HEPHY

Institute of High Energy Physics

Market survey for double sided silicon strip detectors

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- Overview about previous large-scale productions
- Possible DSSD Producers
  - Micron
  - SINTEF
  - Canberra
  - Others ?
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Previous large-scale productions (1)

- ALICE:
  - 2 pixel layer and 2 silicon drift layers
  - 2 DSSD (4”, 300um thickness): 1800 pcs from Canberra, SINTEF, ITC-irst
- ATLAS: conventional single sided detectors
  - Hamamatsu supplied 92.2% of 15,392 sensors, remainder supplied by CiS
- CMS: conventional single sided detectors
  - Hamamatsu supplied almost all of 24,000 sensors (only 600 sensors from STM, although initial plan was 8,000)
- LHC-b VELO:
  - Micron and HPK supplied single sided sensors with semi-circular shape and 300um thickness

Previous large-scale productions (2)

- CDF:
  - Single-sided sensors from HPK, SGS Thomson and Micron (Layer 00)
  - Double sided sensors from HPK and Micron (SVX II)
  - Double sided sensors from HPK (4”) and Micron (6”) (ISL)

- D0:
  - Different sensor types:
    - Double-sided, double-metal, 90° stereo,
    - Single-sided axial,
    - Double-sided with 2° and 30° stereo angle
    - Single-sided sensors glued back-to-back with certain stereo angle
  - All barrel and F-disk sensors were obtained from Micron, Eurisys (now Canberra), or CSEM. All H-disk sensors were obtained from ELMA.

Summary of producers

- Canberra
- SINTEF
- ITC-irst
- Hamamatsu
- CiS
- STMicroeletronics
- Micron
- SGS Thomson
- CSEM
- ELMA

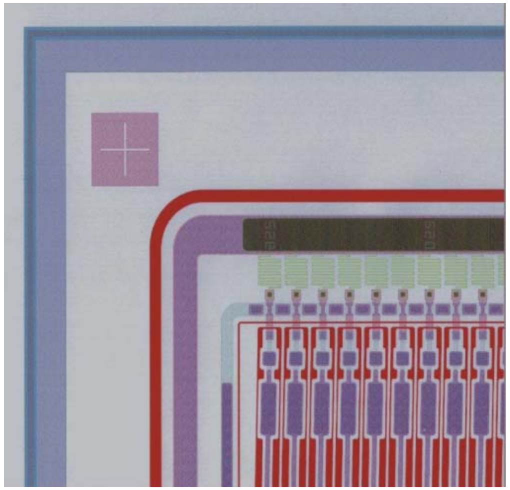
Micron

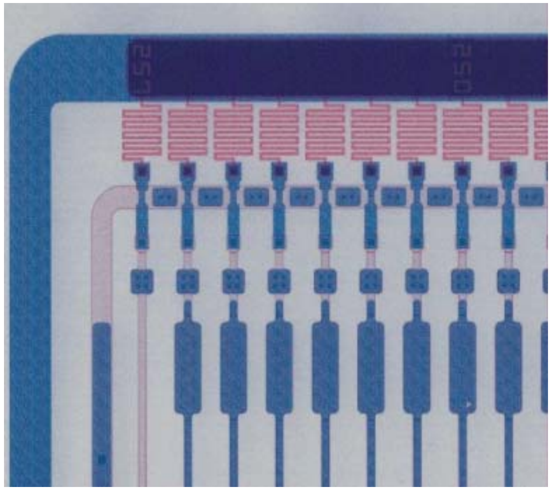
MICRON SEMICONDUCTOR ltd

- Micron Semiconductor Ltd, Sussex, Great Britain
  - Not to be mistaken with Micron Technology Ldt. (US DRAM and Flash producer)

- Experience with double sided 6” technology from CDF and D0 (FNAL)

- Thicknesses between 150 and 675 micron





Micron: Technical Details

- maximum wafersize/detectorsize?
  - 150 mm (6-inch) / 100 x 100 mm2
- Resistivity:
  - Min:100 ohmcm, max: 40kOhmcm. Float Zone and MCZ (P&N type)
- minimal/maximum wafer thickness?
  - between 150 and 675 micron (6-inch)
- minimum strip pitch? 5 um
- minimum distance between two lines? 7 um
- n-side strip separation technique?
  - p-stop and p-spray
- AC-coupling: quality/ thickness/ composition of dielectric
  - SiO2/PECVD Silicon dioxide
- maximum wafer throughput per week/month of your fab?
  - Most Micron orders are "assembled & wire bonded" Alpha /CV/IV Probe-testing to acceptance level with with Depletion and IV,CV: **100 per month**
- time between order and delivery of a sample batch (30 wafer):
  - **Currently 4-6 months**, 6" silicon now on 12 months delivery
- "Order book 2008-2010 reasonably full"

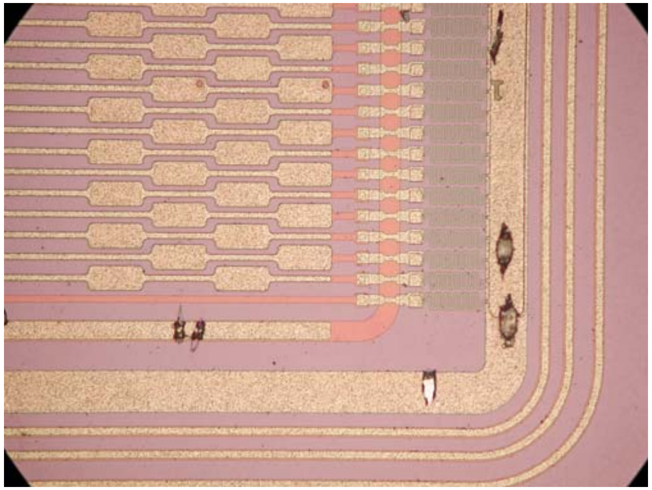
Micron: Example of DDD5 Sensor

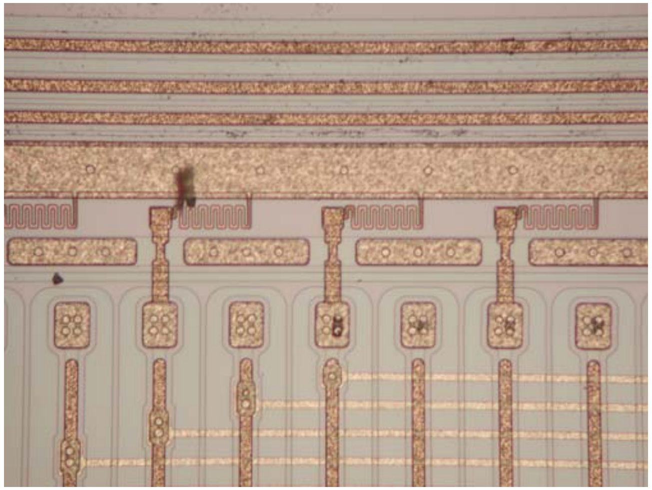
Design DDD5:

- 300 µm thickness, 120 x 21mm
- P-side: 768 strips with 50 µm pitch
- N-side: 768 strips with 153.5 µm pitch, 384 readout strips (2nd metal line for signal routing)

- Electrically tested in Vienna Clean room
  - No judgement about quality (only one sample available)

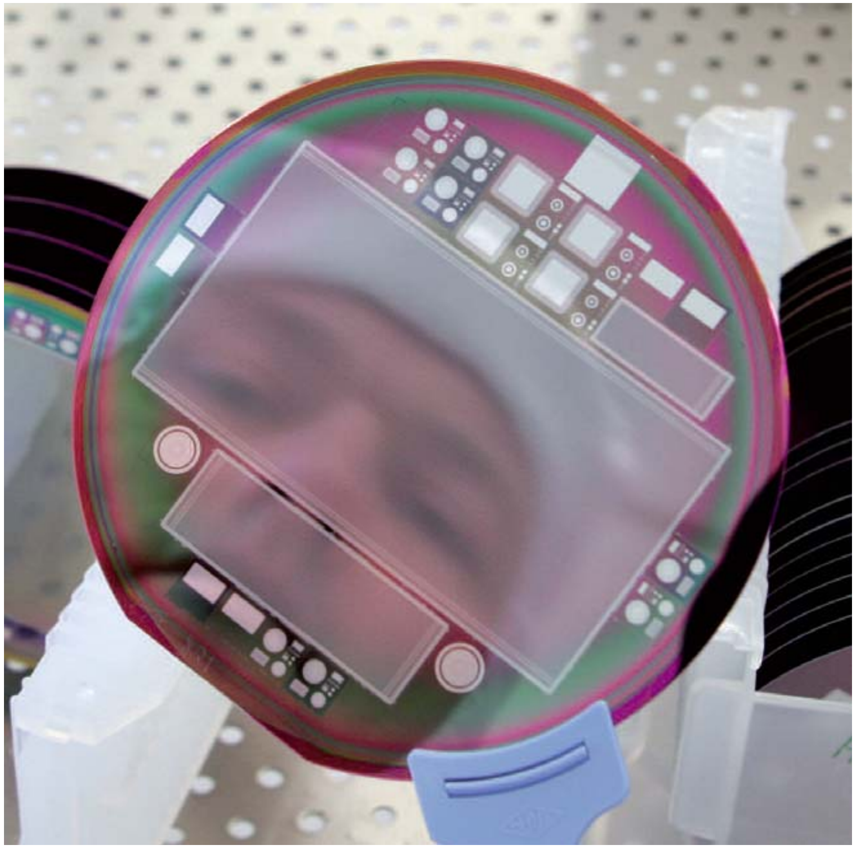
- Test beam at CERNs SPS (June 08)
- KEK's Fuji beam line (last two weeks)
  - Cluster S/N Ratio approx. 12.6 (p-side) and 15 (n-side)





SINTEF

- Located in Norway (Oslo/Trondheim)
- 2000 employees in total (not all in sensor division)
- maximum wafersize/detectorsize? 150 mm (6-inch) / 96 x 96 mm2
- Experience with double sided detectors
  - ALICE Experiment



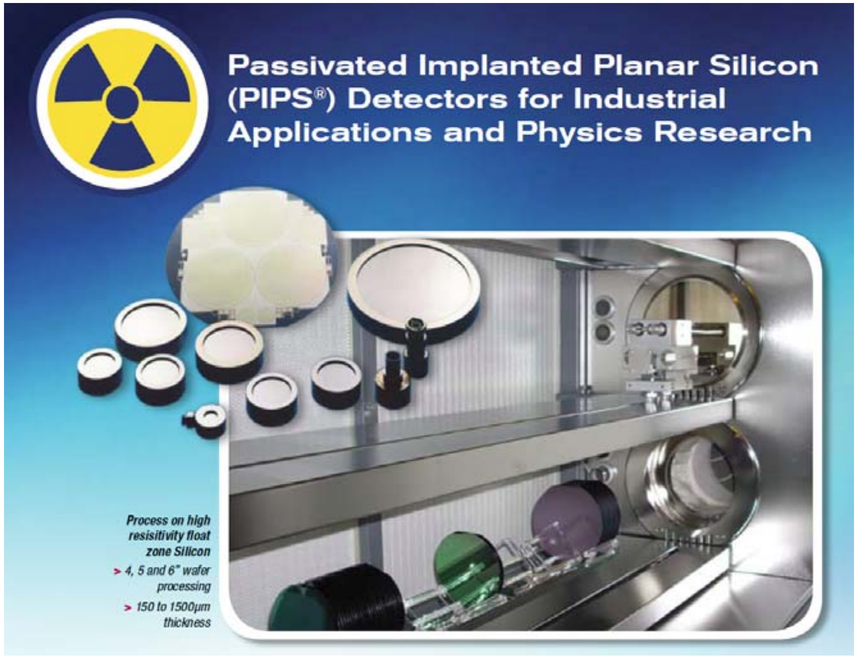
SINTEF: Technical Details

- maximum wafersize/detectorsize?
  - 150 mm (6-inch) / 96 x 96 mm2
- Resistivity:
  - Min:1 ohmcm, max: 30kOhmcm. Normally float zone, but we do Czrochalski for special projects
- minimal/maximum wafer thickness?
  - Min 100 um (4-inch), max: 2 mm (4- and 6-inch)
- minimum strip pitch? 20 um (smaller may be possible on request)
- minimum distance between two lines? 6 um
- n-side strip separation technique?
  - Usually p-stop, but we have also used p-spray
- AC-coupling: quality/ thickness/ composition of dielectric
  - We use a SiO2/Si3N4 sandwich which typically stands 200 V
- maximum wafer throughput per week/month of your fab?
  - Lab designed for 10000 wafer starts/year for 4 mask process on one shift. However, we run projects with up to 17 mask layers which of course reduce the overall capacity. (maybe results in **200/month**)
- time between order and delivery of a sample batch (30 wafer):
  - Depends on workload, but typically 1.5 - 2 months from received photomasks at SINTEF

Canberra

CANBERRA

- World wide presence
  - Contact with people from Belgium
- Detector size max 100 x 100 mm
- Experience with double sided detectors
  - ALICE, D0



- http://www.canberra.com/products/498.asp

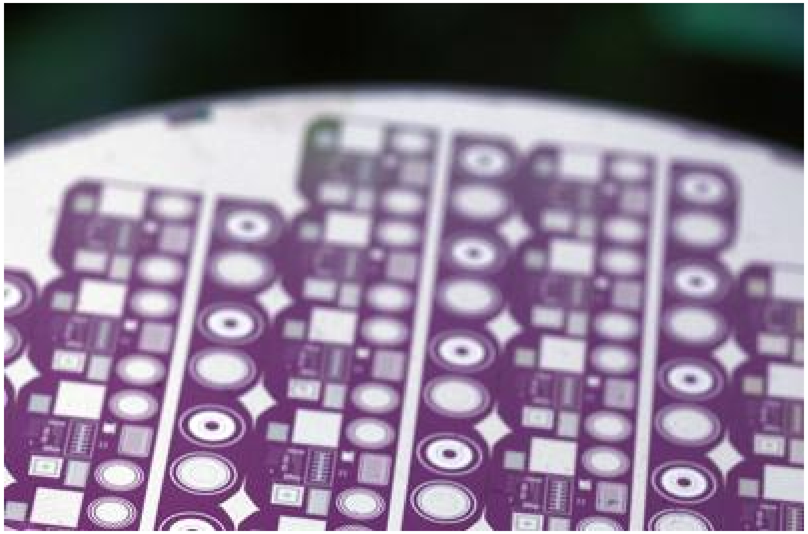
Canberra: Technical Details

- maximum detector size?
  - 6" wafers – max size 100x100mm
- resistivity of wafer?
  - 3000 to 30000ohmcm
- minimal/maximum wafer thickness?
  - 150 to 1500µm (100µm under evaluation)
- minimum strip pitch? 25µm
- minimum distance between two lines? 8µm
- n-side strip separation technique?
  - Both, p-stop and p-spray
- AC-coupling: quality/ thickness/ composition of dielectric (oxide/nitride/sandwich)?
  - Nitride
- maximum wafer throughput per month/year for fab?
  - depends on workload, maximum 30 double sided wafers/ month
- time between order and delivery of a sample batch (30 wafer)?
  - 12 to 16 weeks

Other Vendors

FBK-irst (Trento, Italy)

- Only 4” production
  - max. detector size 4x7cm



CiS, SGS Thomson, CSEM, ELMA

- Not yet contacted
  - Lack of contact person

Hamamatsu?

- HPK officially abandoned the production of double sided sensors
- However, HPK produces excellent sensors
  - Having the sensors from them will certainly avoid lots of trouble
- Maybe we should consider to convince them to change their mind
  - Maybe there is a small chance, especially after this year's nobel prize
  - I propose to send an official request to them (e.g. directly from the Belle spokesperson to Mr. Yamamoto (boss of sensor division)

Possible Future Steps

1. Mask design of full wafer (sensor and test structures)
   - Overall sensor design parameters have to come from community (e.g. requested resolution)
     - When will the SVD layout finalized?
   - This results in detailed specifications (strip pitches, thicknesses)
   - Test structures will be provided by us (have to be adapted to test setups and parameters to be determined)

Possible Future Steps

2. Get in contact with at least two companies (better three) and start negotiation for **production of prototype** batch. This allows
   - Testing of principle design flaws
   - Testing of radiation hardness. Gamma source available at colleagues at Lovain-la-Neuve (Belgium)
   - Performing a test beam together with readout electronics
   - Testing vendors' reliability to commitments (e.g. delivery time, production speed)
   - **Each vendor has to go through this process. Commitments of companies skipping this step (e.g. when jumping in later) cannot be verified and have to be treated with caution!**

Disadvantage of prototype batches:

costs of approx. 12 Million Yen (for each company)

Possible Future Steps

3. Thorough tests of sensors in at least two different labs
   - Vienna and Karlsruhe (?)

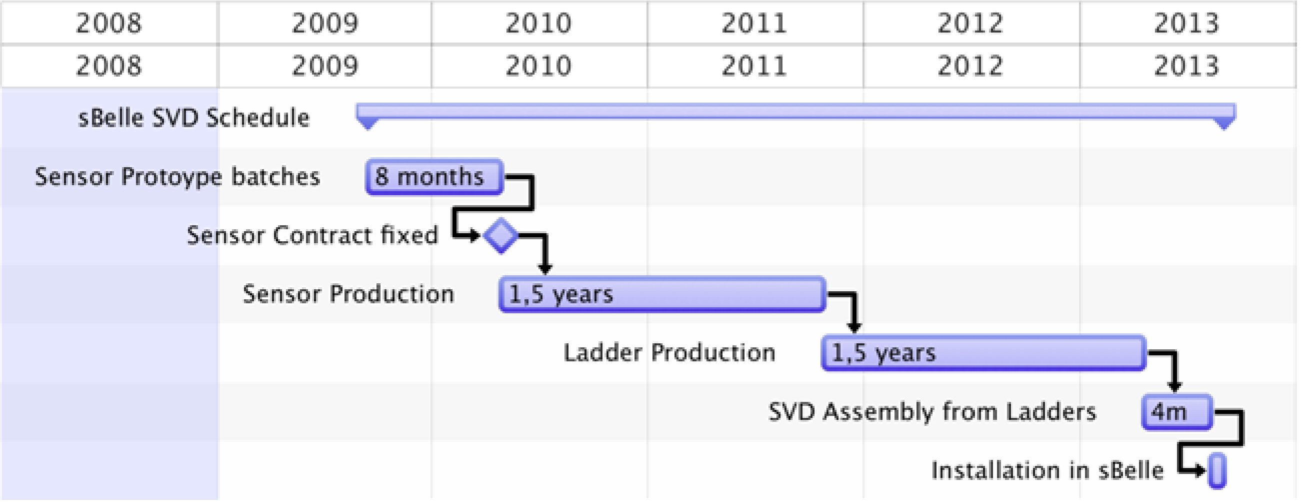
4. Writing of “technical specification document”, which must be as detailed as possible about the companies duties
   - Geometric specifications
   - Electric specifications
   - Testing procedures (e.g. full strip scan must be done at companies)
   - Acceptance criteria
   - Long-term stability
   - Production rates
   - Packaging and shipping details
   - Documentation and Numbering scheme (e.g. barcodes on sensor envelope)
   - Penalties for failures to comply with the rules of the contract (delayed delivery, non-conformance of specifications)

Possible Future Steps

5. Setting up a database which is able to store all measurement results and logistics information
   - To see if parameters are within specs and stable with time
   - Logistics data include information about each object actual location and assembly information (e.g. which sensors are assembled into which modules/ladders)
6. Negotiation of contract for full production

Possible Future Steps

7. Full Sensor Production (including testing/QA)
8. Ladder Assembly (including testing)
9. Installation of ladders in SVD support mechanics
10. Installation of SVD into superBelle



THE END.

Thanks for your attention.