



## Airbus Crisa

Generic High Power System (GHPS) for  
manned missions to the Moon and beyond

### CRISA

Emilio Lapeña<sup>(1)</sup> (emilio.lapena@airbus-com)  
Joel Jermakian<sup>(2)</sup> (joel.jermakian@ngc.com);  
Pablo Ortiz<sup>(1)</sup> (pablo.ortiz@airbus.com);  
Antonio Peña<sup>(1)</sup> (antonio.pena-godino@airbus.com);

Peter Sveum<sup>(2)</sup> (peter.sveum@ngc.com);  
Víctor Romero<sup>(1)</sup> (victor.romero-largacha@airbus.com);  
Jorge Cortés<sup>(1)</sup> (jorge.cortes-gonzalez@airbus.com);

<sup>(1)</sup>Airbus Crisa - <sup>(2)</sup>Northrop Grumman

# Humans in space

A new era of human space exploration is emerging, led by institutional and private actors.

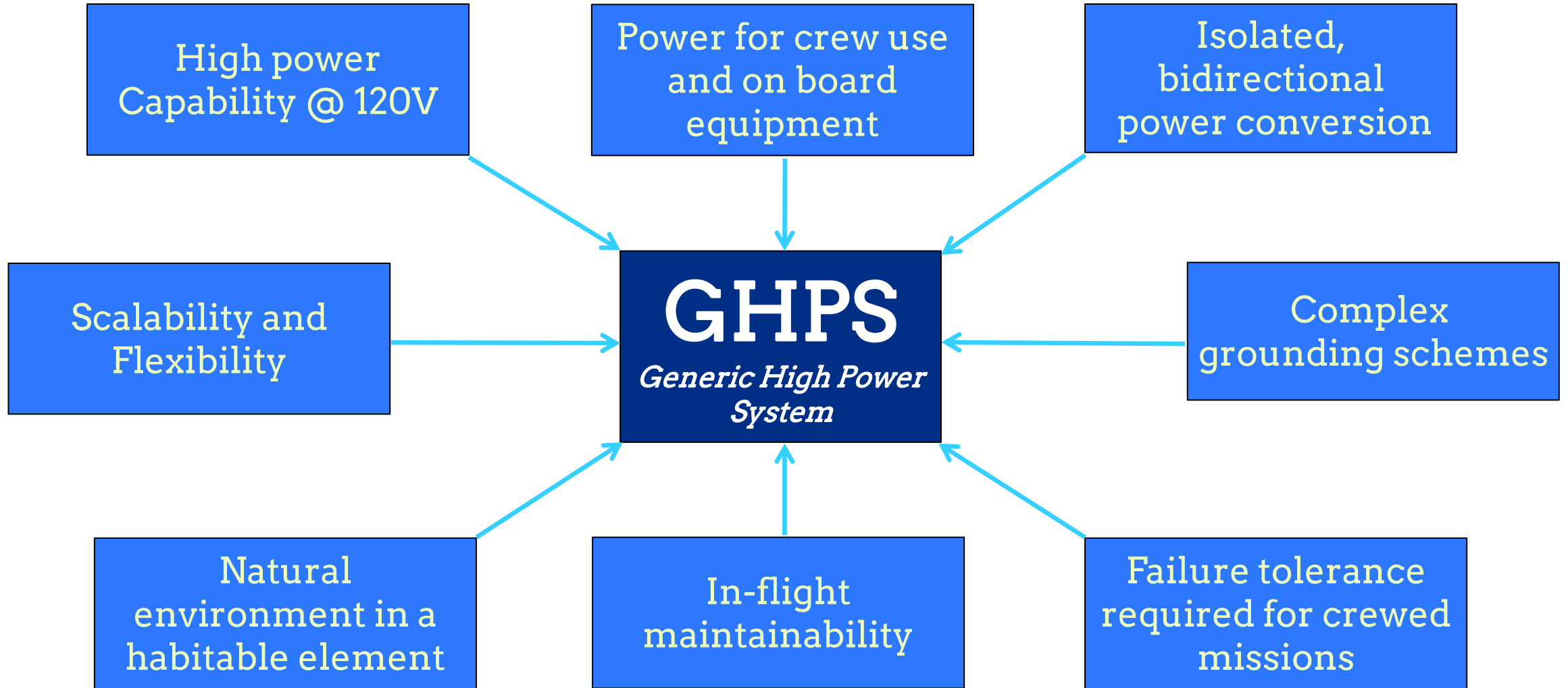
**GHPS (Generic High Power System)** is the **Airbus Crisa** product developed in collaboration with **Northrop Grumman** to provide high power conditioning and distribution capabilities for crewed and exploration missions.

GHPS has been conceived as a **standard product** for the new generation of crewed missions to:

- **Moon** Gateway space station (and eventually lunar surface permanent base).
- **Mars** human exploration.
- **Earth** Orbit space stations.
- Space planes.

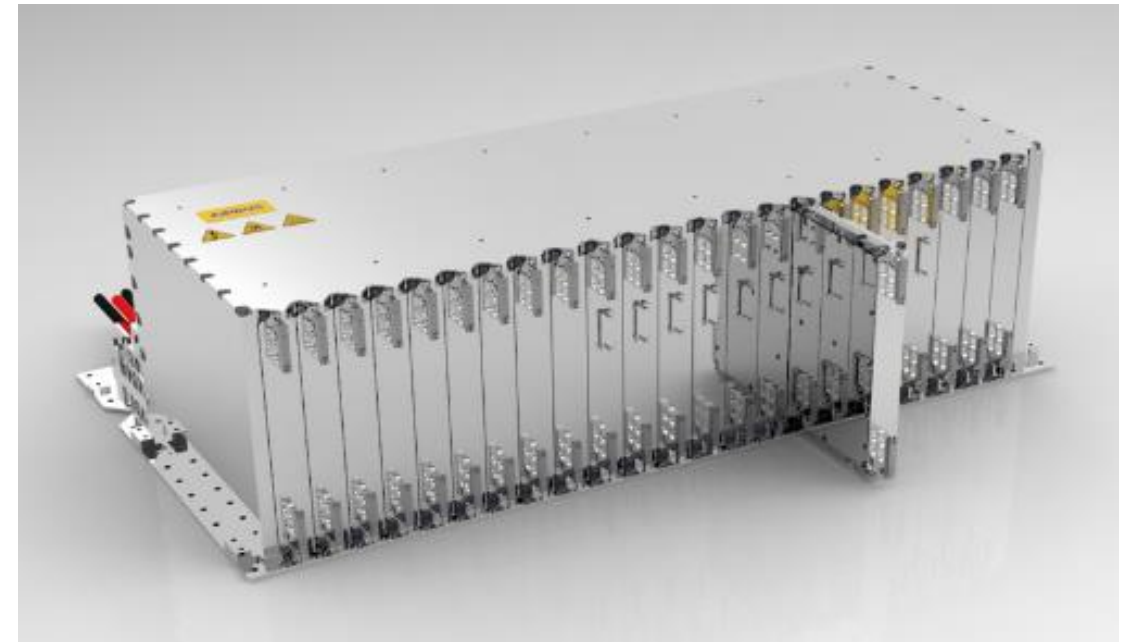


# A new mission scenario demands new solutions



## Generic High Power System (GHPS) key features

- ❑ Designed for crewed exploration compliant with NASA standards
- ❑ In-flight maintainability and reparability
- ❑ Scalable up to 32kW regulated platforms up to 130V
- ❑ Isolated and bidirectional 120V and 28V Buses
- ❑ Smart and autonomous voltage regulation
- ❑ 120V and 28V power distribution:
  - ❖ Heaters
  - ❖ Latching Current Limiters (LCL)
  - ❖ High Current active LCL
  - ❖ Return switches



# Airbus Crisa GHPS product in Gateway Space Station

Airbus Amber

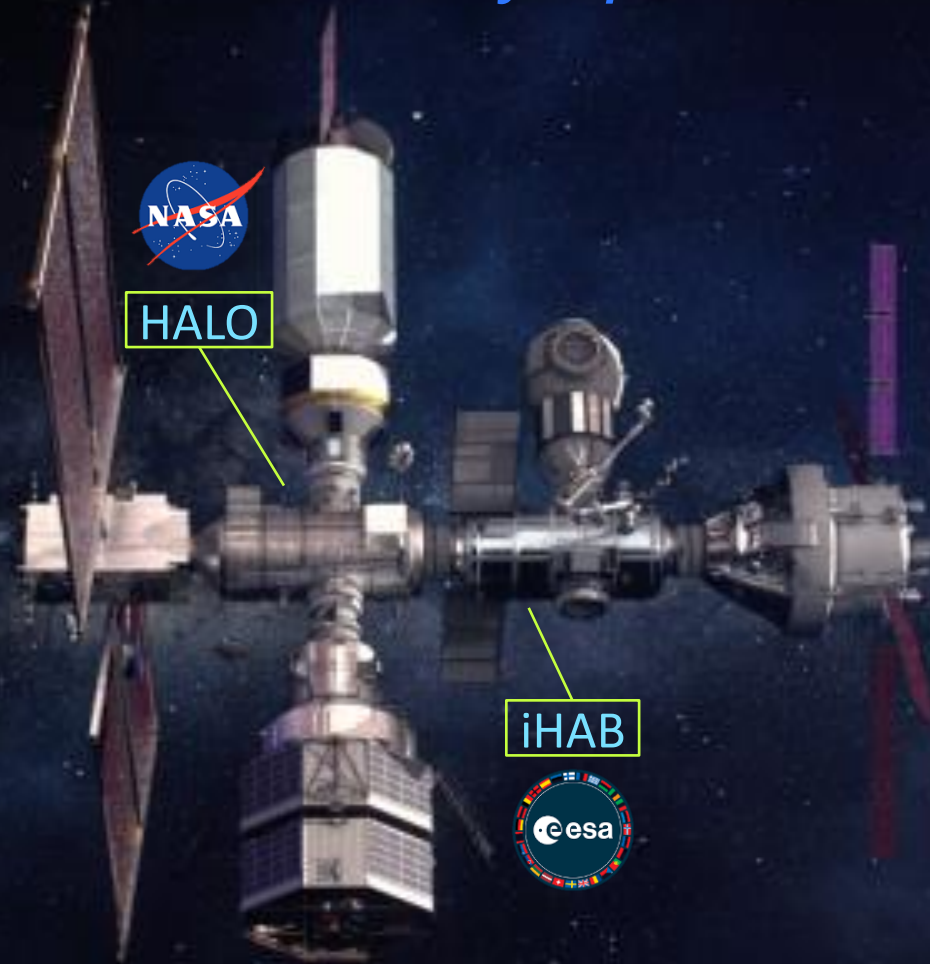


Image credit: NASA

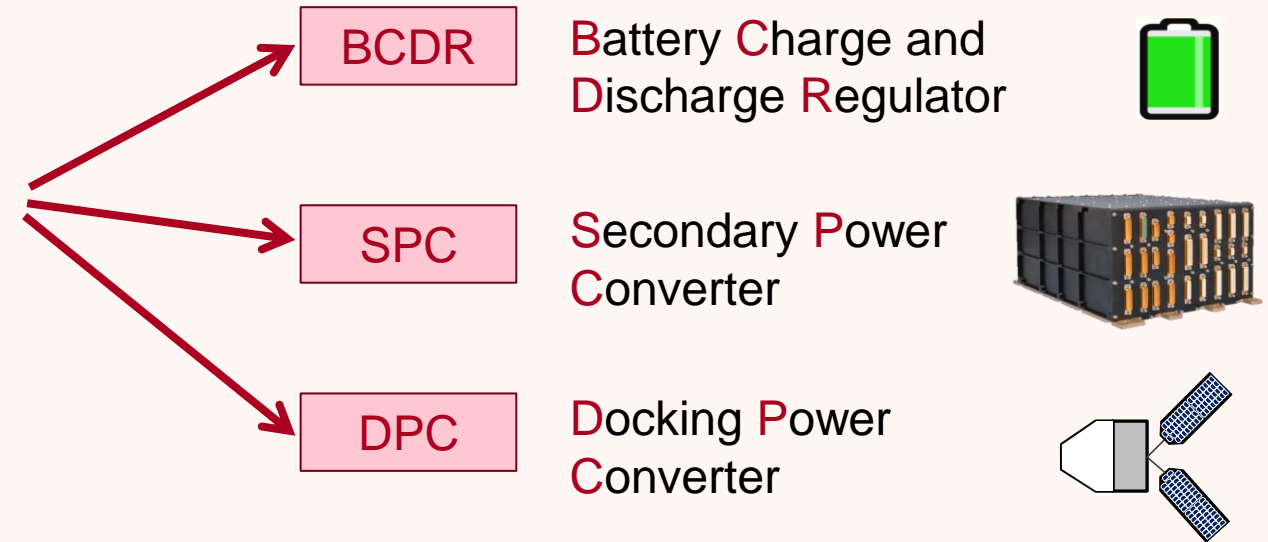
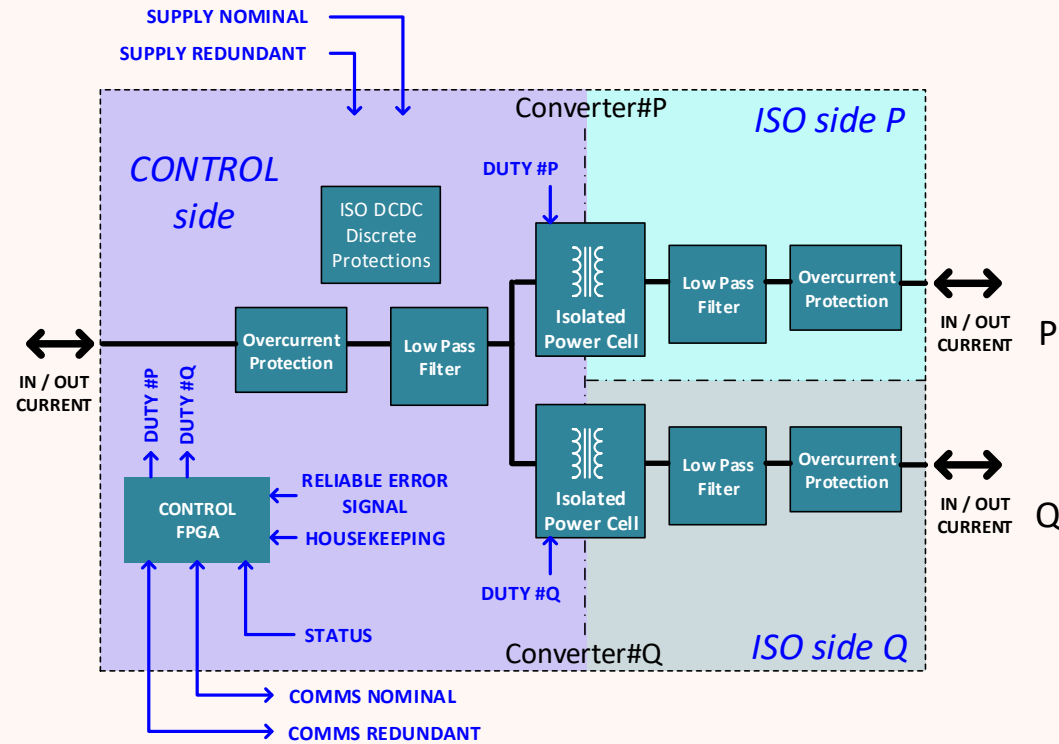
# The GHPS bricks to build flexible box architectures

## Power Conversion

### ISODCDC

Multipurpose isolation **ISO**lation **DCDC** converter

- 3 kW per card
- Voltage range: 98-136 V
- Bidirectional and isolated
- Digital control and configuration



### PDC

**P**ower **D**own **C**onverter from 120 to 28V

- 2 x 560W independent cells per card
- Unidirectional and isolated

# The GHPS bricks to build flexible box architectures

## Power Conversion

<b>BRM</b>	<b>B</b> us <b>R</b> egulation <b>M</b> odule	<ul style="list-style-type: none"> <li>➤ Bus control &amp; quality performances</li> <li>➤ Battery management</li> </ul>	
<b>SUPS</b>	<b>S</b> tandard <b>U</b> ser <b>P</b> ower <b>S</b> ervice	<ul style="list-style-type: none"> <li>➤ 4 x HV outlets (120V / 10A)</li> <li>➤ 4 x LV outlets (programmable 3 – 28V)</li> </ul>	} For crew usage
<b>APR</b>	Solar <b>A</b> rray <b>P</b> ower <b>R</b> egulator	<ul style="list-style-type: none"> <li>➤ DET based on S3R under development</li> <li>➤ MPPT option in roadmap</li> </ul>	

## Control & Auxiliary Supply

<div style="border: 1px solid black; padding: 5px;"><b>CTRL-APS</b></div> <div> <p><b>C</b>ontrol and <b>A</b>uxiliary <b>P</b>ower <b>S</b>upply</p> </div> <ul style="list-style-type: none"> <li>➤ Communications control based on Time-Triggered Ethernet (TTE) I/F at 100 Mbps</li> <li>➤ Management of internal TM/TC bus.</li> <li>➤ Centralized, isolated AC bus for internal supply</li> </ul>	<pre> graph LR     TTE[TTE I/F LINK to Spacecraft] &lt;--&gt; SC[SPACE Controller]     SC &lt;--&gt; Serial link  MF[MASTER FPGA]     MF &lt;--&gt; SSB internal serial link  SS[SSB]     SC &lt;--&gt; FM[Flash Memory]     MF &lt;--&gt; TMEP[TM EEPROM]     MF &lt;--&gt; TCEP[TC EEPROM]     </pre>
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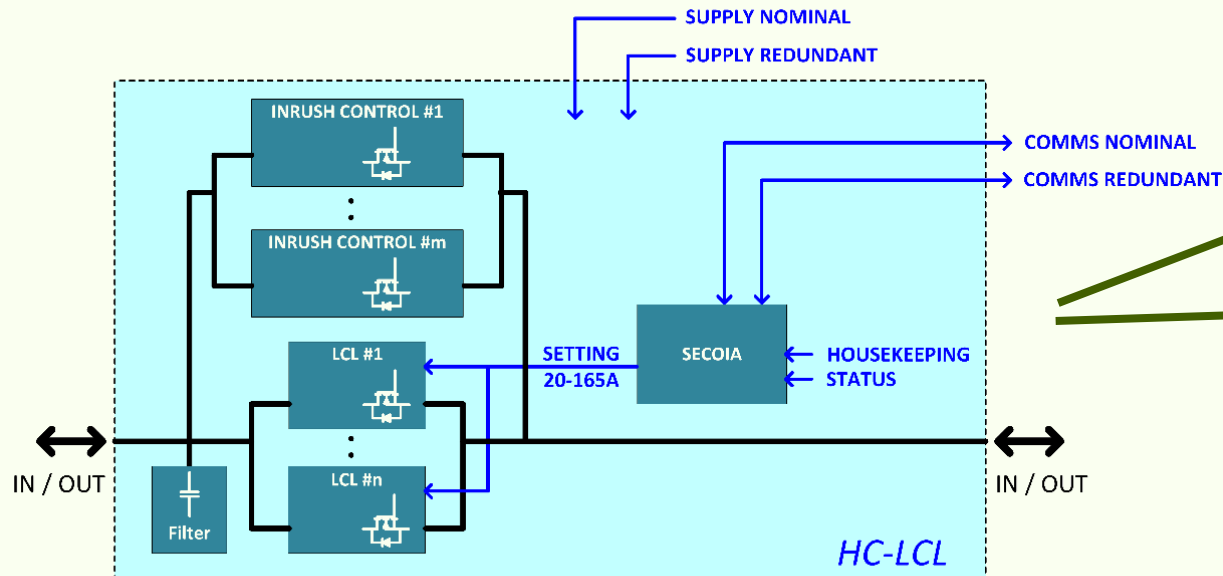
# The GHPS bricks to build flexible box architectures

## Power Distribution

### HC-LCL

High Capacity Latching Current Limiter

- Bidirectional LCL based on solid-state devices
- Programmable current limitation 20 to 165A



### PBS

Primary Bus Switch

### X-TIE (+)

+

### X-TIE (-)

Primary Bus cross-strapping

### PDS28 & 120

Power Distribution Switches @ 120V & 28V

- 18 x Latching Current Limiters (LCL) per card
- 5 A per outlet, can be paralled

### BES28 & 120

Bus Enable Switch @ 120V & 28V

- Cross-strapping link for secondary buses

### HCM

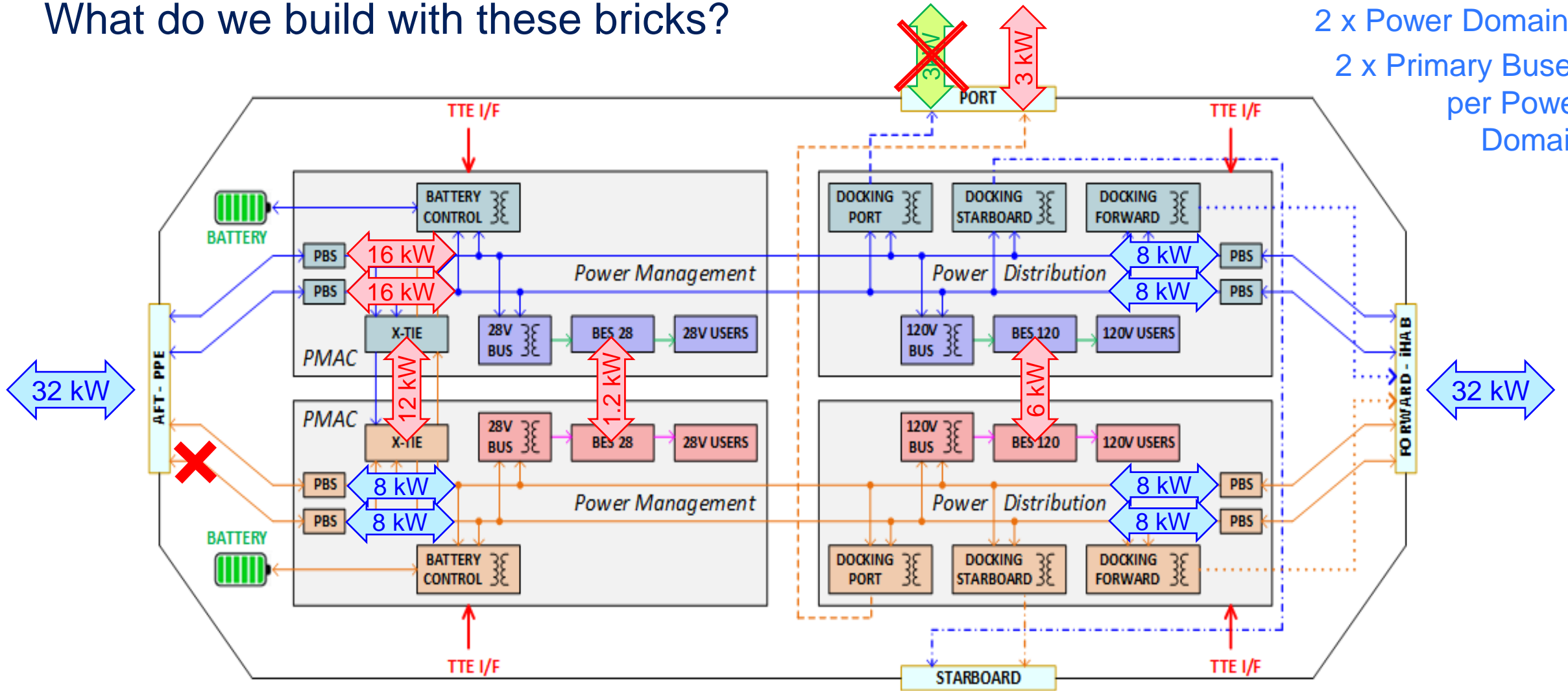
Heater Control Module

- 36 x heater drivers per card with 1 A capability



# What do we build with these bricks?

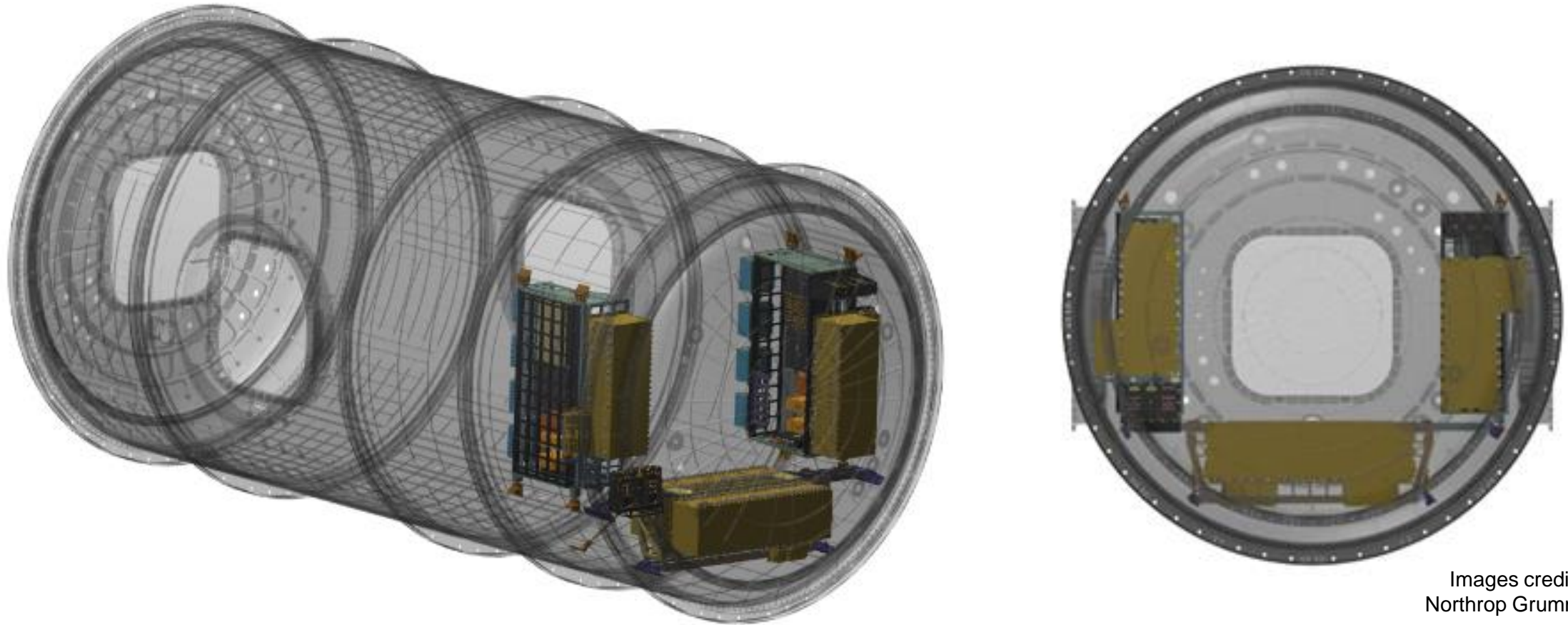
2 x Power Domains  
2 x Primary Buses  
per Power Domain



## Gateway's Habitation and Logistics Outpost (HALO) internal architecture



# What do we build with these bricks?

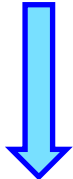
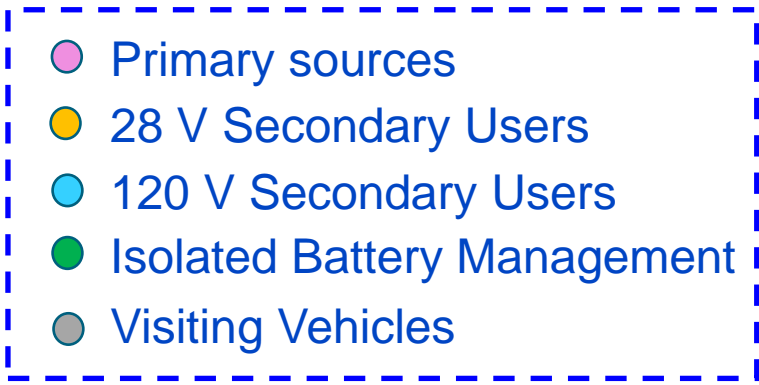


Images credit:  
Northrop Grumman

### PMAD boxes location on HALO cylinder

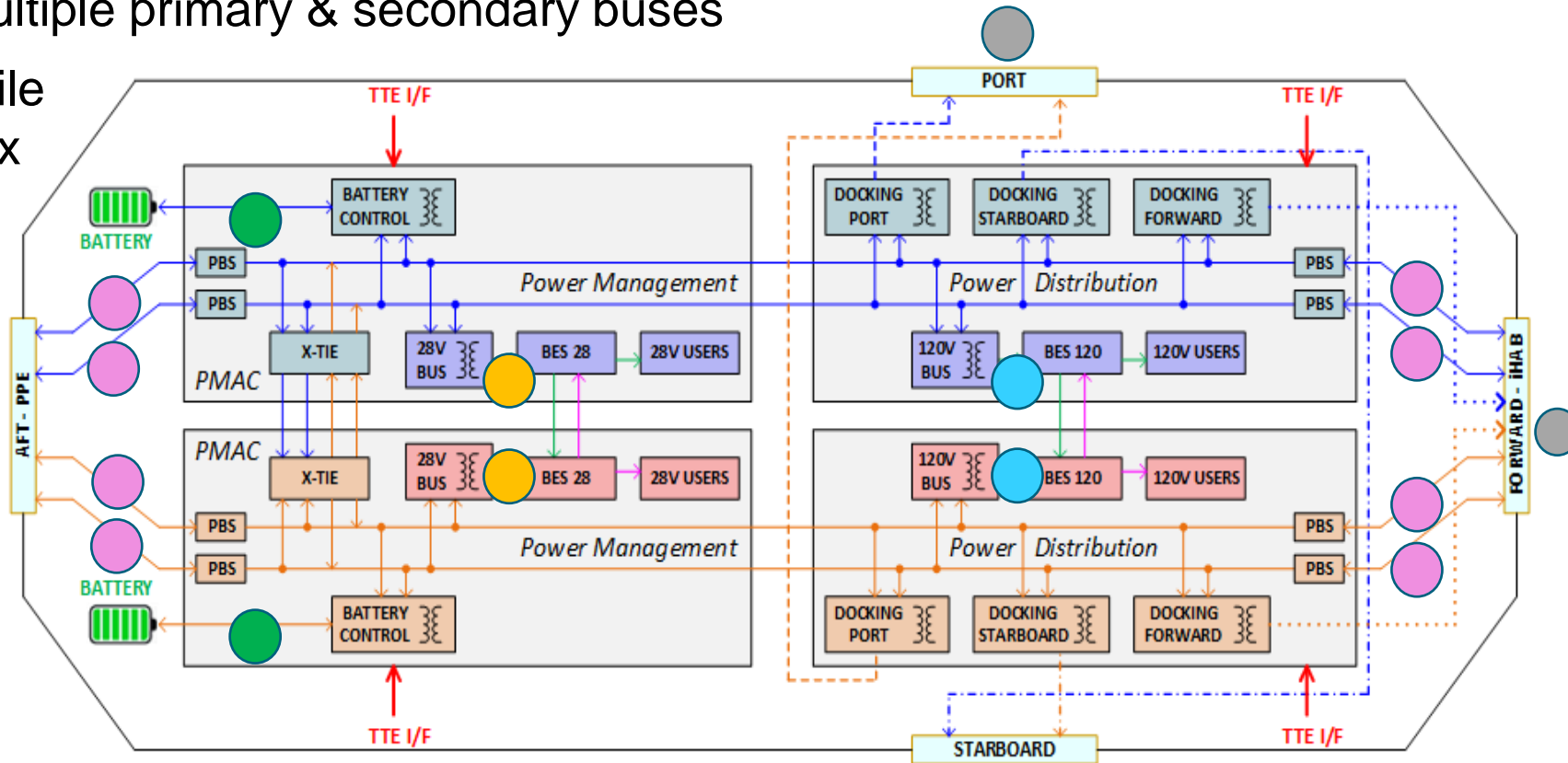
# What do we build with these bricks?

- ❑ Crewed stations demand multiple primary & secondary buses
- ❑ Functions need to be versatile and compatible with complex grounding schemes



All cards feature **isolated** interfaces

- Isolation converters
- APS based on AC-bus topology
- Internal comms. serial bus includes high speed isolation at every card



# Human environment “on top”

Pressurized/  
unpressurized  
operation

30% oxygen  
atmosphere

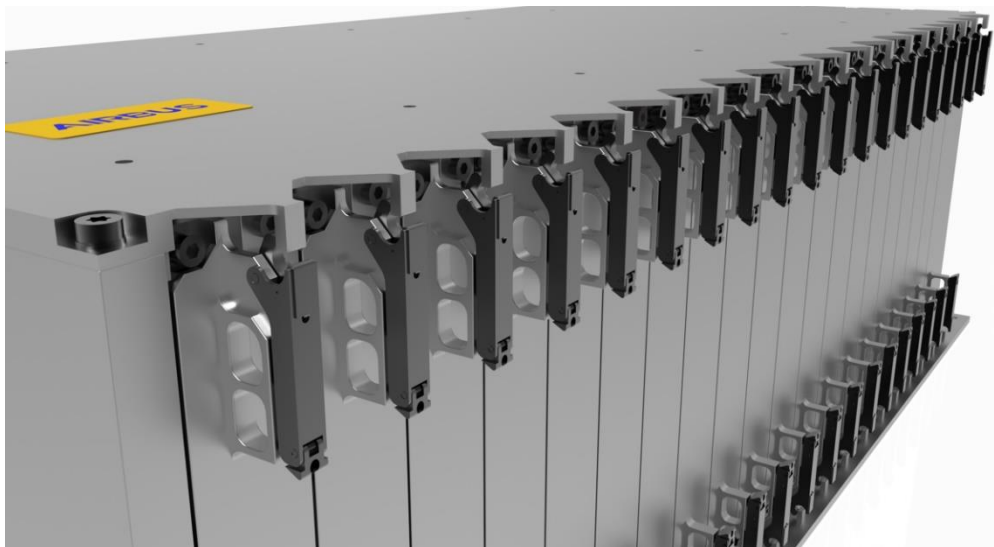
Human  
safety

Double  
failure  
tolerance

Spilled  
liquids

70%  
relative  
humidity

Heat  
evacuation vs.  
hot surfaces



## MANTAINABILITY

- ❑ Easy manipulation through insertion / extraction levers
- ❑ All cards are replaceable in orbit by the crew
- ❑ A single card type can be used in different slots and boxes
- ❑ Cards are initialized by Master Controller with specific settings depending on the slot where they are inserted

# Can we build different systems with GHPS?

*Yes, flexibility and scalability are key*

CARD	QTY
DET	1
BCDR	2
BRM	1
CTRL-APS	2
HCM	2
PDS 120V	2

## “Small unit” example

- 3 kW PCDU / Single Bus
- SA and battery power conversion
- Distribution outlets @ 120V



<b>TOTAL</b>	<b>10 cards</b>
<b>DIMENSIONS</b>	405 x 360 x 250 mm (length x width x height)

CARD	QTY
DET	4
BCDR	4
BRM - PRIM	2
PBS	2
X-TIE(-)	1
HCM	4
PDC	2
BRM-PDC	1
PDS 28V	3
ISODCDC	2
BRM - DPC	1
PDS 120V	2

## “Big unit” example

- 13 kW PCDU / Dual Bus
- SA and battery power conversión
- Primary bus cross-strapping
- Distribution outlets @ 120V and 28V
- Docking Port I/F



<b>TOTAL</b>	<b>28 cards</b>
<b>DIMENSIONS</b>	1130 x 360 x 250 mm (length x width x height)



# Timeline of GHPS



Industrialization continuous improvement



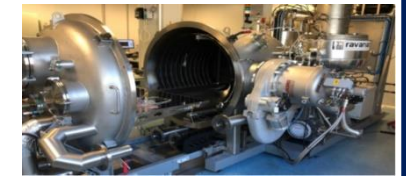
Development of electrical functions Orion ESM TCU

Start of HALO PMAD activities

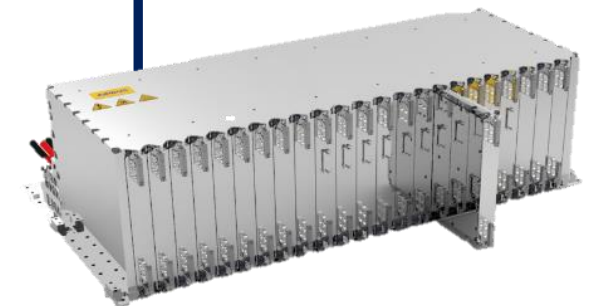
Start of iHAB EPS activities

HALO PMAD CDR

GHPS Qualification HALO FMs delivery

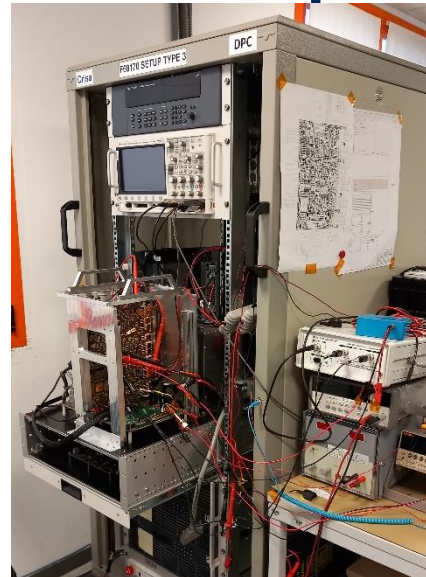
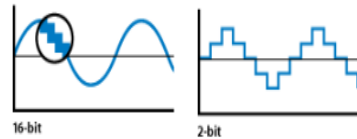


iHAB EPS PDR HALO EMs delivery



Participation in iHAB & ESPRIT Phase A /B1

JUICE: FM with Digital Control



HALO EM manufacturing and characterization



## Conclusions and achievements

- ❑ After 5 years of intense and exciting work, Airbus Crisa has developed **GHPS to provide a reliable multi-scenario power product for crewed missions** and new generation of space stations.
- ❑ Some of the key features that set this product apart are **high power capability, isolation, bi-directionality, scalability and in-orbit replaceability**.
- ❑ A huge engineering effort has been necessary to reach the point where we are today. In several phases more than 140 people from Airbus CRISA have been working in this amazing program.
- ❑ We would like to acknowledge Northrop Grumman for their support in this development in the frame of HALO PMAD.



*"If God wanted man to become a  
spacefaring species, he would have  
given man a moon"*

Krafft Arnold Ehrlicke



**The journey starts here**  
**Airbus Crisa**

Credit: Lick Observatory/ESA/Hubble



# Thank You!!!

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# Airbus Crisa

the power for Space



MVPPU – Multi-technology PPU for medium and High Power Electric Propulsion



GHPS – generic high power system. The Power Standard for Human Exploration



Launcher electronics



MVPCU – Multivoltage PCDU. COTS & GaN Power revolution for New Generation GEO



MVPPU – Multi-technology PPU for medium and High Power Electric Propulsion



EVO PCDU – Power for Earth Observation & Science



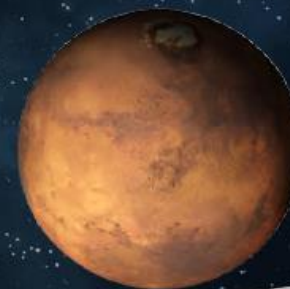
MEGA – main electronics for global access. The Power for the New Space Economy

Solutions for energy conditioning, distribution and electrical propulsion.

A wide range of voltage and power levels.

State of the art technologies: Silicon and GaN, full digital control.

> 2000 years cumulated in orbit.



MVPCU – Multivoltage PCDU. COTS & GaN Power revolution for New Generation GEO



MVPPU – Multi-technology PPU for medium and High Power Electric Propulsion



GHPS – generic high power system. The Power Standard for Human Exploration

