ELMB++

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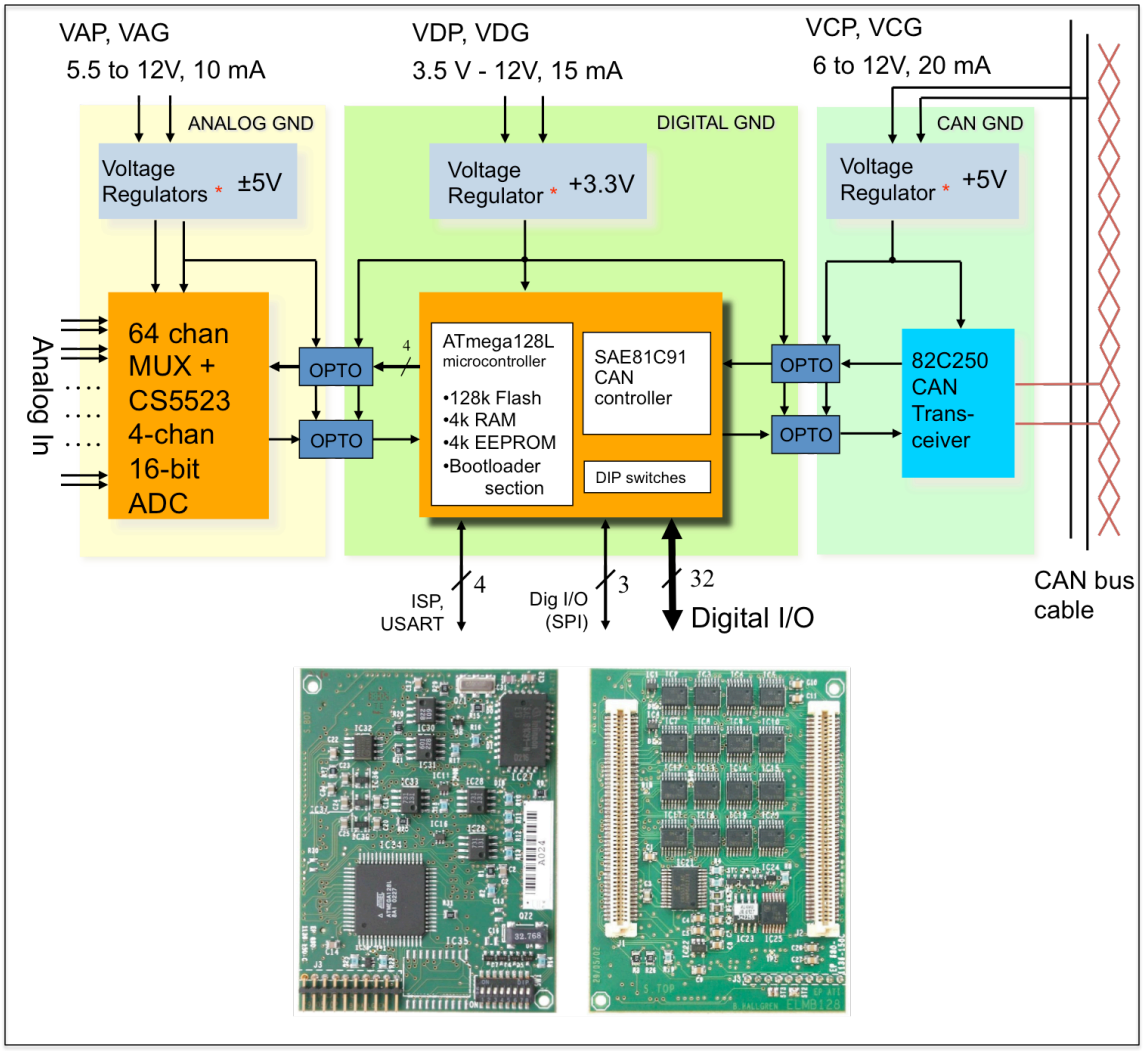
Outline

- What is the ELMB ?
- Motivation for upgrade
- Proposal for the ELMB++
- Next steps

What is the ELMB ?



- **Embedded Local Monitor Board**
- 64 analog channels. 16-bit ADC
- In-system-programmability (firmware upgrade)
- Interface: CANbus
- Radiation tolerance
  - 10^{12} neutrons/cm^2 and ~14 krad
- Magnetic field up to 1.5 T
- High number of pieces:
  - ~20000 produced
  - All experiments
- Highly distributed
  - CAN cable up to 100 m

Motivation for Upgrade

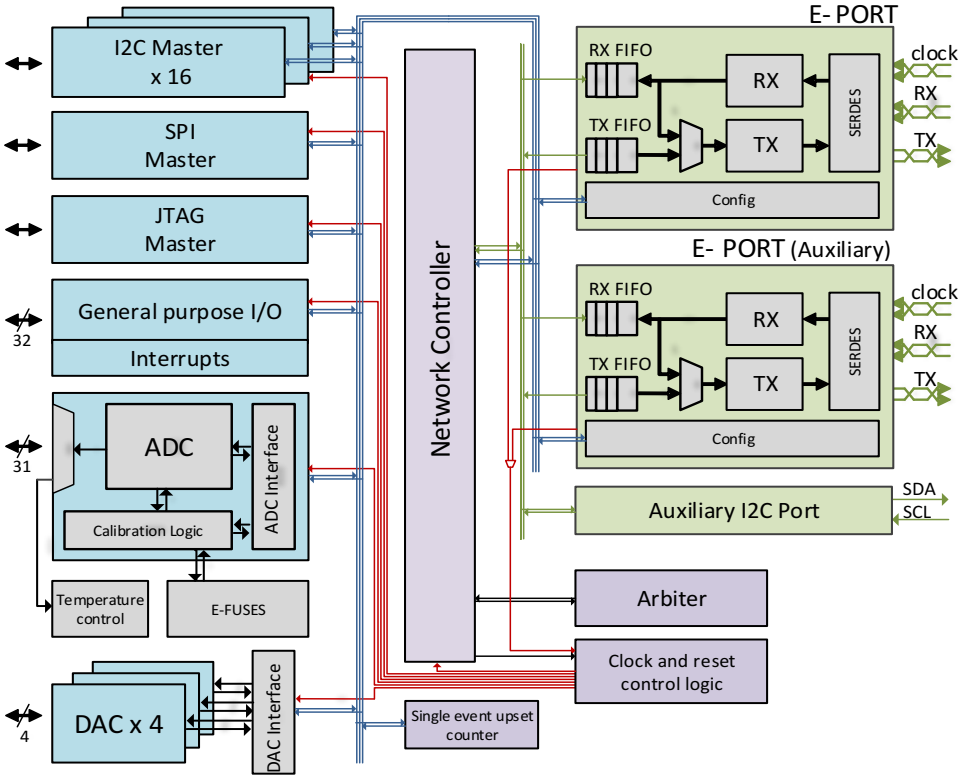
- ELMB designed in the 90'
  - Obsolescence of some components
  - Huge problems for our last production (2–3 years ago)
  - Lifetime problems to be expected during HL-LHC
- Higher level of radiation expected
  - ~100 krad, 4 10^{13} 1MeV neutron.cm^{-2}
  - SEE free (4 10^{4} hadron>20MeV.s^{-1})
  - CAN drivers are a problem
- Some functionalities missing
  - DACs
  - JTAG or I2C direct interface

Needed

- Similar functionality as ELMB for HL-LHC
- Higher level of radiation
  - ~100 krad, 4 10^{13} 1MeV neutron.cm^{-2}
  - SEE free (4 10^{4} hadron>20MeV.s^{-1})
- Similar number of analogue inputs
  - ADC resolution can be reduced to 12-bit
- DAC to be included
  - 12-bit
- Additional digital ports
  - I2C, JTAG, SPI
- CANbus replacement to be envisaged
- *If possible avoid lengthy components qualification*

GBT-SCA

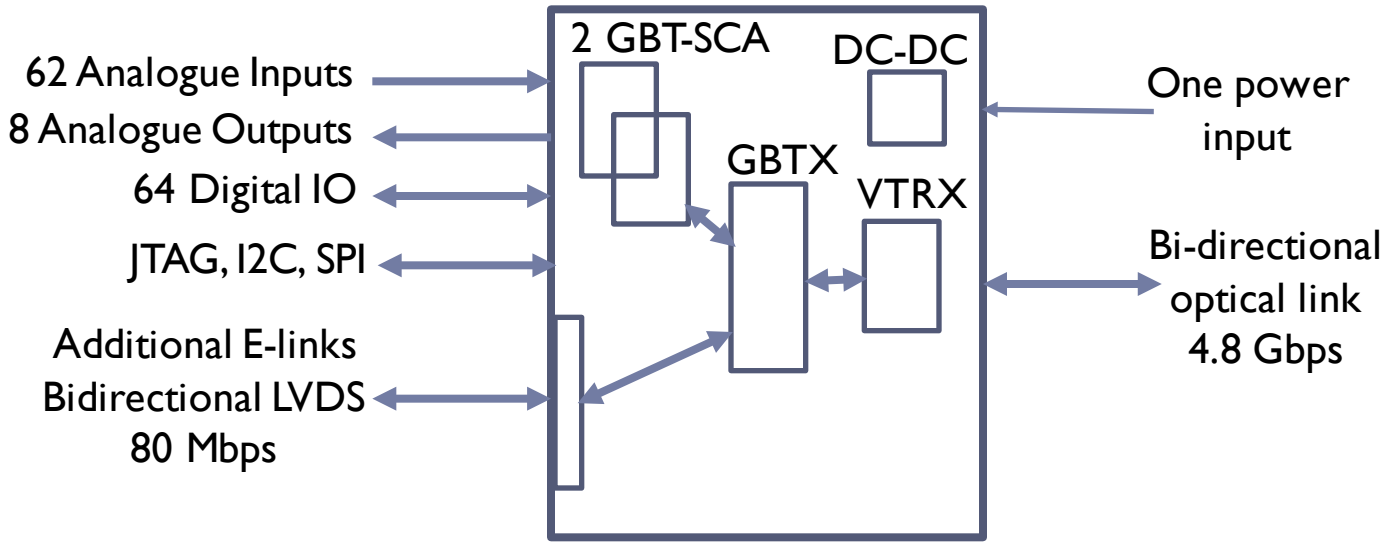
- Slow Control Adaptor of the GBT
- Communicate with the GBTX with an e-link
- 12-bit ADC and 32-ch MUX
  - 31 external inputs
- 4 x 12-bit DACs
- Several digital I/Os
  - I2C
  - SPI
  - GPIO
  - JTAG



GBT-SCA as basis of ELMB++

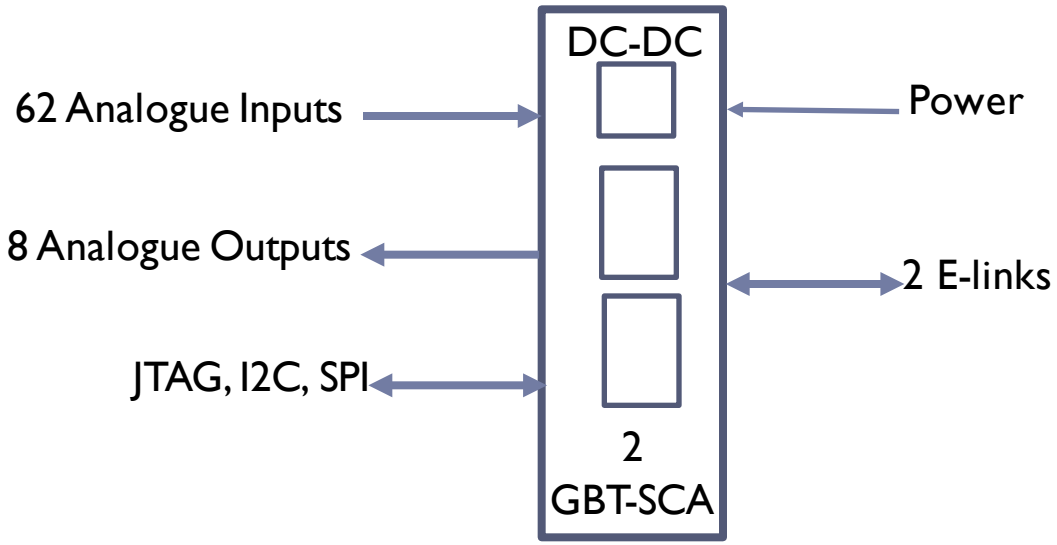
- No local processing
- Raw data to be transferred to remote processing units
  - One bidirectional link per SCA (or group of SCAs)
  - Processing unit could be fully standard (no radiation etc.)
- GBT-SCA planned to be used in the trackers and also in the ATLAS upgraded muon detector (New Small Wheels)

Hub-ELMB++ (1)



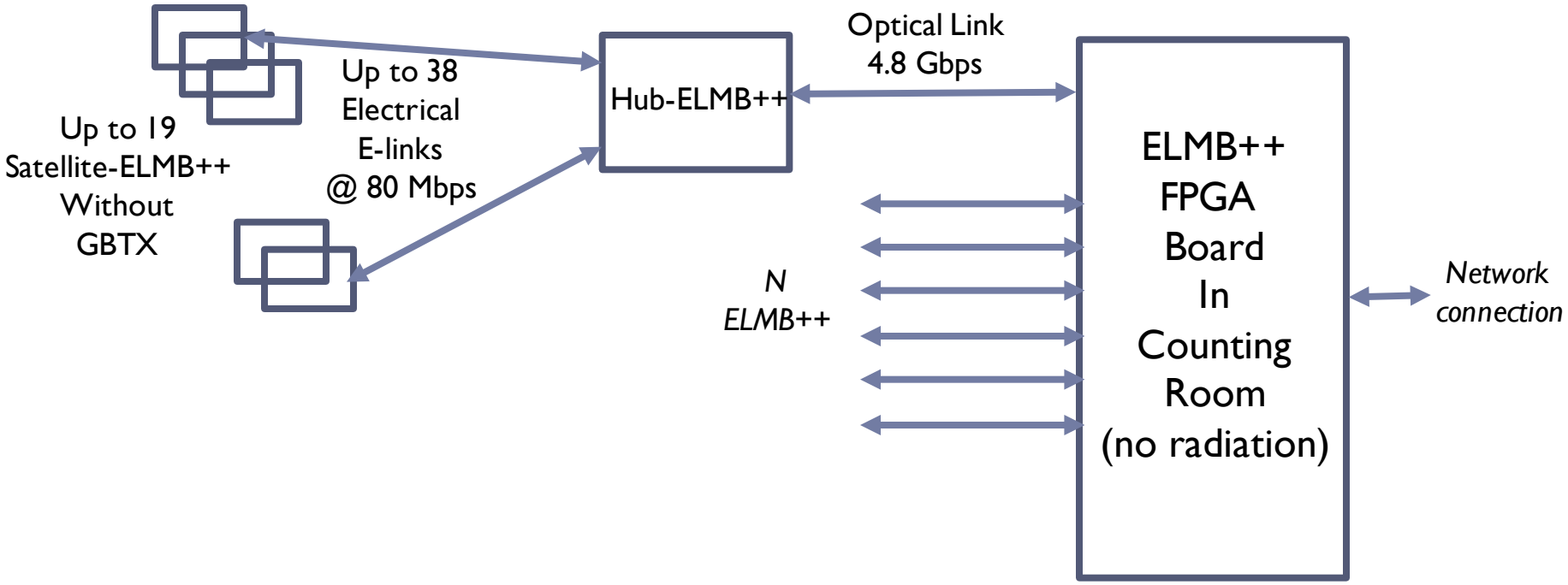
- ADC in the SCA: 12-bit, 3.5 ksamples/s
  - ~100 measurements of each input per second
- Can be used as a hub for simpler boards with only the GBT-SCA's and electrical connection to this one
  - @ 80 Mbps. Transmission distance to be characterised
  - Up to 38 additional SCA possible
- All components exist and are radiation hard qualified
- A demo board with all these components already exists and can be used for validating the idea
  - VLDB (see poster outside)

Satellite-ELMB++ (2)



- Satellite-ELMB++
  - As many as 19 such boards connected to 1 Hub-ELMB++
- Cost impact of the GBTX and VTRX reduced
  - Up to 1240 Analogue inputs for one GBTX/VTRX

Full Picture



- Star topology
  - Cost per channel maintained low
- Concept can be tested with existing hardware
  - VLDB
  - GLIB

Next Steps

- Need an agreement from the experiments for such a scheme
- Design of the Hub-ELMB++ and of the Satellite-ELMB++
  - Physical size
  - Connectors
  - Specification of the e-link cables
    - Maximum length
- Definition of the back-end part (ELMB++ FPGA) and of the network interface
- Estimation of the needed quantities
  - We are producing the GBT chip set this year