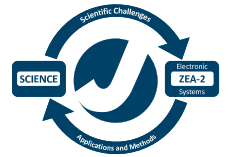
Supporting material to EGU21-7447



JÜLICH Forschungszentrum

High performance modular, compact and ruggedized processing system for airborne and balloon remote sensing instruments

Tom Neubert[1], Georg Schardt[1], Heinz Rongen[1], Egon Zimmermann[1], Thomas Gulde[3], Erik Kretschmer[3], Guido Maucher[3], Peter Preusse[2], Martin Riese[2], Jörn Ungermann[2], Stefan van Waasen[1,4]

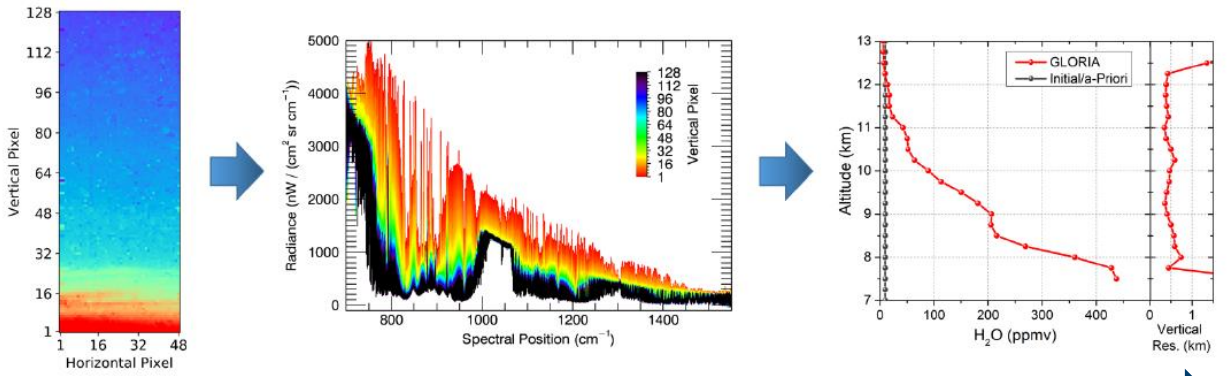
[1] Central Institute of Engineering, Electronics and Analytics - Electronic Systems (ZEA-2), Forschungszentrum Jülich, Germany
[2] Institute of Energy and Climate Research (IEK-7), Forschungszentrum Jülich, Germany
[3] Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research, Karlsruhe, Germany
[4] Faculty of Engineering, Communication Systems (NTS), University of Duisburg-Essen, Germany

Supporting material to EGU21-7447

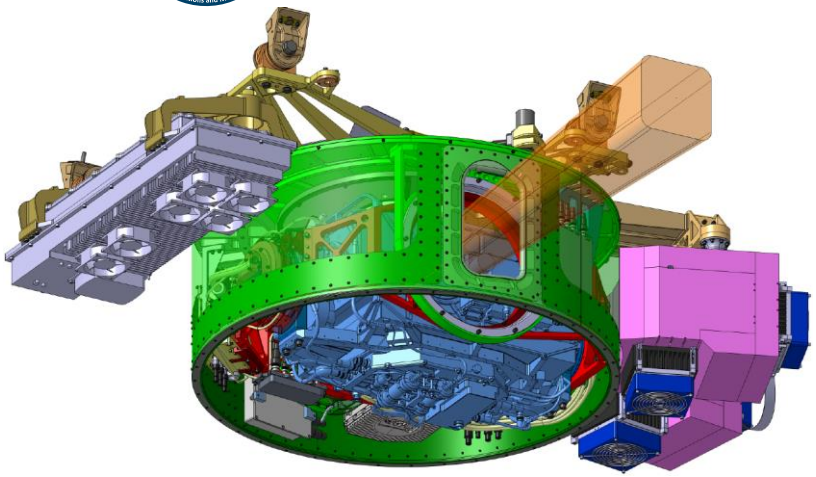
MOTIVATION

GLORIA – Limb imaging Fourier Transform Spectrometer

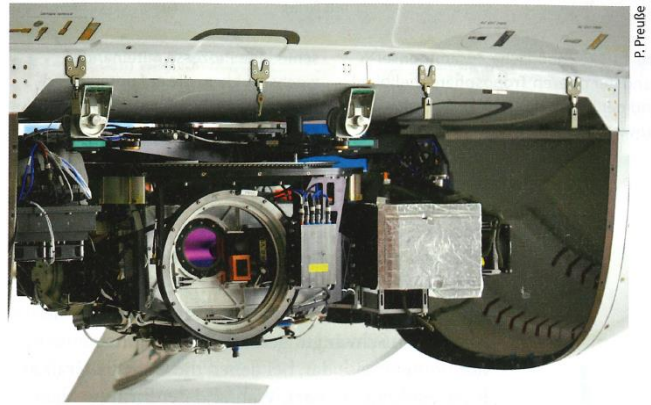
- continuous scanning imaging instrument using large infrared FPAs (256 x 256 pixel)
- high image framerates with 6400 fps at reduced image size
- different detector types, single / dual band readout
- storage capabilities needed during long duration flights
- instrument control, measurement control, remote operation
- data logging, housekeeping and TM/TC
- data transfer download capabilities on ground between flights
- compatible with different aircraft platforms



data processing steps



schematic diagram of the GLORIA instrument [Friedl-Vallon et.al., 2014]



GLORIA mounted on the belly of the HALO aircraft.

instrument paper: Riese, M., AMT, 2014, https://doi.org/10.5194/amt-7-1915-2014
Friedl-Vallon et al., AMT, 2014, https://doi.org/10.5194/amt-7-3565-2014

Supporting material to EGU21-7447

PROCESSING SYSTEM SPECIFICATION

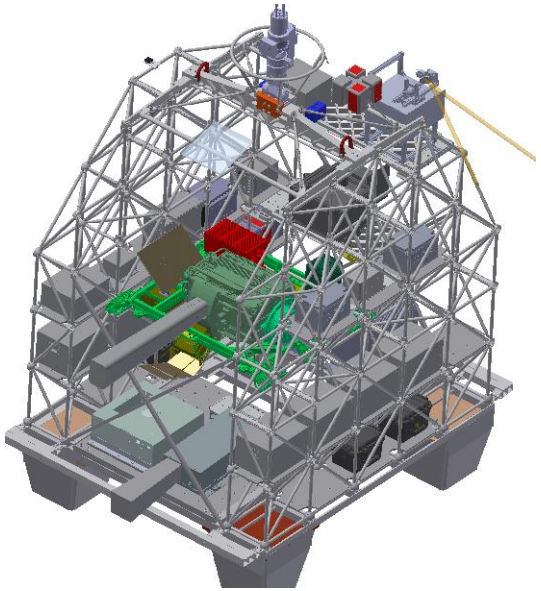
integration into research aircrafts and stratospheric balloon

Gulfstream/DLR G550 ‚HALO‘

inside - pressurized cabin

Myasichshev M-55 Geophysica

outside - unpressurized bay



balloon gondola CARMEN with GLORIA (provided by CNES and KIT)

Environmental conditions:

Operating temperature:	-40°C to +65°C chassis rail surface temperature
Storage temperature:	-55°C to +80°C ambient temperature
Speeds:	5 m/s (accent), horizontal (0 m/s ÷ 50 m/s), 7 m/s (decent)
Acceleration, Shock:	10 g vertical and 5 g lateral, up to 35 g on impact
Humidity:	0 to 95%
Pressure:	5 to 1100 hPa
Altitude:	0 to 40000 m
Flight Time:	8 to 12 hours

Technical requirements:

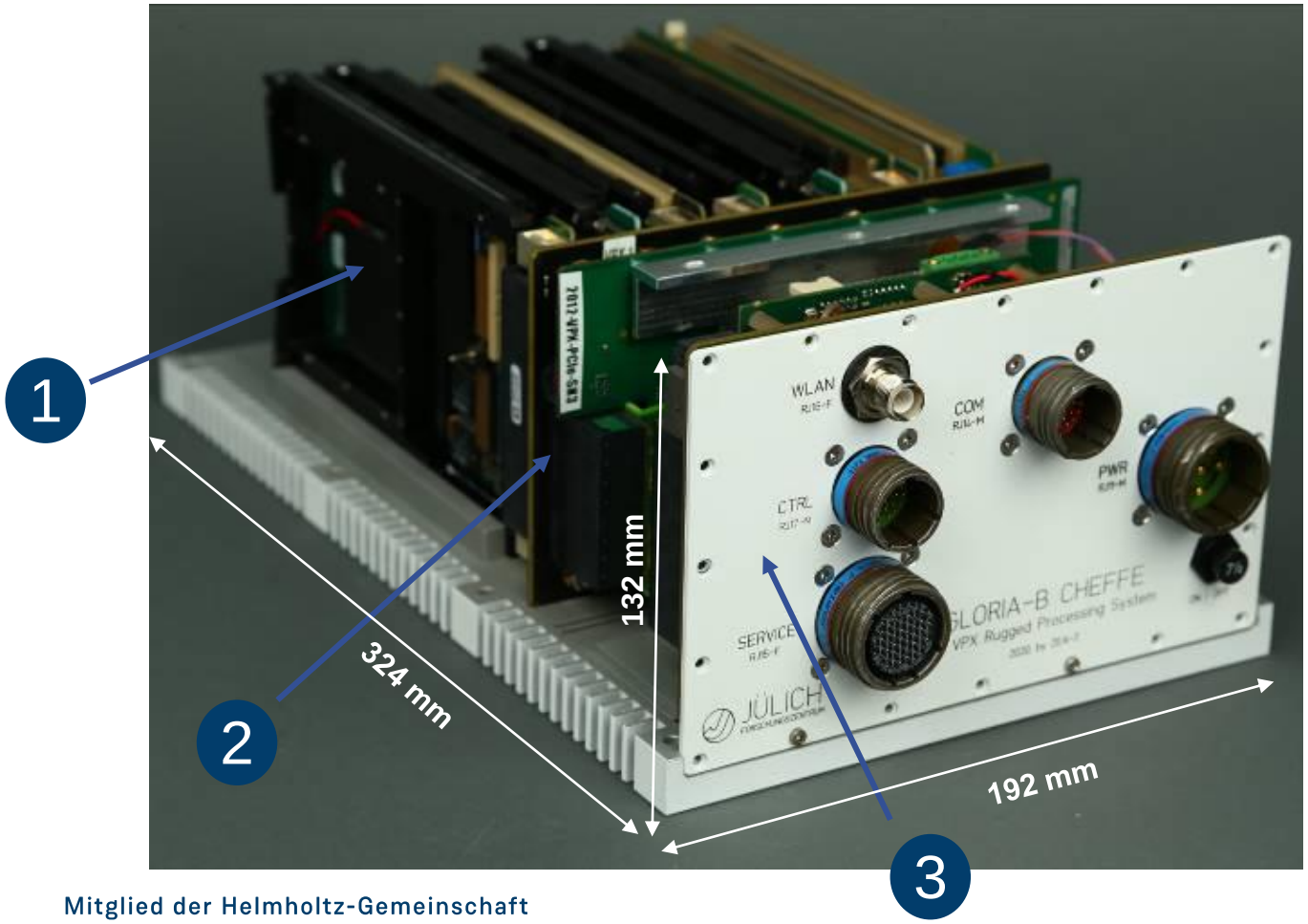
Input voltage:	24 to 36V (100mVpp, ripple)
total Power Consumption:	100 W (pk)
Data Storage Rate:	120 MByte/s (cont.)
Data Storage Capacity:	10TByte (redundant)
Communication / Downlinkrate:	1Gbps / 100kbps operating
Transfer rate:	>1Gbps
EMC compliance:	RTCA-DO160E

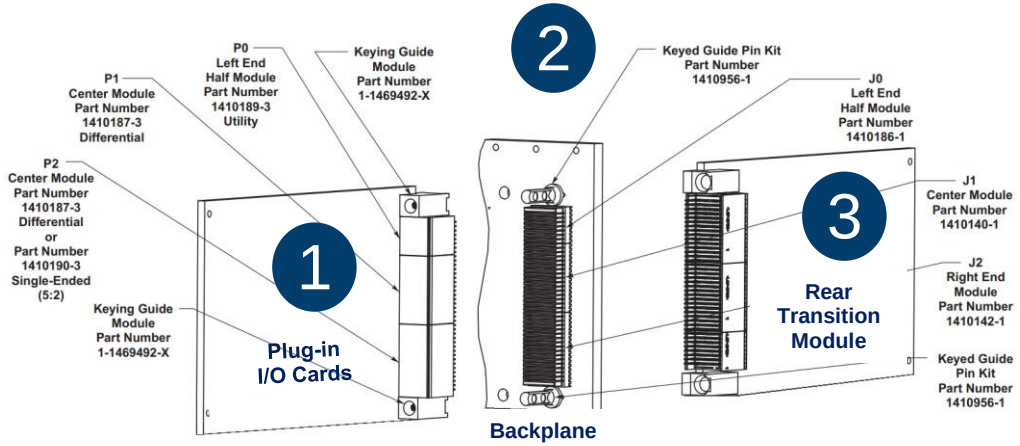
Supporting material to EGU21-7447

OVERVIEW

conduction cooled design

- 3U VPX backplane architecture according to VITA-46





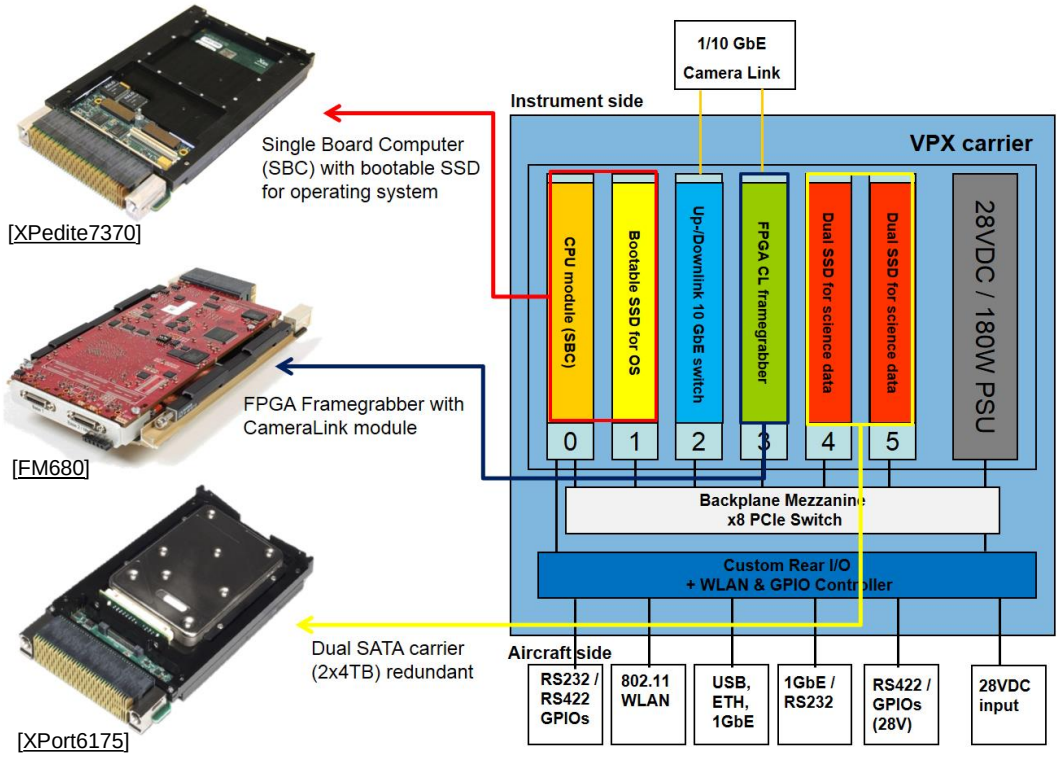
I/O card connections [VITA-46]

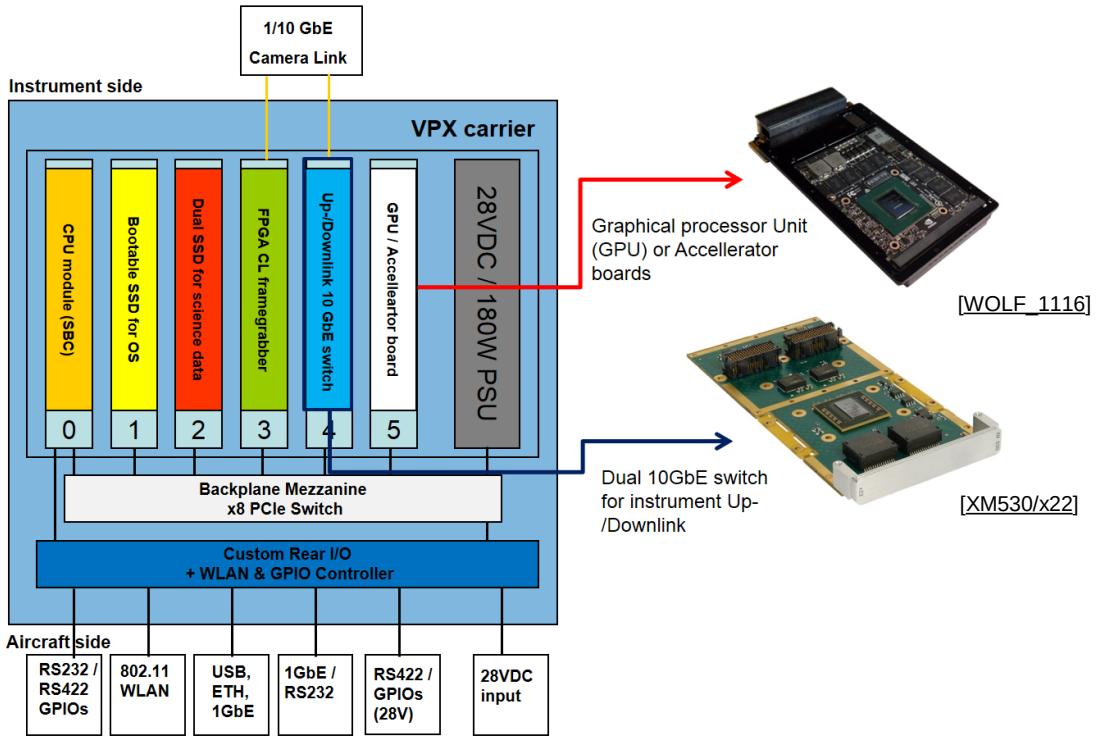
6-slot VPX Backplane with integrated x8 PCIe-switch mezannine board

Supporting material to EGU21-7447

SYSTEM CONFIGURATION OPTIONS

modular with reconfiguration possibilities





streaming and storage

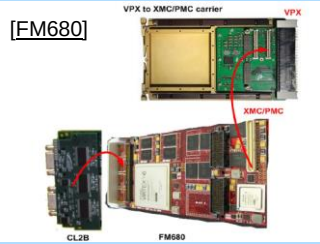
number crunching

Supporting material to EGU21-7447

“MODIFIED” PLUG IN CARDS

standard grades into ruggedized version

Re-programmable I/Os



[FM680]

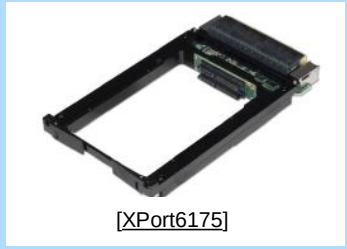
- FPGA XMC Accelerator Board (FM680) with serial I/O interface
- customize I/O Camera Link board (CL2B) + VPX to XMC carrier
- data buffering and pre processing
- flexible I/O reconfiguration (other communication interfaces possible)

Data transfer port on ground


[XM530/x22]

- commercial grade dual 10GbE switch (XM530/x22) in XMC form factor
- XMC to VPX Carrier + customize conduction cooled case
- streaming instrument data and download port

Dual port redundant storage


[XPort6175]

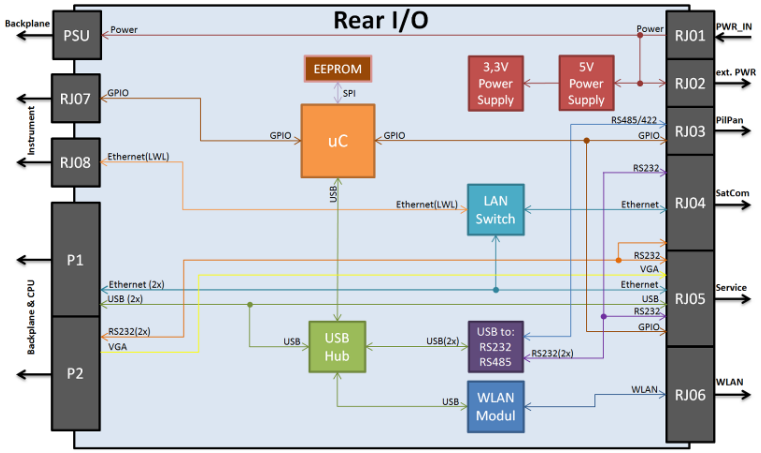
- SATA-3 to PCIe interconnection (XPORT 6175)
- conduction cooled case using industrial grade 2,5 SSDs devices with 4TB capacity
- customize grabbing firmware (stripe set, alternated and parallel data writing)

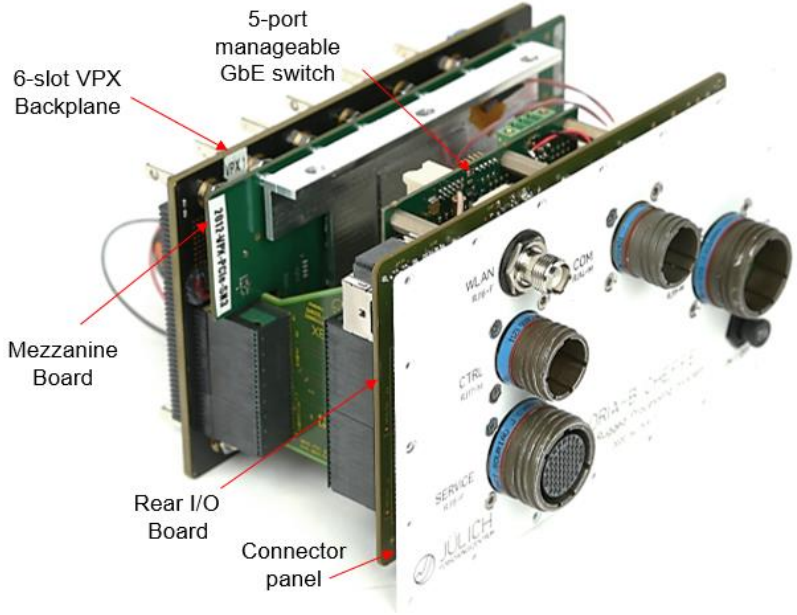
Supporting material to EGU21-7447

REAR TRANSITION MODULE

intelligent connector panel

- microcontroller based instrument control interface (powering, resets subsystems)
- multiple interfaces Wi-Fi/RS232/RS485/USB for TM/TC
- 5 port manageable 1GbE LAN switch to instrument and ground station
- software watchdog for TeleCommand/DataPackage broker
- hardware watchdog for CPU (SBC) board
- internal housekeeping (HK) acquisition (temp. / voltage/ current)
- EMI pre-filtering
- custom I/O connector panel with MIL-DTL-38999 series III

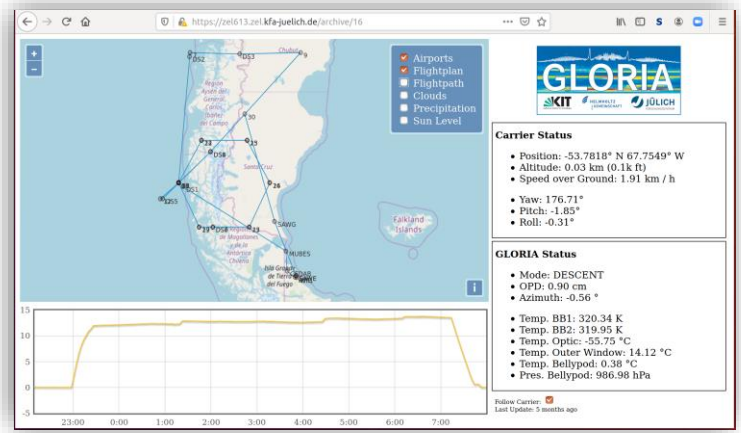




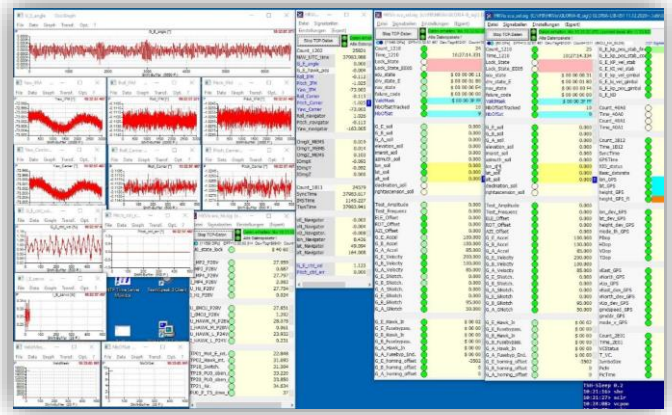
INSTRUMENT CONTROL

communication and online tracking

- network based communication divided into Glo- (instrument) and Lab- (ground station) LANs
- control via on-board operator or completely remotely by ACS (automatic control software) and ground operators
- TM/TC data rate is adaptable to communicator bandwidth
- Housekeeping (HK) data and instrument position tracking via low bandwidth satellite communication interface (web access)

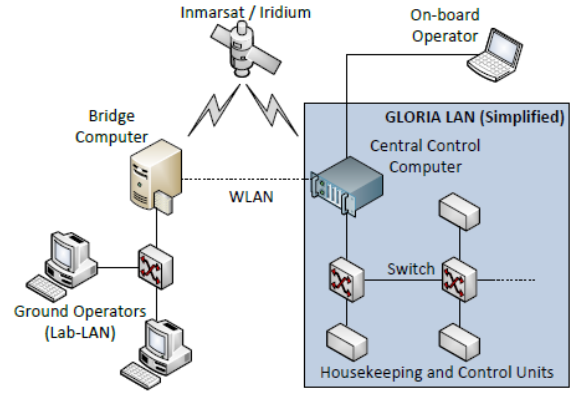


„GLORIA-watch“ flight tracking tool

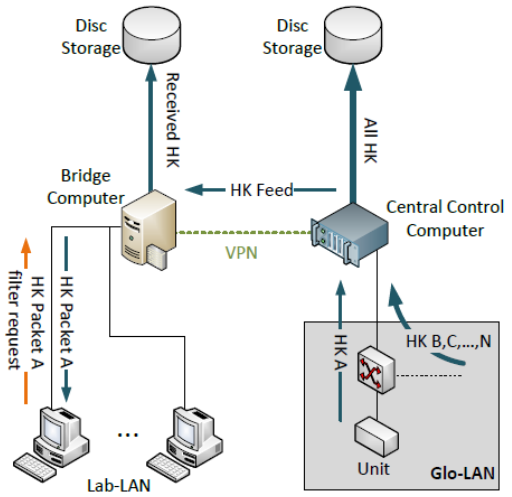


ground operator screen with HK visualisation

TM/TC topology



HK and data handling



communication paper: Kretschmer et al., AMT, 2015, https://doi.org/10.5194/amt-8-2543-2015

Supporting material to EGU21-7447

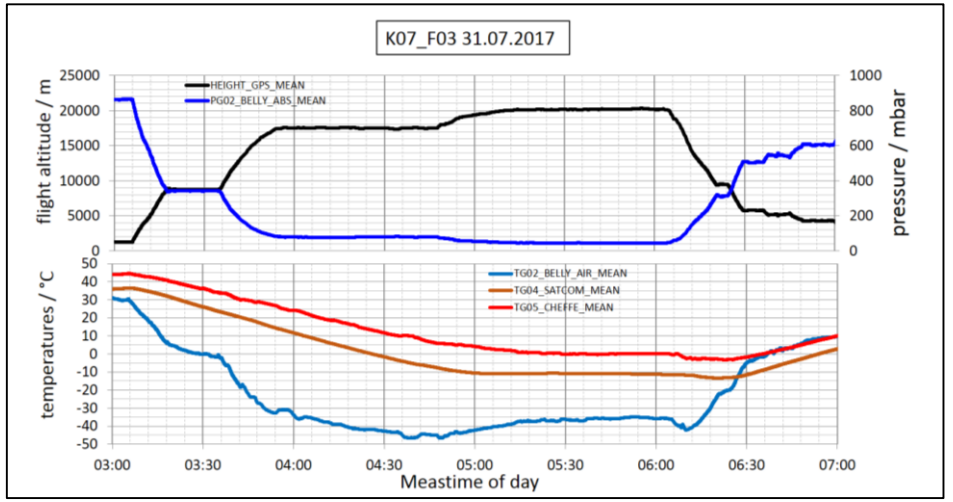
PERFORMANCE RESULTS

scientific campaigns since one decade

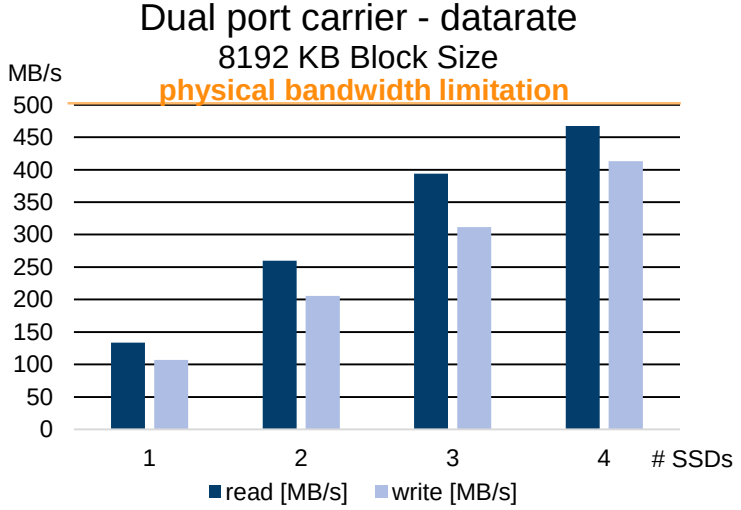
scientific campaigns (without test flights)

year	id	campaign	aircraft	flights	flight hours / h	raw data / TB
2011	K01	ESSENCE	M55	2	7	1.3
2012	K03	TACTS /ESMVAL	HALO	12	105	21.6
2016	K05	POLSTRACC	HALO	18	157	33.7
2017	K07	STRATOCLIM	M55	4 (2)	16	3.2
2017	K08	WISE	HALO	16	135	29.9
2019	K09	SOUTHTRAC	HALO	24	183	41.9
			total	**72**	**603**	**131.6**

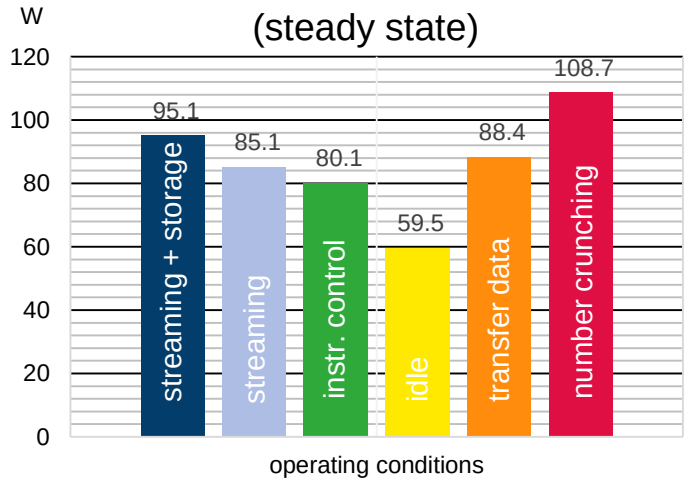
temperature profile



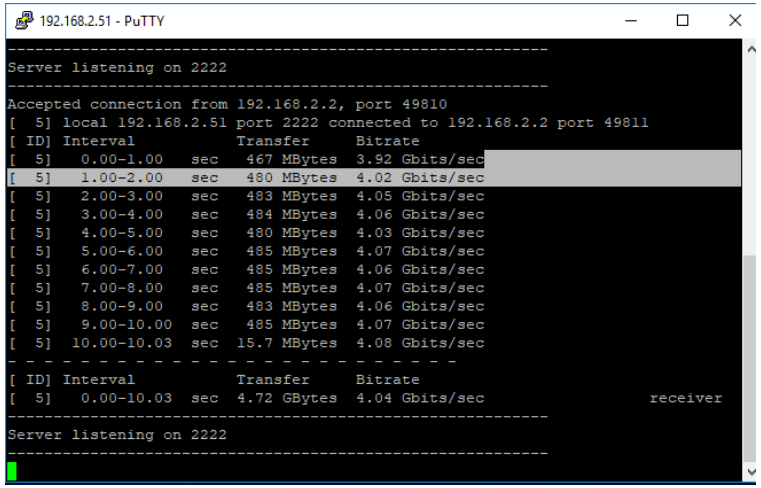
storage throughput



power consumption



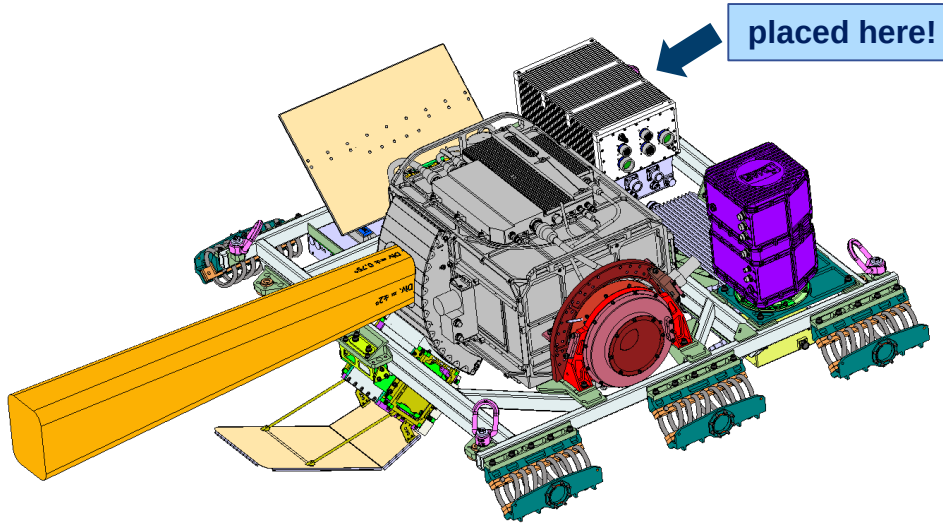
transfer rates on ground



SUMMARY & OUTLOOK

- scientific campaigns since 2011, more than 700 flight hours, of which approx. 600 dedicated to scientific operations and 130 TByte science data collected
- system hardware continuously updated, state of the art VPX cards are applicable
- modified balloon version finalized and integrated into FTS carrier
- campaign August 2021 in Kiruna, Sweden using HEMERA infrastructure
- further deployment on HALO aircraft planned in 2021, 2023 and balloon in 2022

GLORIA balloon processing system



Balloon FTS instrument carrier (provided by KIT)