Notes on PPAP Energy frontier Day: 14th July 2009

(2) Summary of discussion issues

NB: This document does not represent a verbatim transcript of everything said on the day, but rather provides a brief summary of the main points which came up in the discussions, together with findings drawn up by the PPAP. For details of the presentations please see the slides on the agenda page at

http://conference.ippp.dur.ac.uk/conferenceDisplay.py?confId=274 .

Approximately 75 people present

Summary of discussion during/after presentations

PPAN Context: The question of how to cancel projects was raised. A view was expressed from the floor that such decisions should be made by the community via PPAP. JN emphasised that the decision has to come from PPAN, but that a final iteration with the community via PPAP to determine whether a small amount of residual funding could be maintained was desirable.

Phenomenology and Formal Theory: The question of how badly the current funding crisis would impact the health of UK phenomenology in the long-term was discussed. The loss of RAs and potential problems with formula allocation of PhD studentships will harm the flow of young people into the field, without whom the field will stagnate. Further coordination / focussing in key areas and/or large groups would not be beneficial as theory relies on excellent individuals having good ideas, and excellence exists throughout the field. Recent international reviews suggested that the UK theory community was too small. It has since grown but if cut back would be too small again.

It was asserted that theory had suffered a 40% cut in the last grants round, beyond that experienced by other PPAN areas. This was debated – the 40% cut would occur after the next roll, before which the next round will have occurred. Taking this into account the actual cut is ~25%, consistent with other areas. The low level of academic FEC support in this area was also discussed; however 20% now appears to be the norm across all areas. The wisdom of this was questioned, given that the result may be increased teaching loads for STFC funded researchers, however it was pointed out that any increase in academic FEC will have to be paid for by a decrease in the number of funded RAs. Provision of support for some formal theory by EPSRC was discussed and the consensus was that EPSRC should be encouraged to treat such proposals fairly.

LHC Upgrades – Physics and Detectors: Discussion ensued concerning the scope and timescales of the LHC GPD phase-2 upgrades. The technologies required for the upgrades exist already and major R&D is underway. An eye should be kept on promising alternatives; however given the required lead-time for construction fully developed TDRs will be required in 2012/3 for 2019 operation. The question of whether the UK should be involved in both detector upgrades was raised – in answer involvement in both maintains UK involvement in existing areas of world-leading technical expertise.

LHC Upgrades – Accelerator: Discussion focussed on the level of UK involvement in the LHC machine upgrade programme. CERN is very open to collaboration with UK accelerator physicists, for instance at JAI or CI. Several such collaborations are currently being set up. A particularly attractive area for UK involvement is the SPL, where existing UK expertise would be beneficial. In addition CERN is keen to engage with UK industry in the machine upgrade programme. A discussion ensued of the potential return to UK industry of UK investment at CERN. Accelerator funds may present a route to improving the competitiveness of UK companies. One challenge is that the initial R&D outlay required to get established in a particular area can be prohibitively large for many UK companies, which tend to be smaller than some EU competitors. STFC accelerator funds are generally too small to support such R&D, however TSB money would be ideal if we can access it. Nevertheless we should not be distracted from our science goals, and TSB funds are attractive because they are not tensioned against the science line. We must exploit fully the UK investment in CERN.

Linear Collider – Physics and Detectors: The timescale and strategy of ILC R&D was discussed. The aim is to have demonstrated the required machine and detector technology by 2012, in preparation for first LHC results. Nevertheless the design will not be frozen until a final decision to go ahead is made – flexibility will

be retained. There is some interest in evolving the ILC detector concepts (primarily SiD and ILD) for use at CLIC. CLIC now has a detector R&D budget at CERN, and aims for a CDR by end 2010. The question of whether the UK should be involved in more than one detector concept was raised – it was pointed out that involvement in only one does not save any money right now.

Linear Collider – Accelerator: UK ILC accelerator work has now spun-out into other machines, e.g. light sources. An SoI has also recently been submitted by LCABD to contribute to the CLIC TDR. The UK accelerator industry is small, but has strength in magnets, RF and vac. systems, and there is a large body of high-tech companies which would like to get involved. Seed-corn money would be extremely beneficial for this. Money for ILC from STFC is very limited currently but will increase in a measured way if the case can be made. Nevertheless the UK can not expect to be the front-runner in the next decade. The general consensus was that STFC should not artificially exclude all explicit ILC R&D proposals but rather allow R&D proposals to be considered on the basis of the science which they offer.

Future Colliders and Generic Detector R&D: There was an extensive discussion of the realism of a muon collider as a serious competitor to a multi-TeV e+e- collider such as CLIC. Disadvantages are that the technology requires very considerable further R&D, muon-decay backgrounds in the detector can be extremely intense, and neutrino induced groundwater activation limits the energy to 3 TeV. Conversely, considerable further technical challenges must be overcome to realise CLIC (especially related to the drive beam), a muon collider potentially offers superior Higgs mass resolution, and it can be viewed as the ultimate stage of a programme delivering a wide range of additional science including lepton flavour violation with intense low energy beams (e.g. PRISM/PRIME) and neutrino measurements (via the neutrino factory). There was no clear consensus in the room, although the balance of opinion appeared to favour CLIC over a muon collider if multi-TeV energies are required.

There was also a brief discussion of the prospects for laser plasma accelerators. Difficulties exist with the likely wall-plug power of such machines, however high efficiency LED pump lasers are currently being investigated to solve this problem.

LHeC: The main issue discussed was the practicality of constructing and operating LHeC in parallel with LHC (see also below). Studies have shown that the electron beam induces negligible LHC tune shifts however potentially the biggest impact on the LHC would be the time taken to install the electron machine (ring-ring option) into the LHC tunnel. These would be small and slung above the LHC ring – installation might require at least two long shut-downs. By-pass tunnels around ATLAS/CMS of ~250m would be required, with small apertures into the main tunnel. The linac approach would require ~6km of new tunnel. The total cost is claimed to be less than 10% of the ILC by the proponents. A CDR has been requested by the DG for 2010 to provide options for the future CERN programme. *[Note added – a cheaper lower energy option is also being studied using SPL for the electron beam].*

Summary of general discussion (loosely grouped by discussion question)

Should investment in future colliders be dependent upon and await LHC results? The R&D programmes required can be identified now. We should be prepared to invest in these now however we should also be prepared for the eventuality of some technologies not making it into the final detector. Major investment must wait for evidence of new physics from LHC.

If the UK had to choose between major investment in LHC upgrades and a 500-1000 GeV linear collider, what would the decision criteria be? The LHC phase-2 machine upgrade will almost certainly happen and the UK must continue to invest in its flagship detectors. Furthermore, the current detectors have a limited lifetime due to the exceptional radiation environment at the LHC, but further R&D in recent years has pointed the way towards extending survival to even cope with the 10 times higher doses expected at the after the phase-2 machine upgrade. The idea of a competition between the LHC phase-2 upgrades and ILC is a false one however as the cost of the LHC upgrade is an order of magnitude less than that of an ILC. In addition one requires the expertise gained from building upgraded LHC detectors in order to build the ILC detectors – given the timescales if the UK does not contribute to the former we will lose our technical base for the latter.

Under what circumstances should the UK commit significant funds to LHeC? Is this mutually exclusive with the construction of other high energy facilities? There was considerable debate on this topic. The proponents emphasised that if evidence for leptoquarks is seen at LHC then the case is very strong, however it does not rely solely on this and the potential benefits from measuring PDFs are also significant. In the most optimistic scenario the new machine could be started in 2012 for operation in 2020. Given the limited cash however this would put LHeC in competition with other large projects such as the ILC. Other members of the audience emphasised that a major issue for this proposal would be that it would be in

competition with the LHC because construction and installation would inevitably require the LHC to be shut-down for a significant period, potentially at a point when it is operating most efficiently. Points where some consensus was reached were that if leptoquark evidence is found at LHC then the case becomes strong, and that funding for relatively inexpensive R&D on future collider concepts should be supportable, and considered on its merits. Some prioritisation is required by PPAN. Some guidance on the magnitude of such an R&D line would be useful, together with some idea of the projects likely to be bidding against it. In addition some indication of the level of likely capital required will also be required.

Should the UK participate in R&D on very long-term colliders such as a muon collider, or a higher energy hadron collider? A discussion ensued of the general shape of the field in the medium/long term. There was a consensus that major involvement by the UK in only the two LHC GPDs was unhealthy, particularly given that without new ideas the community is unlikely to secure additional cash from government. If we do not think beyond LHC the whole community will stagnate. Similarly it was widely felt that top priority for the field beyond the LHC should be an energy frontier lepton collider. R&D for the ILC and CLIC should be on the roadmap. R&D for a muon collider is naturally included in the neutrino factory R&D programme however a member of the audience pointed out that direct muon collider investment now would buy us a lot. Throughout we must remember that CERN is our lab and hence is our route to future large projects.

Should the UK be a player in the design of future high-energy accelerator facilities, or should we concentrate on physics and detectors? If accelerator projects can access new funding streams then they should be strongly encouraged, however this should not come at the expense of science. We should also work to ensure UK industry secures its share of CERN accelerator contracts.