Could we abandon the HW LLT option and save money (and allow possible further improvements to the upgraded muon system)?

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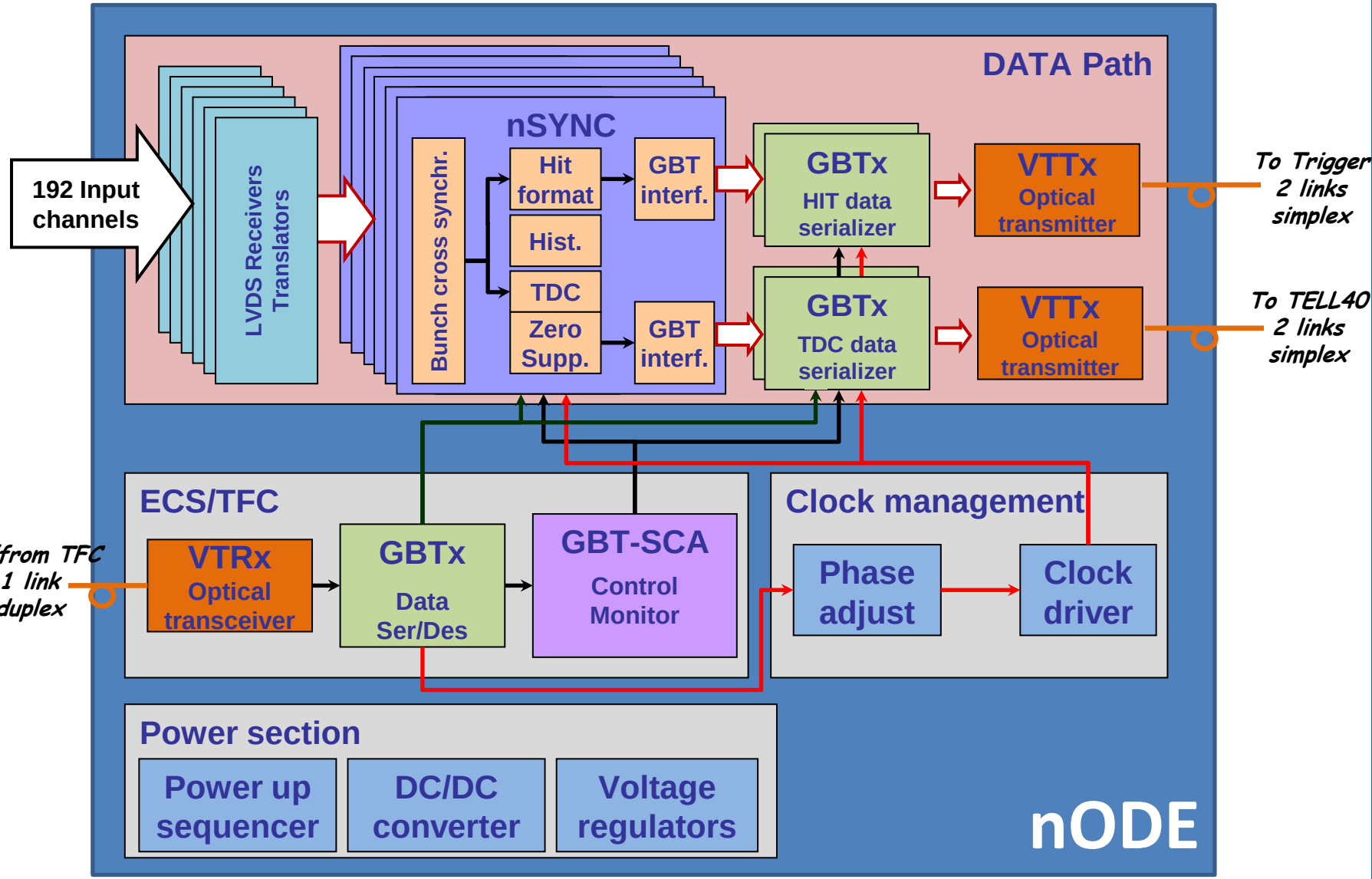
of behalf of the Muon Upgrade Group

The muon upgrade

- Get ready for the 40 MHz readout
  - Muon detector will not be modified, M1 will be removed
  - nODE (with nSYNC ASIC) for an efficient detector readout by TELL40
  - nPDM and nSB for an efficient chamber pulsing and control using GBT through GBT-SCA
  - Ready @ LS2

nODE architecture



Muon readout improvements

- The reviewers of the muon upgrade electronics architecture suggested to include the "TDC info in the binary data stream"
- We agreed on this. So in each nODE we are planning to have:
  - 4 links carrying full information (hit position and time) to DAQ
  - 2 links with only binary hit information for the HW LLT
- By doing so:
  - the number of Optical Links (and transmitter/receiver and readout boards) will increase roughly by 50%
  - The nSYNC design complexity will increase

Could we already discard the HW LLT option?

- We are starting designing the nSYNC
- We would like to define what we should include in it
- We have to define the fibres we need and the amount of optical transmitter/transceiver to order (this order was already done, BTW)
- And there is something more…

The muon upgrade (revised)

- Ongoing muon identification performance studies are suggesting that we could improve the situation with additional "small" changes to the upgraded muon system, although we have still to run detailed MC simulation to exactly quantify the improvements in performances at high luminosity

- A further step currently under study, and ready for 2020:
  - New pad detectors in most irradiated regions (M23R12)
  - More IBs removed (in M2R3, for example)

Possible new pad detectors

- M2R1
  - Rates as high as 600 kHz/cm^2
  - Currently mixed readout ➔ 384 logical pads but only 112 R/O channels
  - We could envisage to readout 192 real pads (24 FEBs, like in M1R1, will fit) with current FEBs
- M3R1
  - Rates as high as 200 kHz/cm^2
  - Currently mixed readout ➔ 384 logical pads but only 112 R/O channels
  - 192 pads as above or even 96 pads (simplified installation, final performances to be studied)
- M2R2
  - Rates as high as 100 kHz/cm^2
  - Currently mixed readout ➔ 192 logical pads but only 112 R/O channels
  - 192 pad detector possible but many cables to be added ➔ we should check if 96 pads are enough that would imply NO cables to be added ➔ check muon performance
- M3R2
  - Not critical from the rate point of view
  - Currently mixed readout ➔ 192 logical pads but only 112 R/O channels
  - 96 pads OK for dead-time, check muon performance

Possible removal of additional IBs

- We currently have 104 ODE in our system. According to PID Upgrade TDR, the removal of IBs in M5R4 will bring to 108 the number of needed nODEs
- M2R3
  - it's already a pad detector ➔ no important CARIOCA dead-time
  - It seems however that there is a large contribution for dead-time coming from DIALOG due to the large number of channels OR-ed together to make the logical strips (to be carefully verified)
  - If we remove all M3R2 IBs ➔ + 16 nODEs
- M3R3
  - Not so critical, if we want to maintain it similar to M2R2 we need +16 nODEs
- If we could afford it, we could also think of removing IBs in M2R4 (+16 nODEs) and in M3R4 (+16 nODEs)
- The option of removing IBs is simple and not too expensive, and can improve the situation in regions where inefficiency is dominated by the DIALOG dead-time (where a lot of logical channels contribute to the creation of a logical strip)

Conclusion

- The design of part of the upgraded muon system electronics components depends on the still open options for the LLT
- A software-only LLT will allow the simplification of some muon components and money savings
- Further modification to the muon system, currently under study, will allow muon performance improvements at high luminosity, but they are likely to be incompatible with an hardware LLT