Summary:
* Aiming for precision $\text{Br}(\pi \rightarrow e\nu) \sim \pm 0.0006 \times 10^{-4}$
* Searching for Sterile neutrinos (60-129 MeV) $|U_{ei}|^2 < 10^{-8}$
* Data taking completed at the end of 2012
  Analysis underway; first Br result expected in 2014
  Complete analysis in 2015
* Also measured direct muon capture to atomic states

IPP Meeting Sudbury June 2014
$\pi \rightarrow e\nu$ Branching Ratio

$$R_{e/\mu}^{th} = \frac{\Gamma(\pi \rightarrow e\nu + \pi \rightarrow e\nu\gamma)}{\Gamma(\pi \rightarrow \mu\nu + \pi \rightarrow \mu\nu\gamma)} = 1.2352(1) \times 10^{-4} \quad \text{Cirigliano, Rosell 2007}$$

Experimental status:

$R_{\text{exp}} = 1.2265(34)(44) \times 10^{-4}$ (TRIUMF, 1992)

$1.2346(35)(36) \times 10^{-4}$ (PSI, 1993)

PIENU Precision goal: $(0.0006 \times 10^{-4})$

Search for BSM physics:

- Mass scales up to 1000 TeV (Pseudoscalars)
  - Charged Higgs,
- $e-\mu$ Universality
- Sterile neutrinos

(Another topic: Direct muon capture to atomic states)
## $e\mu$ Universality Tests

<table>
<thead>
<tr>
<th>Mode</th>
<th>$g_e/g_\mu$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\pi \rightarrow e\nu / \pi \rightarrow \mu\nu$</td>
<td>$0.9979 \pm 0.0016$</td>
</tr>
<tr>
<td>$K \rightarrow e\nu / K \rightarrow \mu\nu$</td>
<td>$1.0022 \pm 0.0018$</td>
</tr>
<tr>
<td>$\tau \rightarrow e\nu\nu / \tau \rightarrow \mu\nu\nu$</td>
<td>$0.9980 \pm 0.0015$</td>
</tr>
<tr>
<td>$\nu_e / \nu_\mu$ scattering</td>
<td>$1.10 \pm 0.05$</td>
</tr>
<tr>
<td>$W$ decays</td>
<td>$0.999 \pm 0.011$</td>
</tr>
</tbody>
</table>

- $\pm 0.0003$ PIENU/PEN
- $\pm 0.0010$ NA62/TREK
- Belle II
TRIUMF PIENU

Measure Energy and time in a precision crystal spectrometer

Fit time spectra simultaneously
- $\pi$-eU, $\pi$-µ-e, $\pi$DIF, old µ
- radiative $\pi$ decays
- $\pi$ + old µ
-(µDIF)
Suppress Backgrounds, Make small systematic corrections for NaI lineshape and other tiny effects.

Response function measurements showed up photo-nuclear n emission.

Background Suppression
- Suppress $\pi$-$\mu$-$\nu$ background with target energy
- Remove $\pi$DIF background with track angles
- Correct for selection bias

Target Energy

Kink Angle

$\pi^+ \rightarrow e^+ \nu$

Decays in Flight Events
**PIENU: Summary of Expected Uncertainties**

<table>
<thead>
<tr>
<th>Source</th>
<th>Old TRIUMF</th>
<th>PIENU Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>0.0028</td>
<td>0.0005</td>
</tr>
<tr>
<td>Low-energy tail</td>
<td>0.0025</td>
<td>0.0003</td>
</tr>
<tr>
<td>Acceptance corrections</td>
<td>0.0011</td>
<td>0.0003</td>
</tr>
<tr>
<td>Pion lifetime</td>
<td>0.0009</td>
<td>0.0002</td>
</tr>
<tr>
<td>Other</td>
<td>0.0011</td>
<td>0.0003</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0.0047</strong></td>
<td><strong>0.0006</strong></td>
</tr>
</tbody>
</table>

**Current PIENU
Result For Sterile Neutrinos:**

![Graph showing neutrino mass distribution](image)