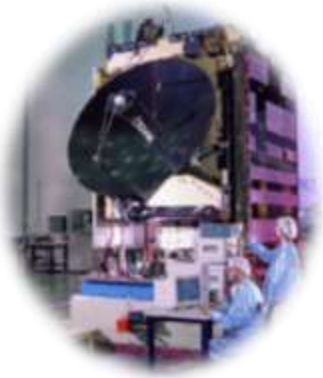
RICOR
CRYOGENIC & VACUUM SYSTEMS

Ricor cryocoolers for space applications
Introductory lecture and MID END space applications

Conference on " Cooling for Space Applications."
Ariel University, 27.11.19

SCOPE

- Introduction
- Customization for Space applications
- Space missions relying on RICOR products
- Recent developments for Space missions
- Summary



INTRODUCTION – RICOR at a Glance

RICOR is THE world leader in development, manufacturing and distribution of Miniature Cryogenic Coolers for IR Detectors, Cryo-pumps, Space, and special Instrumentation

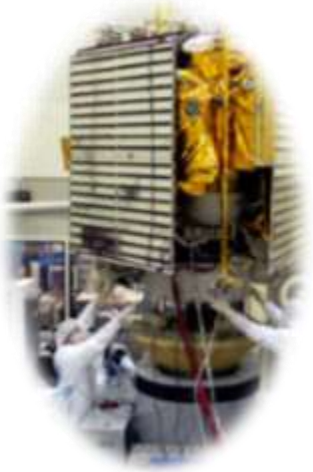
INTRODUCTION – Space Programs at RICOR

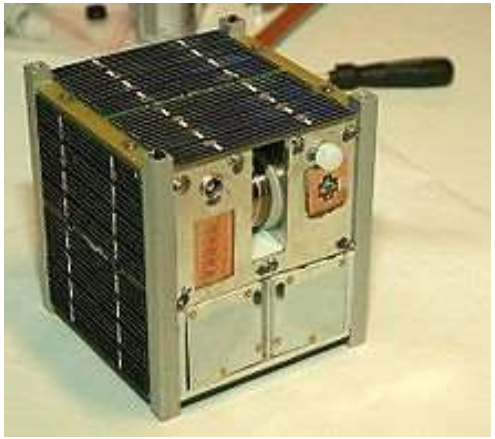
- RICOR's products has Space heritage since 1993
- Delivered more than 90 Flight Models (FM) for dozens of different missions

- RICOR cryocoolers are chosen for Space missions due to their compactness and reliability

INTRODUCTION – Space Missions Classification (I)

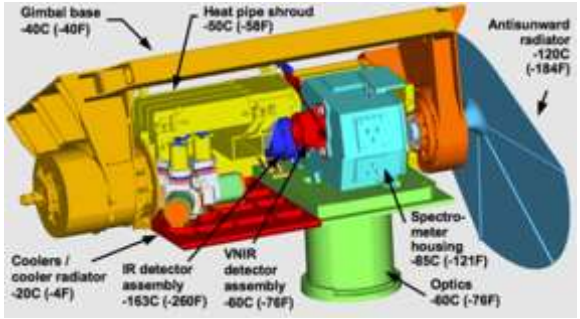
- Space missions are classified by RICOR to LOW-END, MID-END and HIGH-END missions
- LOW-END missions are a new and emerging field and are needed mainly for 1U to 6U CubeSats. These missions will not be covered with this paper





INTRODUCTION – Space Missions Classification (II)

- **MID-END missions are calling for relatively low number of operating hours, <3 years, but still looking for high performance and reliability**
  - **This paper will cover these applications**



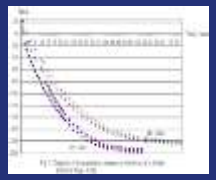
- **HIGH-END missions are looking for a high number of operating hours combined with special requirements**
  - **This will be covered by the following RICOR's paper**

Screening & Customization for Space Applications

System Definition

EM units selection

FM units selection



Customization & Final Tests

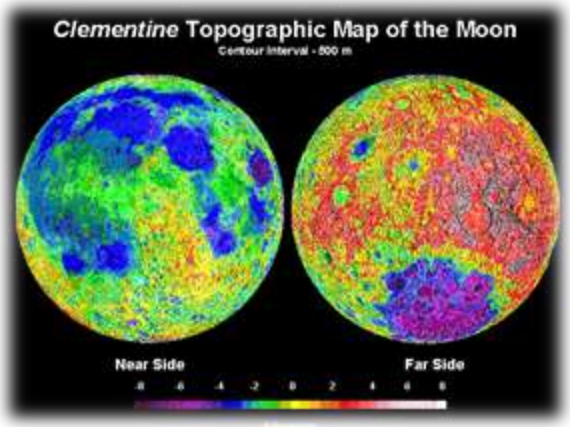
Space Missions Relying on RICOR Products

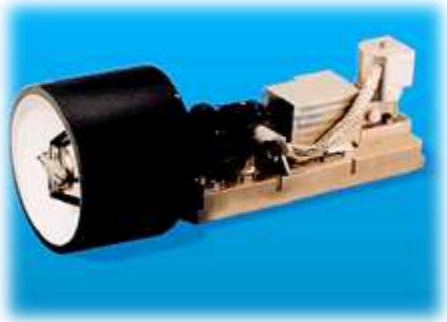
- RICOR products are widely used by the space agencies of USA, Europe and Asia during the last 25 years
- There are still a significant number of missions remaining beyond this survey, due to information that is unavailable or not authorized for publication
- Following are several examples of these Space missions

Space Missions Relying on RICOR Products

CLEMENTINE

- ***Customer*** - NASA
- ***Launch*** - 25 January 1994
- ***Mission objective:***
  - scientific observations of the Moon and the near-Earth asteroid 1620 Geographos
  - testing of specific sensors and spacecraft components
- ***Instrument*** - Near-Infra-Red (NIR) camera
- ***Refrigerator*** – RICOR K506B
- ***Detector*** - 256x256 Amber InSb FPA @70K
- ***Refrigerator task*** – no failures reported
- ***Mission status*** – ended in June 1994

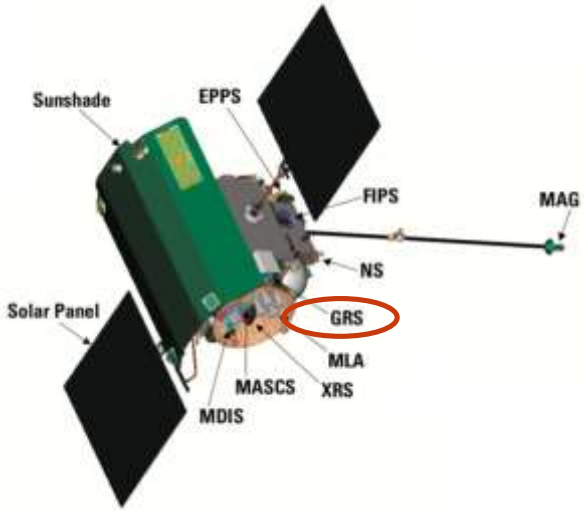


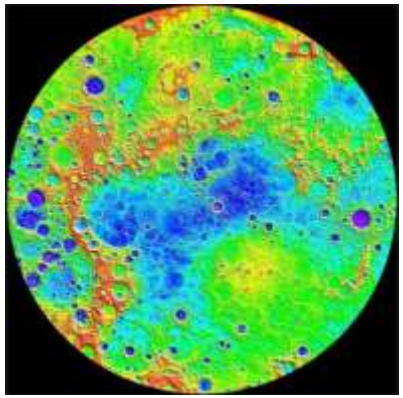


Space Missions Relying on RICOR Products

MESSENGER

- ***Customer*** - NASA
- ***Launch*** – 3 August 2004
- ***Mission objective:***
  - study Mercury's chemical composition, geology, and magnetic field
- ***Instrument*** - GRNS (Gamma-Ray and Neutron Spectrometer)
- ***Refrigerator*** – RICOR K508
- ***Detector*** – Germanium crystal @90K, measured gamma-ray emissions from the surface of Mercury to determine the planet's composition
- ***Refrigerator task*** – no failures reported
- ***Mission status*** – ended on 30 April 2015

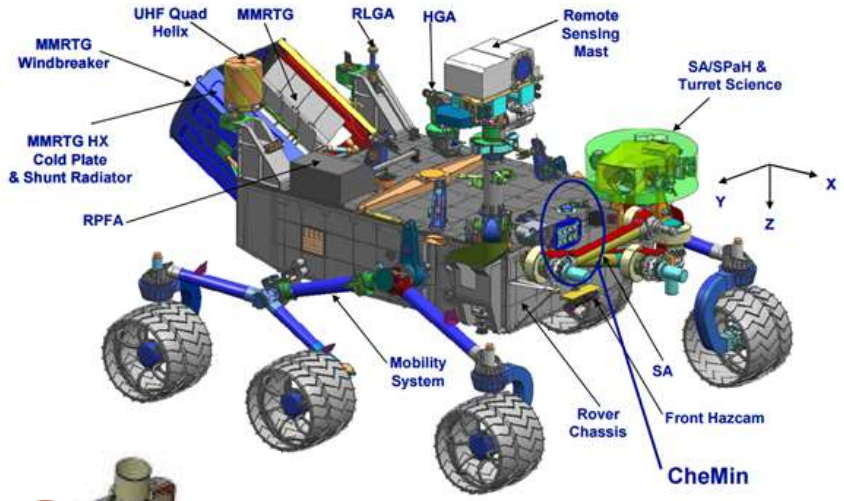


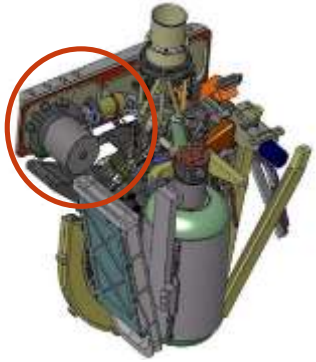


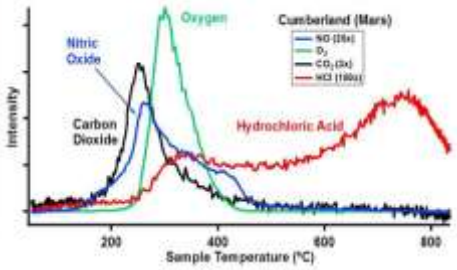
Space Missions Relying on RICOR Products

"CURIOSITY" MARS ROVER

- ***Customer*** - NASA
- ***Launch*** – 26 November 2011
- ***Mission objective:***
  - investigation of the Martian climate and geology
  - assessment of conditions favorable for microbial life
  - habitability studies in preparation for human exploration.
- ***Instrument*** – CheMin (Chemistry Mineralogy)
- ***Refrigerator*** – RICOR K508
- ***Detector*** – 600X600 E2V CCD-224 X-ray sensitive, @173K
- ***Refrigerator task*** – no failures reported
- ***Mission status*** – in progress



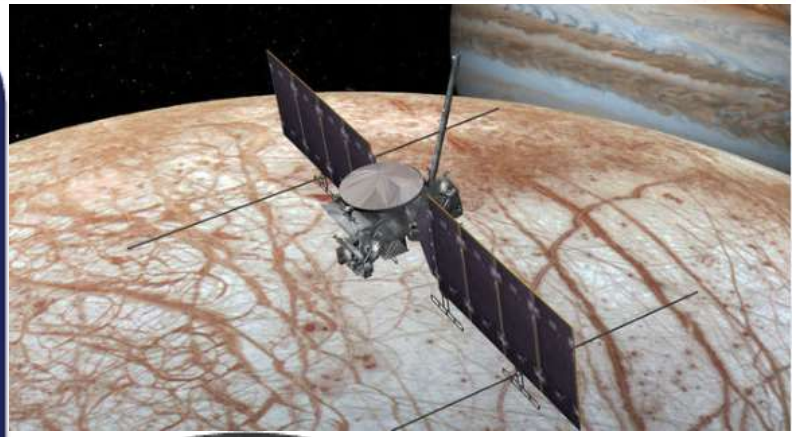


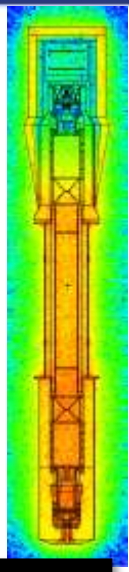


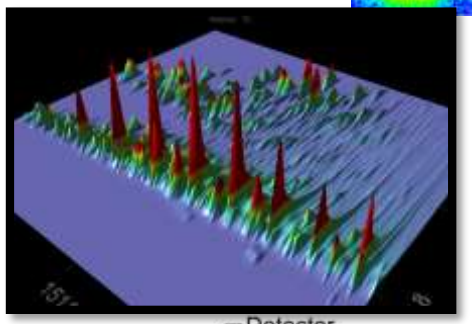
Space Missions Relying on RICOR Products

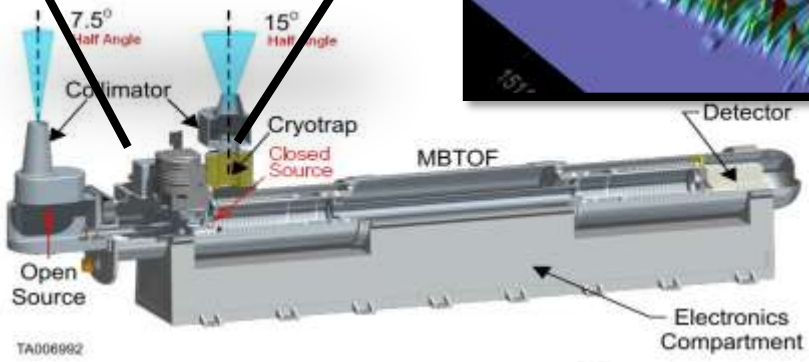
Europa Clipper

- ***Customer*** - NASA
- ***Launch*** – TBD (2020's)
- ***Mission objective:***
  - Detailed investigation of Jupiter moons
  - Survey Europa frozen surface and search for evidence of water vapor and tiny particles in the moon's atmosphere.
- ***Instrument*** – MASPEX - MAss SPectrometer for Planetary EXploration/Europa
- ***Refrigerator*** – RICOR K508
- ***Detector*** – Cryo-Trap (not cooling detector)
- ***Refrigerator task*** – not started
- ***Mission status*** – Tastings before instrument assembly









Recent Developments for Space Missions

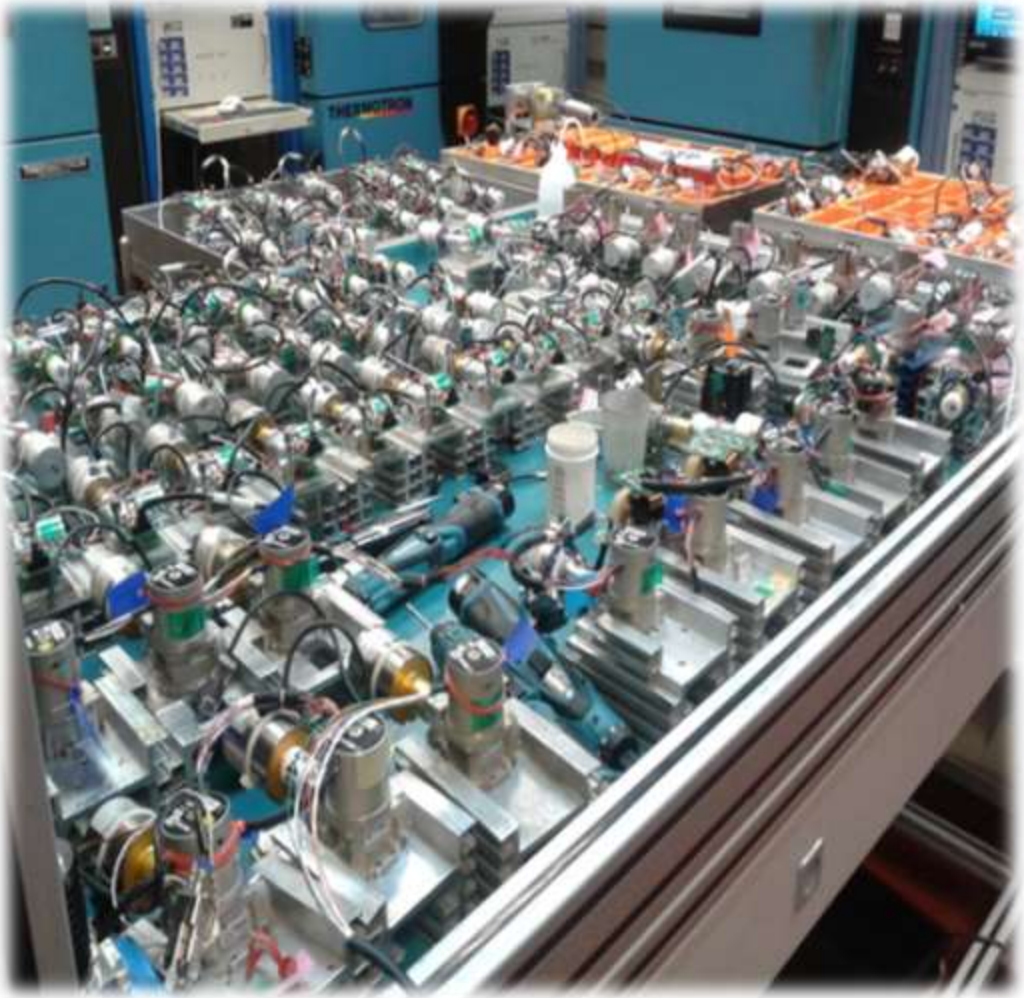
NEW CRYOCOOLERS FOR SPACE MISSIONS

- ***K562S***
  - 300mW @110K @71°C
  - 150mW @110K @23°C @< 3 WDC
  - MTTF > 10,000 Hours
  - -40°C...+71°C
- ***K508N***
  - 500mW @77K @71°C
  - 220mW @77K @23°C @< 7.5 WDC
  - MTTF > 28,000 Hours
  - -40°C...+85°C
- More to follow…

SUMMARY

- RICOR has accumulated a heritage of more than 25 years delivering cryocoolers for space missions
- The space qualified products heritage is continuing focusing on new advanced models
- The space-qualified cryocoolers are continuously adopted at RICOR as a platform for development of novel technologies for ground-based products, in order to improve their reliability, performance and lifetime

QUESTIONS?



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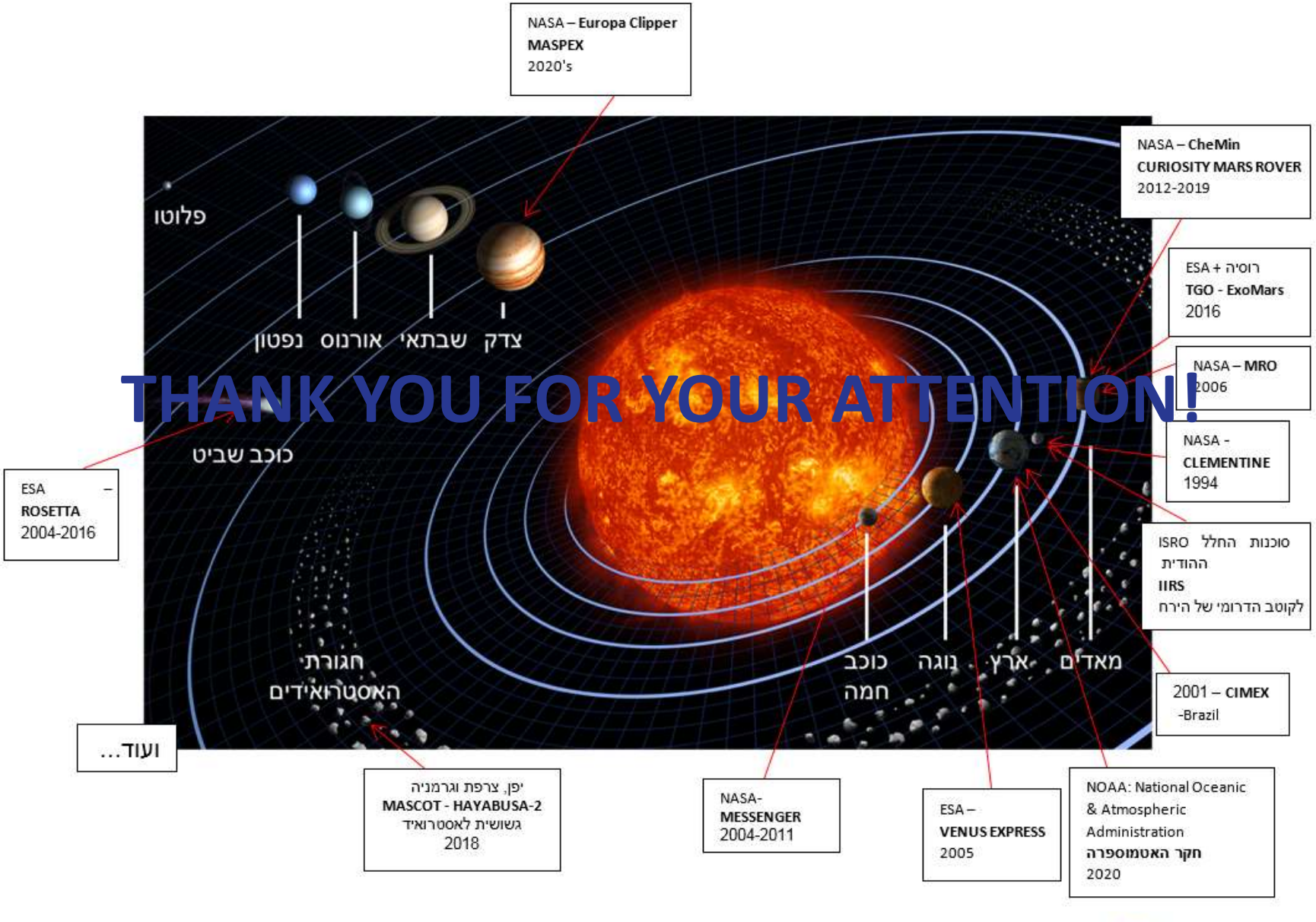

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