ANAIS STATUS REPORT

TAUP 2009
3 July 2009


GIFNA-University of Zaragoza
OUTLINE

- ANAIS: WHAT and WHY
- K40 Characterization of NaI(Tl) crystals
- Threshold and Linearity
- ANAIS-0 Module
- Conclusions and Next Steps
ANAIS: Direct search for WIMPs through annual modulation on NaI(Tl) scintillating crystals at LSC.

ANAIS: uses same target as DAMA
ANAIS: WHAT AND WHY

- DAMA annual modulation observed
- Rate = $Wimp \times Nuclear \times Halo$
  uncertainties
ANAIS

- 14 hexagonal crystals stored underground from 1988. 10.7kg each
- 1 crystal St Gobain. Prism 9.7kg
- Various Prototypes developed by GIFNA at Zaragoza and numerous runs at LSC. Goal: optimize Threshold and Background
K40 Characterization

- Dedicated Set-ups at old LSC to estimate internal K40 Background
- Measurement of 3.2KeV in Coincidence with 1460KeV
- Estimation of K40 internal contamination and calibration in energy and trigger efficiency

G4DecayTable: K40[0.0]
0: BR: 0.8928 [Phase Space] : e- Ca40[0.0] anti_nu_e
1: BR: 0.080325729 [Phase Space] : nu_e Ar40[1460.9]
2: BR: 0.022006024 [Phase Space] : nu_e Ar40[1460.9]
3: BR: 0.0028845003 [Phase Space] : nu_e Ar40[1460.9]
4: BR: 0.001774271 [Phase Space] : nu_e Ar40[0.0]
5: BR: 0.00017397588 [Phase Space] : nu_e Ar40[0.0]
6: BR: 2.5499654e-05 [Phase Space] : nu_e Ar40[0.0]
7: BR: 9.87e-06 [Phase Space] : e+ Ar40[0.0] nu_e
K40 Characterization

3.2 KeV peaks
K40 Characterization of old crystals

- Mean contamination 10-20 mBq/Kg in K40
- ANAIS needs cleaner crystals to achieve 1mBq/Kg or less in K40.

<table>
<thead>
<tr>
<th>Detector</th>
<th>$^{40}$K Activity (mBq/kg)</th>
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<tbody>
<tr>
<td>EL603</td>
<td>14.5±0.2</td>
</tr>
<tr>
<td>EP508</td>
<td>16.2±0.3</td>
</tr>
<tr>
<td>EP509</td>
<td>16.6±0.2</td>
</tr>
<tr>
<td>EP055</td>
<td>15.2±0.1</td>
</tr>
<tr>
<td>EP056</td>
<td>18.8±0.2</td>
</tr>
<tr>
<td>EL214</td>
<td>17.9±0.4</td>
</tr>
<tr>
<td>EP057</td>
<td>20.9±0.4</td>
</tr>
<tr>
<td>EM301</td>
<td>21.2±0.4</td>
</tr>
<tr>
<td>EP604</td>
<td>16.5±0.3</td>
</tr>
<tr>
<td>EP054</td>
<td>13.7±0.3</td>
</tr>
<tr>
<td>PIII</td>
<td>15.7±0.5</td>
</tr>
</tbody>
</table>
LINEARITY

- Prototype III: new encapsulation with mylar window
- Calibration with K40 internal contamination and Fe-55, Cd-109, Ba-133, Co-57, Cs-137
- Linearity down to 3KeVee
- Surface effect for Fe-55 X-ray line
Threshold

- Hardware threshold at photoelectron level
- Analysis threshold extended down to 2KeVee
- Further developments to improve light collection and noise rejection
Threshold and PMTs

- Test Bench at Zaragoza
- Pulse Shape Analysis at LE
### PMTs Radiopurities

<table>
<thead>
<tr>
<th>Isotope</th>
<th>ET 9302B</th>
<th>HAM High QE R6233-100</th>
<th>HAM Low Bkg* R6233-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{40}$K</td>
<td>$(420 \pm 50)$ mBq/PMT</td>
<td>$(19.5 \pm 0.1)$ Bq/PMT</td>
<td>$0.4$ Bq/PMT</td>
</tr>
<tr>
<td>$^{232}$Th</td>
<td>$(24 \pm 4)$ mBq/PMT</td>
<td>$(0.42 \pm 0.04)$ Bq/PMT</td>
<td>$0.3$ Bq/PMT</td>
</tr>
<tr>
<td>$^{238}$U</td>
<td>$(220 \pm 12)$ mBq/PMT</td>
<td>$(0.513 \pm 0.03)$ Bq/PMT</td>
<td>$0.2$ Bq/PMT</td>
</tr>
</tbody>
</table>

- Background measurements at LSC with High purity Ge detector
- HAM High QE good resolution, but high BKG
- Contacts to try both High QE and Low BKG

* Stated by provider. Measurements at LSC ongoing
Design and Cu electroforming of PMTs encapsulation. 9.7kg crystal.
Radiopurity measurement of windows, coupling gels, etc. at LSC
Design of new electronic bases for the PMTs with Teflon, SMD components and new thin cable for HV supply.
Module assembled in Zaragoza and installed at Canfranc. First tests ongoing
ANAIS-0

- In parallel, development of new acquisition system VME based ongoing

- Monitorization of Lab conditions (T, P, Rn, etc)

Objetive: mount ANAIS-0 module in old Canfranc Laboratory with optimized shielding and stability control
Conclusions and Next Steps

- Linearity shown down to 3 keV and analysis threshold at 2keVee. Works ongoing to further improve.
- Set-up for Crystal K40 characterization. Old crystals characterised, 9.7 kg module ongoing.
- Crystals:
  - NaI powder bought at ppm level in K40. Measured at LSC
  - Purification methods and analysis under investigation. Objective less than 30ppb in Knat.
  - Continue contacts with providers.
  - Will be checked at LSC.
- Mount ANAIS-0 module at old LSC with stability control and optimized shielding.
THANK YOU