Si Sensor Alliance meeting 18 June @ CERN, Minutes

A. Oja:

Goals of the meeting:

- Clarify CERN needs for the SLHC
- Evaluate the prospect of European vendor network to bid for the detector upgrade
- The consortium is still open
- Initiate new R&D projects on radiation detectors
- Decision of further steps: next meeting and involvement of CERN and its collaborations

Planned activities:

1. Fabrication of Si sensors for CERN
2. R&D for future detectors (FP7)
3. Network for the detector ecosystem (COST): Networking partially funded by EU.

D.Gregorio:

CERN procurement policy and procedures

- At the moment just guidelines available for the detector specs
- CERN and its experiments have different procurement funding -> will be described in the cover letter of the call for tenders.
- CERN initiative: an announcement by CERN on a forthcoming market survey on march 2009.
- At least 3 tenders need to be collected for the purchases exceeding 200000 chf.
- 4 weeks time to reply to the market survey but the survey is valid 12 months (18 months for prototypes)
- Several market surveys are foreseen for ATLAS and CMS for different detector types -> different company profiles. Will be launched in 2010.
- Two phases:
  1. Preproduction and qualification
  2. Large-scale production
- Qualification criteria:
  1. technical: The design cannot change from the evaluation round to production -> document required
  2. Financial and commercial: Consortium leader has to be nominated. Consortium partners need to back-up other partners in it
- Only companies that survived the market survey will be accepted for the call for tenders.
- All the companies need to be in the CERN database.
- 4 weeks time to reply to the call for tenders, closing date holds.
- Contracts awarded on the basis of lowest compliant bid.
- CASE A: no CERN money involved.
- CASE B: no CERN money involved but institutes can decide how they select the companies or they can ask CERN to do the evaluation.

- CASE C: CERN money
- CASE D: CERN money involved partially and is responsible for the evaluation.
- Consortium needs to be ready at the time of market survey and the members cannot change after that.

S.Stapnes:

ATLAS detector upgrade:

- Phase1: TDR 2010, shutdown 2013/2014
- Phase2: Letter of intent 2010, TDR 2012/2013, shutdown 2018
- Current ATLAS inner barrel: 61 m2 of silicon pixel sensors.
- Pixel detectors produced by CiS and Tesla
- Strip detectors were produces 90% by Hamamatsu and 10% by CiS
- In consortium, all companies' product lines need to qualify.
- Barrel pixel ~6 m2
- n-on-p short strips (2,4 cm) ~55 m2 > 5000 150 mm wafers
- n-on-p long strips (9 cm) ~65 m2 -> 6500 150 mm wafers
- INFRA call: one WP for through wafer interconnections
- Consortium cannot stop the researchers to contact directly with the industrial partners.

M.Mannelli

- CMS Si Tracker
- Present inner pixel detectors (3 layers), ~1m2 of silicon, n-on-n
- Present strip tracker: ~200 m2 of silicon, p-on-n, AC-coupled with poly bias
- Two companies successfully contributed to the pixel sensor production
- One company made 98% of strip sensors
- Crucial importance of realistically matching well established production capability of candidate industrial partners
- Crucial importance of homogeneity and quality assurance through the production
- Phase1: TDR early 2010
- Phase2: TDR 2012

Pixels

Phase1 2013:

- inner barrel from 3 to 4 layers (1.6 x LHC) and end gaps from 2x2 to 2x3 larger discs (2.6 x LHC
- ~2 m2, moderate production capacity
- radiation hardness 2x10^15, DSD, n-on-n (or n-on-p), **200 um**, pixels 150x100 um2, DC coupled, flip-chip – similar to present technology but thinner!

Phase2 2018:

- 5 layers inner barrel, ~4 m2 of silicon
- rad. hard 6x10^15, no sensor type determined (layer2**: n-on-p, <200 um** & layer1: **3D**?), pixels **50x100 um2**

Phase3 2023 possible

Strips
Phase2 2018:

- ~150-250 m2 of silicon, sensor type to be determined (SSD thin p-on-n or n-on-p)
- Tracking trigger layer pixels, 100 um x 1-2 mm, DC coupled large detectors
- Tracking layer strips: 100 um x 2-4 cm,
- Hybrid technology: bonding to front-end electronics

1. Preparatory phase: targeted R&D 2008-2012: study of n-on-p MCZ and FZ & EPI
2. Phase A: preproduction 2012-2014: finalize detailed specs and QA protocols for large scale production
3. Phase B: Large scale production 2014-2016:

- Market survey to identify industrial partners for phases A and B:
  - Producers qualify according to MS may take part to Phase A
  - Qualification for Phase B is contingent on Phase A success

Industry speaks

VTT:

- 2600 m2 clean room, class 10-100
- capacity 3000-4000 wafers per year in 5 shifts
- Capacity 1500-2000 wafers per year in one shifts
- Risks in ion-implantation and needs back-up

Alter:

- Private ownership
- 4 labs
- Specialized to electronic components
- Electronic testing with various radiation sources
- Interest in testing

Acreo:

- capacity for small scale production
- Cleanroom with KTH 1300 m2 class 100-1000, wafer from 100-200 mm
- Silicon carbide R&D

4-labs:

- selling the laboratory competencies
- LETI 200-300 mm line
- packaging 100-300 mm at FhG
- Silicon wafers 150 mm at VTT and FhG
- Microsystem facilities from CSEM, Dresden, new 150 mm line

CiS:

- 70 m2 class 10 cleanroom for wafer processing

- 200 m2 class 100 and 200 m2 class 10000 cleanroom for packaging, assembly, and testing
- 100 mm wafers process line
- 3-shift working regime -> 3000 DSD wafers per year
- 150 mm line at XFAB with 3000-5000 wafers in a year
- limited implantation

Deetee:
- 16 years experience in rad. detectors
- 2100 m2 clean room and dedicated photodiode line

FBK:
- 500 m2 cleanroom class 10-100 on 100 mm wafers
- Capacity 3000 wafers per year in one shift performed

CNM:
- belongs to CSIC, 15 M€ turn over
- 3.3 M€ clean room budget
- 1500 m2 cleanroom class 100-1000
- 100 mm ok, 150 mm line no furnaces
- D+T microelectronics exploits cleanroom
- 1000 wafers per year
- interest in advanced detectors

Okmetic:
- 70 Me sales, profit 13%, person 364
- Crystal growth in Vantaa and SOI
- 150 mm MCZ p -1 kOhmcm (n - 500 Ohmcm) wafers optimum,
- crystals: <100>, <111>, <110>

Sintef:
- 2000 personnel
- 45% income from industry
- 295 M€ turnover
- MiNaLab: 7 M€ turnover
- 800 (+600m2 univ.)
- capacity of 10000 wafers per year on 150 mm wafers in one shift
- Risks:
  - combine research and production
  - cost target
  - limitation in production capacity

SiTek:
- spin-off from
- 800 m2 clean room class 100-1000
- capacity of 2000 wafers per year on 100 mm wafers
- 150 mm line upgrade -> capacity 3000 wafers per year
- Ion implantation at IBS
- Risks:
  - not full 150 mm line
  - back-up needed

Arquimea:

- custom components for customers: sensors, actuators, microsystems
- Investment to detector fabrication, packaging -> own clean room
- 200 m2 class 100 clean room

Discussion:

- Need for the 200 mm wafers from the CERN side – no comment
- Is the MCZ the material for the LHC upgrade?
  - p-type MCZ and FZ did not show difference
  - n-type MCZ better in sense of radiation hardness
  - FZ have advantage of resistivity but higher price.
- Development to 150 mm wafers and 200 um thick – reason that the new pixel detectors will be 2 x 2 cm2 in size and the radiation tolerance improves with the thickness

C.Fröjdh: Academic point of view:

- No research just for HEP

1. Material:
   - doping homogeneity
   - High-Z quality
2. Process
   - large area
   - thin detectors
   - guard rings
   - active edge
   - 3D sensors
   - Fan out
3. Design:
   - speed, fast counting
   - low noise and energy resolution
   - adjustment –> accurate energy determination
4. Hybridisation
   - Bonding: reliable and cheap method
   - 3D stacking: separate chips for analogue and digital pixel electronics, local memories for pre-processing
   - Academic institutes can do development and testing
   - Reliability and yield issues crucial for the industry

Comment: “Large area stacking and high density stacking for HEP” – M.Campbell

Wrap-up: A.Oja, supported by comments and suggestions by other participants

Joint venture:

- reliable vendor for CERN
- well organized and smooth consortium
- one strong supplier:

    - supply chain management
    - quality control
    - partner's roles
    - liability
    - risk management
- Supply chain study starting at September
- Adaptive consortium to correspond to different kinds of market surveys
- consortium stands better for the CERN bit than a joint venture.
- In consortium, there is a contract between the entities to fulfil the promised role in the bit. Joint venture is much more complicated.
- Are the partners of the consortium willing to change process knowledge?
- At the R&D phase, before the TDR, there should be a collaboration that aims for the production. Funding need to be found for this phase. When the TDR is given specific consortium should be made to aim for the market survey.
- Risk in the consortium is that not all the product lines will qualify.
- All the experiments want to have dedicated product line for their detectors at the R&D phase.
- Consortium would be a higher level base for the dedicated clusters.
- Added value of consortium:
    - vertical integration vs. horizontal
    - could deliver highly integrated modules functionally tested
- Consortium could have an important role in preparing a joint roadmap for silicon radiation detectors
- Roles of the partners:
    - wafer manufacturer
    - Si detector manufacture

Next steps:

- Consortium meeting in October 14 at CERN
- Preparatory meeting in September 15-16 at CERN. Main agenda points for the meeting: FP7 application, COST application, preparation for the October 14 meeting.
- Letter of intent to CERN on the consortium
    - first draft in Sep 15

Funding for R&D phase is not yet confirmed and CERN funds are limited. Most likely just experiments make the market survey, CASE A.

Financing, FP7 capacities work program (future colliders)

- Date of publication 30 July 2009
- DL 3 Dec 2009-06-18
- The total budget 217 M€ for the projects within the Call. An average EC grant for the integrating activities is about 161 M€ / 35 projects = 4,6 M€. It is important to have most key infrastructures involved.
- If the concortium decided to make a joint proposal, it would be very difficult to compete with it, because so many key players are involved in this tentative concortium
- Lobbying for future EC calls in the IST and NMP programs
- **Evaluate what commission wants to fund**.

- Steinar Stapnes told that CERN and universities will submit an infrastructure application within the capacities program on radiation testing facilities to develop detectors.

COST funding

- funding for an open network dedicated on enhancement of knowledge on advanced detector technologies
- DL for outline Sep 25 2009:
- 100 k€ country in a year
- project 2011-2014.

Note: all the material presented at the meeting is available at http://indico.cern.ch/conferenceDisplay.py?confId=59396