Fundamental Neutron Physics V

A Few Additional Amusing Experiments

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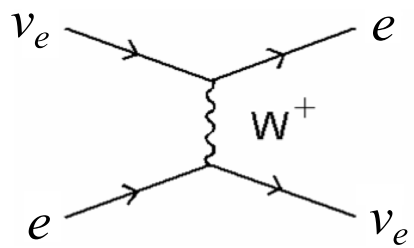
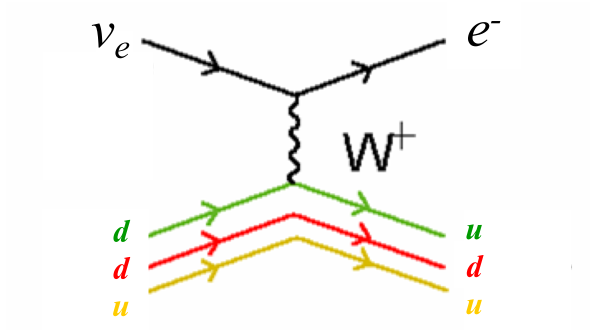
Hadronic Weak Interaction

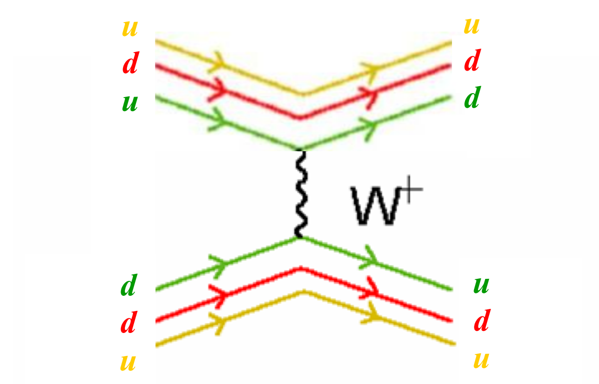
Leptonic Weak Interaction



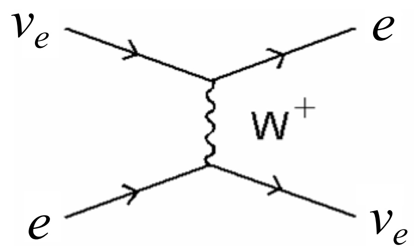
Semi-Leptonic Weak Interaction



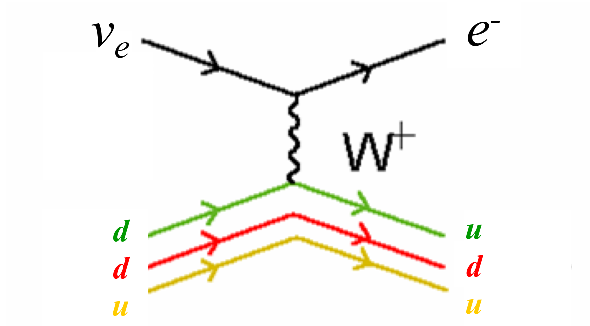
"Pure" Hadronic Weak Interaction



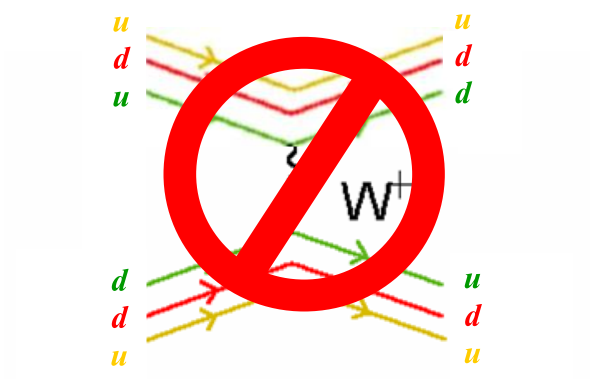
Leptonic Weak Interaction



Semi-Leptonic Weak Interaction



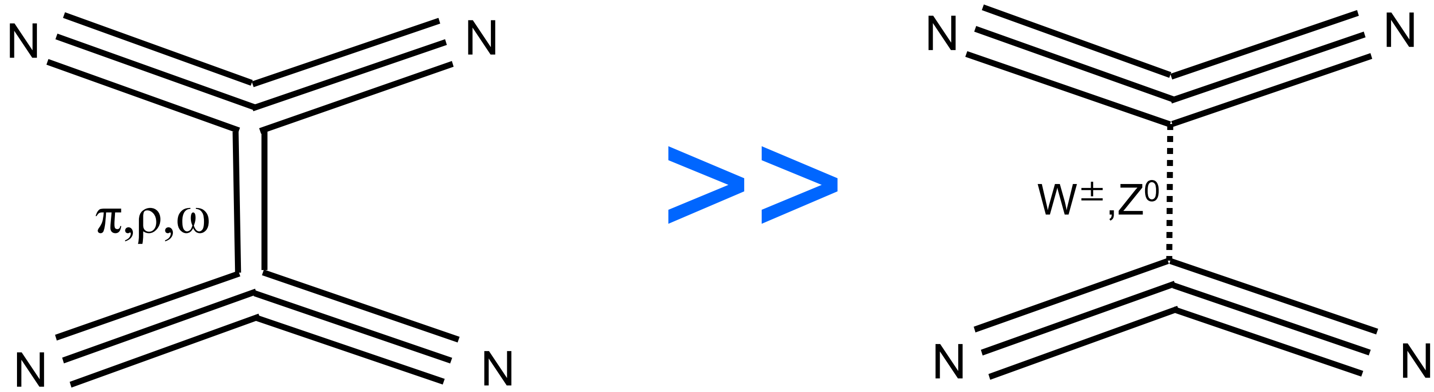
"Pure" Hadronic Weak Interaction



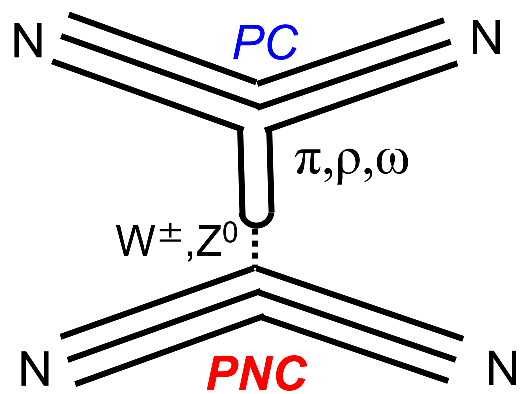
Yukawa Potential

$$V(r) = -g^2 \frac{e^{-mr}}{r}$$

The Weak Interaction between Nucleons is "Overwhelmed" by the Strong Interaction

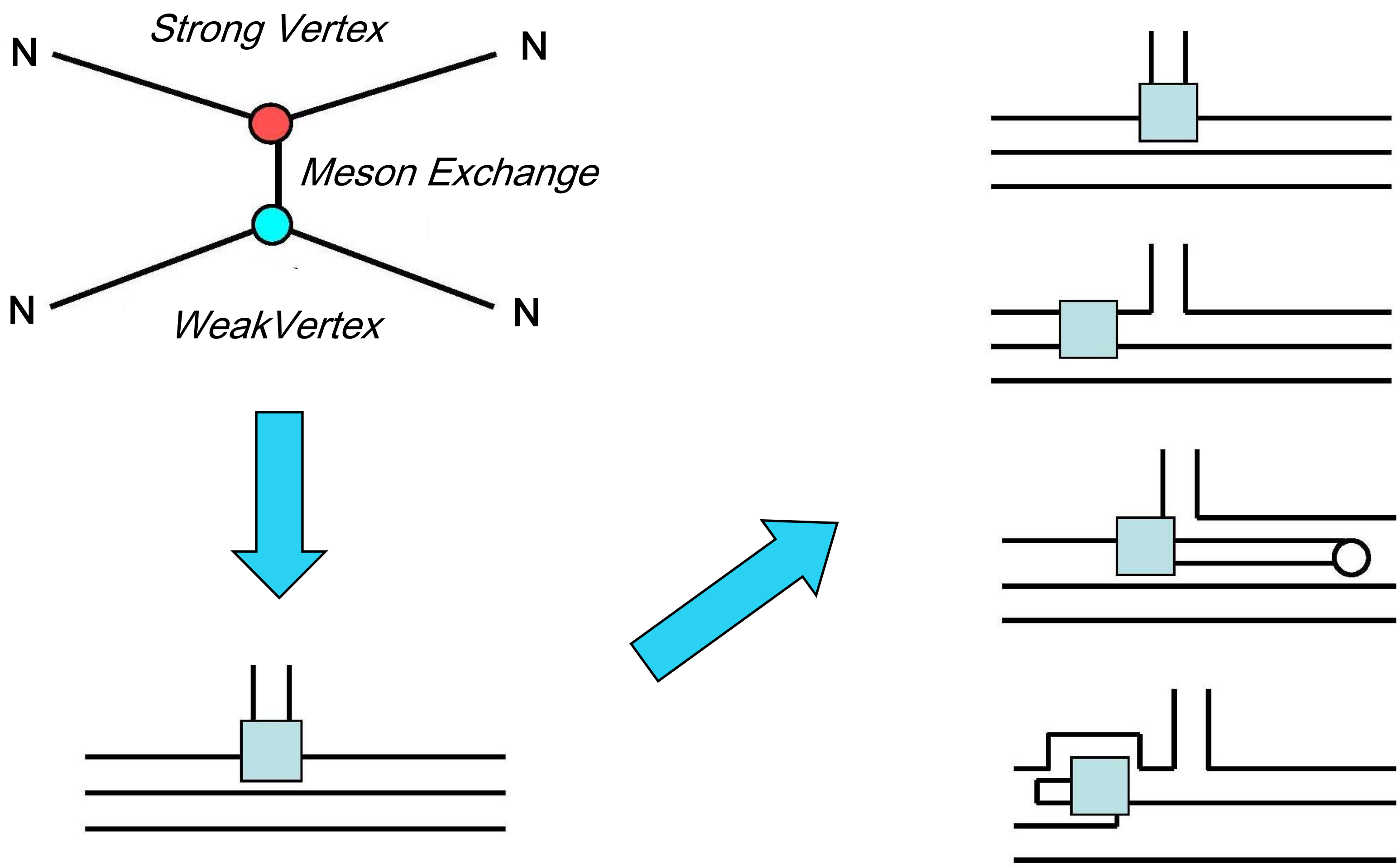


The Weak Interaction Mediated by a Meson is Observable



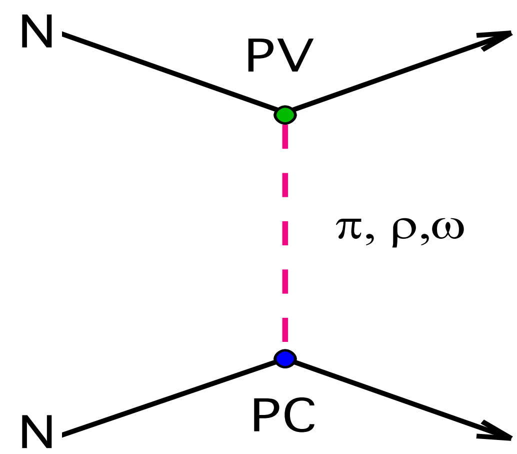
Parity Violation provides a "Tag" for the Weak Interaction_

Parity Violation is Complicated by other Diagrams of the Same Order



The Hadronic Weak Interaction is Traditionally Parameterized By Meson Coupling Constants

π, ρ, and ω exchange dominate the low energy PNC NN potential as they do for strong NN



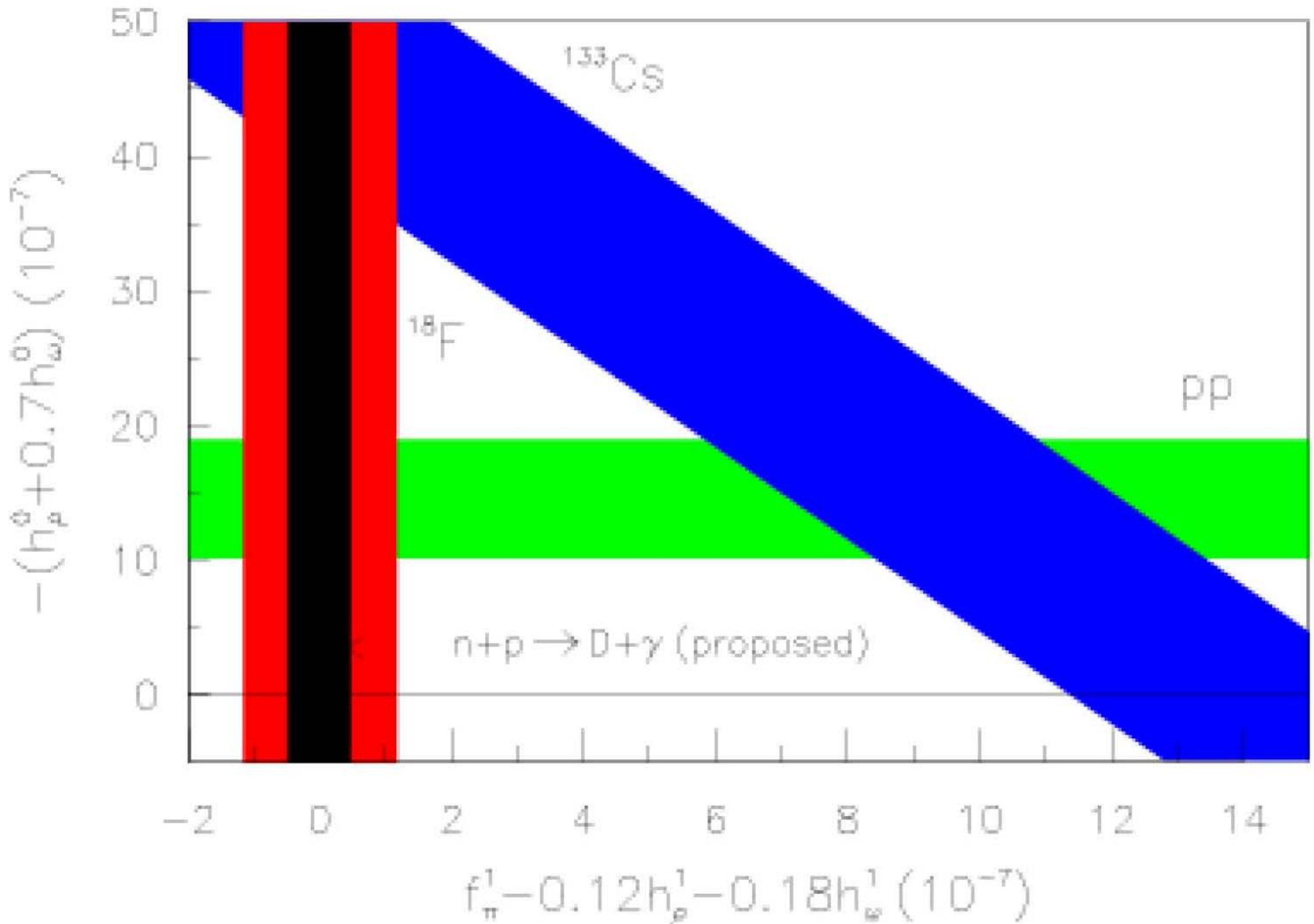
Six "Weak" meson exchange coupling constants suffice:

f_π, h_ρ^0, h_ρ^1, h_ρ^2, h_ω^0, h_ω^1

Due to mass considerations, the effect of f_π is the presumed to provide the dominant effect.

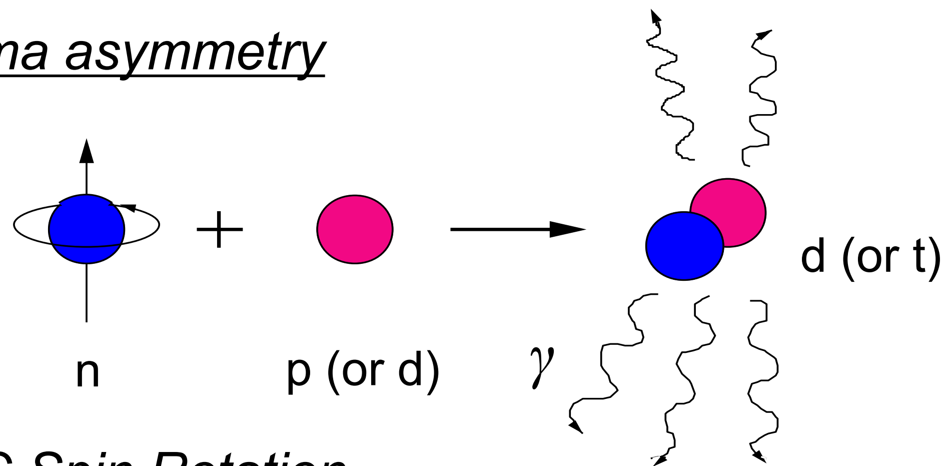
Slide courtesy of Mike Snow

There is Currently Some Inconsistency in Data from Heavy Elements

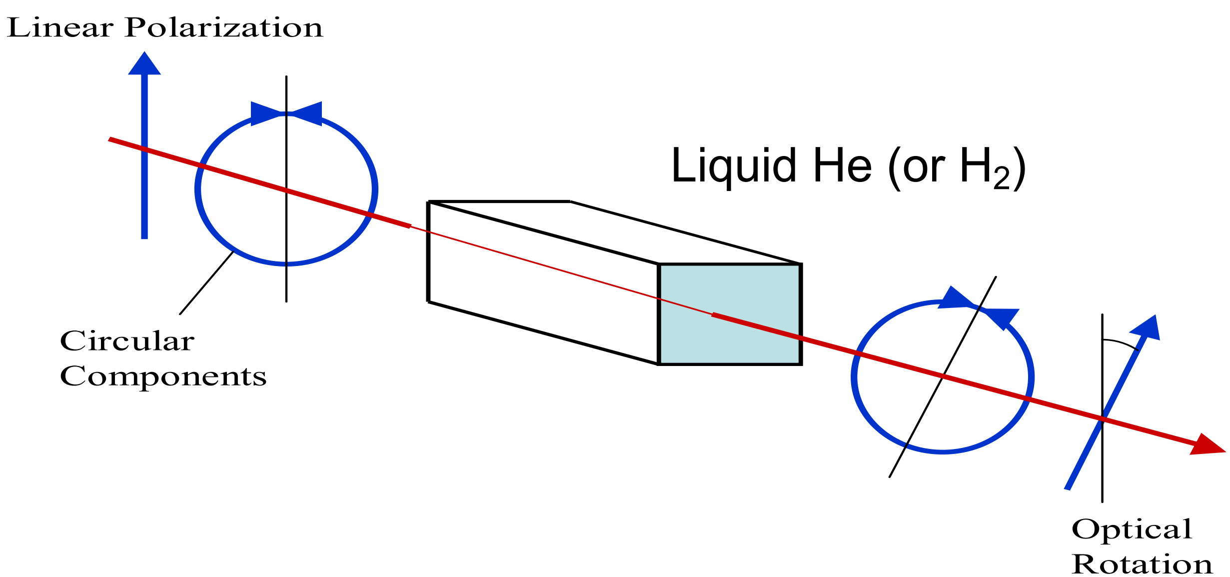


Need Data in "Simple" Systems
n+p, n+d, n+α

PNC Capture Gamma asymmetry



Weak Nuclear PNC Spin Rotation



Slide courtesy of Mike Snow

Neutron / Anti-Neutron Oscillations

A Stupid Question ??

Why doesn't a neutron spontaneously turn into an anti-neutron ?

$$n \rightarrow \bar{n}$$

- *Conserves Mass*
- *Particle-AntiParticle transitions are well known for other neutral particles:* $K^0 \rightarrow \overline{K}^0$, $B^0 \rightarrow \overline{B}^0$
- *If* $\vec{B} = 0$, *conserves energy* $\vec{\mu} \cdot \vec{B} = 0$
- *Conserves just about everything except Baryon Number:*

$$B(n) = 1$$

$$B(\overline{n}) = -1$$

Is Baryon Number Conserved ?
We Don't Think So !

Why Do We Think ΔB ≠ 0 ?

1. There are no knows laws of physics which require B conservation

"That which is not forbidden is required"

2. Baryon Non-Conservation is required for Sakharov process

3. Super-symmetry suggests that B is not conserved.

A great deal of effort has gone into searches for ΔB=1 process like:

$$p \rightarrow e^{+} + \pi^{0}, p \rightarrow \bar{\nu} + K^{0}, p \rightarrow \mu^{+} + K^{0}, \ldots$$

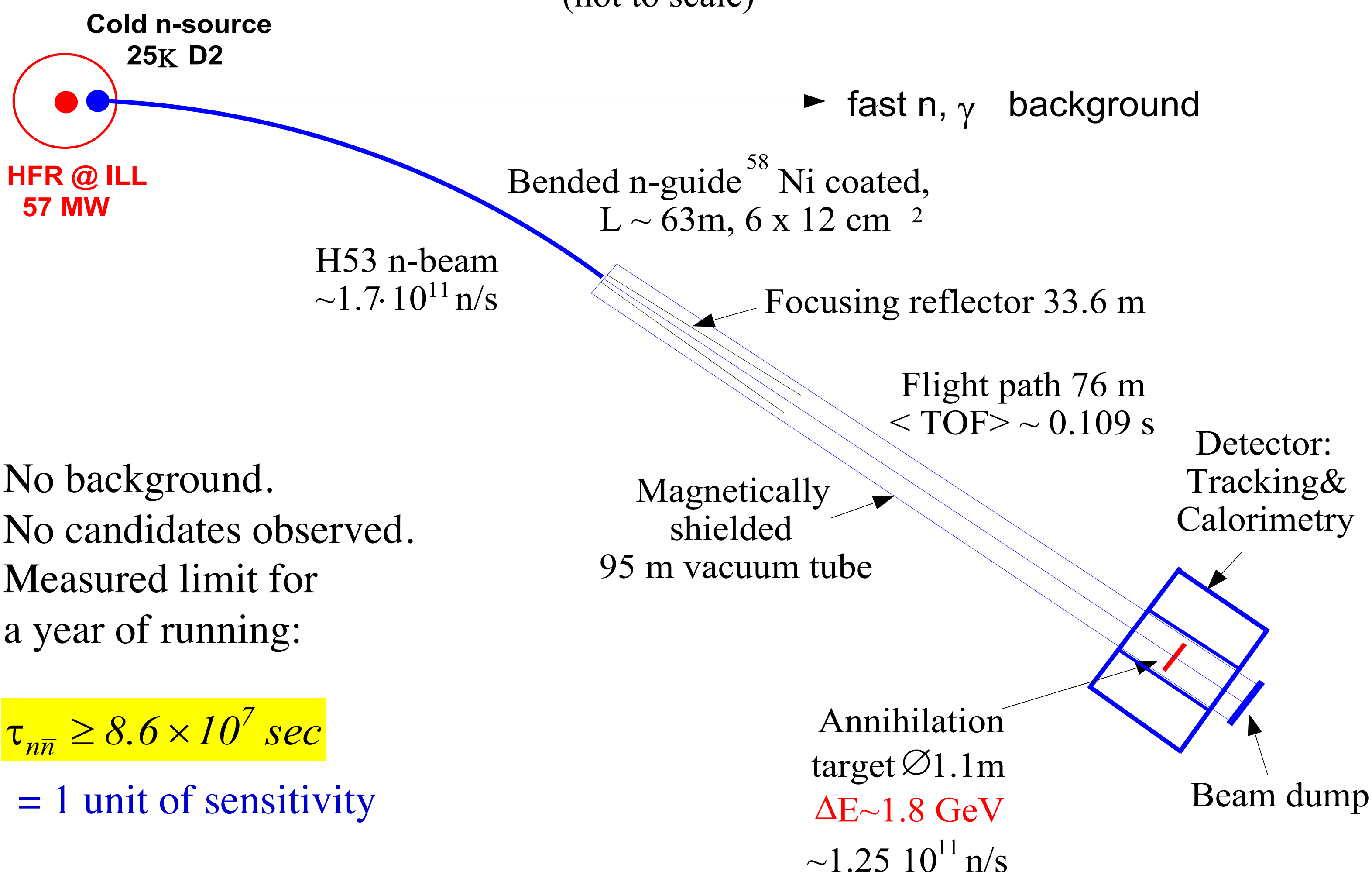
Without success.

It has been suggested that it would be fruitful to look for ΔB=2 like

$$n \rightarrow \bar{n}$$

Schematic layout of Heidelberg - ILL - Padova - Pavia $n\bar{n}$ search experiment at Grenoble 89-91

(not to scale)



No background.
No candidates observed.
Measured limit for
a year of running:

$$\tau_{n\bar{n}} \geq 8.6 \times 10^{7}\ sec$$

= 1 unit of sensitivity

Slide courtesy Y. Kamyskov

End of Lecture V