MUX-2010 DISCUSSION: WHAT DO WE NEED NEXT IN HEP

MICRO ELECTRONICS IN HEP

- Vital to build new detector **systems** with improved performance, increasing channel count, increasing functionality/complexity, lower power ,improved radiation tolerance , , , , , at affordable cost.
  - Micro electronics R&D is "expensive" but not the dominating cost of large detector systems.
  - The micro-electronics R&D must often be made very early in the project, where only limited funding is available.
- Trackers depend critically on very high integration of electronics and detector and very low power (material budget)
  - LHC upgrades mainly in the tracker domain (but not only)
- Increasingly complex systems and technologies plus the ever appearing problem of **radiation tolerance**.
- The HEP community needs to work together on IC technologies to deal with the increasing complications of IC technologies, the related tools and the problems of radiation tolerance (technology, qualification, design tricks, libraries, IP blocks , ,)
  - The current CERN support for the IBM technologies, tools, MPW and design support is requiring a significant part of CERN's limited number of micro electronics specialists.
  - Experienced IC designers are a scarce and distributed resource in HEP.
- Lots of potential novel detector/system improvements using new IC technologies and very interesting challenges ahead.

(Extracted from our justifications for continued/increased investments in micro electronics for HEP, despite generally reduced manpower/budgets)

TECHNOLOGIES

- Can our community afford (money/manpower) to work with multiple technologies (radiation qualification, tools, libraries, IP's) ?.
  - Who will actually allow us access to their technology for projects that will only have small scale production several years ahead in the future ?.
- How many technology nodes can we keep active ?
(250nm, 130nm, 90nm ?, 65nm ?)
  - Should we skip every second node (180nm, 90nm ?).
  - HV technologies for power conversion: radiation hardness a particular challenge.
  - Each node has its advantages and problems (rad tol, reduced power supply, power consumption ,density ,tools , libraries ,mask cost , ,)
- 3D opens a new dimension of possibilities, challenges and problems.
  - How much can we do in this domain before it gets industrial mainstream ?
    - Tools, libraries, testing, yield, mixing technologies (companies) , ,
  - First initiative to make common MPW run in this domain has faced significant problems.
  - We all follow the news in this domain with great interest.
- What are the right technology nodes for which projects ?:
  - LHC upgrades phase 1 (2016), XFEL, ,: 130nm
  - LHC upgrades phase 2 (2020 ?): 65nm ?
  - CLIC/ILC/Other: ???
- Is there an interest in the community to have a collaborative effort to investigate ~65nm technologies (uses silicon oxide as gate "oxide").
  - For 2020 upgrades this could be appropriate ?
- Export restrictions (caused by our ever returning question of radiation tolerance)

TOOLS

- The effort to have appropriate tools for our specific needs has been significantly underestimated.
  - Ideas how to improve on this ?.
- Large and diverse community with different levels of expertise makes support heavy and difficult.
  - Ideas how to improve on this (everybody on their own or a collaborative effort to improve on this ?)
  - "Basic" design flow to get designers started.
- Do we work in the most appropriate fashion:
  - Industry: Horizontal experts that know specific (and very complicated) tools very well. Each project needs a whole set of different experts. Quick time to market.
  - Us: Vertical engineers. Each engineer has to manage the best he can using all the different tools, know the technology plus make the design.
  - Any realistic way to improve on this ?.
    - Collaborative effort across several small groups for large projects. Experience with this ?.

LIBRARIES

Libraries are posing significant challenges to us.
  In 130nm (and below ?) we can/are using standard libraries
  BUT:

- They may not come from the same source as the foundry and we may have to pay for their use (payment schemes for such libraries not geared for people like us)

- Integration into tools becomes our problem

- We would like to get the full layouts (but they in general do not want to give this)

- We want to include our own special cells (e.g. DICE)

- We would like to have library cells with separate ground and substrate contacts (for mixed signal)

- Libraries today are not just one library for one technology but many tens of libraries (high speed, low power, different technology options, different operating voltages, IO, ,)

- Solution ?
  - Use black box libraries
  - Each designer makes his own
  - "Community" makes our own
  - Other ?

IP's: Even more complicated

- Memories: Most designs needs memories, but normal high density memories may not be appropriate
  - Radiation induced leakage current
  - Multiple bit SEU's in same memory word makes simple ECC inefficient.
- Commercial IP's normally not appropriate for our radiation environment
- Alternative: From within our own community
  - DAC's, references, basic opamp, front-ends, discriminators, PLL's, DLL's, serializers, LDO regulators, switched capacitor, , ,
  - How to solve the problem: I would like to use your IP's but do not have time (or do not want) to make my own available to the community.
    - A. Just a list of who have made what cells end then possible sharing based on "private" discussions.
    - B. Small initial list of IP's that people can only use if they contribute their own IP's ?.
    - C. ?
  - Take as is with no guarantee/support/documentation ?
    - The commercial model for IP's will for sure never work among us.
    - We are not without competition among ourselves (among experiments)

TRAINING

- There seem to be a large need for training in our HEP *IC* community.
  - A very large number of inscriptions for the training course on the CERN/VCAD design "kit"
  - Further needs/ideas for training and/or workshops (a la MUX)
    - We do clearly not want to do what other (Europractice, Cadence, mentor, synopsis , ,) already do very well in this domain.