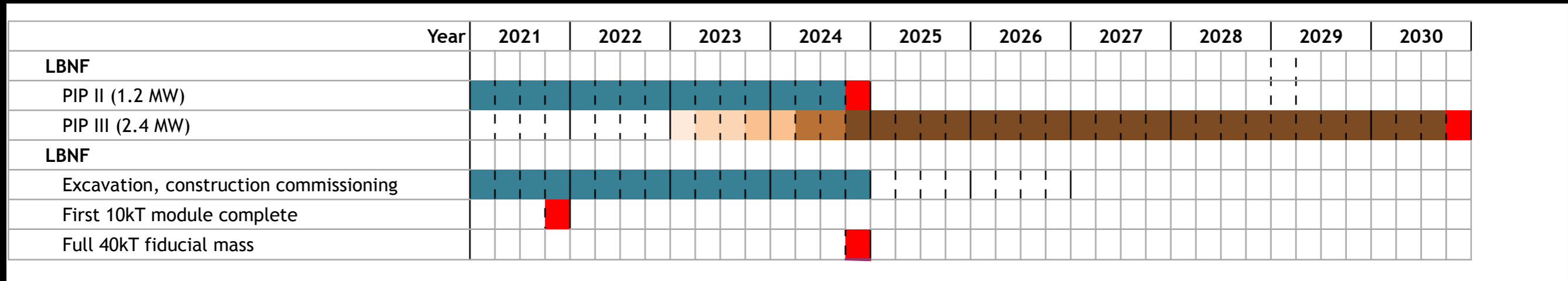


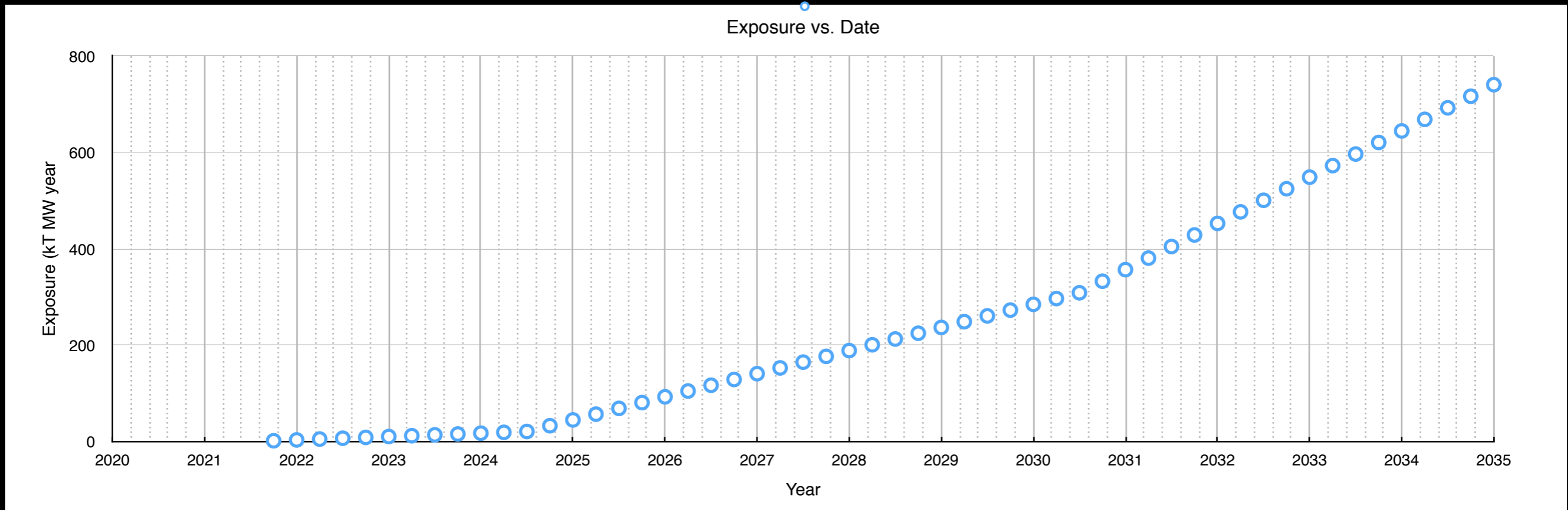
M. O. WASCKO, H. A. TANAKA

# LBNF/DUNE ROADMAP

# LBNF/DUNE SCHEDULE



- 2021 Q4: start of operations with 0.7 MW and 10 kT mass
- 2024 Q4: start of operations with PIP II (1.2 MW) and 40 kT mass
- 2030 Q4 start of operations with PIP III (2.4 MW)



# IN TABULAR FORM

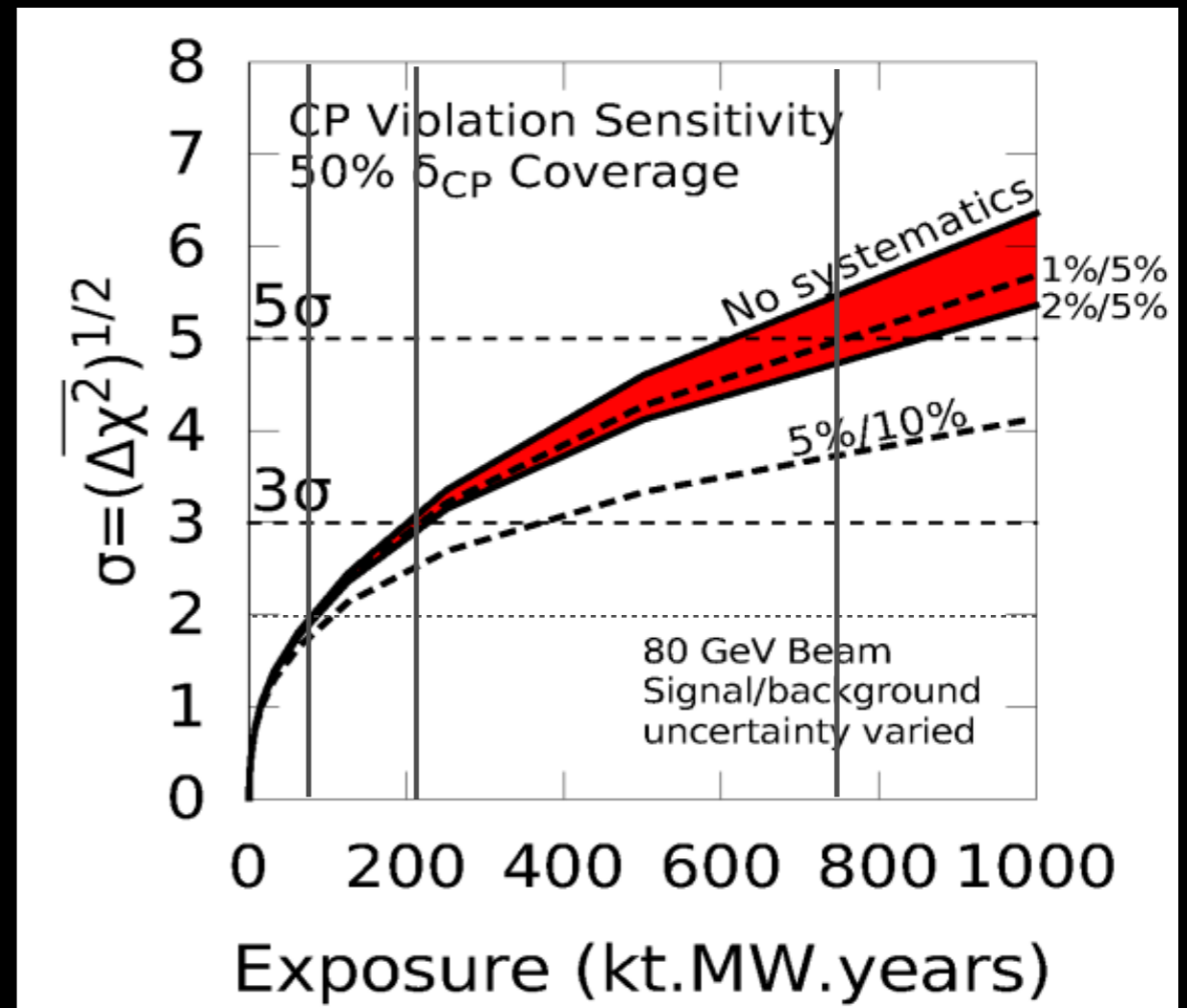
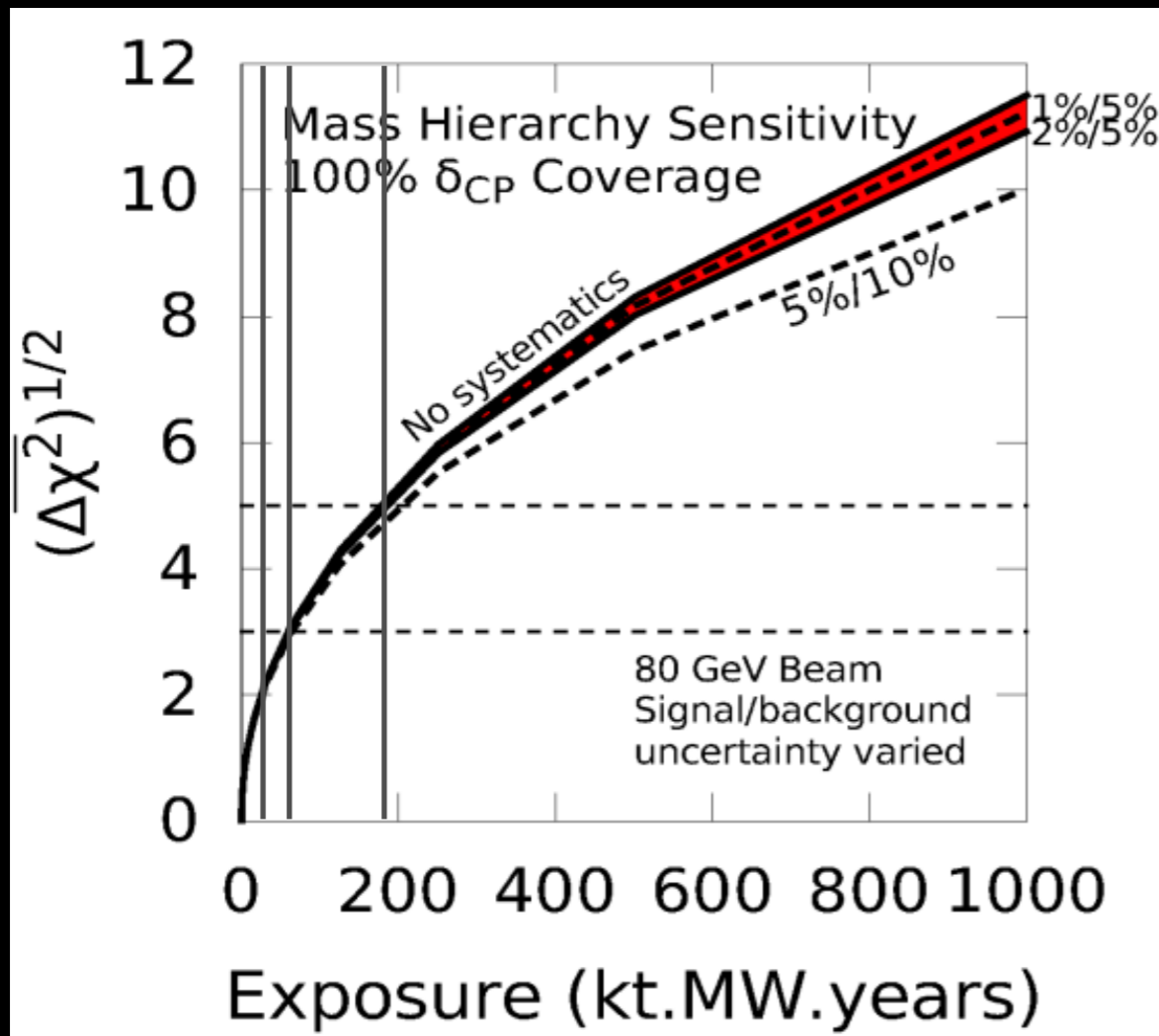
Table 1

Year	Calendar year	power (MW)	detector mass (kt)	operational time years	Incremental exposure	Net exposure
0.0	2021.75	0.7	10	0.25	1.75	1.75
0.25	2022.00	0.7	10	0.25	1.75	3.5
0.50	2022.25	0.7	10	0.25	1.75	5.25
0.75	2022.50	0.7	10	0.25	1.75	7
1.0	2022.75	0.7	10	0.25	1.75	8.75
1.25	2023.00	0.7	10	0.25	1.75	10.5
1.50	2023.25	0.7	10	0.25	1.75	12.25
1.75	2023.50	0.7	10	0.25	1.75	14
2.00	2023.75	0.7	10	0.25	1.75	15.75
2.25	2024.00	0.7	10	0.25	1.75	17.5
2.50	2024.25	0.7	10	0.25	1.75	19.25
2.75	2024.50	0.7	10	0.25	1.75	21
3.0	2024.75	1.2	40	0.25	12	33
3.25	2025.00	1.2	40	0.25	12	45
3.50	2025.25	1.2	40	0.25	12	57
3.75	2025.50	1.2	40	0.25	12	69
4.0	2025.75	1.2	40	0.25	12	81
4.25	2026.00	1.2	40	0.25	12	93
4.50	2026.25	1.2	40	0.25	12	105
4.75	2026.50	1.2	40	0.25	12	117
5.00	2026.75	1.2	40	0.25	12	129
5.25	2027.00	1.2	40	0.25	12	141
5.50	2027.25	1.2	40	0.25	12	153
5.75	2027.50	1.2	40	0.25	12	165
6.00	2027.75	1.2	40	0.25	12	177
6.25	2028.00	1.2	40	0.25	12	189
6.5	2028.25	1.2	40	0.25	12	201
6.75	2028.50	1.2	40	0.25	12	213

Table 1-1

7	2028.75	1.2	40	0.25	12	225
7.25	2029.00	1.2	40	0.25	12	237
7.5	2029.25	1.2	40	0.25	12	249
7.75	2029.50	1.2	40	0.25	12	261
8	2029.75	1.2	40	0.25	12	273
8.25	2030.00	1.2	40	0.25	12	285
8.5	2030.25	1.2	40	0.25	12	297
8.75	2030.50	1.2	40	0.25	12	309
9	2030.75	2.4	40	0.25	24	333
9.25	2031.00	2.4	40	0.25	24	357
9.5	2031.25	2.4	40	0.25	24	381
9.75	2031.50	2.4	40	0.25	24	405
10	2031.75	2.4	40	0.25	24	429
10.25	2032.00	2.4	40	0.25	24	453
10.5	2032.25	2.4	40	0.25	24	477
10.75	2032.50	2.4	40	0.25	24	501
11.00	2032.75	2.4	40	0.25	24	525
11.25	2033.00	2.4	40	0.25	24	549
11.5	2033.25	2.4	40	0.25	24	573
11.75	2033.50	2.4	40	0.25	24	597
12	2033.75	2.4	40	0.25	24	621
12.25	2034.00	2.4	40	0.25	24	645
12.5	2034.25	2.4	40	0.25	24	669
12.75	2034.50	2.4	40	0.25	24	693
13	2034.75	2.4	40	0.25	24	717
13.25	2035.00	2.4	40	0.25	24	741
13.5	2035.25	2.4	40	0.25	24	765
13.75	2035.50	2.4	40	0.25	24	789

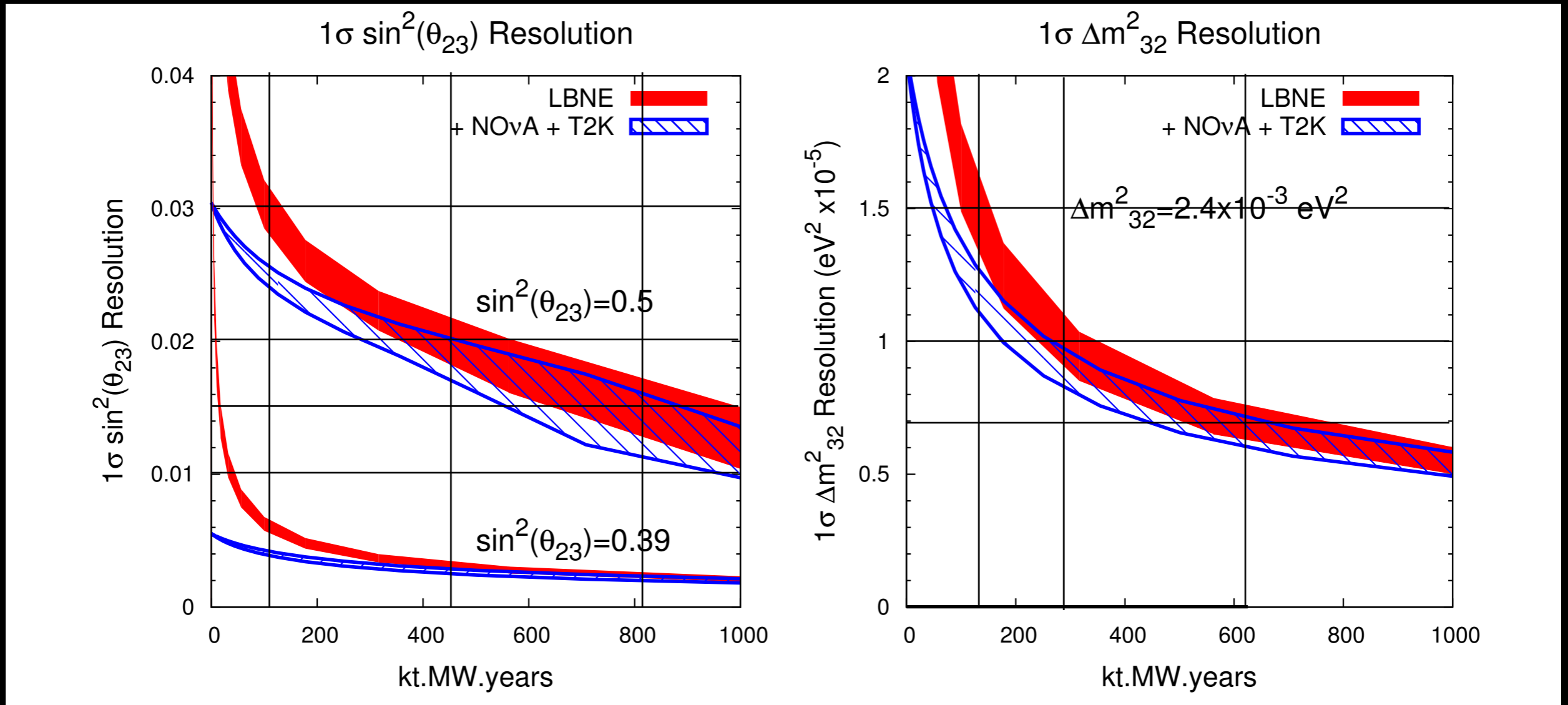
# MH AND CPV SENSITIVITY



- MH: min. sig. 100%  $\delta_{CP}$  coverage:
  - $2\sigma$ :  $\sim 30$  kt x MW x yr = 2024 Q4
  - $3\sigma$ :  $\sim 65$  kt x MW x yr = 2025 Q2
  - $5\sigma$ :  $\sim 180$  kt x MW x yr = 2028 Q1

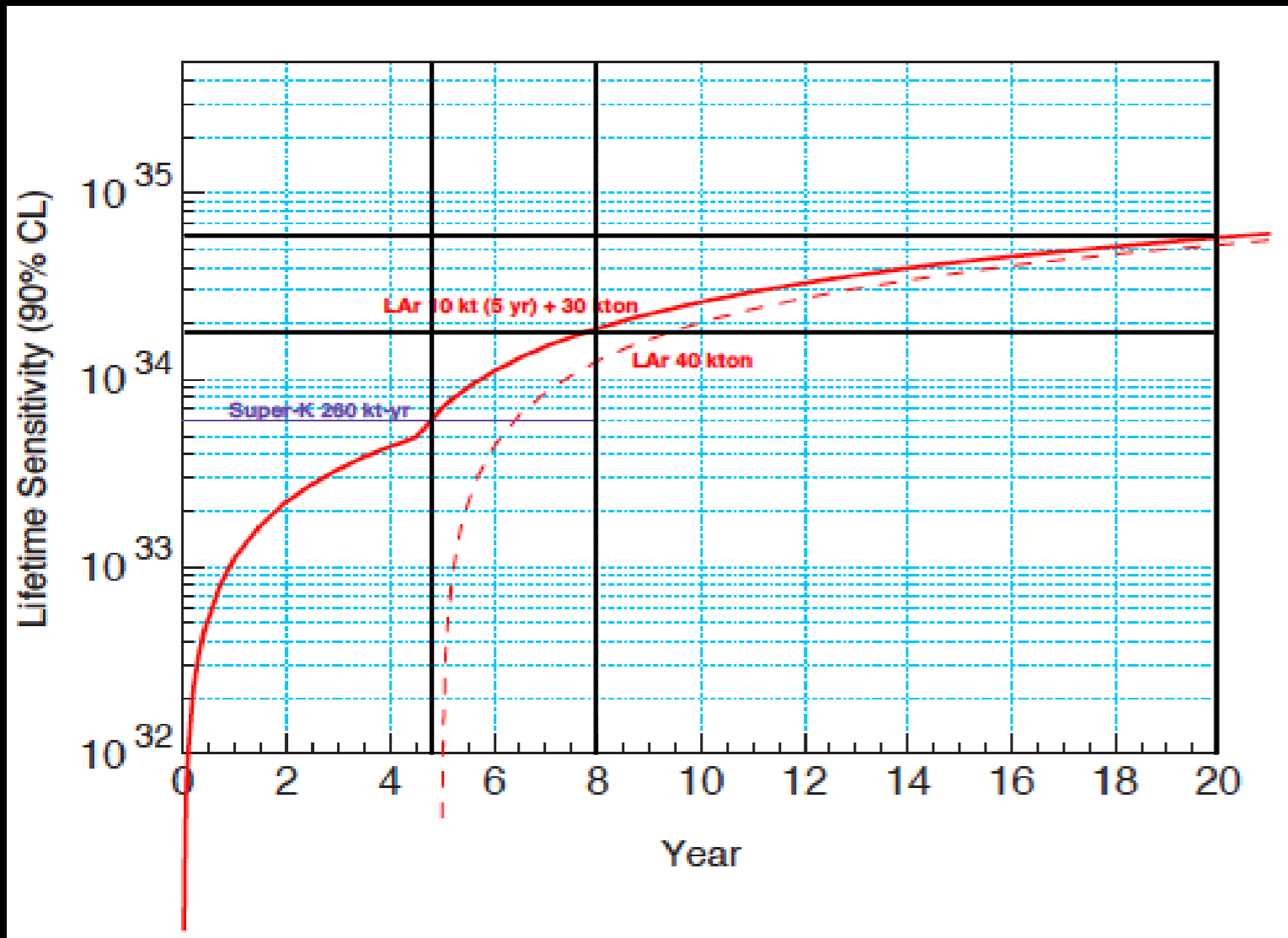
- CPV: min. sig. for 50% of  $\delta_{CP}$ 
  - $2\sigma$ :  $\sim 85$  kt x MW x yr = 2026 Q1
  - $3\sigma$ :  $\sim 210$  kt x MW x yr = 2028 Q2
  - $5\sigma$ :  $\sim 750$  kt x MW x yr = 2035 Q2

# $\Theta_{23}$



- precision on sin<sup>2</sup>θ<sub>23</sub> (assuming sin<sup>2</sup>θ<sub>23</sub> = 0.5)
  - δ(sin<sup>2</sup>θ<sub>23</sub>) ~ 0.030: ~100 kt × MW × yr = 2026 Q1
  - δ(sin<sup>2</sup>θ<sub>23</sub>) ~ 0.020: ~450 kt × MW × yr = 2032 Q1
  - δ(sin<sup>2</sup>θ<sub>23</sub>) ~ 0.015: ~825 kt × MW × yr = 2036 Q1
- precision on Δm<sup>2</sup><sub>32</sub> (×10<sup>-3</sup> eV<sup>2</sup>)
  - δ(Δm<sup>2</sup><sub>32</sub>) ~ 1.5: ~130 kt × MW × yr = 2026 Q4
  - δ(Δm<sup>2</sup><sub>32</sub>) ~ 1.0: ~290 kt × MW × yr = 2030 Q2
  - δ(Δm<sup>2</sup><sub>32</sub>) ~ 0.7: ~621 kt × MW × yr = 2033 Q4

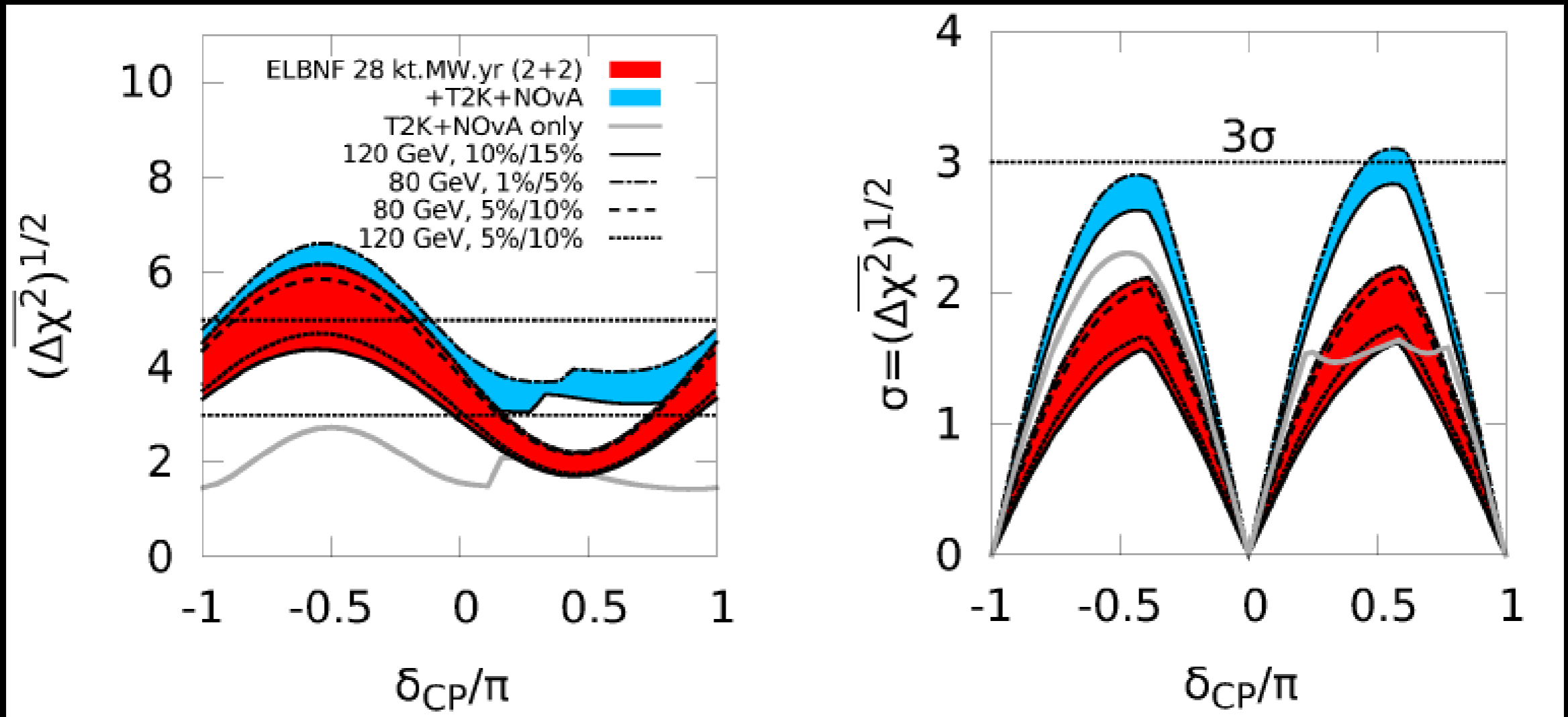
# PROTON DECAY ( $p \rightarrow K + \nu$ )



- Lifetime sensitivity at 90%CL (x SK limit of  $6 \times 10^{33}$  years)
  - 1x: 4.75 years ~ 2026 Q3
  - 3x: 8 years ~ 2029 Q4
  - 10x: 20 years ~ 2041 Q4
- (with faster 40 kT deployment)
  - 1x: 3.5 years
  - 3x: 6.5 years
  - 10x: 18.5 years

- Note difference in staging strategy
  - Here, 10 kt initial phase for 5 years followed by 40 kt
  - LBL assumes 10 kt for 3 years, followed by 40 kt

# NOTE:



- Note: 28 kT x MW x yr of LBNF operation
  - 4 years with 10 kT detector @ 0.7 MW
  - roughly equivalent in CPV sensitivity to T2K/NOvA