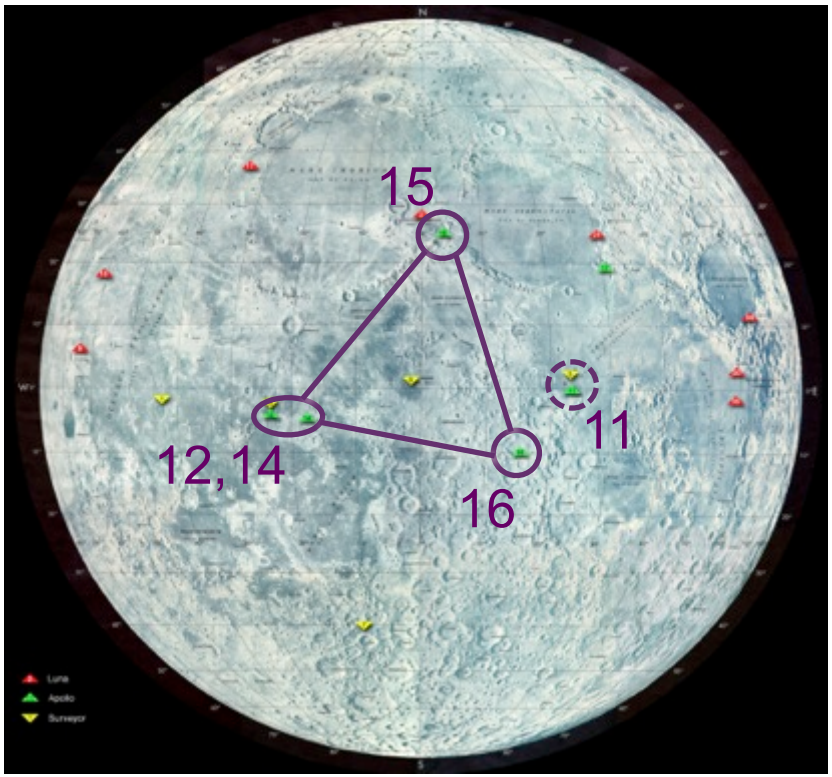
La sismologie planétaire



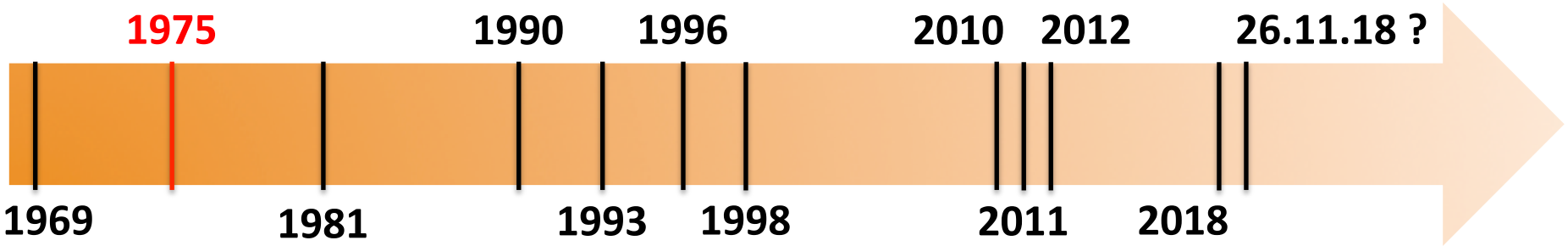
La sismologie planétaire

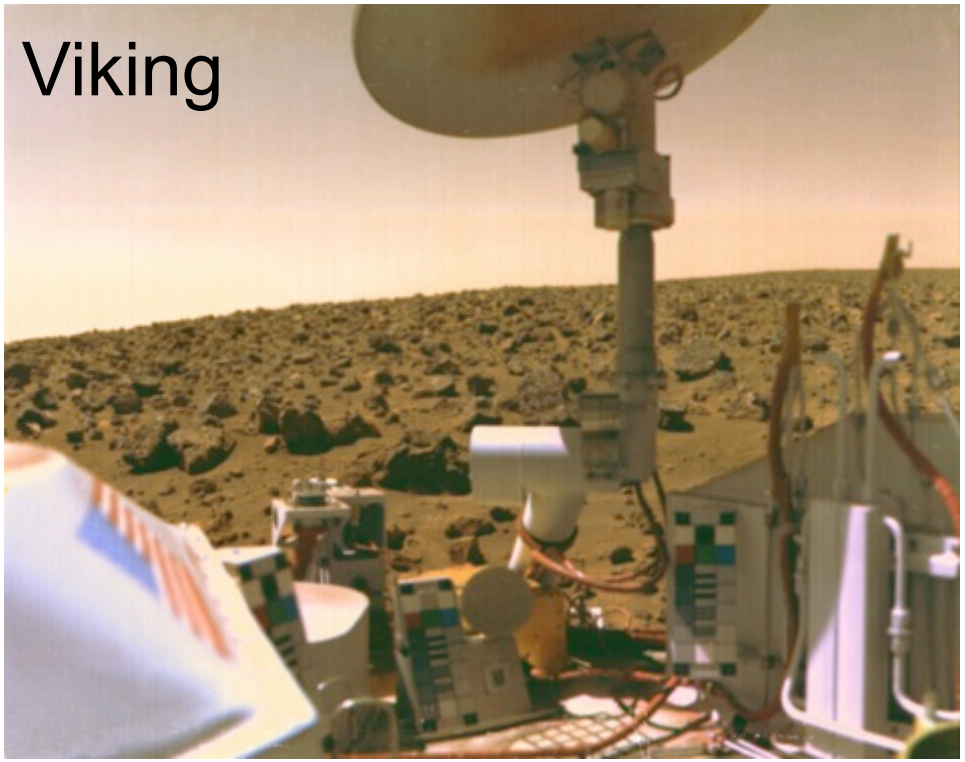




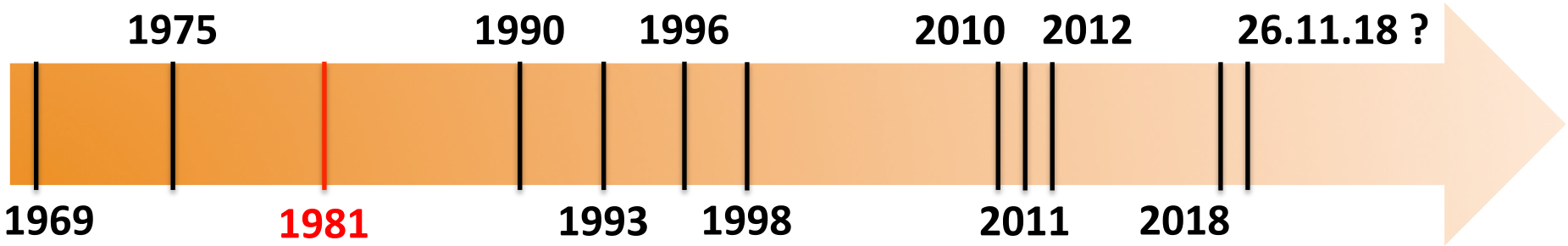


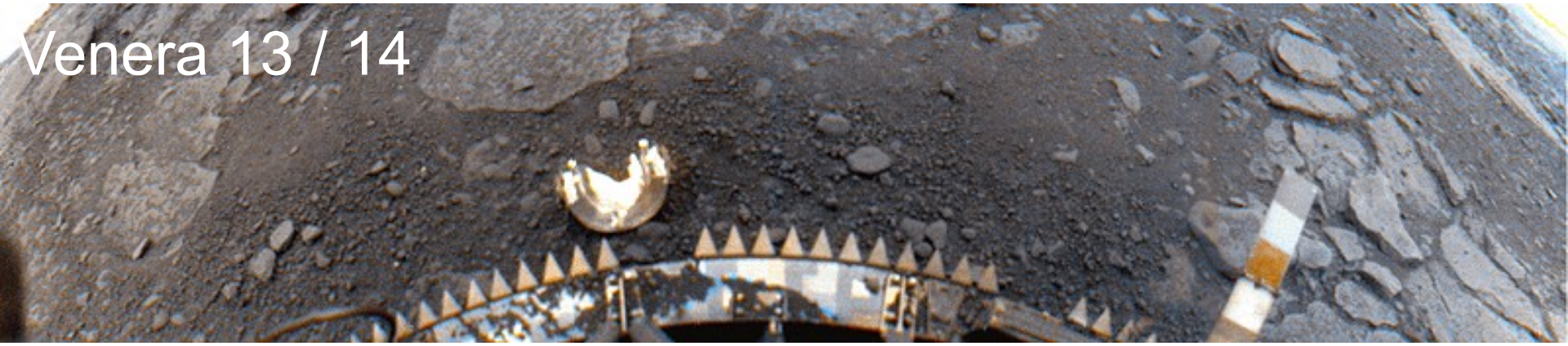
La sismologie planétaire



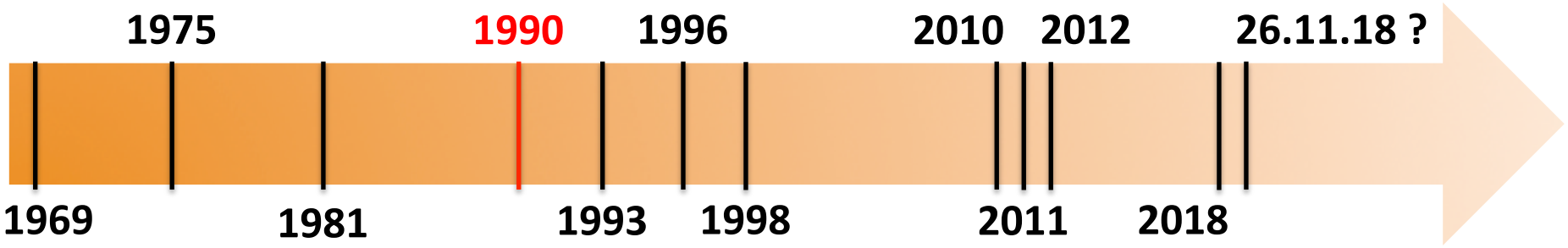


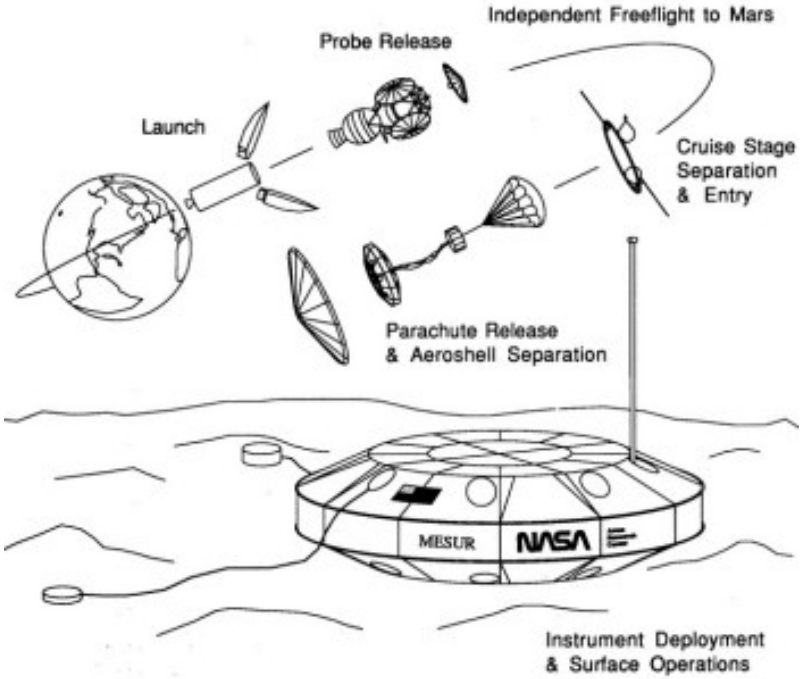
La sismologie planétaire





La sismologie planétaire





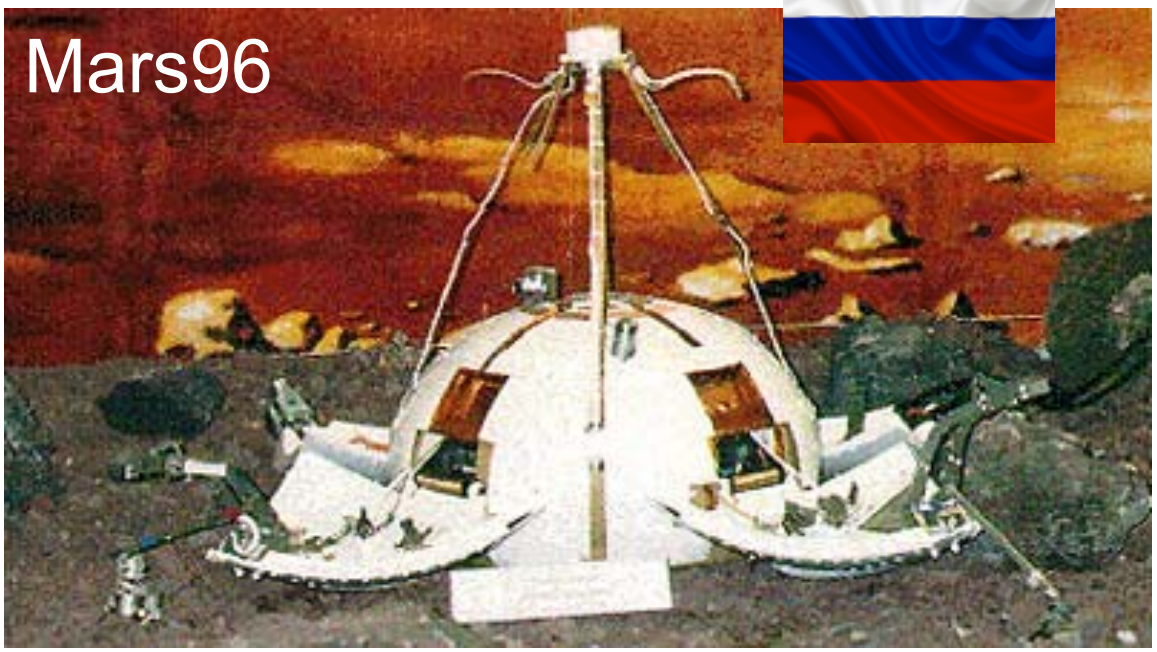
La sismologie planétaire

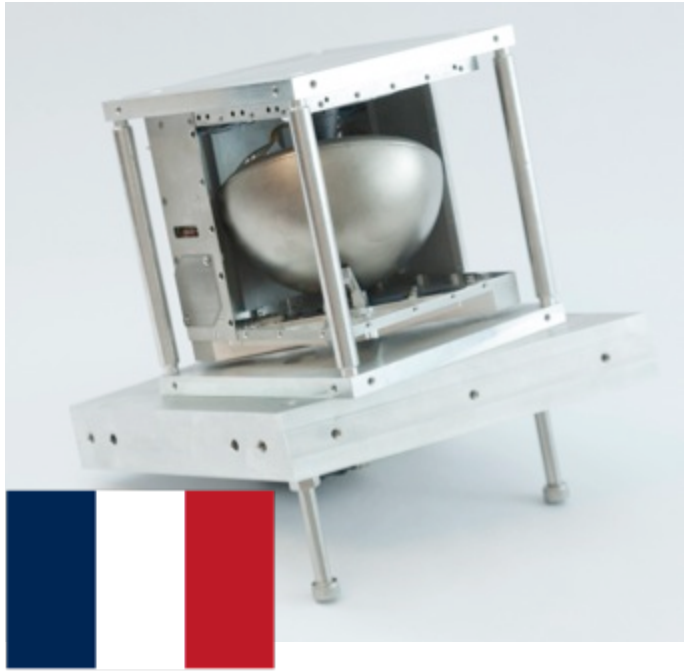
1975 1990 1996 2010 2012 26.11.18 ?

1969 1981 1993 1998 2011 2018

La sismologie planétaire

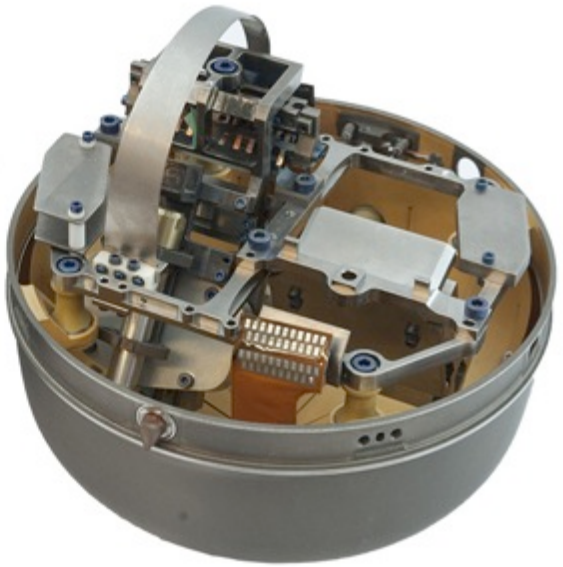
1969 — 1975 — 1981 — 1990 — 1993 — **1996** — 1998 — 2010 — 2011 — 2012 — 2018 — 26.11.18 ?



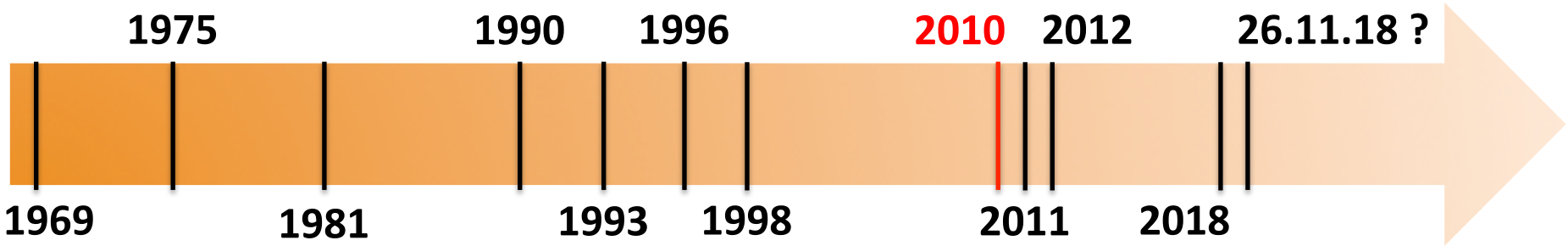


La sismologie planétaire

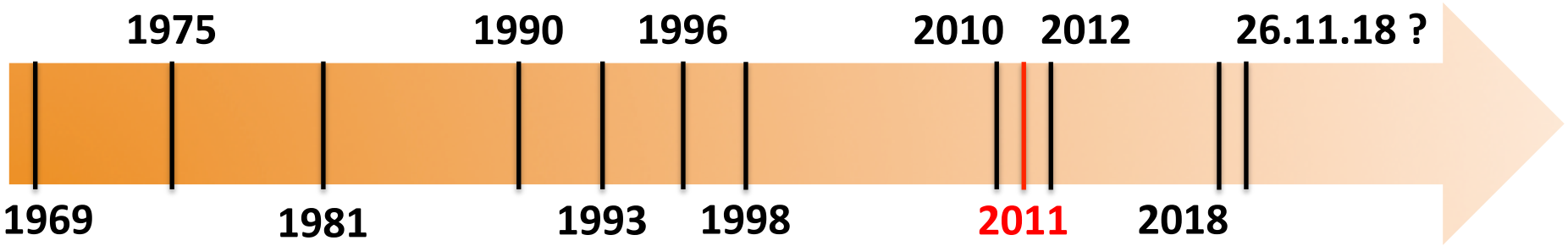
1969 — 1975 — 1981 — 1990 — 1993 — 1996 — 1998 — 2010 — 2011 — 2012 — 2018 — 26.11.18 ?



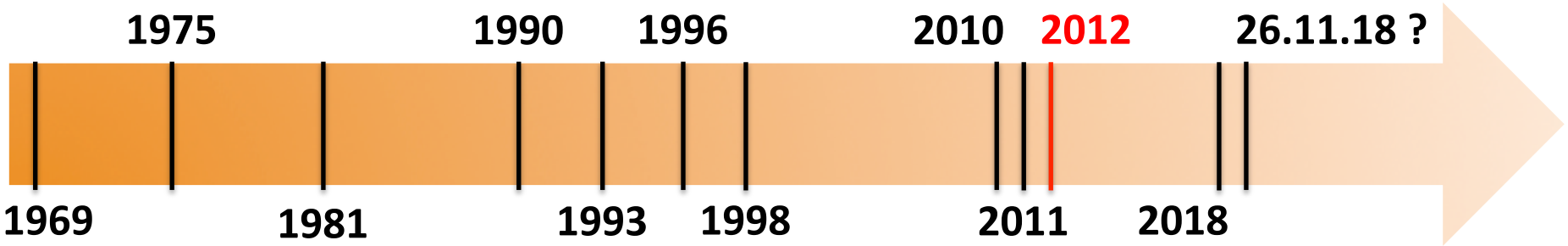
La sismologie planétaire



La sismologie planétaire

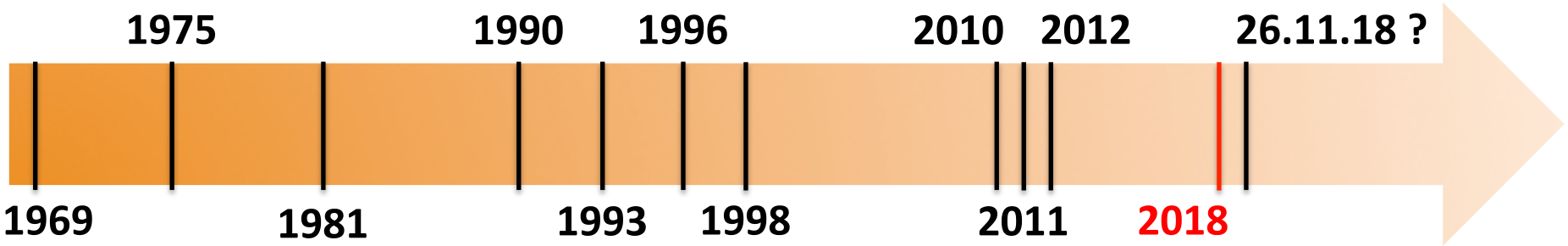


La sismologie planétaire

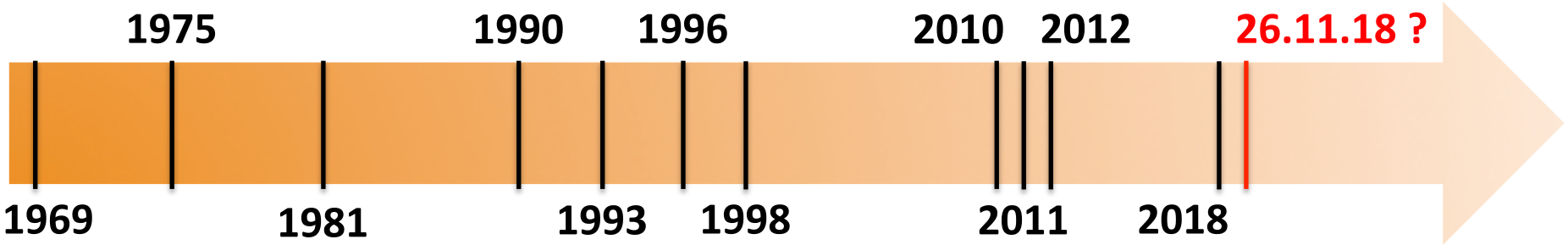


InSight

La sismologie planétaire



La sismologie planétaire



La mission, en résumé:

- Lancement prévu le 4 mars 2016
- 6,5 mois de voyage
- Atterrissage prévu le 28 septembre 2016
- 67 jours martiens de déploiement des instruments
- Fonctionnement = une année martienne

La mission, en résumé:

mai 2018

– Lancement prévu le 4 mars 2016

26 novembre 2018

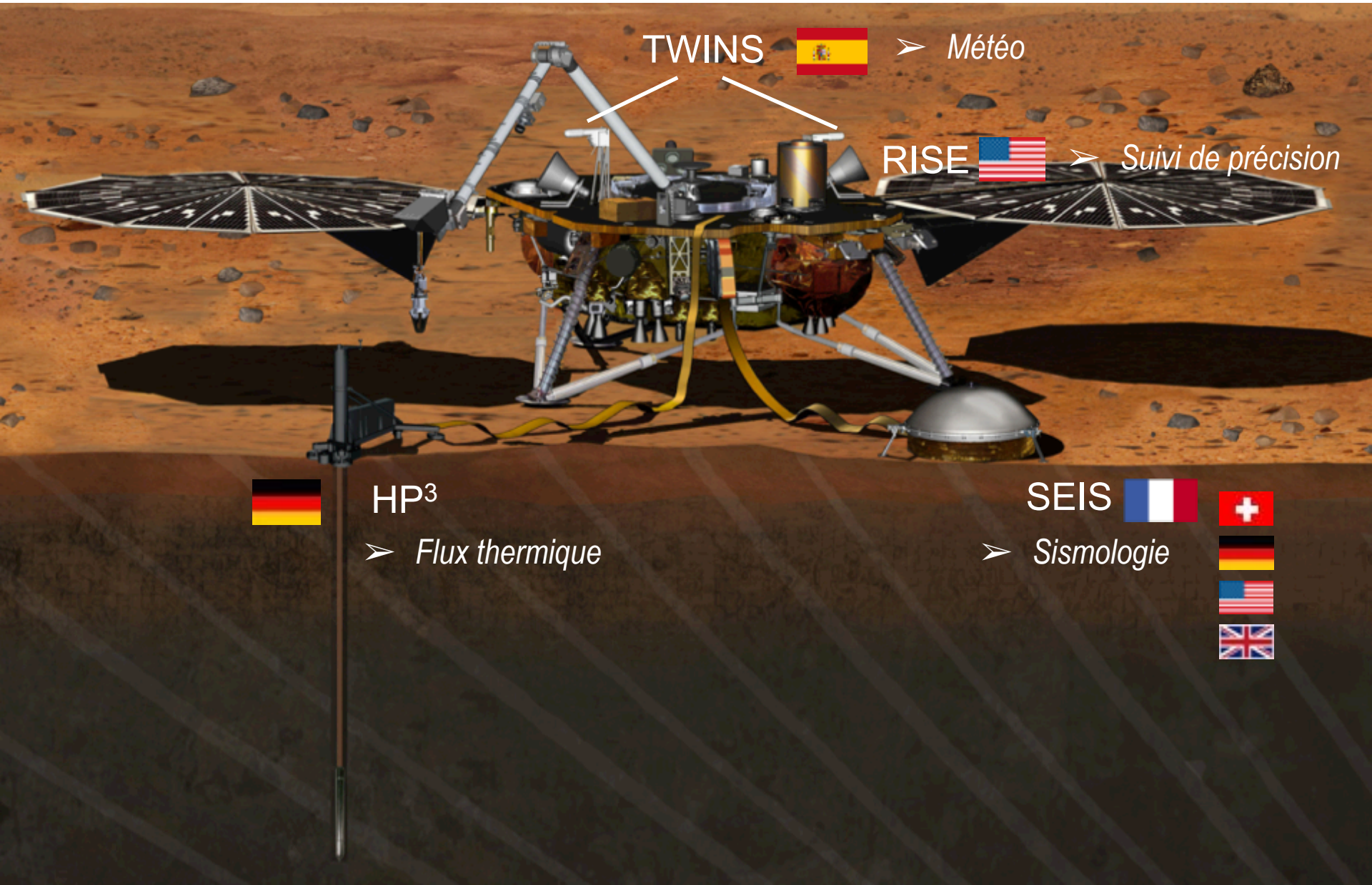
– 6,5 mois de voyage

– Atterrissage prévu le 28 septembre 2016

– 67 jours martiens de déploiement des instruments

– Fonctionnement = une année martienne

La charge utile



APSS

Station météorologique complète !

Capteur TWINS

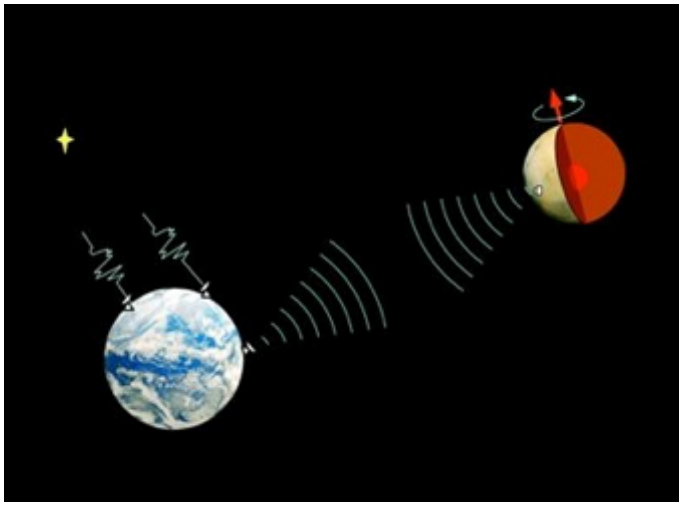
- Thermomètre
- Girouette
- Anémomètre
- Baromètre
- Magnétomètre

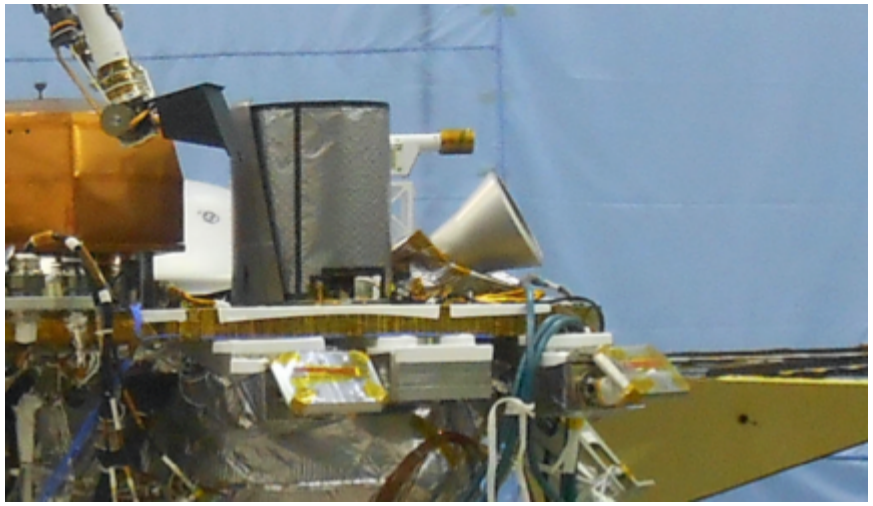
RISE

"RISE helps us keep tabs on InSight! This tells us exactly where Mars is in space, and just how much the planet wobbles around in its orbit. This information will add to our knowledge of the size of Mars' core, and helps us determine whether it is liquid or solid."

-- William Folkner

Télécommunication + Rotation de Mars :

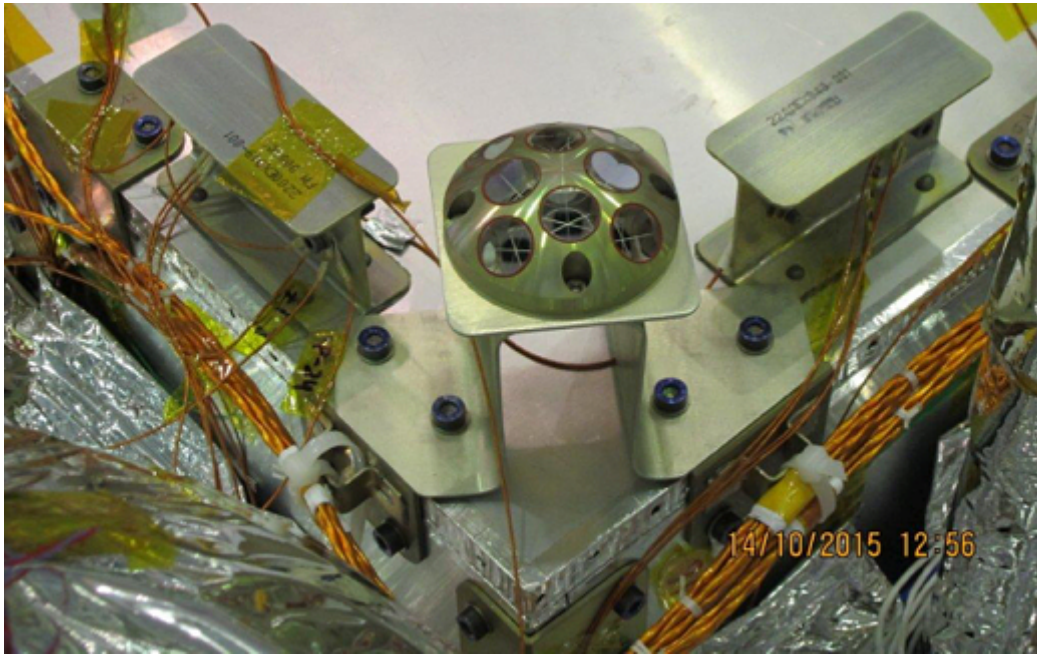




LaRRI

Le dernier arrivé !

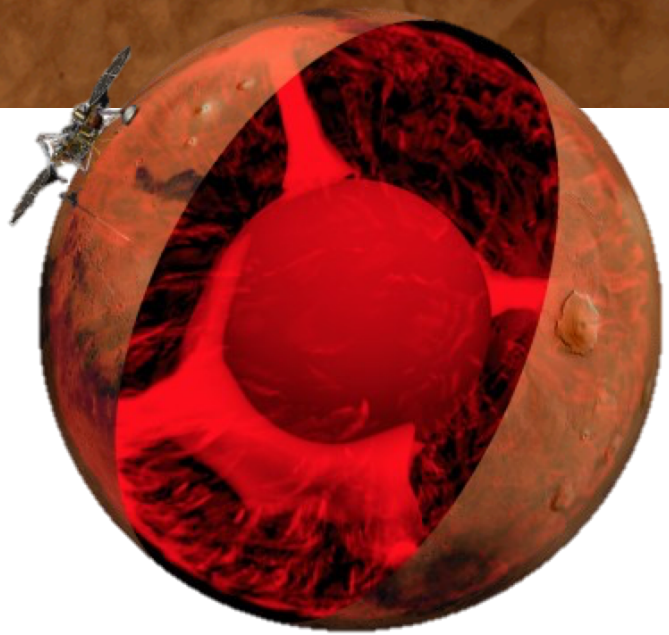
INRRI (sur Schiaparelli) :



HP^3

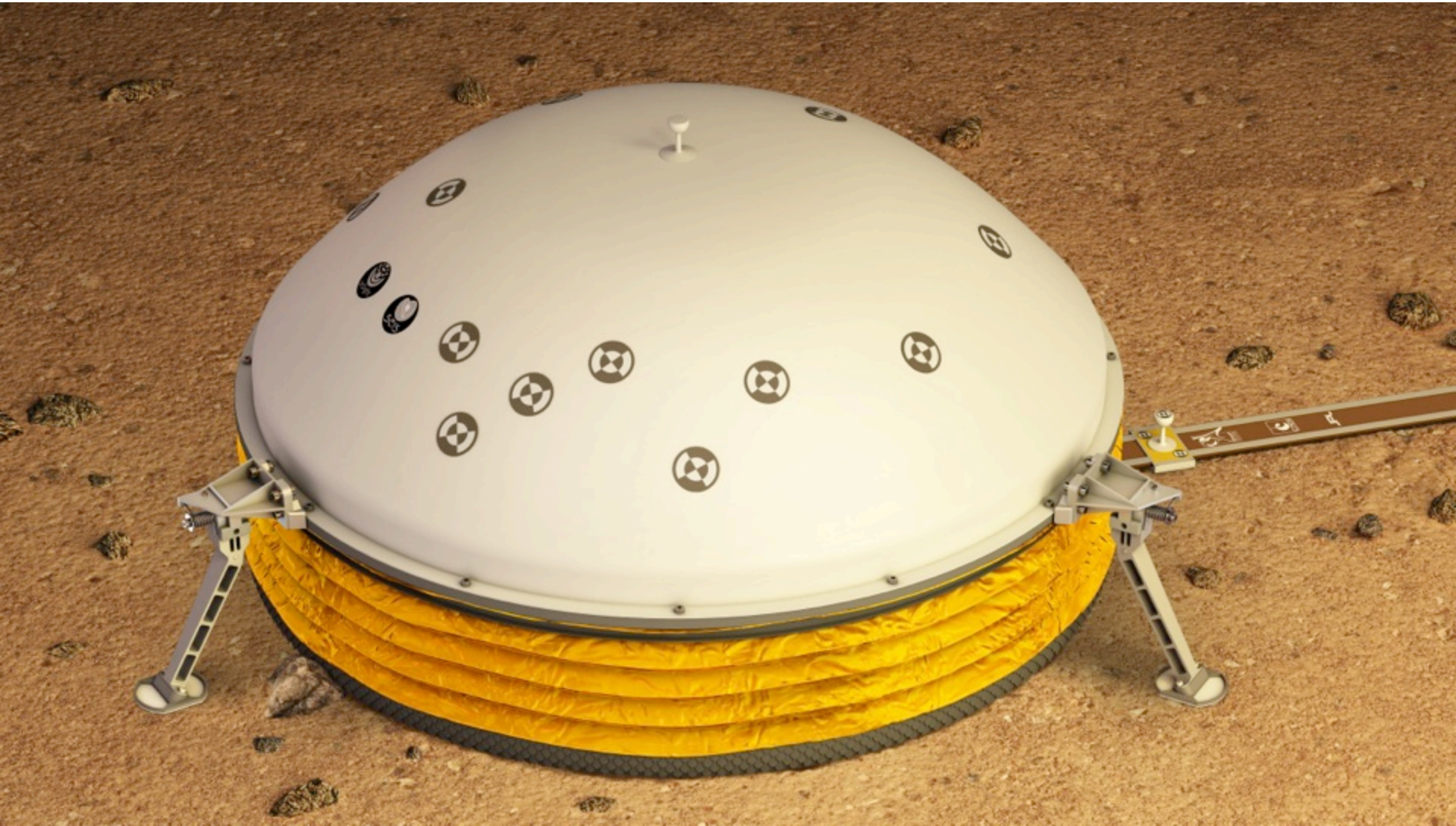
"We know that Mars' interior is not as warm as Earth's, but we've never taken the planet's temperature. HP^3 will take Mars' temperature, tell us how much heat is leaving the planet, and whether Earth and Mars formed from the same stuff. That's key to learning not only about Mars, but about how all the rocky planets of the solar system formed and evolved."

-- Tilman Spohn

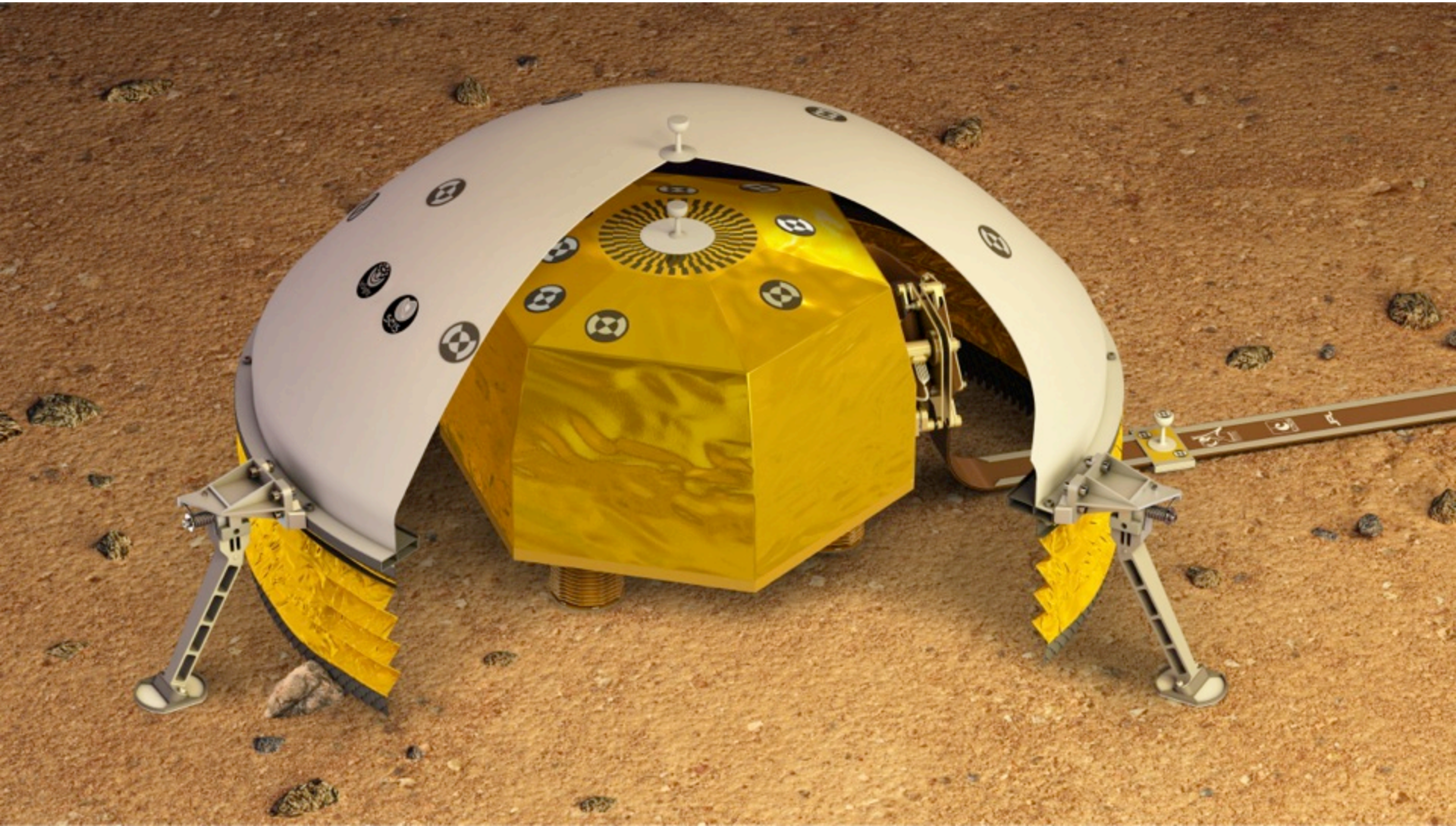


HP^3

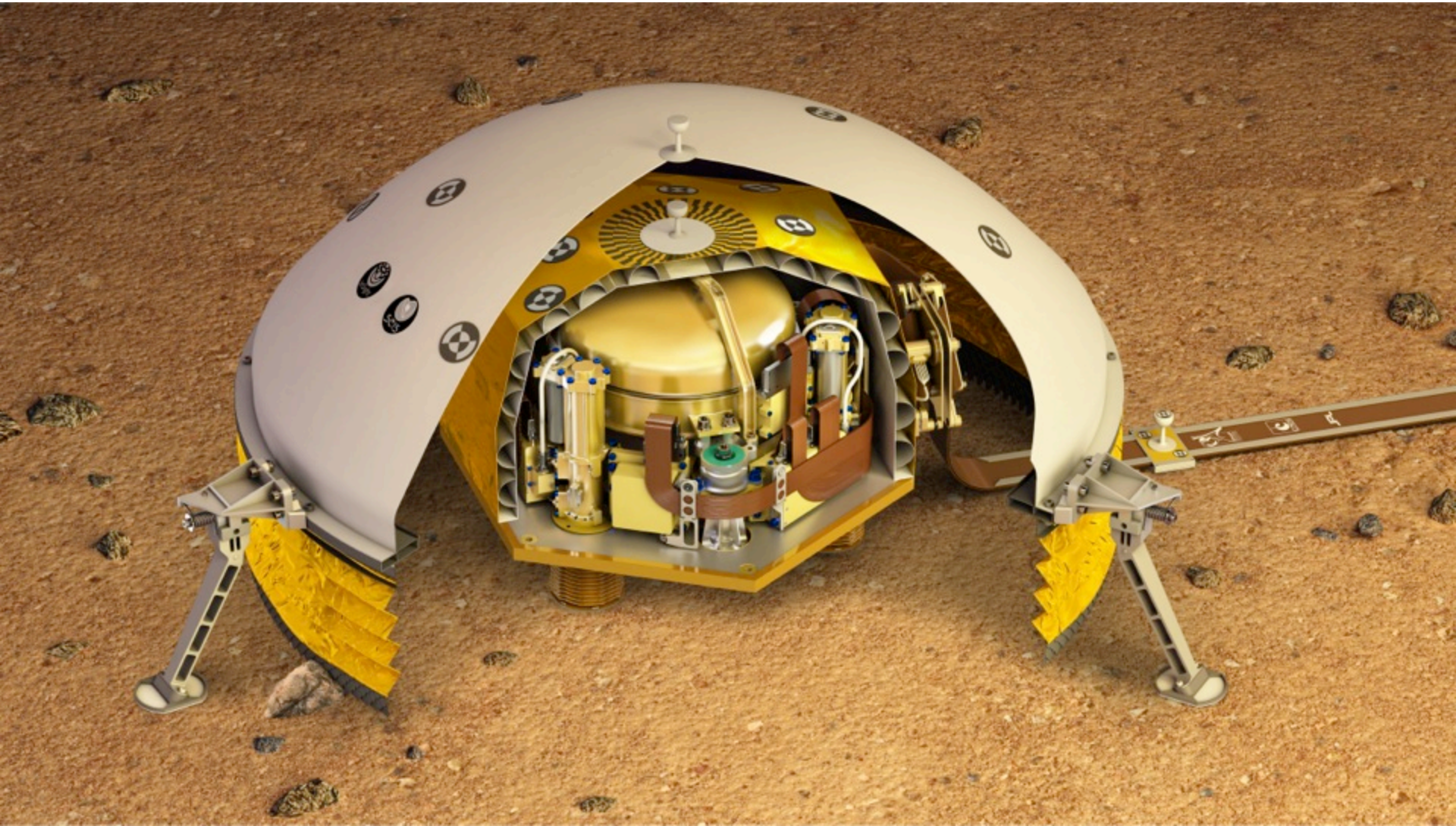
SEIS



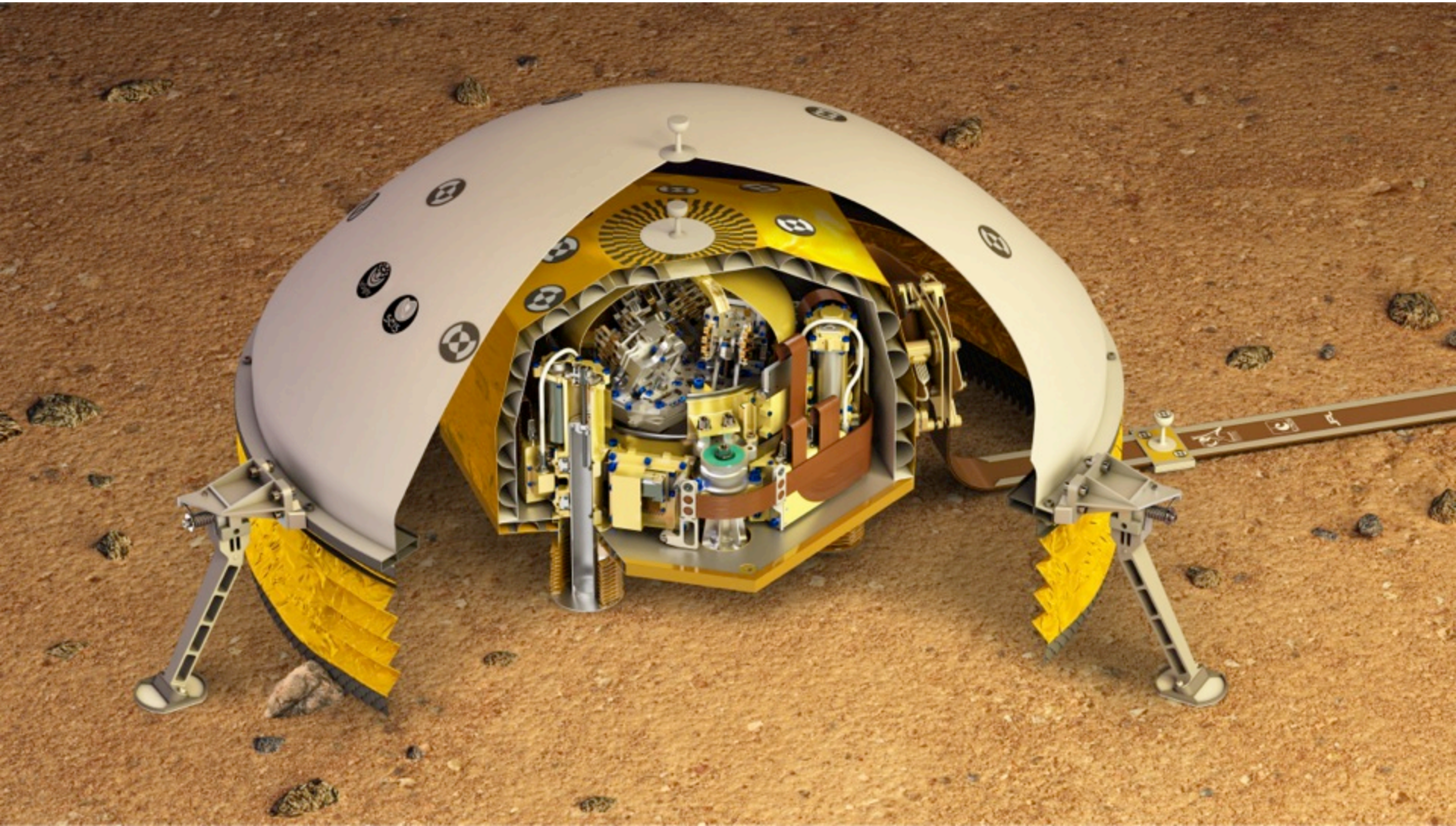
SEIS



SEIS



SEIS



Défis technologiques

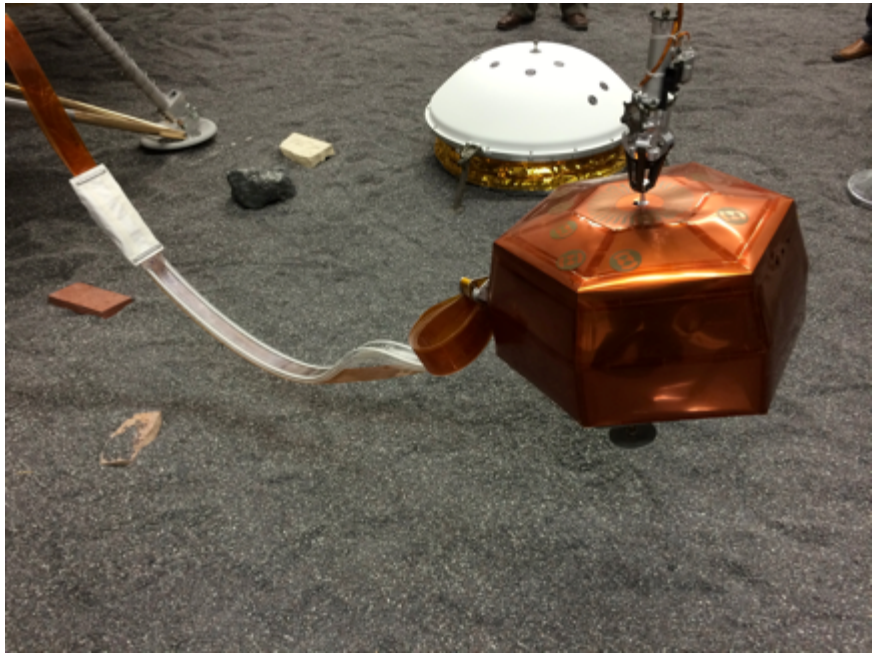
Bouclier thermique

Bouclier thermique et de vent

Jupe d’étanchéité

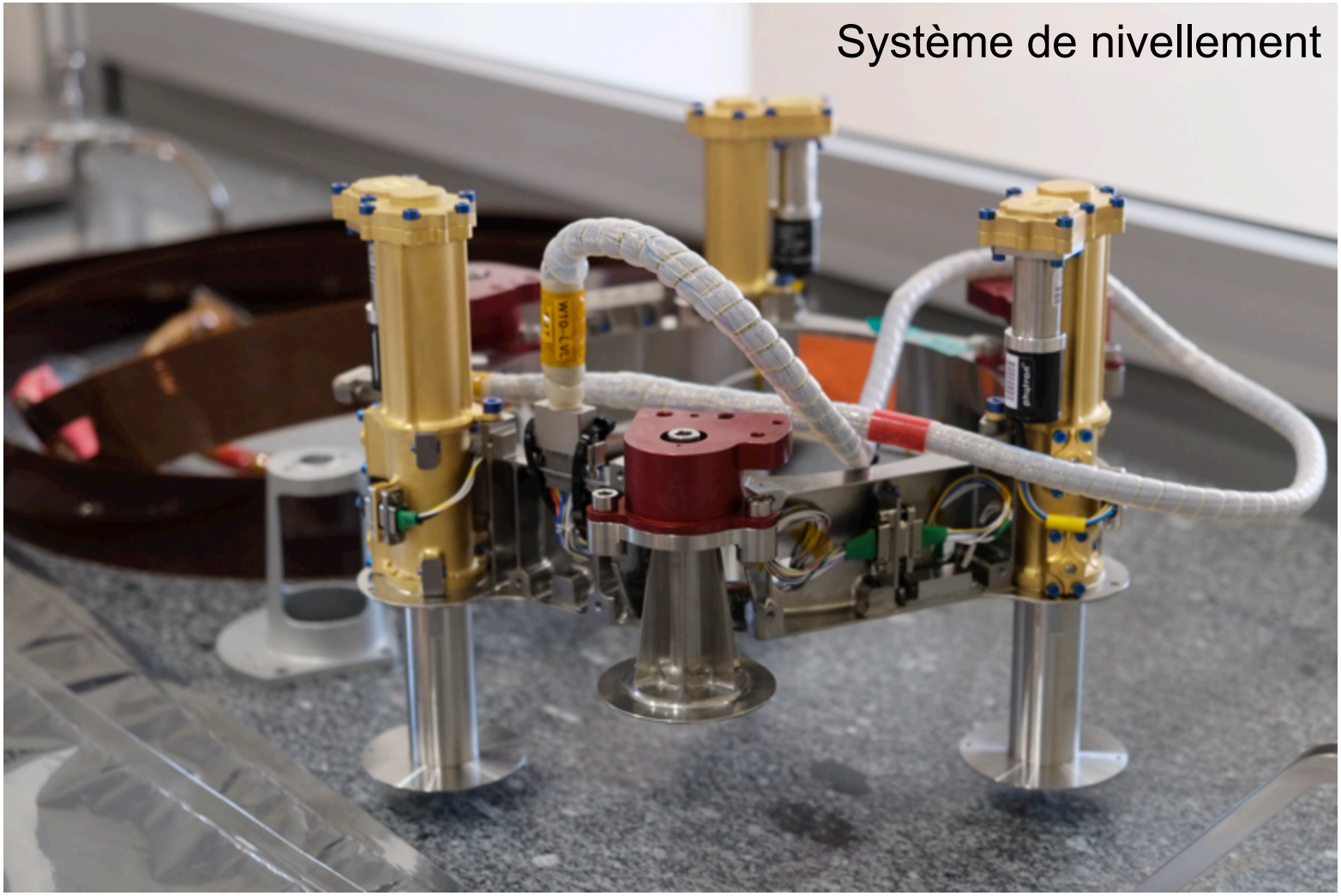
Défis technologiques

Câble électronique

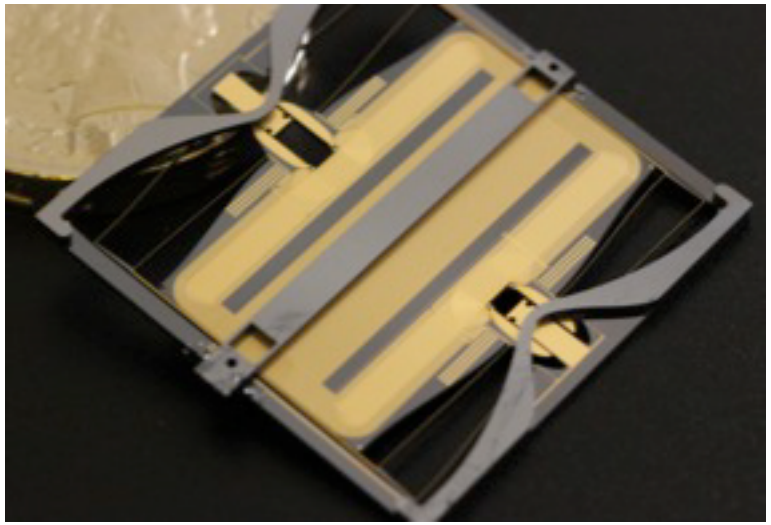


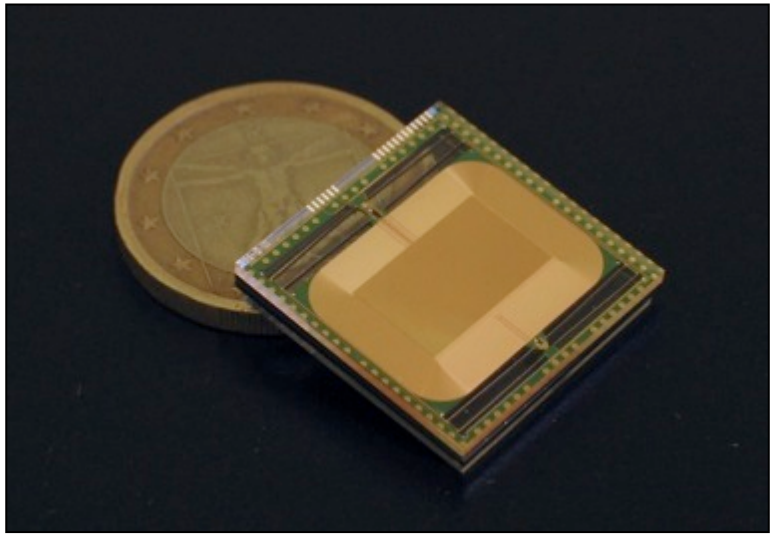
Boucle de découplage

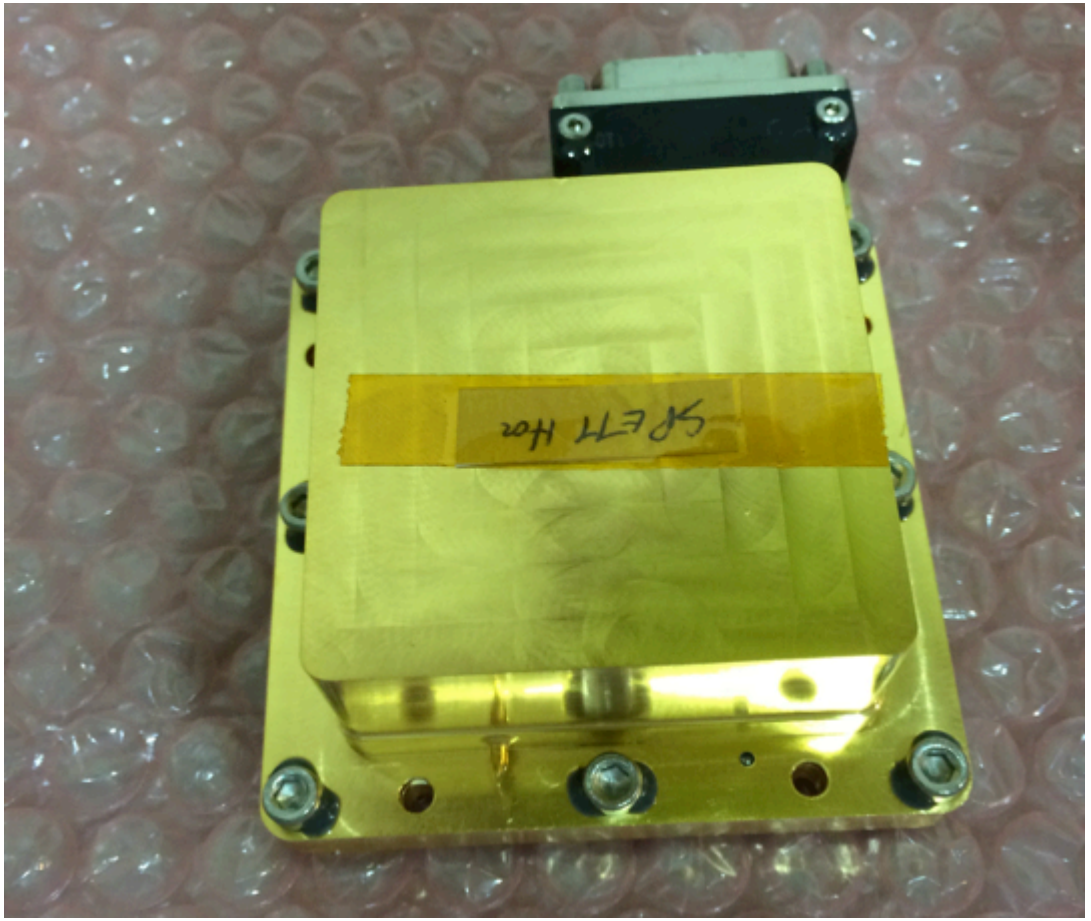
Défis technologiques



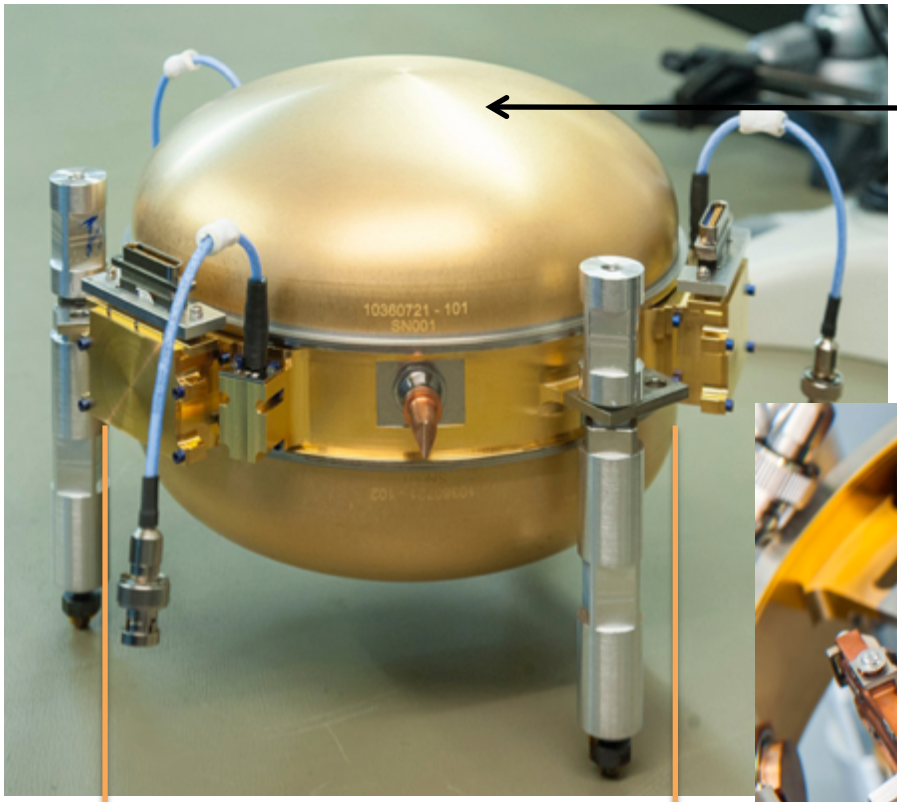
SP (Short Period)





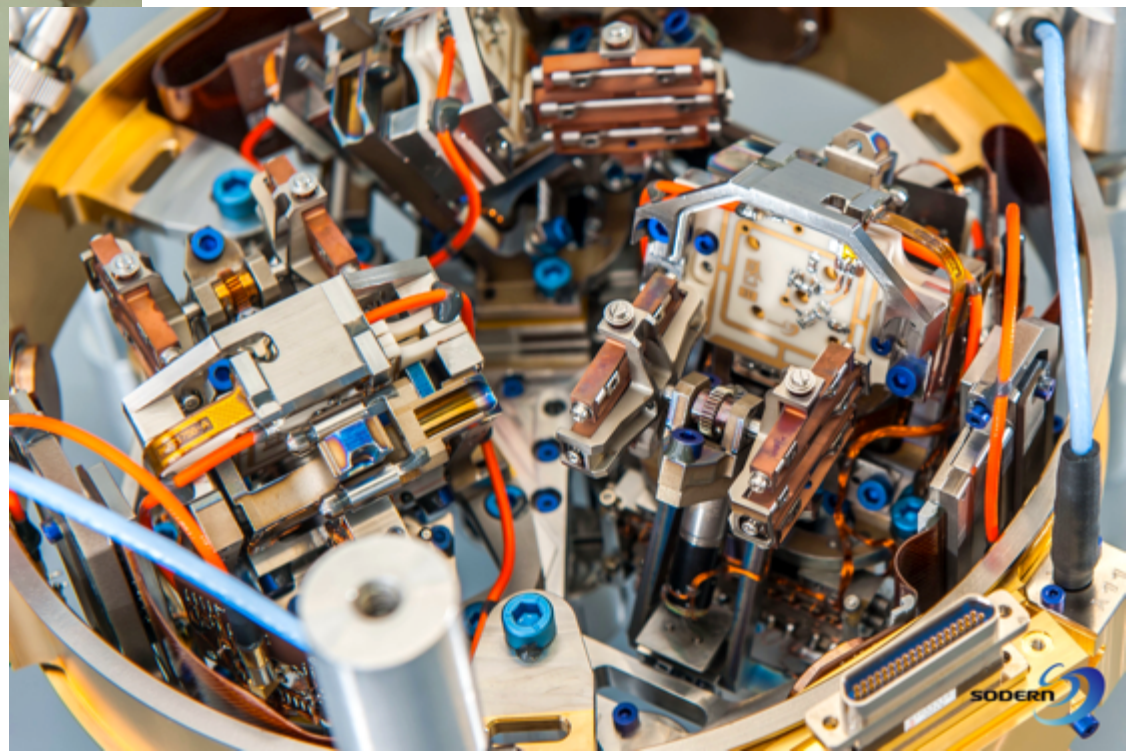


VBB (Very Broad Band)



Sphère à vide

22 cm



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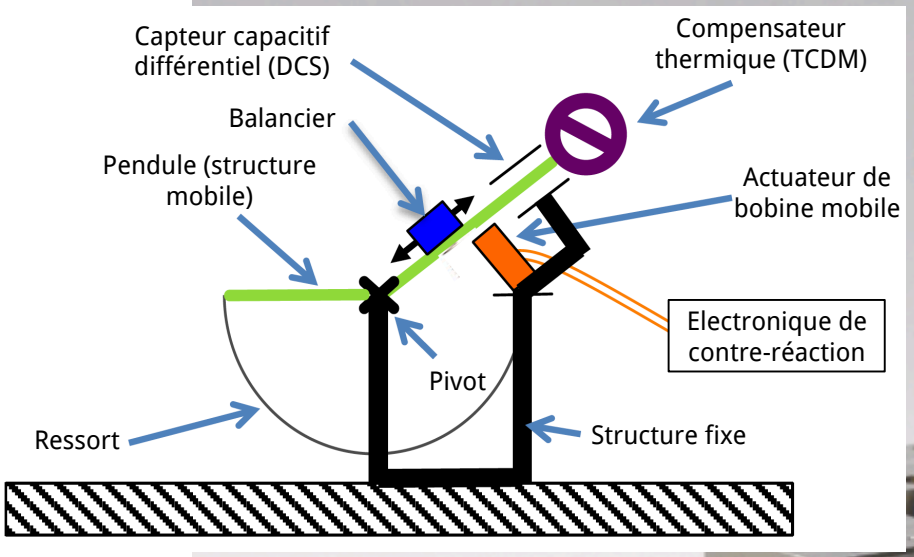
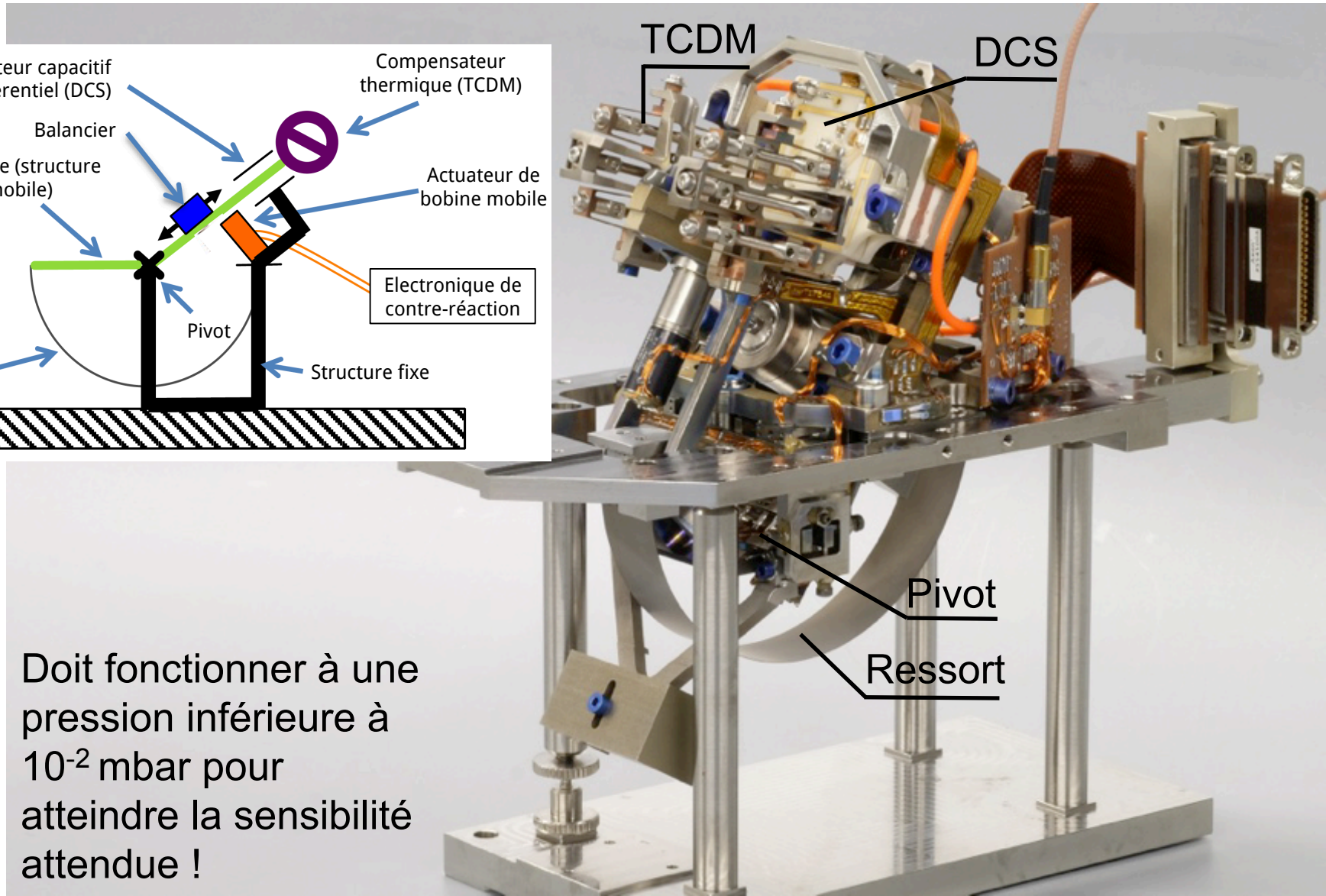
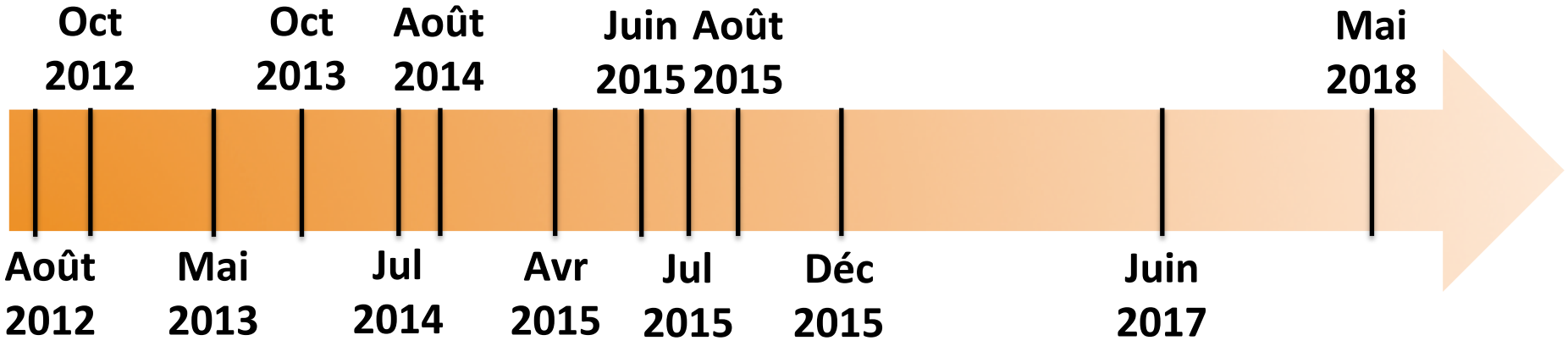




Doit fonctionner à une pression inférieure à 10^{-2} mbar pour atteindre la sensibilité attendue !

L’histoire des VBBs et de SEIS



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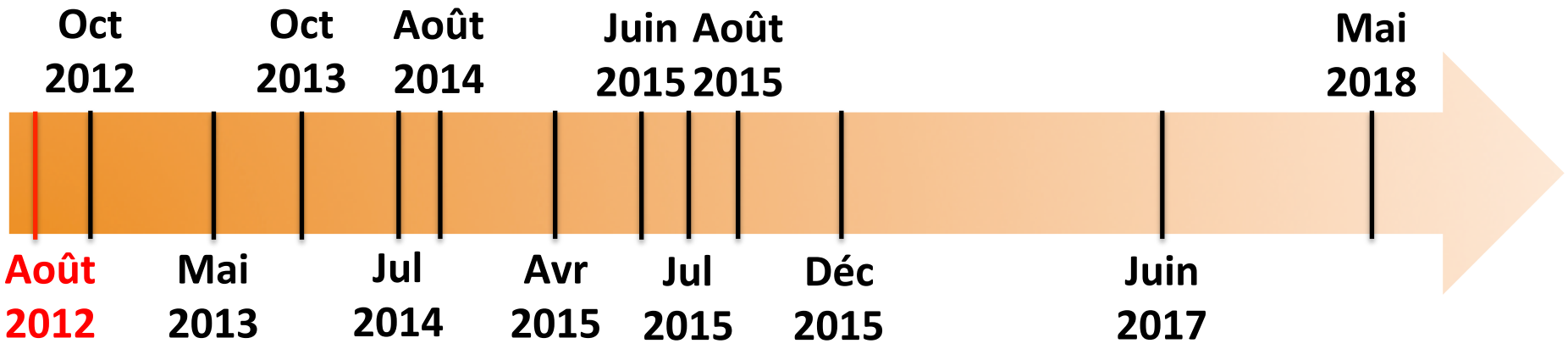
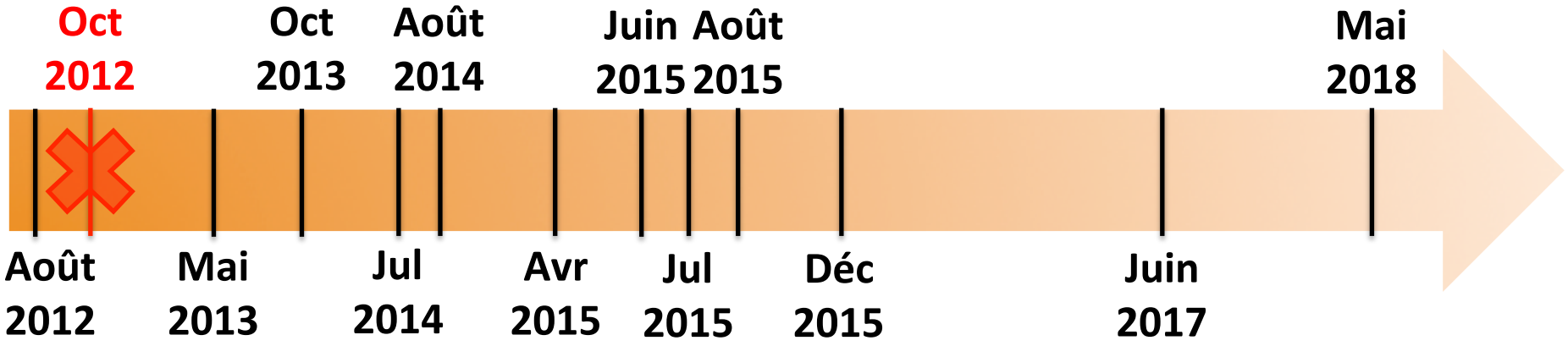
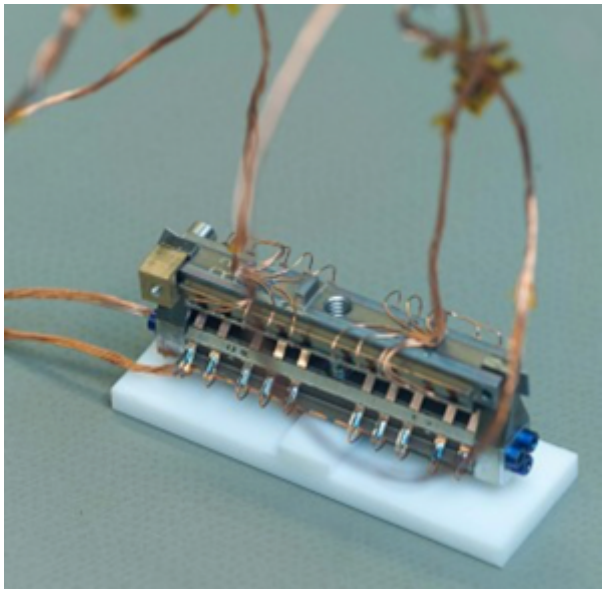


SELECTION !!

L’histoire des VBBs et de SEIS



Modèle thermique structurel
-> Lames du pivot



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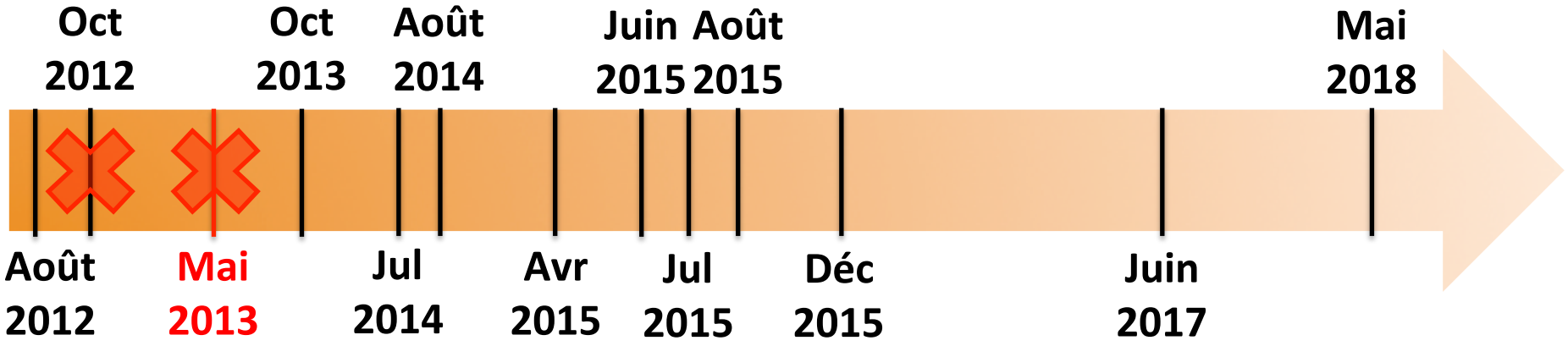
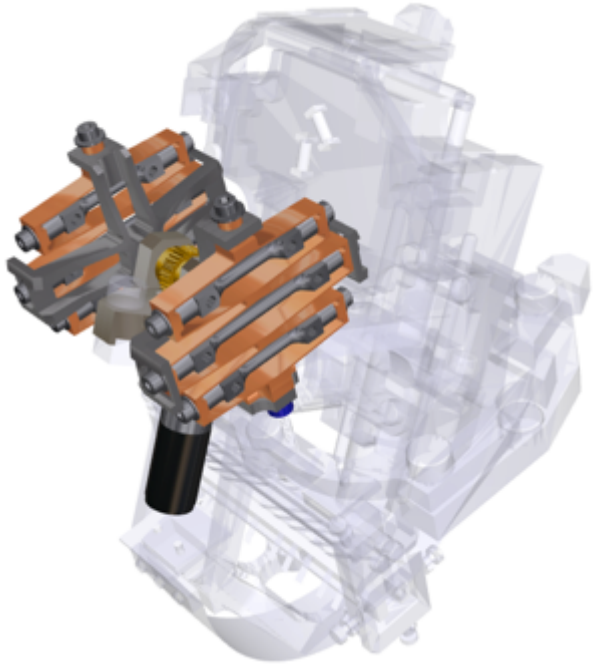
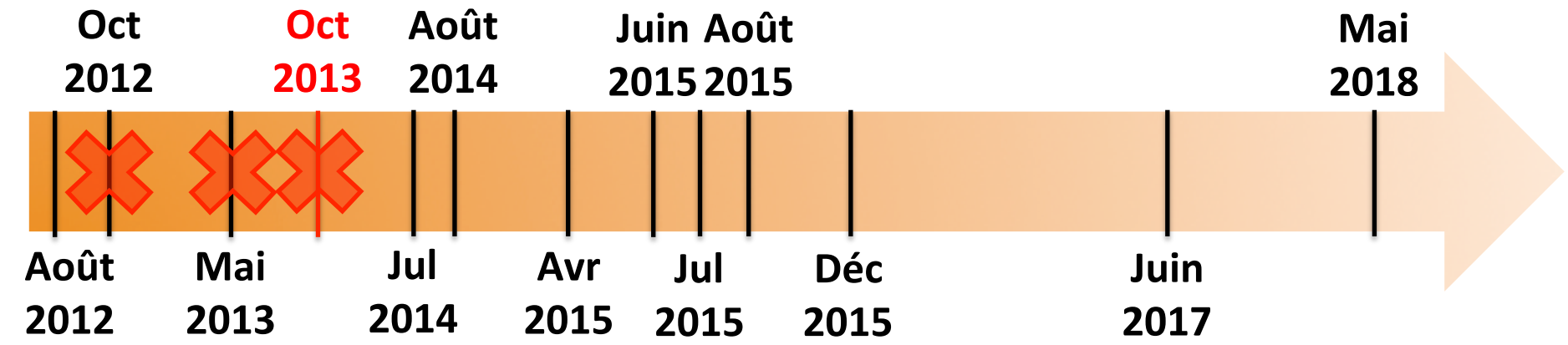




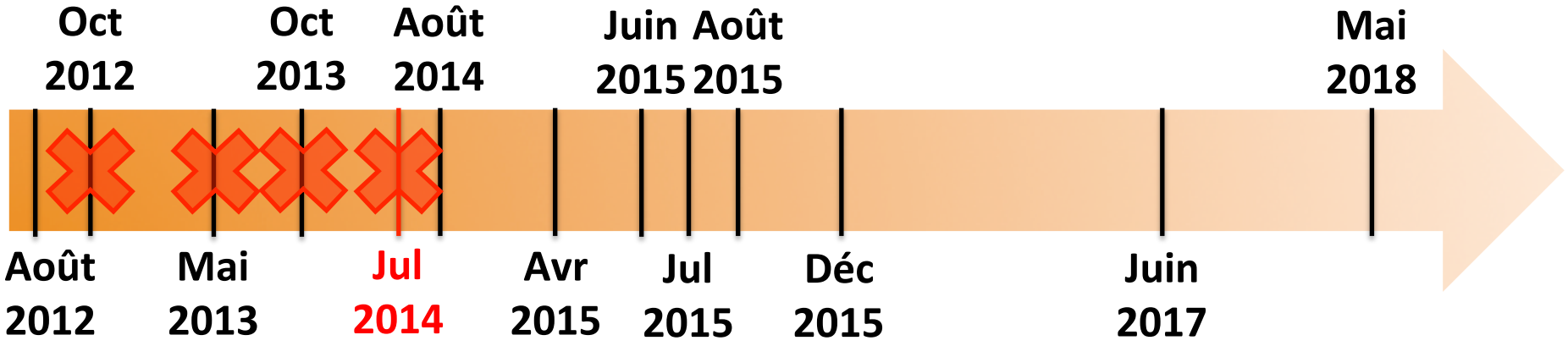
Mécanisme d’équilibrage
-> Pièce cassée

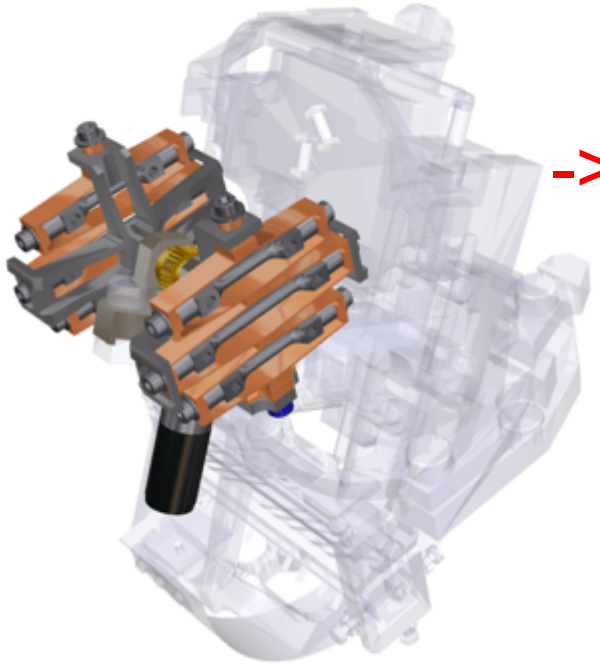
L’histoire des VBBs et de SEIS



Céramique
-> Cracks

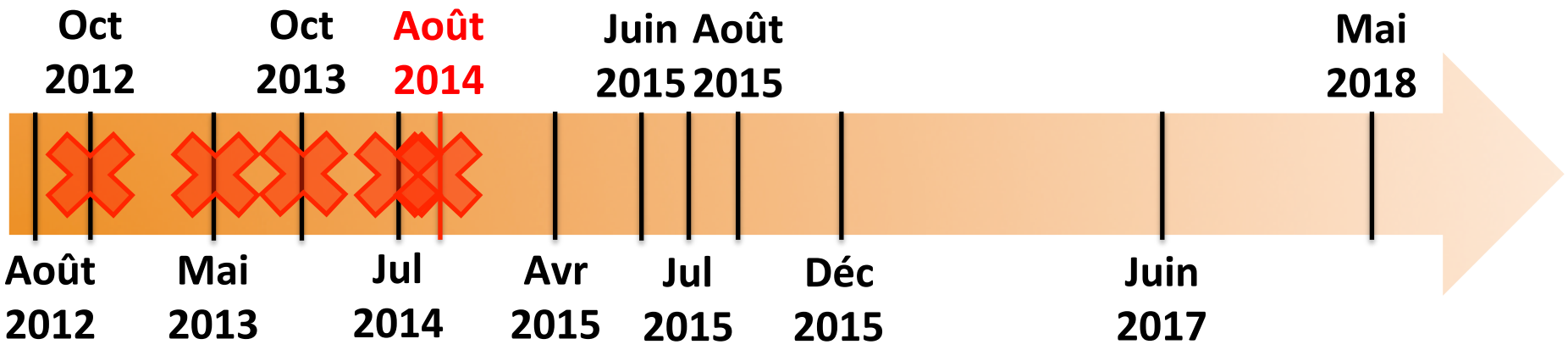
L’histoire des VBBs et de SEIS





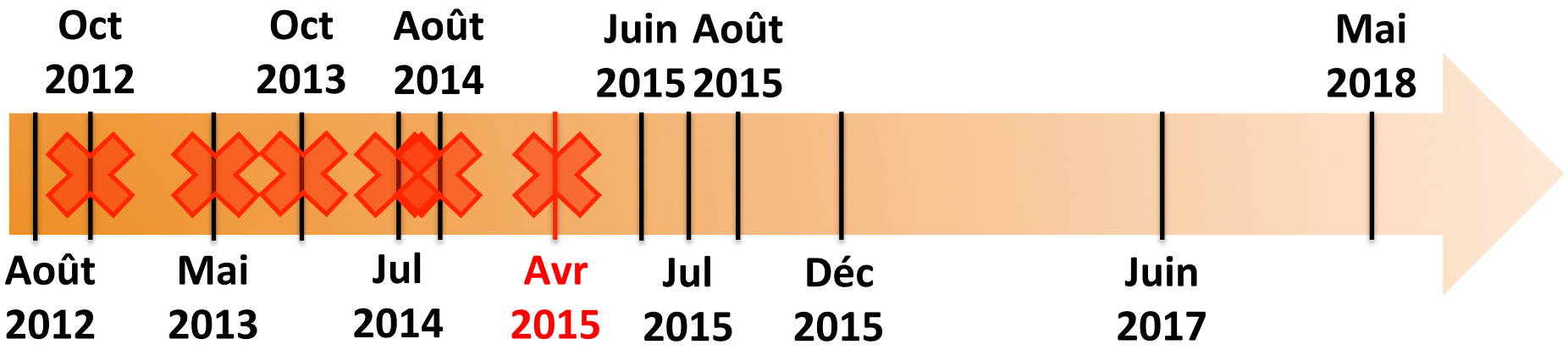
Moteur d’équilibrage
-> Durée de vie BIEN TROP limitée

L’histoire des VBBs et de SEIS

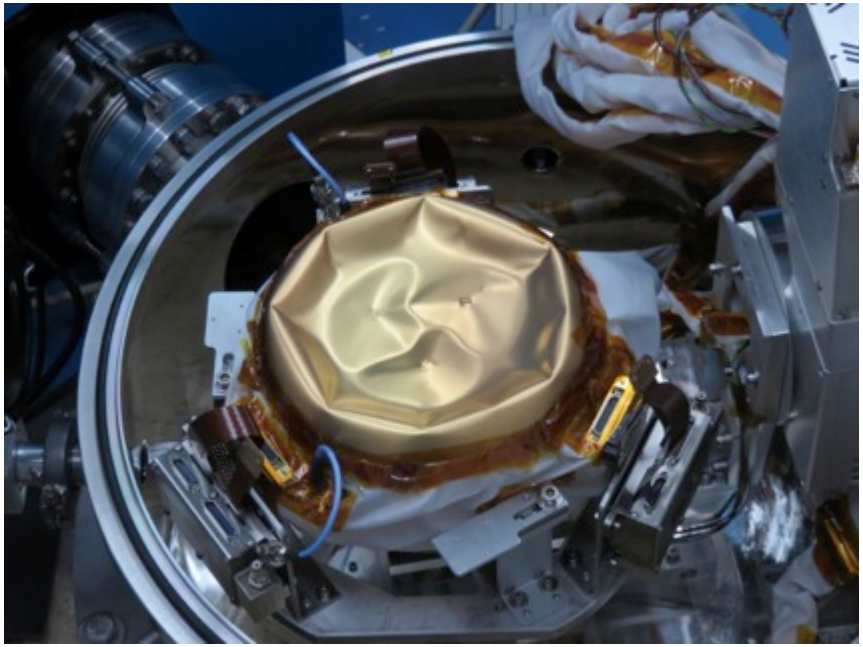


1er VBB de vol
-> N’oscille pas

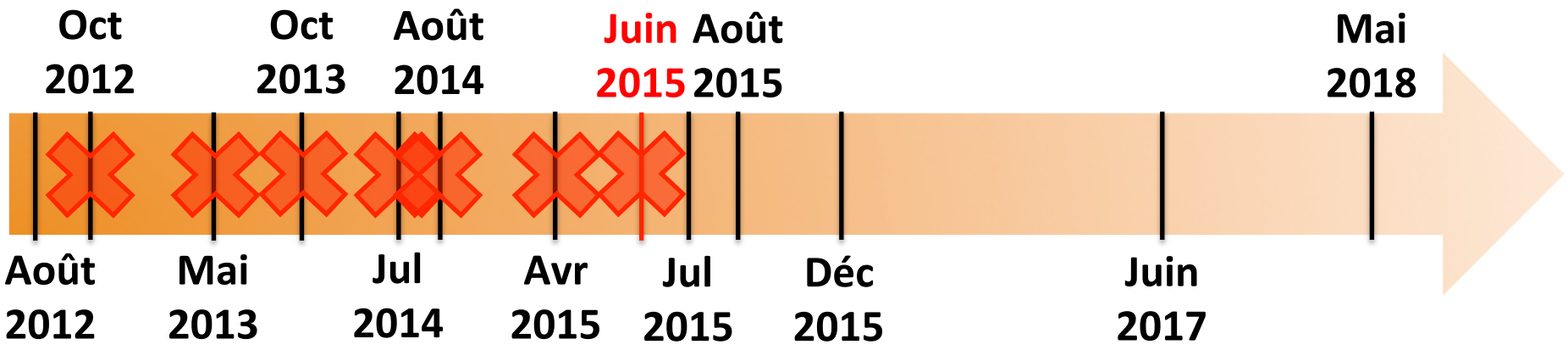
L’histoire des VBBs et de SEIS



Sphère à vide
-> Effondrement

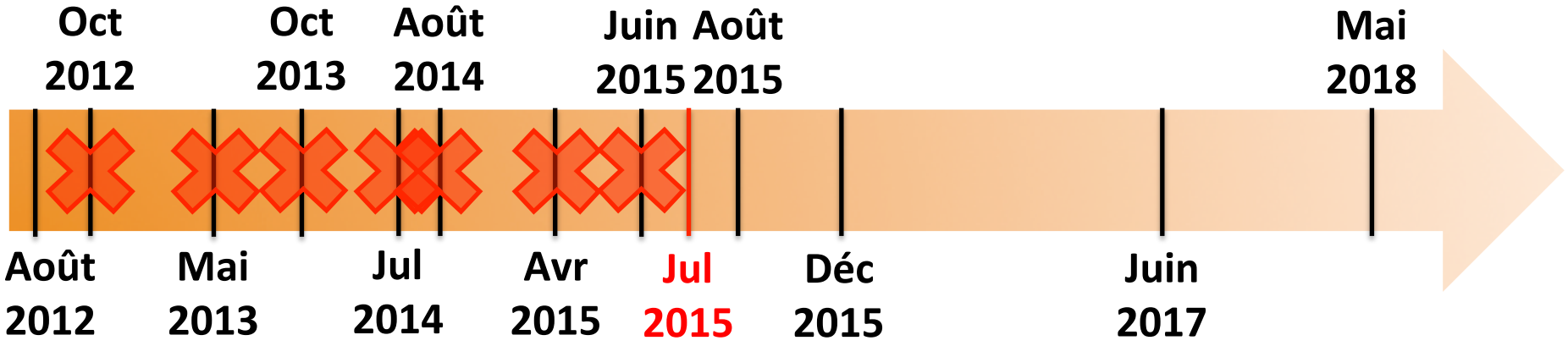


L’histoire des VBBs et de SEIS



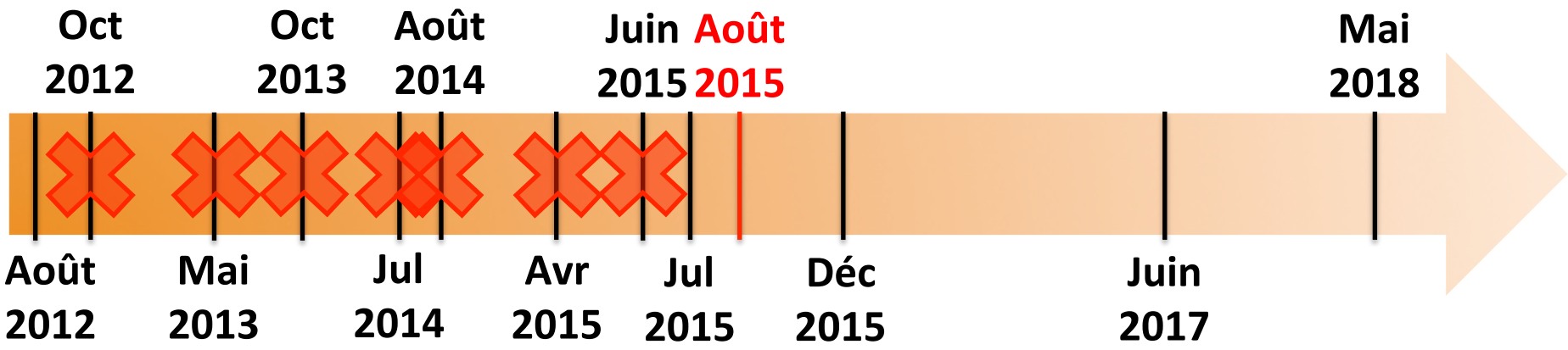
Guetters
-> Cracks

L’histoire des VBBs et de SEIS

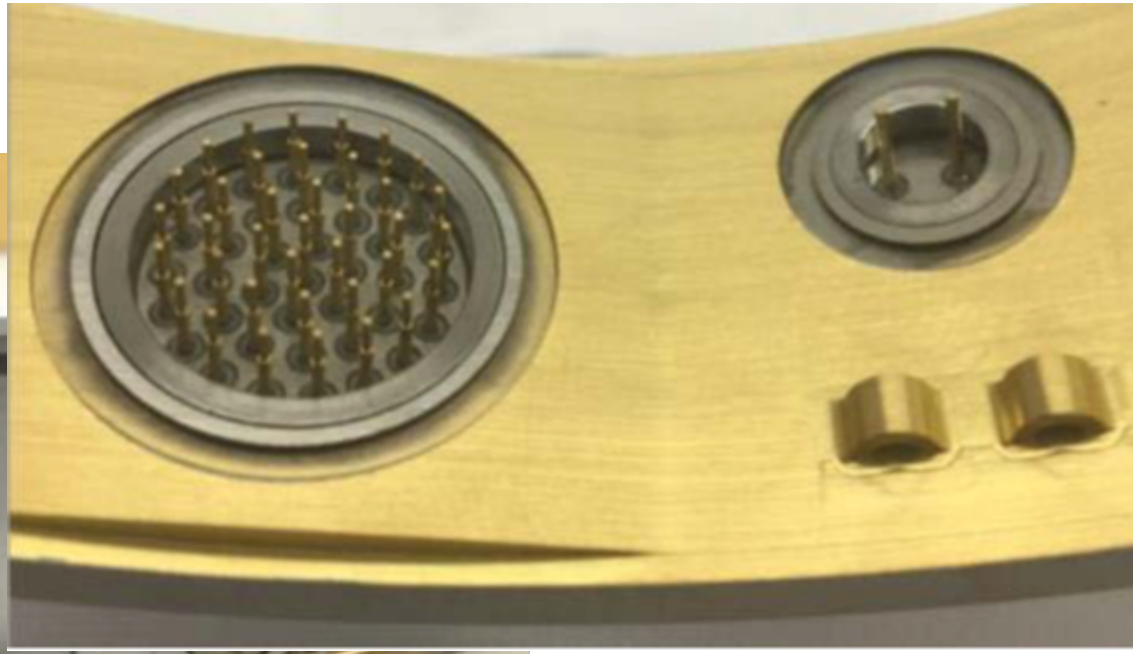


Sphère 1.0 délivrée

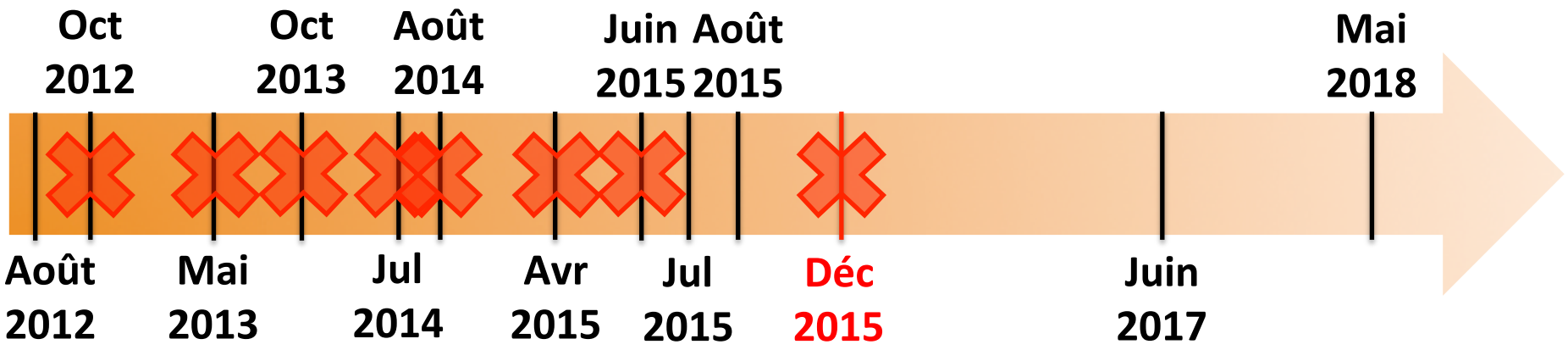
L’histoire des VBBs et de SEIS



Fuite de la sphère !!

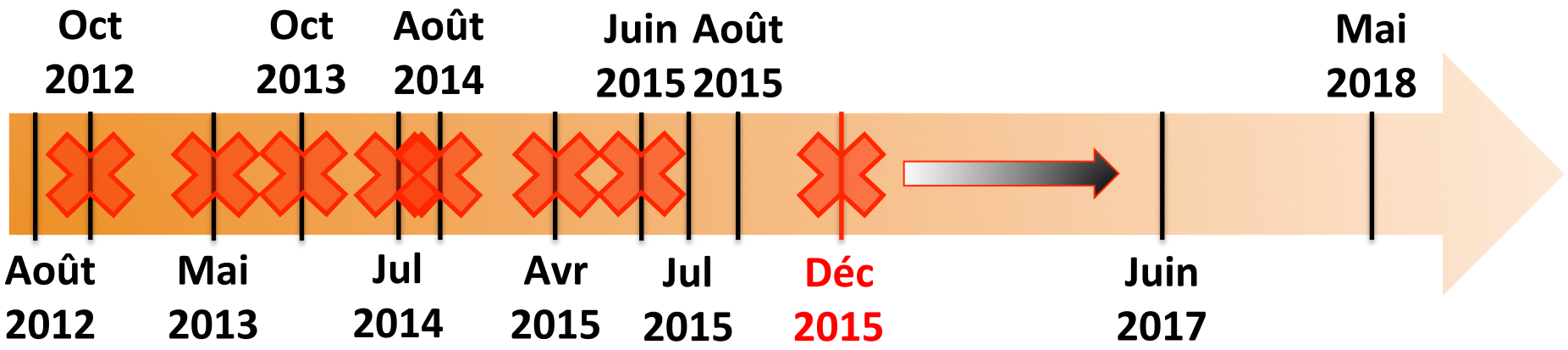


L’histoire des VBBs et de SEIS



LANCEMENT ANNULÉ !

L’histoire des VBBs et de SEIS

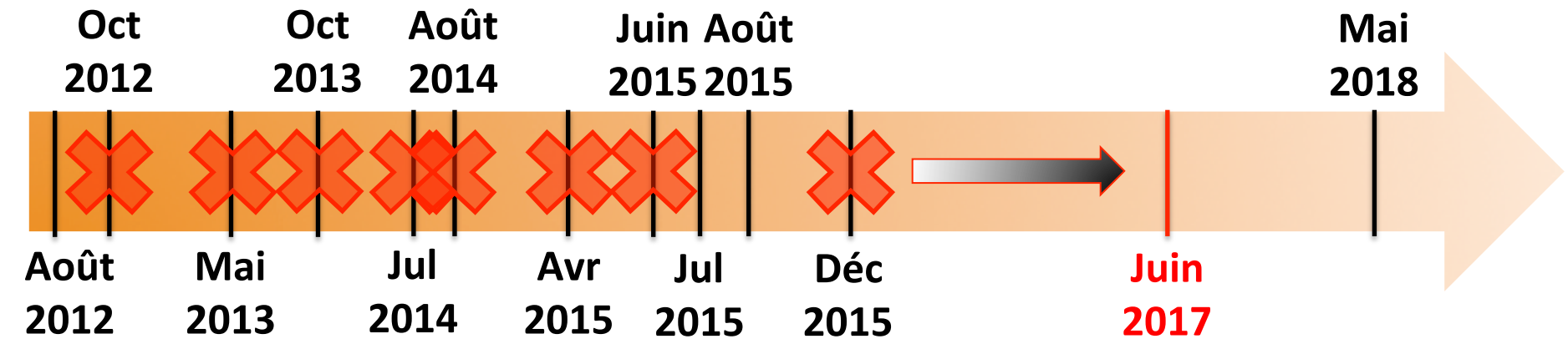


Redesign électronique

+

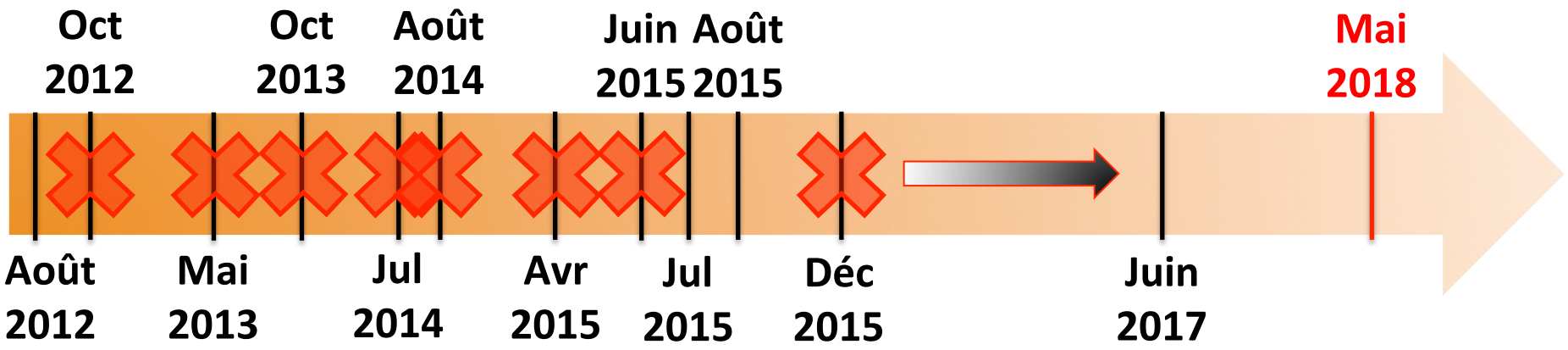
Nouveaux VBBs

L’histoire des VBBs et de SEIS



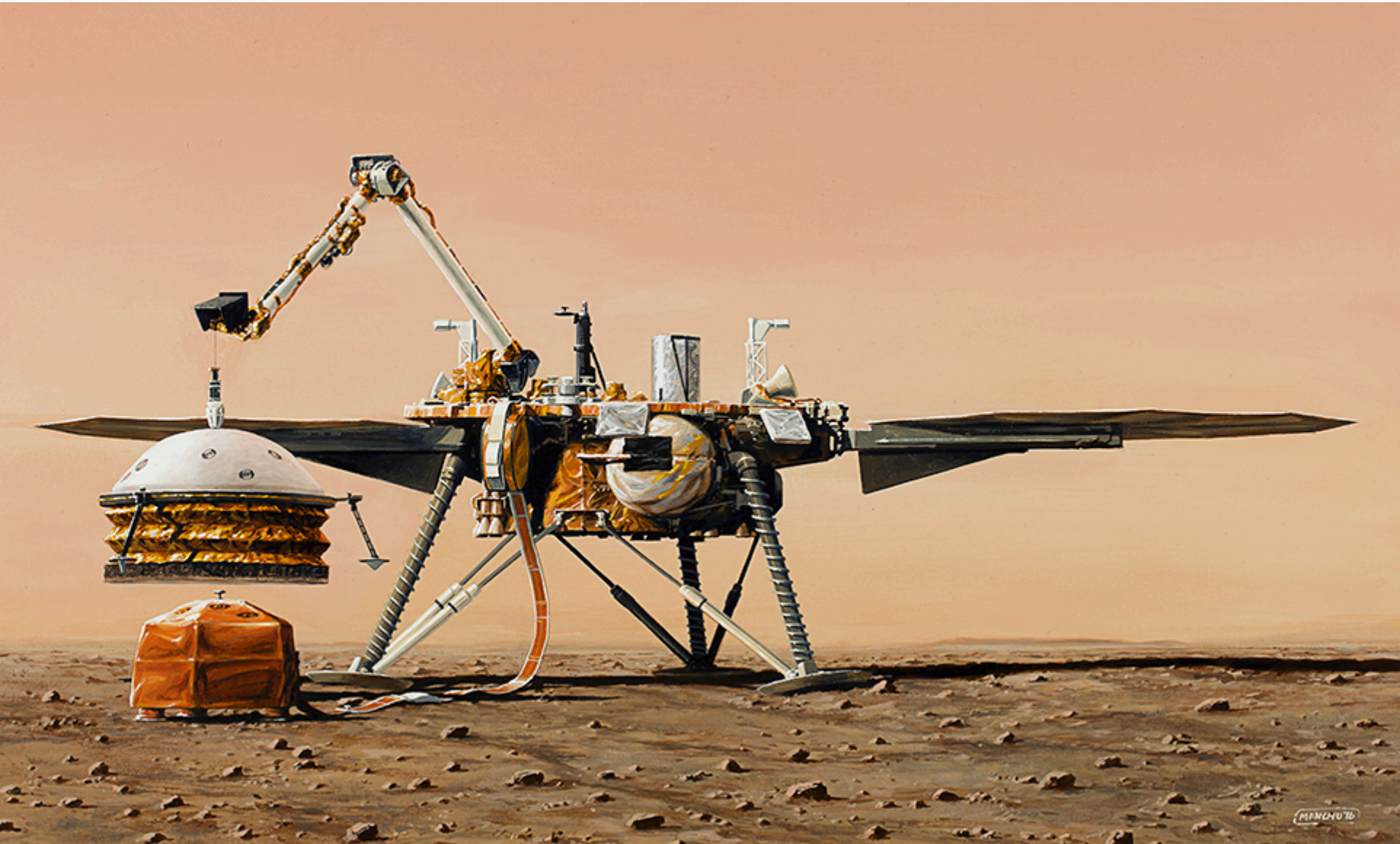
Livraison de l’instrument

L’histoire des VBBs et de SEIS

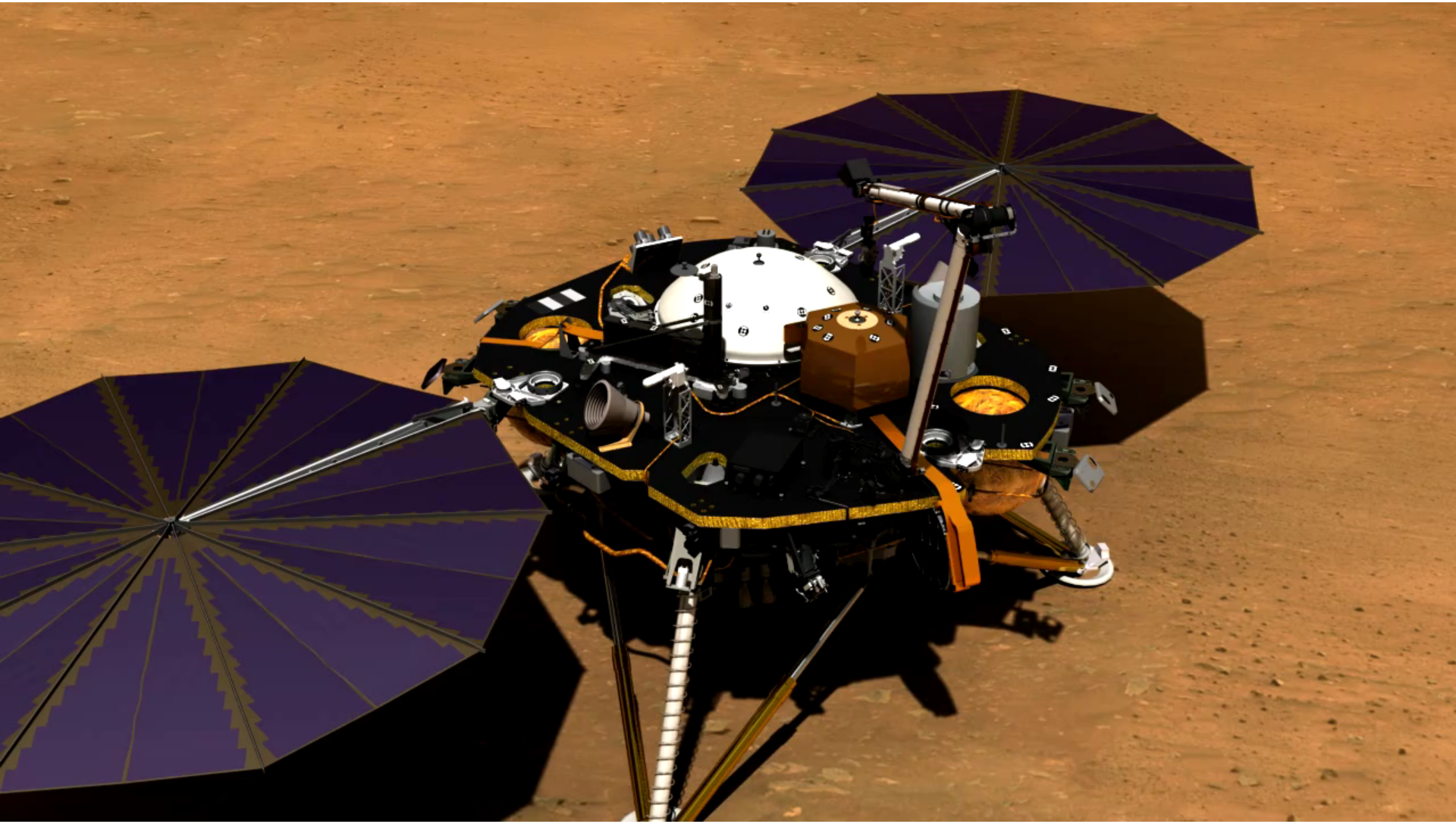


Le lancement

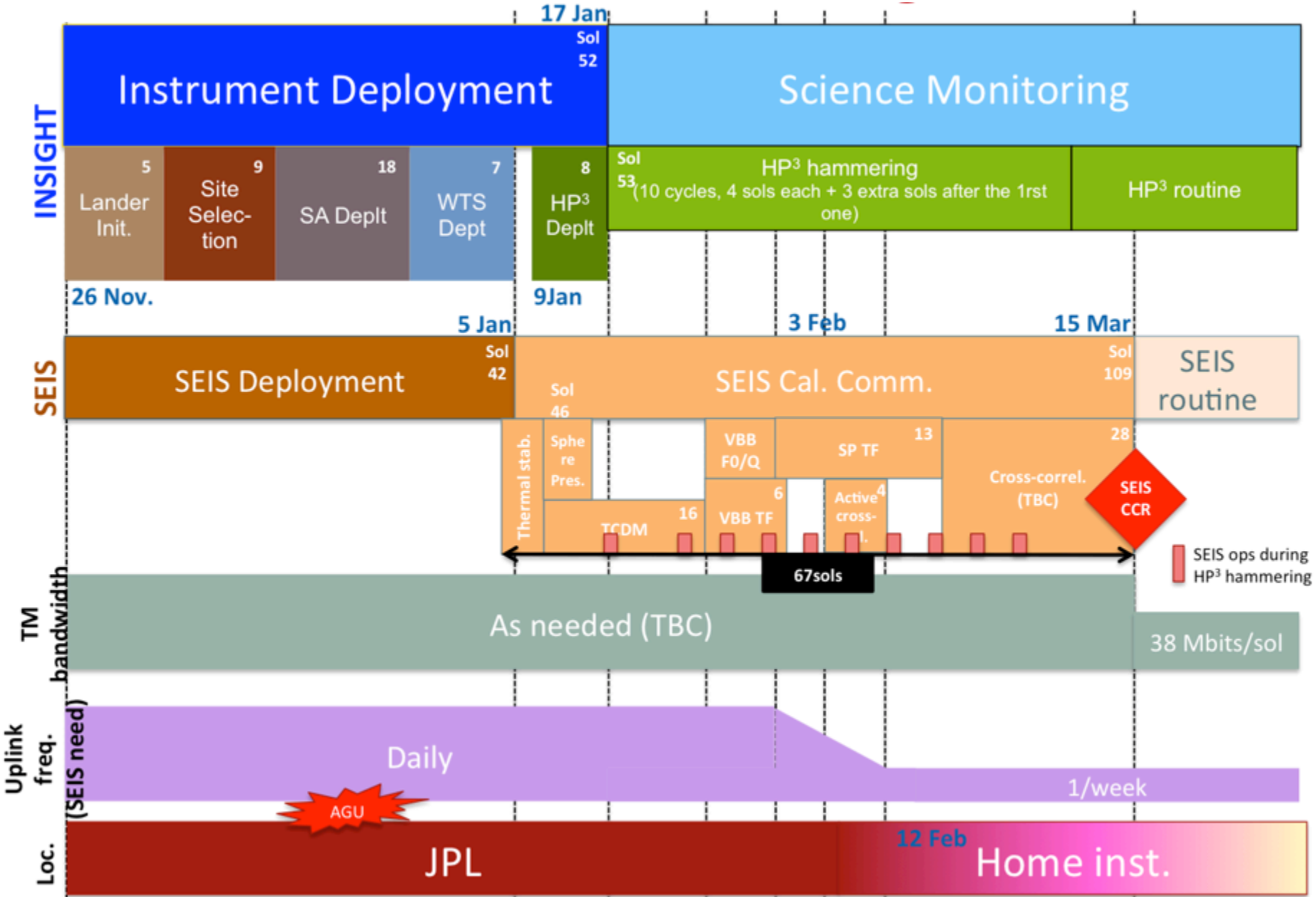
Nov->Fév : Déploiement



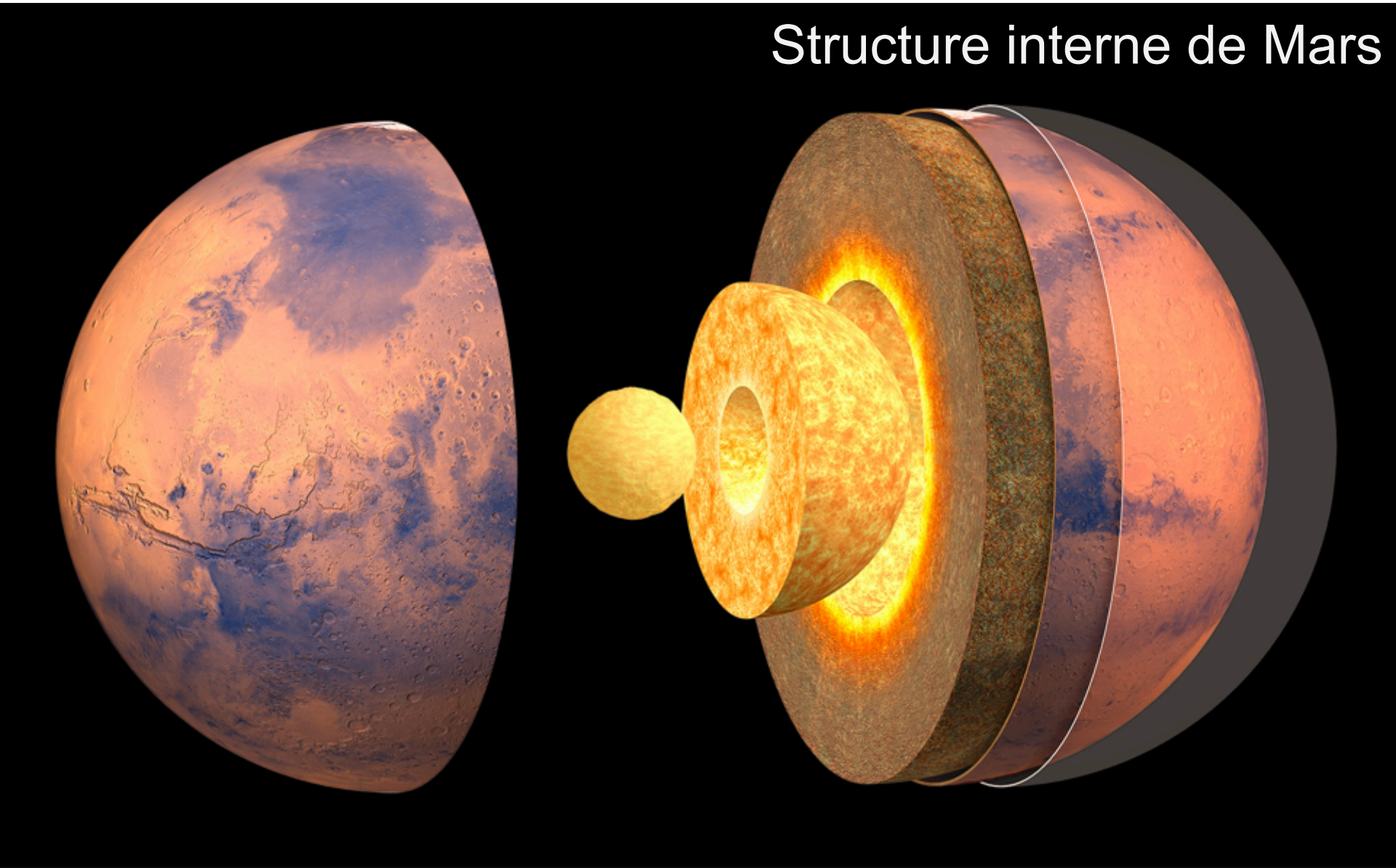
Nov->Fév : Déploiement



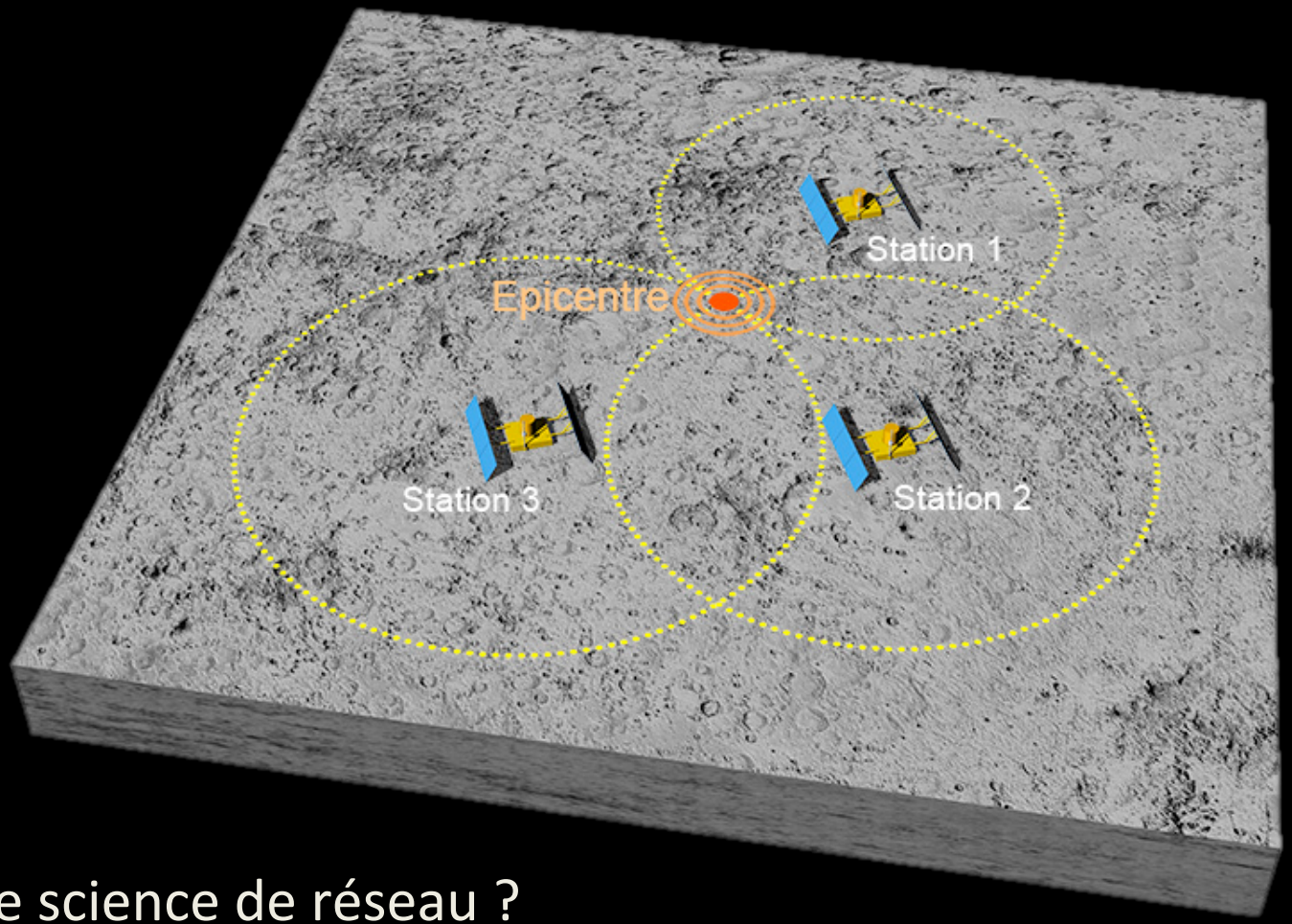
Nov->Fév : Déploiement



2019-2020 : Acquisition des données



Etudier la planète avec un seul sismomètre

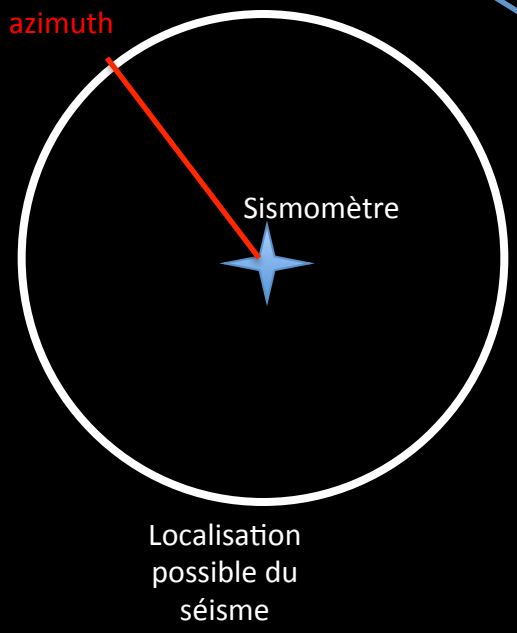


Une science de réseau ?

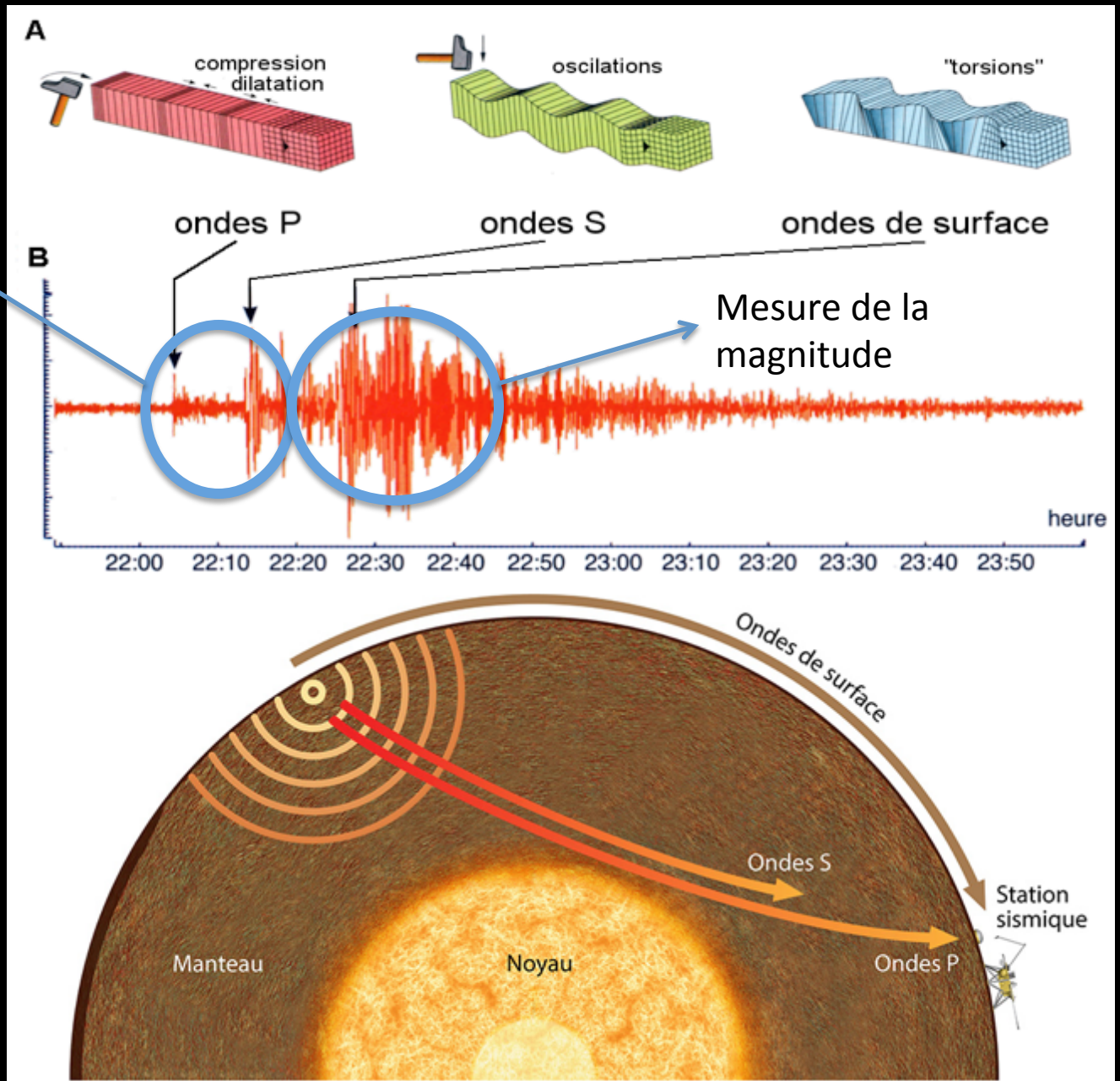
IPGP/David Ducros).

Etudier la planète avec un seul sismomètre

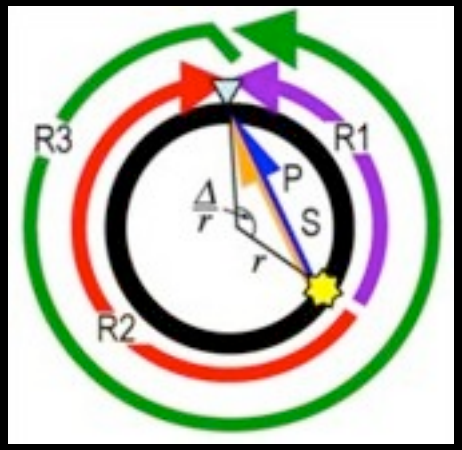
Différence de temps d'arrivée des onde P et S nous donne la distance à la source



Détermination de l'azimuth (±10°) grâce à l'enregistrement sismique dans le plan horizontal

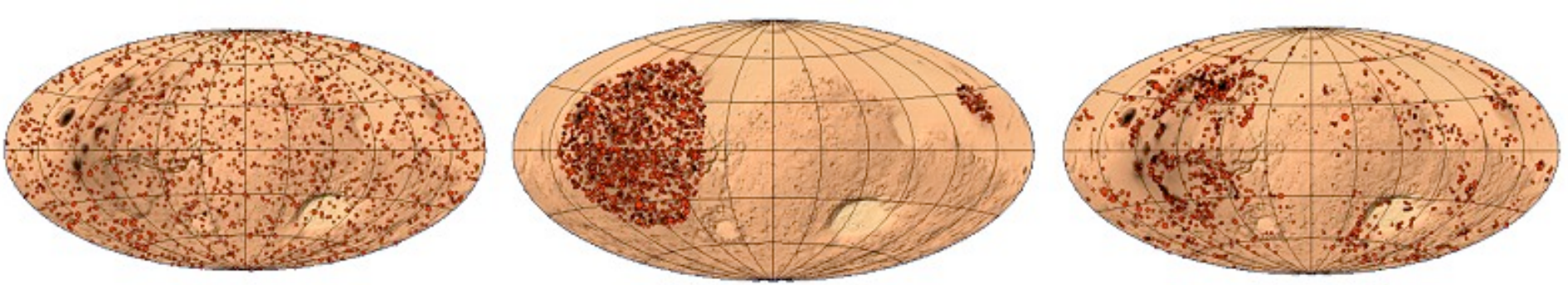


Etudier la planète avec un seul sismomètre



Pour les gros séismes (M>4.5), distance déterminée grâce aux sondes de surface

Détermination de l'azimuth (±10°) grâce à l'enregistrement sismique dans le plan horizontal



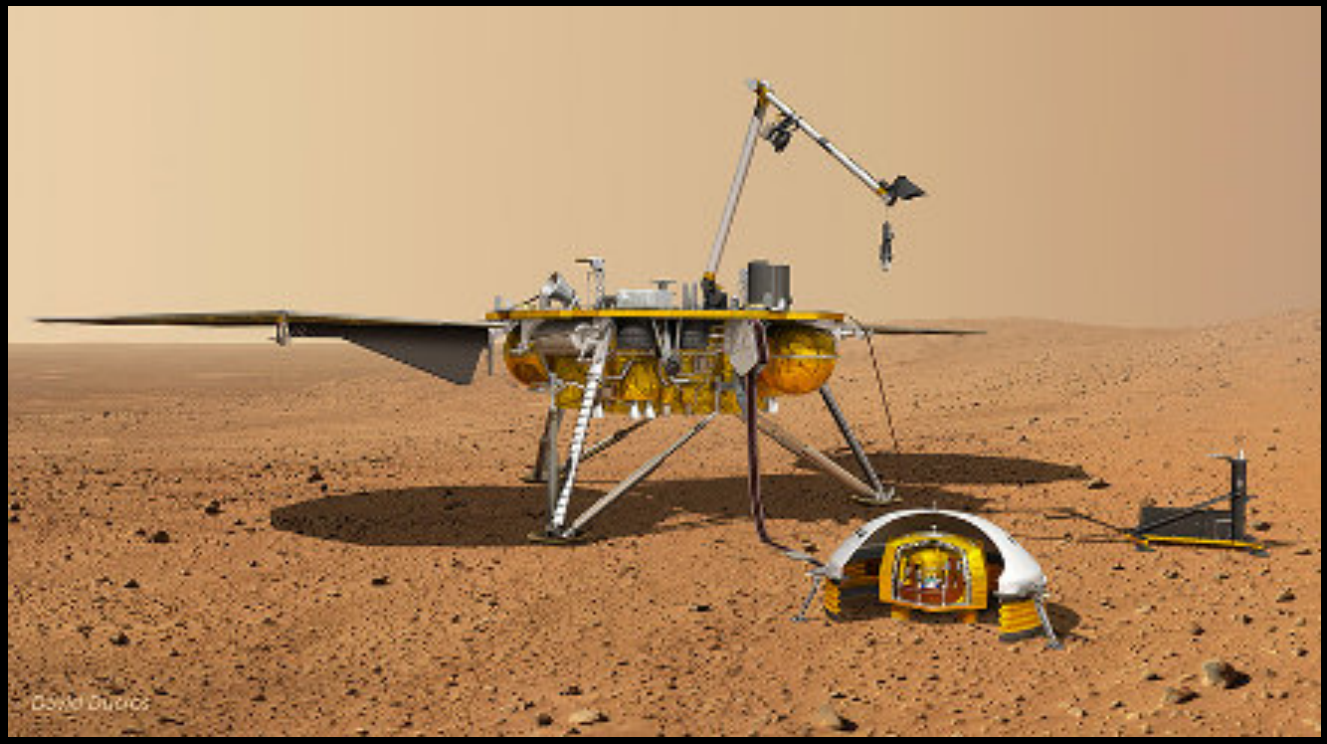
Trois scénarios possibles pour la localisation des séismes martiens

Trois grandes questions scientifiques

Quelle est la structure interne de la planète?

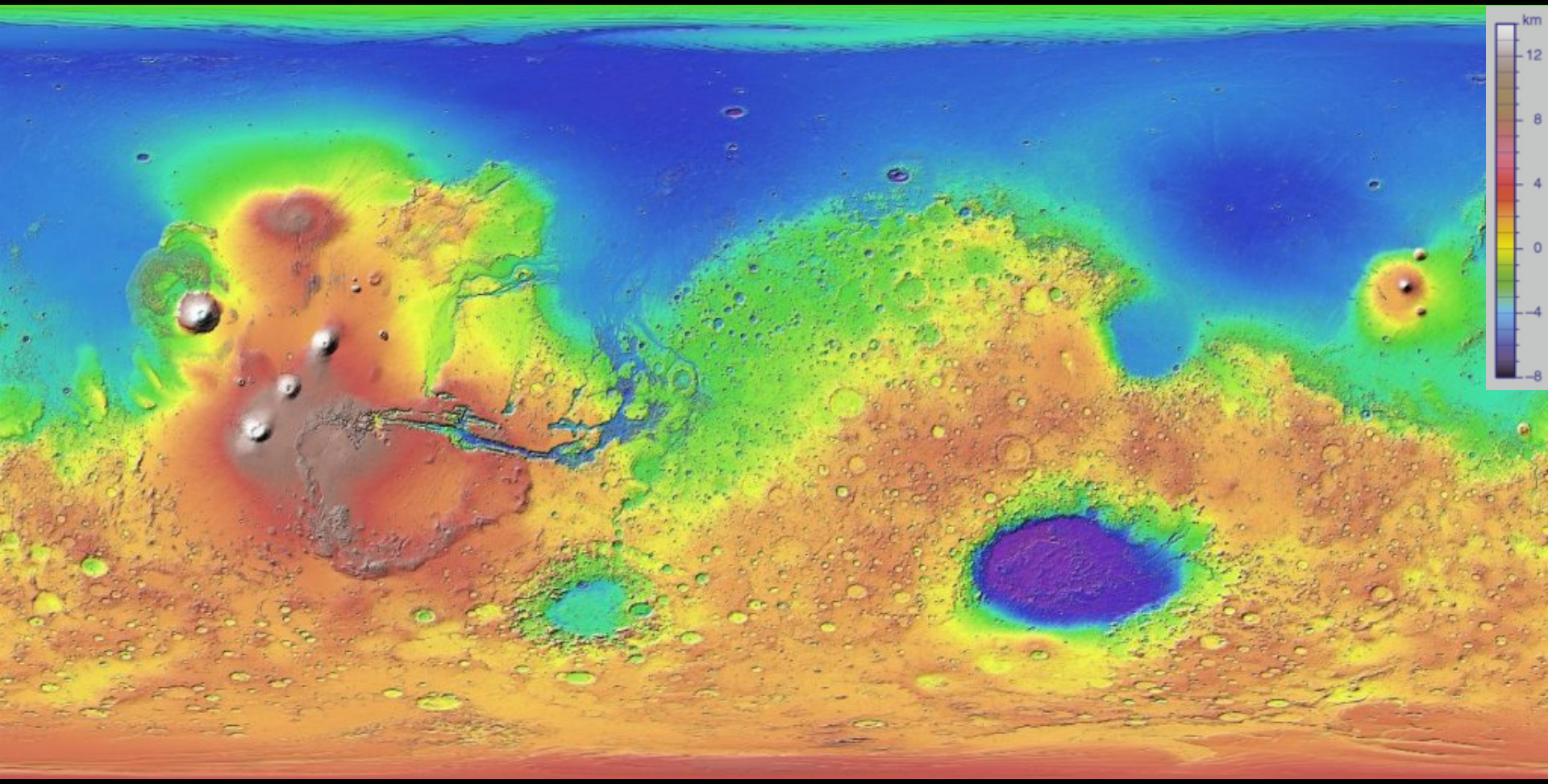
La planète Mars a-t-elle une activité sismique?

Quel est le flux d'impact sur Mars ?



Structure interne de Mars

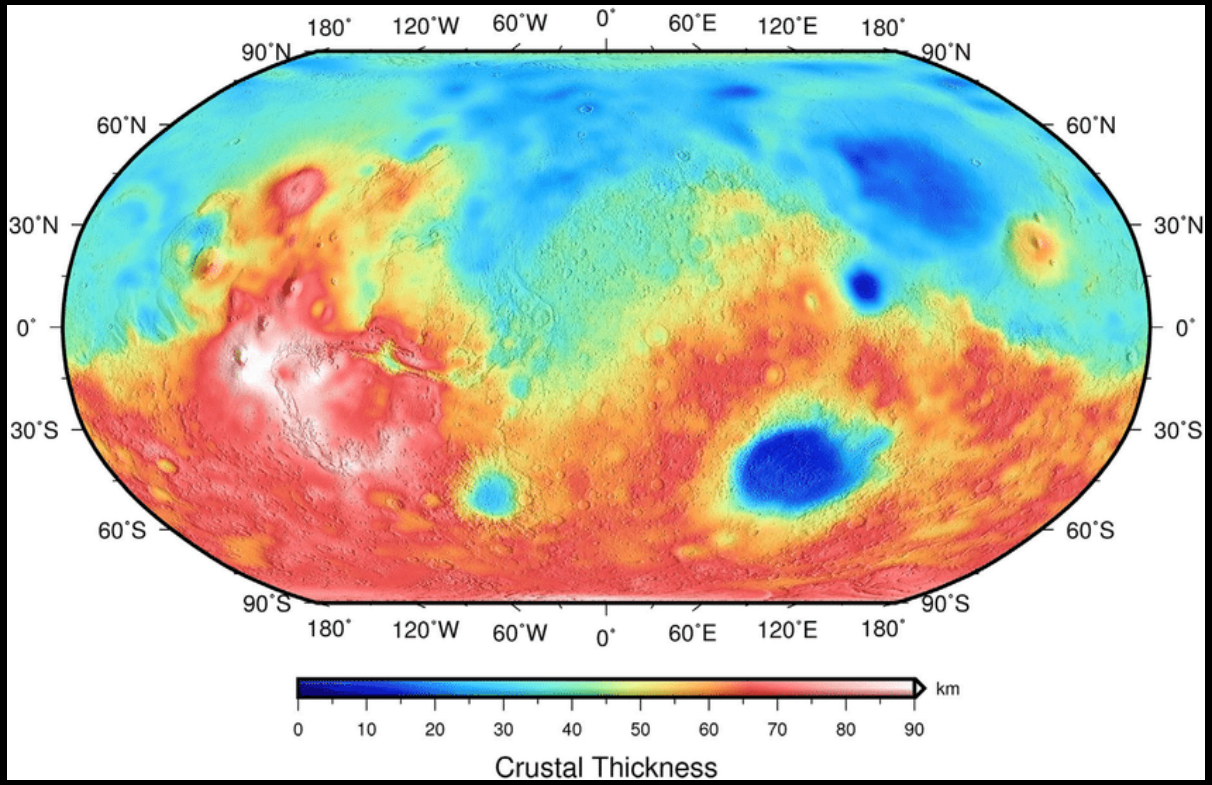
Des informations sur la croute martienne

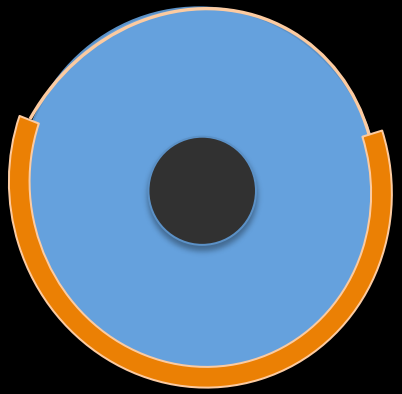


Quelle est l'épaisseur de la croute martienne ?

Structure interne de Mars

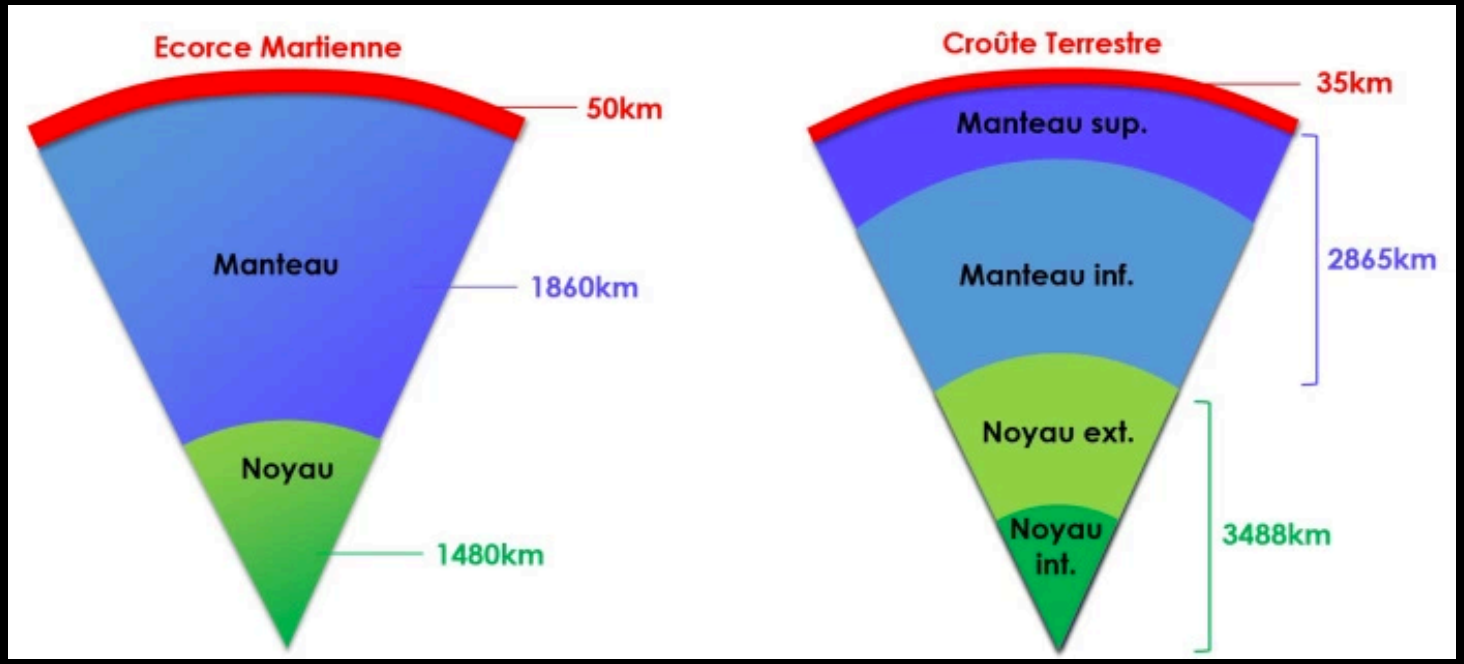
Des informations sur la croute martienne





Structure interne de Mars

Des informations sur le manteau

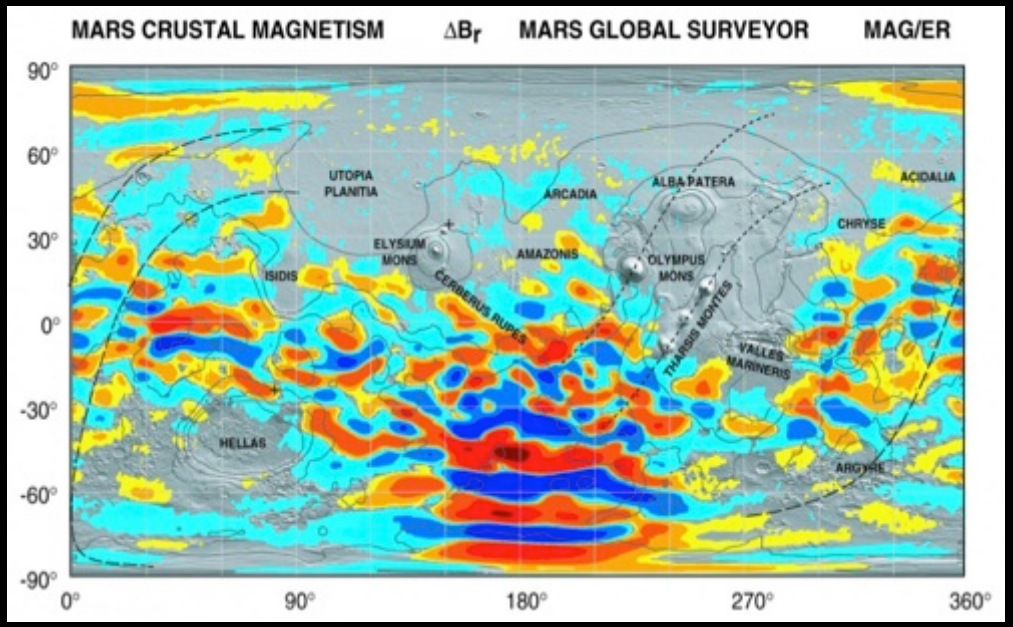


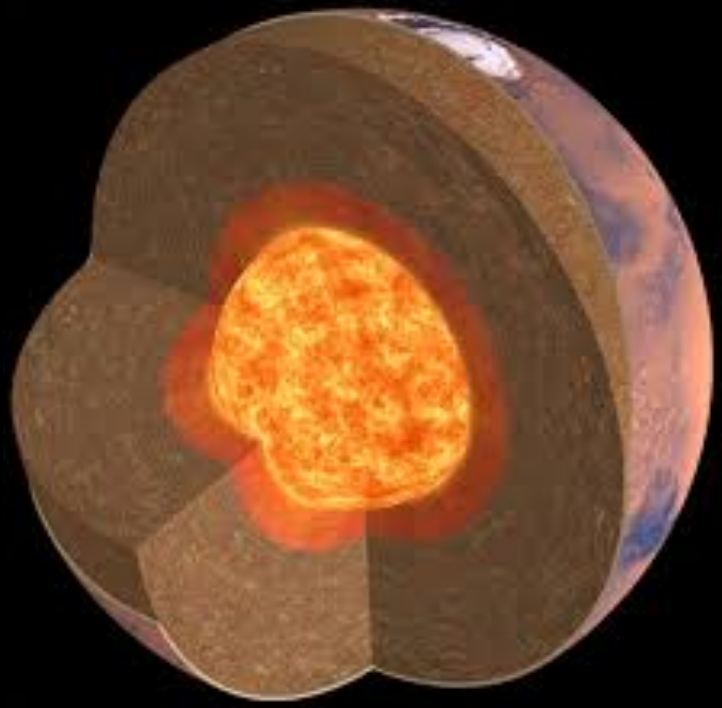
Le manteau est il stratifié comme sur Terre ?

Y a t'il de la convection dans le manteau ?

Structure interne de Mars

Des informations sur le noyau

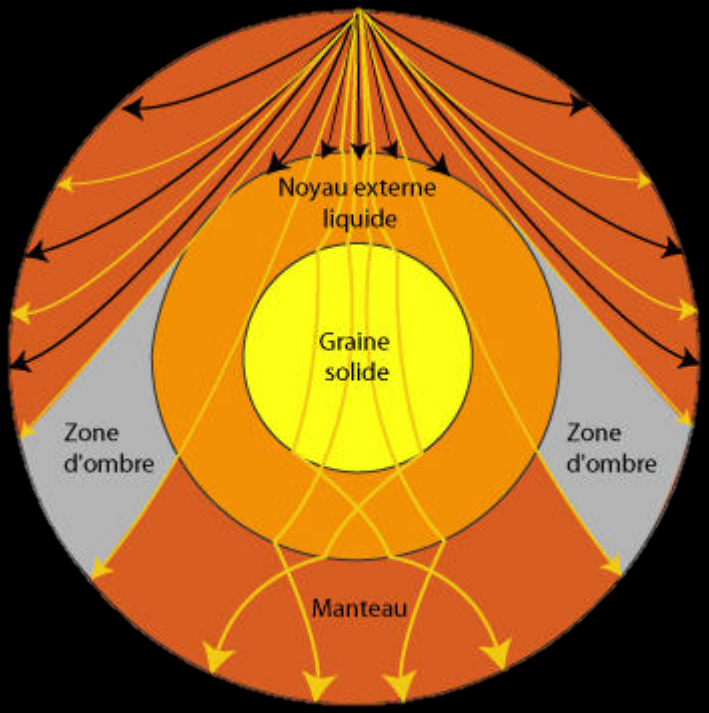


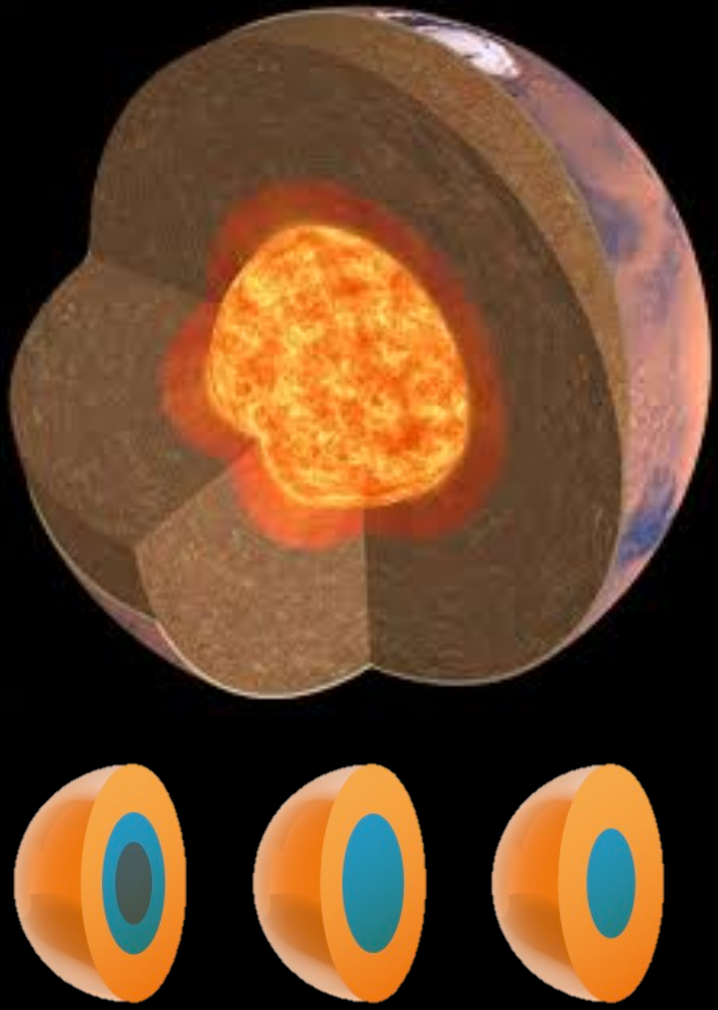


Quelle est la structure du noyau?

Structure interne de Mars

Des informations sur le noyau

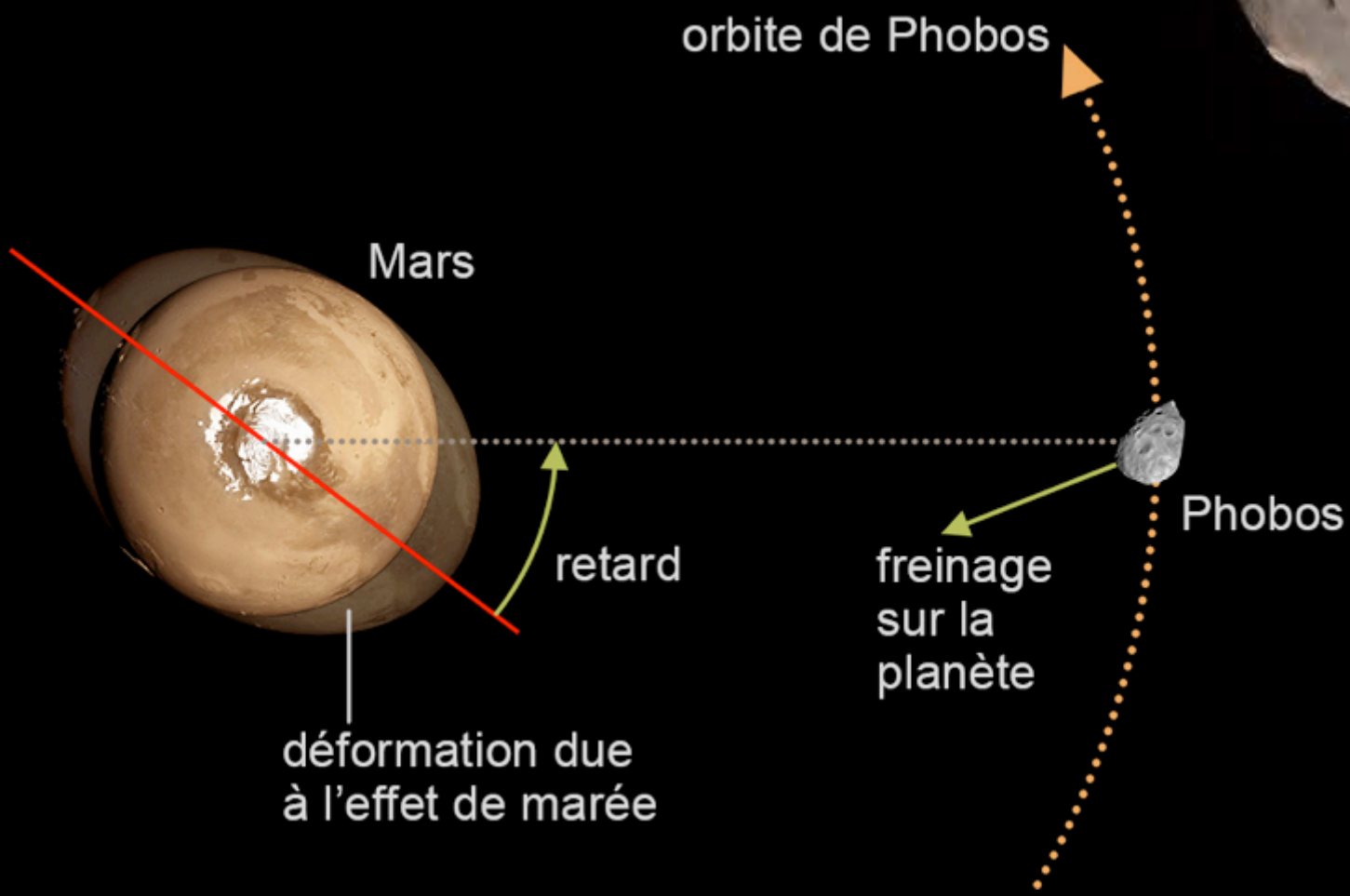




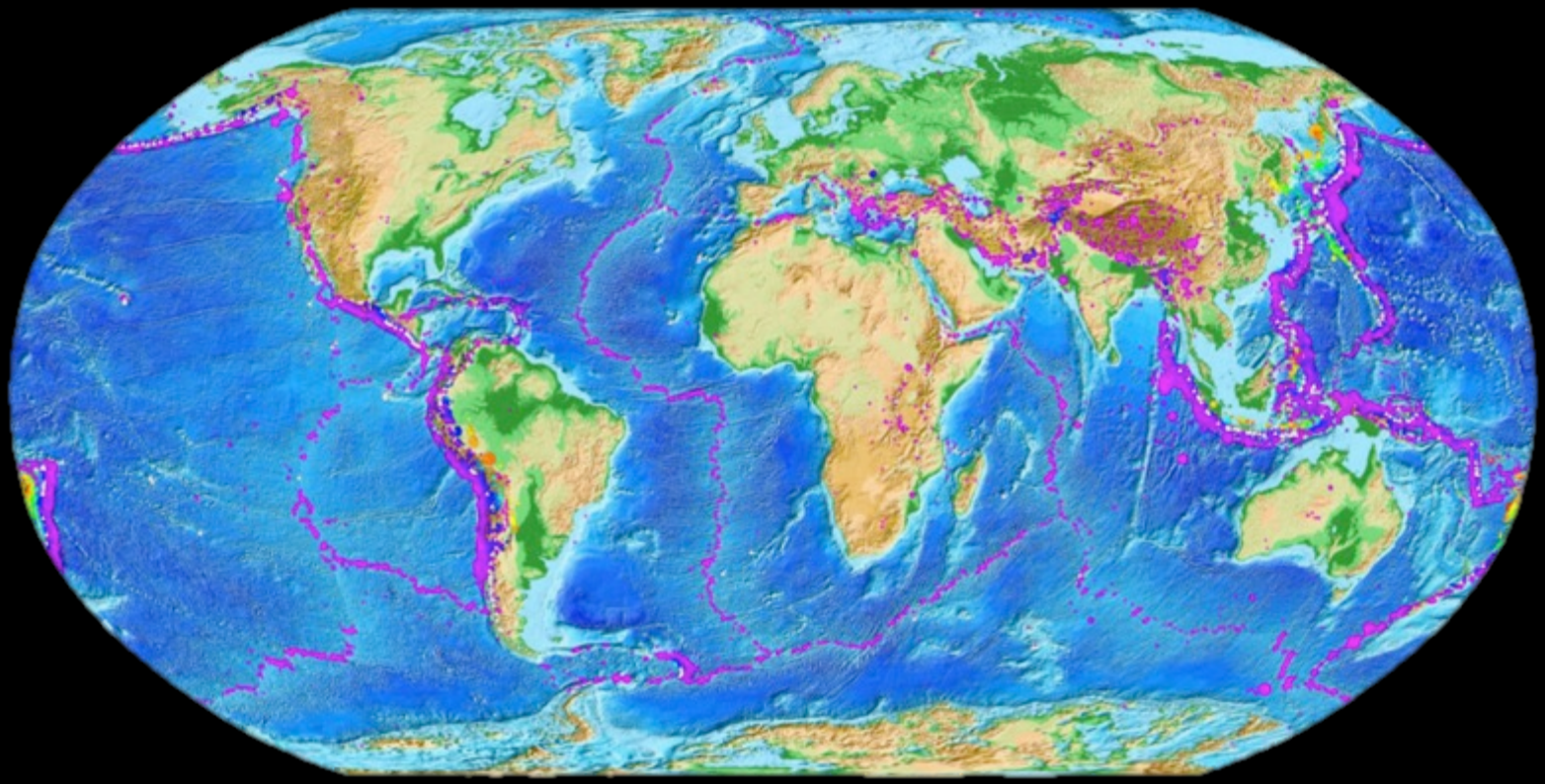
Quelle est la structure du noyau?

Structure interne de Mars

Les marées sur Phobos

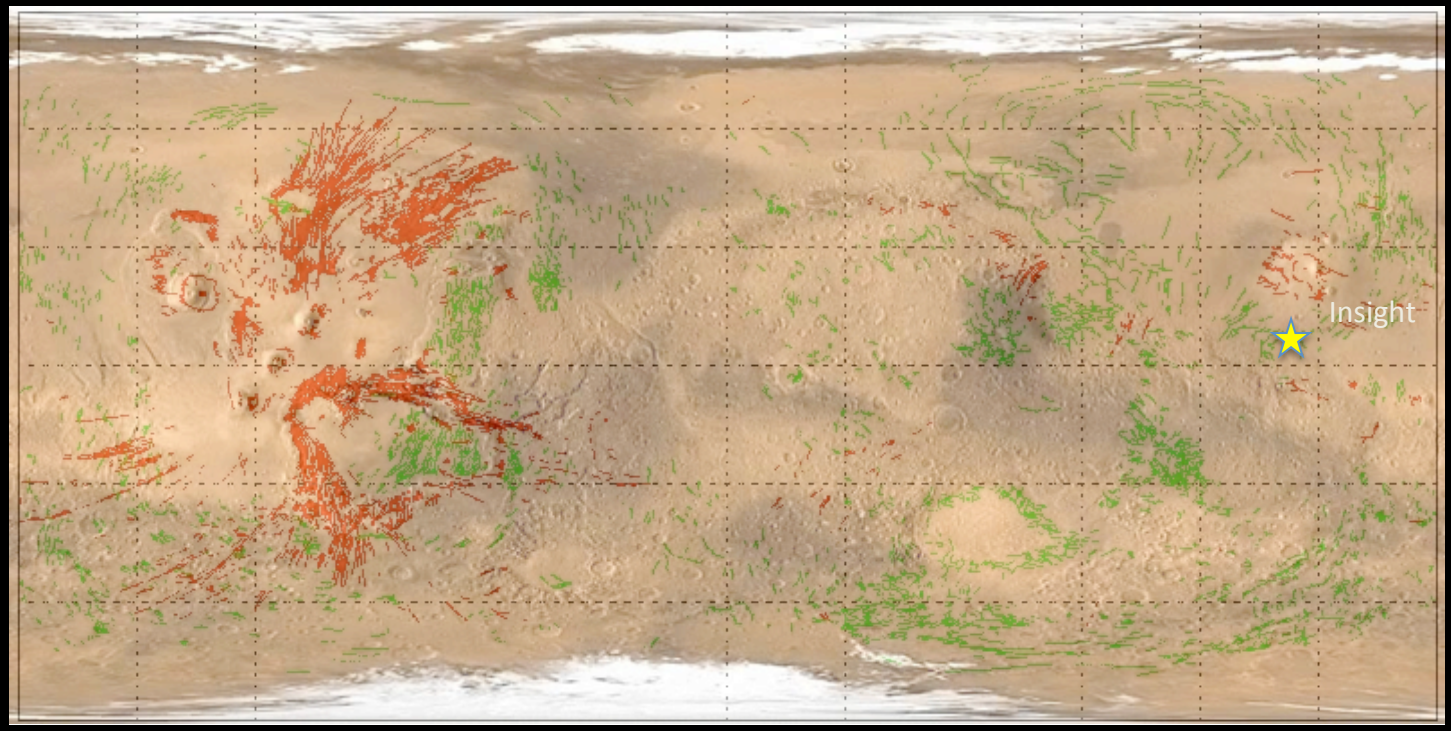


La planète Mars tremble t'elle ?



Quelques milliers de séismes pas jour sur Terre!

La planète Mars tremble t'elle ?

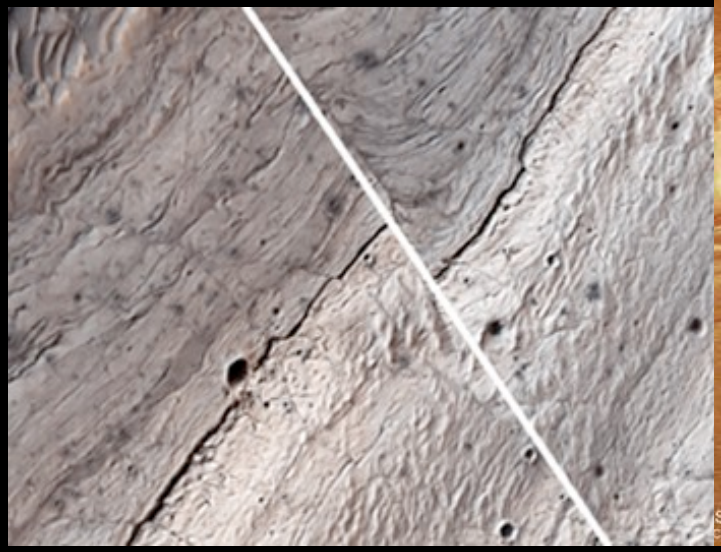


Des milliers de failles sur Mars !

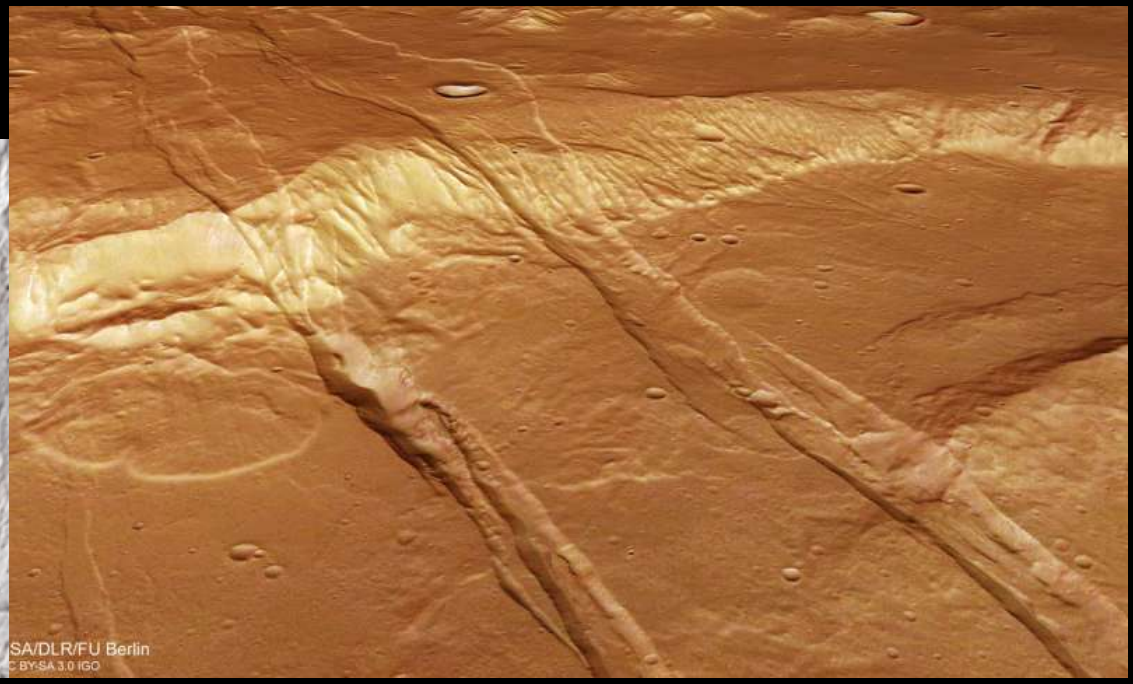
Sont t'elles encore actives?

La planète Mars tremble t'elle ?

Des milliers de failles sur Mars

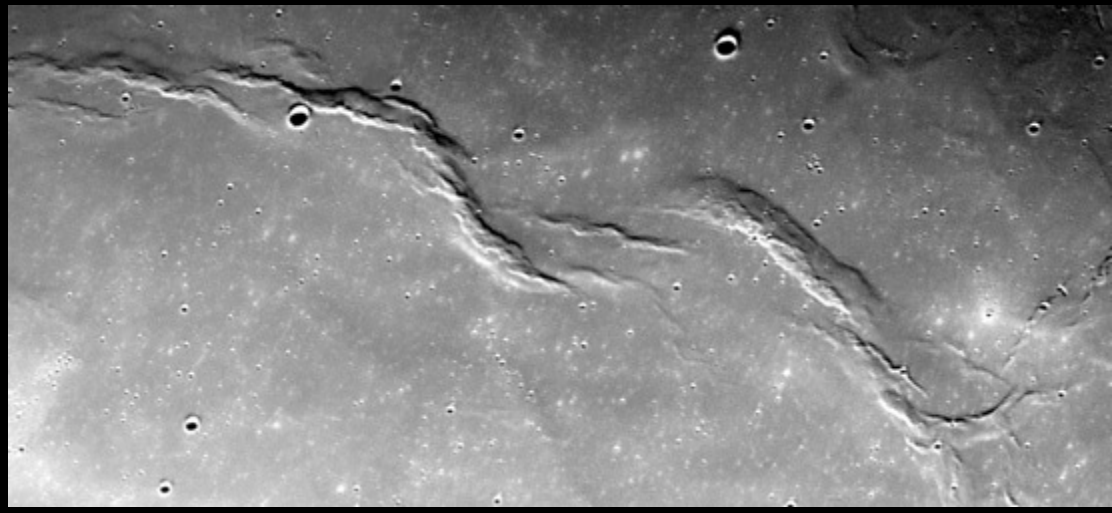


Des failles décrochantes



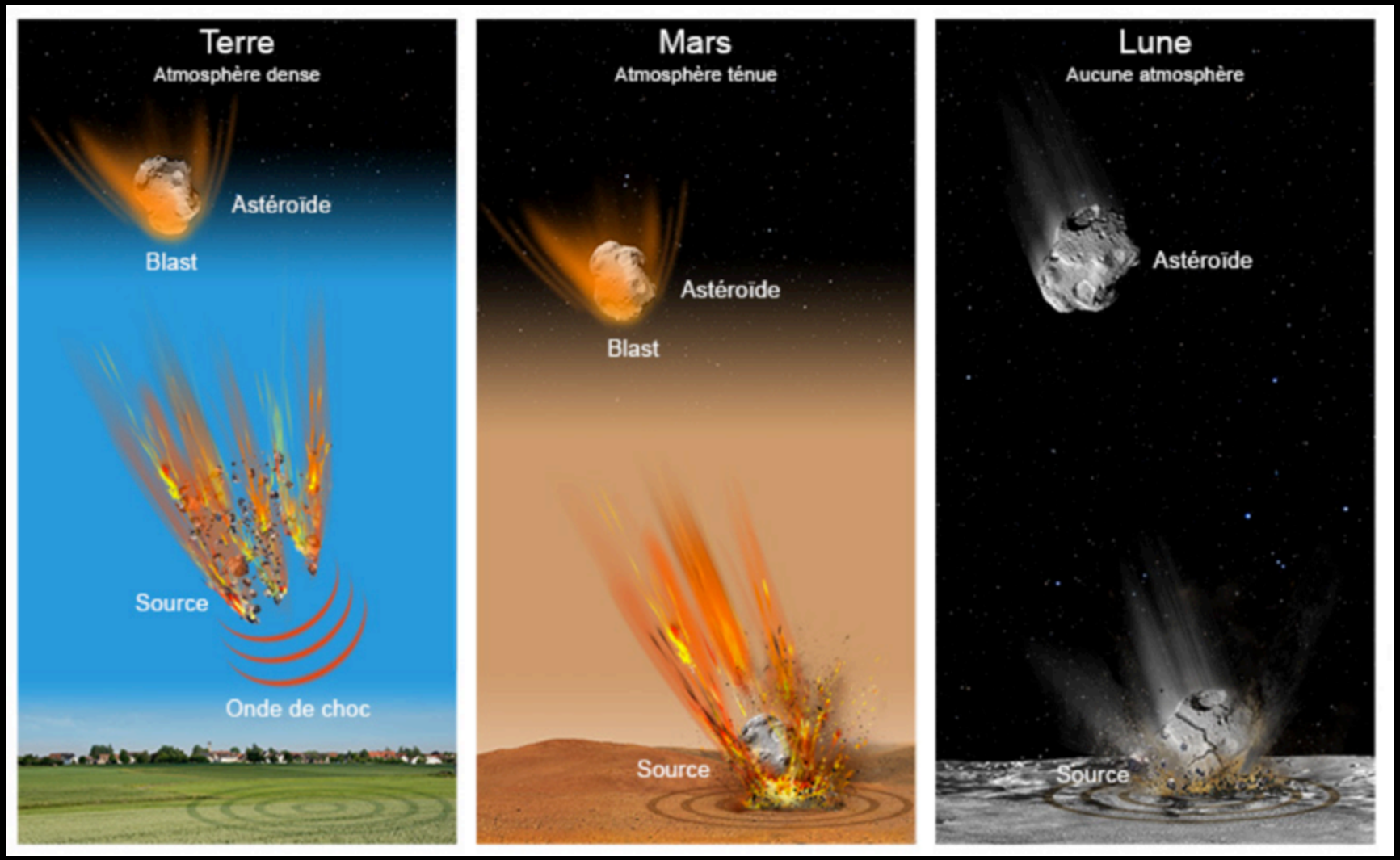
Des failles extensives

Des failles compressives



D’autres sources sismiques?

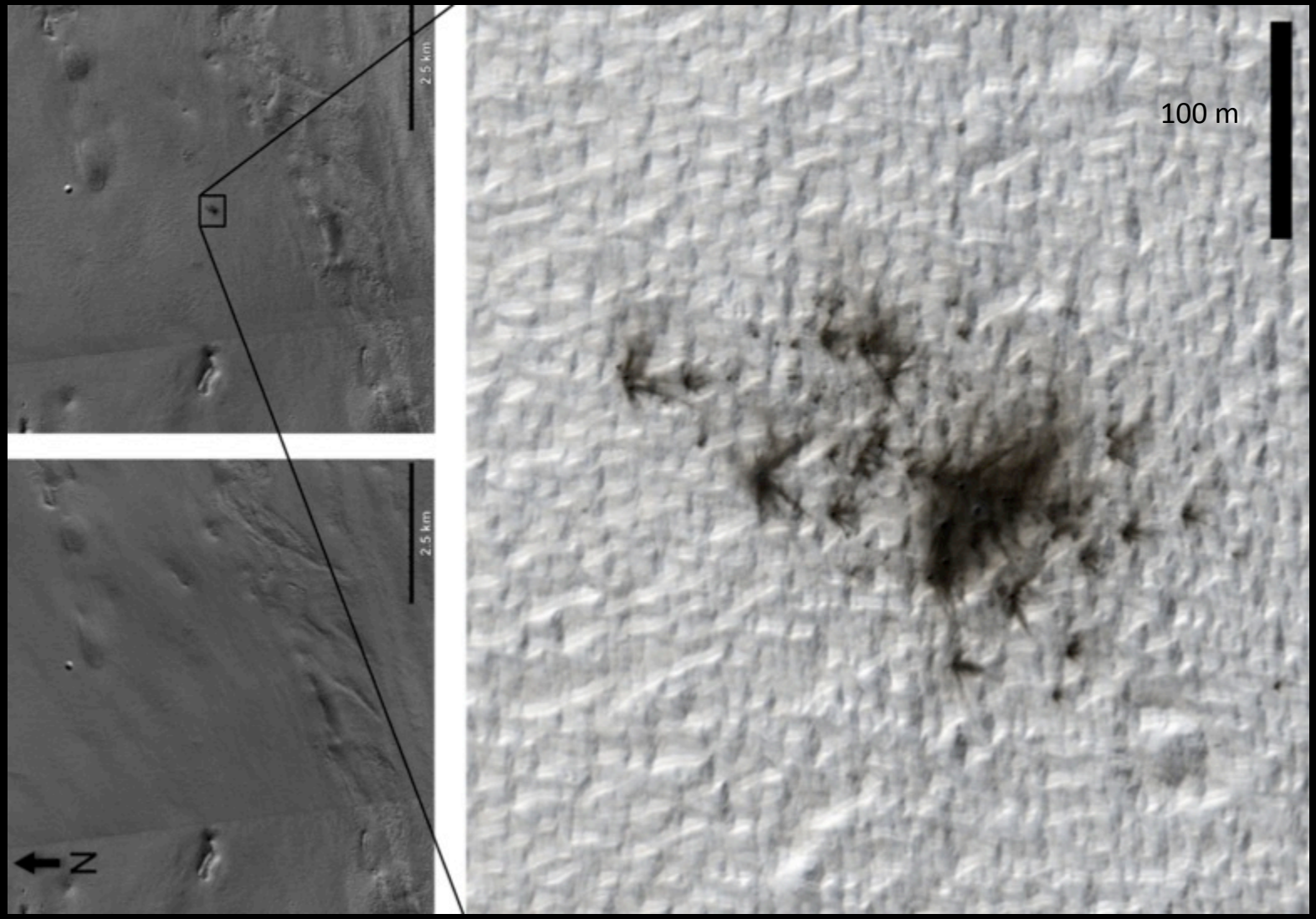
Les impacts de météoroides



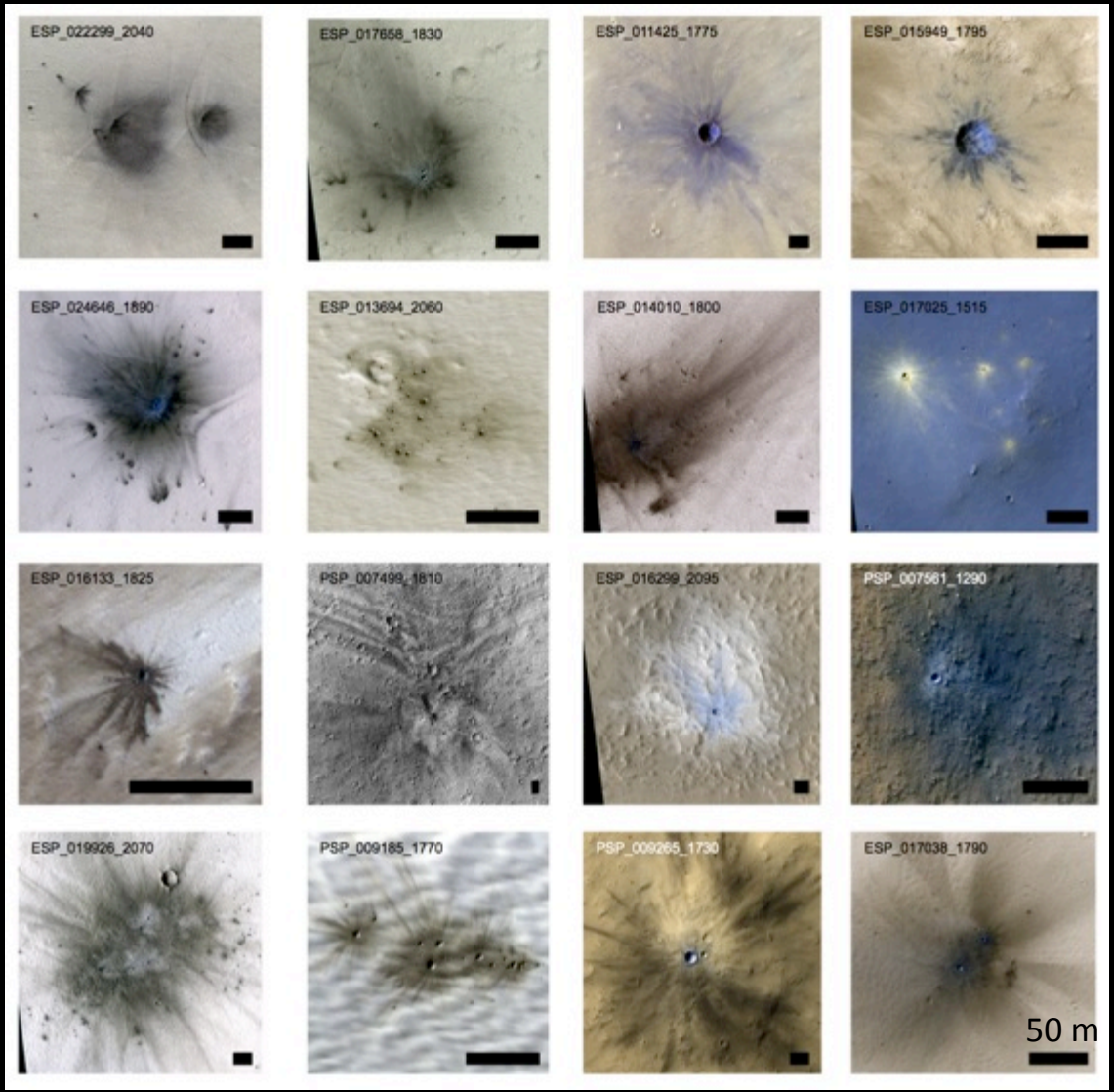
IPGP/David Ducros

D’autres sources sismiques?

Les impacts de météoroides



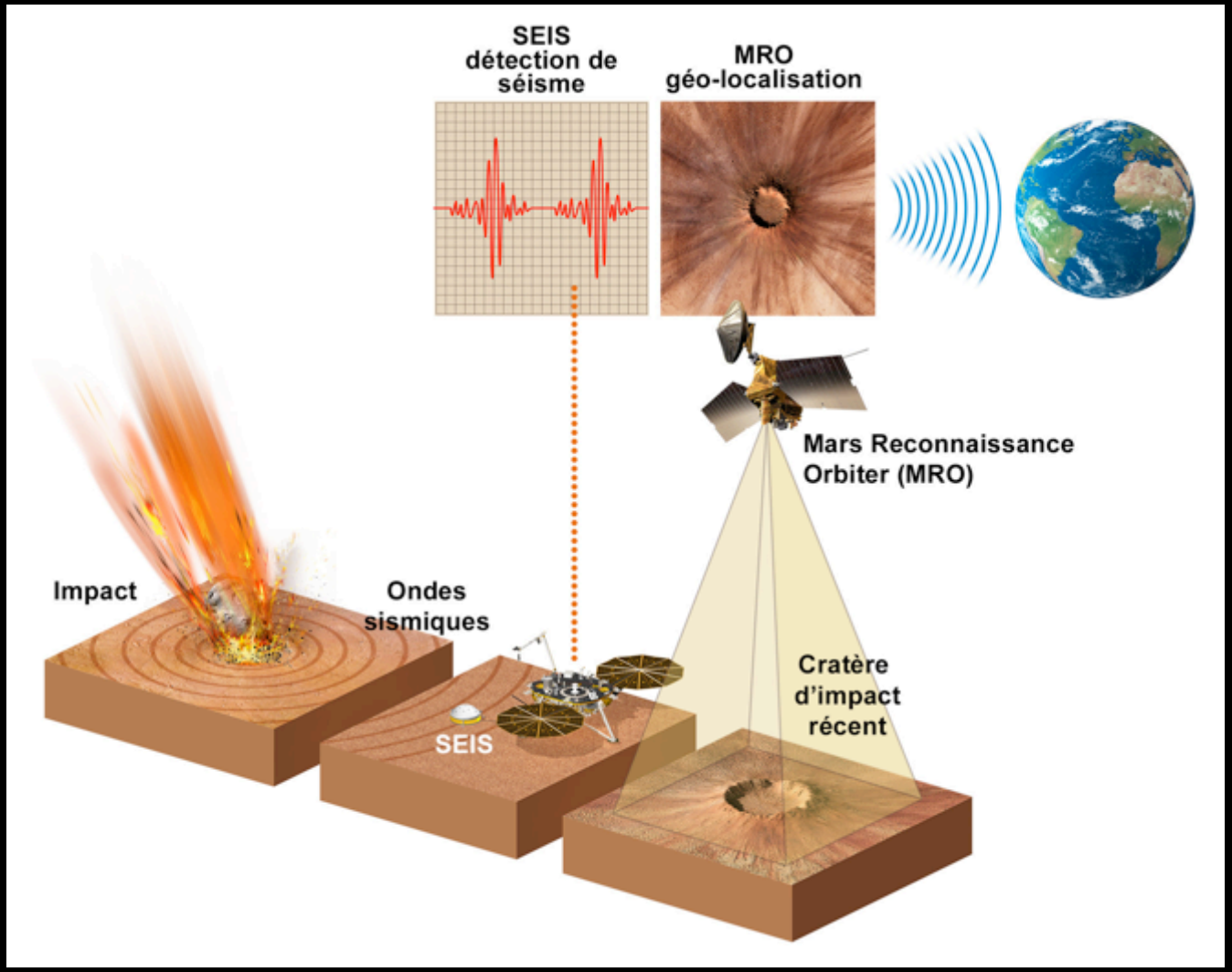
D’autres sources sismiques?



Détermination du flux d’impact et amélioration des méthodes de datation par comptage de cratères

D’autres sources sismiques?

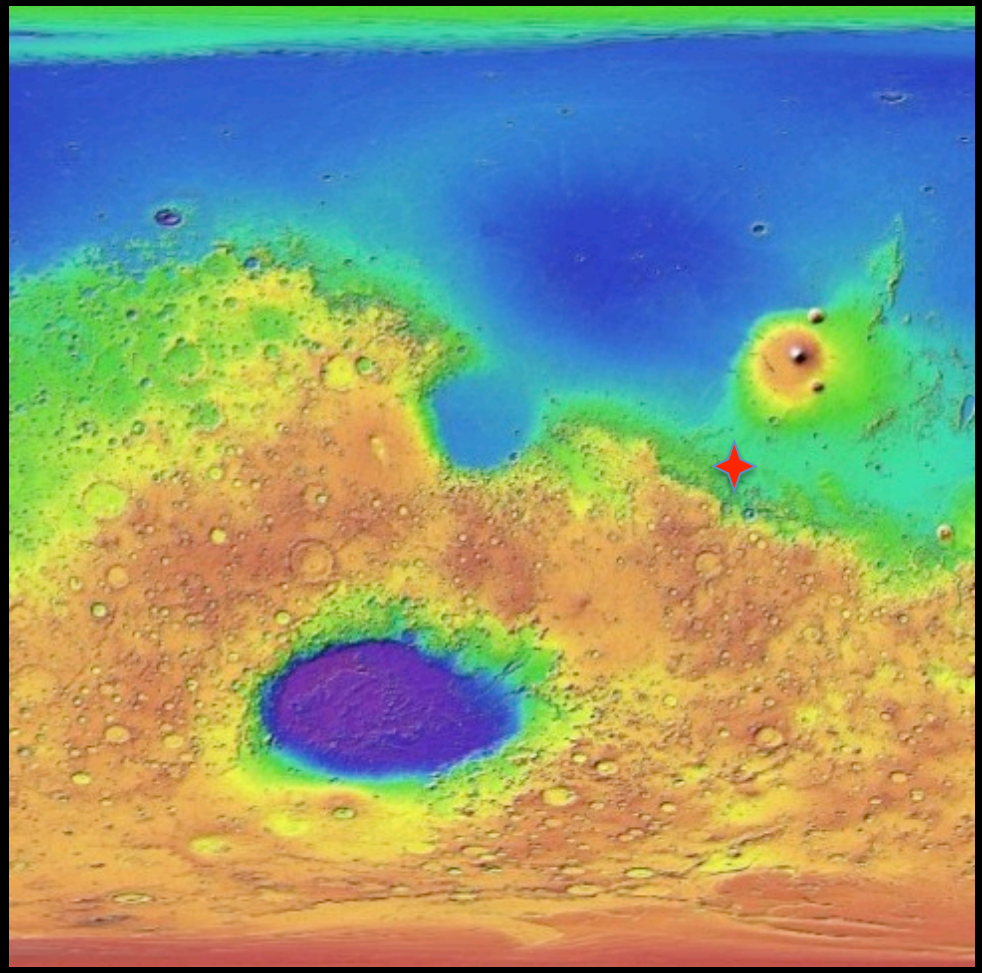
Les impacts de météoroides

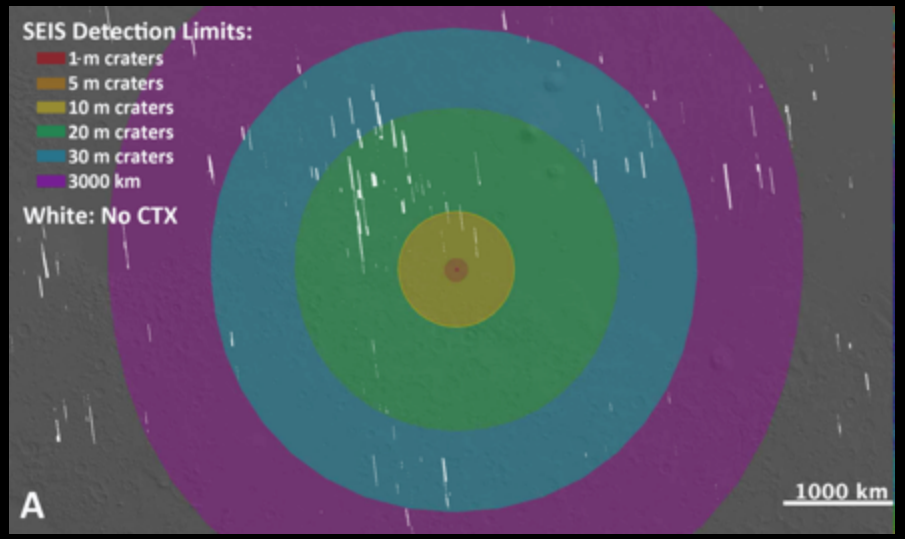


IPGP/David Ducros

D’autres sources sismiques?

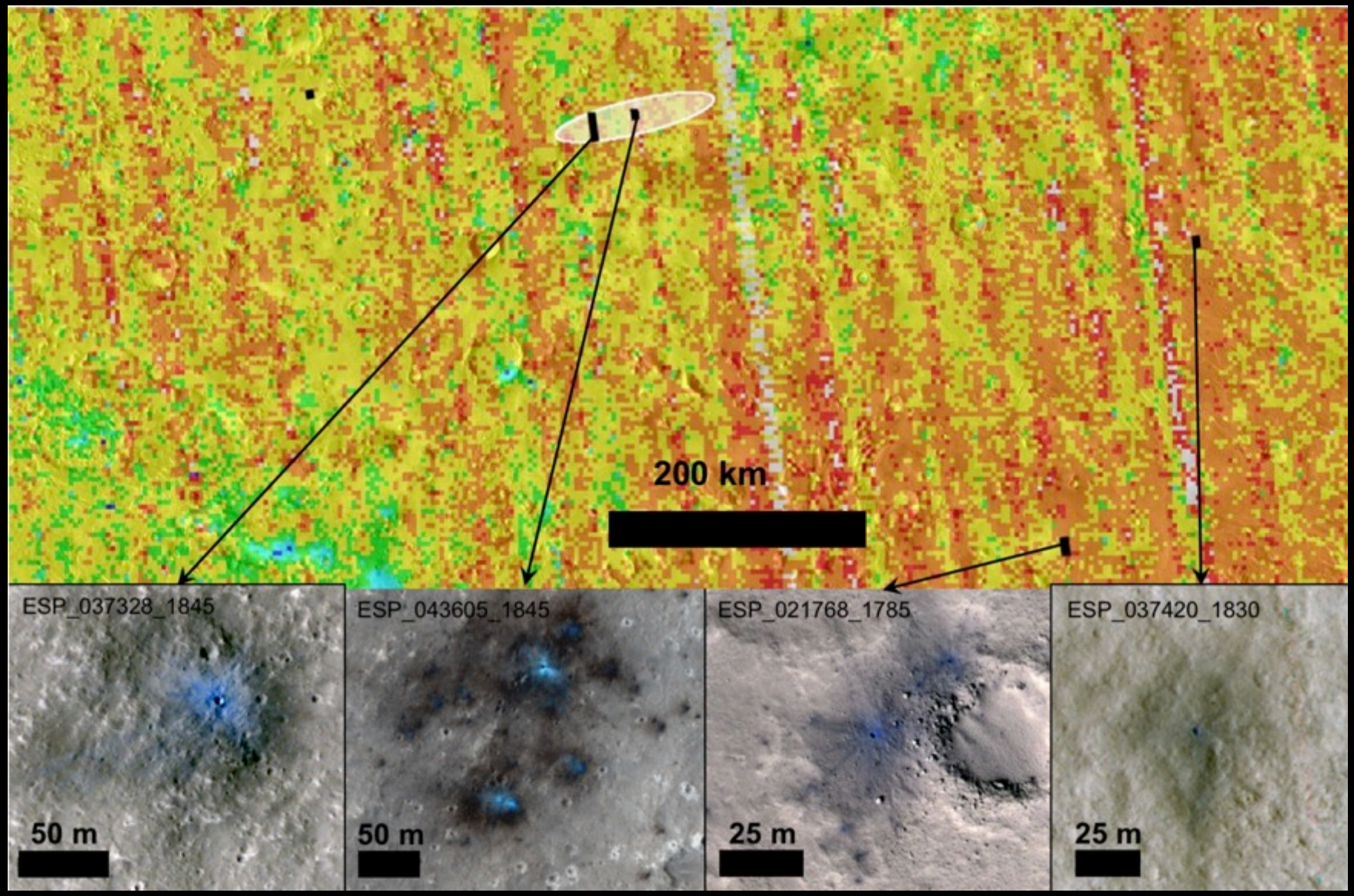
Quelles cratères est-il possible de détecter?





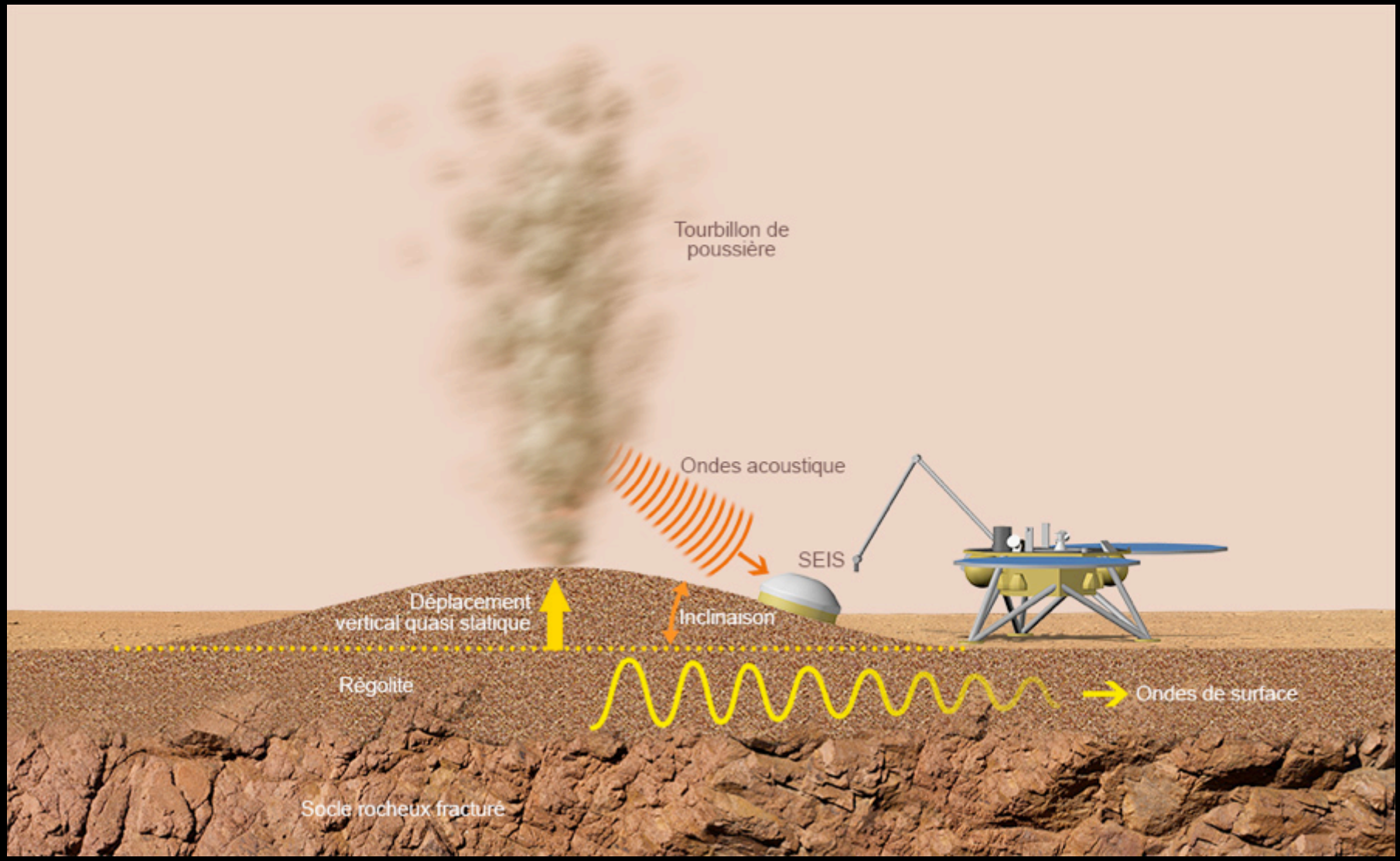
D’autres sources sismiques?

Quelles cratères est-il possible de détecter?



D’autres sources sismiques?

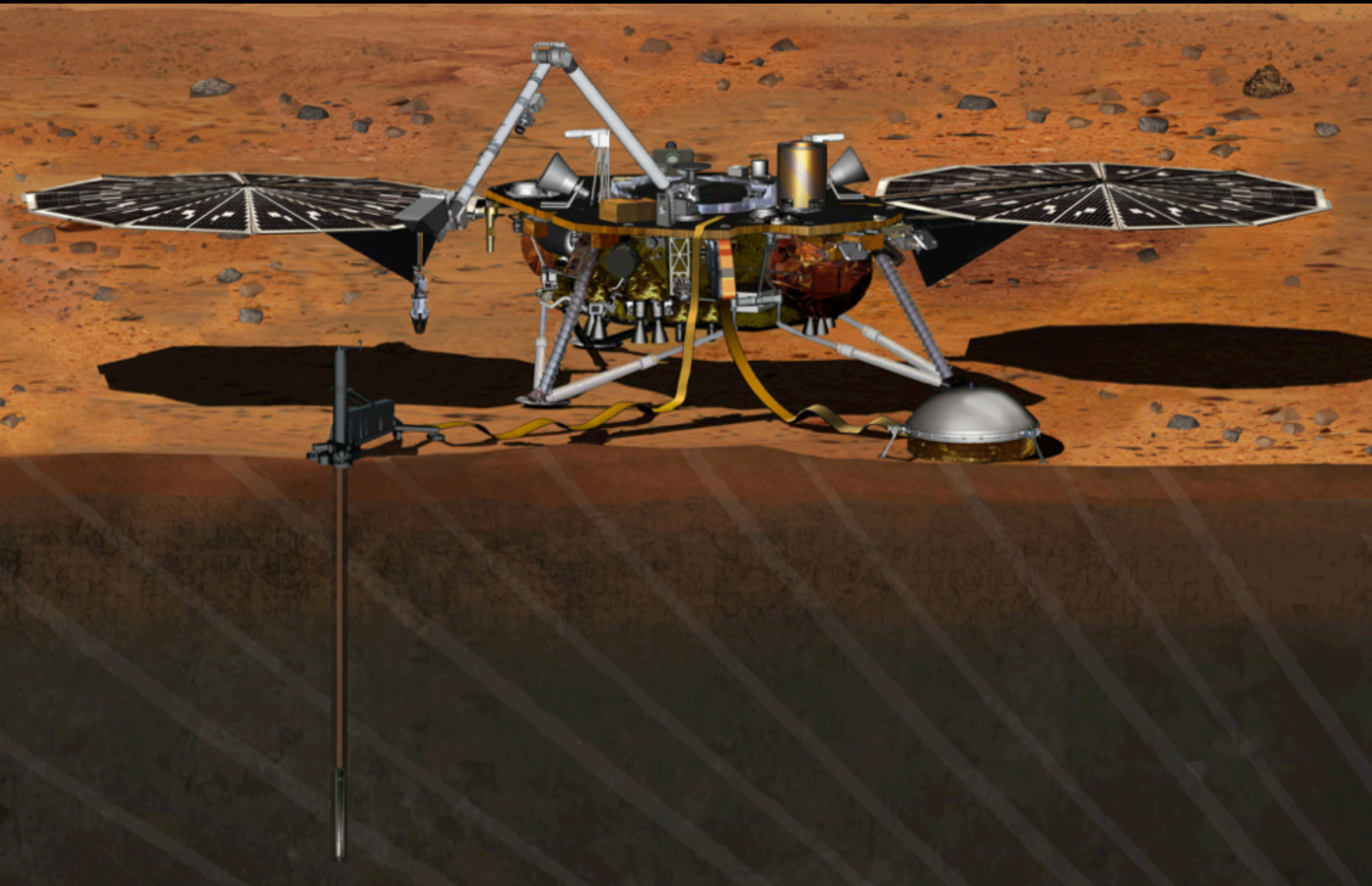
Les phénomènes atmosphériques



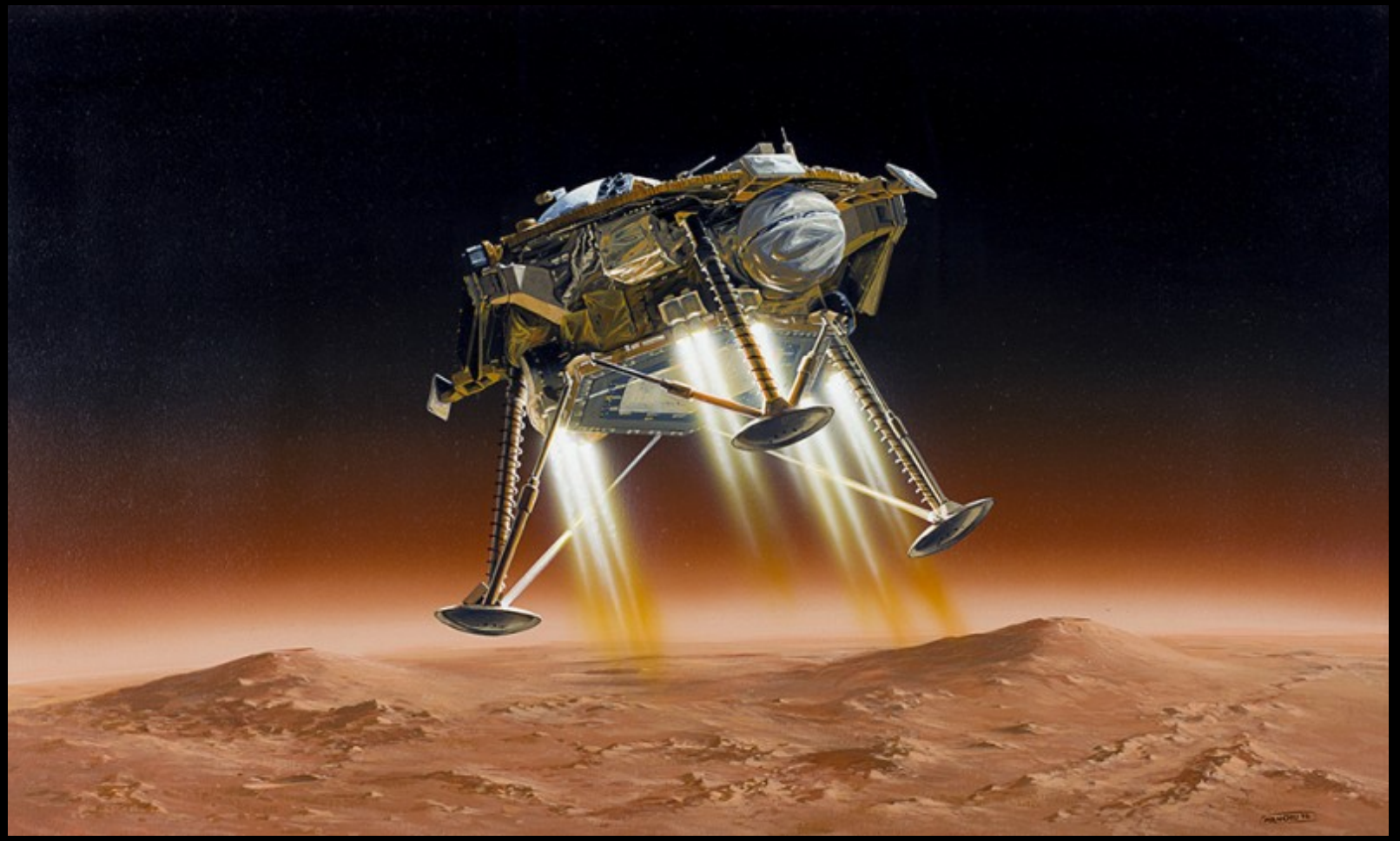
IPGP/David Ducros

Mesure du flux de chaleur

HP³



Rendez vous le 26 novembre prochain



Adultes: https://www.seis-insight.eu
Enfants: marsatschool.ethz.ch
Video: youtube UniverSCiel (à partir de mercredi)