MAX-PLANCK-INSTITUT
FÜR PHYSIK

RADES

AXION SEARCHES WITH HTS COATED CAVITIES IN RADES

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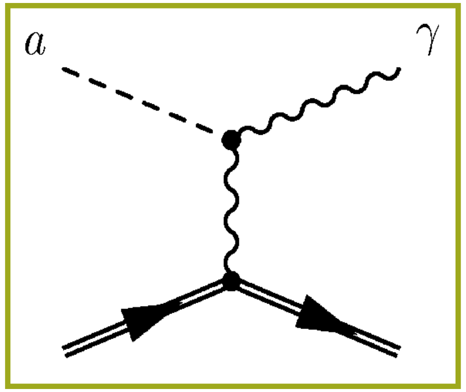
20th Patras Workshop on Axions, WIMPs and WISPs. Tenerife 2025

AXION HALOSCOPES

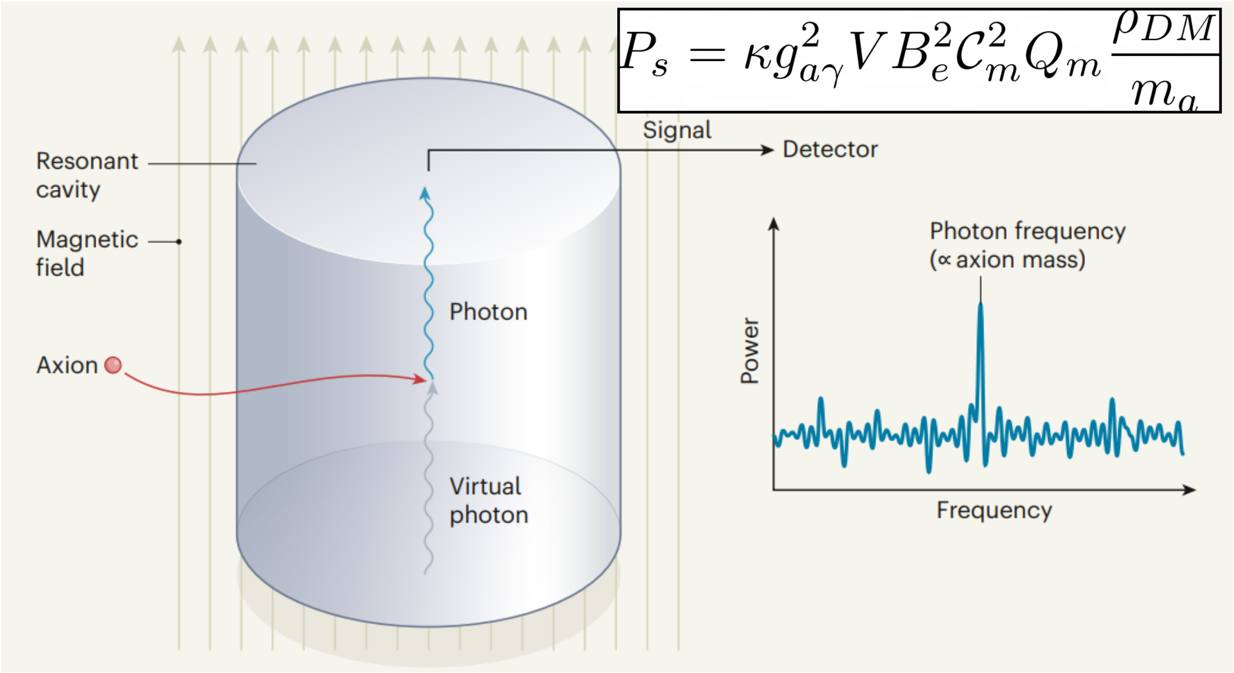
Axions are hypothetical pseudoscalar pseudoNambu-Goldstone bosons that could:

- Solve the strong CP problem of QCD
- Account for the dark matter content of the universe
- Mix with photons at low energies

Main detection strategy: Conversion of axions into photons under a strong magnetic field



Haloscope approach to DM axion detection



$$P_s = \kappa g_{a\gamma}^2 V B_e^2 C_m^2 Q_m \frac{\rho_{DM}}{m_a}$$

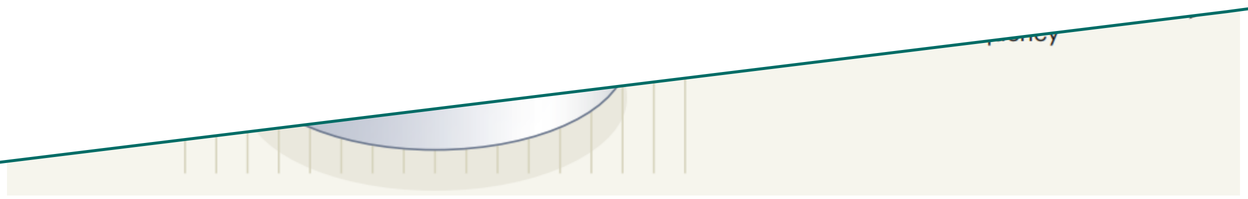
AXION HALOSCOPES

Axions are hypothetical pseudoscalar pseudoNambu-Goldstone b

- Solve the strong CP problem of QC
- Acc

KONSTANTIN'S LAW:

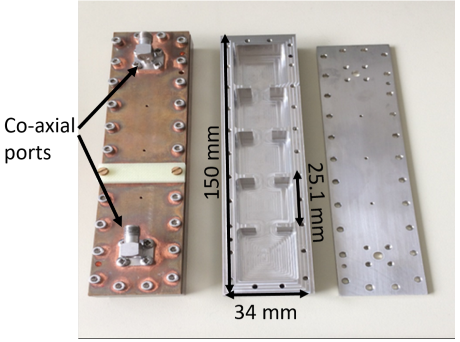
ONE EXPLANATION OF THE PRINCIPLES OF A HALOSCOPE PER PATRAS WORKSHOP IS MORE THAN ENOUGH*



*You can refresh your memory checking my poster though

THE RADES COLLABORATION

Started as a haloscope experiment exploring the use of multi cavity structures for bigger detection volumes at higher frequencies.



Current Status of RADES Installation in CAST'

65rd CAST collaboration meeting
September 26, 2017
Antonio José Lozano Guerrero, Alejandro Álvarez Melcón, Benito Gimeno Martínez, Igor García Irastorza, Cristian Cogollos, Javier Redondo, Carlos Peña, Juan Daniel Gallego, Babette Döbrich and Alejandro Díaz Morcillo

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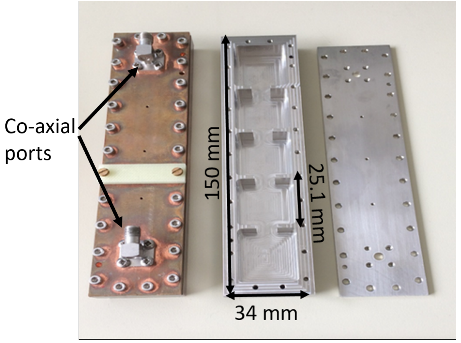

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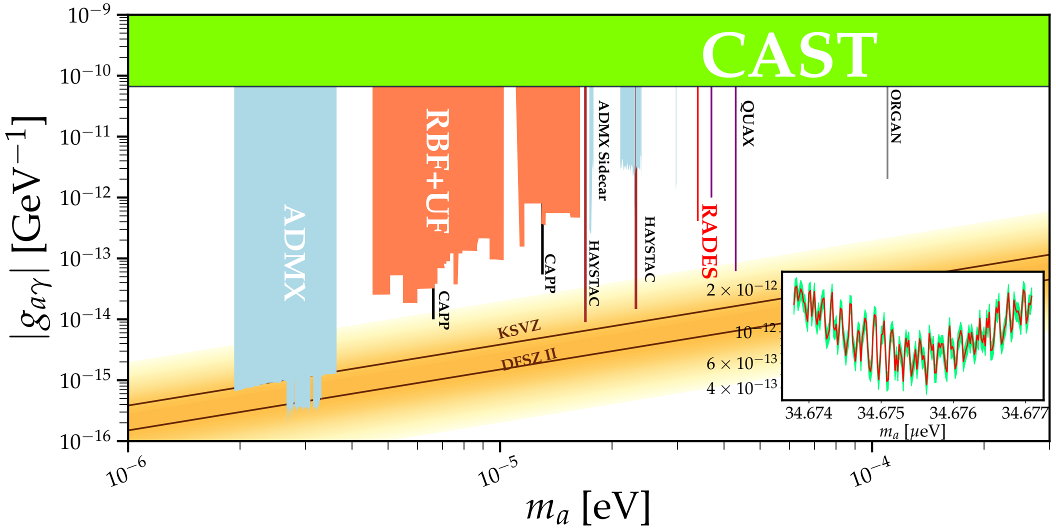
Figure 4.20 - Frustrated wannabe theorist student working on the experiment

A first run inside of the CAST magnet in 2018 served as a proof of principle and allowed us to extract exclusion limits for a mass of 34.67 μeV



THE RADES COLLABORATION

Currently we are more than 30 collaborators from more than 10 different institutions working on cutting-edge technologies for high-frequency axion searches.

HTS COATED PROTOTYPE

Another approach for higher frequency searches in RADES

Increasing sensitivity of smaller cavities → Superconducting taped cavities

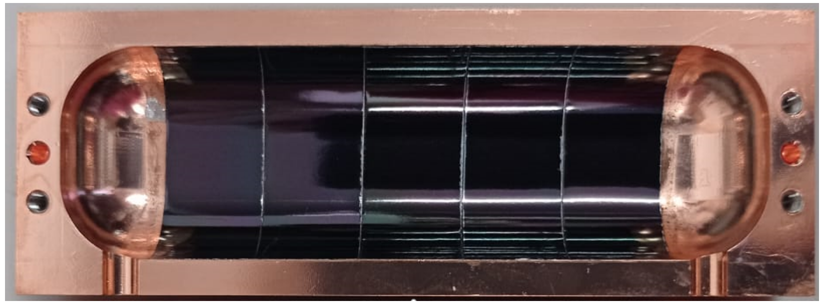
Thin Film (High Temperature) Superconducting Radiofrequency Cavities for the Search of Axion Dark Matter

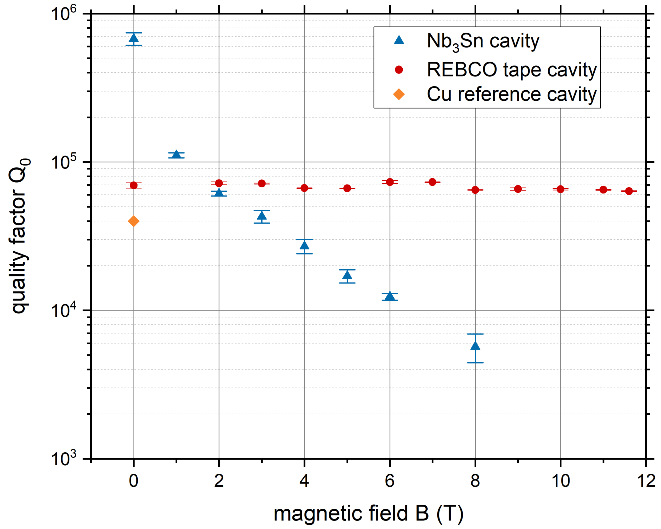
J. Golm (CERN), S. Arguedas Cuendis (CERN), S. Calatroni (CERN), C. Cogollos (ICC, Barcelona U.), B. Döbrich (CERN) Show All(22)

Oct 4, 2021 IEEE Trans.Appl.Supercond. 32 (2022) 4, 1500605

[arxiv:2110.01296]

ReBCO tapes provided by THEVA used (Critical field over 100 T)





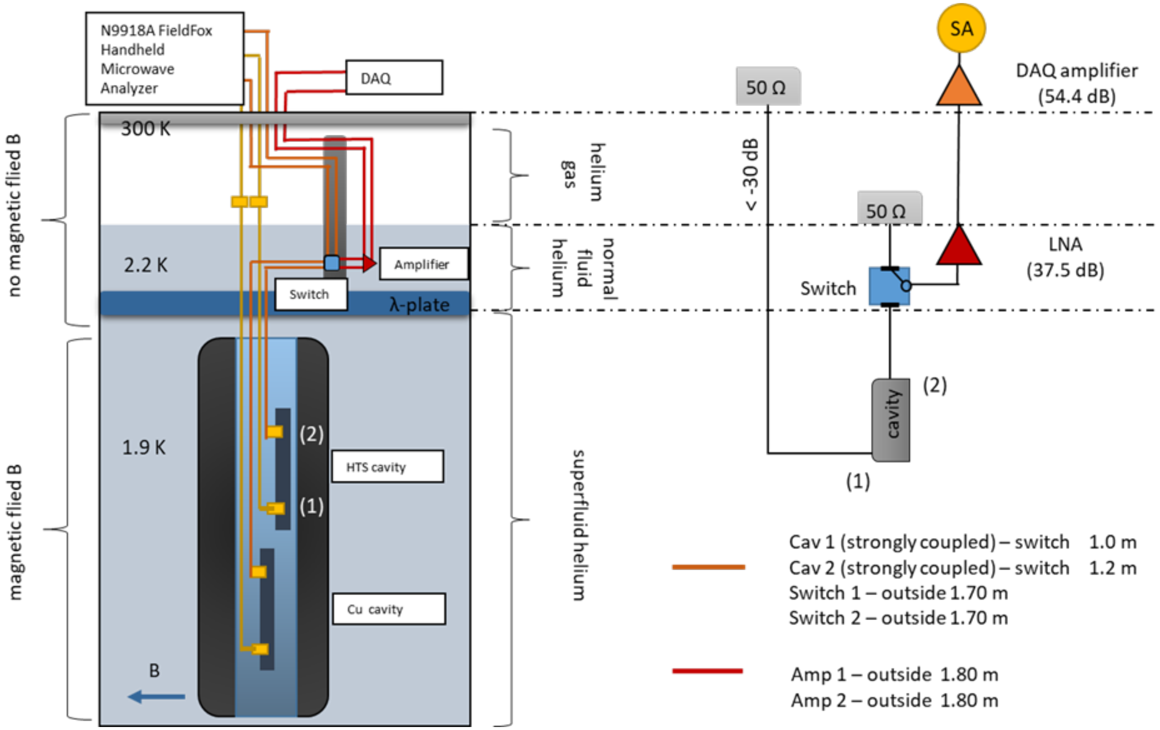
Q-Factor shows almost no degradation up to 12 T

DATA TAKING 2021 AT CERN

In 2021 a data taking was performed at the SM18 magnet testing facility at CERN

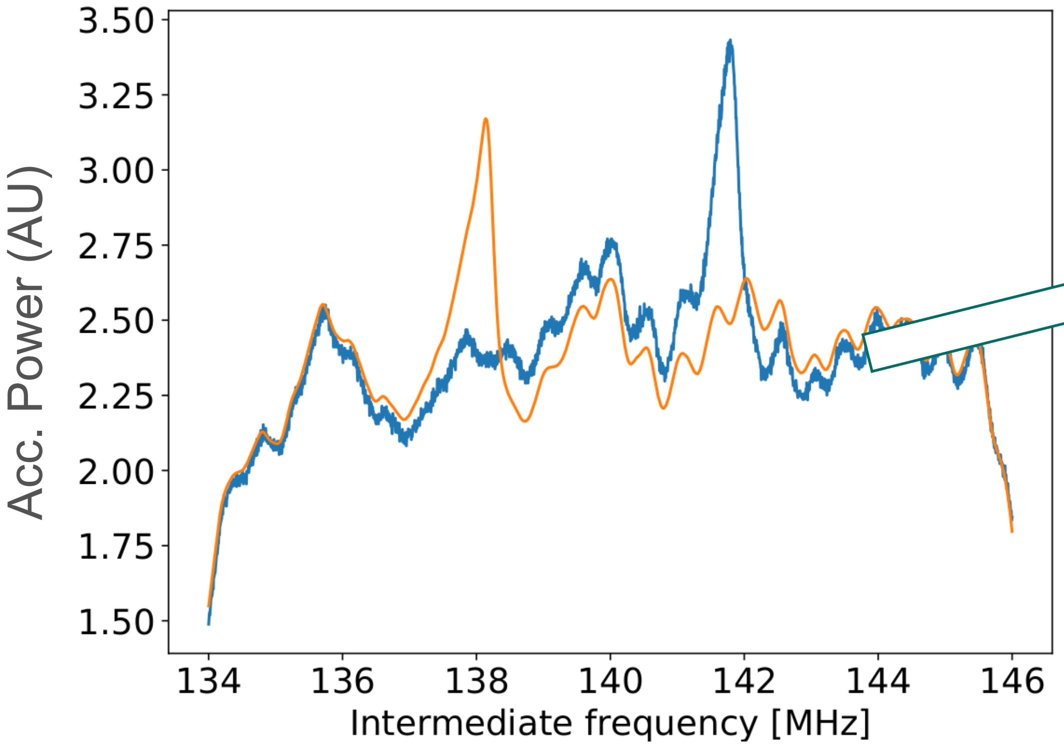
Rather simple setup with 27 hours of axion data taking recorded

Parameter	Symbol	Value
Axion DM Density	ρ_a	$0.45\,\mathrm{GeV\,cm^{-3}}$
Total cavity volume	V	$(0.0288 \pm 0.0002)\,\mathrm{L}$
Magnetic field	B	$(11.7 \pm 0.1)\,\mathrm{T}$
Loaded quality factor	Q_L	$(36\,656 \pm 387)$
Coupling factor	β	(0.81 ± 0.01)
Form factor	C	(0.634 ± 0.001)
Cable attenuation	η	(0.85 ± 0.04)
Noise Temperature	T_{sys}	$(6.2 \pm 1.1)\,\mathrm{K}$



DATA ANALYSIS

However the data analysis was complicated due to a rather complex gain curve structure on the receiver system



Not Flat + Lorentzian

A principal components analysis was performed in order to remove the ease the effect of the DAQ noise structure

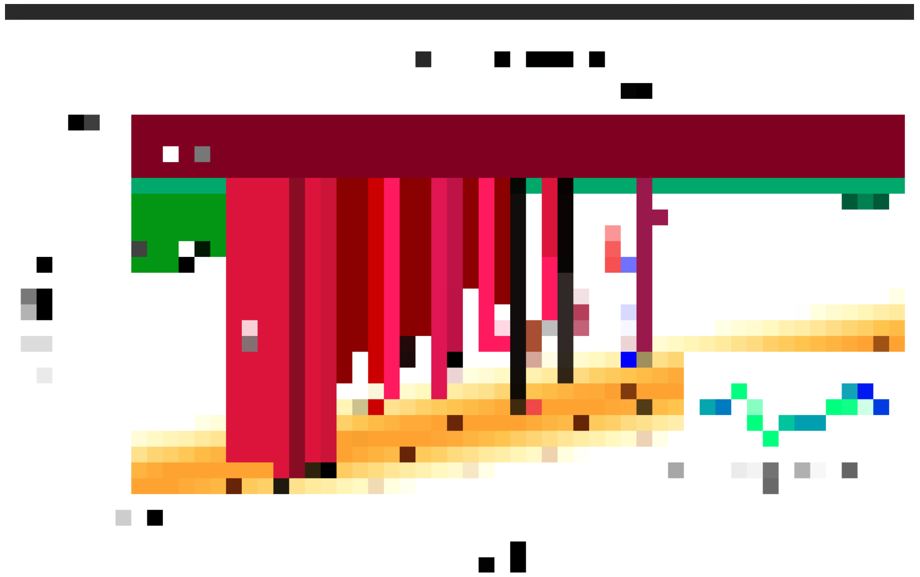
(Details in the poster)

DATA TAKING RESULTS

Last year we released the results for a first run with a high-temperature superconducting (HTS) coated cavity at the SM18 magnet testing facility at CERN

> **RADES axion search results with a high-temperature superconducting cavity in an 11.7 T magnet**
>
> S. Ahyoune (ICC, Barcelona U.), A. Álvarez Melcón (Cartagena Politecnica U.), S. Arguedas Cuendis (ICC, Barcelona U.), S. Calatroni (CERN), C. Cogollos (Garching, Max Planck Inst.) Show All(26)
>
> Mar 12, 2024

JHEP 04 (2025) 113 [arxiv:2403.07790]



THANK YOU FOR YOUR TIME, AND I HOPE TO SEE YOU AT THE POSTER SESSION

Peace, love, dark matter.