Radiopure electronics for the Micromegas detector for IAXO

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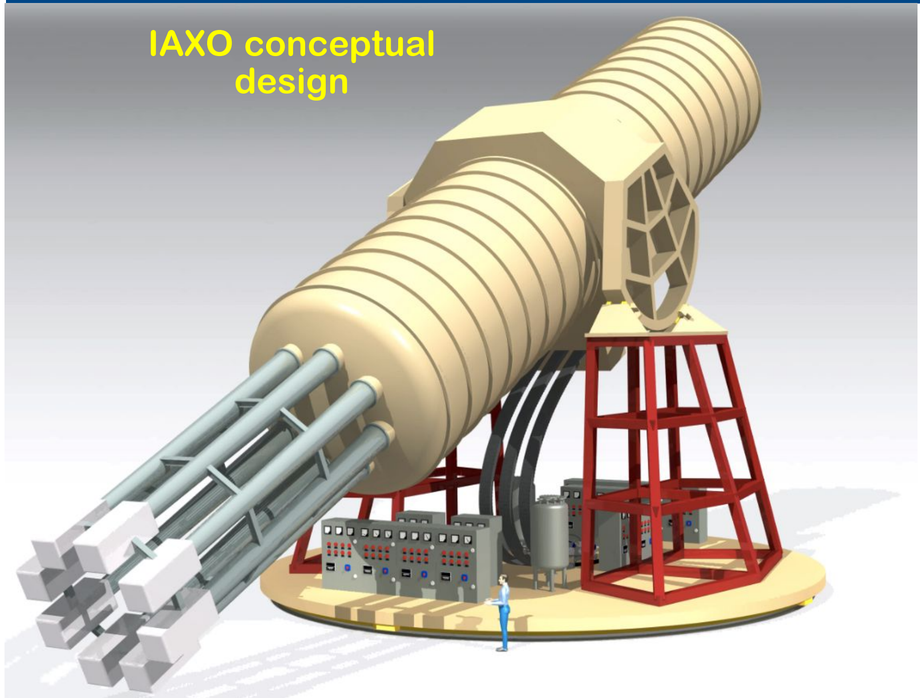
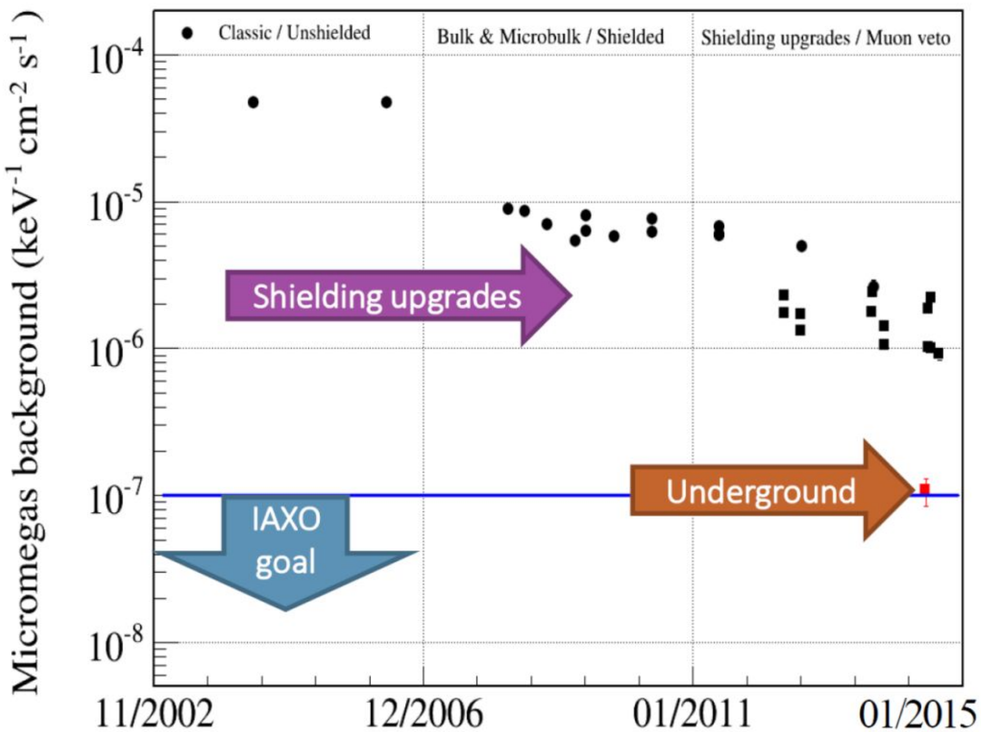
Electronics for IAXO and background levels

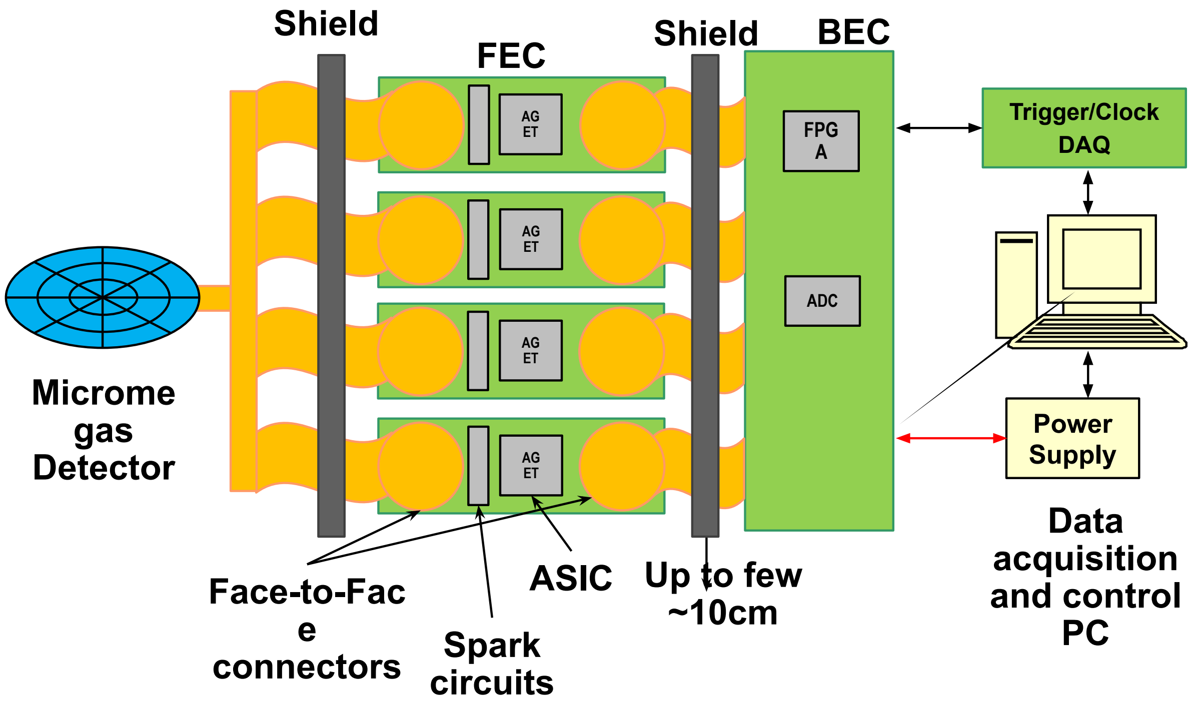


- **Next generation "axion helioscope" after CAST**
  - **Purpose-built large-scale magnet**
  - **8 conversion bores of 60 cm Ø, ~20 m long**
  - **Sun-tracking time is ~50% day**
- **Detection systems (XRT+detectors)**
  - **Low-background techniques for detectors**

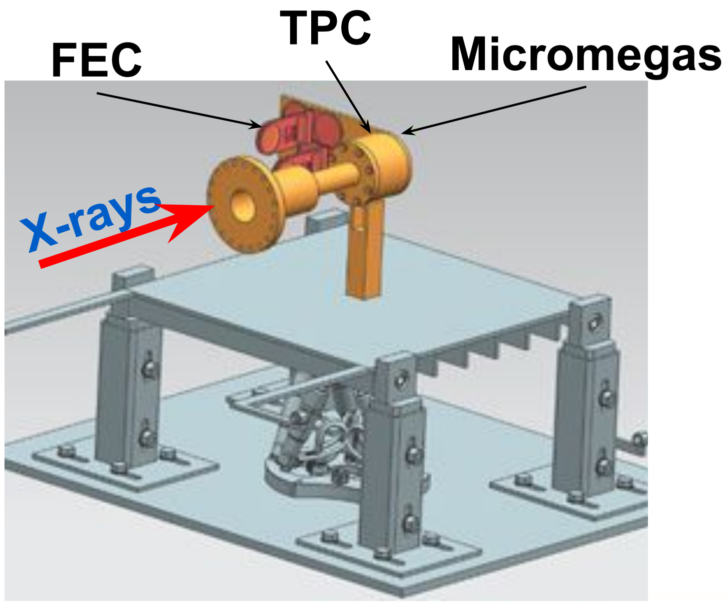
- **Up to now, background levels have been reduced using high radiopure materials, shielding and muon vetos.**
- **Main goal of new readout electronics detector: reduce noise as much as possible to maximize sensitivity for IAXO.**
  - **Reduce Micromegas detector to electronics distance**
  - **Use radiopure components**



New electronics partition and placement



- **New partition of the electronics**
  - **Based on the FEC-Feminos cards (Saclay)**
  - **Move sensitive, AGET, in Front End Card (FEC) as close as possible to the detector to optimize S/N**
  - **Back End Card (BEC), with FPGA+ADC, separated tens of cm by extra shielding**
- **Redesign of the cards**
  - **Different partition**
  - **Component selection and validation**

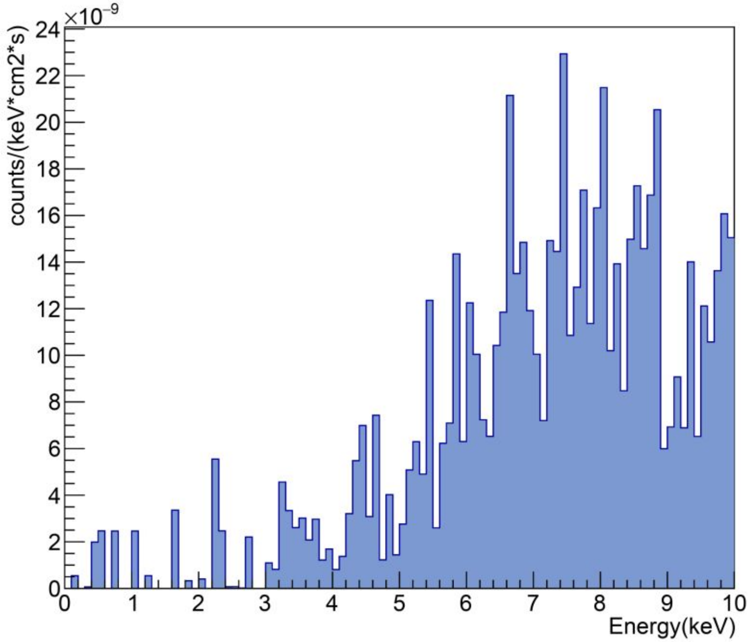


- **Detector and electronics placement inside the shielding**
- **Radiopurity and components**
  - **Kapton PCB**
  - **Face to Face connector**
  - **Selection of radiopure packaging for the AGET ASIC**
  - **Spark protection circuits (R, C, diodes)**
  - **Coupling capacitors**

Electronics simulated activity

- **Simulations to study the effects of the electronics on the detector**
  - **Replicate the design (boards and components)**
  - **Emission events generated via Monte Carlo**
  - **Estimate the energy deposited by impurities**
  - **REST framework**
- **Previous studies of background models and data analysis on the CAST experiment by the group of the University of Zaragoza.**
- **Search for FEC optimal placement: check several positions of the board and distances from the detector**
- **The elements included in the FEC simulation and their activity**
  - **Measured activities of components and materials obtained from a screening program of the TREX project**
  - **If not already measured, worst cases of known similar components are used.**

Deposited energy in gas due to radiation emmited from the electronics



Component	Quantity (per board)	Dimensions	^{40}K	^{60}Co	^{137}Cs	^{226}Ra	^{228}Ra	^{228}Th	^{232}Th	^{235}U	^{238}U
Capacitors	106	mBq/unit	5.29	<0.036	<0.043	5.29		8.75	8.52		10.4
Resistances	128	μBq/unit	83.6	<0.2	104	4.1		4.4	4.4		85
AGET Chip	1	mBq/unit	0.83			0.48	0.16	0.47			8.77
Diodes	64	μBq/unit							2.9	2.6	1.4

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Summary

- **The proposed Micromegas detection system for BabyIAXO places the Front-End electronics inside the Pb shielding for reducing signal degradation.**
- **Approaching the electronic components increases background due to radioactive impurities:**
  - **The larger sources of radiation coming from the electronics are impurities of the capacitors (238U, 228Th, 232Th) and of the encapsulation of the AGET chip (238U) .**
  - **A smaller fraction comes from resistors and diodes from the spark protection system.**
- **Total integrated effect of electronics at ¼ distance from the Micromegas inside the shielding has been simulated to be less than the environment contamination in underground laboratory conditions at Laboratorio Subterráneo de Canfranc (LSC).**

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