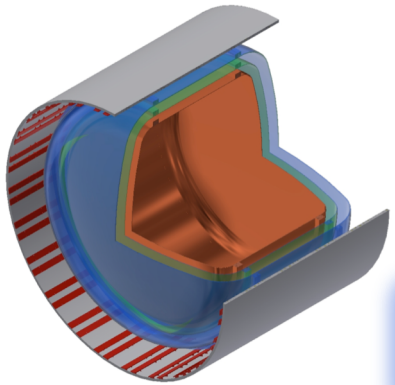
QUAX

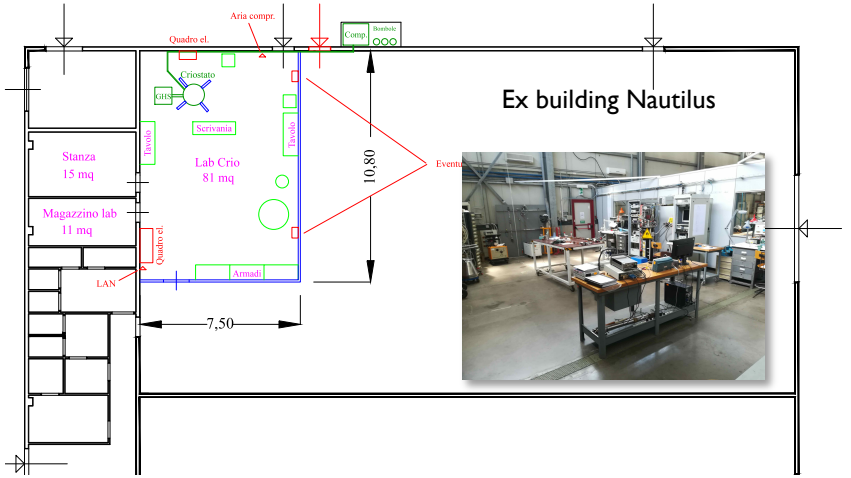
CLAUDIO GATTI

CryOgenic Laboratory for Detectors

SIMP (CSN5)
SIngle Microwave Photon detection

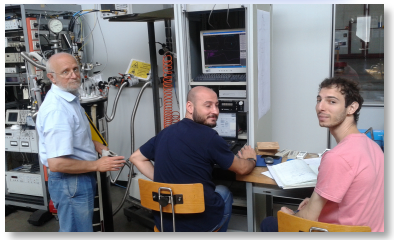


KLASH (CSN2)
KLoe magnet for Axion SearcH



Nb-Island Device
(In collaboration with TERA CSN5)

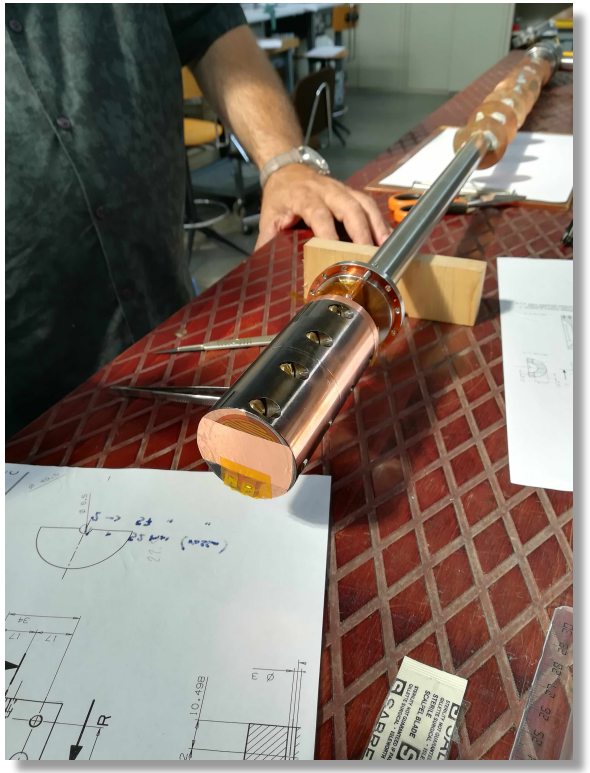
QUAX (CSN2)
QUest for AXions

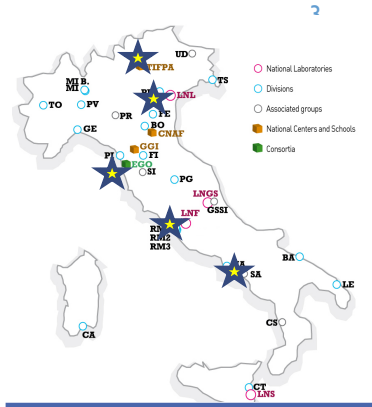


QUAX: Quest for Axions

Quax: 3 years R&D (2017-2019) funded by CSN2 (total budget about 300 k€).

LNF 2019	FTE
C Gatti (PR, Loc Resp)	0.5
D Di Gioacchino (R)	0.5
C Ligi (T)	0.2
D Alesini (DT)	0.1
G Lamanna (Uni Pi)	0.1
G Maccarrone (PR)	0.3
D Babusci (PR)	0.3
D Moricciani (R)	0.3
S Tocci (Research fellow)	1.0
A Rettaroli (PhD student)	1.0
Tot	4.3



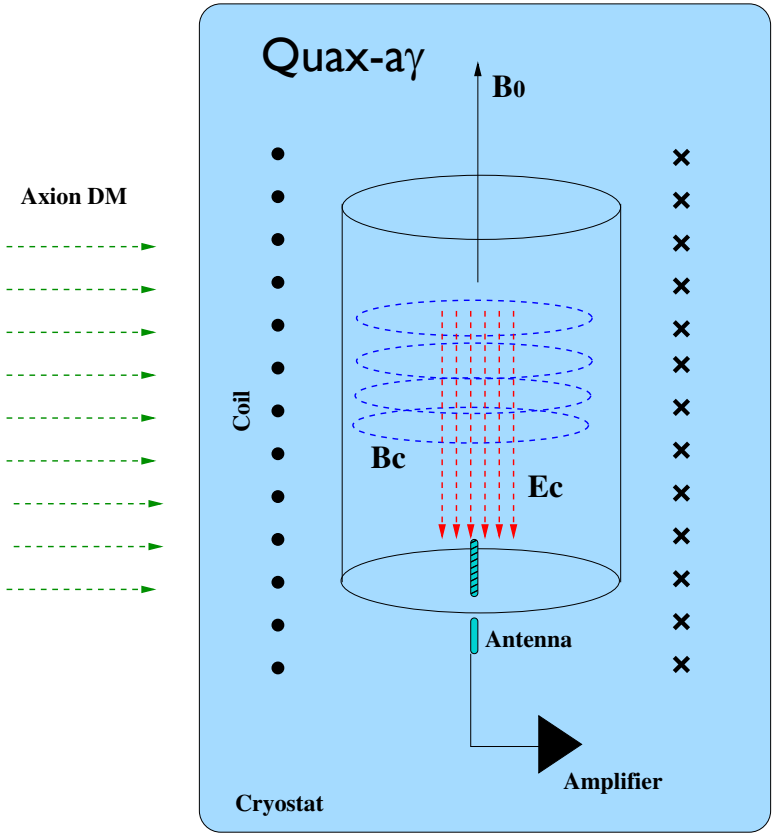


Research Units
Padova (Nat Resp)
LNL (experiment site)
LNF
TIFPA FBK
Sa
Pi

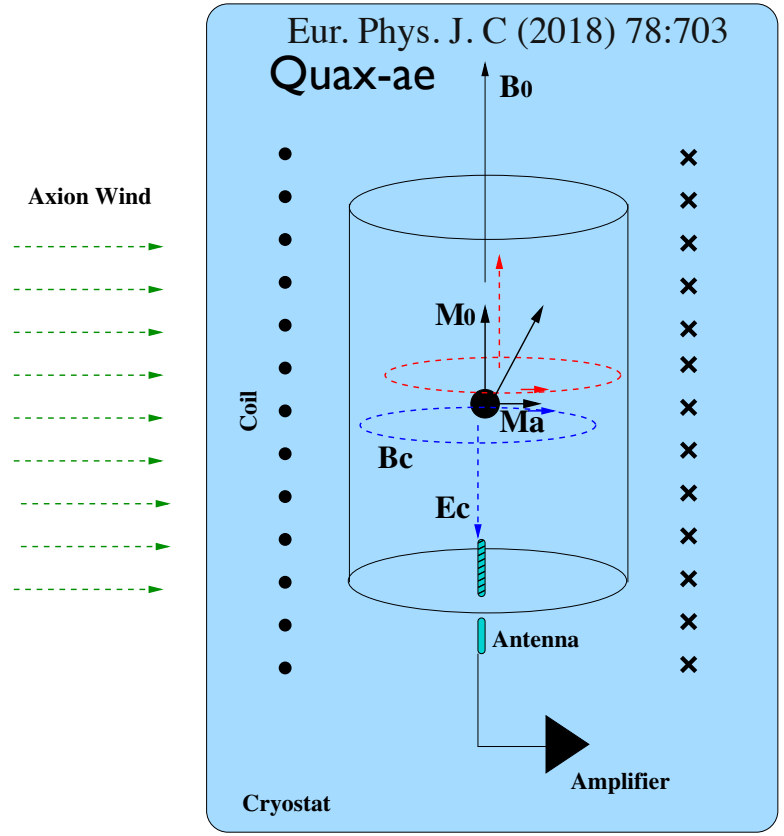
QUAX: Quest for Axions

$$\mathcal{L} = i\frac{g_d}{2} a \left(\bar{N}\sigma_{\mu\nu}\gamma^5 N\right) F^{\mu\nu} + i\frac{g_{aNN}}{2m_N}\partial_\mu a \left(\bar{N}\gamma^\mu\gamma^5 N\right) + i\frac{g_{aee}}{2m_e}\partial_\mu a \left(\bar{e}\gamma^\mu\gamma^5 e\right) + g_{a\gamma\gamma} aE\cdot B$$

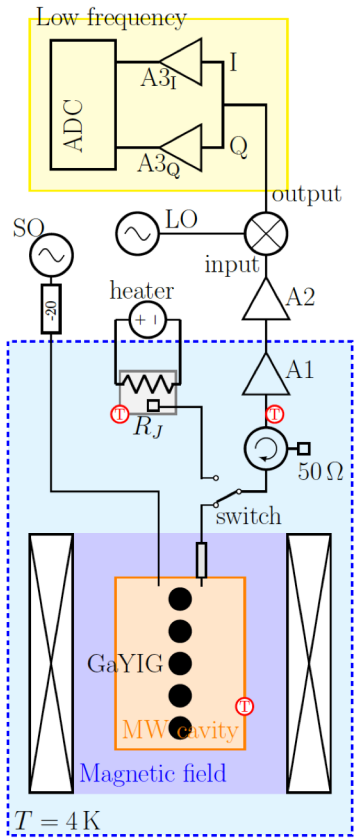
See Nicolò Crescini Talk



Eur. Phys. J. C (2018) 78:703



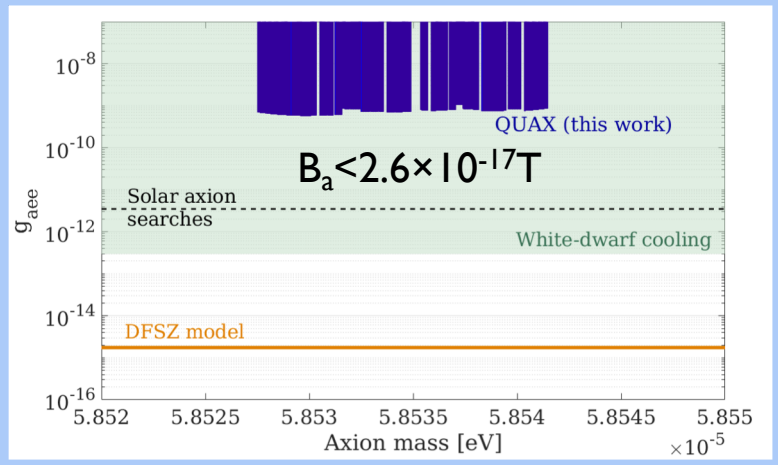
First Operation of a Ferromagnetic Axion Haloscope at m_a = 58μeV



QUAX demonstrator succesfully put in operation!

Experimental Setup	
B [T]	0.5
N. of GaYIG Sphere (diameter =1 mm)	5
n_s [spin/m^3]	2.1×10^{28}
τ_{min} [μs]	0.11
Frequency [GHz]	13.98
Cu-cavity Q (mode TM110)	50,000
T_{cavity} [K]	5.0

EPJC (2018) 78:703



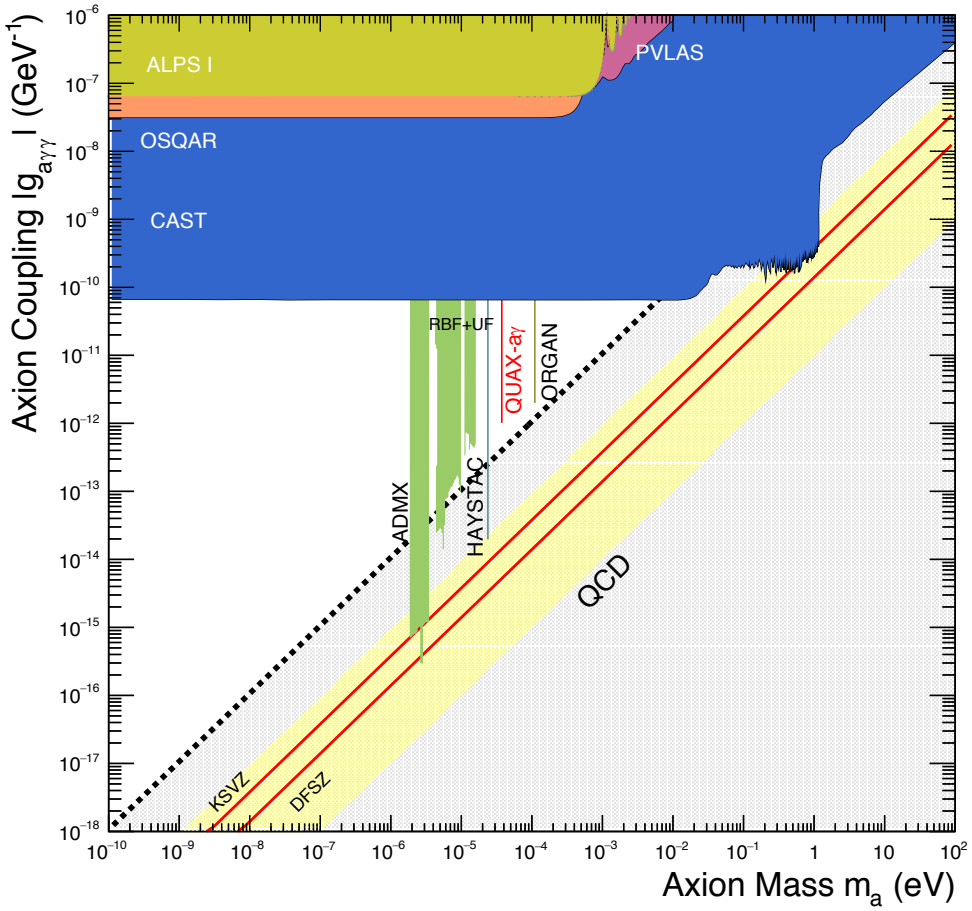
- Next improvements (sensitivity gain 10^2):
  1. Larger sample volume
  2. Longer relaxation time
  3. Ultra cryogenic temperature
  4. Quantum limited amplifier (JPA).

First QUAX-aγ Result with SC Resonant Cavity

$g_{a\gamma\gamma}$ 95% c.l. exclusion at m_a=37.5 μeV in 45 kHz band

$$g_{a\gamma\gamma} < 1.03 \times 10^{-12}\,\mathrm{GeV}^{-1}$$

Phys. Rev. D **99**, 101101(R) (2019)



Perspectives: Next Sensitivity Improvement Expected for QUAX-aγ

In preparation:

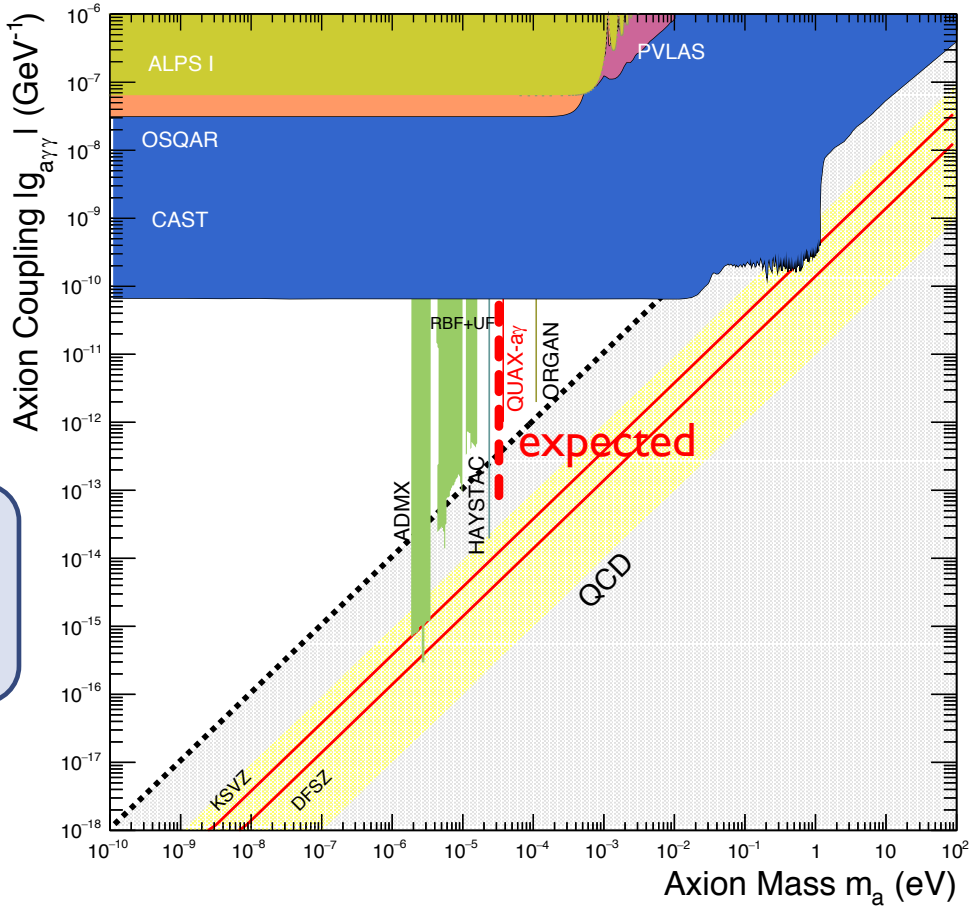
1. New Setup installed in a dilution refrigerator (100 mK, 100 μW): T=50 mK
2. Quantum Limited Amplifier (JPA) installed: T_{noise}=500 mK
3. Bought new 8 T Magnet: 5T
4. New 20cm-long NbTi Cavity in preparation.

Next year with this configuration we will reach the QCD axion band:

Expected $g_{a\gamma\gamma} < 4 \times 10^{-14}$ GeV $^{-1}$

In the following years scan O(100 MHz) band
(200 MHz JPA band)

Expect to reach KSVZ with dielectric resonant cavity and 8 T.
Plannnig to produce higher field magnet.



Contributo LNF

LNF impegnati soprattutto nello sviluppo del single photon device (SIMP e SUPERGALAX-H2020).
Nei prossimi anni contributo limitato a:

- Progettazione e costruzione cavità con zaffiri (simulazione e meccanica tuning)
- Presa dati e loro analisi
- Schermo magnetico JPA

Richiesta tecnici in linea con quanto chiesto negli anni passati. Contributo a progettazione meccanica criogenica sistema tuning cavità zaffiri (gia in corso anche quest'anno).
FTE da definire (minimo 0.4 coordinatore locale, e 1.6 per Sigla LNF, dipende da sviluppi R&D KLASH)