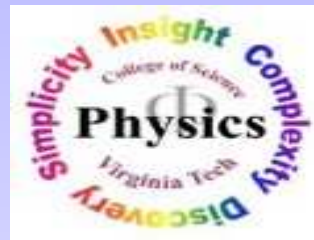


# NuFACT09

## Constraining sterile neutrinos with a low energy beta-beam

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work done in collaboration with

Patrick Huber and Jonathan Link

[arXiv:0907.3145](https://arxiv.org/abs/0907.3145)

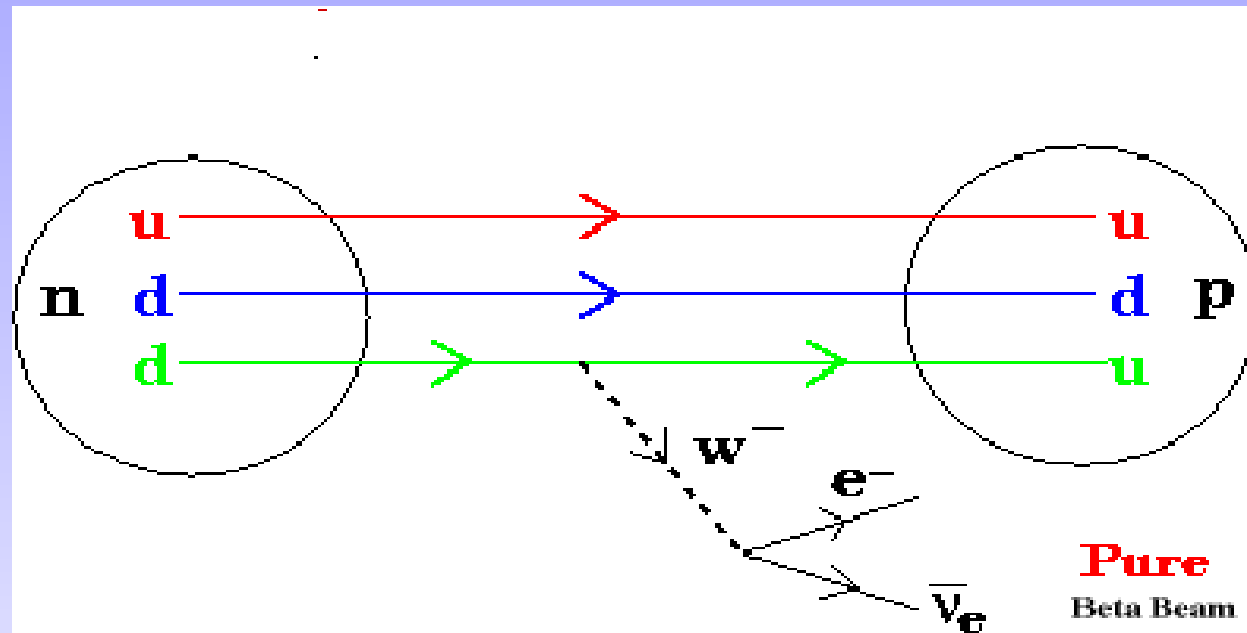
# Motivations for Sterile $\nu$

- Sterile  $\nu$  : Gauge singlet fermion  
Sterile  $\nu$  : Do not couple to W and Z
- Key role : Particle and Astro Physics and Cosmology
- Essential in generating neutrino mass
- Contribute to energy density of the Universe
- Highly relativistic  $\Rightarrow$  Hot dark matter
- Very weakly mixing sterile neutrinos  $\Rightarrow$  Visible effects in astrophysics or Big Bang nucleosynthesis
- LSND, Bugey, Chooz and MiniBooNE

@@@ What Next ? @@@

# What is Beta-Beam?

A pure, intense, collimated beam of  $\nu_e$  or  $\bar{\nu}_e$ ,  
essentially background free



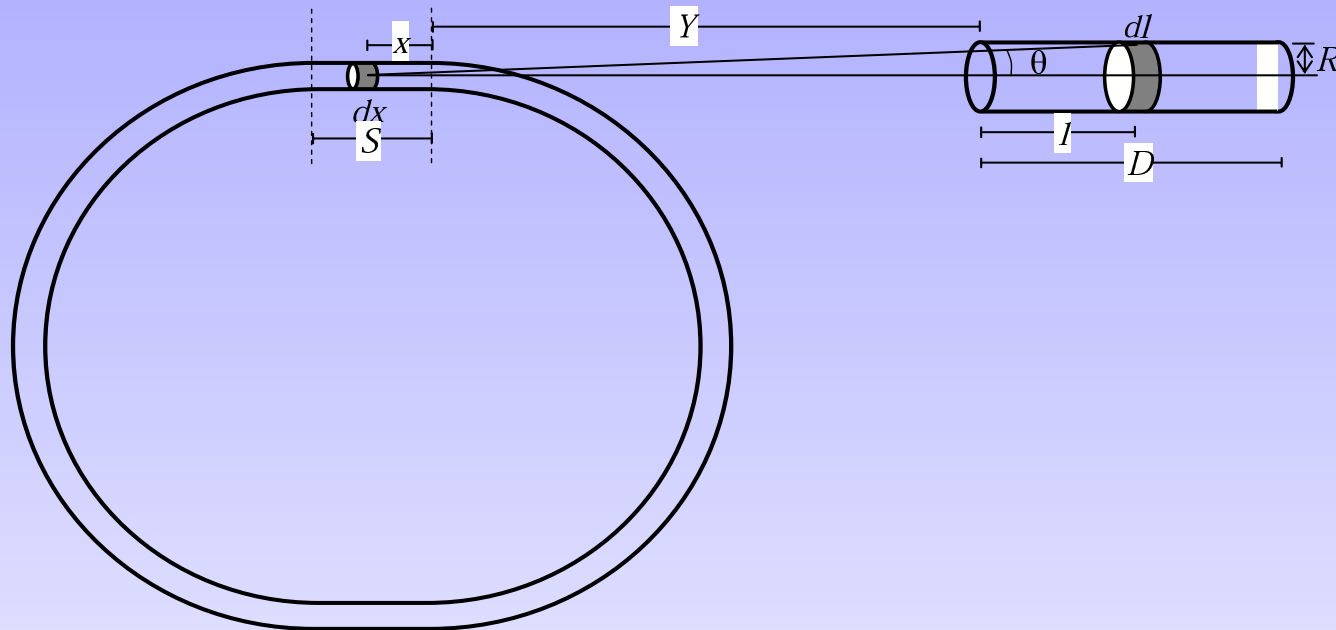
See the talk by Elena Wildner, CERN

Beta decay of completely ionized, radioactive ions  
circulating in a storage ring. No contamination of  
other types of neutrinos

# Low Energy $\beta$ -beam Set-up

$S = 10 \text{ m}$ ,  $Y = 50 \text{ m}$ ,  $R = 3.6 \text{ m}$  and  $D = 28.7 \text{ m}$  (1 kton)

${}^6_2\text{He}^{++}$ ,  $3 \cdot 10^{12} \text{ ions s}^{-1}$ ,  $B = 5 \text{ T}$ ,  $\rho = 56 \text{ m}$ ,  $f = 2.7\%$



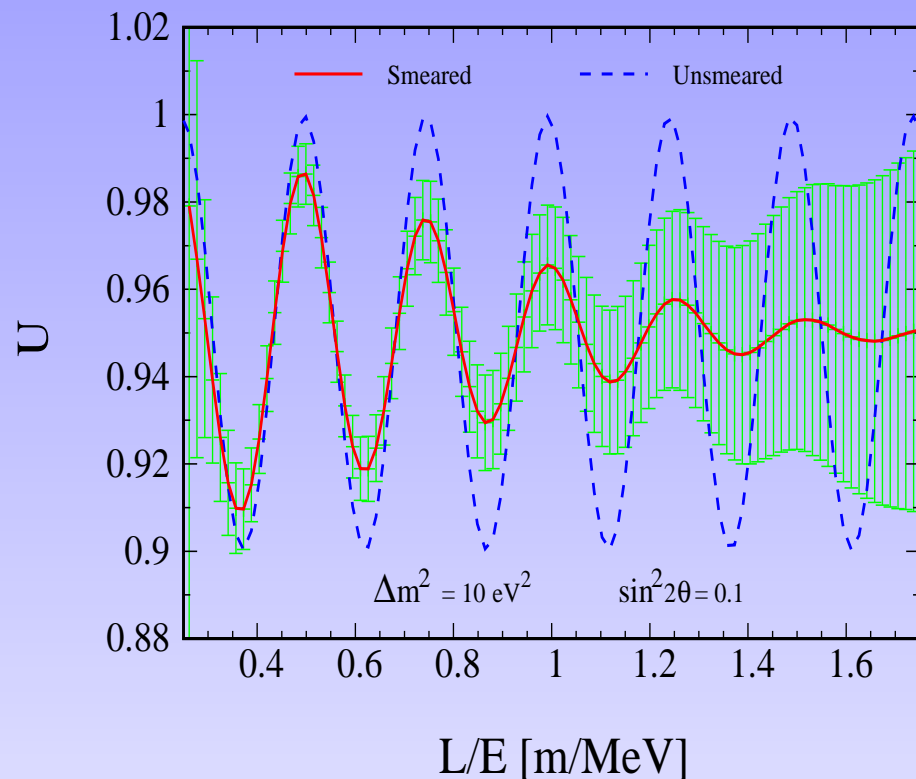
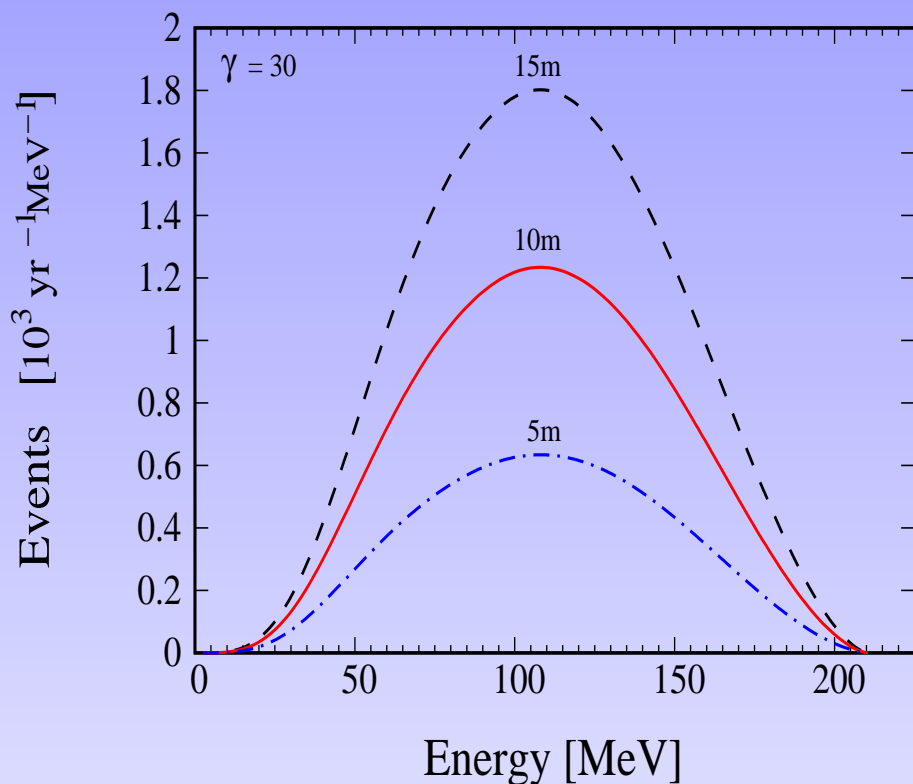
Agarwalla, Huber, Link, arXiv:0907.3145

Beam :  ${}^6_2\text{He} \rightarrow {}^6_3\text{Li} + e^- + \bar{\nu}_e$ , ( $E_0 = 4.02 \text{ MeV}$ ,  $t_{1/2} = 0.81 \text{ s}$ )

Detection :  $\bar{\nu}_e + p \rightarrow n + e^+$ , ( $\bar{\nu}_e$  disappearance, No CP)

# Event Rates

$$\gamma = 30, E_{peak} \simeq 120 \text{ MeV}, E_{max} \simeq 210 \text{ MeV}$$

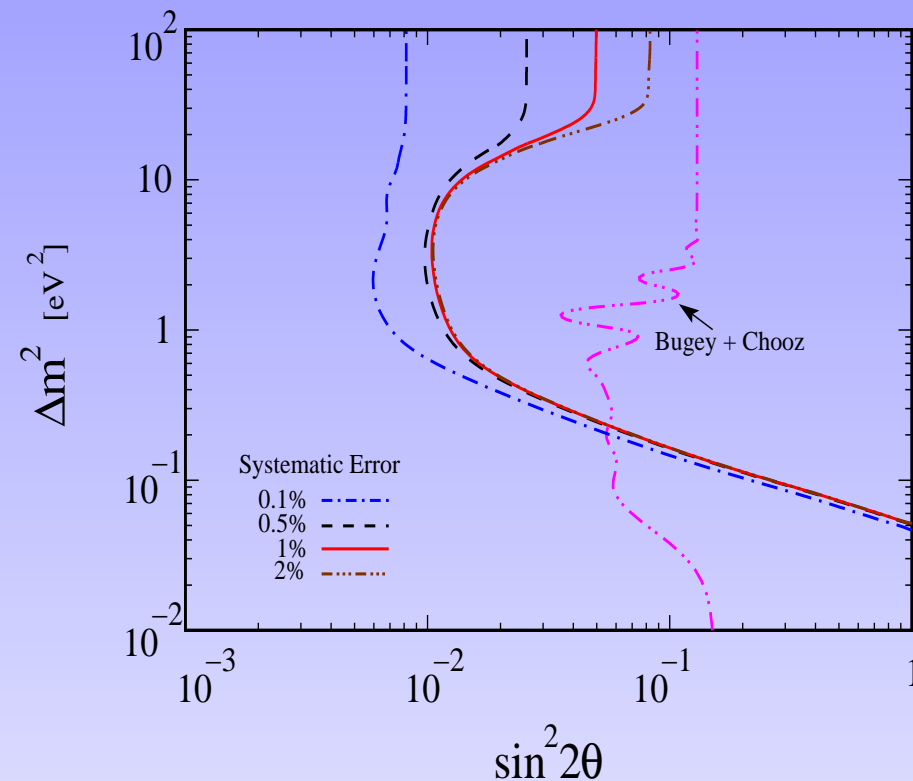
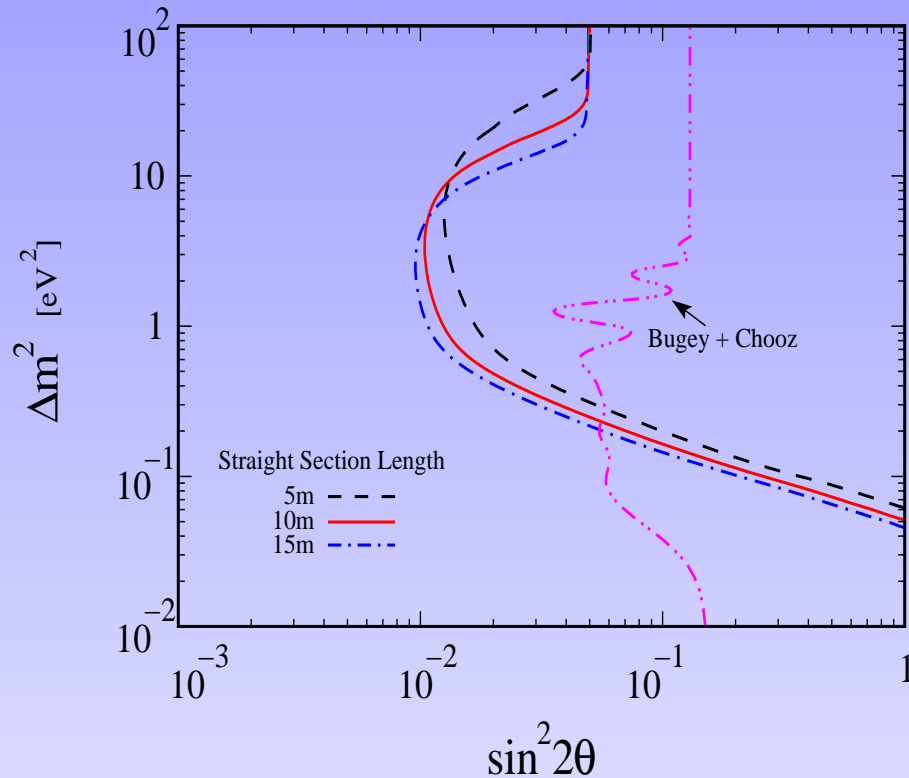
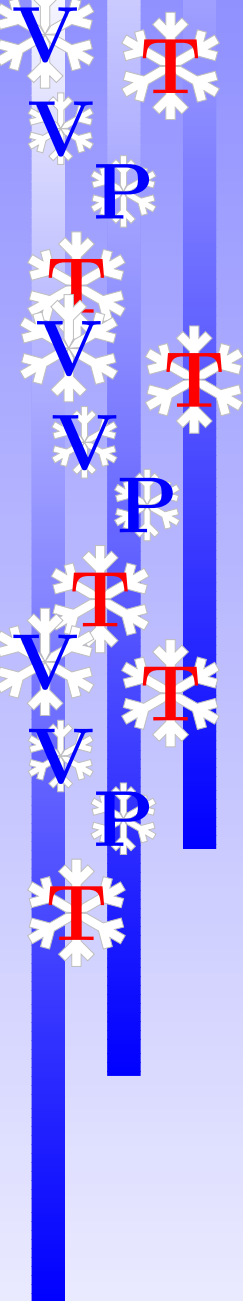


Agarwalla, Huber, Link, arXiv:0907.3145

Left Panel : Un-oscillated Event Rate : Geometry Effects

Right Panel : Oscillated Events/Un-oscillated Events

# Active to Sterile Oscillation

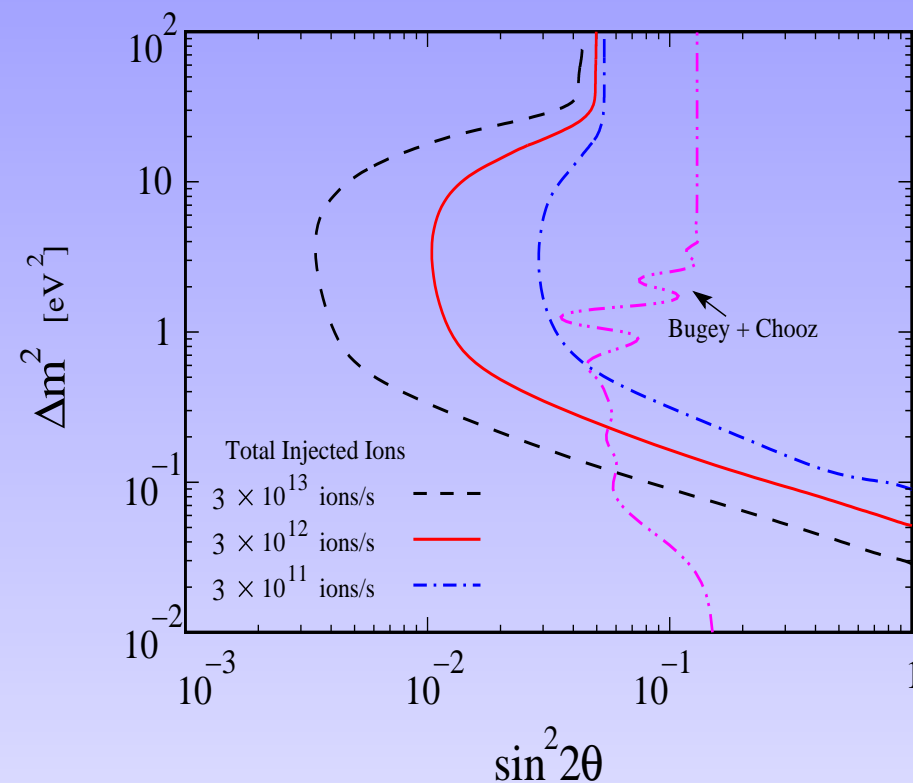
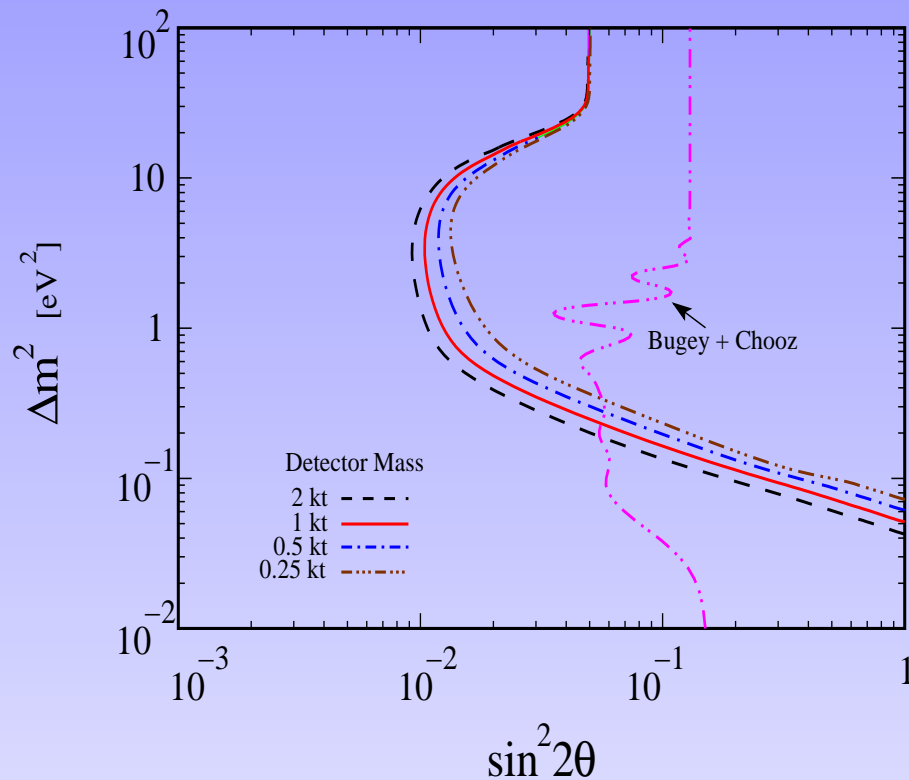


Agarwalla, Huber, Link, arXiv:0907.3145

Exclusion Plots : Active  $\rightarrow$  Sterile Osc, 99% CL

Variation of Straight Section and Systematic Error

# Active to Sterile Oscillation



Agarwalla, Huber, Link, arXiv:0907.3145

Exclusion Plots : Active  $\rightarrow$  Sterile Osc, 99% CL

Variation of Detector Mass and Luminosity

# Conclusions

- Observation of  $\nu$  mass  $\rightarrow$  Sterile neutrinos
- A near detector low energy beta-beam experimental set-up can play crucial role in this direction
- Disappearance of  $\bar{\nu}_e$ , detected by inverse beta decay
- Free from Hadronic uncertainties, No CP dependence
- Can constrain the sterile mixing as small as  $\sin^2 2\theta = 10^{-2}$  at 99% confidence level

!! Thank You !!