How can RD50 contribute to the pixel detectors after an LHC upgrade?

Approaches not (yet) considered

Problems

Coming Pixel Detectors

What can we realistically do in near future (1yr)?

What is a realistic aim for the next years?

What is (yet) completely missing?

Not (yet) considered

- Monolitic Detectors
  - MAPS (usually mentioned in context of LC)
    - Radiation hardness
    - Collection speed / high rate capability
  - DEPFETs (also more suited for LC like environment)
    - Radiation hardness
    - Readout mode / speed
- “New” materials
  - Availability
- “New” structures
  - Maturity (large scale application)

Pixel Specific Problems

- Readout Electronics
  - Chips hardly available (might change very soon if one accepts “class B” chips from experiments in construction)
  - Chips are very specialized and require complicated (and expensive) read out chain (unrealistic to be operated by “outsiders”)
- Bump-Bonding
  - Expensive
  - Only possible on wafer level (in most cases)

But:

- A small pixel sensor contains all important features of a full size module

- R&D for pixel detectors
  - Involves many financial and personnel resources (probably not available in RD50)
  - Or is done “parasitic” to Experiments under construction
- Pixel detectors currently under construction:
  - **ATLAS,CMS, BTeV: all also members of RD50** but very busy with building their detectors
  - TESLA/LC, Alice (probably not interested “ultra-radiation hard” detectors)
  - Panda and CBM at GSI: Still in a very early stage of R&D

Goal for the near Future

- Find the limitations of the present “conventional” n-in-n sensors
- How can the be extended using defect engineered material (However trapping, which is up to now not engineerable, will limit the life time)?
- Can a level of 3E15 cm^{-2} be reached ?
  - Expected signal height ~ 25% ≈ 6000 electrons (very crude extrapolation) → still a useful device (spatial resolution might be degraded)
  - Saw very promising results this workshop
  - Would imply pixel layers at r ≥ 8cm (L=1E35)
  - For lower radii present readout electronics will not work anyhow (no “fast” solution possible)

Two activities currently under way

- "Simulation based" activities
  - Understand charge collection behaviour observed in test beam experiments and its degradation
    - ATLAS: Lari et al.
    - CMS: Swartz, Chiochia et al.
  - Use these models and new "pad detector characterisation data" (e.g. trapping time constants for fluences > 1E15) to extrapolate

- Feed “special” detectors into the quality monitoring procedure of ATLAS and CMS:
  - Sensors with (slight) design variations (fabricated aside the production sensors)
    - CMS: Gap sizes (p-spray sensors), p-stop geometries, etc. tested in test beam (CERN and FNAL) and with laser
    - ATLAS, BTeV: ?
  - Sensors irradiated to fluences > 1E15
    - CMS: Next irradiation (starting next week) and SPS test beam this summer
    - ATLAS, BTeV: ?
  - Sensors processed on not-DOFZ silicon
    - CMS (US): Magnetic Cz wafer with Sintef (may be also with CiS)
    - ATLAS/BTeV: ?
  - “New” Sensors: ???

Goals for Mid Term Future

- Develop a not experiment specific easy readout system (including a simple ROC with non zero suppressed analogue read out)
  - currently done at PSI, pitch: $100 \times 150 \mu m^2$, chip size ~ $20 mm^2$ (but is not a “high priority project”, chips available on CERN-MPW 14 **???**)
- Bump bond “new” structures (can be anything available on 100mm wafers) to such or any other ROC and test with laser, source or particles.
- Any other proposals ???

Missing Activities

Presently there is no activity for

- Cheaper pixel detector for replacement of inner strip layers (r<30cm) e.g.:
  - Single sided “n on p” sensors ??
    - There are very promising activities in the strip community
    - Is there space for a 4mm × 5mm pixel device ?
    - Bump bonding will be very difficult (single die)
  - Special care for module and guard ring design
- Very cheap “Makro pixels” (30<r<50cm)
  - 1 ROC per sensor and signal routing (MCMD? Interesting for ATLAS/Wuppertal ?)
  - 150mm wafers?

Discussion

Please comment and make further suggestions!!!