Heavy(ish) Sterile decay at IsoDAR

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IsoDAR workshop

16th Jan 2018

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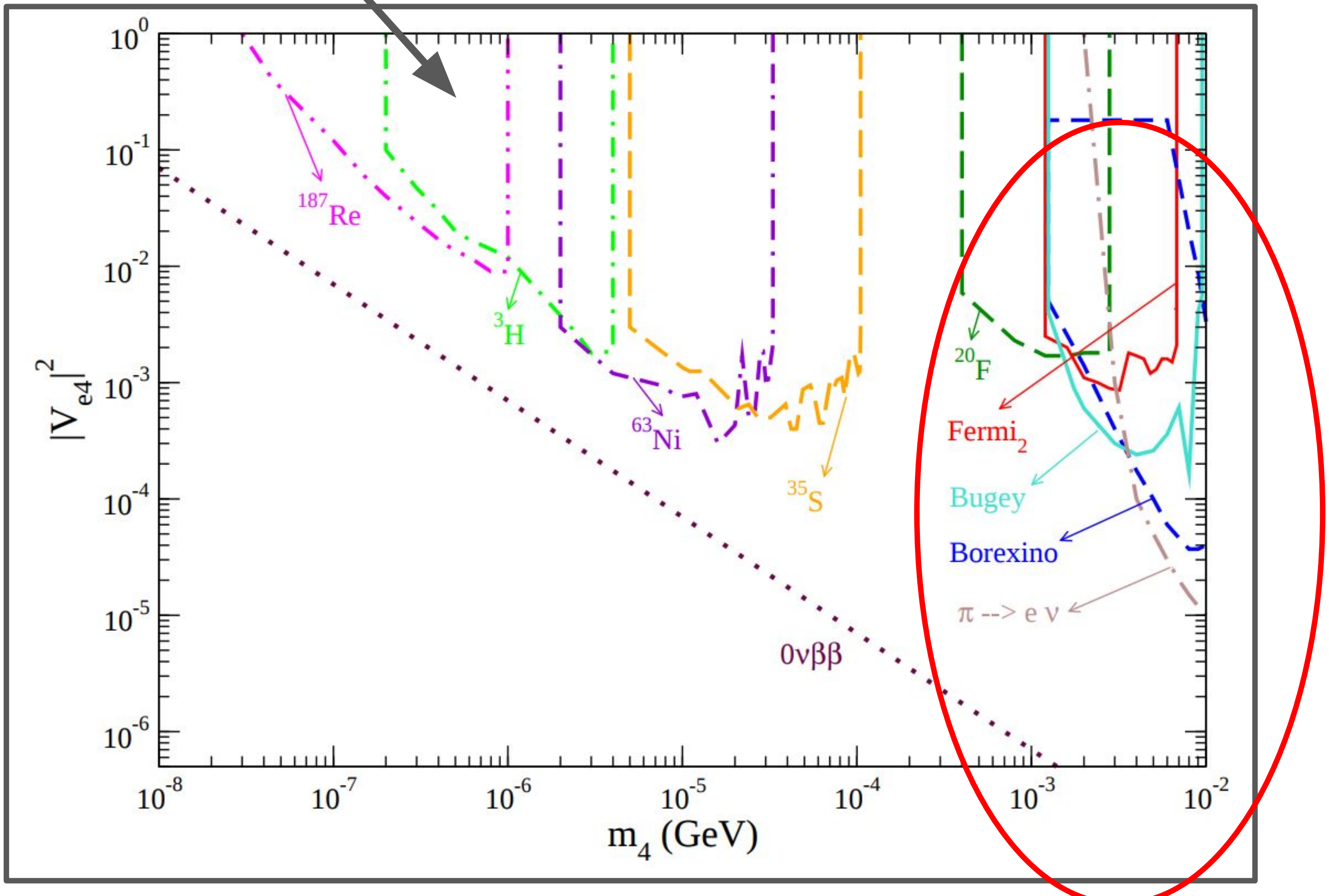
Bounds on ~MeV Steriles (e.g 0901.3589)

Most beta-decay experiments are much lower energy, therefore lower mass sterile probed

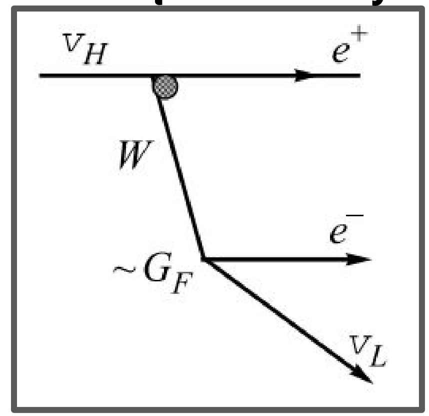
IsoDAR doesn't have access to the beta spectrum of Li^8, but could look for direct products of the sterile decays in the 1MeV->10 MeV region



Signal, sterile deacy to e+e-

Produced in Li^8 beta decay with an additional factor of $|U_{e4}|^2$ (and additional kinematics due to massive neutrino)

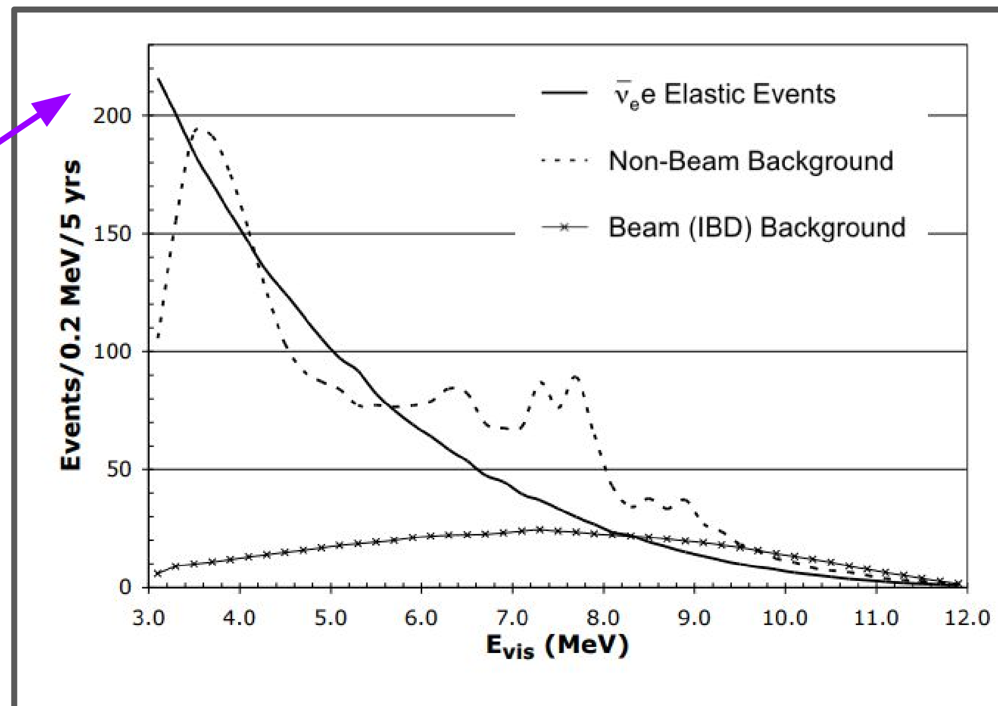
Subsequent decay



KamLAND not sensitive to e+e- pairs directly.

All the backgrounds to nuebar-e scattering are also backgrounds here, on top of nuebar-e elastic events

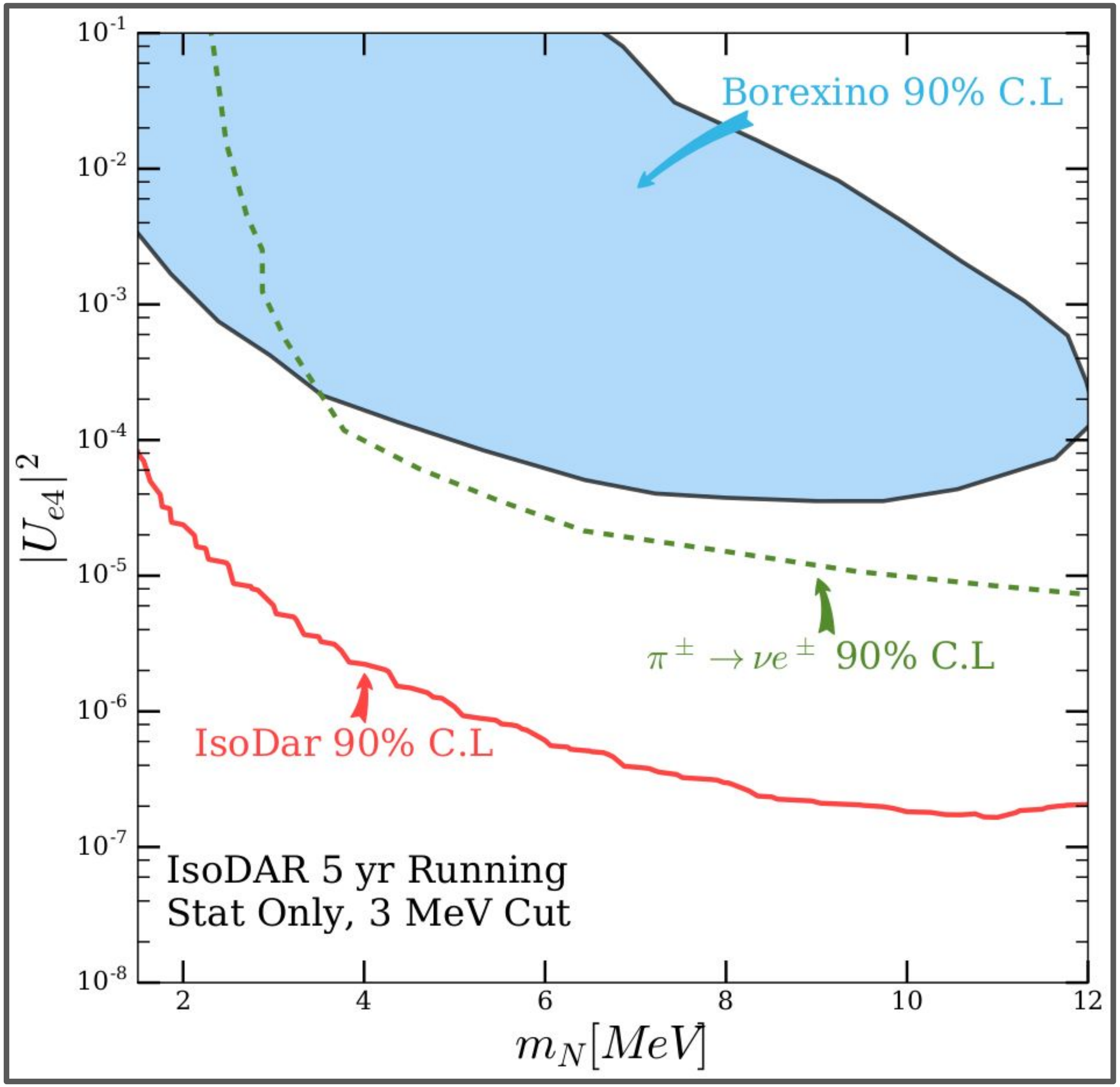
	Events
Elastic scattering (ES)	2583.5
IBD Mis-ID Bkgnd	705.3
Non-beam Bkgnd	2870.0
Total	6158.8



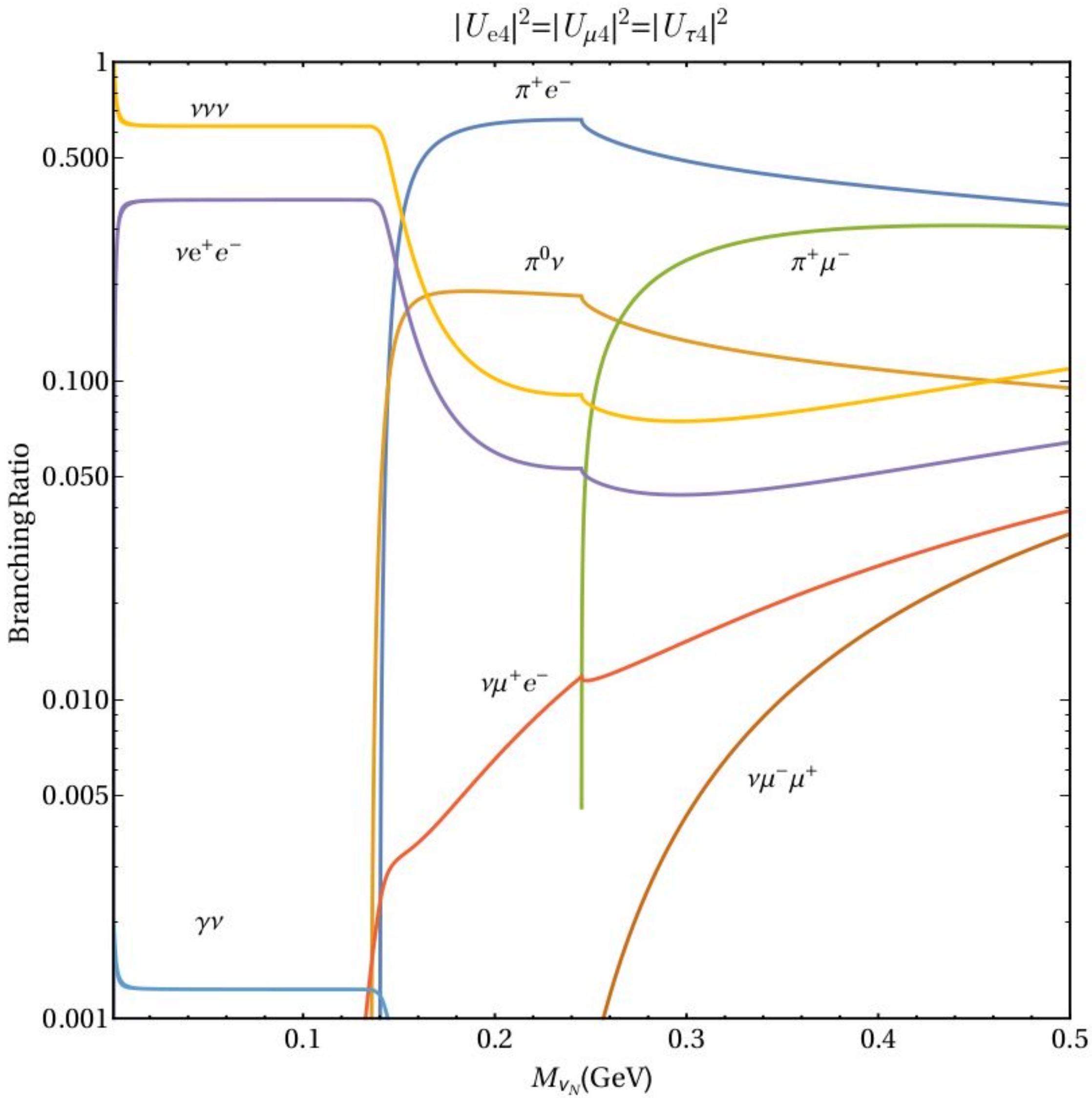
Bounds for IsoDAR @ KamLAND

With 5 years IsoDAR would produce a flux of $|U_{e4}|^2$ x 1.3e23 Sterile neutrinos.

Caveat! Did not recompute the beta decay kinematics for a massive sterile, so there should be a steeper turnoff as sterile mass rises.



Backup



$|U_{e4}|^2=|U_{\mu4}|^2=|U_{\tau4}|^2$
$\nu\nu\nu$
π^+e^-
νe^+e^-
$\pi^0\nu$
$\pi^+\mu^-$
$\nu\mu^+e^-$
$\nu\mu^-\mu^+$
$\gamma\nu$
Branching Ratio
1
0.500
0.100
0.050
0.010
0.005
0.001
0.1
0.2
0.3
0.4
0.5
M_{ν_N}(GeV)

$$\Gamma\left(N \to \nu_\alpha e^+ e^-\right) = \frac{G_F^2 m_N^5}{96\pi^3} |U_{\alpha 4}|^2 \left[\left(g_L g_R + \delta_{\alpha e} g_R\right) I_1\left(0, \frac{m_e}{m_N}, \frac{m_e}{m_N}\right) + \left(g_L^2 + g_R^2 + \delta_{\alpha e}(1 + 2g_L)\right) I_2\left(0, \frac{m_e}{m_N}, \frac{m_e}{m_N}\right)\right],$$

where $g_L = -1/2 + \sin^2\theta_W$, $g_R = \sin^2\theta_W$. The two functions, $I_1(x, y, z)$ and $I_2(x, y, z)$ are integrals over phase space such that $I_1(0, 0, 0) = 1$ and $I_2(0, 0, 0) = 0$, and

$$I_1(x, y, z) = 12 \int_{(x+y)^2}^{(1-z)^2} \frac{ds}{s}(s - x^2 - y^2)(1 + z^2 - s)\sqrt{\lambda(s, x^2, y^2)}\sqrt{\lambda(1, s, z^2)},$$

$$I_2(x, y, z) = 24yz \int_{(y+z)^2}^{(1-x)^2} \frac{ds}{s}\left(1 + x^2 - s\right)\sqrt{\lambda\left(s, y^2, z^2\right)}\sqrt{\lambda\left(s, y^2, z^2\right)},$$

$$\lambda(a, b, c) = a^2 + b^2 + c^2 - 2ab - 2bc - 2ca.$$