Project X: Kaon Working Group Summary

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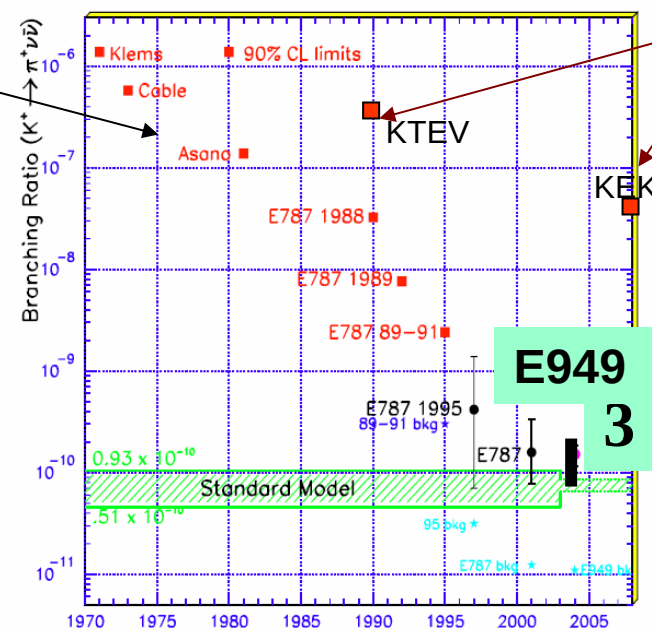
Star Class Experiments:

$K^+ \to \pi^+ \nu\bar{\nu}$ and $K_L^0 \to \pi^0 \nu\bar{\nu}$

$K^+ \to \pi^+ \nu\bar{\nu}$

$K_L^0 \to \pi^0 \nu\bar{\nu}$



E949

3

KEK->
J-PARC?

NA62? 100

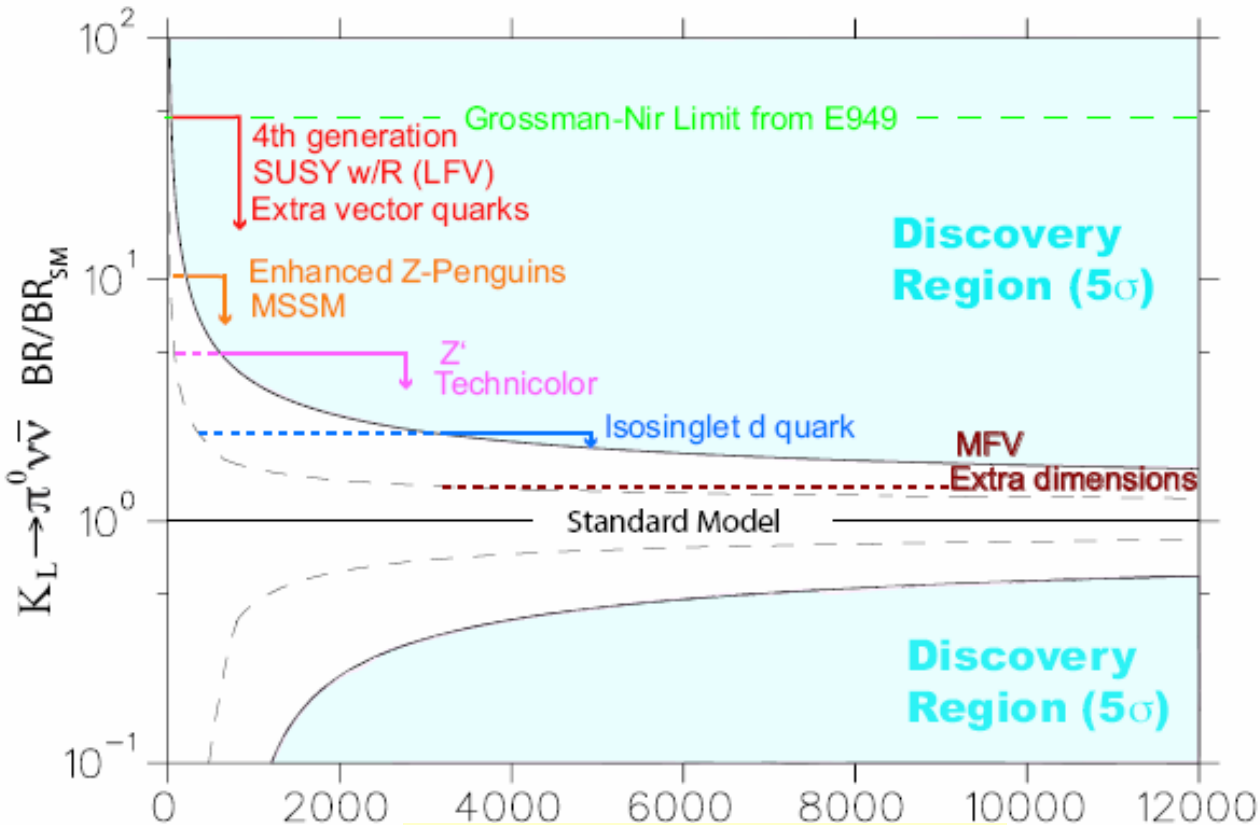
Project X?
1000???

Discovery Potential

$K_L^0 \to \pi^0 \nu\bar{\nu} \left(BR / BR_{SM} \right)$ *vs.* Events Observed

Experiment Sensitivity for SM Events

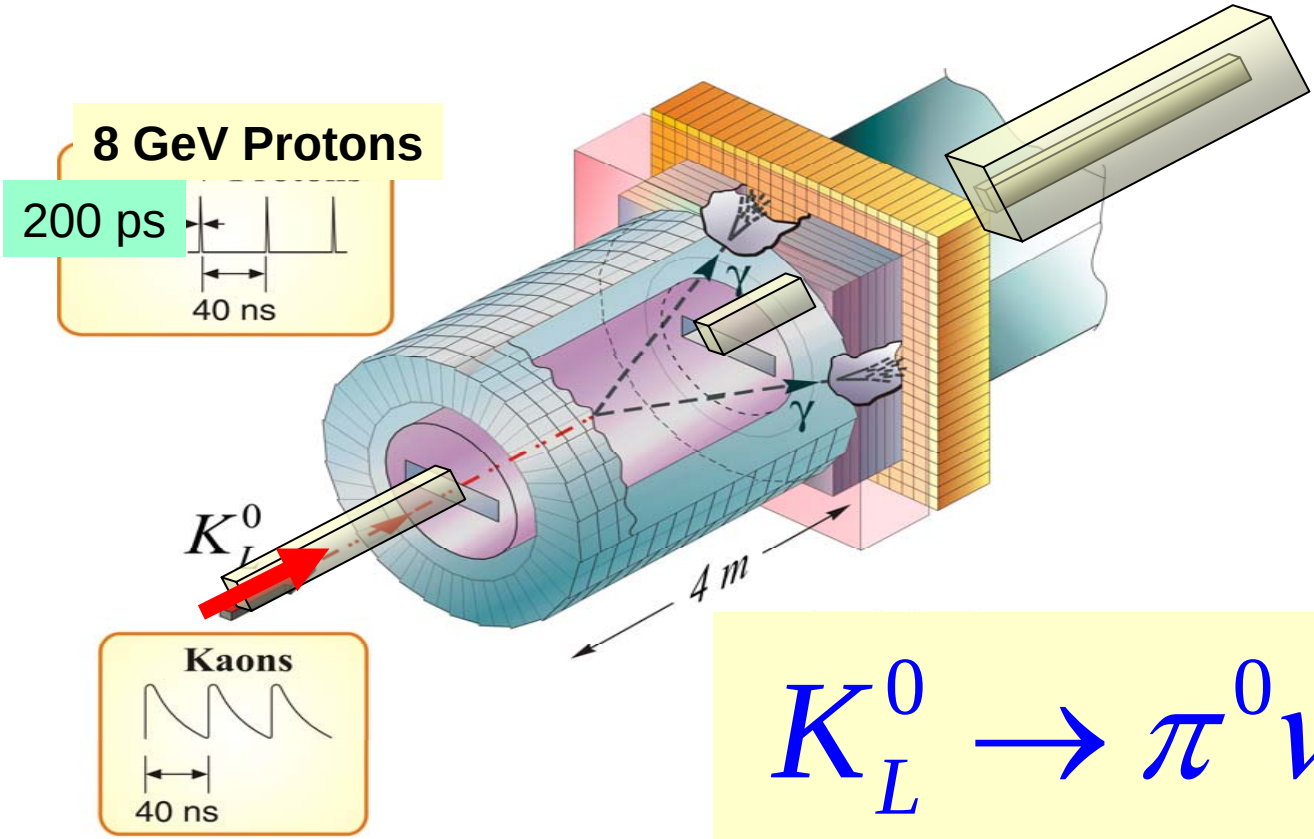
O(100) → O(1000)



Run Duration (Hours*)

*AGS

$K_L^0 \to \pi^0 \nu \bar{\nu}$ Experiment Concept



$$K_L^0 \to \pi^0 \nu \bar{\nu}$$

- Use TOF to work in the K_L^0 c.m. system
- Identify main 2-body background $K_L^0 \to \pi^0 \pi^0$
- Reconstruct $\pi^0 \to \gamma\gamma$ decays with pointing calorimeter
- 4π solid angle photon and charged particle vetos

$K_L^0 \to \pi^0 \nu \bar{\nu}$ Conclusions

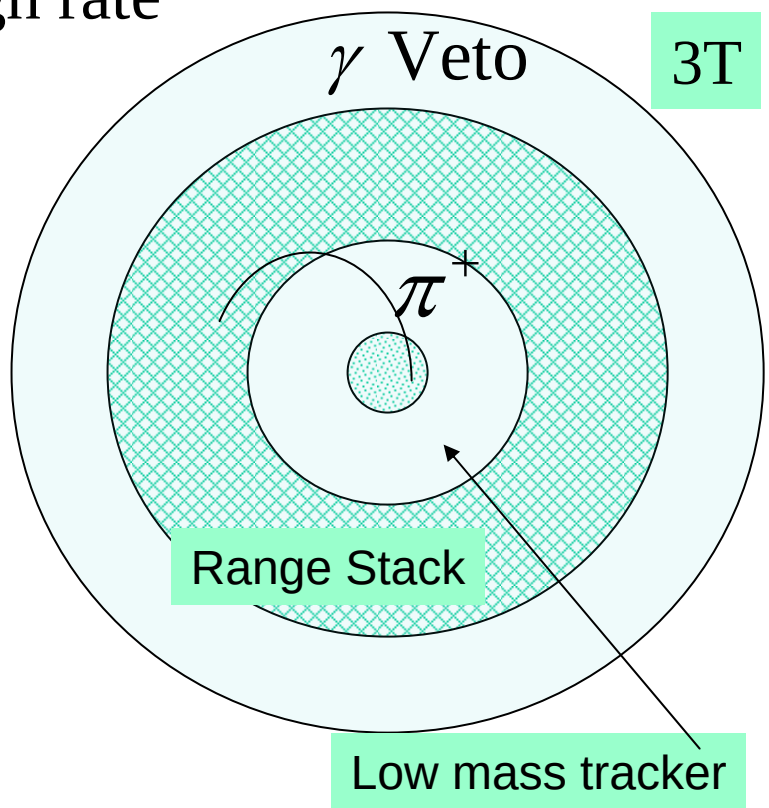
High intensity of Project-X made in heaven for the TOF-based K_L experiment.

- Can use small aperture, symmetric beam - makes for simpler, higher acceptance detector
- Can exploit post-KOPIO advances in instrumentation

- 300 equivalent events/year at 1st stage of Project-X
- Possible to use at least 5 times higher intensity & get ~900 equivalent events/year

Compact High Field System for $K^+ \to \pi^+ \nu \bar{\nu}$

- Low P_K ~400 MeV/c for high stopping efficiency
- Sci-Fi target and range stack for high rate $\pi \to \mu \to e$ measurements
- High acceptance and precise momentum measurement to suppress $K^+ \to \pi^+ \pi^0, K^+ \to \mu^+ \nu$ backgrounds
- "Ideal" homogeneous photon veto e.g. LXe 20 X_0



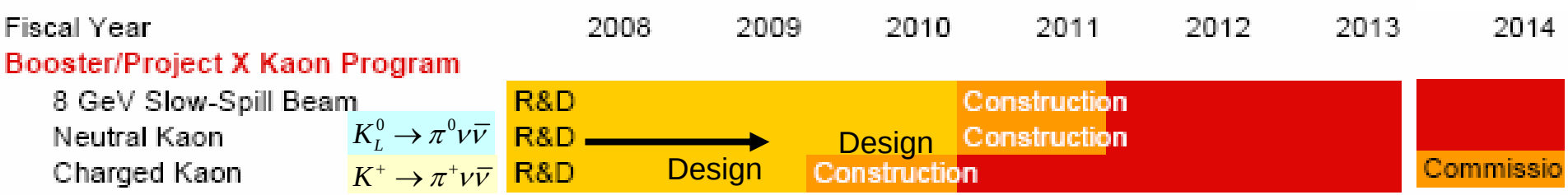
$K^+ \rightarrow \pi^+ \nu \bar{\nu}$	FNAL Booster X0	FNAL Proj X1	FNAL Proj X2
Events/yr	38	268	1487
Events/5yr	189	1341	7433
Precision w/bckgnd*	**8.4**	**3.2**	**1.3**

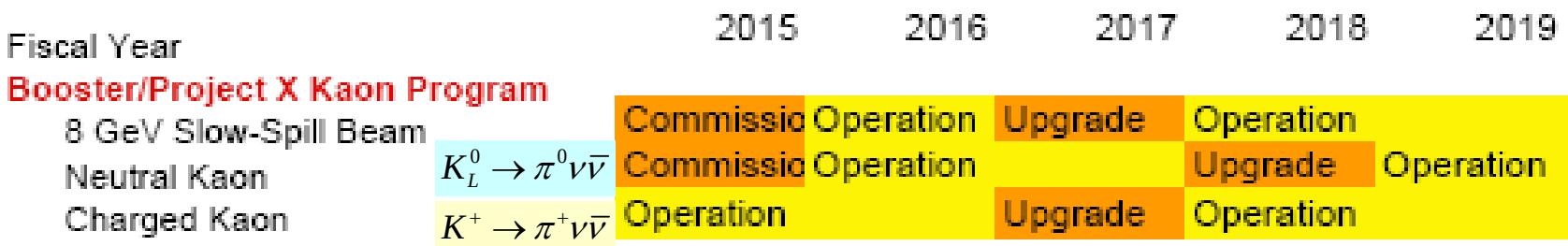
**** Includes separate estimates of backgrounds in Regions I (10%) and 2(75%)***.

Kaon Group Issues

- Details of scheme for delivering ~100% duty factor beams starting from Booster need to be worked out.
- Uncertainties in K production cross-sections at 8 GeV need to be reduced. - Can MIP experiment help?
- Dual targeting for charged and neutral experiments appears feasible but needs examination.
- Some detector technology R&D required.
- Further development of CKM parameters (from theory and B physics) needed for 3% measurements.

Kaon Experiments Staging Concepts





Kaon Working Group Conclusons:

- Precise measurements of $K^+ \to \pi^+ \nu\bar{\nu}$ and $K_L^0 \to \pi^0 \nu\bar{\nu}$ are highly motivated by exploration of high mass scale physics.
- Both $K^+ \to \pi^+ \nu\bar{\nu}$ and $K_L^0 \to \pi^0 \nu\bar{\nu}$ experiments appear feasible collecting O(1000) events at the SM levels.

World leading experiments can begin at the Booster facility and transition to Proj. X.