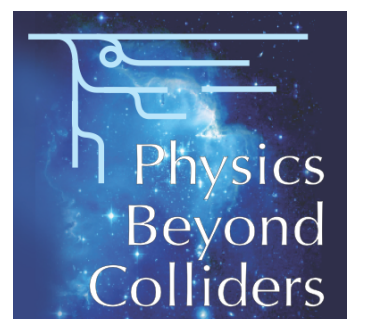
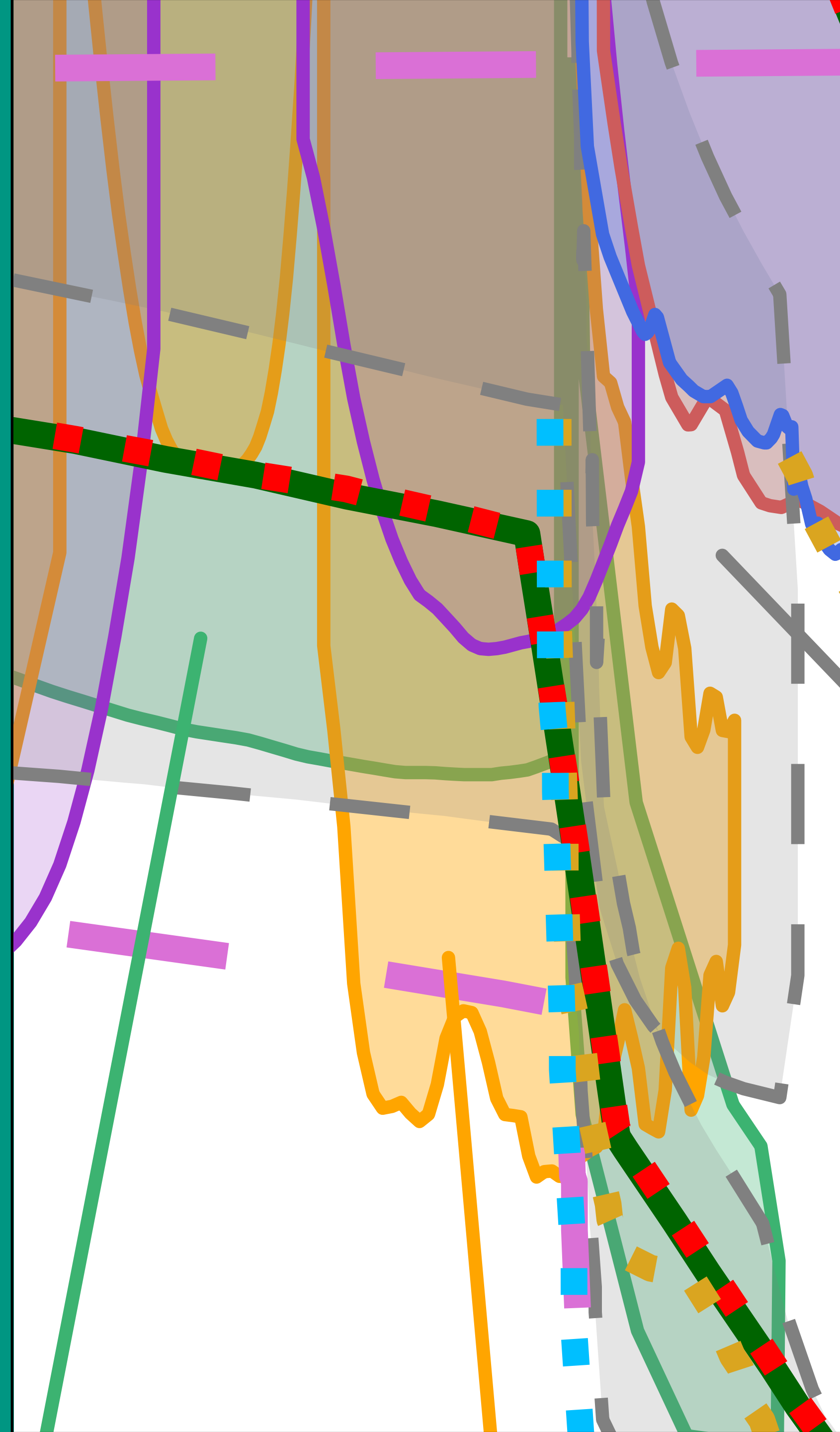


EPPSU:

Benchmark models and Experiment table

PBC March 12 2025

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PBC line- and fill-styles for existing limits

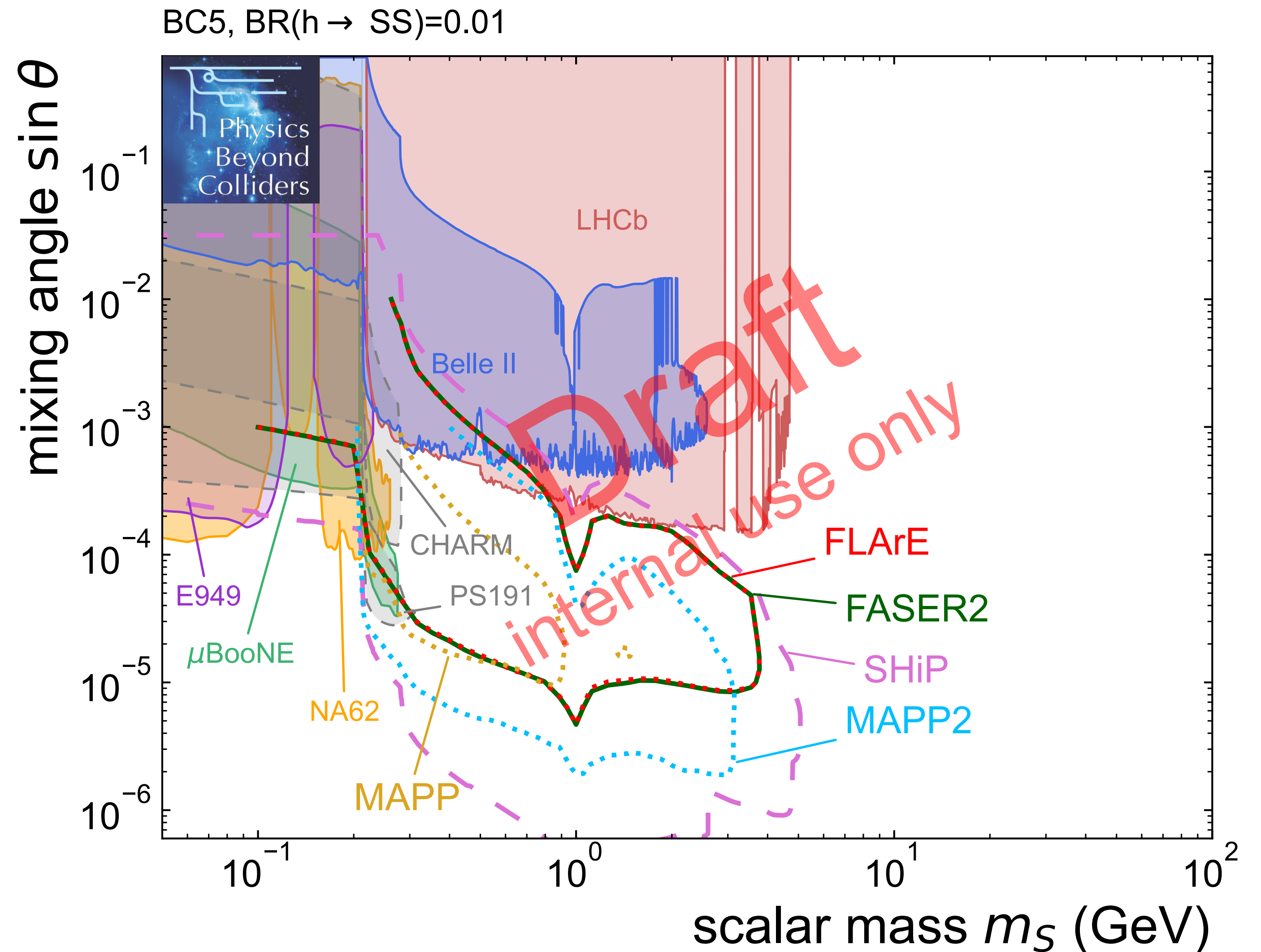
- Existing constraints are shown as color-filled areas with solid outlines
- Constraints colored in gray with a dashed outline are reinterpretations not performed by the experimental collaborations and without access to raw data
- We may show all existing limits (including reinterpretations) as gray areas to not distract the eye from the new PBC projections

PBC line styles for sensitivities

- **solid lines** correspond to background estimates based on the extrapolation of existing data sets
- **dashed lines** indicate background estimates based on full Monte Carlo simulations (this includes the case that after full simulations the backgrounds are zero, e.g. at SHiP)
- **dotted lines** represent projections based on toy Monte Carlo simulations or on the assumption that backgrounds are negligible

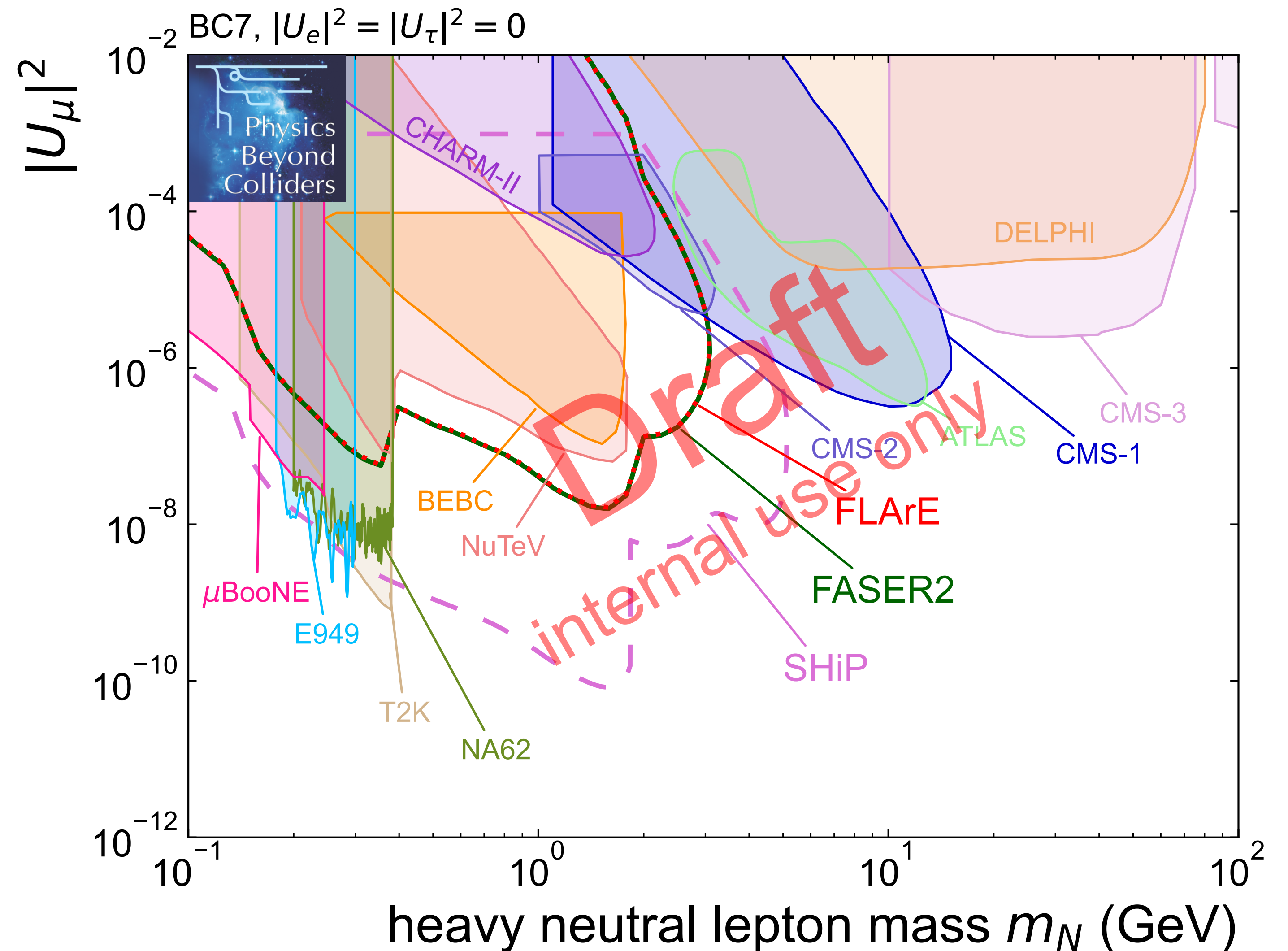
Benchmark model BC5 ($h \rightarrow SS$)

- Most planned experiments probing dark Higgs production in B decays are independent on the branching fraction $BR(h \rightarrow SS)$, and limits for BC5 are identical to BC4
- For $BR=0.01$, the transition where the limits from $h \rightarrow SS$ dominate is at about $\theta=10^{-5}$, which effects SHiP (included), but possibly also MAPP2 (not included)?
- **We are still missing sensitivities for MATHUSLA, ANUBIS, and CODEX-B**



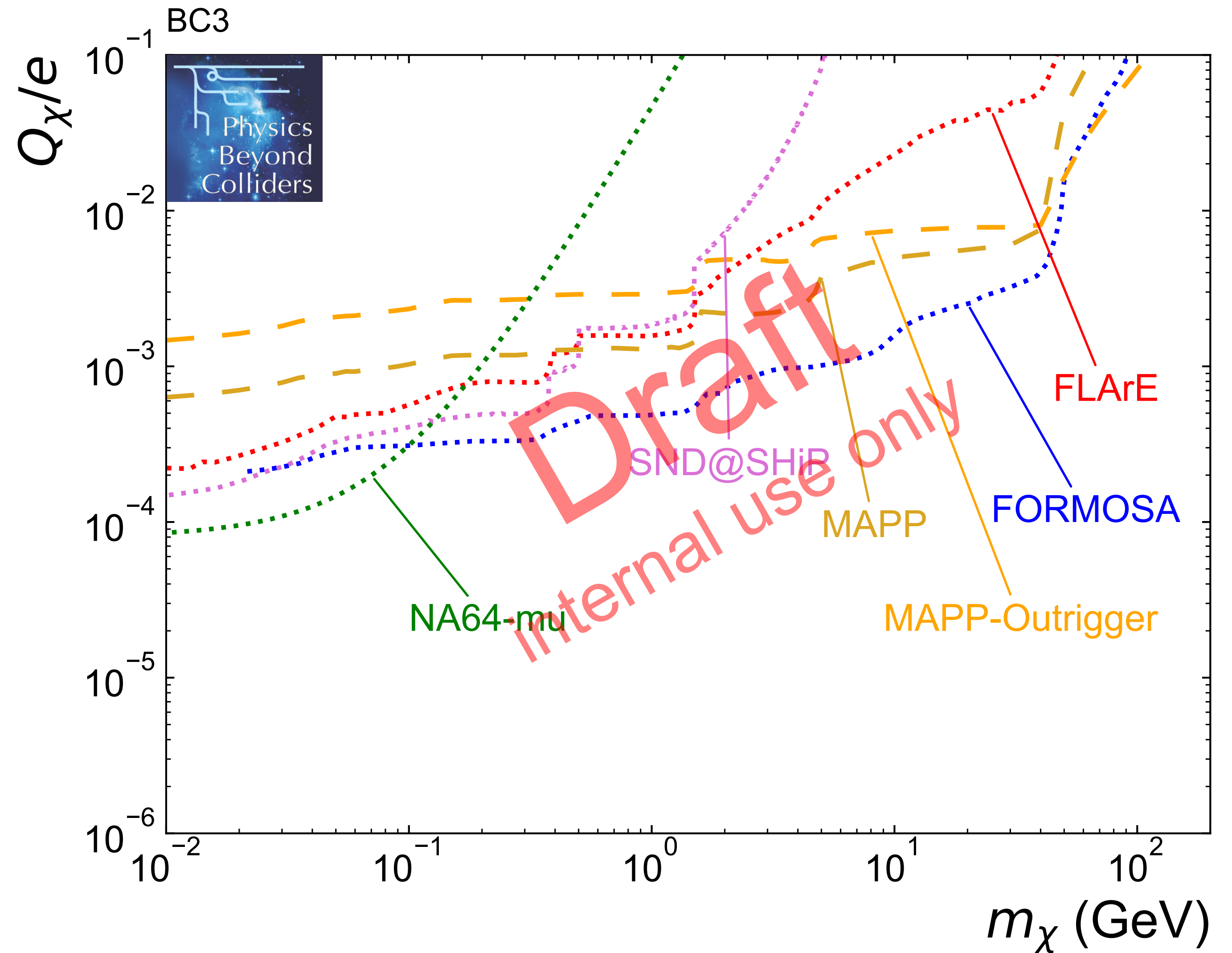
Benchmark model BC7 (HNL with muon couplings)

- We will discuss in the text that moving forward, experiments must not only look into single-flavour dominance
- MAPP-Outrigger currently only has sensitivities for an extended model that is not covered by BC7
- **We are still missing sensitivities for MATHUSLA, ANUBIS, and CODEX-B**



Benchmark model BC3 (millicharged particles)

- Most experiments do not have full MC-based studies or have not updated after significant experiment re-designs
- We are missing the existing limits split by experiments - does anyone have them in a machine readable format?



Remarks

- We will harmonise line colors of PBC experiments across all plots (the same color per experiment)
- We will mention PBC experiments that did not provide sensitivities in time with a qualitative statement in the captions
- We will cite all existing limits in the captions

Experiment table

	MATHUSLA	Codex-b	ANUBIS	FASER2	FORMOSA	FLArE	NA64	SND@SHiP	SHiP	MAPP-1 Outrigger	MAPP-2	AdvSND
facility/beam	HL-LHC	HL-LHC	HL-LHC	HL-LHC	HL-LHC	HL-LHC	SPS	SPS	SPS	LHC + HL-LHC	LHC + HL-LHC	HL-LHC
physics focus	LLP	LLP	LLP	neutrino, LLP	mQP	DM, LLP, mQP	LLP, DM	neutrino, DM	LLP	mQP, LLPs	LLPs	DM
CM energy	14TeV	14TeV	14TeV	14TeV	14TeV	14TeV		27.4 GeV	27.4 GeV	14 TeV	14 TeV	14 TeV
η coverage	$0.69 < \eta < 1.1$	$0.13 < \eta < 0.54$	$-1.01 < \eta < 1.01$	> 6.7	$> \sim 7$	> 5.6	fixed target	> 2.2	> 1.7	$-3.1 < \eta < -4.2$	$-1.3 < \eta < -3.0$	$6.9 < \eta < 7.6$
Φ coverage (rad)	$0.5/2\pi$	0.36	1.78	2π	2π	2π	fixed target	$\sim 2\pi$	$\sim 2\pi$	-	-	$\sim \pi/4$
distance	$\sim 120\text{m}$	$\sim 25\text{m}$	$\sim 23\text{m}$	620 m	620m	620 m	active dump	28 m	32 m	120m	25 m to 55 m	480 m
overburden (mwe)	0	?	?	100m	100m	100m	?	0	0	105m	105m	-
DV/detector length (m)	$\sim 14\text{m}$	$\sim 10\text{m}$	$\sim 13\text{m}$	10 m	5m	7 m	5m	3 m	50 m	$\sim 5\text{m (max.)}$	$\sim (6\text{m} - 15\text{m})$	$\sim 3\text{ m}$
magnetic field (T)	no	no	no	2Tm	no	Yes (for HCAL)	Yes	1.7 T	0.65 Tm	No	No	1.75 T
timing (ps)	yes	?	yes	< 100	100	300	?	< 500	< 100	< 1000	< 1000	< 50
ECAL	no	no	no	yes	Sort of	Excellent	?	Yes	Yes	no	Pre-shower	Yes
energy threshold	N/A	N/A	N/A	GeV	keV	MeV	GeV	1 GeV	1 GeV	0.5 GeV	100 MeV	$\sim \text{GeV}$
direction resolution	N/A	N/A	N/A	$\ll \text{mrad}$	$\sim 0.05\text{ rad}$	1-2 mrad	?	O(1 mrad)	O(1 mrad)	?	?	$\sim \text{mrad}$
HCAL	no	?	no	yes	no	yes	?	Yes	No	No	No	Yes
tracking	yes	?	yes	excellent	Yes (crude)	excellent	?	Yes	Yes	Yes (crude)	Yes	Yes
charge threshold	1e	1e	1e	1e	0.001e	0.01e	1e	1e	1e	0.01e	1e	1e
reference	[?]	[?]	[?]	[?]	[?]	[?]	[?]	[?]	[?]	[?]	[?]	[?]

Table 1: Comparison of various PBC experiments.

<https://www.overleaf.com/read/vmyrhwbcyxyz#6e93bc>

Experiment table

- Overburden in “meters water equivalent” (mwe) may not be relevant for your core physics goals, but is a crude proxy for cosmic background rejection
- We **need a reference** to a document that is consistent with these numbers
- The **table must be consistent** with what you describe in the text of the document
- The **plots must be consistent** with what you describe in the text of the document