Discussion on new p-type common structures of RD50 in 2005

Workshop on p-type detectors, IRST, Trento, March 1, 2005

Motivations to do new common structures:

1) Motivation:
    a. N-strip isolation studies
    b. Charge collection and noise studies. Of special interest is the performance of n-type MCz Si after irradiation in comparison with p-type FZ and MCz
    c. System studies (e.g. cooling, high bias voltages…)
    d. Different materials (including non-inverting and p-type MCz, Epi)
    e. Optimised geometrical parameters (thickness, strip pitch, width…)

The aim of producing new microstrip detectors is the study of their radiation hardness for the fluence level expected at the innermost microstrip layer foreseen at the upgraded General Purpose Detectors (GDPs) at sLHC. In the inner part of the experiment there will be 3-4 layers of pixels and microstrips will reasonably start from R = 30cm. The fluence scale is up to few (3-5) $10^{15}cm^{-2}$. In order to keep the same occupancy level as in the present LHC tracker, a simple scaling down factor of the cell size can be extrapolated from the present ATLAS and CMS geometries, and a strip length of 3cm for a strip width of 80um would fulfil the requirement of 1%. It was agreed that this geometry is kept as the most direct demonstrator for sLHC-like sensor size, but a few other geometries are possible on the wafer. For example it is possible to include pixels, but it was reported (Hartmut) that ATLAS pixel groups show a low level of interest in this development at present (more concentrated on the electronics aspect). The present pixel devices of the RD50-FDS-1 mask could be kept as our pixel demonstrator.

A 6" mask should be necessary to go to commercial manufacturers. This should help also for presenting our results to CMS – ATLAS experiments and show them that the ideas of RD50 can be scaled to 6". It is suggested to have two runs, one on 4", one on 6". Some detectors in 6" and 4" should be the same to make comparison between the two processes. Process on 4" could be performed by CNM, IRST; 6" by e.g. Sintef, Micron, CSEM. Hamamatsu will be approached directly by experiments.

The new production should consist in two batches with 20 wafers each.

An RD50 mask set has already been produced with the common project in 2004. The project will be completed by CNM process in 2005 (CNM-2005). In these masks there are also pixel structures. This mask set will be used by Micron for thick/thin detector comparison (140/300 μm). These masks have only p-spray, no p-stop. Micron is already producing large scale n-in-n detectors with p-spray so they qualify as an experienced producer. The new mask should contain detectors with p-stops as well.

Which mask manufacturers (Manuel Lozano)? We usually keep using Photronics (Gianluigi). It follows a comparison between different mask manufacturers.

Details on common structures

1. p-spray and p-stop. An R&D on best p-spray dose should be performed to ensure high breakdown voltage before irradiation. With p-spray, after irradiation, there is no problem, you have a very high resistance to breakdown. On the contrary, with p-stop, detectors behave better before irradiation and worse after irradiation. Maybe a combination of the two isolation techniques is the best.
2. Strip geometry. As discussed above, the suggested strip length is 3cm. The number of strips should be 128 to match the number of channels in presently available electronics analogue chips at LHC speed. We should also keep backward compatibility (comparison with existing results). Try 50 and 100µm pitch, and 80µm as in ATLAS. You don't want to add excess capacitance with too narrow strips. Suggestion of Gianluigi: 50-80-100µm pitch, strip over pitch ratio 0.25, overhang (after processing) 2µm over-metal on both sides. Beside these, we could have still room for longer detectors or other structures, e.g. longer strips. Alberto: try to use also bigger sensors inside the 6" wafer.
3. directions on wafer thickness. Gianluigi suggests that thickness could not be a major constraint as, p-type detectors, like n-on-n, can work well non fully depleted. Anyway it is suggested to test two thicknesses: 150 and 300µm. As 200µm is the limit for IRST (Maurizio), thicknesses are chosen to be 200&300µm.
4. Materials of interest are:
    a. p-type standard 4kΩcm, <100>, Topsil, Wacker, Silktronic (70.5Euro of Silktronic)
    b. p-type oxygenated by diffusion on few standard p-type (DOFZ)
    c. p-type MCz Si - 45Euros in Okmetic)
    d. p-type epi 150µm ITME
    e. n-type MCz Si as this n-type seems not to invert
    f. n-type epi 150µm ITME

All of them have been the subject of a process done or under way:

Material	Done or under way
A	CNM-2005
B	CNM-2005
C	SMART-2
D	CNM-2005
E	SMART-1
F	CNM-2005

The studies under way should investigate material optimisation. The new project should investigate strip isolation and geometries.

CNM-2005 process will be finished in June. Then test structures will be irradiated at Karlsruhe and tested. This structures will give information for the next process. SMART1 and SMART2 will continue post-irradiation tests to the same purpose. These detectors are going to Karlsruhe within few days from now.

Final project to be submitted to RD50 will contain

Request of process of 3 batches 20 wafers each 4-6" (to be decided)
No specific on wafers before tests on previous sensors are made
Indication of test structures to be inserted in the new mask

Availability of wafers within RD50 must be checked to know what should be bought in future.