

23rd-26th September

ECFA-UK Workshop for the 2026 ESPPU

Please use this google doc for any followup questions / discussion that there isn't time for in the sessions, as well as linking any additional resources of interest.

Also any ideas for uncovered studies!

Plug: ECR Scientific Secretaries for ESPPU. Deadline **26th September!** Nominations can come from anyone, and self-nominations are particularly encouraged. Send the nominee name, a brief profile and group preference to Lydia Brenner & Daniela Bortoletto (email: lydia.brenner@cern.ch; daniela.bortoletto@physics.ox.ac.uk)

Make sure you're getting **Hi-Phi** emails! "To subscribe to the list, go to JiscMail as described at <https://www.jiscmail.ac.uk/advancedsearch.html> with the list name Hi-Phi-L. Note most members of particle physics groups are not subscribed individually, but via a group list at their institute."

Intro, ESPPU & UK Drafting

How are we defining 'unfeasible' plan A to go to plan B? Just physics based or funding, technical etc. -> Up to us to discuss. Noting we are also going fast as a country and don't have the final info e.g. FCC study.

-> Note also: backup/alternative plans: you can have more than one and we prioritise them.

-> Note also, the ESPPU is for what CERN does over the next 5ish years, still scope for again updating in the future, on a shorter timescale than the projects themselves.

RS: Is it the right approach not to submit input for briefing books for some areas, e.g. Neutrinos?

-> 'some' projects are/aren't. Also re. Boulby lab, it could also be more important to given our elaborate UK plans? Expect groups that have a big update will contribute.

UK input doc. 10 page limit for main body! (TBC if you can have extra appendix type things)

e+e- Colliders

Questions and Notes

- colour reconnection in W mass measurement -> 4quark measurement, used in-situ data for LEP. largest systs, limited different models and stat. Uncertainty in the syst uncertainty estimate..... -> could drop the 4jet final state from the projections if this is a bit too untrustworthy.
- HP: HHH / quartic self-coupling studies? Yes (s22 CLIC study), more dedicated studies exist too, @Aidan please link.
- Flavour: pi0 reco. In calorimetry is super important (also for hadronic taus) so crystal is ideal; not necessarily the same in other areas.

Action Items & Study Ideas

- Use W charge measurement to do differential measurements in hadronic channel of WW? (@Mario Campanelli please rephrase this more accurately!)
- Compare Higgs, Top etc. studies to more up to date HL-LHC projections based on more recent LHC results.
- Would be nice to have more person-power doing the studies from Matt Kenzie's talk with Full Simulation, current results FastSim Delphes, eventually, to get more accuracy. However this would be more specific to different detector setups..

Detector R&D

Questions and Notes

- EIC: ePIC detector 'ownership' not UK, UK involvement in the MCP-PMT characterisation specifically.
- UK detector work living in DRDs is great but should still feed into strategy discussions beyond.
- [CP] DRD organisation emerged from the last European strategy, a clear demonstration of a successful outcome from the previous update. The setup of a clear international coordination and funding mechanism for the programme should be an outcome of the next period. The programme will have opened up useful dialogue. Close coordination between FAs is now required to be put in place to achieve the coordinated development of technologies suitable for application in experimental programme.
- [CP - comment Ruben] Ensure tension is navigated between mid-TRL R&D programme and not stifling blue-skies research. R&D must be agile and large organisations can lock in programmes.
- [CP] DRD4- Strong UK activity in emerging area of high time precision (order 50ps) photodetector development with application to charged particle PID at future flavour physics measurements including at ALICE, LHCb, future kaon experiments, EIC, FCCee.
- [CP] DRD6 - Smaller involvement in digital ECAL development, based on MAPS detectors. Potential synergy with tracking detector development.

- [CP] DRD1 - Smaller involvement in gaseous detector development, including: novel gas based thick GEM for neutrino and dark matter sector; application of resistive plate chambers to LHC (Anubis or Codex-b) long-lived particle proposals. Latter would require the development of eco-gases (current gases have unacceptably large global warming potential).
- [CP] DRD2 - Strong UK leadership, with UK programme themes of light detection and background reduction. Novel areas including VUV sensor development and charge+light detection.
- ARAP commissioned to do full life-cycle assessment for components for ILC/CLIC. Results soon! Surprising how large support structures contribute, but can fix with change in material -> emphasise importance of testing this early to be able to respond and alter the plans.
- How much is a megatonne of CO₂? 1 million tonnes (e.g. FCC/CEPC construction) -> 100 tonnes/scientist. Normally aiming for 1-2 tonnes per person per year (10 usually at the moment)
- UK emissions = 1% of world emissions; USA = 1/3.
- For COTS don't own IP, can be hard to get access to specifics of designs etc. also tied to provider, need to have good relationship etc. More concerning for microelectronic/ASIC regime. Trying to address through the 7.7 structure - CERN/RAL legal team, expertise etc.
- Note strong links with quantum computing, other non HEP things important.

Action Items & Study Ideas

...

Theory

Questions and Notes

- Dipole shower chosen over angular ordered because more robust against non-global logarithms

Action Items & Study Ideas

- Don't have NNLL for Initial State radiation yet, results for Final state only so far.

DM Detection

Questions and Notes

- Are there nuclear physics uncertainties on the constraints? Yes, and there are nuclear theorists looking at quantifying them. Xenon fairly challenging as heavier, but e.g. spin-independent interaction no uncertainty. Generally they are small apart from e.g. proton interactions.
- DarkSide-20 notes strong P5 endorsement up to 2037(?)

- Why not loading PMMA with Gadolinium? Not much sensitivity loss in veto eff., Gad has some technical challenges.

Action Items & Study Ideas

...

ep Colliders

Questions and Notes

- Valence quark PDFs at high x limiting for HL-LHC?
- [CP- Paul Newman] LHeC is not the next major collider at CERN. It could be an impactful and affordable upgrade of LHC, extending energy frontier programme with operation for a number of years.
- V High x , reasons to worry about the PDF projections - some caveats. V small x saturation, comparison to dglap, expect more difficult at N^3 LO or in resummed calculations.
- V_{tb} more like 1% precision not 5% now.
- In HLeC+HL-LHC+LHC combinations, do you account for PDF improvements, flavour tagging improvements, etc.? Not sure....
- N^3 LO Higgs = hard process N^3 LO + PDFs NLO, not a full N^3 LO predictions. (also for other processes)

Action Items & Study Ideas

- Can we do anything at totem etc. to help? Exclusive processes with 1 photon in final state and 1 low mass diffraction -> could validate photo production there.
- Can you recognise saturation? (studies ongoing)

...

QTFP

Questions and Notes

- Not deciding to try for PhD students much yet since can't promise they have a future.
- Losing PDRAs is bad - takes time to replace/retrain, very niche set of expertise so smaller pool in academia but Lots of desirable alternative industry jobs they could go for.
- Even struggle for faculty hires, compared to other countries.
- :(
- Go Complain to MPs
- [CP - Jon Butterworth] The CERN quantum programme (QTI etc <https://quantum.cern/>) needs to be well targeted to underpin the areas in which the community are interested.

Action Items & Study Ideas

...

Accelerator R&D

Questions and Notes

- ILC @ CERN a possible plan B, will be included in linear collider Doc.
 - How much would CLIC geology etc. studies be reusable for ILC in this scenario? They weren't as detailed at FCC ones have been, would be easy to repeat the CLIC studies for ILC as footprint is the same
 - Also a simpler problem to consider than for FCC, in terms of finding a site that works.
- RF change, install all up to ZH in one go -> does this freeze the point of being able to alter things for sustainability etc? Basically yes.
- Exchange rates make relative worth change for Yen/CHF/Dollar costing.
- What physics can the UK do with the plasma programme on the 5-10 year timescale? What government wants to hear.

Action Items & Study Ideas

...

Non-Collider experiments and facilities

Questions and Notes

...

Action Items & Study Ideas

...

10 TeV pCM

Questions and Notes

- <https://cds.cern.ch/record/2642471> - Higgs and EW measurements at FCC-hh (only?)
- Are there any studies looking at FCC-hh with the FPF?

Action Items & Study Ideas

- Generally studying more thoroughly the scenario where we go straight to FCC-hh (if CEPC happens and takes care of the ee front), but are restricted to a lower energy than 100TeV. How high do we have to go to get the results we want? 50TeV? 70TeV?...

- Top physics @ muon collider OTHER than BSM top compositeness etc.
- More work into projecting top mass -> estimating the uncertainty projection, better guesses of analysis improvements.
 - Dileptonic $t\bar{t}$ decays?
 - How much data are needed to reach <100 MeV in a simple combined fit to all three of these observables and individually.
 - What lepton resolution would be needed to preserve the needed sensitivity? (inform detector design)
- Hadron collider Higgs coupling sensitivity studies that don't assume that a lepton collider will happen first.
 - Also looking to lower than 100TeV energies in more detail.
- 5% uncertainty on Higgs trilinear couplings at FCChh -> where is this from, is it accurate?
- Considering better the improvements in analysis approach, object ID, jet tagging, etc., in the projections? (generally)
- HH extrapolations including channels other than $4b$, $b\bar{b}\tau\tau$, $b\bar{b}\gamma\gamma$ (e.g. $b\bar{b}l\bar{l}$, multilepton)
- $g \rightarrow t\bar{t}$ splitting for top mass measurement using recoil.
-

Software & Computing

Questions and Notes

...

Action Items & Study Ideas

...

LHC Exploitation

Questions and Notes

...

Action Items & Study Ideas

...

Neutrinos

Questions and Notes

Notes:

→ IceCube probes Pseudo-Dirac → Gen2 is powerful due to 8xStat

- Future data, especially improved measurements δ & θ_{23} , will reduce the number of viable flavour models & lead to a deeper understanding of the flavour problem
- RHNS searched for displaced showers in the CMS muon system
- JUNO is competitive with DARWIN in probing nature of neutrinos

Action Items & Study Ideas

- highlighted the importance of the neutrino cross-section calculations.
- theory at the boundary of HEP and nuclear tend to be pushed at the margin (need more theorists)
- Clear indications from the theory on the precision required to measure parameters (e.g. δ_{CP}) is important
- **neutrinos from accelerators & the cern neutrino platform MUST be in the european strategy**
-

1st May 2024 Kick-Off Meeting over Zoom

<https://indico.stfc.ac.uk/event/1012>

•

Plug for ECRs to please fill in survey <https://forms.gle/WKGqSxAfWGSnNoeF6> . part of the related RECFA process.

23rd-25th September for Durham workshop!

Anyone please feel free to add any helpful links, info or questions!

EPPSU Process Notes

- Lab director rep previously Jon B. Mark T, John W. New reps. Not yet chosen. We (the UK) will get 2 as RAL and DL and both LDG labs.
- ICFA = International Committee for Future Accelerators
- Expect to have National input after the Open Symposium too. XLZD is a consortium of three collaborations (XENON, LUX-ZEPLIN and DARWIN)
- What does full exploitation of HL-LHC mean?
 - 3iab -> ATLAS+CMS? + ...
-

e+e- Colliders

Further Resources

- FCC mid-term report: <https://new-cds.cern.ch/records/zh1gz-52t41>
- Expect CEPC approval decision in 2025 (start construction 2027, start running 2035)
- Cool Copper Collider (C³) <https://arxiv.org/abs/2110.15800>
- HALHF <https://www.adams-institute.ac.uk/halhf>
- **How to get involved?**
 - **FCC -> Can join FCC collab. Contact Guy Wilkinson**
 - **Other linear collider? Contact Brian Foster, Phil Burrows, Aidan Robson**
 - **Wider ECFA Higgs/top/EW factors study: Contact Aidan Robson and Christos Leonidopoulos studies listed: arxiv:2401.07564 -> look at website for mailing lists and kick-offs for remaining studies (simulation+reconstruction expertise particularly welcome).**

Overflow discussion and questions

Try and push to have a sustainability section in the briefing book, like last time!

ep Colliders

Further Resources

Large Hadron electron Collider (LHeC) <https://arxiv.org/abs/2007.14491>

ep/eA pp/pA/AA synergies workshop: <https://indico.cern.ch/event/1367865/overview>

How to get involved?

- See Slide 15. : <https://e-groups.cern.ch/> (use the search option, and search for “ep-eA-WG” in all e-groups)
- 5 WGs defines for work.
- Contacts: Uta Klein (Uta.Klein@liverpool.ac.uk) , Claire Gwenlan (c.gwenlan1@physics.ox.ac.uk) , Paul Newman (paul.richard.newman@cern.ch) , Monica D’Onofrio (Monica.D'Onofrio@cern.ch).

Overflow discussion and questions

All the Higgs stuff on 1 table, looking apples-apples between experiments, seeing how it improves over time considering complementarity and different projects running in parallel.

-> We should try to do this for the september workshop

10 TeV pCM Colliders (i.e. muon, 100TeV pp)

Further Resources

CEPC EU workshop april 2024 <https://indico.in2p3.fr/event/20053/>

FCC UK mailing list: fcc-uk@cern.ch

Muon4Future workshop 2023 <https://agenda.infn.it/event/33270/>

MuCollider sim/reco software tutorial:

<https://mcd-wiki.web.cern.ch/software/tutorials/cern2023/>

MuCollider website <https://muoncollider.web.cern.ch/>

How to get involved?

- Full review of physics case for FCC-hh and interplay with Muon Colliders (more like reviewing existing literature) -> contact Andy Pilkington
- FCC-hh S8 topics that are covered in the UK / uncovered anywhere.
- Muon Colliders
 - Catch-up meetings: first Monday of Month at 3pm
 - UK Mailing List: UK-MUON-DETECTOR@JISMAIL.AC.UK
 - In-person meeting on July 3 in Birmingham.
 - Goal is to drive interest in the μ C physics program in UK!
 - Indico page: <https://indico.stfc.ac.uk/event/983/> (zoom option)

Overflow discussion and questions

Note one possible option is FCC-ee @ CERN -> Muon Collider @ US -> FCC-hh @ CERN.
How do these pieces interplay?

Q: How did the UK handle involvement with previous US-based experiments like the Tevatron?

QTFP (Quantum Technologies for Fundamental Physics)

Further Resources

UK QT programme <https://uknqt.ukri.org/>

How to get involved? ...

@Ian TO ADD: contacts and work areas for EPPSU

- AION Oliver Buchmuller, o.buchmueller@imperial.ac.uk
- QUEST-DMC Andrew Casey, A.Casey@rhul.ac.uk
- QSHS Ed Daw, e.daw@sheffield.ac.uk

Overflow discussion and questions

...

Neutrinos

Further Resources

- Onubb UK community strategy 11/23 <https://zenodo.org/records/10620723>
- Lookout for UK high-energy astrophysical neutrino consortium community building workshops this year!
- Backup slides!

How to get involved?

- **NUSTORM a perfect topic to study further for briefing book. In particular, how it could benefit DUNE/HK over their own near detectors, as well as as a self-contained experiment. Contact Ken Long.**
- **For other items, contact Kirsty Duffy (she can direct you to other people if appropriate)**

Overflow discussion and questions

On the long term prospects for neutrino oscillation experiments, it seems Europe is well-placed to push this development precisely because we are not hosting a superbeam (so we don't have quite the same sort of pressures).

Other non-Collider Experiments/Activities

Further Resources

Search for Hidden Particles (SHiP) <https://cds.cern.ch/record/2839677/files/SPSC-I-258.pdf>
Forward Physics Facility (FPF) <https://arxiv.org/pdf/2203.05090>,
https://indico.cern.ch/event/1358966/contributions/5806440/attachments/2809999/4904237/FPF_Physics.pdf

How to get involved?

- **Contacts: COMET: Yoshi Uchida Mu2e: Mark Lancaster MuEDM: Gavin Hesketh Mu3e: Joost Vossebeld nEDM2: Philip Harris pEDM: Themis Bowcock / Alex Keshavarzi**
- **FPF slide 18. Contact Alan Barr, Josh McFayden, WG convenors (<https://fpf.web.cern.ch/node/86>)**
- **SHiP, slide 15 high priority tasks for this year. Contact Andrei Golutvin, Mitesh Patel.**

- **Keep Carl and Mark in cc if you get in touch with anyone!**

Regarding Uta's question on PDFs and forward charm at the FPF, here are some inputs for those interested ...

DIS & PDFs:

<https://indico.cern.ch/event/1275380/contributions/5379619/attachments/2662969/4613853/ojo-FPF6-WG1.pdf>

New-physics independent PDFs:

https://indico.cern.ch/event/1384135/contributions/5884087/attachments/2842618/4970176/Ubiali_EFTWG.pdf

Forward charm:

<https://indico.cern.ch/event/1275380/contributions/5379620/attachments/2658988/4613890/Updates-WG2-Reno.pdf>

Overflow discussion and questions

...

Direct Dark Matter

Further Resources

Snowmass DM report (2021) <https://arxiv.org/abs/2209.08125>

LZ sensitivity <https://arxiv.org/abs/1802.06039>

Darkside <https://link.springer.com/article/10.1140/epjp/i2018-11973-4>

XLZD <https://arxiv.org/abs/2203.02309>

NEWS-G

[https://indico.cern.ch/event/1188759/contributions/5230554/attachments/2621904/4534484/NEWS-G_UCLA_v2\(1\).pdf](https://indico.cern.ch/event/1188759/contributions/5230554/attachments/2621904/4534484/NEWS-G_UCLA_v2(1).pdf)

MIGDAL

https://indico.cern.ch/event/1272184/contributions/5668244/attachments/2769167/4825693/Migdal_P.Majewski_v3.pdf

ADMX

<https://indico.cern.ch/event/1188759/contributions/5232884/attachments/2622622/4534916/UCLADarkMatter.pdf>

How to get involved:

- **DarkSide:** Jocelyn Monroe, Oxford, jocelyn.monroe@physics.ox.ac.uk
- **XLZD:** Henrique Araujo, h.araujo@imperial.ac.uk

- NEWS-G: Patrick Knights, prk@hep.ph.bham.ac.uk
- SOLAIRE: Darren Price, Darren.Price@cern.ch
- MIGDAL: Paweł Majewski, pawel.majewski@stfc.ac.uk
- ADMX: Ed Daw, e.daw@sheffield.ac.uk

Overflow discussion and questions

...

TODO for september try to map out the full reach/timescales of the different experiments