REPORT TO THE LHCC REFEREES

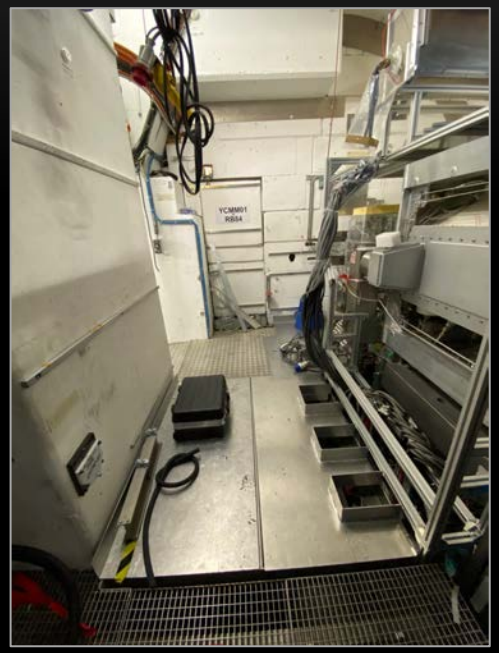
156 LHCC Week – 28th November

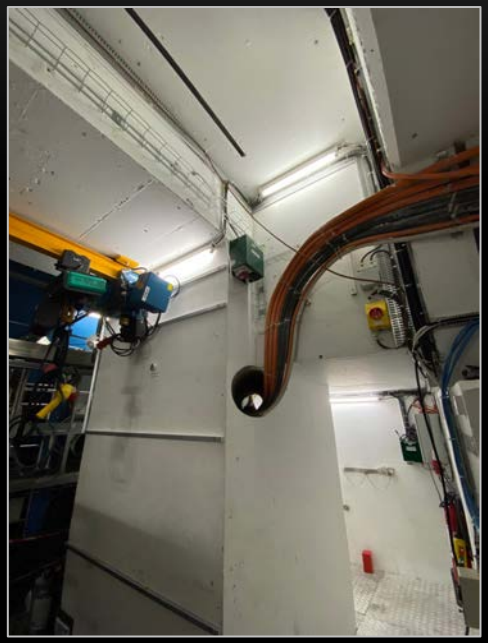
James Pinfold for the MoEDAL-MAPP Collaboration

AGENDA

- *MoEDAL*
  - *Temporary Removal for LHCb repairs in VELO region*
  - *Dates for Reinstallation*
- *MAPP*
  - *MAPP readout completed*
  - *Installation to date*
  - *Final installation schedule*
- *MAPP Outrigger*
  - *Shielding installation and ECR*
  - *Technical Proposal*

MoEDAL Removal & Reinstallation





- *All elements of the MoEDAL detector were removed without issue in 2 days starting on October 30th from the VELO cavern (team from Alberta and Valencia) to enable repairs to LHCb's VELO secondary vacuum system.*
- *We have agreed with LHCb on a reinstallation window of 5 days in February 2024*

MAPP Electronic Readout Design is Completed – All Boards Available

- *The Frontend Readout Board has now been completed and all boards produced:*
  - *All components have been supplied and the Boards are now being populated - first readout boards will be deployed December 10th*
- *Calibration LED boards and calibration control board are completed*
  - *Special cables and connectors for the calibration board are due to be delivered*
- *Cockcroft Walton powering boards for PMTs are completed*
- *All PMTs tested and PMT bases completed and tested.*

MAPP-1 Installation to Date

- *The MoEDAL-MAPP team continued to install MAPP from Nov 1st after removing MoEDAL from the VELO cavern.*
  - *All 400 scintillator units are installed + one half instrumented with a PMT*
  - *The DAQ computer and local storage as well as all power supplies are installed*

Looking at Cosmics with MAPP

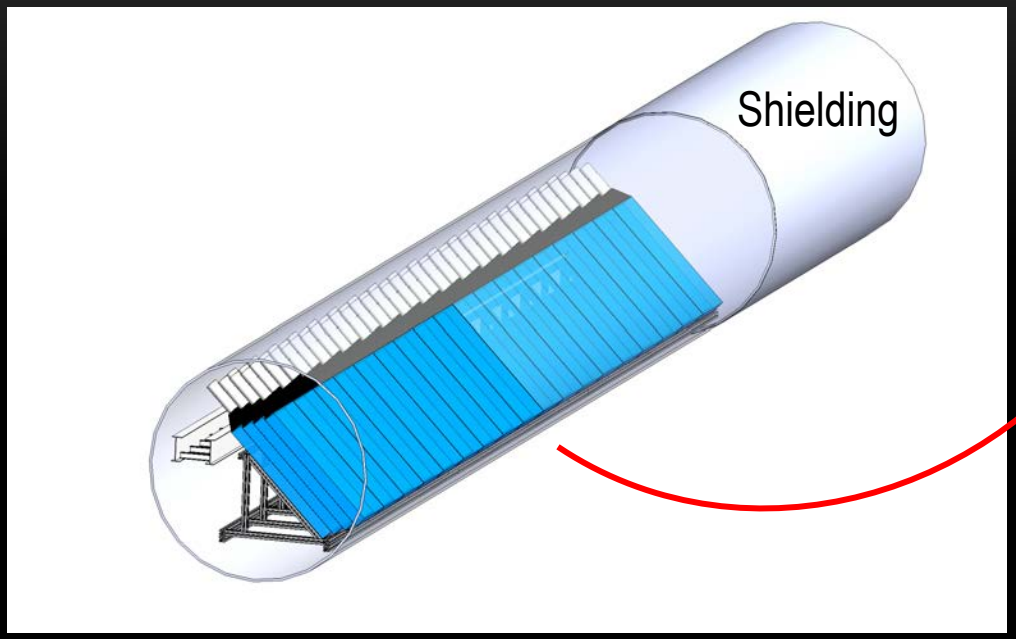
video

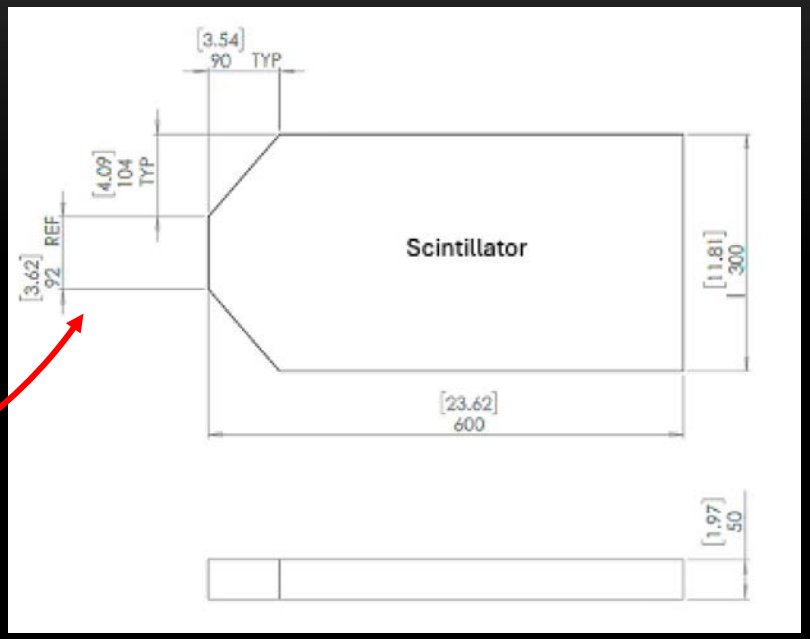
- *Each installed PM is checked using cosmic rays that still manage to penetrate the 105m overburden*

Remaining MAPP Installation Schedule Overview

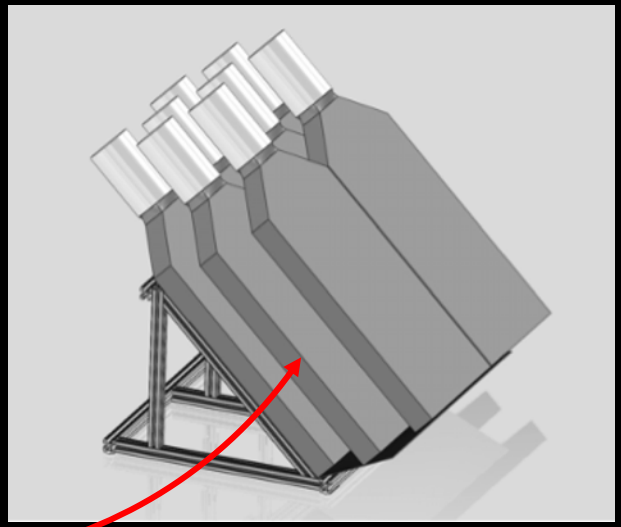
- December 1st → 10th continue installation of PMTs and start the installation of readout electronics
  - First tests of complete readout chain using cosmics
- January 7th to February 8th – Complete installation of electronic readout + connection to LHC timing (fibre is in place)
  - First test of a complete readout system for 64 channels
- February 9th to Start of Data Taking:
  - Test of calibration system
  - Test of complete detector + complete readout chain for all channels using cosmics.

The Outrigger Design

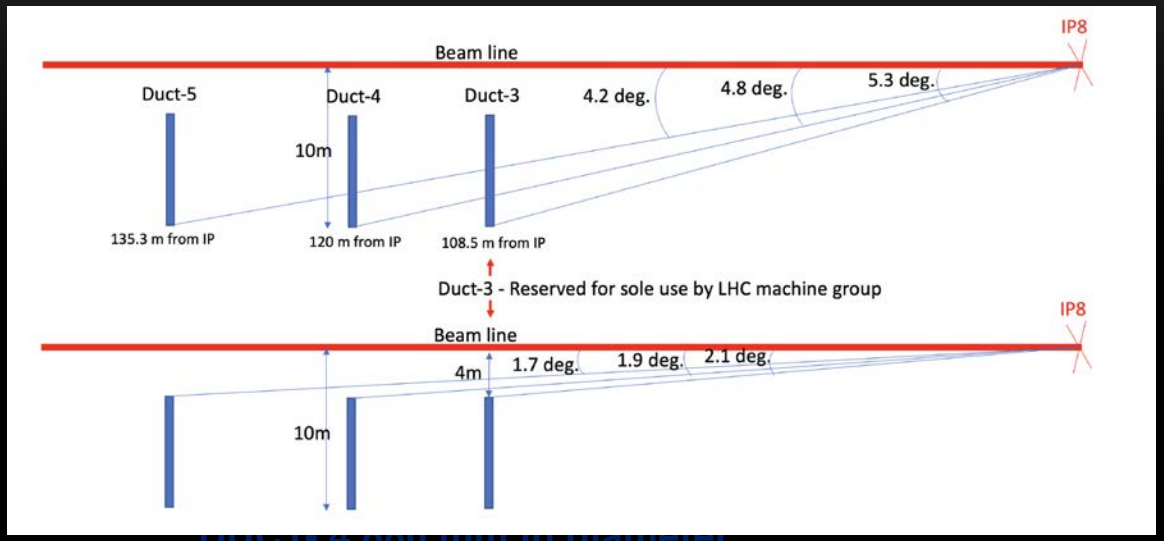


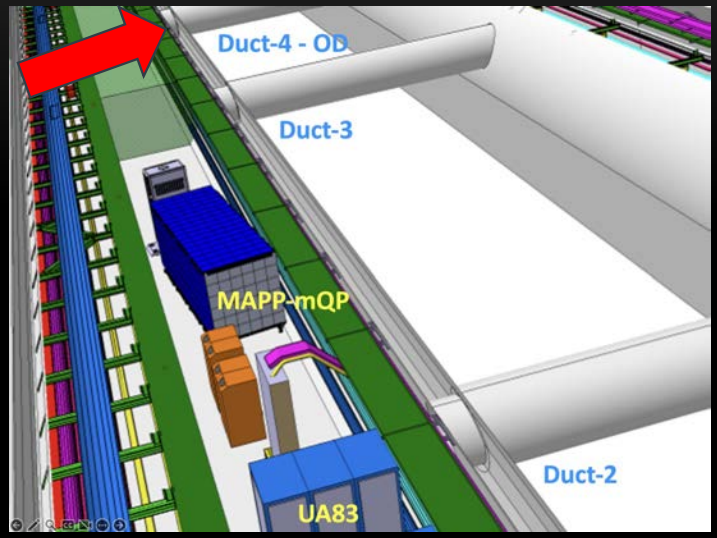


- *The final design is 92 detectors assembled into 4 planes*
  - *The detector is deployed in Duct-4*
  - *The detector is protected by 1m of iron shielding*
  - *The installation is performed using installation subunits of 8 detectors as shown*



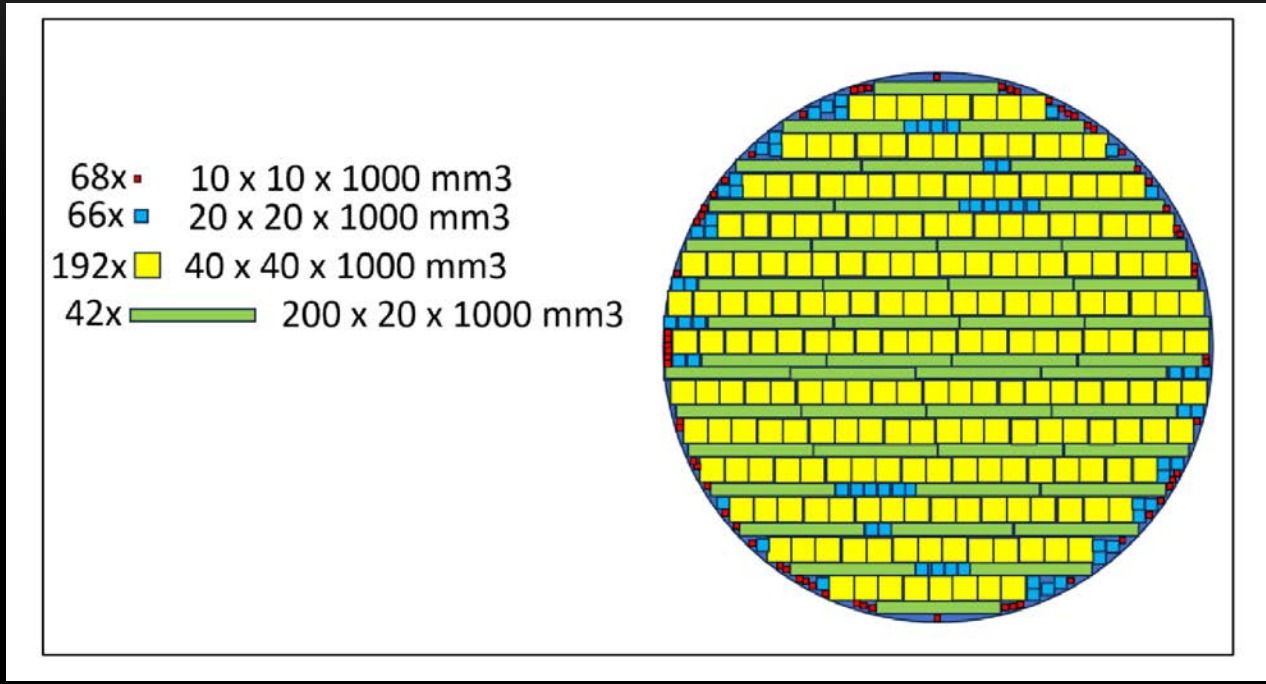
The Outrigger Shielding (1)





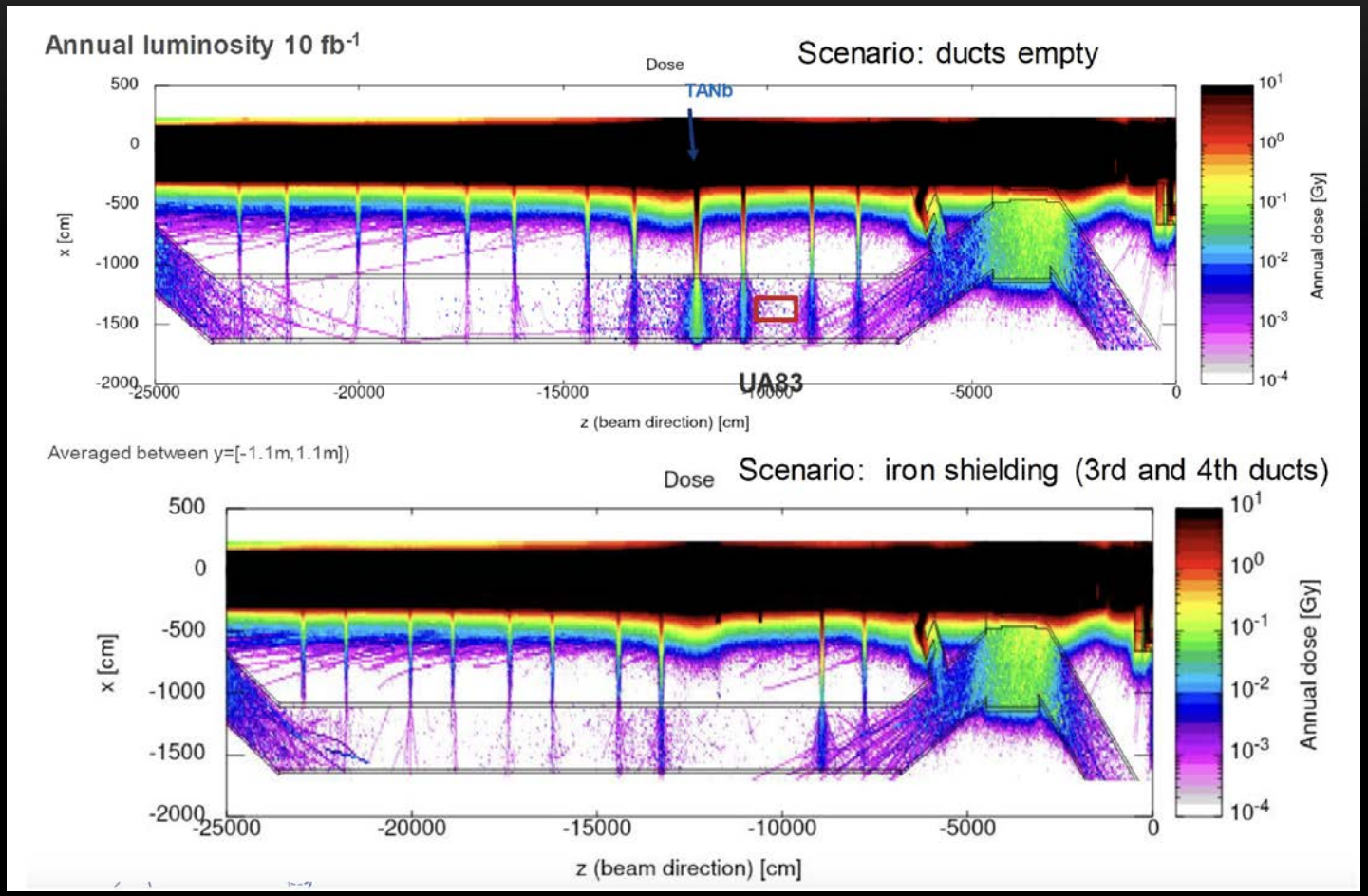
- *The LHC Machine Group have recently stipulated that only Duct-4 is currently available for Outrigger deployment.*
  - *Duct 5 is under consideration for additional outrigger elements.*
- *Shielding is required in the tunnel to protect the outrigger from beam related radiation*

The Outrigger Shielding (2)



- *The shielding design recently approved by the Machine Group has 1m of iron arranged in the Duct as shown and supersedes our original proposal of 2m of concrete*
  - *Simulations show that 2m of continuous concrete is roughly equivalent to 1m of continuous iron in terms of shielding efficacy*
- *One issue is the channels between the shielding elements cannot be modelled well by FLUKA.*

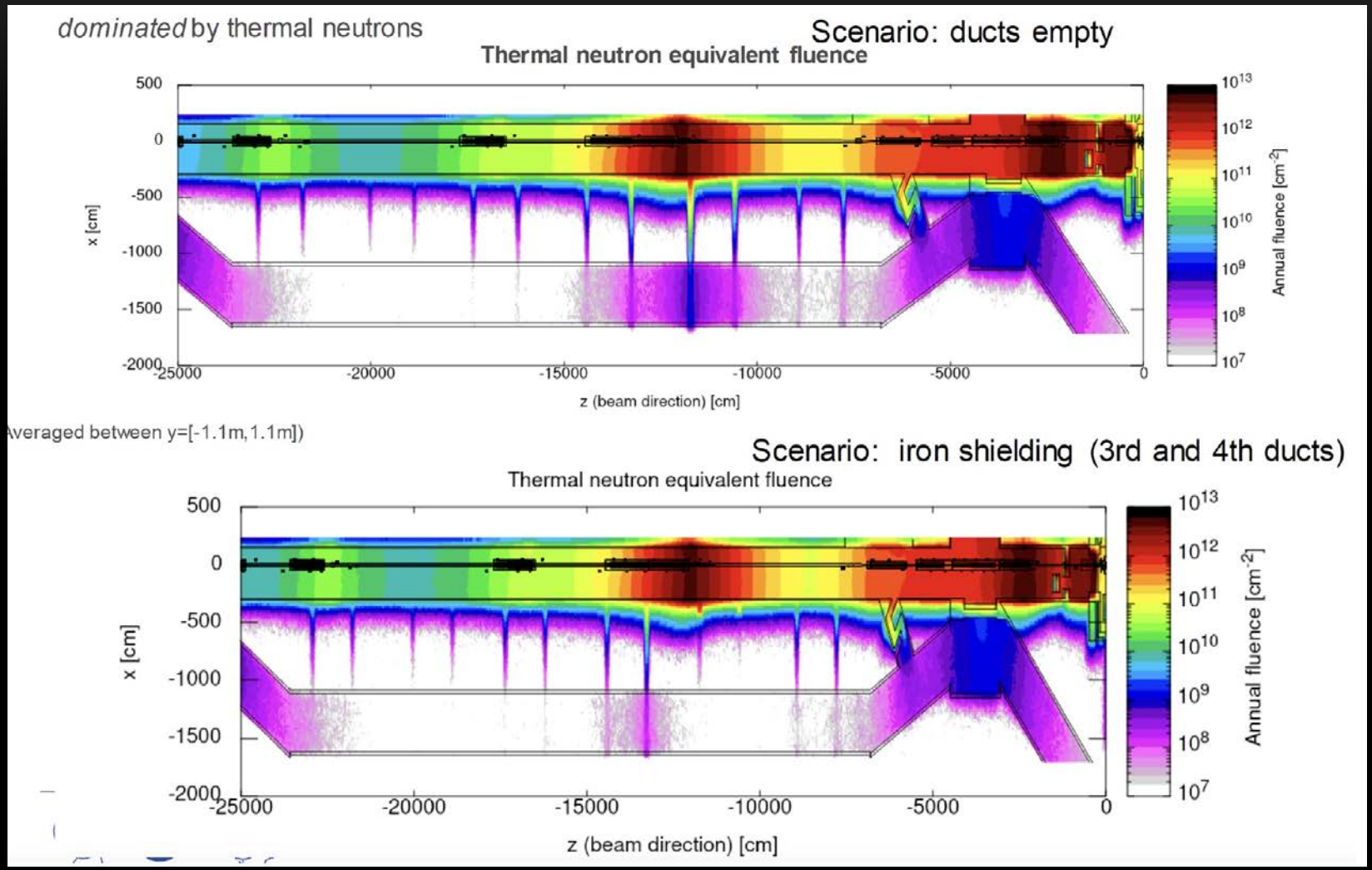
Beam Backgrounds - Dose



- *The effect on the dose in the Ducts 3 &4 of 1 m of <u>continuous</u> iron shielding*

FLUKA studies performed by fully Francesco Cerutti & Alessia Ciccotelli of the Beam-Machine Interaction section of the CERN Eng. Dept.

Beam Backgrounds – Thermal n's

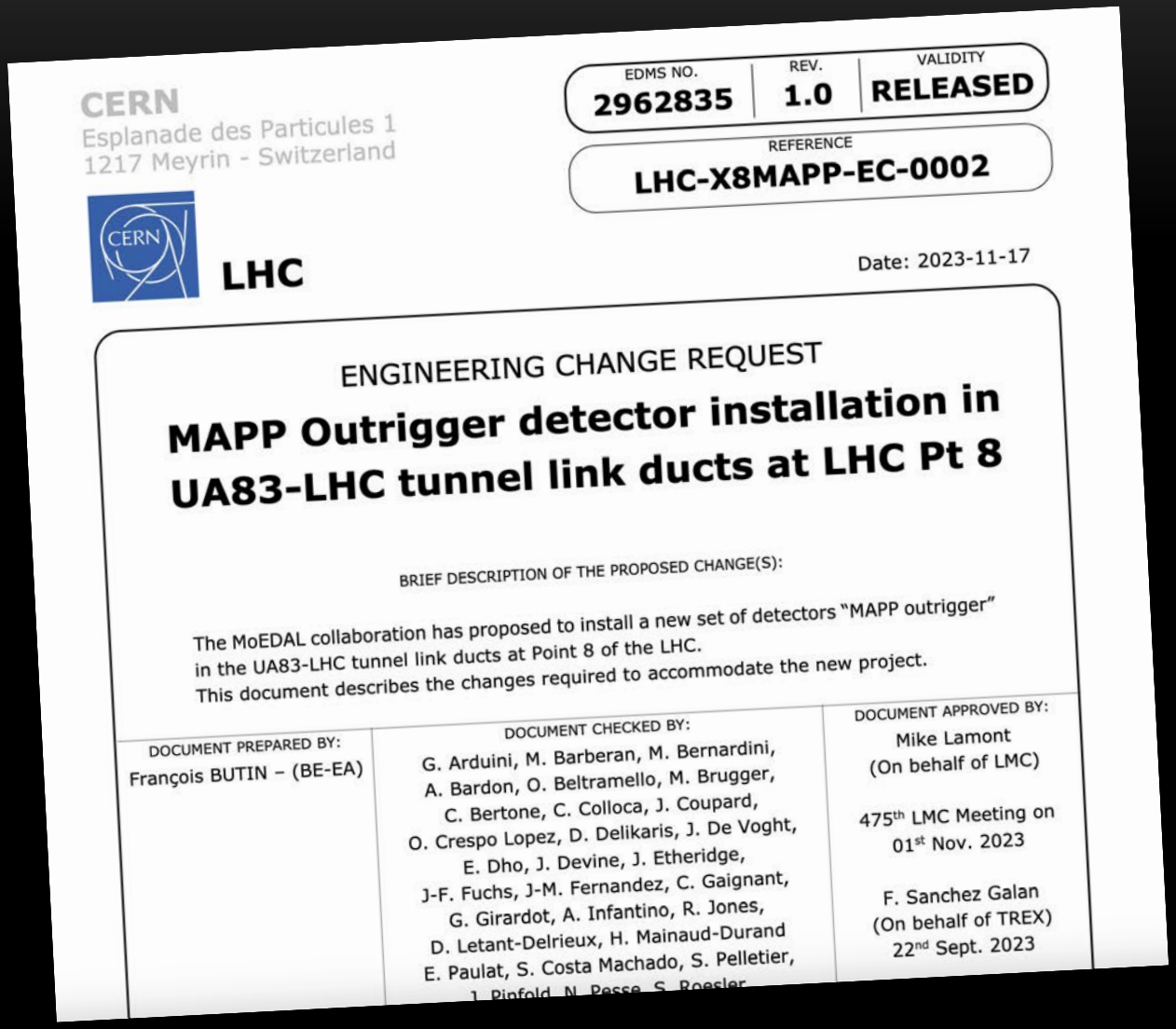


FLUKA studies performed by fully Francesco Cerutti & Alessia Ciccotelli of the Beam-Machine Interaction section of the CERN Eng. Dept.

Installation of Shielding + Support Rails and Cable Tray for the Outrigger

- *Scaffolding will be installed on the LHC side W49:12/03-08/2023 (2 h)*
- *The team in charge of removing the air tightness plug on LHC side and the internal existing structure will work W50:12/10-15/2023 (2-3 days)*
- *The scan of the inside of the duct will take place end of W50 or W51 (1 h work)*
- *Duct-4 and region will be available for installation of our support rails and cable tray, internal to Duct-4, from W51:12/17-22/2023 till the end of W4:01/28/2024 (excluding Xmas break)*
- *The iron shielding will be laid W5:01/29/24 {> 02/02/2024 (2 days)*
- *The air tightness plug will be re-installed in W6:02/5-11/2024 (0.5d)*
- *The scaffolding will be removed W6*
- *Work to be carried out bt CERN Engineering Group*

The ECR for the Outrigger Shielding



CERN
Esplanade des Particules 1
1217 Meyrin - Switzerland

EDMS NO.	REV.	VALIDITY
2962835	1.0	RELEASED

REFERENCE
LHC-X8MAPP-EC-0002

LHC

Date: 2023-11-17

ENGINEERING CHANGE REQUEST

MAPP Outrigger detector installation in UA83-LHC tunnel link ducts at LHC Pt 8

BRIEF DESCRIPTION OF THE PROPOSED CHANGE(S):

The MoEDAL collaboration has proposed to install a new set of detectors "MAPP outrigger" in the UA83-LHC tunnel link ducts at Point 8 of the LHC.
This document describes the changes required to accommodate the new project.

DOCUMENT PREPARED BY:	DOCUMENT CHECKED BY:	DOCUMENT APPROVED BY:
François BUTIN – (BE-EA)	G. Arduini, M. Barberan, M. Bernardini, A. Bardon, O. Beltramello, M. Brugger, C. Bertone, C. Colloca, J. Coupard, O. Crespo Lopez, D. Delikaris, J. De Voght, E. Dho, J. Devine, J. Etheridge, J-F. Fuchs, J-M. Fernandez, C. Gaignant, G. Girardot, A. Infantino, R. Jones, D. Letant-Delrieux, H. Mainaud-Durand E. Paulat, S. Costa Machado, S. Pelletier, J. Pinfold, N. Pesse, S. Roesler	Mike Lamont (On behalf of LMC) 475th LMC Meeting on 01st Nov. 2023 F. Sanchez Galan (On behalf of TREX) 22nd Sept. 2023

CERN has agreed to cover the cost of the Outrigger shielding in Duct 4

The MAPP Outrigger TP

MoEDAL

The MAPP Outrigger Technical Proposal

Version 1.1

B. Acharya[1,2] J. Alexandre[1] P. Benes[3] B. Bergmann[3] S. Bertolucci[7] A. Bevan[4] R. Brancaccio[16] H. Branzas[5] P. Burian[3] M. Campbell[6] S Cecchini[7] Y. M. Cho[8] M. de Montigny[9] J. Ellis[1] M. Fairbairn[1] D. Felea[5] M. Frank[10] J. Hays[4] A. M. Hirt P.Q. Hung[12] J. Janecek[3] M. Kalliokoski[13] D. Lacarèrre[6] C. Leroy[14] G. Levi[7] A. Maselek[27,28] A. Margiotta[7,16] A. Maulik[7,9] N. Mauri[7] N. E.Mavromatos[1,17] M. Mieskolainen[18] L. Millward[4] V. A. Mitsou[15] G. Moss[19] Musumeci[15] I. Ostrovskiy[20] P.-P. Ouimet[21] J. Papavassilou[15] L. Patrizii[7] G. E. Păvălaş[5] J. L. Pinfold[9,1] L. A. Popa[5] V. Popa[5] M. Pozzato[7] S. Pospisil[3] A. Rajantie[21] R. Ruiz de Austi[15] Z. Sahnoun[7,23] M. Sakellariadou[1] K. Sakurai[28] S. Sarkar[1] G. Semenoff[24] A. Shaa[9] G. Sirri[7] K. Sliwa[7] R. Soluk[9] M. Spurio[7] M. Staelens[9] M. Suk[3] M. Tenti[25] V. Togo[7] J. A. Tuszynski[9] A. Upreti[20] V. Vento[7] O.Vives[7]

Abstract

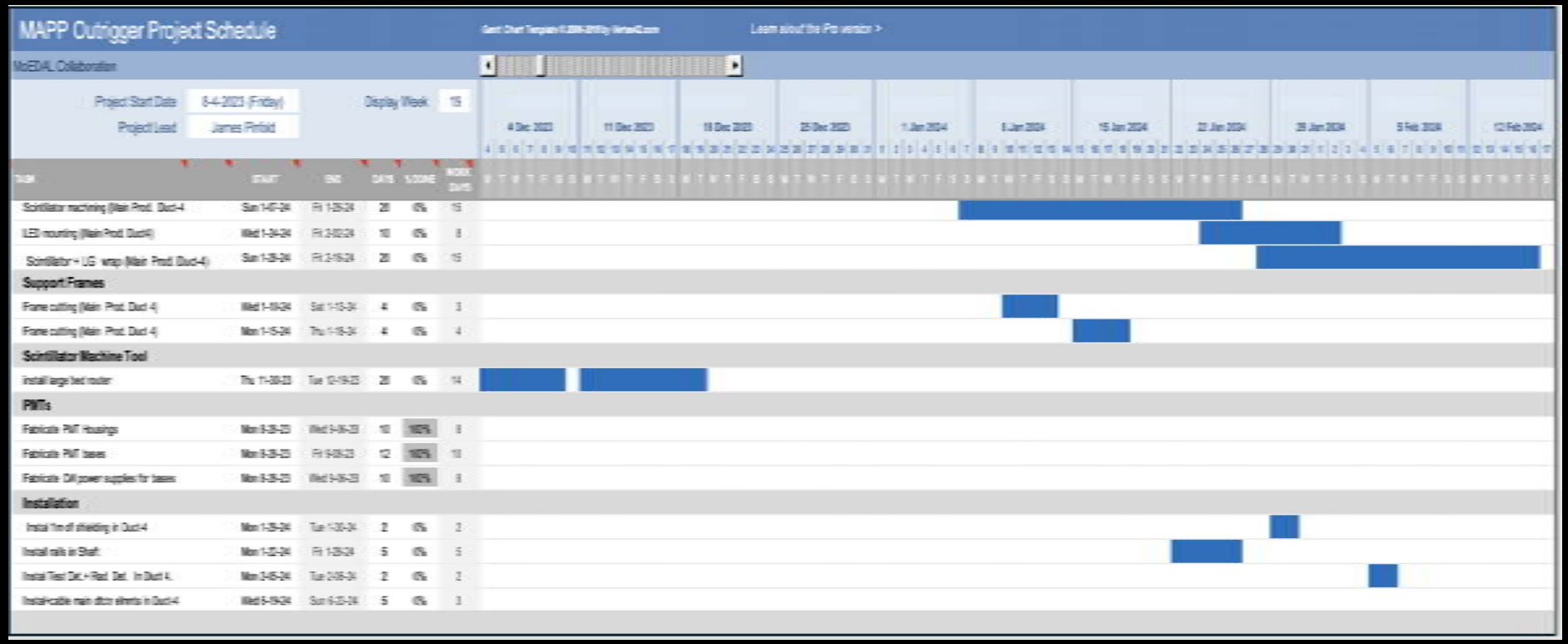
This is the Technical Proposal for the outrigger detector for the MAPP (moEDAL Apparatus for Penetrating Particles) detector being installed in UA83 for data taking during Run-3 and on. The outrigger is an auxiliary detector designed to greatly improve the acceptance of the Phase-1 MAPP detector (MAPP-1) for milli-charged particles with large fractional charges. The outriggers are four 6m scintillator planks, comprised of 60 cm x 30 cm x 5 cm scintillator slabs, deployed in a horizontal duct joining the UA83 tunnel to the beam tunnel in the vicinity of the MAPP detector.

- *Version 1.1 of the MAPP Outrigger Technical Proposal sent the LHCC referees on November 20th 2023.*

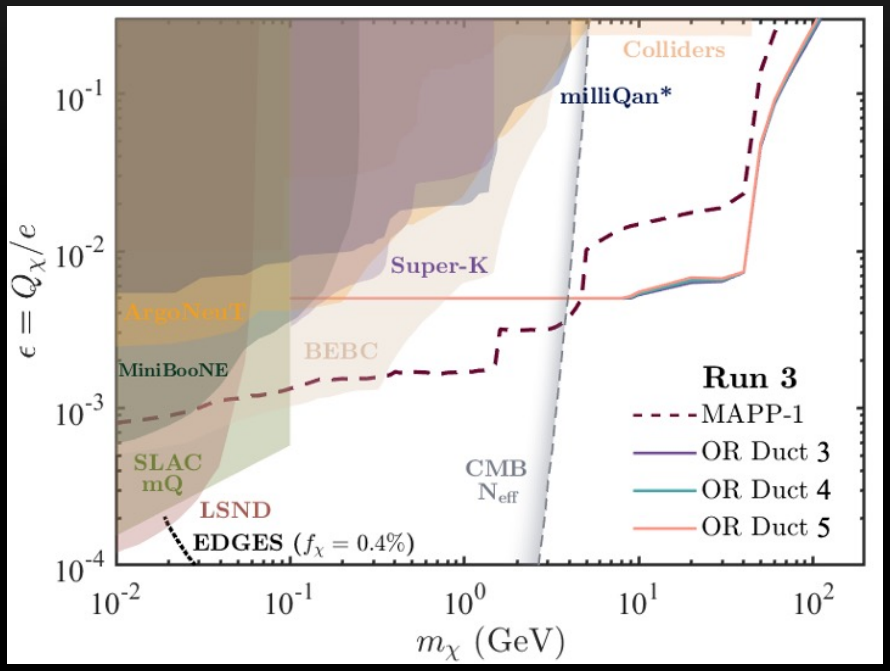
Outrigger Installation Schedule

- *The shielding will be installed in January 2024 as noted.*
- *Due to the non-continuous nature of the shielding we would need to insert test detectors & dosimeters with varying amounts of HDP shielding before inserting the Outrigger detectors for the start of the run in 2024.*
- *We envisage that possible upgrades to the shielding will be to stop low-energy neutrons from travelling down gaps between the shielding bars using HDPE layers.*
- *If, as we expect, the shielding is found to be effective after a short period of running we would install the Outrigger Detectors during the next possible period.*
  - *The use of easily handled installation subunits that slide on rails into the Duct allows us to install the whole Outrigger detector in an estimated 5 days*
  - *We have used as an example the use of a 5 day, TS similar to the one in June 2023, as a possibility for early installation*
  - *In any case we would use the 2024 YETS*

The Construction and Installation Schedule for the Outrigger

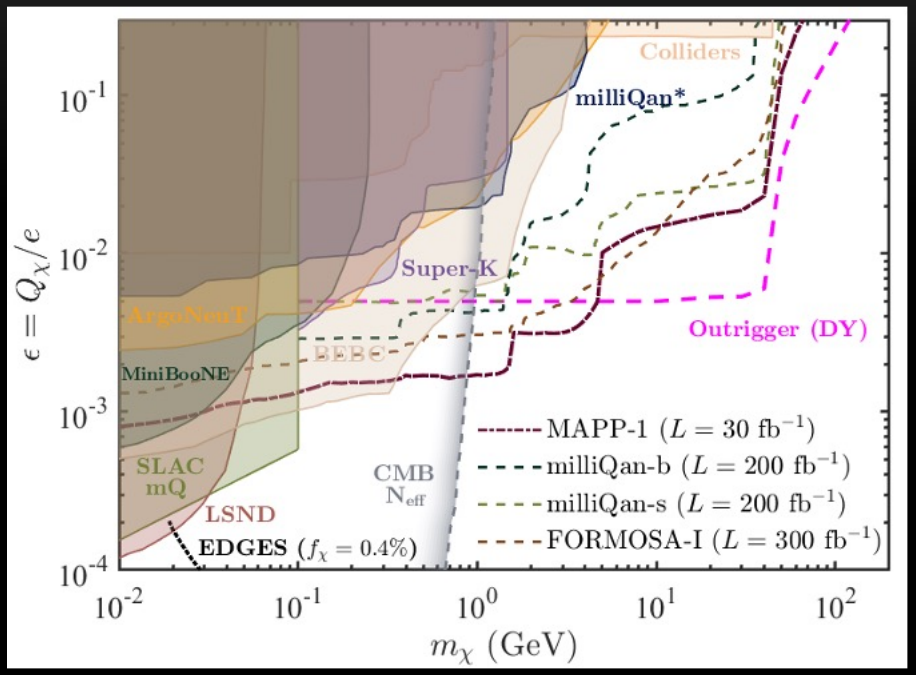


Physics Expectations



The effect on the sensitivity of the Outrigger Detector for mCPs due to its position. MAPP detector efficiencies

This study shows that the exact position of the Outrigger, in either Duct 3, 4 or 5 , does not impact its sensitivity in a significant way.



Direct bounds from accelerator-based searches and indirect bounds from the effective number of neutrinos from Planck are shown. The projected sensitivity for mCPs, for models with a massless dark photon, are presented for milliQan, MAPP-mCP and FORMOSA-1 at Run-3.

MAPP detector efficiencies are included but not yet in the Outrigger case