“Mini-workshop” on connectivity issues in ILC/CLIC very forward calorimeters

DRAFT summary notes of the meeting held at CERN, 16 September 2010

Introduction (L Linssen)

Lucie gave a brief introduction to ILC and CLIC, and showed some images on how we might imagine the very forward region of a CLIC detector. In this way, the two instruments of interest in the discussion were introduced: **LumiCal** for precision luminosity measurement, **BeamCal** to close the forward region solid angle and potentially to give fast feedback for beam tuning to the machine. While LumiCal is foreseen to operate as a tungsten-silicon sandwich calorimeter, the radiation levels at BeamCal are too high for this. Presently, GaAs is envisaged as sensor for BeamCal, but other options are also under study.

Issues on Connectivity (M. Idzik, W. Lange, W. Wierba)

Marek took over and gave a more detailed overview of the LumiCal technical design. He explained the main connectivity issues which he sees as being of concern today:

- Sensor – front-end connection
- Sending data out of LumiCal (BeamiCal) plane
- Delivery of large power currents to the detector
- Testbeam: temporary connectivity solutions

Marek mentioned, without entering into a more detailed discussion, that the need for power-pulsing of (eventually all) ILC and CLIC sub-detectors will certainly add additional problems, i.e other connectivity issues.

Wolfgang completed the introduction to the discussion with further remarks, mainly referring to the issue of sensor-front-end connections for the final LumiCal (BeamCal), rather than the test-beam set-up. He listed the solutions envisaged, such as

- PCB with glue or wire-bond connections, as presently used in the lab and for the first tests with beam
- double metal layer on the sensor itself, connection to the edge of the sensor
- sensor with integrated electronics

Wojciech showed a few slides illustrating fan-out and ideas for connectivity. He mentioned that an attempt at glueing (by hand) was not successful, and Alan confirmed that small-point glueing is difficult. Moreover, such small contacts with conductive glue are bound to fail with age. As a result of contacts with Hamamatsu, Wojciech presented a sketch (pdf file "Layertickness" on Indico) showing a possible integrated fanout on the sensor plane.

Discussion

In the discussions throughout the day, it became clear that

(1) certain solutions can only be envisaged for silicon sensors, i.e. the connectivity solution chosen may well be different for LumiCal and BeamCal
(2) in terms of requirements from physics, a fresh look may be necessary to answer the following questions:
    a. what are the requirements for LumiCal now that the 10**-4 accuracy on the luminosity measurement has been reduced to 10**-3 for ILC; how critical is the actual gap between the tungsten plates, do 100 or 200 microns of lower Z material really matter ?
    b. what are the corresponding requirements for BeamCal, given that this instrument is not foreseen for precision measurements as is LumiCal?
(3) in the next 2-3 years, for the forthcoming testbeam campaigns, only the PCB-type solutions can be envisaged (money, manpower...); the AIDA mechanical set-up must allow to modify the spacing between tungsten plates, such that the mechanics can easily be modified as new solutions for sensors-electronics and their connections are being introduced
(4) in parallel to the on-going testbeam preparations and measurement campaigns, the double metal layer solution and in particular the proposal made by Hamamatsu will be actively pursued. Modeling of a complete circuit with realistic parameters for such a solution is necessary.

The thin layer of silicon oxide (standard solution 1 micron) was a concern to several of the participants.

It was not clear, at the workshop, who would do what as a next step and how long it would take for an in-depth analysis of this option (prior to eventually ordering new sensors with integrated fan-out). *After the meeting, Marek communicated that these studies will of course be continued (as mid- or long-term solution) by the groups of AGH-UST and IFJPAN (Cracow), and that all input and contribution is welcome.*

Alan stated that bump-bonding for the large pads such as in LumiCal would be extremely difficult. He also pointed out that one should advance rather soon to a realistic complete design e.g. of LumiCal, since there will be many "devils in the details" and solutions discussed might not work once all the details are drawn. For example, although one wants by all means to avoid airgaps in LumiCal, some spaces to account for imperfections of the layers might be necessary. Alan also thinks that there are other connectivity methods than the one discussed so far, he mentioned that there should be several other options to be looked at.

Among other topics discussed was the large powerconsumption (at least 100A for LumiCal), which appears to be unavoidable in the present design and technology. The impact of such high currents will depend on the distance to the power supplies. One possibility considered to alleviate the issue was “voltage down-conversion” with components placed right next to (downstream of) LumiCal, provided that radiation levels will permit this. NOTE that not all of the down-conversion methods will allow power pulsing. *After the meeting, Marek Idzik mentioned new ideas in the domain of current consumption – to be presented and discussed at the FCAL meeting in TelAviv, beginning of October 2010.*

Longer term future

To complete the picture, Walter gave a brief introduction to the LePIX project (monolithic detectors in advanced CMOS). This is a development under way, which might eventually find its application also in the FCAL calorimeters. Questions raised concerned e.g. the not-fully depleted detectors. The investment for every new submission of this type of device is rather large, and Walter is encouraging as many groups as possible to join forces (hopefully helped with by a significant contribution by CERN).