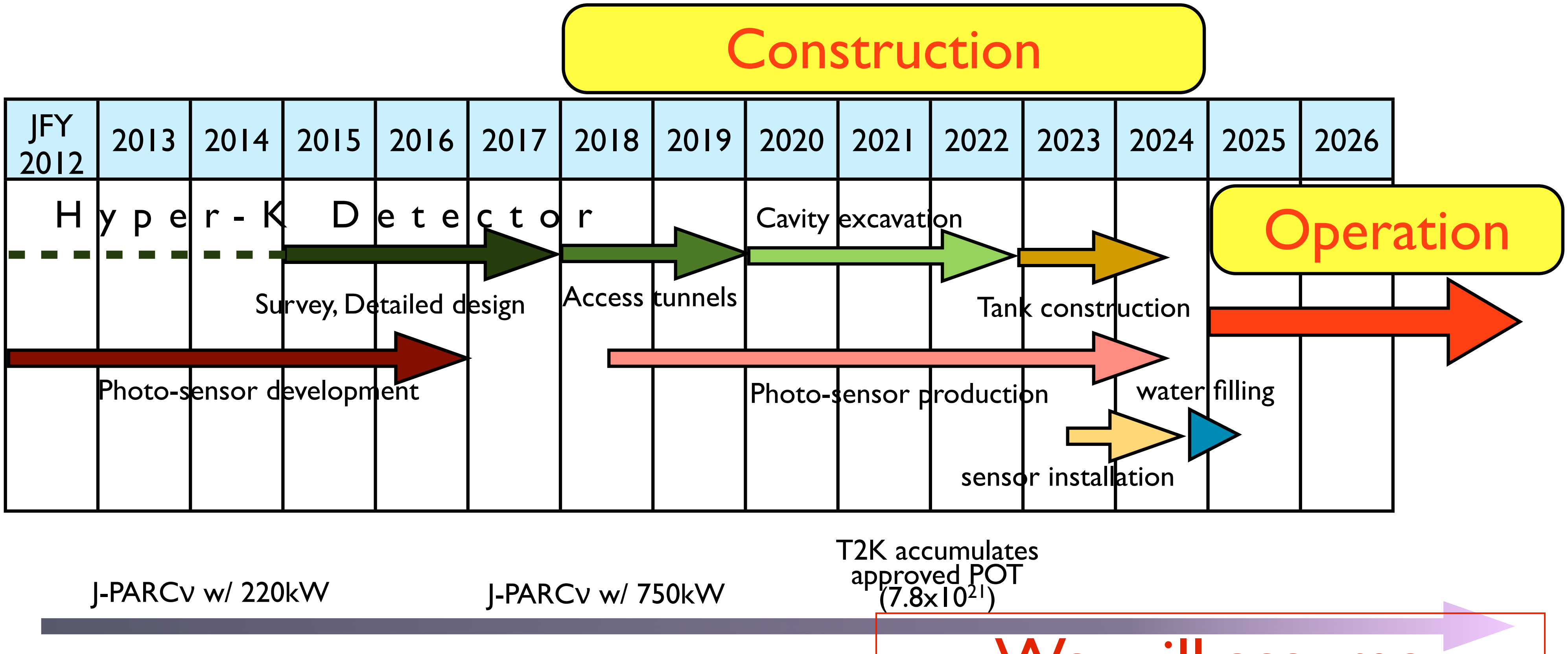
NBB

Kobayashi, Shiozawa

Hyper-K Notional Timeline



We will assume 0.75MW 10^7sec / year

(Optimistic) Timeline for anticipated results

- -2022 ~2σ CPV indication (sinδ=1) by T2K+ Nova +reactors
- -2025 *Start Hyper-K data taking*
- -2028 Discovery of leptonic CPV w/ >5σ (MH at the same time or earlier)
- -2030 Discovery of proton decays
- -20XX Always ready for Supernova neutrino burst

Strength of Hyper-K

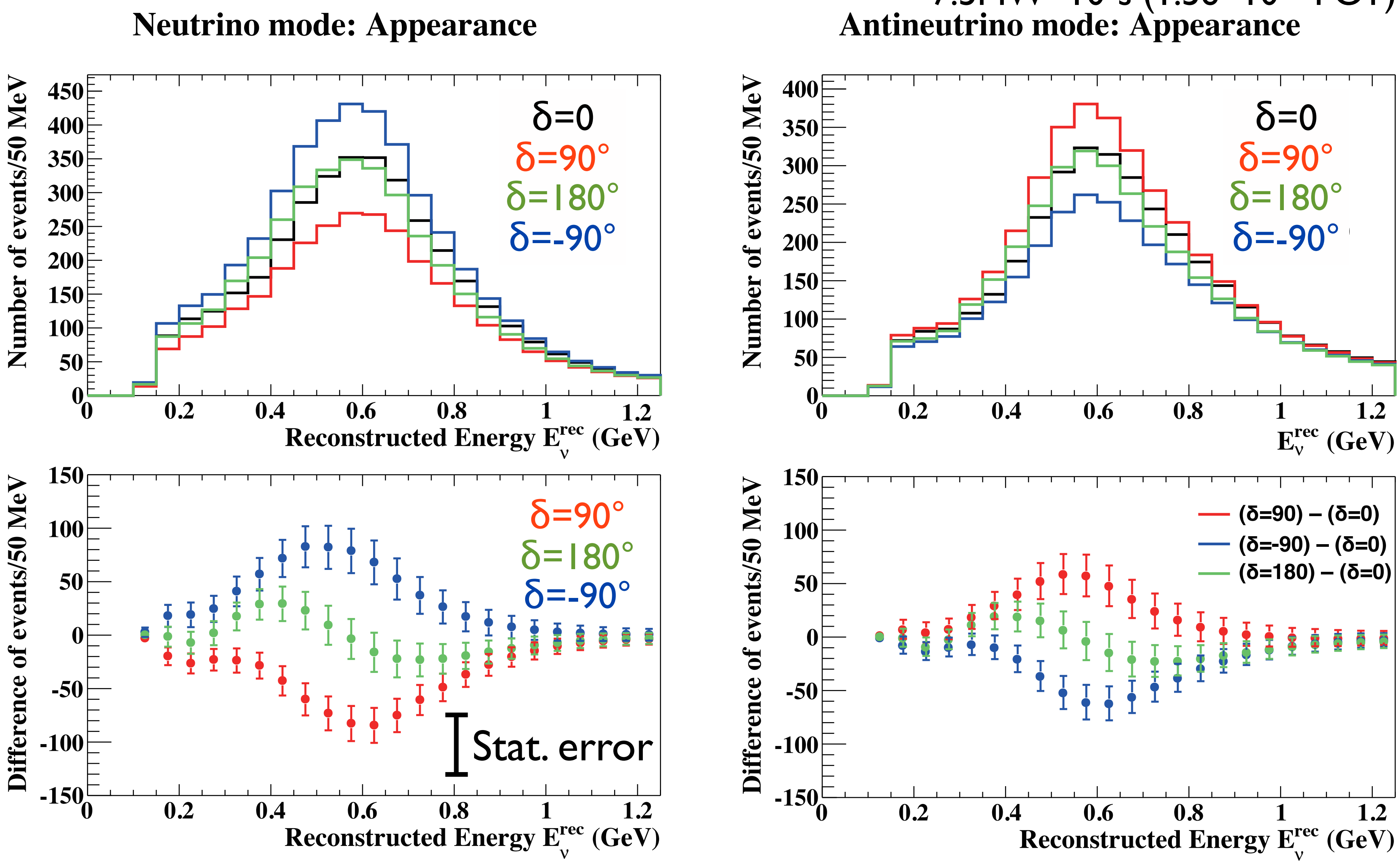
- Best sensitivity for CP measurement
  - Relatively short baseline (~300km): less matter effect
  - Off axis beam at 1st oscillation maximum
- Large statistics with good S/N
  - 2000-3000 appearance signal events expected
  - S/N~10 at appearance peak
- Performance proven with real data
  - Building on experience from T2K/Super-K
  - Systematics well understood
  - Further improvement expected as we go

δ_{CP} dependence of observables

7.5MW×10^7s (1.56×10^{22} POT)

νe candidates

Difference from δ=0



Sensitive to all values of δ with numbers + shape

Expected number of events for νe appearance

for normal hierarchy, δ=0

			HK (Erec<2GeV)
ν	νe signal		3,016
	Total BG		734
		wrong-sign app.	28
		NC	172
		Beam νe	523
		$\nu\mu$ CC	11
		$\nu\tau$ CC	0
νbar	νe signal		2,110
	Total BG		1,288
		wrong-sign app.	396
		NC	265
		Beam νe	618
		$\nu\mu$ CC	9
		$\nu\tau$ CC	0

Assumed systematic uncertainties

Realistic estimation based on SK/T2K

- Beam flux + near detector constraint
  - Conservatively assumed to be the same
- Cross section uncertainties not constrained by ND
  - Nuclear difference removed assuming water measurements
- Far detector
  - Reduced by increased statistics of atmospheric ν control sample

Uncertainty on the expected number of events at Hyper-K (%)

	ν mode		anti-ν mode		(T2K 2014)	
	ν_e	ν_μ	$\bar{\nu}_e$	$\bar{\nu}_\mu$	ν_e	ν_μ
Flux&ND	3.0	2.8	5.6	4.2	3.1	2.7
XSEC model	1.2	1.5	2.0	1.4	4.7	5.0
Far Det. +FSI	0.7	1.0	1.7	1.1	3.7	5.0
Total	3.3	3.3	6.2	4.5	6.8	7.6

- Further reduction by new near detectors under study

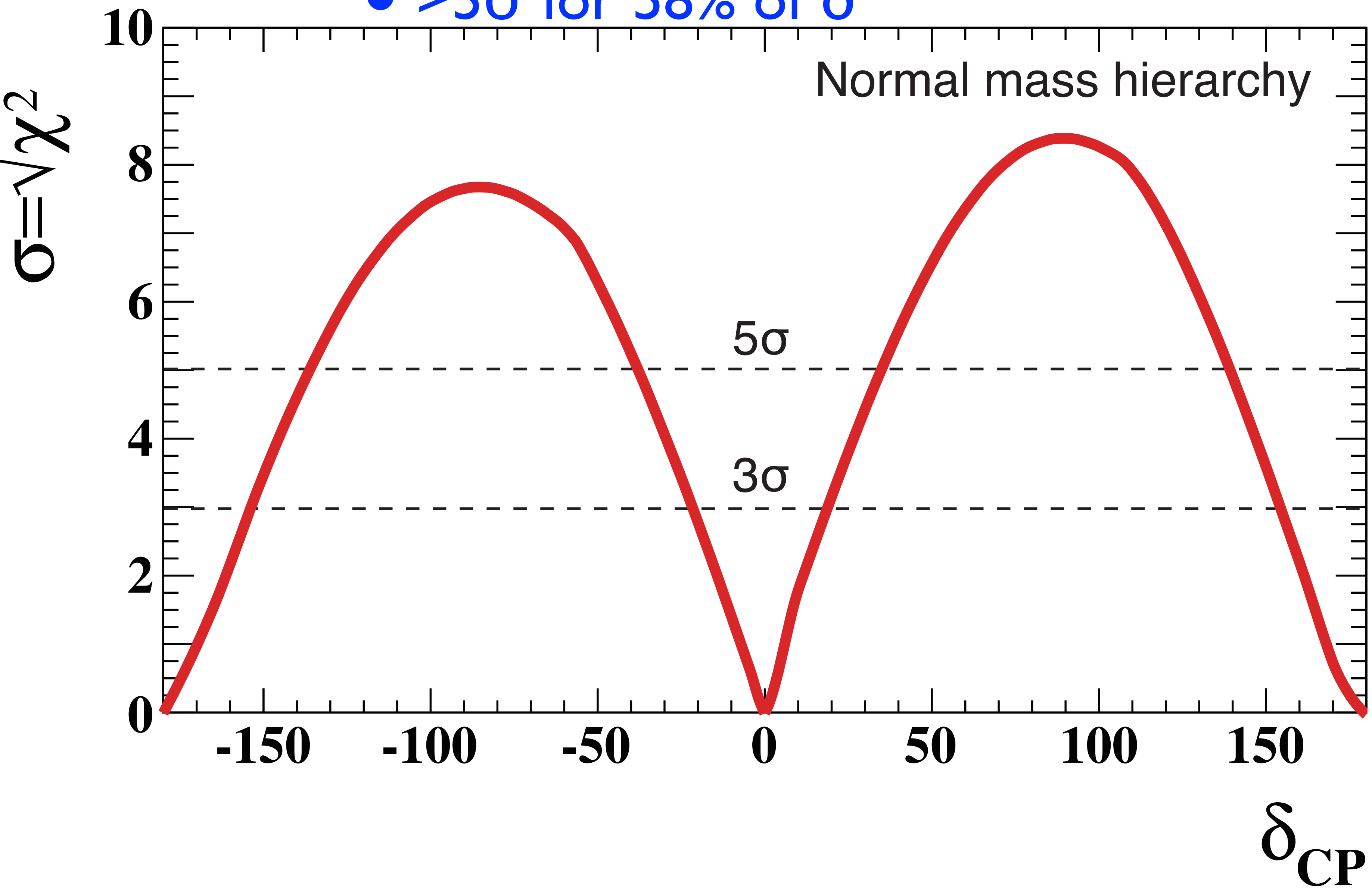
Sensitivity to CP violation

arXiv:1502.05199 and submitted to PTEP

- >3σ for 76% of δ
- >5σ for 58% of δ

Mass hierarchy assumed to be known

7.5MW×10^7s (1.56×10^22 POT)



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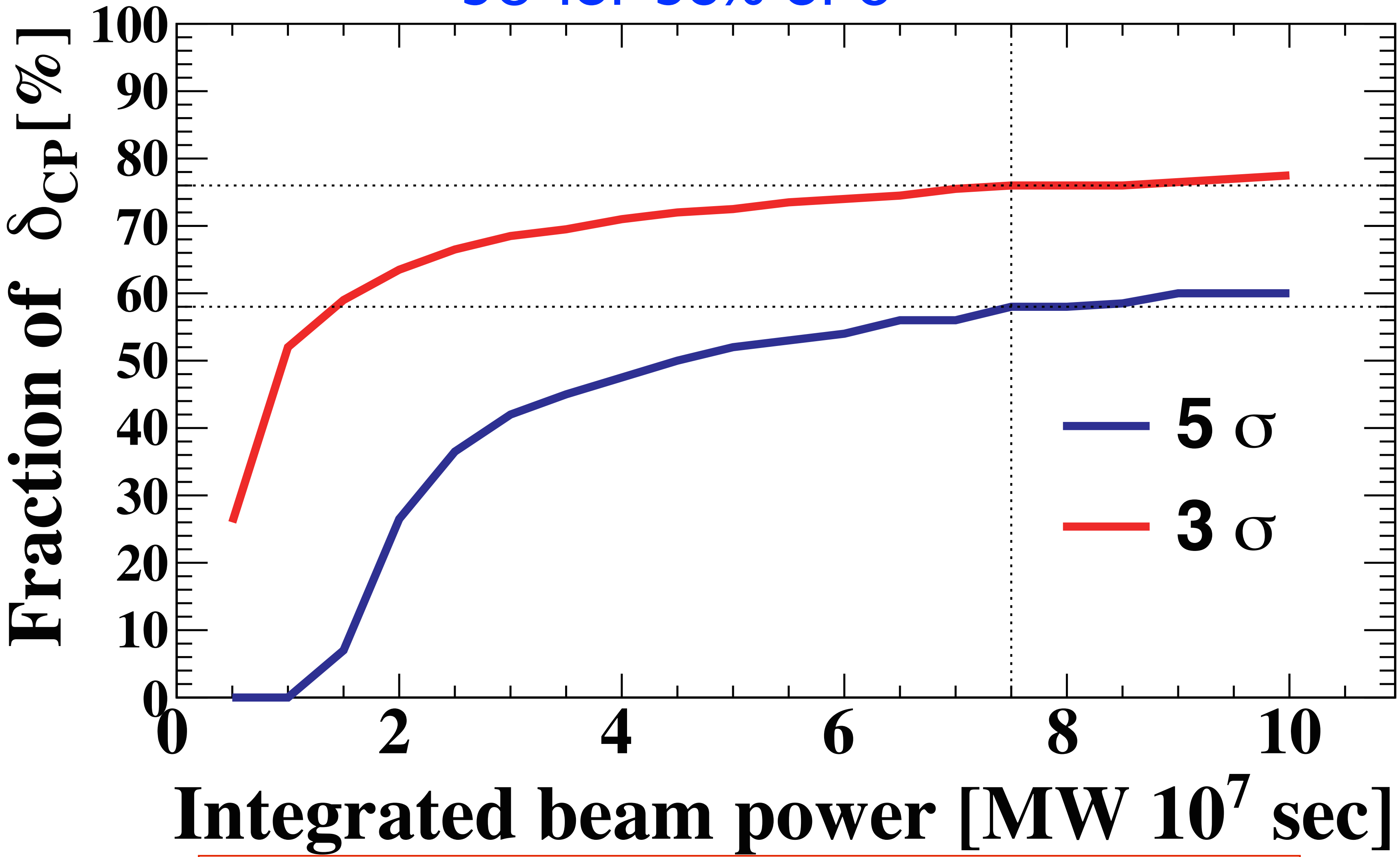

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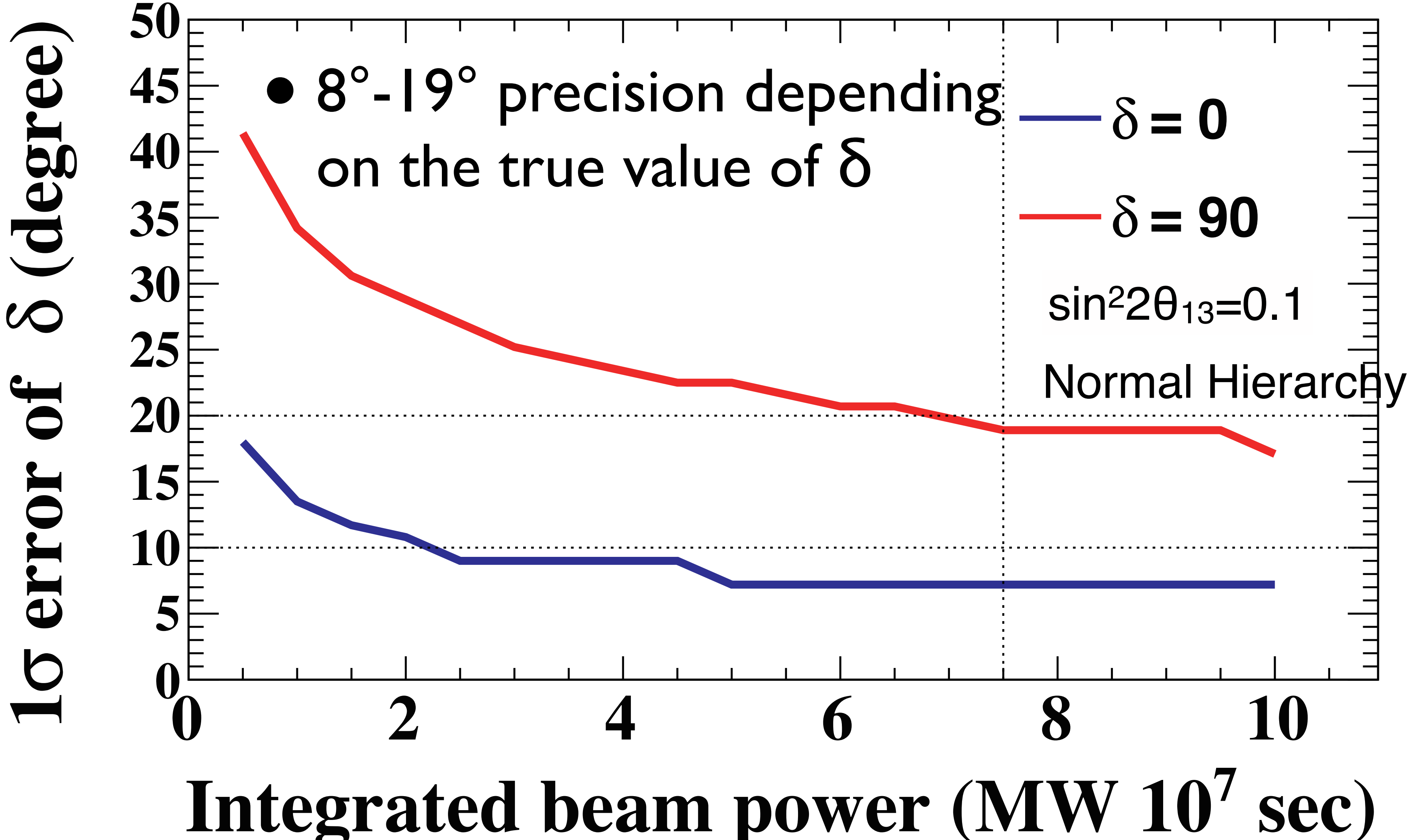

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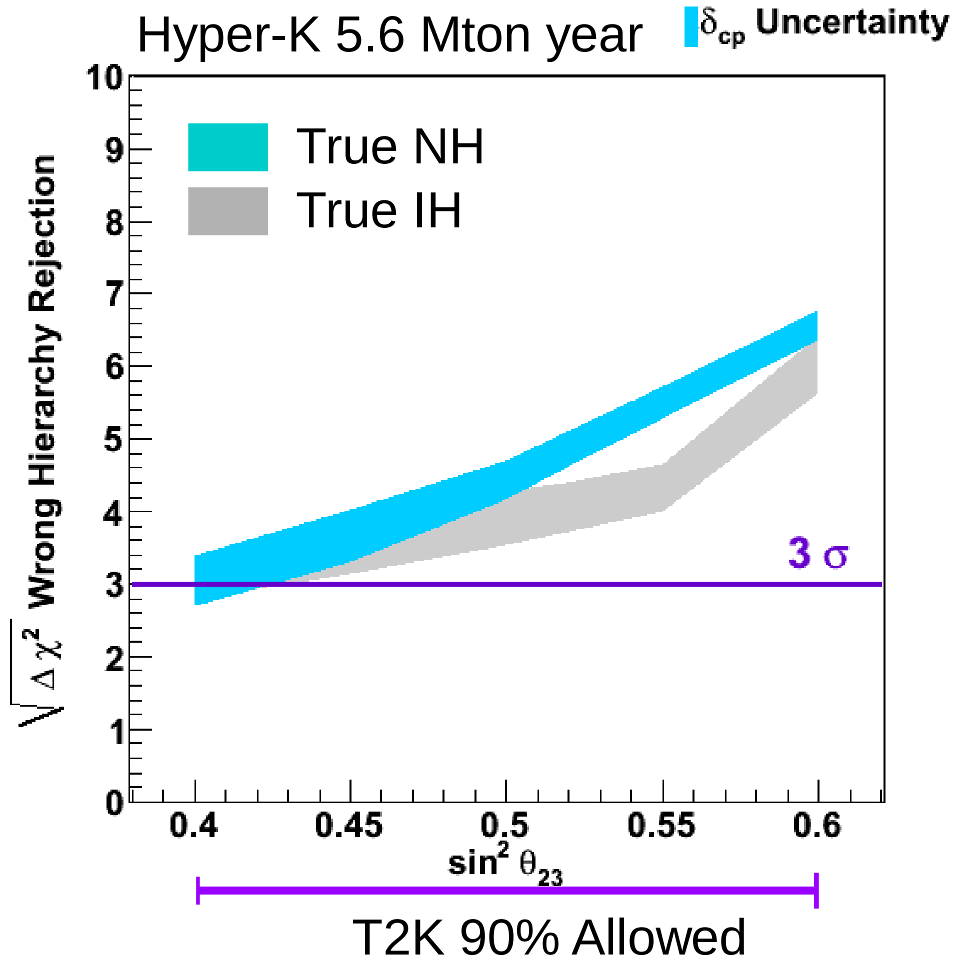
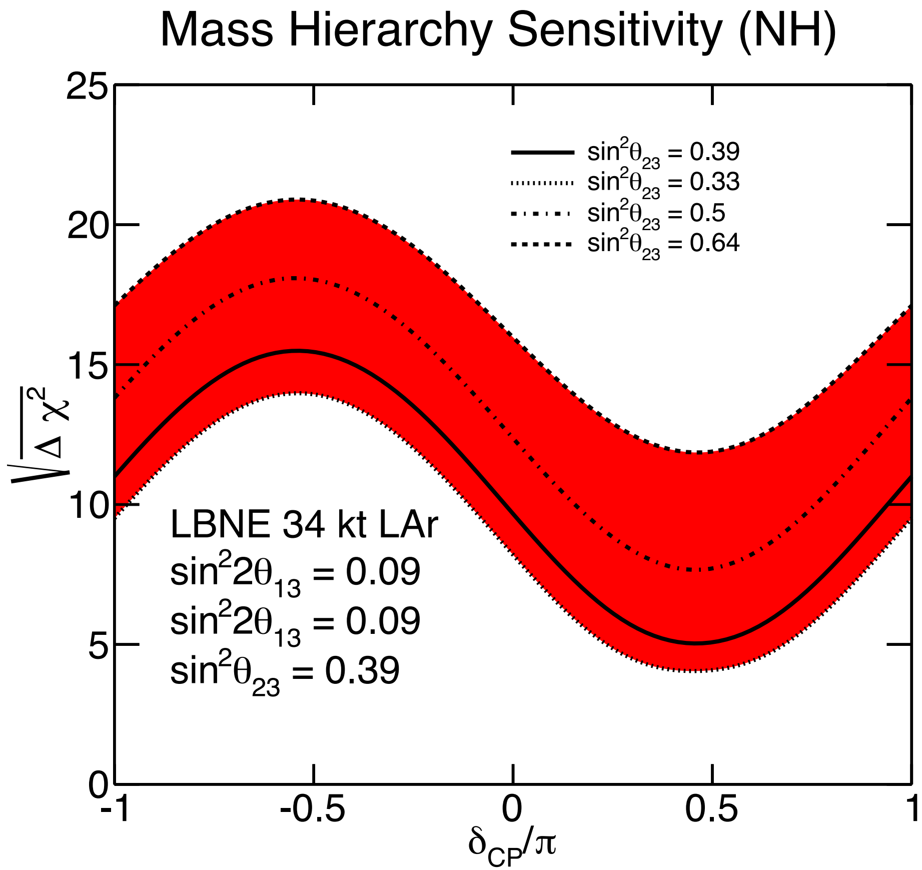
Mass hierarchy sensitivity

Hyper-K atmospheric



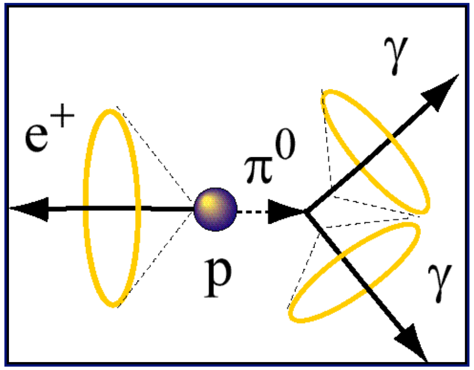
LBNE accelerator

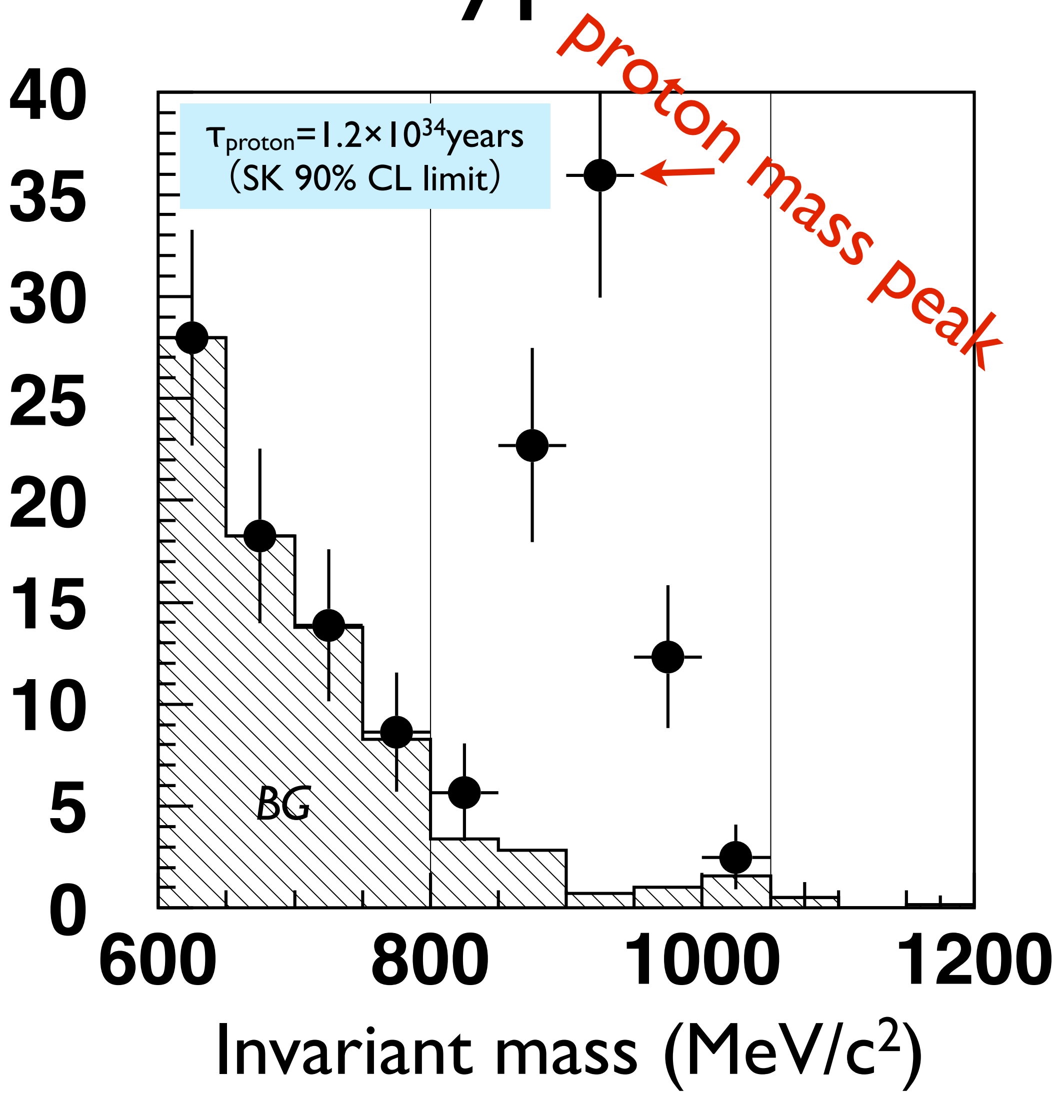


LBNE has better sensitivity to MH thanks to longer baseline
HK has significant sensitivity with atmospheric neutrinos

Discovery potential in Hyper-K

$p \to e^+ \pi^0$



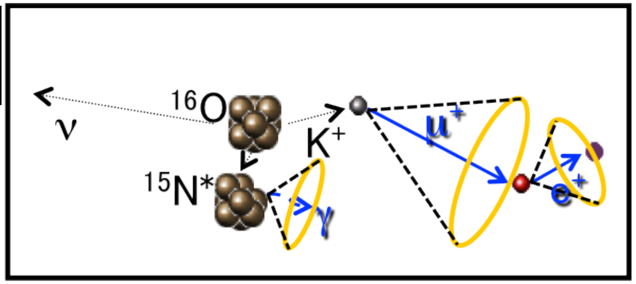


- Discovery reach (3σ)
  - $\tau(p \to e^+\pi^0) \sim 5\times10^{34}$ years (HK 10yrs)
- Limit (90%CL)
  - $\tau(p \to e^+\pi^0) > 1\times10^{35}$ years (HK 10yrs)

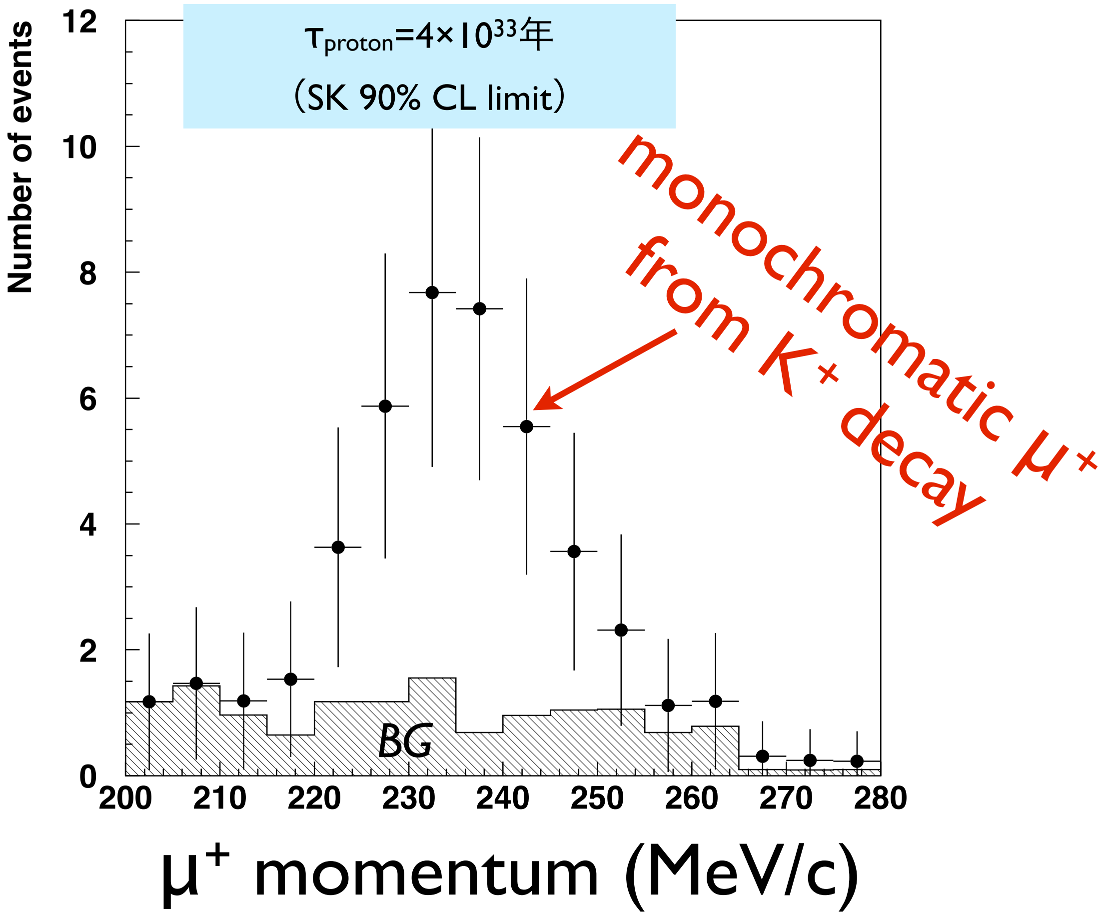
Only realistic proposal to reach the lifetime of 10^{35} years for $p \to e^+\pi^0$

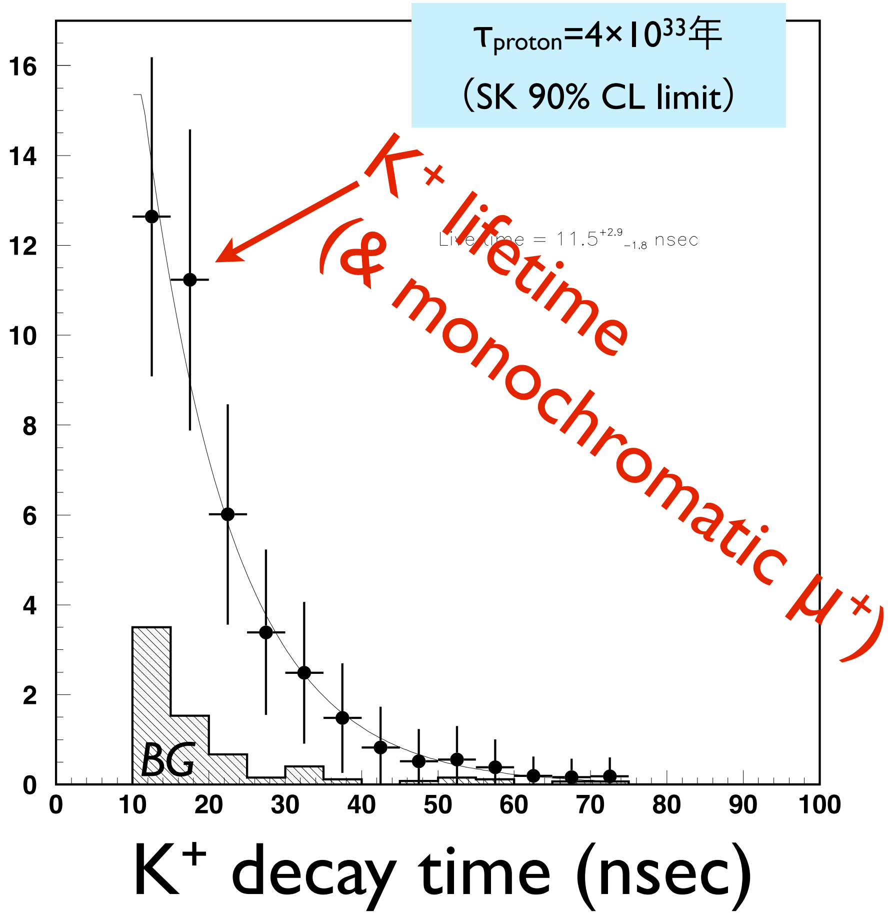
Discovery potential (2)

$p \rightarrow \nu K^+$

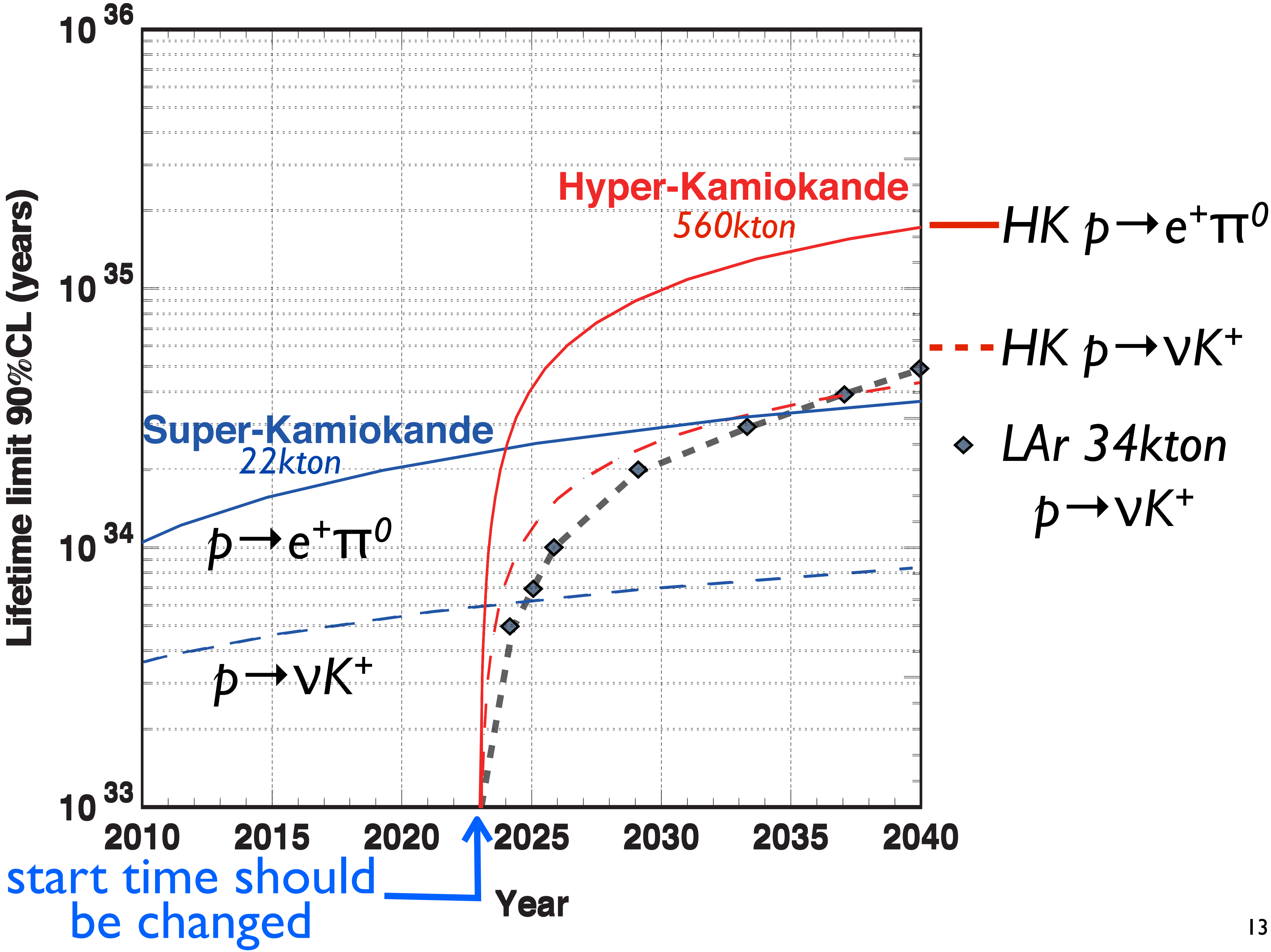


- Discovery reach (3σ)
  - $\tau(p \rightarrow \nu K^+) \sim 1 \times 10^{34}$ years (HK 10yrs)
- Limit (90%CL)
  - $\tau(p \rightarrow \nu K^+) > 3 \times 10^{34}$ years (HK 10yrs)



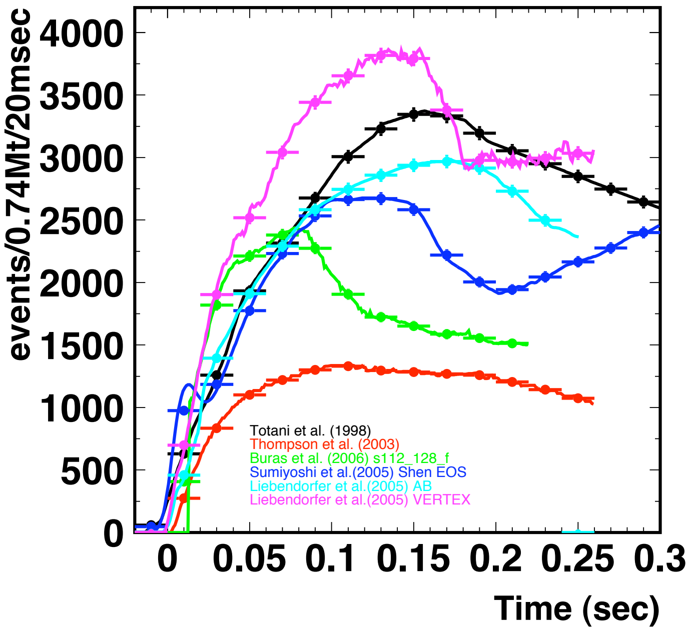


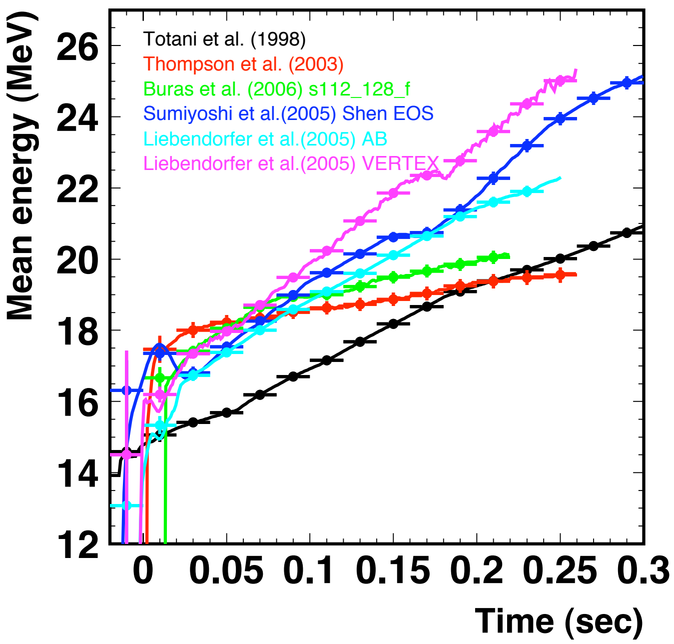
Experimental test on Supersymmetry

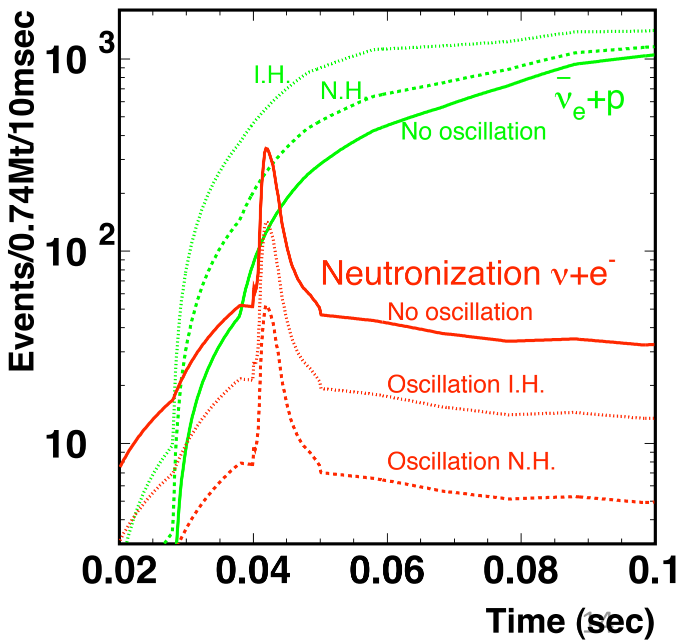

Hyper-Kamiokande
560kton
HK p→e+π0
HK p→νK+
LAr 34kton
p→νK+
Super-Kamiokande
22kton
p→e+π0
p→νK+
Lifetime limit 90%CL (years)
10 36
10 35
10 34
10 33
2010
2015
2020
2025
2030
2035
2040
Year
start time should
be changed

ν burst @ Milky way (10kpc)

- High statistical observation by 200,000 ν events
  - Time variation of (ν luminosity, temperature, flavor)
  - Explore core collapse and cooling mechanism (model)
    - exp'd νe from neutronization is 20(NH) or 56(IH) in 10msec duration→precise moment when a neutron start is born.
    - Precise time determination~1ms→combined study w/ optical and gravitational wave observation
  - Absolute ν mass (ν's TOF)→0.3~1.3eV/c^2
  - Energy spectrum transition by ν mass hierarchy

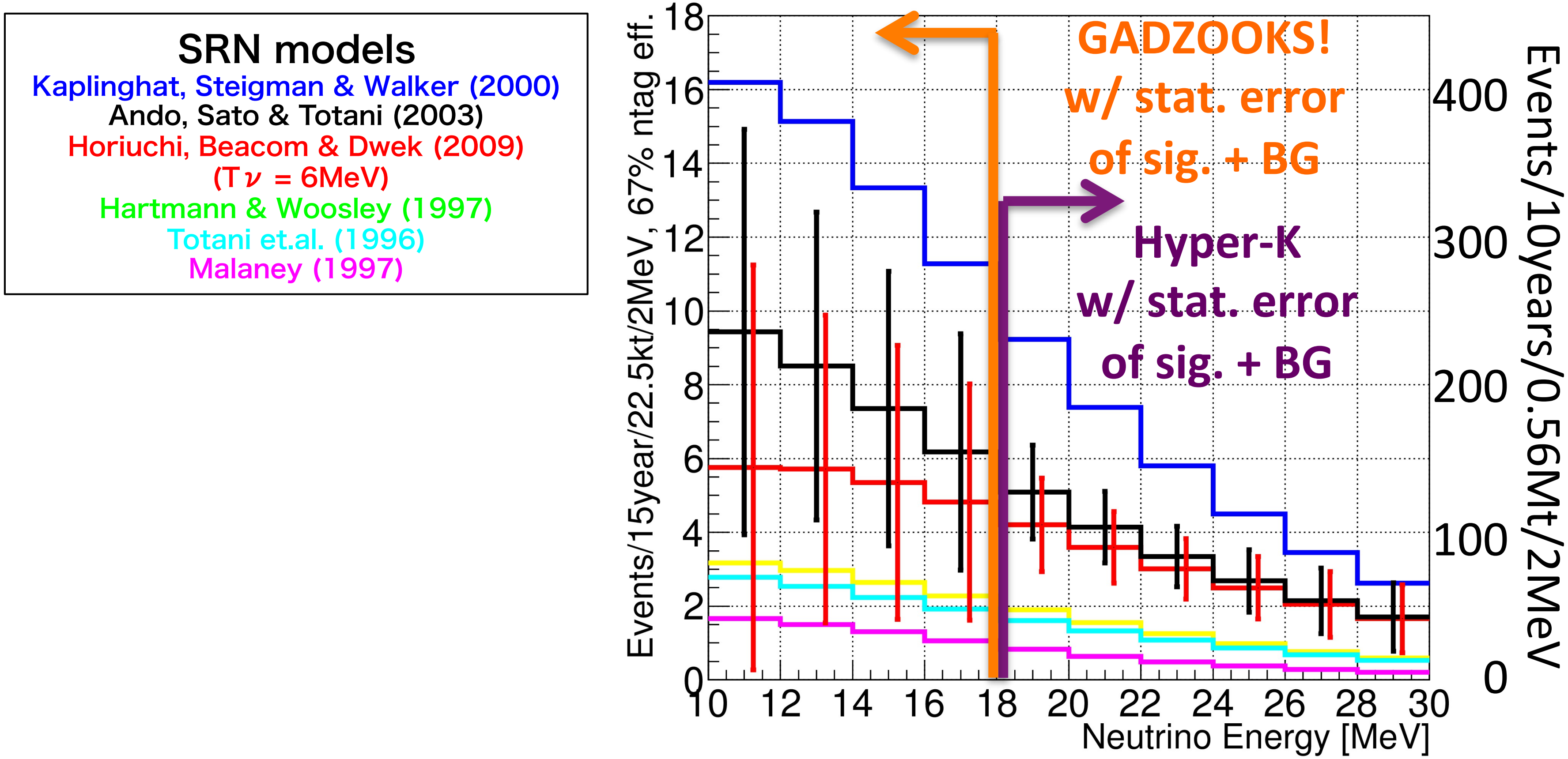






Supernova relic ν (SRN)

- SRN is guaranteed signal which will provide precious information on SN rate and SN ν spectrum



- ~300 SRN / 10 years (>17.5MeV) is expected