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LG
DRAFT

DRAFT Yield Model for PXL Detector

The PXL detector is a low mass detector that will be located very close to the beam pipe. It consists of two layers of silicon pixel detectors, one layer at 2.5 cm average radius and the other at 8.0 cm average radius. The PXL has a total of 40 ladders, 10 in the inner layer and 30 in the outer layer. Each ladder contains a row of 10 monolithic CMOS detector chips and each ladder has an active area of ~19.2 cm × ~1.92 cm. The CMOS chips contain an 928 × 960 array of 20.7 μm square pixels and will be thinned down to a thickness of 50 μm to minimize Multiple Coulomb Scattering (MCS) in the detector. A set of four ladders is combined on a trapezoidal carbon fiber tube to generate a sector with one ladder on the inner surface and three ladders on the outer surface. The full detector consists of an array of ten such sectors. The sector geometry is shown in Figure 1

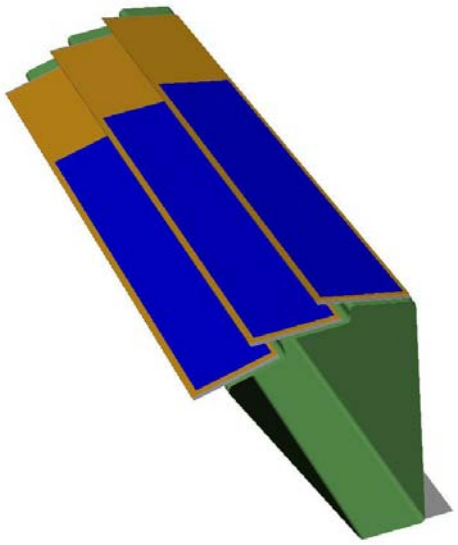

Figure 1 Sector geometry showing the four ladders that make up a sector with three in the outer positions and one in the inner position.

The steps involved in the assembly of these sectors and yield points are described below.

1. Wafers delivered from foundry
2. Wafers thinned and diced at vendor
3. Thinned sensors are probe tested, characterized and sorted.
4. 10 sensors assembled onto a Kapton cables to form a ladder
5. Sensors on ladders wire bonded

6. Components and wire harness added to ladders and ladders tested.
7. Wire bonds encapsulated.
8. Ladders assembled onto sectors and sectors tested.
9. Sensor positions measured on sector with CMM.

	Task	**Components involved**	**Estimated yield**	**Comments**
1	Wafers delivered from foundry	wafers	90%	The typical die yield from the wafers with a "good:" die having <4 bad columns or rows is over 90 % as measured on wafers of other full and half-reticle size sensors at both IPHC and LBNL. http://rnc.lbl.gov/hft/hardware/docs/sensor_review/ultimate_design_review_5dec.pdf
2	Wafers thinned and diced at vendor	Wafers	80%	The vendor reports over 95% standard yield for the pre-scribing and back-thinning process. We have used this process only once and achieved a lower yield of 70% based on one wafer. Please see http://rnc.lbl.gov/hft/hardware/docs/Phase1/Phase_2_thinned_yield_initial.pdfThe thinning of already diced sensors has a yield of >90% based on >5 years of experience with this vendor.
3	Thinned sensors are probe tested, characterized and sorted.	sensors	95%	The sensors are handled during this process and manipulated with vacuum holders. We have, to date, had minimal handling related losses.
4	10 sensors assembled onto a Kapton cables to form a ladder	1 x Cable 10 x sensors	90%	The yield is relatively high because we have assembled >3 test ladders without damage for this step. Nevertheless, this is a crucial step and the estimated yield is reduced to 90%
5	Sensors on ladders wire bonded	1 x Cable 10 x sensors	95%	The expected yield is high. We have not had, to date, any losses associated with bonding and bonding problems can be repaired.
6	Components and wire harness added to ladders and ladders tested	1 x Cable 10 x sensors	95%	The yield is high because we have assembled all of our test ladders without damage for this step. Also, errors in parts and wire harness can be detected and corrected in testing.
7	Wire bonds encapsulated	1 x Cable 10 x sensors	99%	This step has been highly reliable for other detector assemblies.
8	Ladders assembled onto sectors and sectors tested	4 x ladders	95%	Ladders on sectors can be replaced so this step is a ladder risk.
9	Sensor positions measured on sector with CMM	4 x ladders	95%	Ladders on sectors can be replaced so this step is a ladder risk.

So, working only from the average value (the errors on our yield estimates are probably larger than the statistical errors);
The number of working ladders required for 2 full detectors +spare ladders for a third are = 120

From Steps 4-9 =>Full yield applied to ladders = 73%
Sensor yield from steps 1-3 = 68%
Sensors/wafers needed:
(120/.73 * (10)) = (X * (.68)) => 2403 sensors required => ~48 wafers + spares

We can also deduce the number of flex cables required based on the ladder assembly yield:
Full yield applied to cables = 73%
Cables needed => 165 + spares

Sector tubes can be reused so we will need only the required amount of good sector tubes.
Sector tubes needed => 20 + spares