MoS analysis and ORCA

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2 modes:
- coupled → following MS HV at the analysing plane
- not coupled → stand-alone experiment (with HV power supply)
High Voltages in KATRIN

HV = Very important parameters. Resolution and response of KATRIN is coming partially from the HV at the analysing plane.
  → Reducing the value of the voltage to measure it precisely using a commercial 10 V voltmeter
  → Reproductability for stacking runs in neutrino mass analysis (feedback loop)

\[
M := \frac{U_{in}}{U_{out}} = \frac{\sum_{i=1}^{n} R_i + R_{LV}}{R_{LV}}
\]

Reduction factor

• Voltage divider

Example: K65 KATRIN
High Voltages in KATRIN

K35 (5 ppm level)


Specific very stable resistors, flushed with nitrogen gas, 25°C +/− 0.1
Shielded chamber, etc → Best precision in the world
Example of reduction 1972:1 for K35. Good commercial voltmeter up to 10V.
Less precise voltage divider installed at the MoS: JRL.

Calibration using K65, K35 and Krypton lines:
- O. Rest et al., Metrologia 56 (2019) 045007 (10pp)

K65 (ppm level)

s. Bauer et al., JINST 8 (2013) P10026
K35 (5 ppm level)


What about long term drift? Ageing material, degradation, etc

Calibration of the K35/K65 can NOT be done DURING measurement

Specific νε

Shielded chamber, etc → Best precision in the world

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Less precise voltage divider installed at the MoS : JRL.

Calibration using K65, K35 and Krypton lines :

• O. Rest et al., Metrologia 56 (2019) 045007 (10pp)
→ Measure long term drift using $^{83}$Kr source
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Conversion electrons from $^{83}\text{Kr}$

From MoS perspective:
- Ultra stable source: M Zbořil et al., JINST 8 (2013) P03009
- Nuclear standard close to the tritium endpoint
- Produce at Bonn Isochronous Cyclotron. $\alpha$ beam to $^{81}\text{Br}$ target on highly oriented pyrolitic graphite substrate. Production with $^{81}\text{Br}(\alpha,2n)^{83}\text{Rb}$ reactions.
Conversion electrons from $^{83}\text{Kr}$

From TRISTAN perspective:
- Ideal working condition
- Monoenergetic electron lines (almost no background) from 7.7 to 30 keV with <1 eV resolution
- Modification of the beam tube size/electron incident angle playing with the source insertion depth
- Modification of the B field intensity playing with the superconducting magnet current
- Source activity mapping known
Conversion electron line = Lorentzian. Fitting a Doniach-Sunjic-Gaussian:
- Lorentzian initial distribution
- Gaussian broadening
- Asymmetric result.

**Fit Results**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>3755.46 +/- 40.82 cps</td>
</tr>
<tr>
<td>Line position</td>
<td>17827.10 +/- 0.03 eV</td>
</tr>
<tr>
<td>Background rate</td>
<td>573.57 +/- 3.33 cps</td>
</tr>
<tr>
<td>Gaussian Width</td>
<td>0.447 +/- 0.072 eV</td>
</tr>
<tr>
<td>Asymmetry parameter</td>
<td>0.057 +/- 0.005</td>
</tr>
<tr>
<td>Chi2 / Dof</td>
<td>18.78 / 13</td>
</tr>
</tbody>
</table>
Monitor Spectrometer KNM2

K\text{r} \text{ Line Position (eV)}

slope = -1.43 +/- 0.07 mV/day

Normalized residuals
ORCA

ORCA Overview

ORCA stands for **Object-oriented Real-time Control and Acquisition**. ORCA is a data acquisition application for the MacOS X operating system. The goal is to provide a general purpose, highly modular, object-oriented, acquisition and control system that is easy to use, develop, and maintain. To this end, ORCA is written using the MacOS X Cocoa application framework development environment and Objective-C. Its general-purpose design enables a user to easily configure it at run-time to represent different hardware configurations and data read-out schemes.

A key design feature of ORCA is the design of the internal, acquired data stream and how this stream is written out for permanent storage. Each hardware object is responsible for writing out both its hardware parameter settings as well as the actual data it acquires. A supervisory data collection object controls which hardware objects are used in the experiment and the order and hierarchy of the read-out scheme. In this fashion a user can completely reconfigure the experimental hardware and the data read-out without rewriting any code or re-compiling the application.
ORCA

http://orca.physics.unc.edu/~markhowe/Getting_STARTED/Overview.html

Responsible for time synchronization between hardware objects, execution of running procedure (scanning of different HV, interplay with MS), storing data on server (Root format, accessed through beans, stored on KaLi)
1 subrun = Summed of 1s histogram sent to ORCA system (histogram and timestamps)  
Common clock with slow control (voltmeters, power supplies, etc)  
Acquisition is started from remote control room

Injection of fake signals with fix frequency (here 200 Hz) to precisely measure the rate

Rate for a fix HV = Integration of events in a ROI / Real time of acquisition
We need time synchronization and common data architecture between HV measurements (K35, JRL, source voltates) and Kerberos.

General ideas to stick to the actual infrastructure:

- **ship histogram data** every second with synchronized clock from a computer. Is it possible from Kerberos? Can we have external synchronization?

- **the pulse injector** was very usefull. Should we keep it, injecting fake signal through reset? Only using reset signals (correlated with rate, no dead-time)?

- **keep the « running » outside ORCA?** (run labelisation, subrun structure, Root format, start and stop from external scripts)

- **Talking with ORCA responsible at KIT** : what is needed to fit to the actual data stream? For now interface to access data is with Beans.