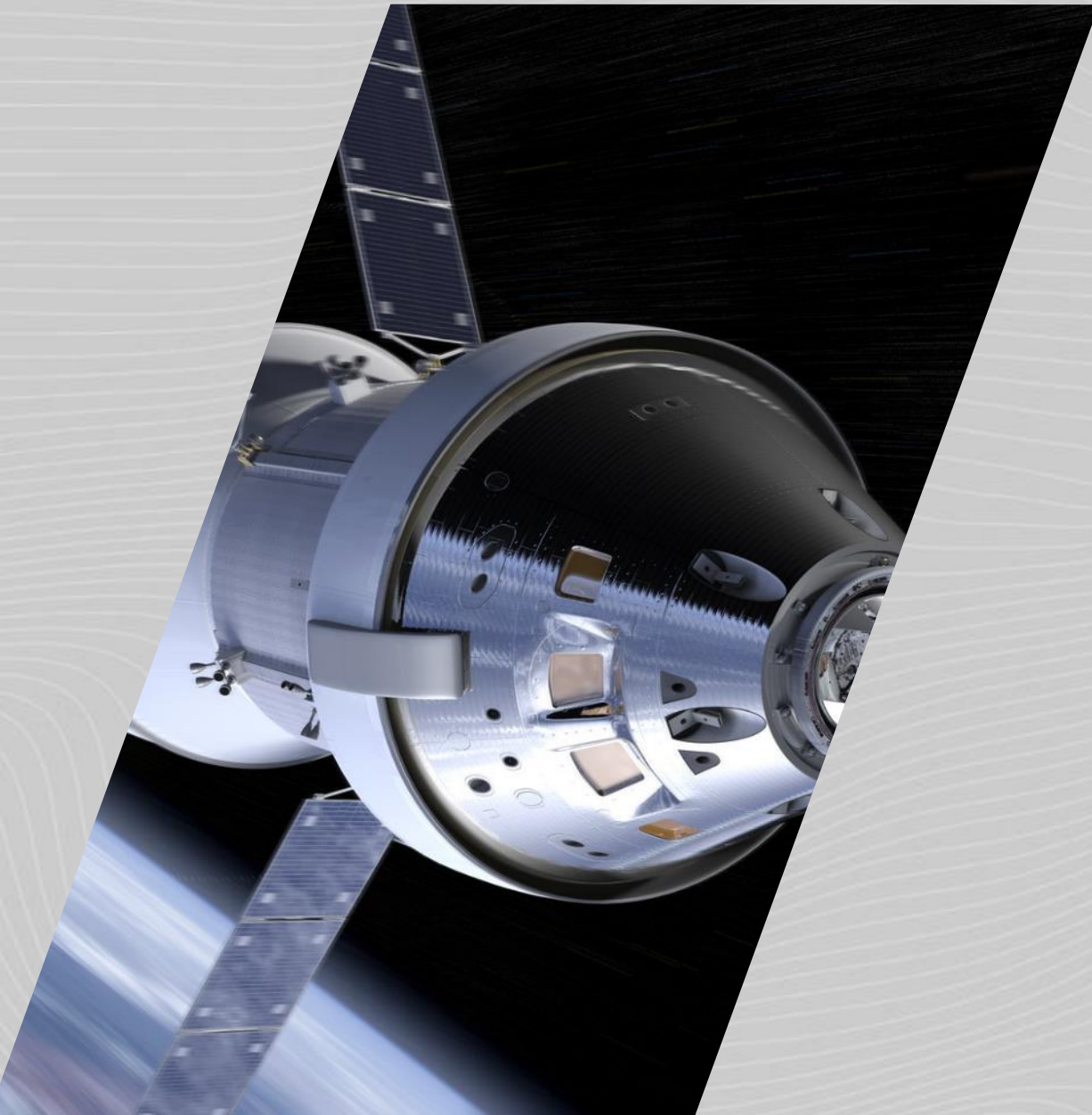


# GR740 Plastic BGA Development

Overview Presentation

Date: 2021-03-11



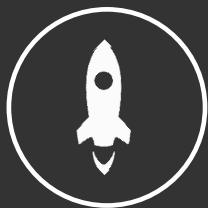
# Abstract

- Strong demand to reduce cost for space electronics including EEE components, especially for telecom constellation programs
- Done by employing methods, materials and techniques used for commercial and automotive industry, e.g. organic packages
- Development objective:
  - Assemble existing GR740 die in suitable organic package
  - Process it through an adapted test flow
  - Perform an evaluation demonstrating the capability to reach required standards for telecom constellation programs.

# Agenda

- About Cobham Gaisler (CG)
- Introduction to GR740
- Scope
- Project organization
- Milestones
- Evaluation activities
- Conclusion





A world leader in embedded computer systems for harsh environments



Experts in fault-tolerant computing



We provide a full ecosystem to support hardware and software design for:

- Standard components
- Semi-custom FPGA
- Full custom ASIC



Based on SPARC and RISC-V architectures



Established 2001,  
20-year anniversary!

- Acquired by Aeroflex in 2008
- Acquired by Cobham in 2014



Located in Gothenburg, Sweden



40 employees



In-house facilities

- ASIC and FPGA design
- Software
- Component lab



# Components

## High-reliability

- Radiation hardened
- Space qualified
- Fault-tolerant

### NOEL Processor Family

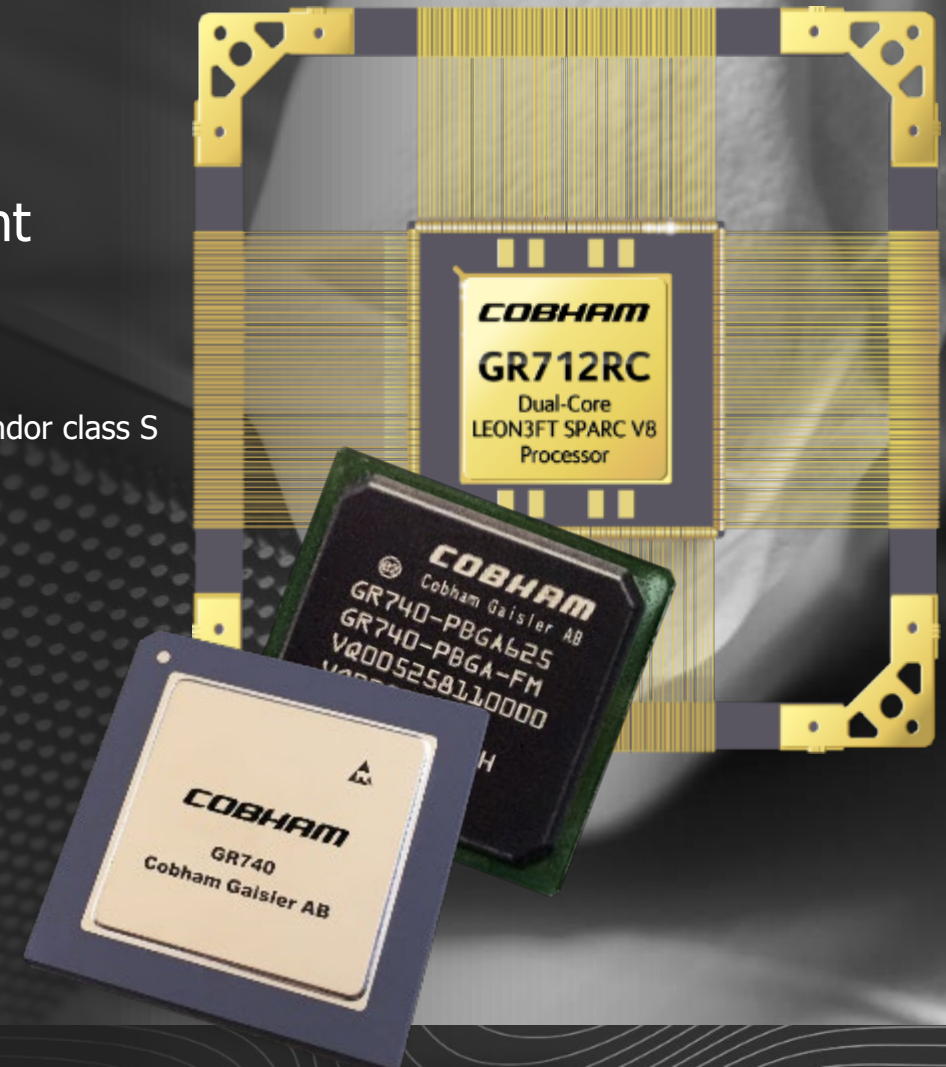
- GR7xv, NOEL-V, 16-Core, in development

### LEON Processor Family

- GR765, LEON5FT, in development
- GR740, LEON4FT, quad-core, 250 MHz, QML-V approval exp. Q2 2021
- GR740 PBGA, LEON4FT, quad-core, 250 MHz, prototypes Q2 2021
- GR716A, LEON3FT, single-core, 50 MHz, ESCC 9000 screening exp. Q2 2021
- GR716B, LEON3FT, single core 100 MHz, in development
- GR712RC, LEON3FT, dual-core, 100 MHz, Vendor class S
- UT700, LEON3FT, single-core, 166 MHz, QML-Q, QML-V
- UT699E, LEON3FT, single-core, 100 MHz, QML-Q, QML-V
- UT699, LEON3FT, single-core, 66 MHz, QML-Q, QML-V

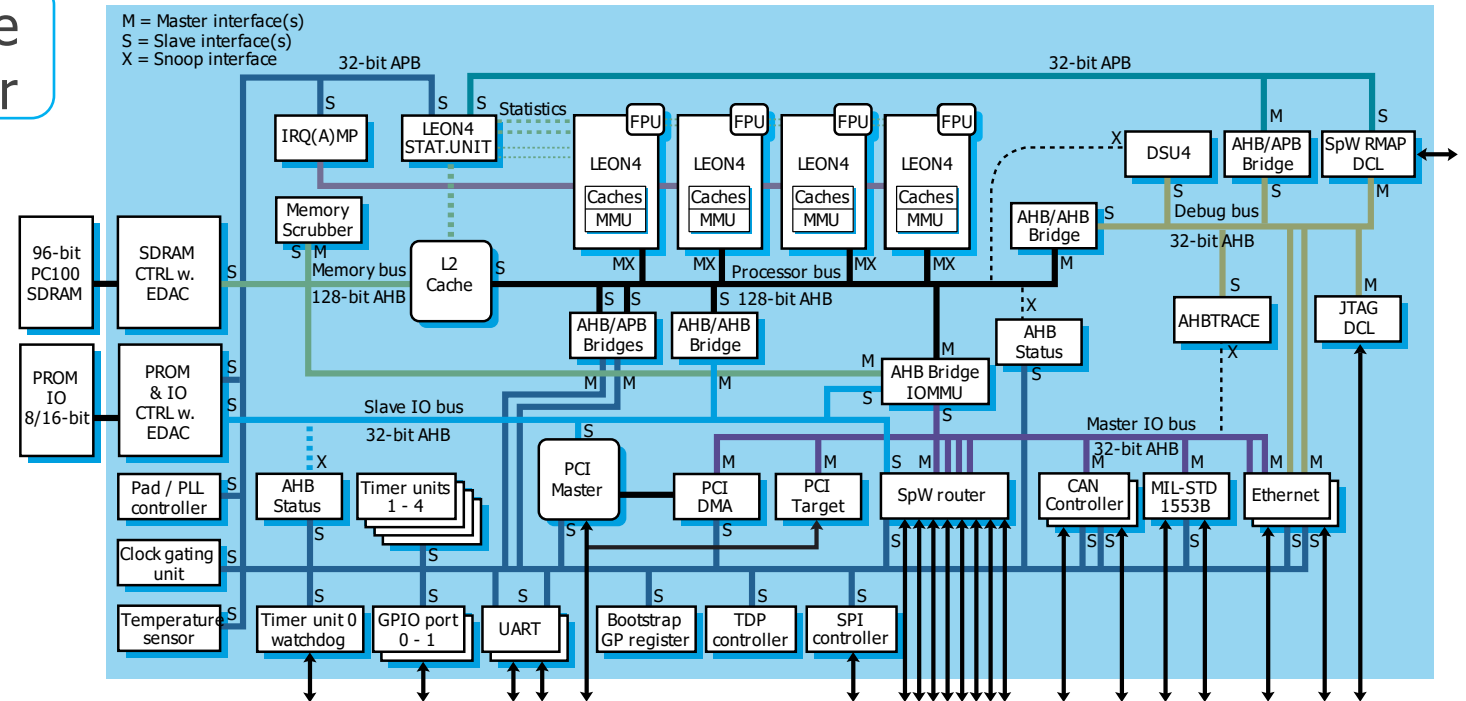
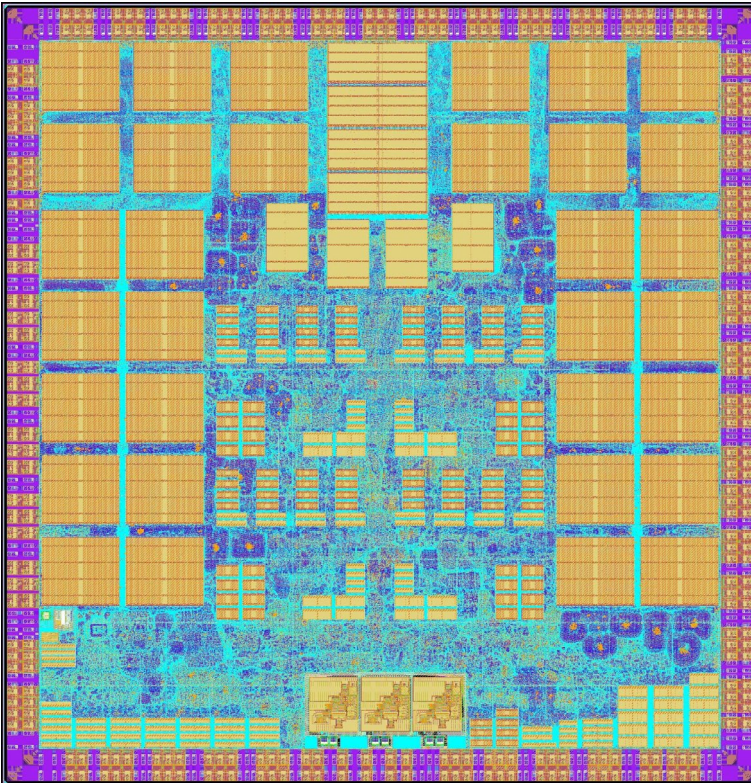
### Interconnect

- GR718B, Vendor class S



# Introduction to GR740

Radiation-hard system-on-chip quad-core  
fault-tolerant LEON4 SPARC V8 processor



Cobham Gaisler digital IP: LEON4FT and IO peripherals  
STMicroelectronics C65SPACE technology platform  
Complete software toolchain and debuggers are available

**LEON**



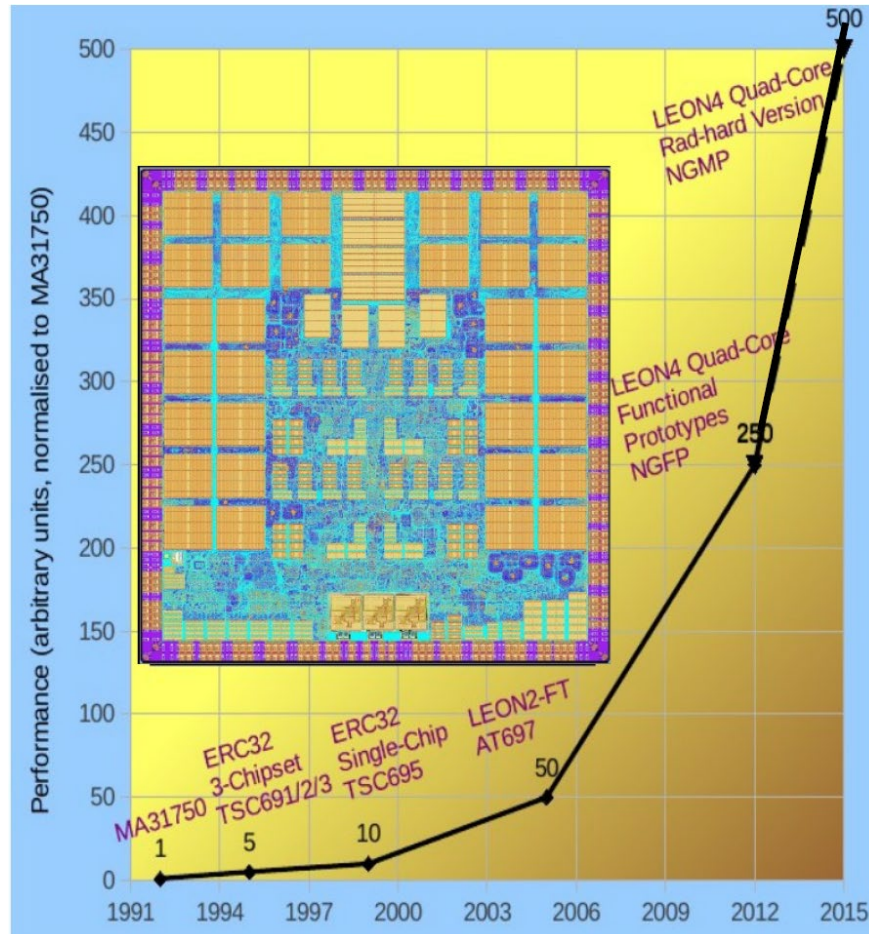
<https://www.gaisler.com/>



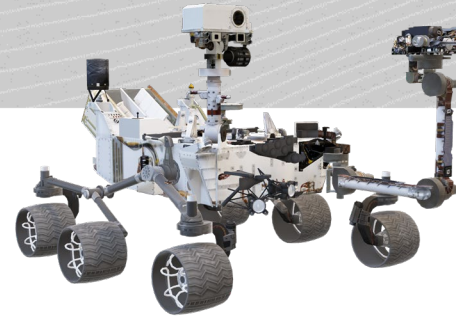
# Introduction to GR740

**CAES** PIONEERING  
ADVANCED  
ELECTRONICS

Power <2.0W, Performance >1700 DMIPS



Ref: Roland Weigand. GR740 User day presentation:  
"from concept to product NGMP to GR740"



GR740 - IPAC Computer for the Platino mission

**ThalesAlenia**  
A Thales / Finmeccanica Company  
*Space*

GR740 - WFIRST Processor Board

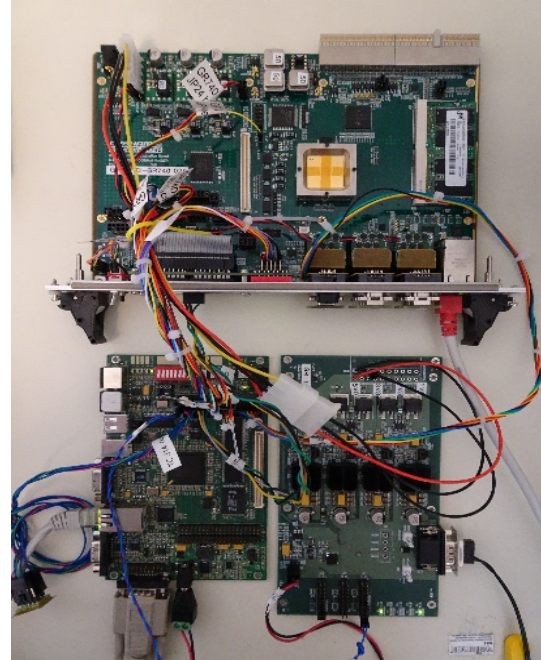
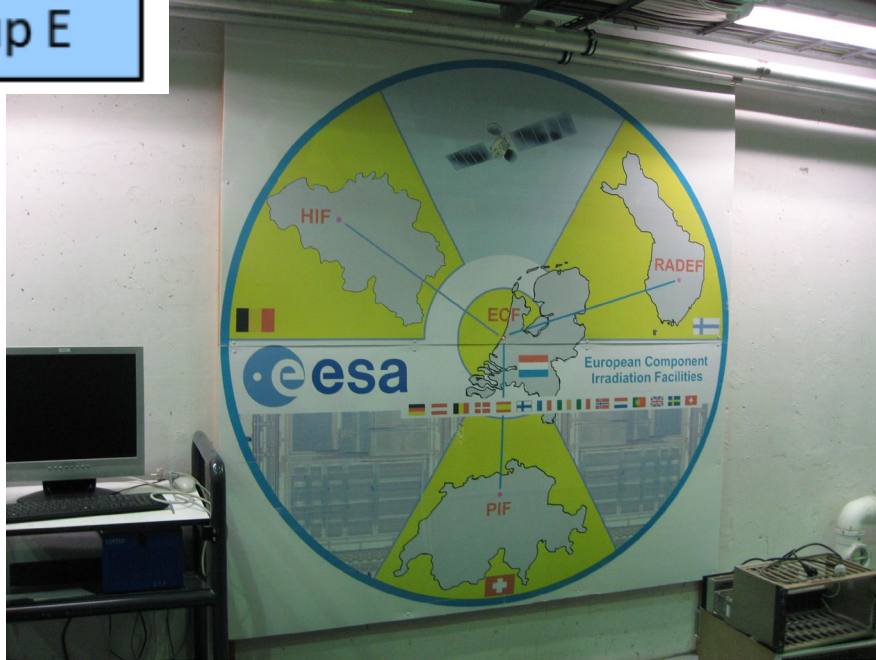


*Goddard*  
SPACE FLIGHT CENTER

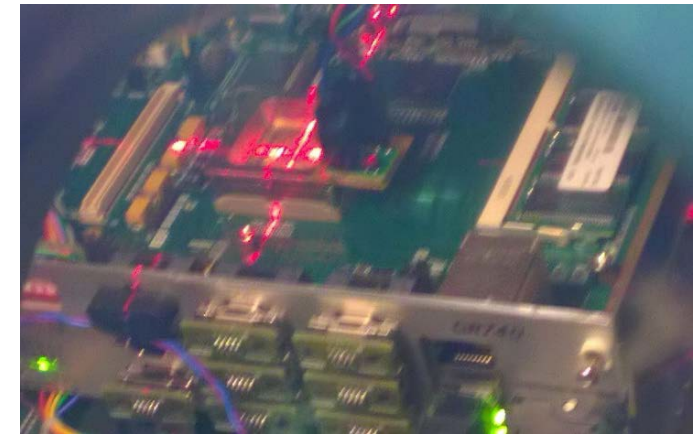


# Introduction to GR740. Radiation results

## Group E



- TID tolerance of 300 krad(Si)
- Overall SEE rate below  $1 \times 10^{-5}$  events/device/day (GEO)
- SEL > 125 MeV.cm<sup>2</sup>/mg (T>85°C & max supply)



**ALL TESTS SUCCESSFULLY COMPLETED!**





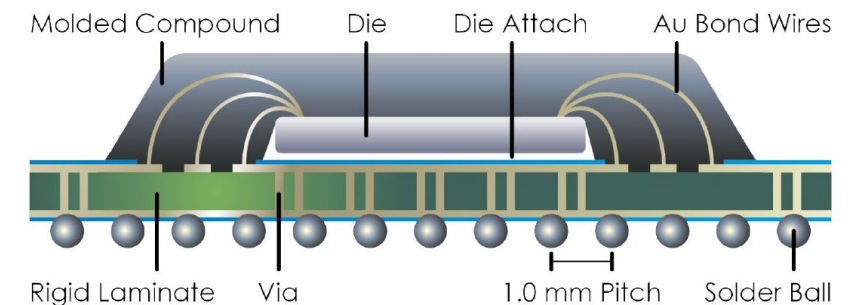
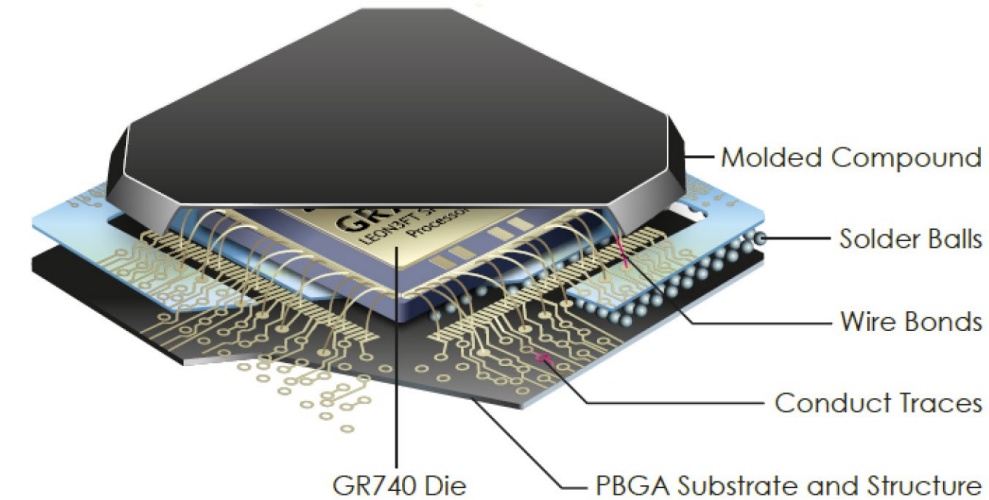
ESA's next generation Microprocessor (NGMP) development time-line:

- Ceramic
  - 2009, Start of the development under a TRP contract with ESA (VHDL design and verification by simulation on FPGA).
  - 2014, Implementation of NGMP into a space chip technology (C65Space).
  - 2016, Engineering models of the GR740 were evaluated.
  - 2018, Flight Silicon manufactured and validated (including radiation).
  - 2020, All QML-V related qualification tests successfully completed.
  - 2021-Q2, QML-V and QML-Q certification by the DLA expected
- Organic (GR740PBGA)
  - 2020-Q1, Start of the development under an ESA ARTES Competitiveness & Growth contract
  - 2021-Q1, First electrical samples being validated



# Scope of ARTES program

- Cobham Gaisler to develop the quad-core LEON-4 GR740 in plastic package
- Same wafer material used as for the ceramic package product i.e. full traceability
- Re-use lessons learnt and heritage from the ceramic package project
- Perform an evaluation demonstrating the capability to reach required standards for telecom constellation programs.



# Project organisation

## Prime contractor

- Cobham Gaisler AB, Sweden
  - Product owner

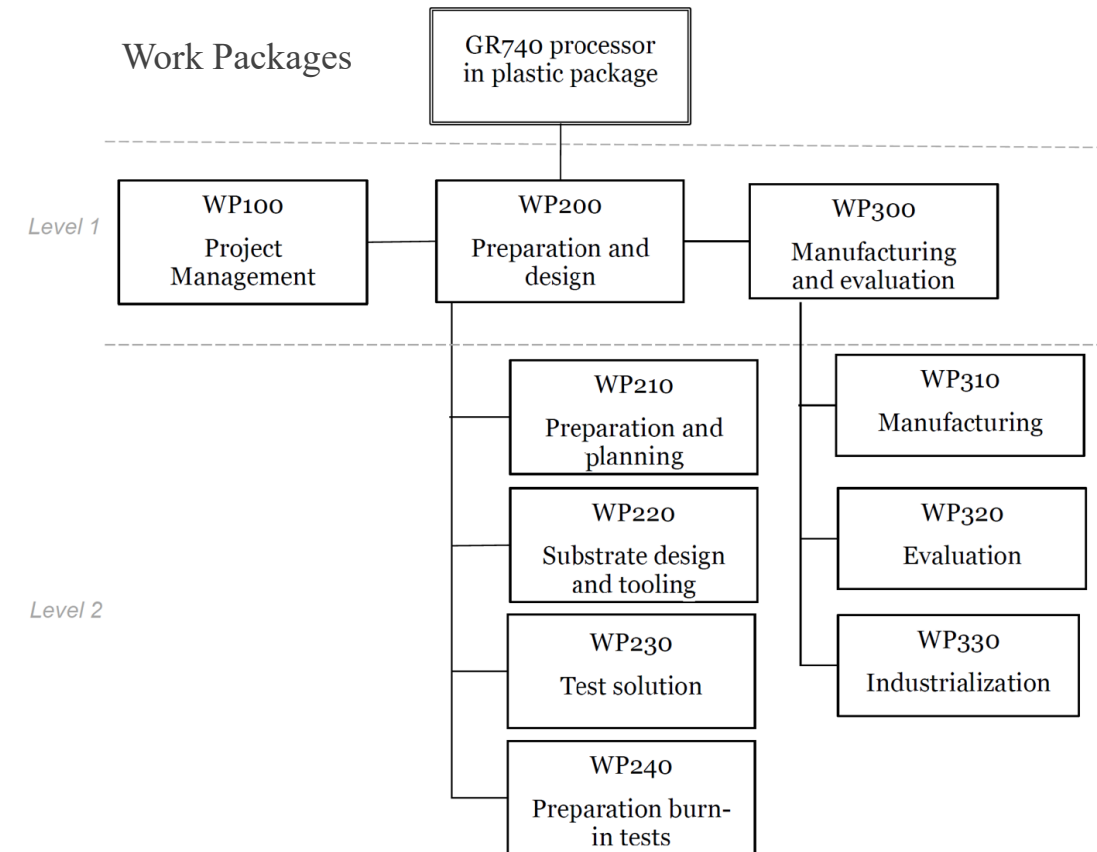
## External service providers:

- Synergie CAD PSC, France
  - Overall responsibility for electrical testing, mechanical screening and evaluation activities
    - Design and fabricate;
      - The test load board
      - The HTOL system
      - The THB board
    - Adapt the production test program
  - Interface towards ST Microelectronics
- ST Microelectronics, France
  - Responsibility for supply of dice, substrate and package design and assembly

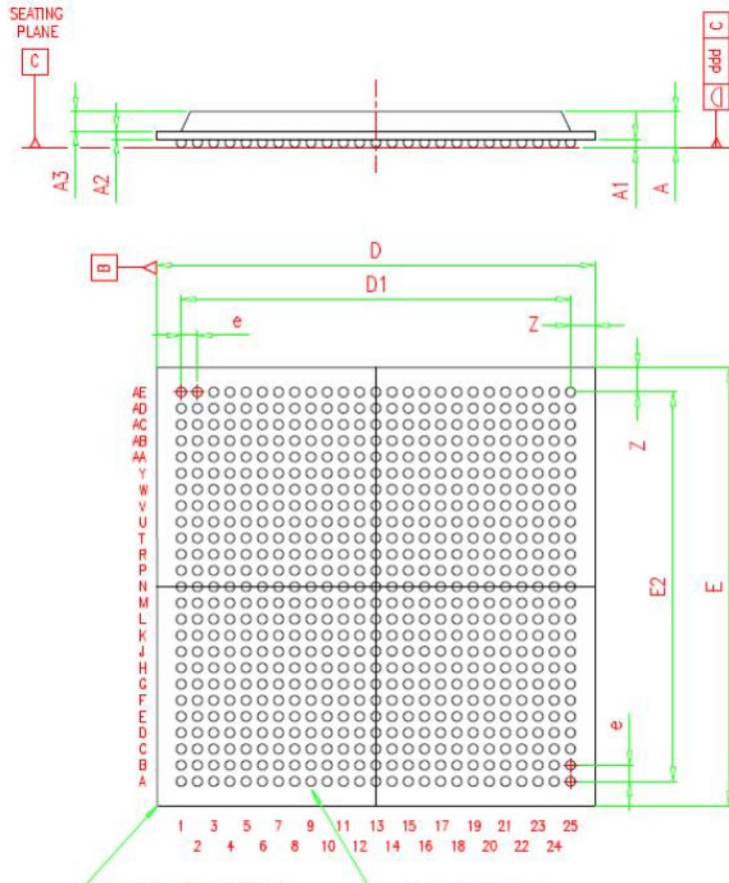




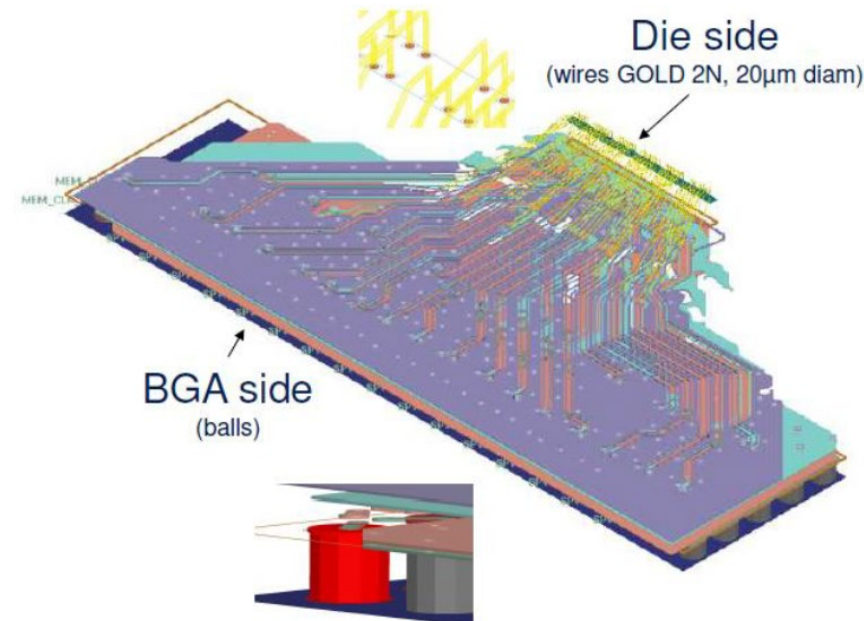
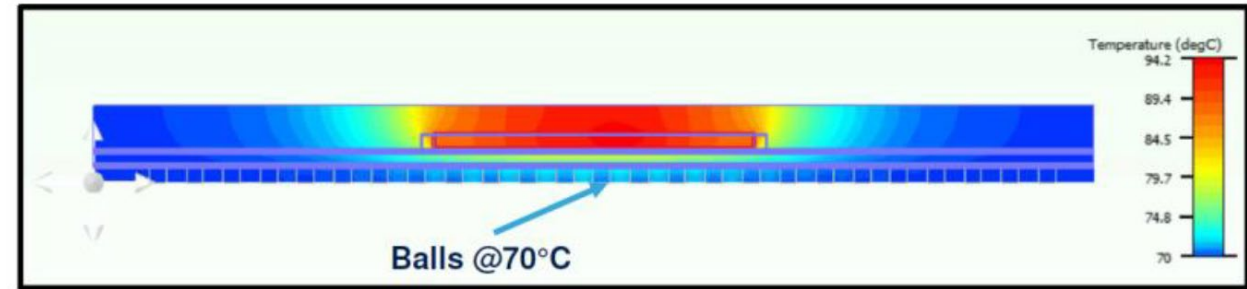
- Package drawing
  - Body size: 27\*27mm, 625 balls
  - Solder ball pitch; 1 mm
  - Same footprint as ceramic package and pin-compatible
- BOM
- Electrical & thermal simulations
- Load board, THB and HTOL boards developed
- First samples have been manufactured and electrically tested



# GR740PBGA package



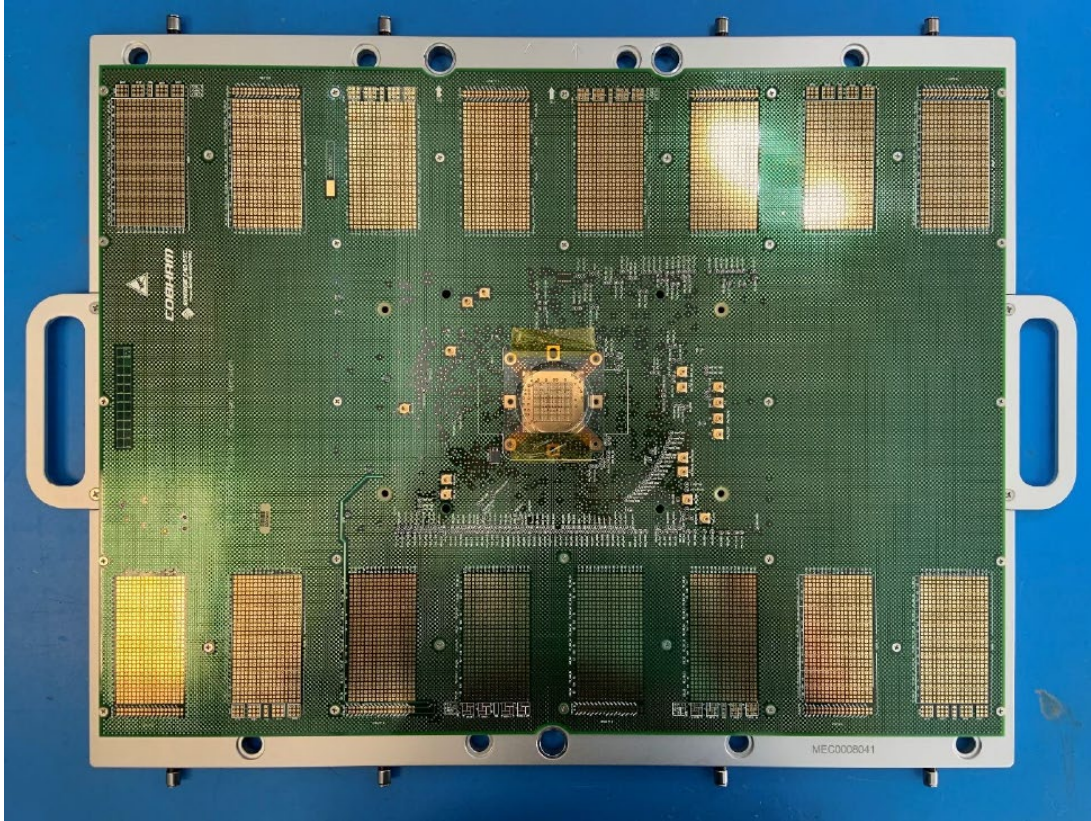
- Thermal and electrical simulations of the package performed by ST



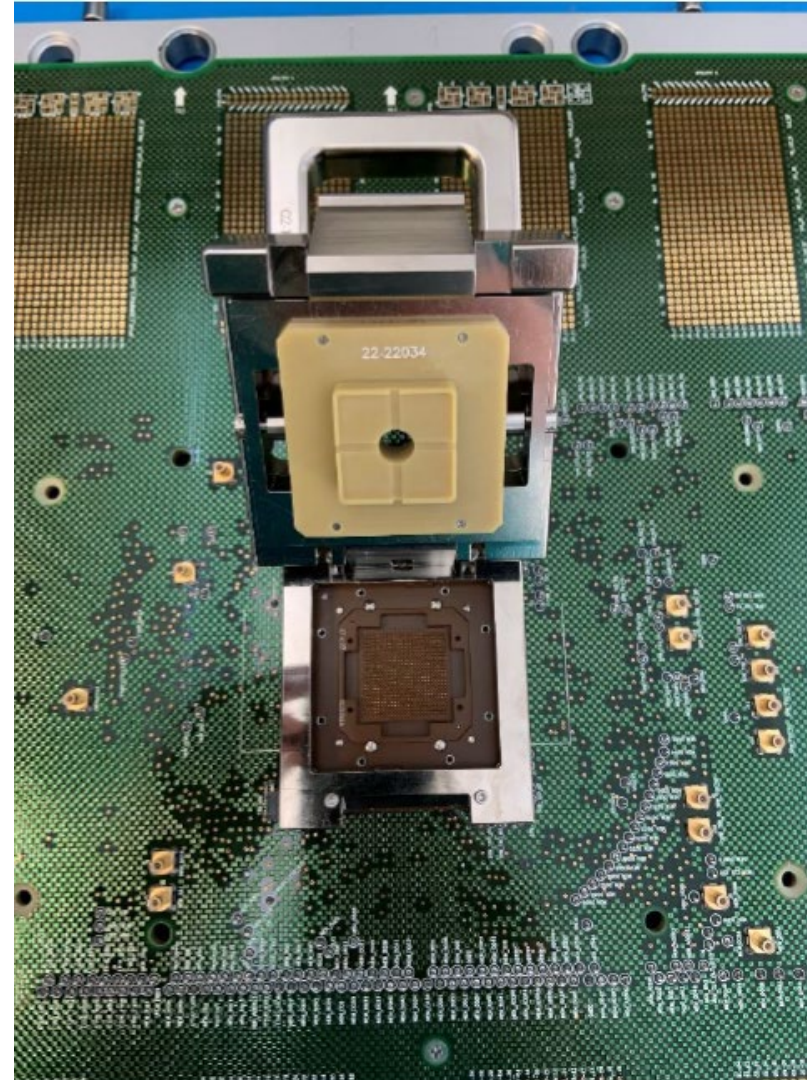
- Same footprint as ceramic package and pin-compatible
- 4-layers substrate
- SACN306 balls



# GR740PBGA Load board



- Load board verified and operational
- Temperature range selected for GR740PBGA:
  - -40°C to +105°C

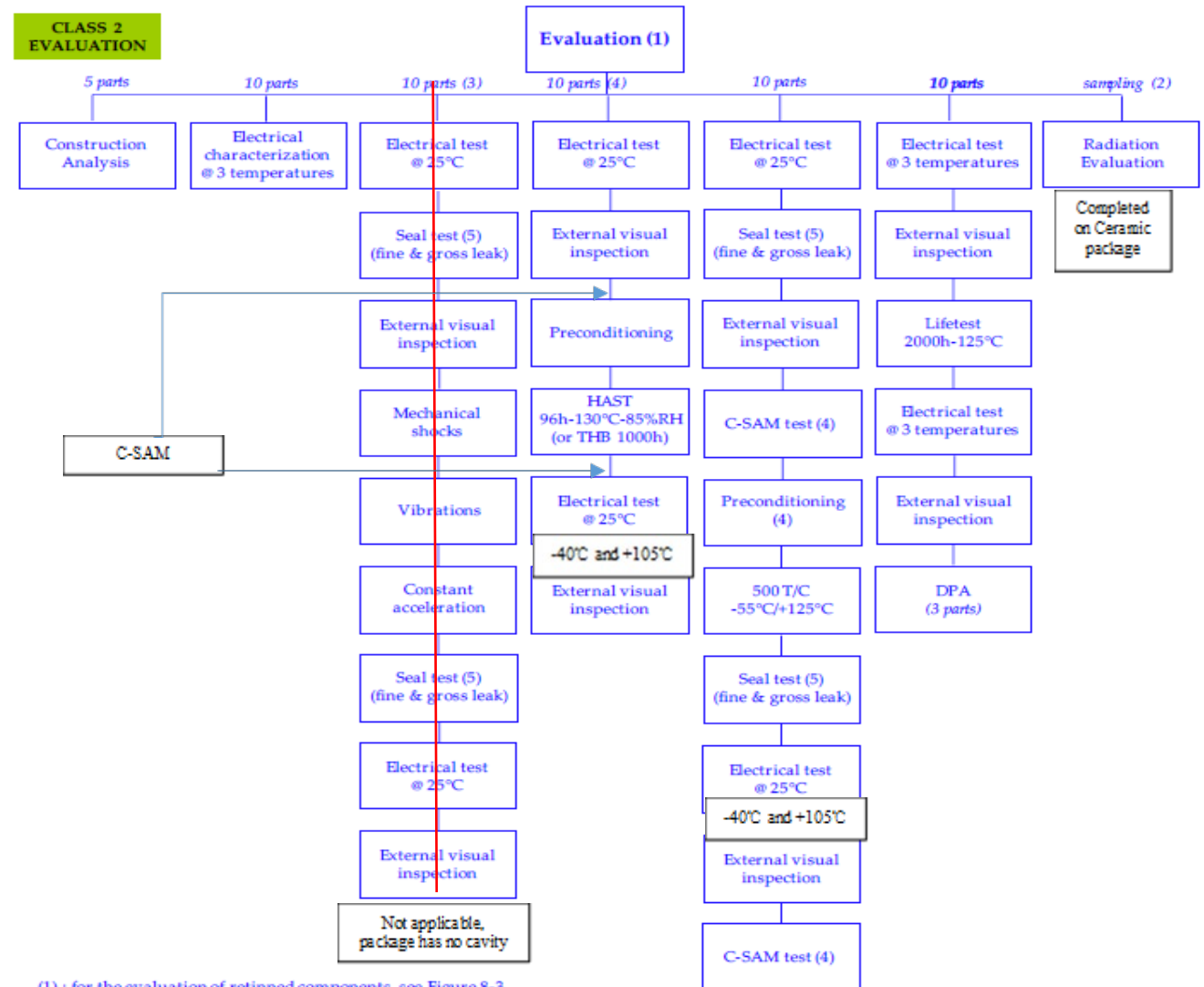


Images courtesy of Synergie CAD



# Evaluation activities

- ECSS-Q-ST-60-13C, class 2
  - Constructional Analysis
  - Electrical characterisation
  - THB, 1000 hours
  - 500 TC
  - HTOL, 2000 hours
- ESD CDM
- Outgassing characterisation



(1) : for the evaluation of retinned components, see Figure 8-3

(2) : sampling and testing conditions in conformance with requirements of ECSS-Q-ST-60-15

(3) : applicable in case of cavity package

(4) : applicable to plastic package only

(5) : applicable to hermetic & cavity package



- About to supply the telecom constellation market with
  - a high-rel rad-hard die developed for QML-V
  - that will be able to support telecom constellation programs with a cost-effective package technology
- Great market interest for the GR740PBGA

**Thank you for  
your attention!**

