Common electronics
projects-solutions across experiments and sub-systems

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Why common solutions ?

- Common solutions across experiments can have several advantages:
  - Minimize total needs of manpower and resources (scarce resources these days)
  - Make something once and well instead of in N different versions, each with its individual problems.
    - Qualification (radiation, reliability, temperature, noise, etc.)
    - Access to high end modern technologies (difficult and expensive)
    - Simplifies system integration (and in many cases also software aspects which is often “forgotten”)
  - Assure short and long term support and maintenance.
- But can also imply some difficulties:
  - It can be very difficult to make a common solution that fits everybody
    - If it is used in the majority of cases then we have already gained quite a bit.
    - How to reach common specifications must be determined.
      (large committees to make detailed technical specifications may not be the ideal way ahead: “political electronics”)
      - Somebody must make a first draft proposal to focus discussions and finally arrive at an “agreed” specification.
  - If it is made to fit everybody's needs it may become overcomplicated and imply a significant risk for the successful implementation.
  - Funding from where: CERN, Experiments, collaborating institutes,

What ?

- Currently identified fields for common electronics :
  (in first iteration among electronics coordinators)
  - Access to IC technologies, their radiation hardness, libraries, IP blocks
  - Optical links: TTC, ECS (or DCS), Readout
  - Power distribution within detector
  - Common radiation hard building blocks (chips)

  These developments justified from our specific problem of radiation hardness
- Not:
  - Detector specific front-ends as highly optimized for each detector/application
    - But they can profit from IC technology access, IP blocks, common building blocks and power distribution.
    - Some "common" examples though exist: ALICE/LHCb pixel, ASDBLR (ATLAS -> LHCb), HPTDC (CMS, ALICE, "ATLAS", and other non CERN experiments). Across sub-detectors in same experiment (ALTRO, BEETLE, HAMAC, ?)
- Potentially, but most likely difficult:
  - Controls and monitoring interfaces (ATLAS ELMB, CMS trackers and calorimeters control system, LHCb SPECS, ALICE ?, ?) -> strong connection with optical links.
  - DAQ interface modules (each experiment have different DAQ systems)
    - DAQ interface technology will be dictated by available low cost/affordable commercial solutions few years before startup of experiment: 10G Ethernet, Infiniband, ?, ?
  - New crate – bus standards VME -> ATCA, VSO ? (use standards, so what is there really for us to do in this field: Tender, purchase, support. Do not repeat Fastbus)
  - Others ?. Proposals and ideas most welcome (purpose of this workshop)

Who ?

- Non CERN Collaborating institutes normally member of one specific experiment and takes commitment to design, produce, install, commission and maintain a specific sub-system (intrinsically non common)
  - This makes it difficult for non CERN institutes to initiate common projects across experiments.
- CERN naturally involved across all experiments and have specific obligations as hosting lab.
  - This makes CERN the natural candidate to enable/start initiatives in the domain of common solutions.
    - In strong collaboration with the experiments (e.g. electronics coordination)
  - This does not exclude strong involvement of external institutes in the organization/coordination and implementation of such common solutions.
  - Involvement of external institutes highly encouraged to assure that common solutions can in fact be used in the implementation of the systems that they make commitments to make.

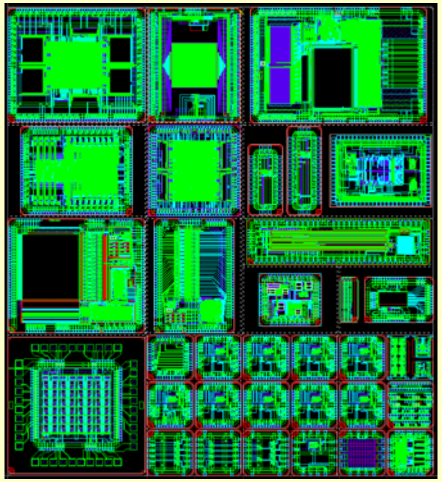
When ?

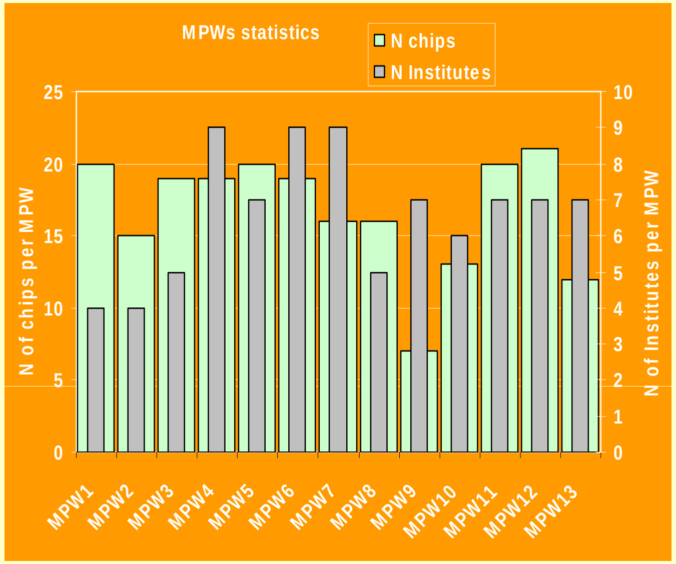
- This is another delicate question for common solutions.
- For a common solution to be adopted/enforced for the implementation of detector sub-systems "everybody" must be convinced that the solution is there when needed and will be reliable.
- This implies that common solutions must be developed rather early to prove that it works and is really available when the sub-system designs are started.
- Which implies some potential problems
  - The common solution must (start to) be designed before the details of systems using it are yet 100% clear.
  - The common solution may not be in the latest and highest performance technology (e.g. 130nm) on the day of starting (e.g. 2015) the experiment (example TTCrx). Technology may even have become obsolete and can not anymore be produced.
  - Possible scheme to minimize this dilemma:
    - System/component concepts and demonstrators must be made in first iteration.
    - A second iteration after this may imply some specification changes and mapping into new modern technology.

    More than two iterations should though be prevented as we can not allow ourselves to "play" with technology over many iterations before final solution.

IC technology and IP

- Technology access: not easy for expensive deep sub-micron technologies
  - MPW
  - Libraries
  - Design kit
- Radiation qualification and design recommendations for our environment
  - Different technologies from same technology node can have quite different radiation behavior
- IP blocks
  - Bandgap (under qualification)
  - Memories (from library company)
  - DAC's for biasing ?, ADC for slow monitoring ?
  - Timing: PLL ?, DLL ?
  - ADC ?: speed, resolution, power ?
    - Get from specialized IP company and make rad hard (a la CMS cal ADC)
  - Special IO: high speed serial, AC coupled, ?
  - ON-chip power regulation ?
  - Others ?



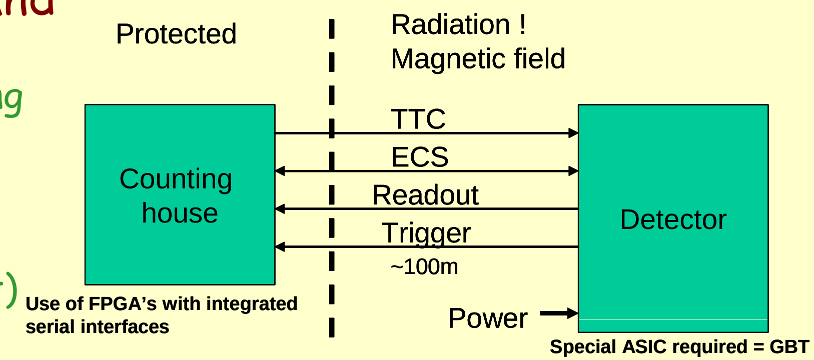


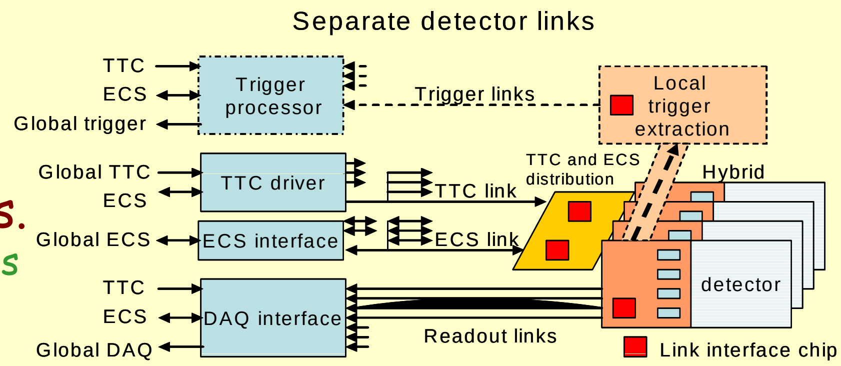
Who makes these, pays, tests, qualifies, documents ?.

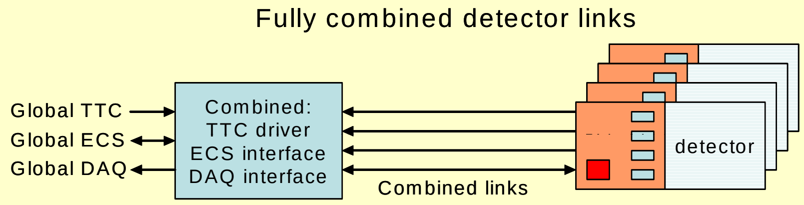
- Often developed locally as parts of specific chips. Sharing within community required (known to be non trivial)

Optical links

- Optical connections between experiment and counting house
  - Timing and trigger. Readout. Control and monitoring
- This requires bidirectional link handling different types of traffic
  - A. Use as one bidirectional link with all
  - B. Use for single function (e.g. unidirectional readout)
- Detector side:
  - Radiation hard, SEU immune, low power , , -> GBT ASIC
  - Radiation hard Laser and PIN -> identify components
- Counting house side
  - Many links per module, low cost -> Direct use of serial interfaces of FPGA's (or GBT ASIC)
  - Normal commercial Laser/pin (in arrays)
- Initial study/work on this has started among people/groups with interest in this.
  - Specification to be made with experiments/users
  - See GBT presentation
- Versatile link
  - Optical Aspects: Point-to point, Fan-out/in, PON
  - Opto components (radiation, integration, characterization, infrastructure)
- Opto electronics working group
  - Exchange of experience: See report
  - Other optical link projects

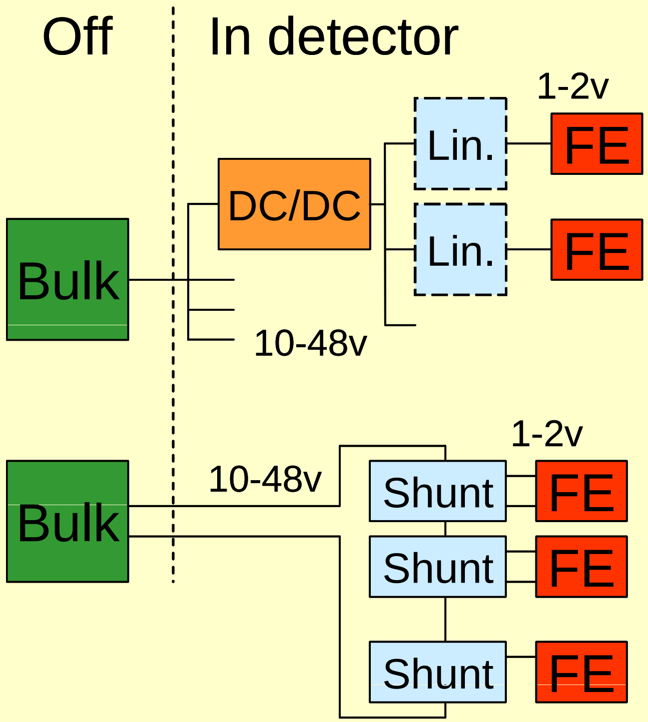






Power distribution

- Power distribution and related cabling and cooling has been a largely underestimated problem.
- A more systematic approach needed for future programs/upgrades.
  - A. Radiation hard and magnetic field tolerant DC/DC converters for small power levels ~10watts and low voltages: 1 – 2 volt (inductive, capacitive, ceramic). Galvanic isolation ?.
  - B. Radiation hard linear regulators (possibly on-chip)
  - C. Radiation tolerant bulk power supplies for intermediate voltages (10 - 48 volt)
  - D. Serial powering and shut regulators (and corresponding grounding aspects)
  - E. (Pulsed powering for low duty cycle applications like ILC and CLIC)
- Identification of interested players in this domain
  - HEP groups
  - Companies (ST, CAEN, WIENER, ?, ?)
  - Other domains: SPACE, ITER, ?
- Find a way to organize this community: working group, collaboration, EU project, ?, ?
  - This workshop could be instrumental for this.

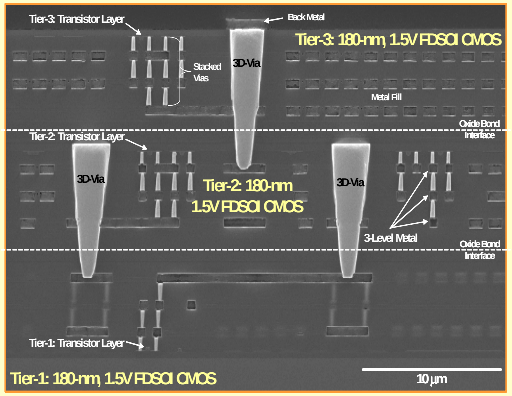


Common rad hard chips

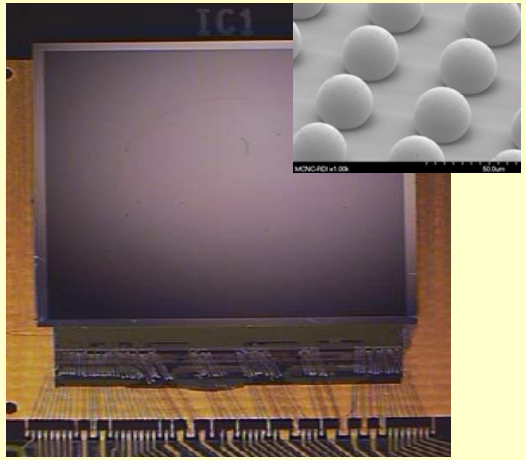
- What type of general chips needed can be common ?
- Environment monitoring in detector (DCU like)
- Rad hard ADC (would be nice but may be difficult: speed, resolution, power, etc.)
  - Or as IP block (also non trivial)
- TDC a la HPTDC
  - Is new TDC needed for SLHC upgrades as most muon systems are supposed to stay as is ?
  - Improved time resolution of interest ? (~5-10 ps)
    - Distinguish between individual interactions (~200) in same bunch collision ? (only ILC/CLIC ?)
- Radhard PLD/mini FPGA
  - This would for sure have been very useful for LHC
  - CAE tools support needed
- Others ?.
- Feedback and collaborators needed

Interconnect technologies

- Interconnect technology will be vital for large area, high channel count tracking detectors
  - Wire bonding may still be around for large area silicon strip detectors.
  - Bump bonding, flip chip for pixel and “strixel” detectors
  - 3D packaging for pixels (se presentation in this workshop)
  - Anisotropic conductive films and others.
- User needs from specific tracker developments
- Interconnect technology itself normally driven/dictated by industrial availability
- Common/shared developments, tests, quality evaluation could be useful for everybody.
- Ideas of how to organize possible common work in this domain is most welcome: working group, collaboration, common projects ?.



MIT Lincoln Laboratory



CERN Medipix

CERN involvement

- CERN PH will emphasize manpower and funding support for common projects, as it is seen as an efficient way of investing with high global return and match well role of hosting lab.
- First guesses for total manpower and funding needs for common projects have been made.
  - Assumes significant contributions from external institutes in a not yet defined form.
- Request for CERN funding to **start** currently defined common projects included in the DG white paper request for increased CERN funding.
  - We will hopefully know more about this in the coming months.
- Final outcome of this will depend on identification of partners for these projects and obtained manpower and funding resources.

Conclusion

- Some specific fields for common developments have been identified.
  - IC technology, optical links, power distribution, common rad hard chips, interconnects, ?
  - Project groups/collaborations for these to be defined.
  - Scheme to agree on basic specifications must be found.
  - Funding schemes to be defined.
  - More details on some of these in presentations in this workshop
- Hopefully this workshop will allow us to clarify:
  - Basic needs of experiments
  - Appropriate fields for common developments
  - Interested collaborators
  - How to organize our work on this