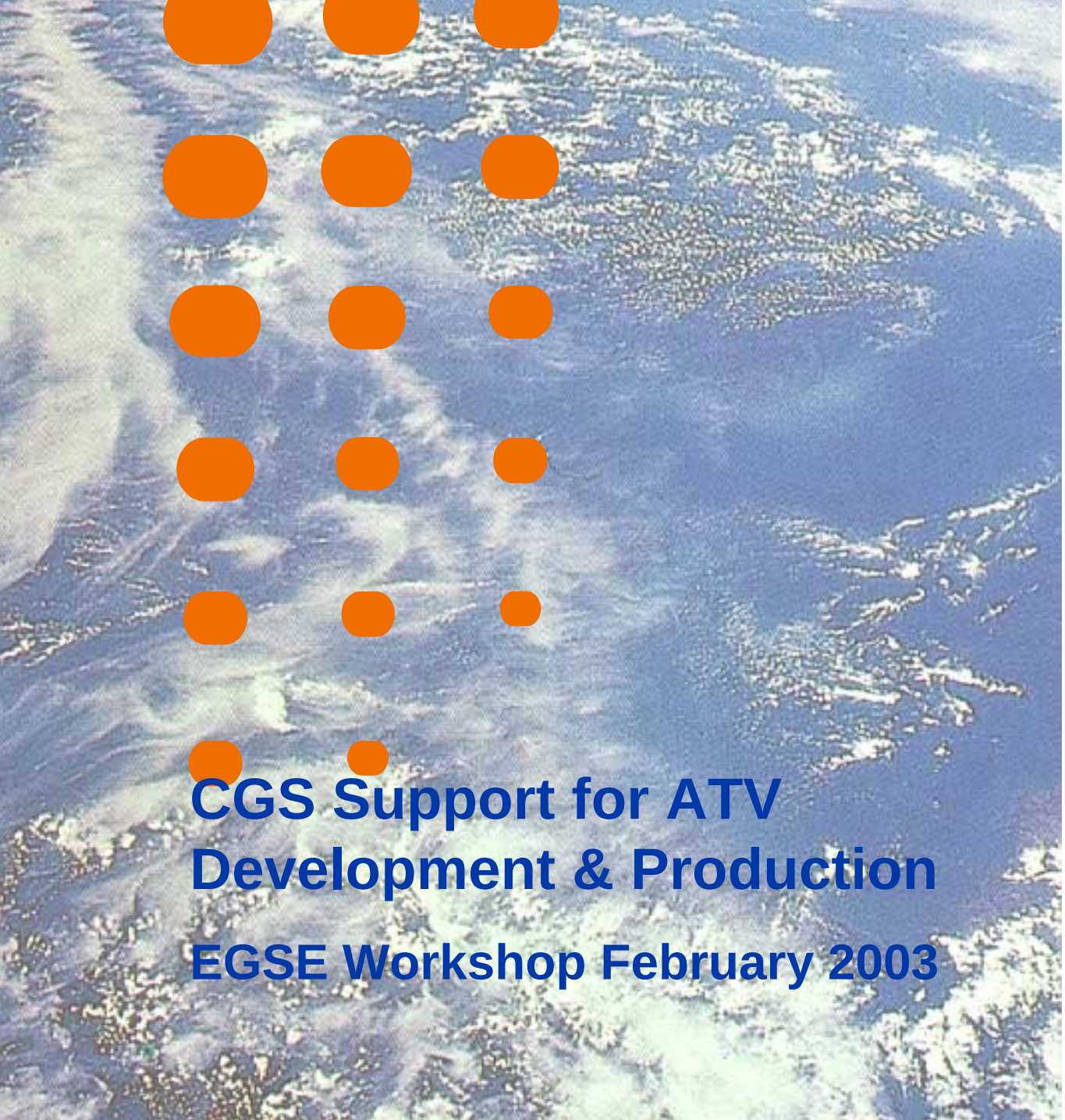

CGS Support for ATV Development & Production

EGSE Workshop February 2003

astrium

an EADS joint Company with BAE SYSTEMS

EADS LAUNCH VEHICLES

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CGS for ATV

- The ATV Vehicle
- Overview ATV Test Facilities
- Common S/W Architecture
- CGS extensions for the ATV Project
- Communication Protocols with Front-End Equipment
- Status of ATV Test Facilities
- Some Pictures from the Facilities

The ATV Vehicle

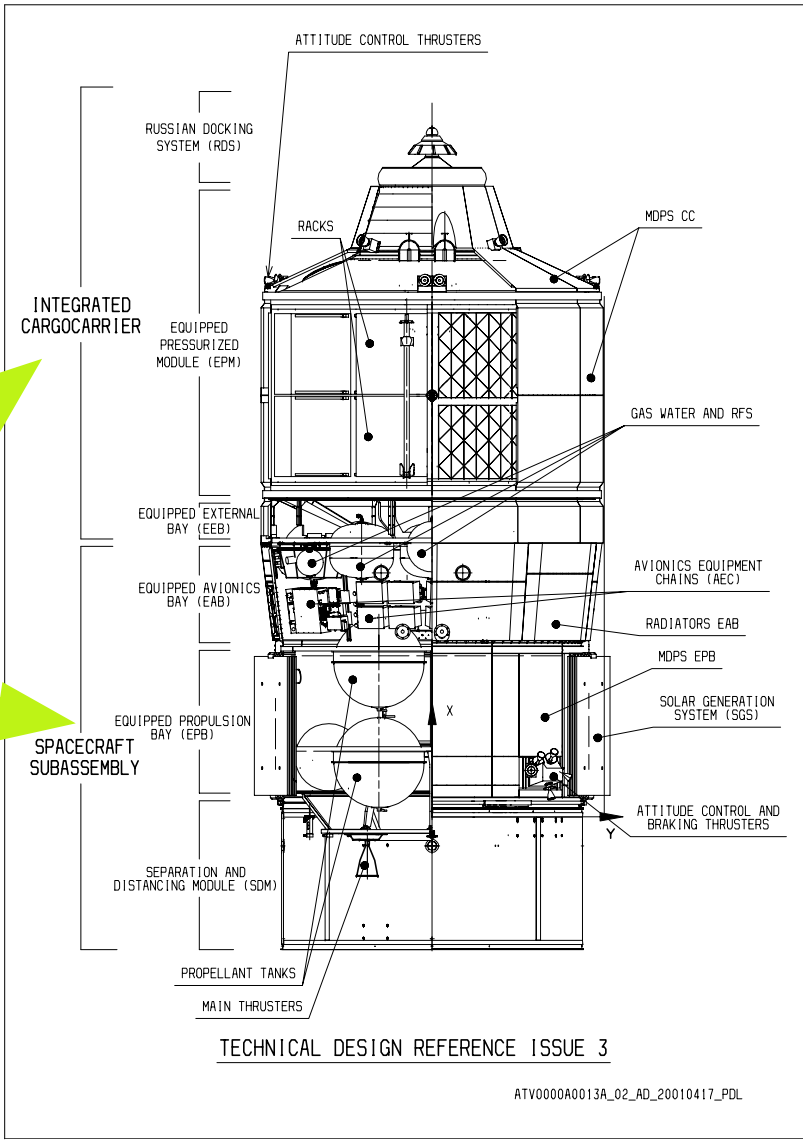
The Automated Transfer Vehicle:

- 21 tonnes
- 10.3 metres long
- 4.5 metres in diameter
- spans 22 metres with its solar panels deployed.

The ATV comprises 2 modules:

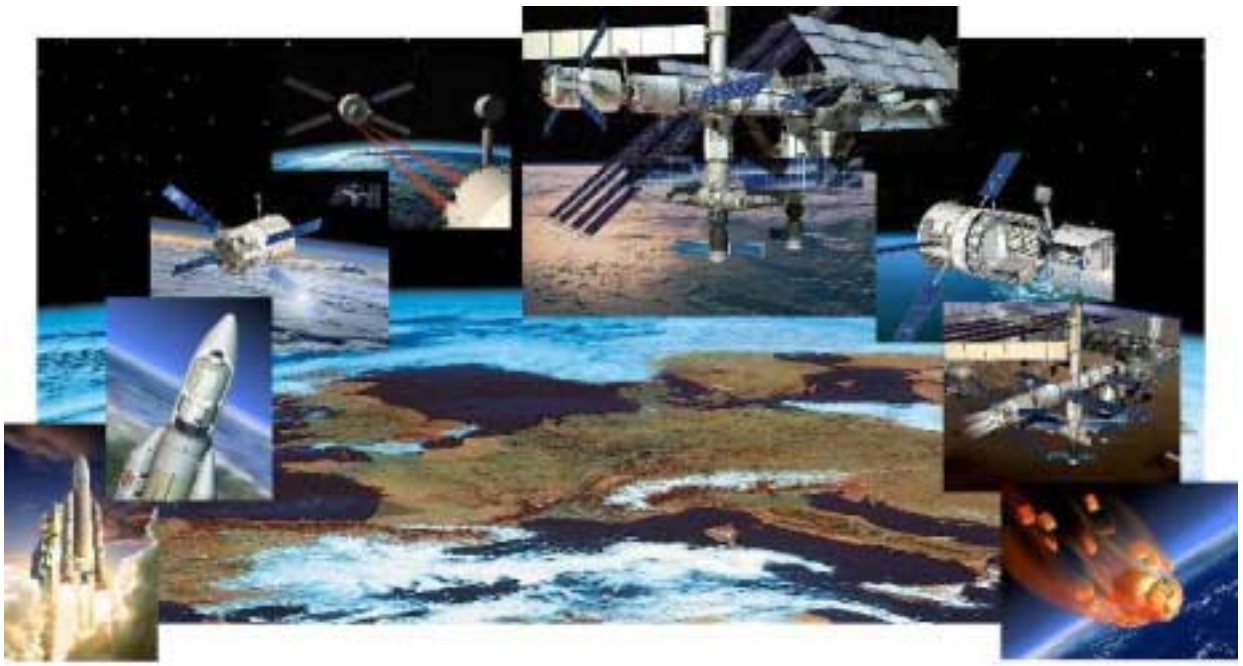
- The “ cargo carrier ”
- The service module, called the “ spacecraft ”

The ATV is mounted on the Ariane 5 launcher using a cylindrical adapter called “ separation and distancing module ”.



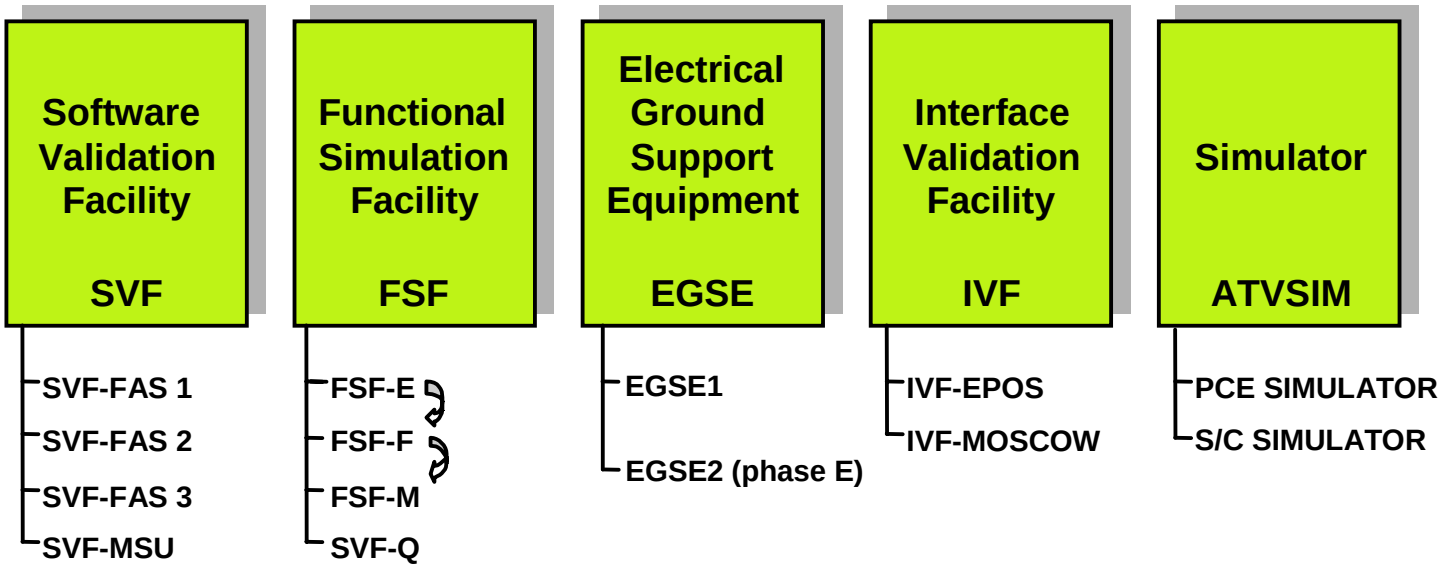
The ATV Mission

- After the docking to the ISS, the 40 m^3 pressurised module of the ATV delivers up to 7.2 tons of equipment, fuel, food, water and air for the Crew.
- With up to 4.7 tons of propellant , ATV raise the ISS altitude during Reboost manover
- 6 months later , the ATV is loaded with 6.5 tons of waste and leave the Station to fully burn up during a guided and controlled reentry.



Overview ATV Test Facilities

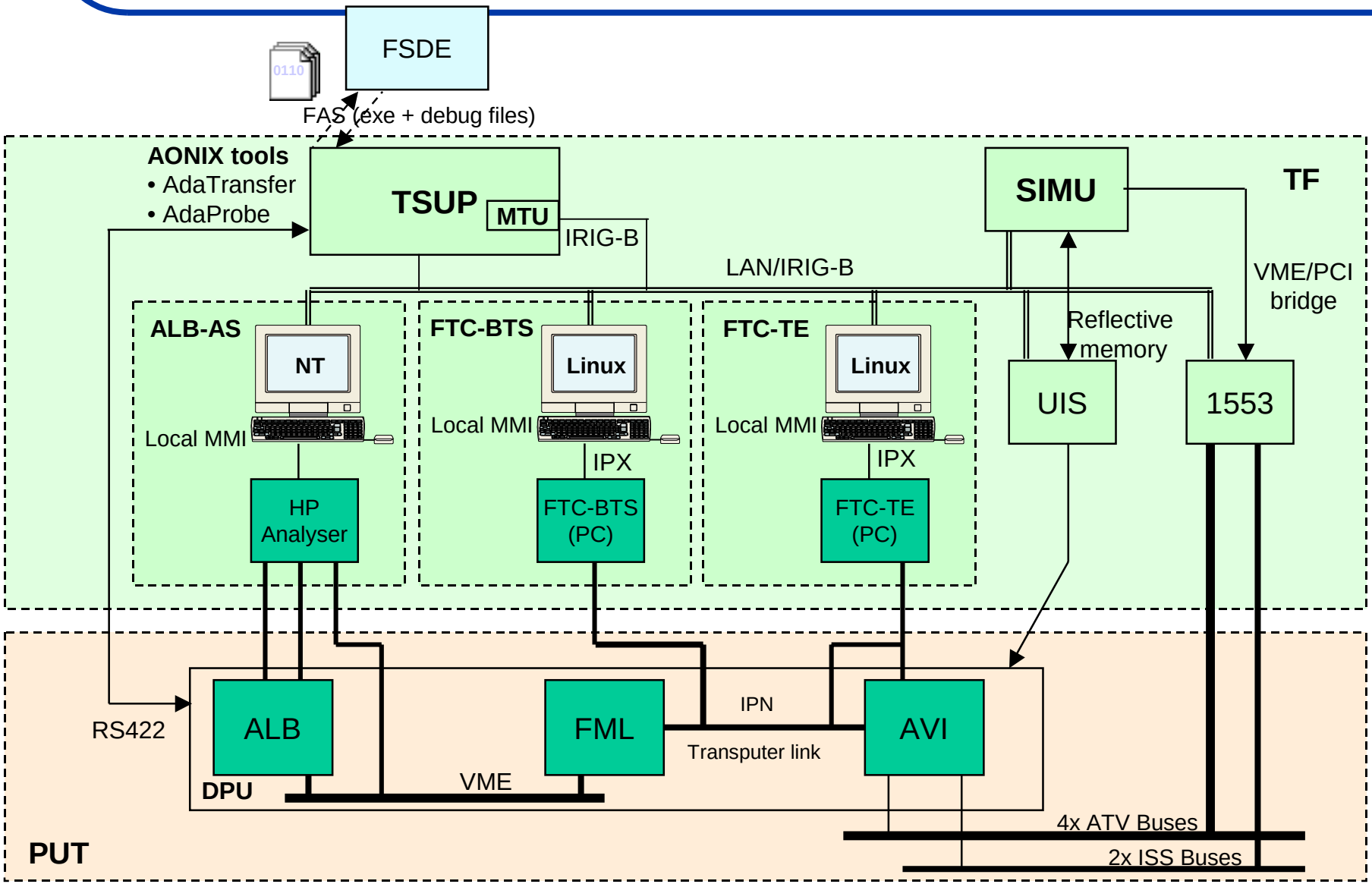
The ATV Test Facilities are grouped by family and built in an incremental way around a common S/W kernel (CGS)



The Software Validation Facilities (SVF)

- Integration & Test of on-board S/W on real target
- Validation of algorithms for
  - GNC (Guidance, Navigation, Control)
  - MVM (Missions Vehicle Management)
  - FDIR (Failure, Detection, Isolation, Recovery)
  - MSU (Monitoring and Safety algorithms)
- Validate the real-time closed-loop performance
- Check the CPU load, sequence, 1553 and TM/TC links
- Simulation of avionics equipment via EUROSIM model responses on the 1553 busses

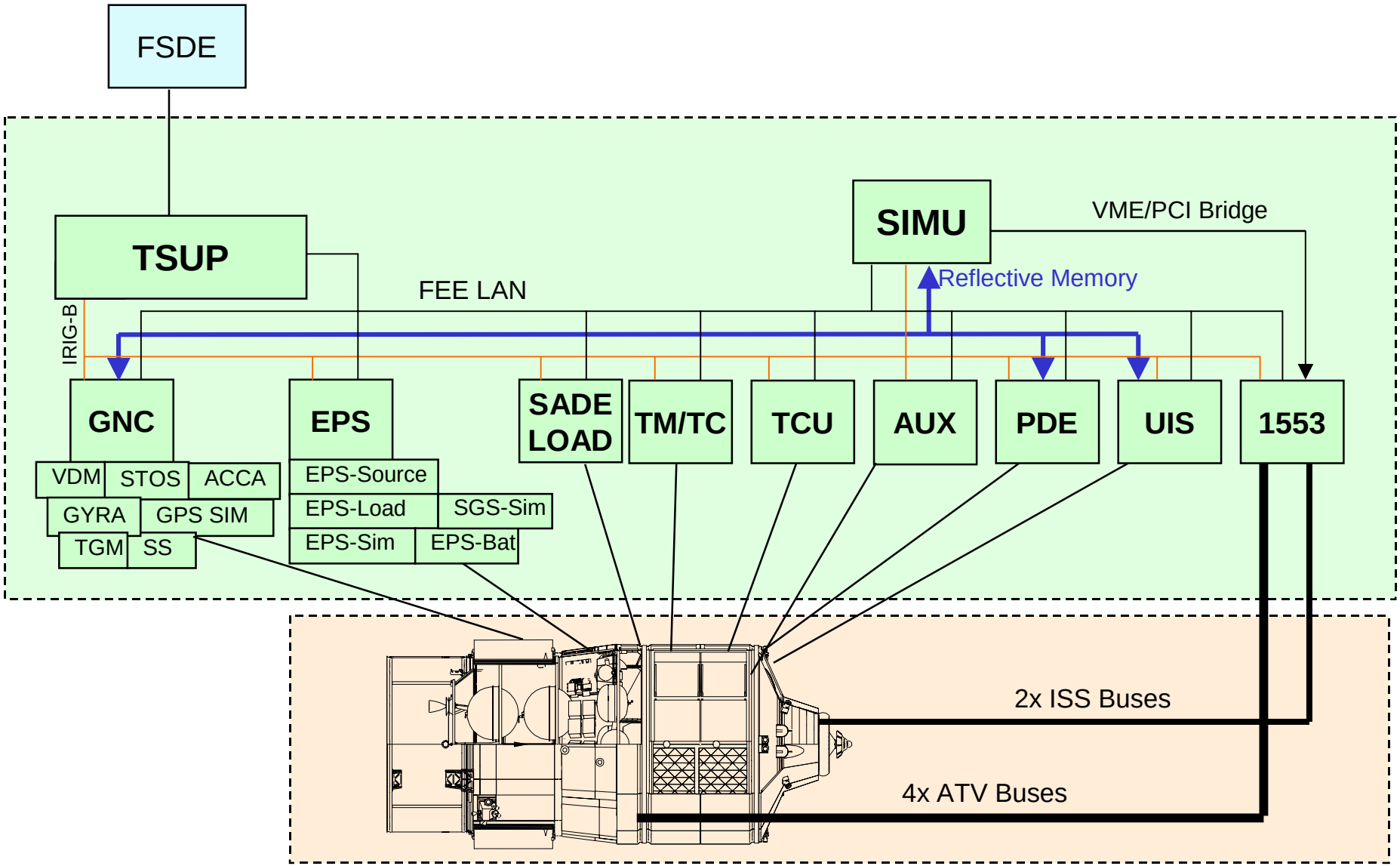
The SVF Architecture



The Functional Simulation Facility (FSF)

- Qualification of the on-board S/W on target computers
- Check of electrical interfaces between H/W equipment and on-board S/W
- Qualification end to end of Electrical chains (measurements, propulsion, thermal chains ...)
- Check of correct system performance in representative operational scenarios
- Simulation of environment und missing H/W equipment through EUROSIM models

The FSF Architecture



The Interface Validation Facilities (IVF)

- Bilateral tests with the ISS, performed in Moscow, with the Russian service module
- Rendez-Vous bilateral tests, at DLR, Oberpfaffenhofen, on the EPOS facility
  - Validation of the rendez-vous in final approach phase
  - Real-time closed-loop tests with real RdV sensors
- The IVF configuration is a reduced FSF

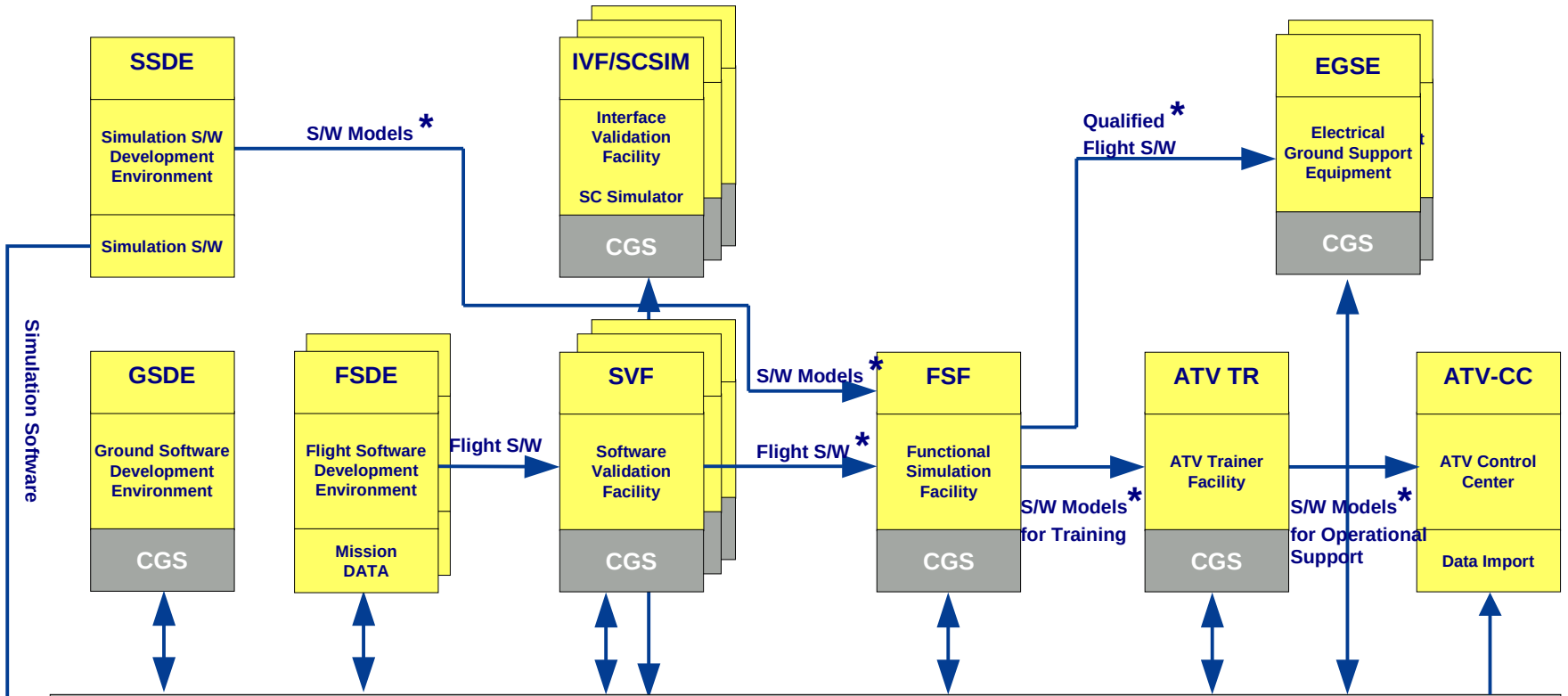
The EGSE Facilities

- Flight System Integration and Qualification including launch support
- The tests performed are:
  - Acoustic tests
  - Deployment of the solar panels
  - EMC tests
  - Compatibility test with the TDRS system
  - Overall System Test
- The EGSE configuration is a reduced FSF without the simulator
- Two set of EGSE are built-up in the ATV Project

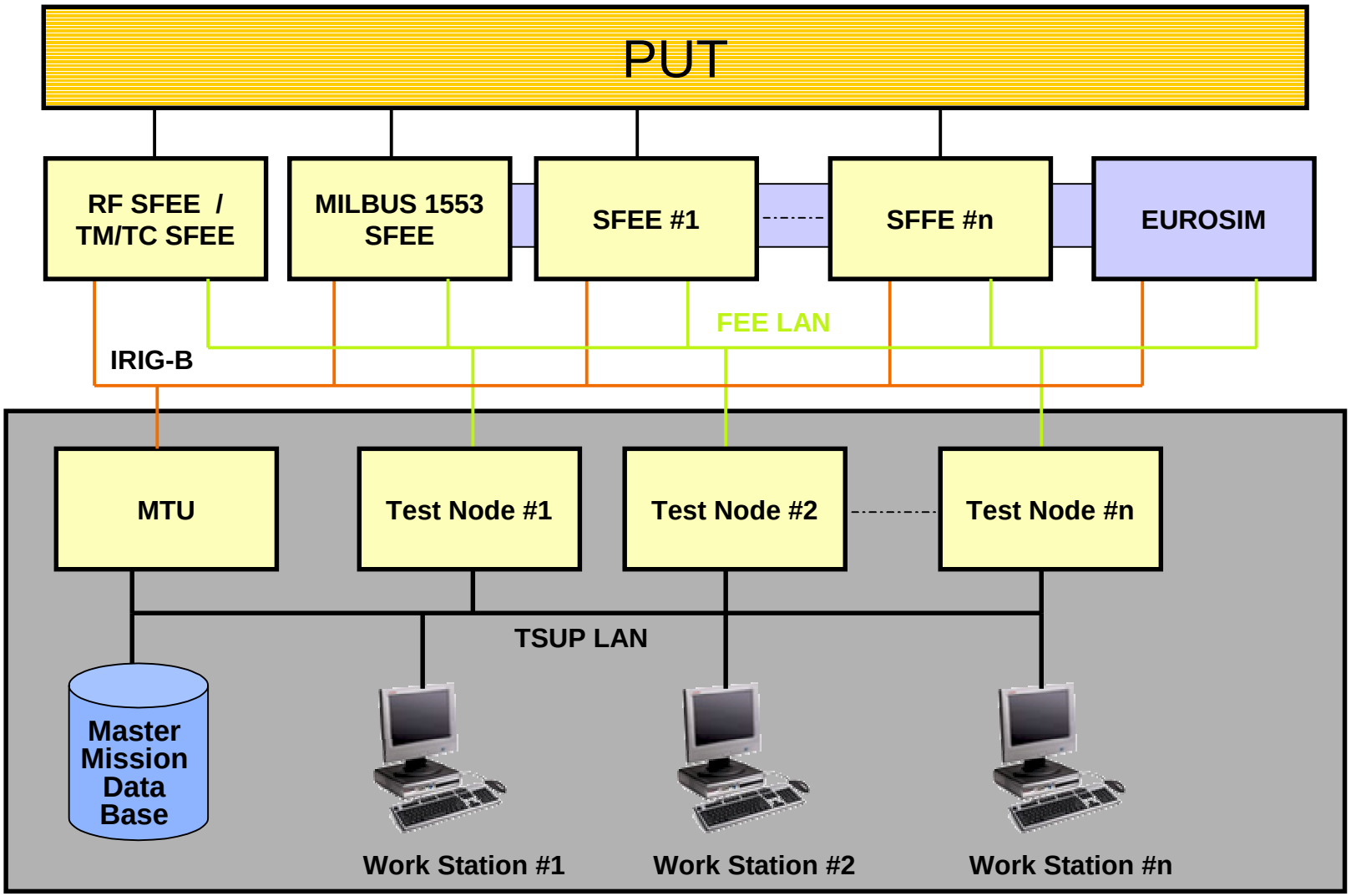
The Spacecraft Simulators (SCSIM)

- Electrical interface verification of the Russian equipment embedded inside ATV
- Simulates the ATV avionics that are connected to the Russian Units.
- The SCSIM configuration comprises:
  - ✓ Test Supervisor (TSUP) - CGS based
  - ✓ 1553 Front End Equipment
  - ✓ Power Front End Equipment
  - ✓ UIS Front End Equipment (hardwire links)
  - ✓ Load Simulation (IAPIS) simulating the ATV load for the ISS power delivery.

ATV Ground Facilities Overview



Common S/W Architecture ATV Test Facilities



CGS extensions for the ATV Test Facilities

The common CGS S/W version used for all ATV Test Facilities is S/W Version V5. This CGS version is based on the proven Columbus version V4.5, with the following main updates:

- S/W upgrade to Ada95 using GNAT compiler
- Implementation of PUS Standard (ATV)
- Access to database end items via nicknames
- Database input and update via MDB EXCEL Tool to manage “bulk data”
- Increased resolution of time (in particular for FEECP protocol to satisfy FSF needs)
- Handling of TC authorization, pre-conditions and execution verification

Communication protocols with Front End Equipment

Three types of communication protocols have been used to connect with the various Front End Equipments:

- **FEECP: Front End Communication Protocol**
  The standard communication protocol already used in the Columbus Project; suitable for response time not more than 100msec
- **RPC: Remote Procedure Calls**
  Used for FEEs, where this protocol was already implemented
- **Proprietary message based protocols**

The underlying communication interface H/W is:

TCP/IP, RS422, IEE488, reflective memory or a PCI/VME bridge

Status of ATV Test Facilities

- Most of the ATV Test Facilities have been delivered and installed (at Les Mureaux, Moscow) and the usage has been started
- Integration of EGSE in Bremen started
- The feedback received from the SVF and FSF users in Les Mureaux:

It took us quite an effort to understand the complexity of the system in the beginning,

but after that,

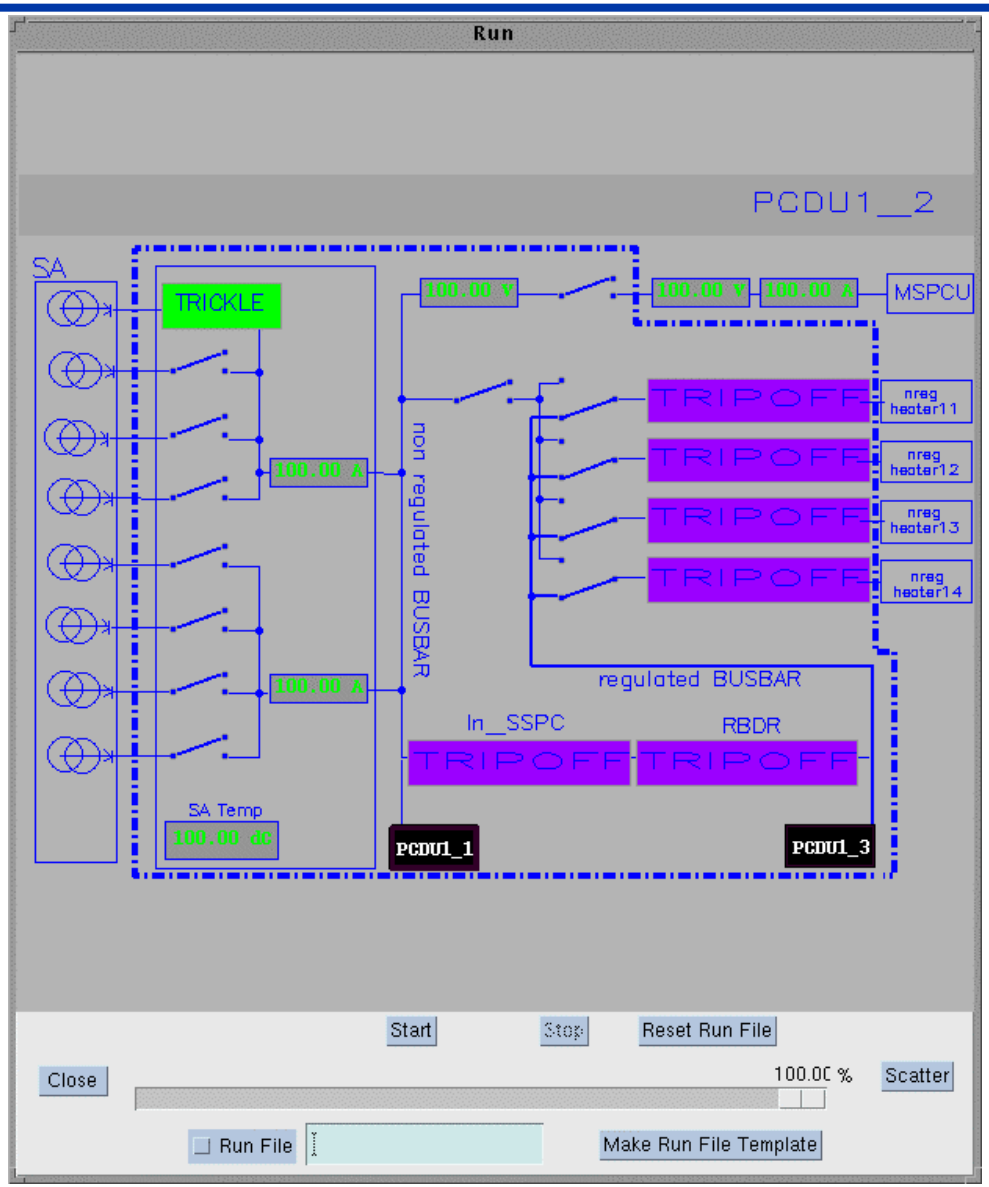
we got a very powerful and helpful system.

H/W Layout of FSF Kernel

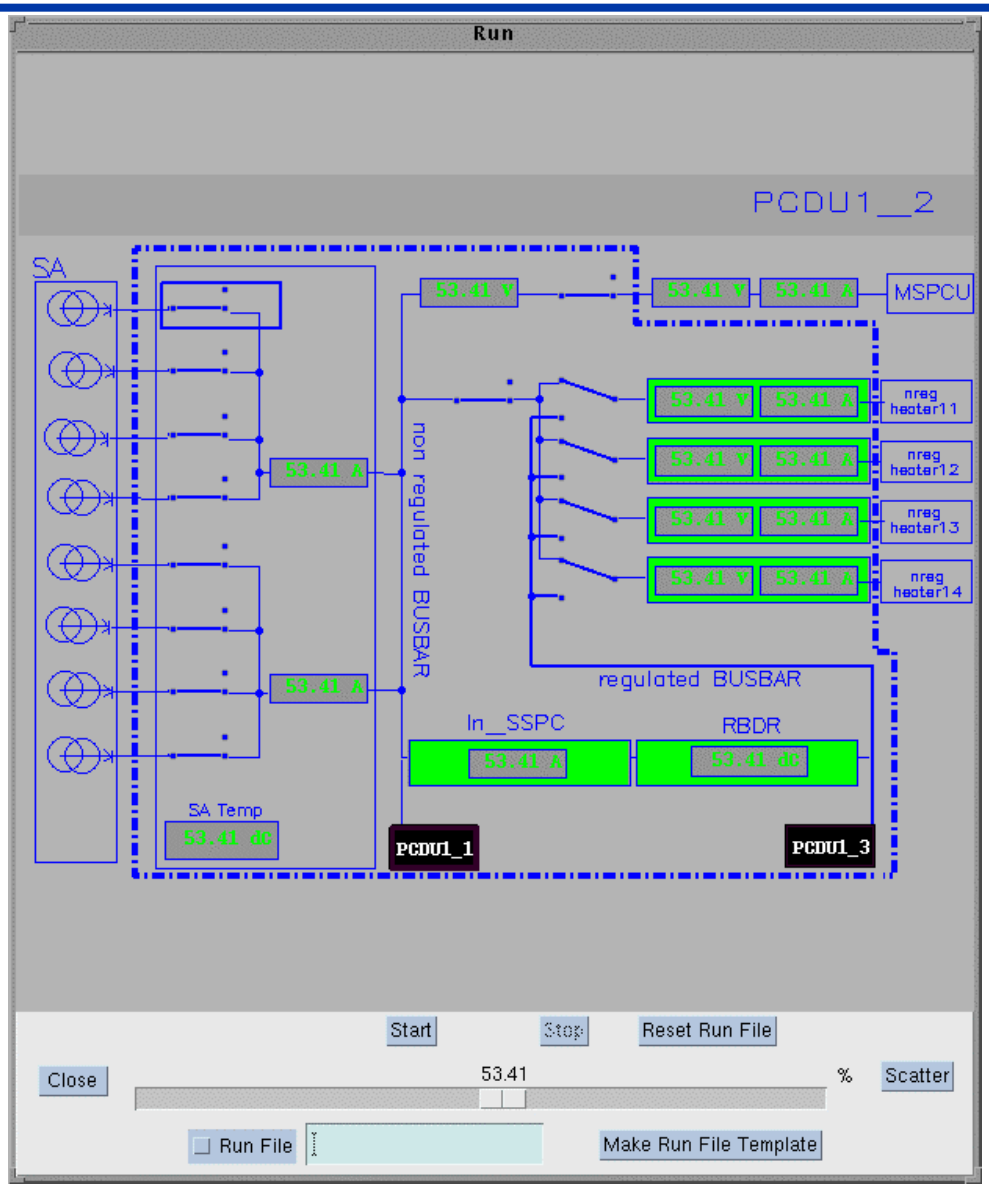
- Fan
- Cisco Switch
  Catalyst 2950
- MTU
  Datum TymServe
- 3 x IRIG-B Distr.
  Datum RF Distribution
- Local Controller
  PC / LINUX
- Local Console
  TFT/KBD in Drawer
- MIL 1553 SFEE
  3x2 Mil Bus 1553
- Simulator
  2 x SGI O200
- Power
  Distribution & Protection

- Fan
- Spare
  MSU Signal Conditioning
- DB Server Disks
  2 x 2 SCSI Disks (32 GB)
- DB Server
  SunFire 280R
- Test Node #1
  SunFire 280R
- Test Node #2
  SunFire 280R
- Test Node #3
  SunFire 280R
- Drawer
- Power
  Distribution & Protection

Synoptic Display Example



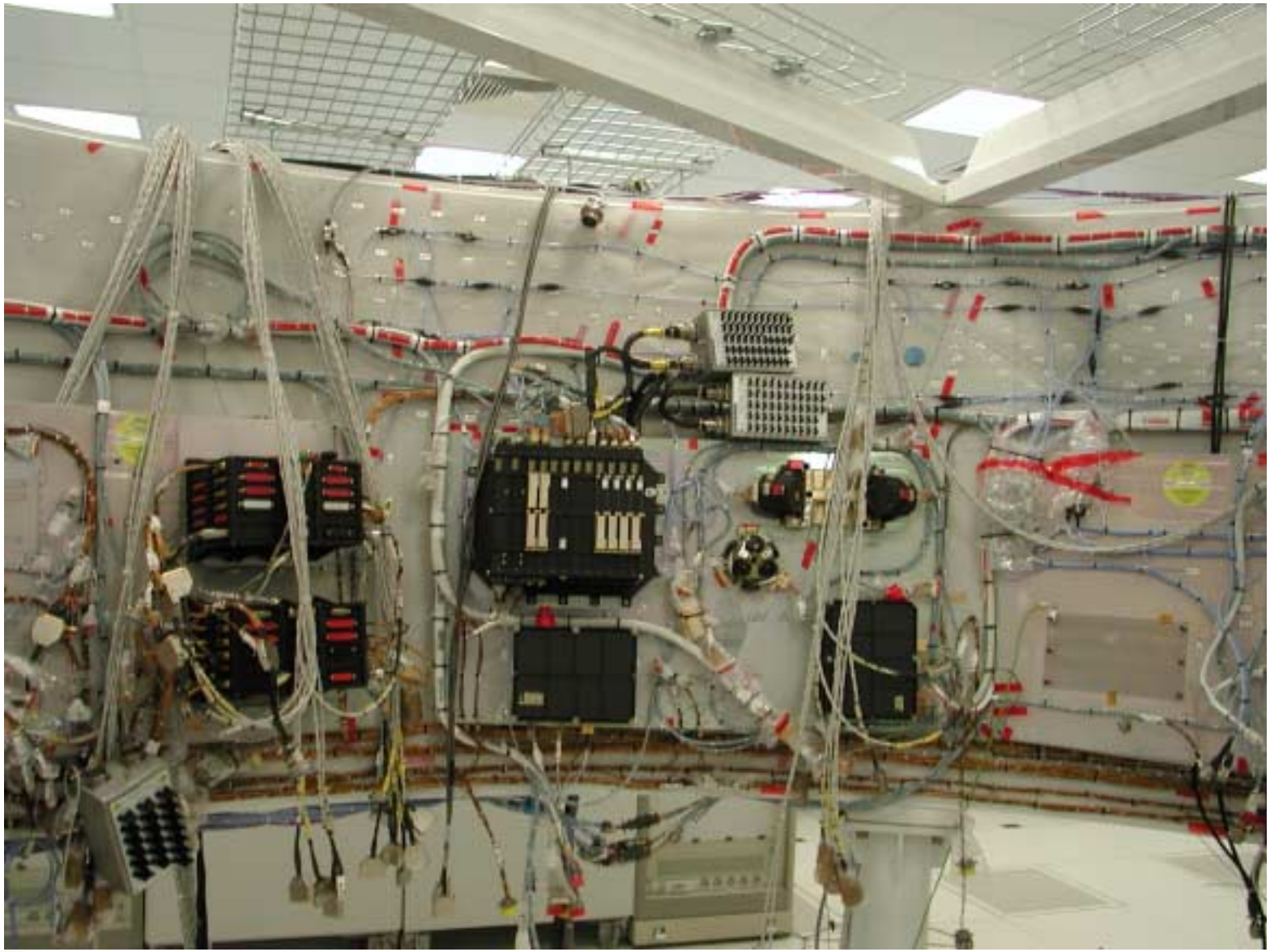
Synoptic Display Example



FSF Control Workstations in Les Mureaux

FSF: Equipped Avionics Bay & FEEs

FSF: Inside view of the EAB



Backup Charts

ATV User Feedback: CGS Good Points

- The system-wide coherence provided by the MDB mechanism.
- The Synoptic displays ; providing low cost MMI.
- The powerful command-line interface allowing to reach easily, any acquired data or to trigger any command.
- The unified description of all kind of signals (TMTC, bus, wire)
- The central timing capability allowing to compare the events across the whole facility.

ATV User Feedback: CGS Negative Points

- A poor ergonomic MMI for preparation and analysis tasks.
- The reduced capabilities of post-analysis tool.
- A rather specific logic for data organisation resulting in :
  - ✓ Restrictions in data handling (moving a sub-tree within the MDB requires a significant effort).
  - ✓ The long “scoe file generation” process before each execution.
  - ✓ A “one facility” design which implies a lot of data distributions and deliveries on the many ATV facilities.