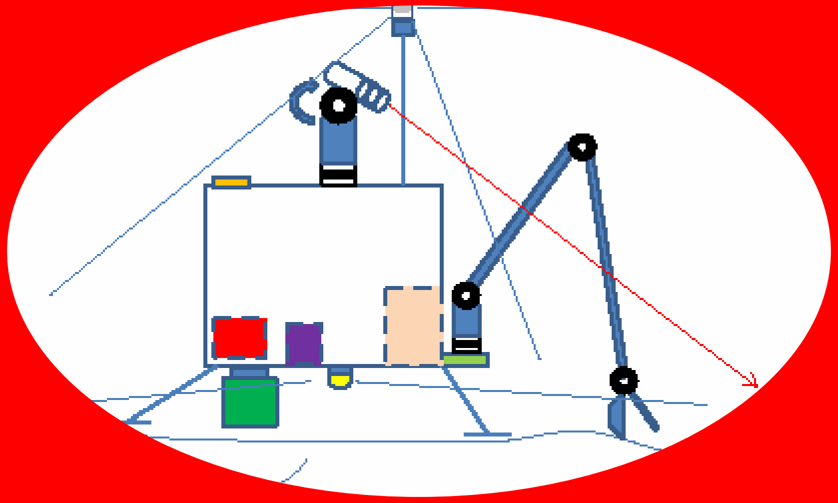
The science rationale for an in-depth *in situ* science (MASCOT)



Marco Polo Symposium, Paris, May 20, 2009

The science rationale for an in-depth *in situ* science (MASCOT)

J-P. Bibring

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and

the entire MASCOT team

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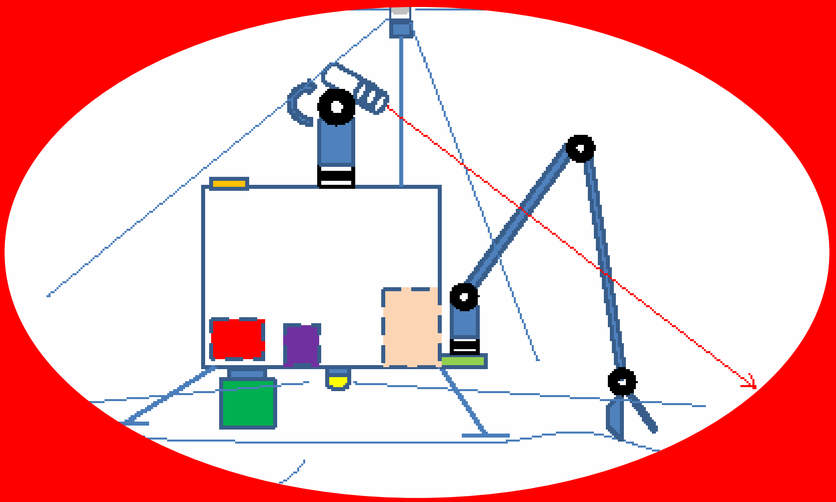

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The science rationale for an in-depth *in situ* science (MASCOT)

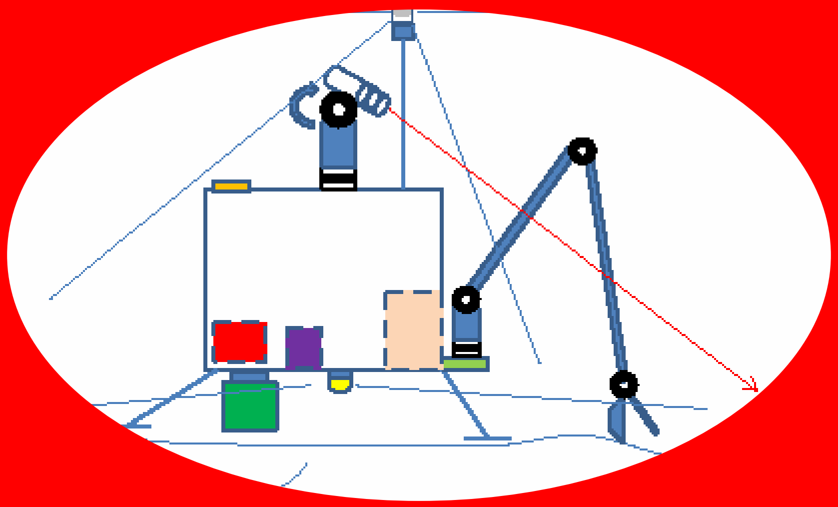
Goal of this talk:

contribute to the strengthening of the case of

Marco Polo

by integrating in a single mission the three fundamental aspects of a balanced implementation of complemented investigations:

- *in situ* science
- *orbiter* science
- *sample return* science



The science rationale for an in-depth *in situ* science (MASCOT)

Pre-return sample mission data sets

	Moon	Mars	Asteroïd
remote sensing	From Earth	From Earth In orbit	From Earth
in situ	(Surveyor, Lunakhod)	Viking, PathFind, MERs	
sample analyses		SNCs	CCs

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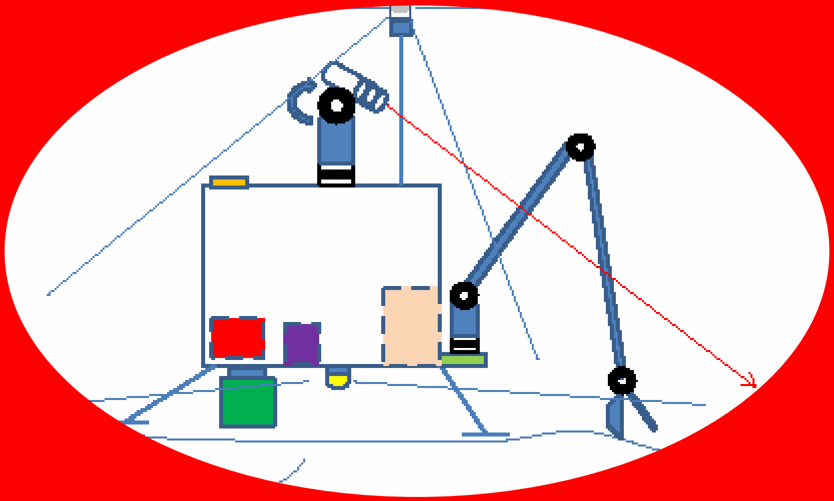
The science rationale for an in-depth *in situ* science (MASCOT)

Remote sensing, in situ and sample analyses are truly complementary, and must be cross-correlated to enable an optimized understanding of the formation and evolution of the studied body.
For the Moon and Mars, it could be envisioned to build a balanced program through a sequence of missions.
For an asteroid, the three data sets must be built on a single mission.
We will not get back to JU3 after we analyze its surface samples.

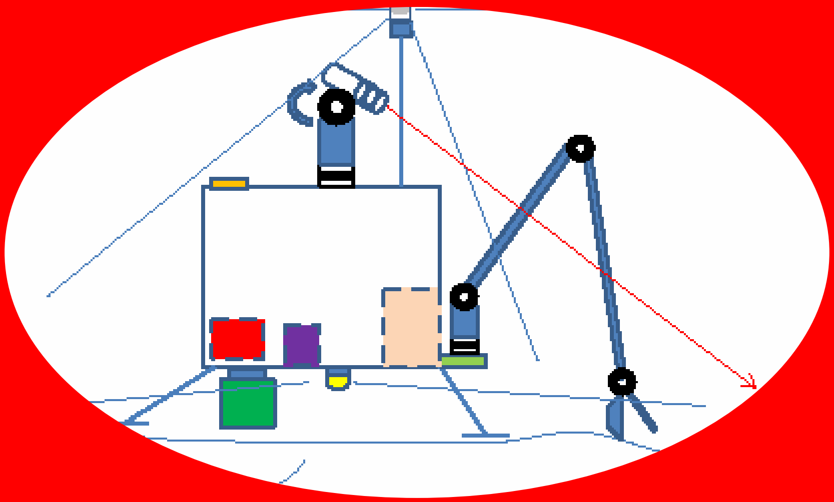


The science rationale for an in-depth *in situ* science (MASCOT)

For

Marco Polo

to reach a convincing level of outstanding capability to decipher the origin of the solar system,
it should incorporate in its baseline (yellow book) a substantial *in situ science* complement as a self-sustained landed component
of high performances.

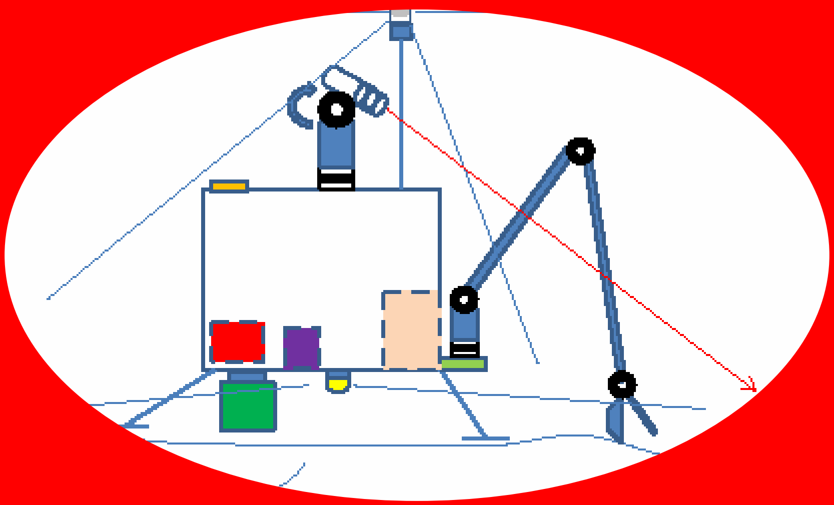


The science rationale for an in-depth *in situ* science (MASCOT)

You are kindly invited to send (up to) three short sentences summarizing and prioritizing your view of

why to carry Lander science investigations on Marco Polo, a sample return mission

bibring @ ias.fr



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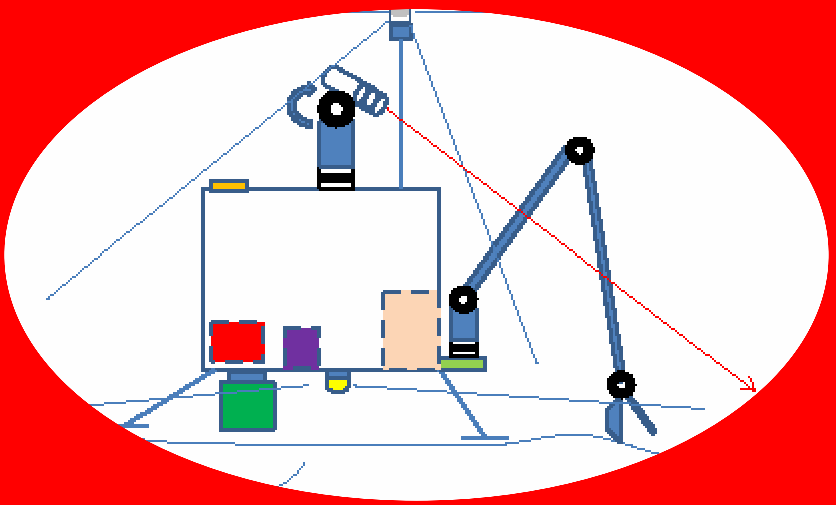
The science rationale for an in-depth *in situ* science (MASCOT)

1. The "just in case" case.

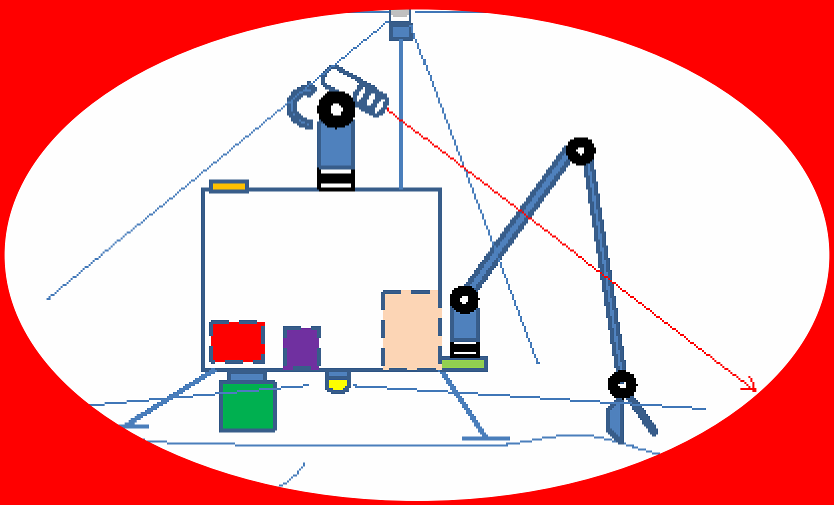
Up to now, only Soviet Union succeeded in returning sample automatically (Luna 16/20/24).

Should not we dare to state that to acquire the required sample return technologies constitutes an utmost challenge, and that we must insure a significant (Cosmic Vision grade) science return even if the sample return segment failed?



The science rationale for an in-depth *in situ* science (MASCOT)

2. The "balanced success" case.



The science rationale for an in-depth *in situ* science (MASCOT)

1. Unique investigations of major science importance

2. Ground truth for orbital science

3. Ground truth for sample return analyses

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The science rationale for an in-depth *in situ* science (MASCOT)

- Bulk asteroïdal properties

  surface physical properties (thermal, mechanical, electrical, magnetic…)

  of relevance to origin and evolution

  internal properties (structure: homogeneous / differentiated)

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- Compositional properties

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  microscopic composition (elemental, isotopic, molecular, mineralogical)

  water: how much ?

  organics: how much ? which ?

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  water: how much ?

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  ⇒ astrobiological investigation

The science rationale for an in-depth *in situ* science (MASCOT)

1. Unique investigations of major science importance

2. Ground truth for orbital science

3. Ground truth for sample return analyses

The science rationale for an in-depth *in situ* science (MASCOT)

- From the macro- to the micro- scale: a continuum
    - Structure: bombardment record
- From the macro- to the micro- scale: a continuum
    - Composition: primordial fractionation / maturation

The science rationale for an in-depth *in situ* science (MASCOT)

The coupling of the first two achievements:

1. Unique investigations of major science importance

2. Ground truth for orbital science

must insure a "minimal mission success"

The science rationale for an in-depth *in situ* science (MASCOT)

1. Unique investigations of major science importance

2. Ground truth for orbital science

3. Ground truth for sample return analyses

The science rationale for an in-depth *in situ* science (MASCOT)

- Context of sample selection (degree of representativity)

  - Surface / deep (crater ejecta) material
  - Homogeneity / heterogeneity of sample collection
  - Temperature / radiation / other environmental properties

The science rationale for an in-depth *in situ* science (MASCOT)

- Context of sample selection (degree of representativity)
    - Surface / deep (crater ejecta) material
    - Homogeneity / heterogeneity of sample collection
    - Temperature / radiation / other environmental properties
- Initial properties of collected samples
    - degree of preservation from parent body to the lab (volatiles)
    - degree of preservation from parent body to the lab (fractionation)

The science rationale for an in-depth *in situ* science (MASCOT)

- Complement of sample analyses
  - Elemental / molecular / mineralogical composition (grain scale)
  - Physical characterization at a microscopic scale

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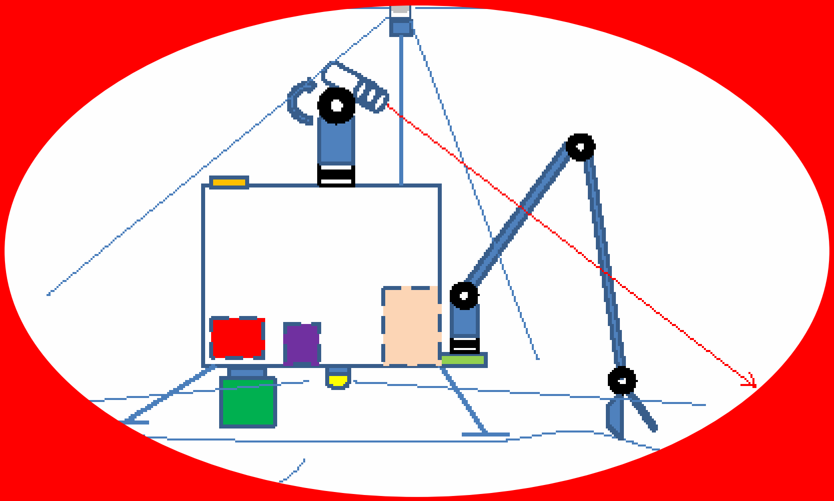
- Complement of sample analyses
  - Elemental / molecular / mineralogical composition (grain scale)
  - Physical characterization at a microscopic scale
- Contribution to sample collection
  - collection site (if hopper-like capability)
  - sample selection (coupling with analyses)

The science rationale for an in-depth *in situ* science (MASCOT)

Although by far less performing than lab instruments, space systems have reached impressive capabilities in a wide range of fields.
Specifically, developments made in Europe for Philae/Rosetta and Exomars have built unique expertise in highly miniaturized systems, which enable to conceive micro-instruments with still enhanced performances, fulfilling ambitious scientific challenges, at an unprecedented level.



The science rationale for an in-depth *in situ* science (MASCOT)

With the present level of European excellence in flight instrumentation, an ambitious sample return mission should include a significant contribution of in situ science,

- to enhance the science return of the sample analyses, and
- to perform a self-sustained characterization of a primitive body down to the microscopic scale of its constituent materials.

Marco Polo would greatly benefit from the inclusion of an instrumented lander in its baseline complement.