CAST and more than CAST;

A Dark Sector Probe for 20+ Years

Serkant Ali Çetin

On behalf of the CAST Collaboration

ISU ISTINYE UNIVERSITY ISTANBUL

1st General Meeting of COST Action COSMIC WISPers (CA21106)

5-8 Sep 2023 / Bari, ITALY

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 ...

proposal

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Nuclear Instruments and Methods in Physics Research A 425 (1999) 480–487

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A

A decommissioned LHC model magnet as an axion telescope

K. Zioutas[a], ... nski[d],
J.I. Collar[e] ... one[c],
C.K. Guérard ... Miley[d],
A. Morale ... dis[a],

CERN- SPSC-99-21

CERN 99-21
SPSC/P312
August 9, 1999

Sw 199948

Proposal to the SPSC

A solar axion search using a decommissioned LHC test magnet

The Solar Axion Telescopic ANtenna

http://cds.cern.ch/record/410414/files/SC00001091.pdf

C.E. Aalseth [1], D. Abriola [2], F.T. Avignone III [1], R.L. Brodzinski [3], J.I. Collar [4*], R. Creswick [1], D.E. Di Gregorio [2], H. Farach [1], A.O. Gattone [2], Y. Giomataris [5], S.N. Gninenko [6], N.A. Golubev [6], C.K. Guérard [2], F. Hasenbalg [2], M. Hasinoff [7], H. Huck [2], A.V. Kovzelev [6], A. Liolios [8], V.A. Matveev [6], H.S. Miley [3], A. Morales [9], J. Morales [9], D. Nikas [8], S. Nussinov [10], A. Ortiz [9], G. Polymeris [8], G. Raffelt [11], I. Savvidis [8], S. Scopel [9], I.N. Semeniouk [6], J.A. Villar [9], K. Zioutas [8,12#].

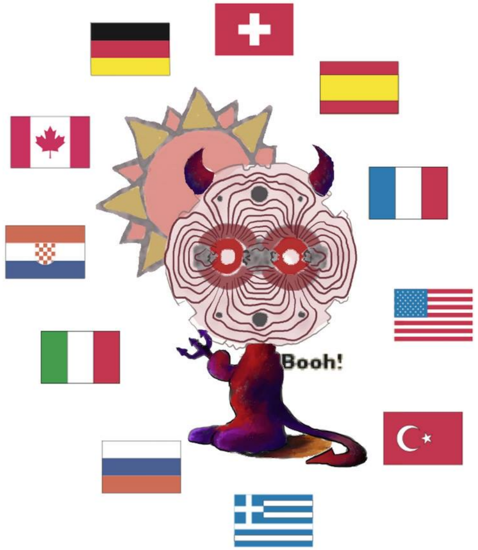
The name of the experiment in the initial proposal, i.e.

- **S**olar **A**xion **T**elescopic **AN**tenna -

was, for some reason, changed as

- **C**ERN **A**xion **S**olar **T**elescope -

... we saved the logo though :)



Solar Axion Flux

Provided by P. Serpico & G. Raffelt
Based on the standard model BP2004 (Bahcall et al., 2004)

Solar axions produced by photon-to-axion conversion of the solar plasma photons: the Primakoff Effect [1951]

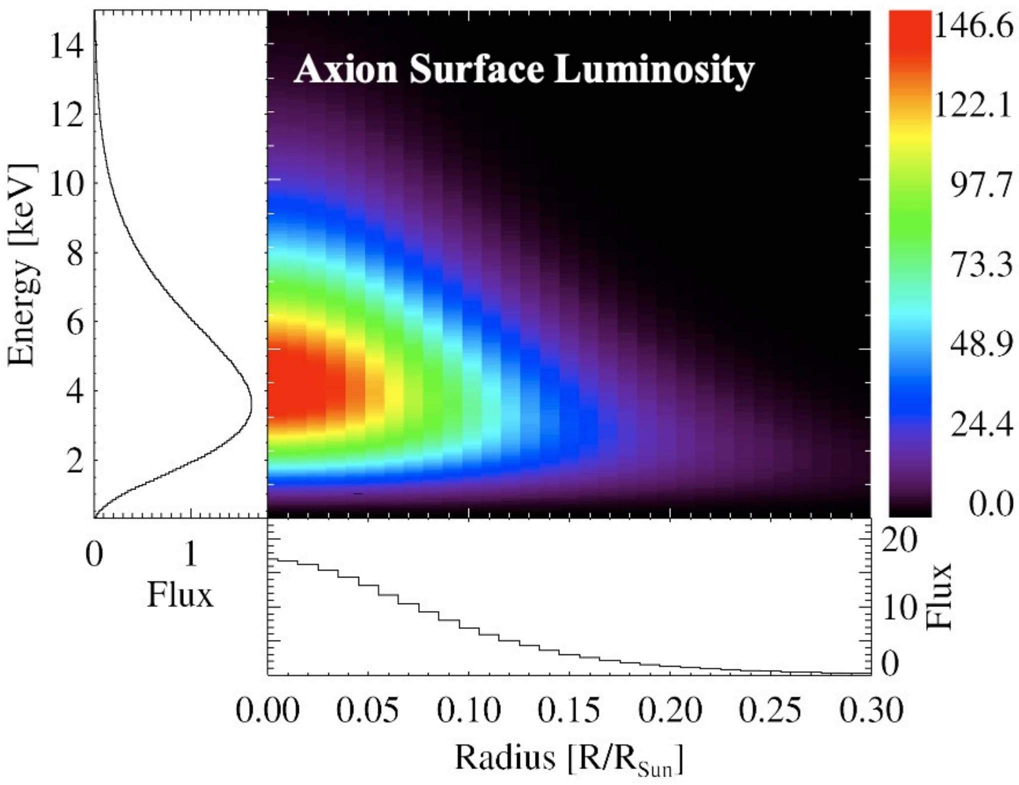
$$\frac{d\Phi}{dE_a} = \left(\frac{g_{a\gamma}}{10^{-10} GeV^{-1}} \right)^2 \frac{\Phi_0}{E_0} \frac{(E_a/E_0)^{2.481}}{e^{(E_a/1.205E_0)}}$$

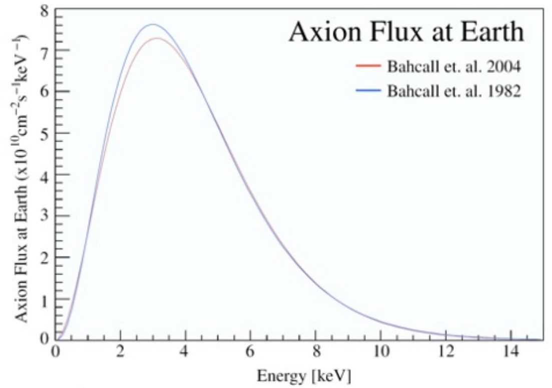
$$\Phi_0 = 6.020 \times 10^{10} cm^{-2} s^{-1}$$

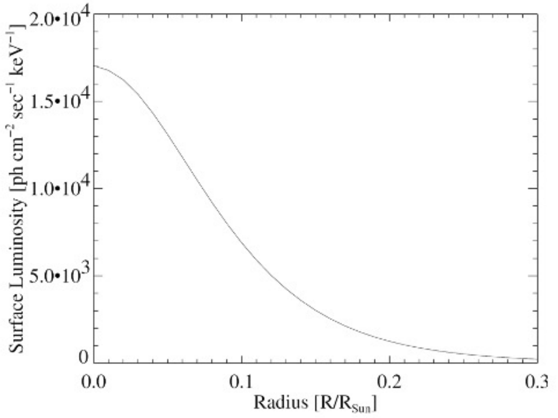
Mean energy = 4.2 keV

Axion Luminosity =1.9 x 10^{-3} L$_\odot$

Axion flux = 3.8x10^{11} cm^{-2} s^{-1}



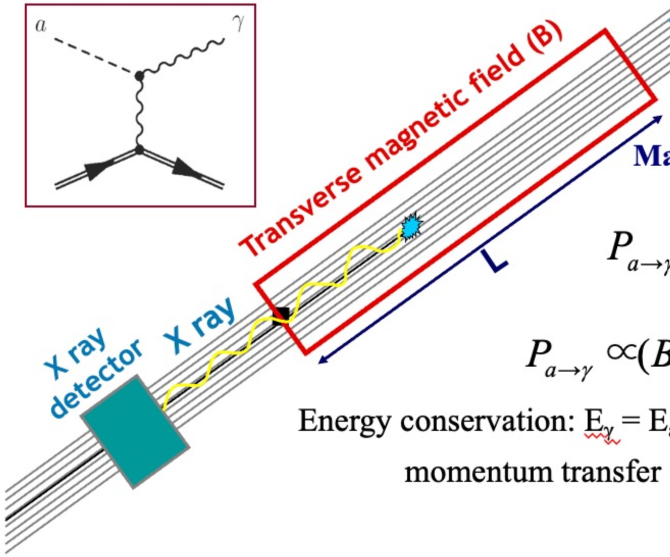




Principle of detection

[Sikivie PRL 51 (83)]

AXION PHOTON CONVERSION



$$P_{a\to\gamma} = \frac{g_{a\gamma}}{4}\left|\int B e^{iqz} dz\right|^2$$

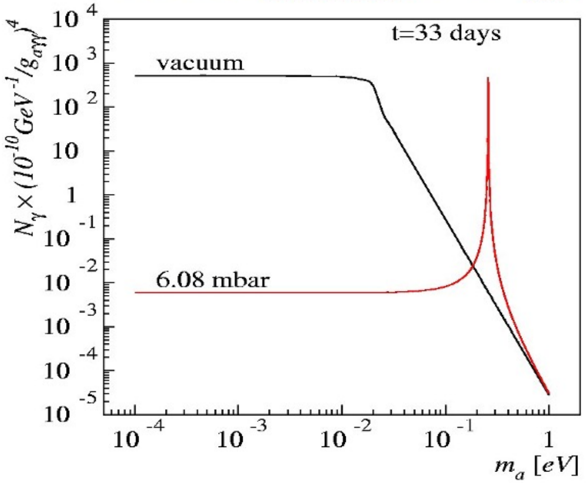
$$P_{a\to\gamma} \propto (BLg_{a\gamma})^2 \frac{\sin^2(qL/2)}{(qL)^2}$$

Energy conservation: $E_\gamma = E_a$

momentum transfer → $q = \frac{m_a^2}{2E_\gamma}$

For coherence: qL«1 (axion and photon field are in phase)

For CAST expriment $m_a < 10^{-2}$ eV



⇒ Every specific pressure of the gas allows the test of a specific axion mass.

$$m_\gamma = \sqrt{0.02\frac{P(mbar)}{T(K)}}$$

Signal: excess of X-rays over background when magnet points to the Sun

Phase II: Magnet pipes filled with buffer gas

Extending the coherence to higher axion masses …

Conversion Probability

$$P_{a\to\gamma} \propto (Bg_{a\gamma}/2)^2 \frac{1}{q^2+\Gamma^2/4}\left[1+e^{-\Gamma L} - 2e^{-\Gamma L/2}\cos(qL)\right]$$

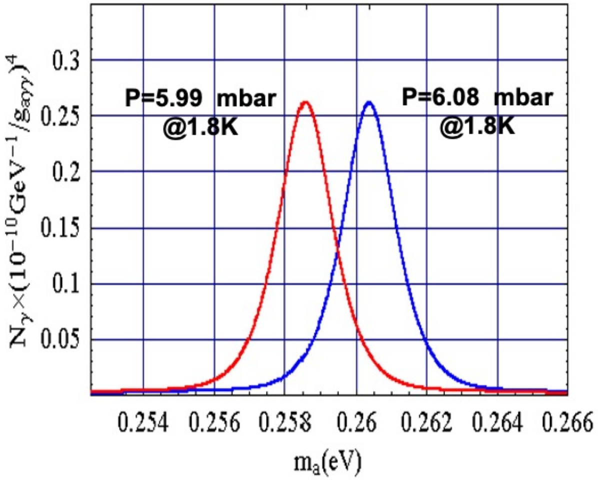
Momentum transfer is $q = \left|\frac{m_\gamma^2 - m_a^2}{2E_a}\right|$

Γ: absorption coefficient
N_e: number of e^-/cm^3
ρ: gas density (g/cm^3)

$$m_\gamma = \sqrt{\frac{4\pi\alpha N_e}{m_e}} = \sqrt{\frac{Z}{A}\rho}$$

Coherence condition (qL<<1) is recovered for a narrow mass range around m_γ

$$qL < \pi \quad \Rightarrow \quad \sqrt{m_\gamma^2 - \frac{2\pi E_a}{L}} < m_a < \sqrt{m_\gamma^2 + \frac{2\pi E_a}{L}}$$



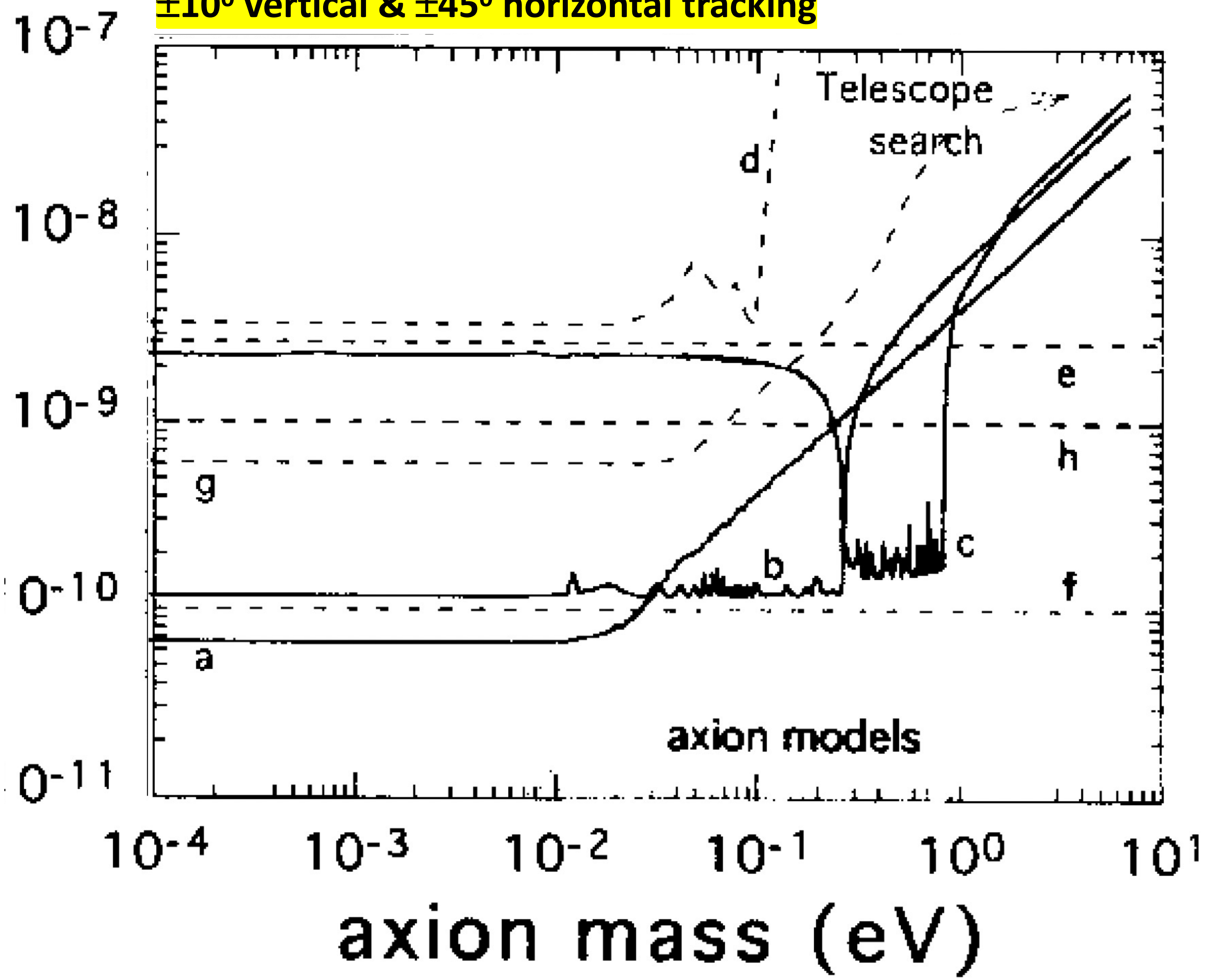
proposal

- Axion helioscope a la Sikivie.
- Recycled LHC dipole magnet; a straight twin aperture superconducting test magnet:
  - ✓ ~10 m long
  - ✓ running at ~1.8 K with ~12 kA
  - ✓ ~9 T field within the bores of 5 cm diameter
- Primakoff conversion of the axion to photon inside the cold bores of the magnet.
- Low background photon detectors.

The plot from the proposal shows 3σ limits for

a. 1 year run with vacuum in the pipe line
b. +1 year run with gas in the pipe line; 0 to 1 atm
c. +1 year run with gas in the pipe line; 1 to 10 atm

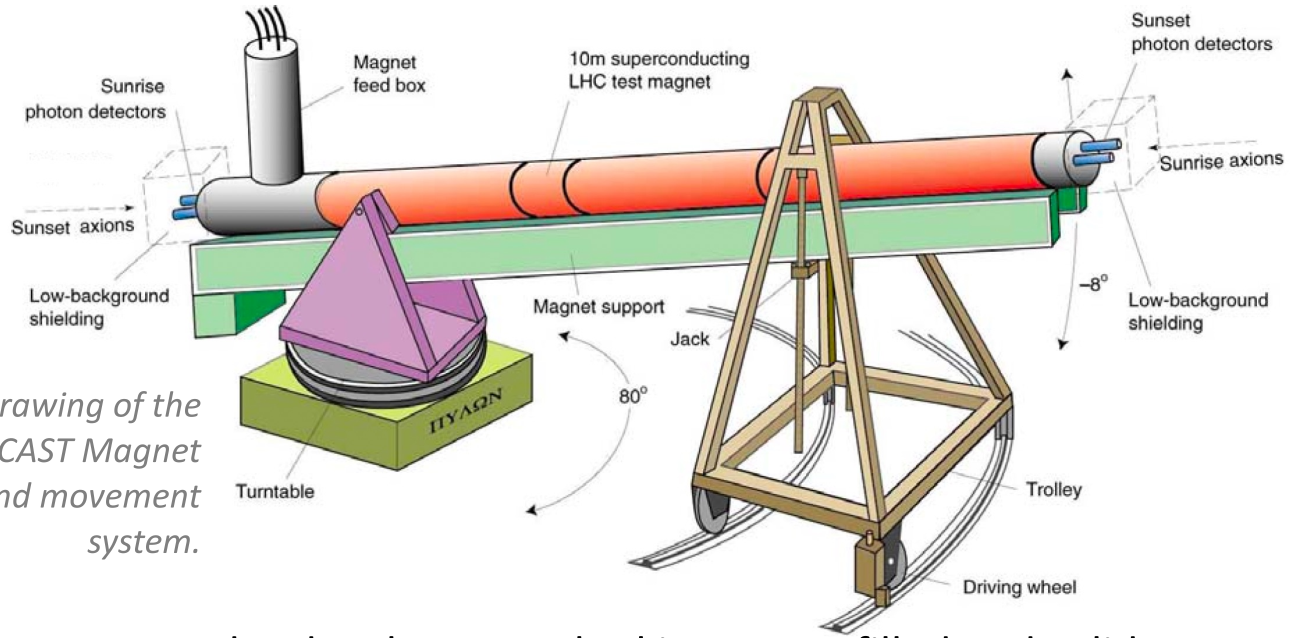
±10⁰ vertical & ±45⁰ horizontal tracking



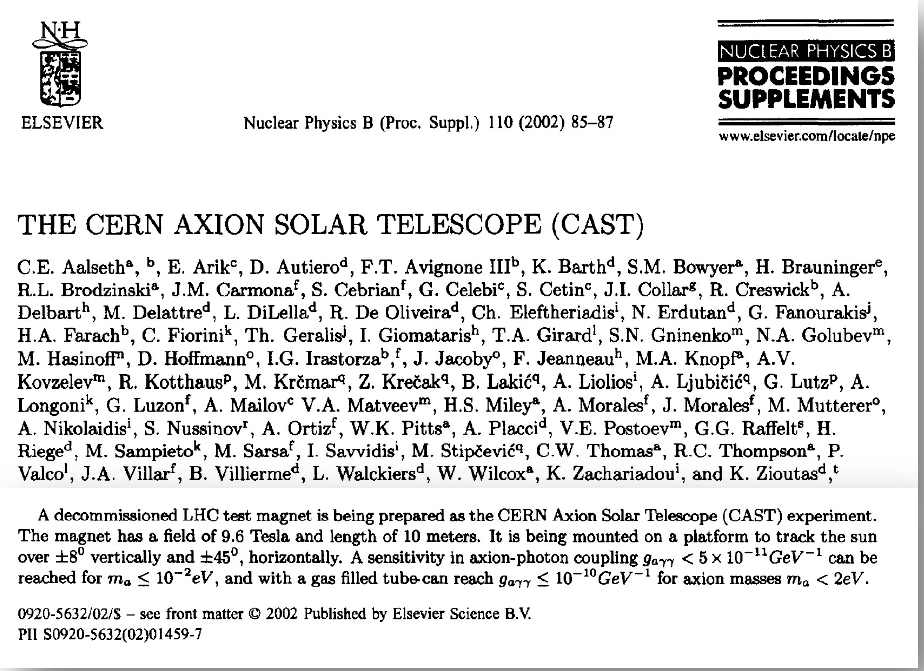
1999 | **2000** | **2001** | **2002** | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | ...

approval, construction & commissioning

CAST's LHC magnet to be mounted on a moving platform (±8⁰ vertical & ±40⁰ horizontal) with X-ray detectors on either end, to **observe the Sun ~3 hours per day** including sunrise and sunset.
Rest of the day devoted to background measurements and, through the Earth's motion, observations of a large portion of the sky.



Drawing of the CAST Magnet and movement system.



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Nuclear Physics B (Proc. Suppl.) 110 (2002) 85–87

NUCLEAR PHYSICS B PROCEEDINGS SUPPLEMENTS

www.elsevier.com/locate/npe

THE CERN AXION SOLAR TELESCOPE (CAST)

C.E. Aalseth[a, b], E. Arik[c], D. Autiero[d], F.T. Avignone III[b], K. Barth[d], S.M. Bowyer[a], H. Brauninger[e], R.L. Brodzinski[a], J.M. Carmona[f], S. Cebrian[f], G. Celebi[c], S. Cetin[c], J.I. Collar[g], R. Creswick[b], A. Delbart[h], M. Delattre[d], L. DiLella[d], R. De Oliveira[d], Ch. Eleftheriadis[i], N. Erdutan[d], G. Fanourakis[j], H.A. Farach[b], C. Fiorini[k], Th. Geralis[j], I. Giomataris[h], T.A. Girard[l], S.N. Gninenko[m], N.A. Golubev[m], M. Hasinoff[n], D. Hoffmann[o], I.G. Irastorza[b,f], J. Jacoby[o], F. Jeanneau[h], M.A. Knopf[a], A.V. Kovzelev[m], R. Kotthaus[p], M. Krčmar[q], Z. Krečak[q], B. Lakić[q], A. Liolios[i], A. Ljubičić[q], G. Lutz[p], A. Longoni[k], G. Luzon[f], A. Mailov[c] V.A. Matveev[m], H.S. Miley[a], A. Morales[f], J. Morales[f], M. Mutterer[o], A. Nikolaidis[i], S. Nussinov[r], A. Ortiz[f], W.K. Pitts[a], A. Placci[d], V.E. Postoev[m], G.G. Raffelt[s], H. Riege[d], M. Sampieto[k], M. Sarsa[f], I. Savvidis[i], M. Stipčević[q], C.W. Thomas[a], R.C. Thompson[a], P. Valco[l], J.A. Villar[f], B. Villierme[d], L. Walckiers[d], W. Wilcox[a], K. Zachariadou[i], and K. Zioutas[d,t]

A decommissioned LHC test magnet is being prepared as the CERN Axion Solar Telescope (CAST) experiment. The magnet has a field of 9.6 Tesla and length of 10 meters. It is being mounted on a platform to track the sun over $\pm 8^0$ vertically and $\pm 45^0$, horizontally. A sensitivity in axion-photon coupling $g_{a\gamma\gamma} < 5 \times 10^{-11} GeV^{-1}$ can be reached for $m_a \leq 10^{-2} eV$, and with a gas filled tube-can reach $g_{a\gamma\gamma} \leq 10^{-10} GeV^{-1}$ for axion masses $m_a < 2eV$.

0920-5632/02/$ – see front matter © 2002 Published by Elsevier Science B.V.
PII S0920-5632(02)01459-7

CAST's X-ray detectors under development, looking at gas-filled and solid state options.

The aperture of the LHC magnet's beam pipes is around five times the predicted solar axion source size, so its X-ray detectors must be correspondingly large, implying a high level of noise. To overcome this problem, using X-ray lenses to focus the converted X-rays emerging parallel from the 50 mm magnet aperture to a sub-millimeter spot was considered; this would bring a vast signal-to-noise improvement.

CAST was a new departure for CERN, relying not on the lab's expertise in accelerators but on its know-how in X-ray detection, magnets and cryogenics.

1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | ...

approval, construction & commissioning

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Nuclear Physics B (Proc. Suppl.) 114 (2003) 75–80

PROCEEDINGS SUPPLEMENTS

www.elsevier.com/locate/npe

The CERN Axion Solar Telescope (CAST): status and prospects

I. G. Irastorza[a*], S. Andriamonje[b], E. Arik[c], D. Autiero
R. Brodzinski[f], J. Carmona[g], S. Cebrian[g], S. Cetin[c] J. C
A. Delbart[b], L. Di Lella[a], C. Eleftheriadis[i], G. Fanoural
T. Geralis[j], I. Giomataris[b], S. Gninenko[l], N. Goloubev[l],
J. Jacoby[m], D. Kang[k], K. Konigsmann[k], R. Kotthaus[n],
A. Ljubicic[o], G. Lutz[n], G. Luzon[g], H. Miley[f], A. Morale
A. Ortiz[g], T. Papaevangelou[m], A. Placci[a], G. Raffelt[n], I
J. Villar[g], B. Vullierme[a], L. Walckiers[a], K. Zachariadou

[a] *European Organization for Nuclear Research (CERN), Gen*
[b] *DAPNIA, Centre d'Etudes de Saclay (CEA-Saclay), Gif-Su*
[c] *Department of Physics, Bogazici University, Istambul, Turk*
[d] *Department of Physics and Astronomy, University of South*
[e] *Max-Planck-Institut für Extraterrestrische Physik, Max-Pla*
[f] *Pacific Northwest National Laboratory, Richland, Wa, USA*
[g] *Instituto de Física Nuclear y Altas Energías, Facultad de C*
[h] *Enrico Fermi Institute, University of Chicago, Chicago, Il,*
[i] *Aristotle University of Thessaloníki, Thessaloníki, Greece*
[j] *National Center for Scientific Research "Demokritos" (NRC*
[k] *Albert-Ludwigs-Universität Freiburg, Freiburg, Germany*
[l] *Institute for Nuclear Research (INR), Russian Academy of S*
[m] *Institut für Kernphysik, Technische Universitat Darmstadt,*
[n] *Max-Planck-Institut für Physik, Munich, Germany*
[o] *Ruder Boskovic Institute, Zagreb, Croatia*

The CAST experiment is being mounted at CERN. It wi
to look for solar axions through its conversion into photons
of 9.6 Tesla and length of 10 m and is installed in a platforr
horizontally. According to these numbers we expect a sens
GeV^{-1} for $m_a \lesssim 0.02$ eV, and with a gas filled tube $g_{a\gamma\gamma} \lesssim 1$

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
Laboratory for Particle Physics

Departmental Report

CERN/AT 2004-1 (ECR)

COMMISSIONING AND FIRST OPERATION OF THE CRYOGENICS FOR THE CERN AXION SOLAR TELESCOPE (CAST)

K. Barth, D. Delikaris, G. Passardi, M. Pezzetti, O. Pirotte, L. Stewart, B. Vullierme, L. Walckiers, K. Zioutas

A new experiment, the CERN Axion Solar Telescope (CAST) was installed and commissioned in 2002. Its aim is to experimentally prove the existence of an as yet hypothetical particle predicted by theory as a solution of the strong CP problem and possible candidate for galactic dark matter. The heart of the detector consists of a decommissioned 10-m long LHC superconducting dipole prototype magnet, providing a magnetic field of up to 9.5 T. The whole telescope assembly is aligned with high precision to the core of the sun. If they exist, axions could be copiously produced in the core of the sun and converted into photons within the transverse magnetic field of the telescope. The converted low-energy solar axion spectrum, peaked around a mean energy of 4.4 keV, can then be focused by a special x-ray mirror system and detected by low-background photon detectors, installed on each end of the telescopes twin beam pipes. This paper describes the external and proximity cryogenic system and magnet commissioning as well as the first operational experience with the overall telescope assembly.

Accelerator Technology Department and Physics Department

Presented at the 2003 Cryogenic Engineering Conference and International Cryogenic Materials Conference
CEC/ICMC 2003
22-26 September 2003, Anchorage, Alaska

Administrative Secretariat
AT Division
CERN
CH - 1211 Geneva 23

Geneva, Switzerland
29 January 2004

CAST, being approved in 2000, worked hard to finish the installation phase.

The cryogenics of the magnet and the tracking system ready and two gas detectors (a TPC and a micromegas) installed at both ends of the magnet.

Some preliminary data taken, and the definitive data taking phase to start with the third detector and the X-ray focusing mirror system to be installed.

The main purpose of the experiment:

- original goal of a sensitivity to axion-photon coupling down to $g_{a\gamma\gamma} \lesssim 5.10^{-11}$ GeV^{-1} for $m_a \lesssim$ 0.02 eV.
- A second phase of acquisition with a gas filled tube to provide a mass to the photons will allow to extend a limit $g_{a\gamma\gamma} \lesssim 10^{-10}$ GeV^{-1} for axion masses up to $m_a \lesssim 1$ eV.

approval, construction & commissioning

Status Report CAST

A Solar Axion Search Using a D

1) MAGNET

The conceptual design is ready.

Installation : August-September 200

The power supply has been ordered

Delivery time : end of 2001 (?)

The pumping station

will be delivered by Darmstadt.

The US collaborators have found one

Helium buffer gas & small X-ray mirrors implementation:

EST-ME started the mechanical design.

Be - windows are under investigation.

Magnet assembly will start in July 2001 (LHC-CRI group).

Magnet commissioning will be done by the LHC division.

2) CRYOGENICS

The conceptual design is ready.

The Cold Box was dismantled and is under maintenance.

New gas bag housing & helium buffers are in preparation.

Dismantling of He-buffers and removal of LN_2 reservoir behind SUH8 is planned for end of May 2001.

The MFB is under revision.

External utilities (water, c

are in preparation.

Principal cryo process :

A detailed P&I diagram a

drawings are in preparati

3) MOVING PLATFORM

The conceptual design has been prepared at CERN.

The stability has been checked by the construction firm PYLON in Greece.

Conclusion : the suggested platform structure is stable and an additional load of ≥ 30% is allowed.

The construction

has been started and will be completed in June 2001.

approval, construction & commissioning

4) X-RAY DETECTORS

Preparation and tests in progress.

3 different options :

TPC, Micromegas and CCD.

The background level is $\sim 5\times$ - $10\times$ above the CAST nominal value of $\sim 2 \cdot 10^{-6}/s \cdot cm^2 \cdot keV$.

Improvements are expected with shielding, cosmic-veto and 2D readout.

TPC

The mechanical design & construction of the drift region is ready.

The 12 drift electrodes, in the region of the HV degrader, have been made of aluminised plexiglas.

FE calculation was performed for the mechanical strength of Plexiglas or Delrin frames under the load of the wires.

The 3 wire planes could be ready end of July 2001 (Cu-Be wire has arrived).

The readout electronics : The front-end electronics will be identical to that of the HARP TPC.

Work to be done is the design of the printed circuit boards which couple the front-end electronics to the wire planes (3 kV capacitors).

MICROMEGAS

A prototype has been tested at CERN and in Saclay.

The frame is made out of plexiglas (low radioactivity).
The anode plate is a 100 μm epoxy.
The anode Cu-strips have 317 μm pitch (printed at CERN).
Gassiplex chip is used for the readout.

The raw counting rate was $\sim$3 Hz (200 cm^2 $\times$ 6 cm).

Background rejection by a factor of $\sim$ 100 comes from event topology.
The remaining background level was
$\sim 10^{-5}/s \cdot cm^2 \cdot keV \cdot (0.8 - 10\ keV)$.

A 2D strip detector board is expected to further improve the rejection factor. Such a detector prototype has been built and will be tested soon.

The final detector version will have 2D-readout :

a) 6 cm$\times$6 cm, and

b) 1.5 cm$\times$1.5 cm
(Further background rejection with a pad readout).

c) Strip pitch will be equal to 350 μm.

CCD

An X-ray CCD camera & X-ray lens (used in XMM/Newton observatory) can provide the *sun's axion image*.

A camera including soft & hardware is available (MPI/HLL):

1/ Surface = 1$\times$3 cm^2.
Pixel size = 150$\times$150 μm^2.
Si-thickness = 300 μm.

2/ Q.E. $\approx$ 100 % (0.3 to 10 keV).

3/ Windowless operation in vacuum is possible.

4/ Very good energy resolution & threshold $\leq$ 0.5 keV.

5/ Background rejection from event topology & spectral analysis is possible.

First low background rates have been obtained.

Improvement is expected by using new CCD chips and low radioactive components.

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 ...

approval, construction & commissioning

5) TELESCOPE - SUN ALIGNMENT

The solar tracking is being followed in collaboration with the EST division.

Magnet orientation with 0.001^o precision is possible.

The prediction of the solar centroid can be $\leq$ 5% of the CAST solid angle.

An engineering design for platform motor control has been completed.

A LabVIEW-based code is under development.

Tests using model motors have started.

6) EXPERIMENTAL HALL

The layout is almost final.

The preparation of the experimental hall, including the necessary infrastructure, has started.

The use of the X-ray lens requires more space.

The available space for detector shielding is marginal.

Some 50 cm can be gained by shortening the magnet & scraping the walls.

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 ...

approval, construction & commissioning

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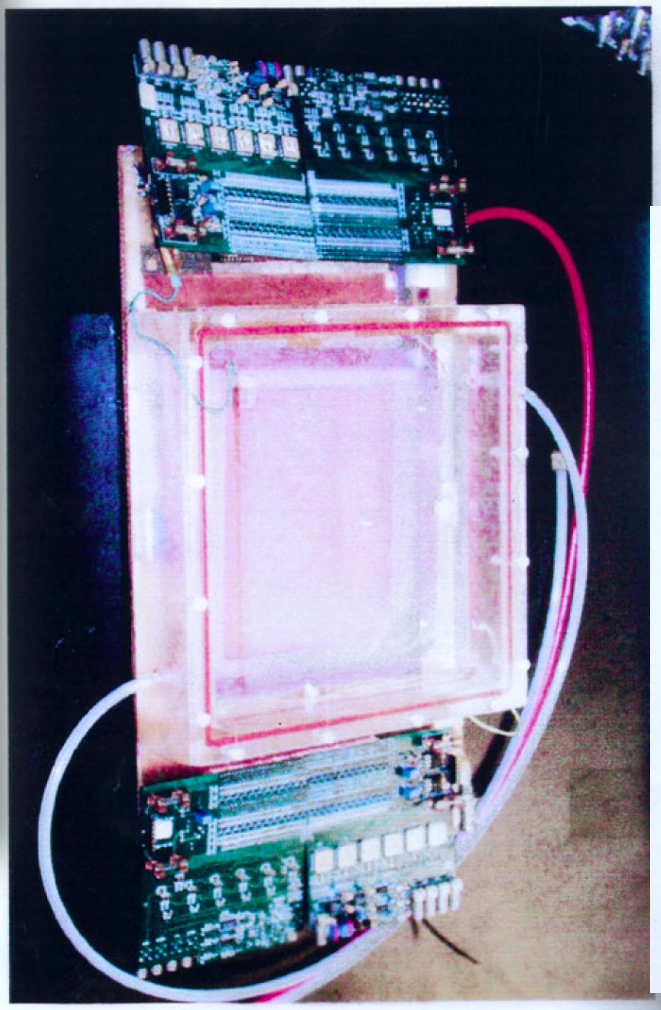


Micromegas

Time schedule :

a) The mechanical design using low-radioactive materials is ready. The frame construction and the design of the 2D PCB have been started.

b) The production of the final frames and PCBs is expected at the beginning of June 2001.

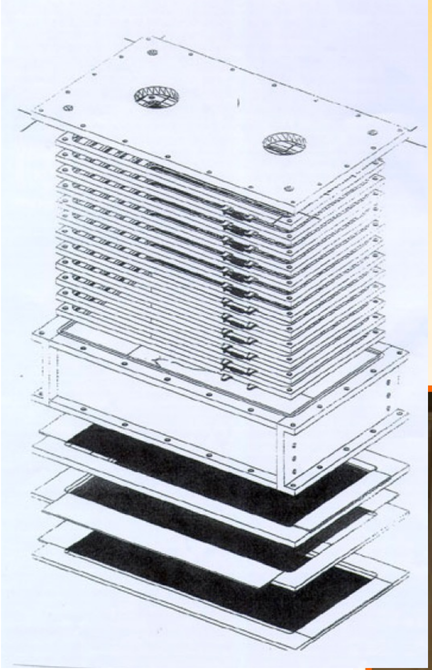
c) The first detector should be ready at the end of June.

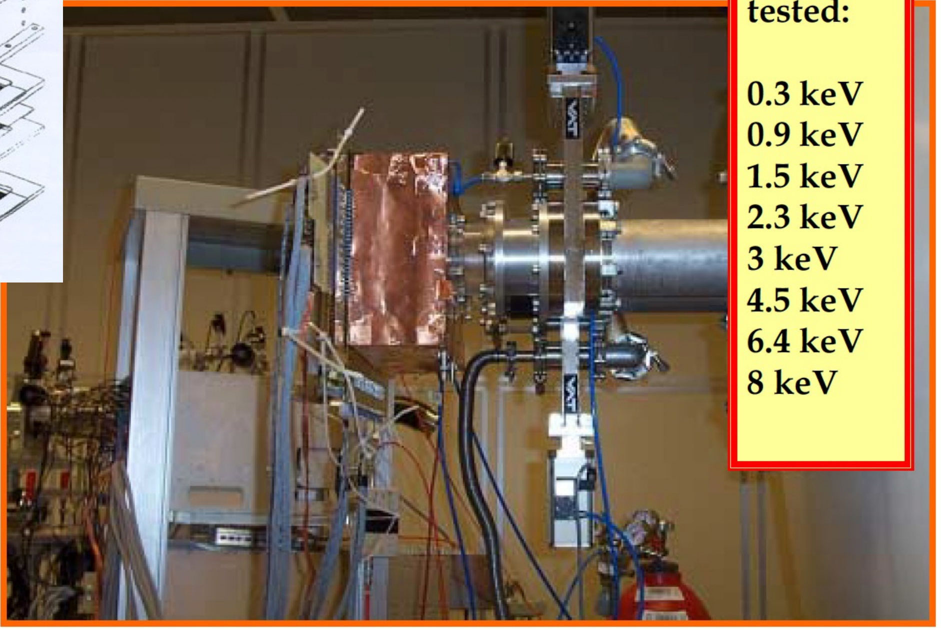
d) The first detector could be tested at CERN in July.

e) The construction of the detectors should be completed in september 2001.

Program of measurements at PANTER

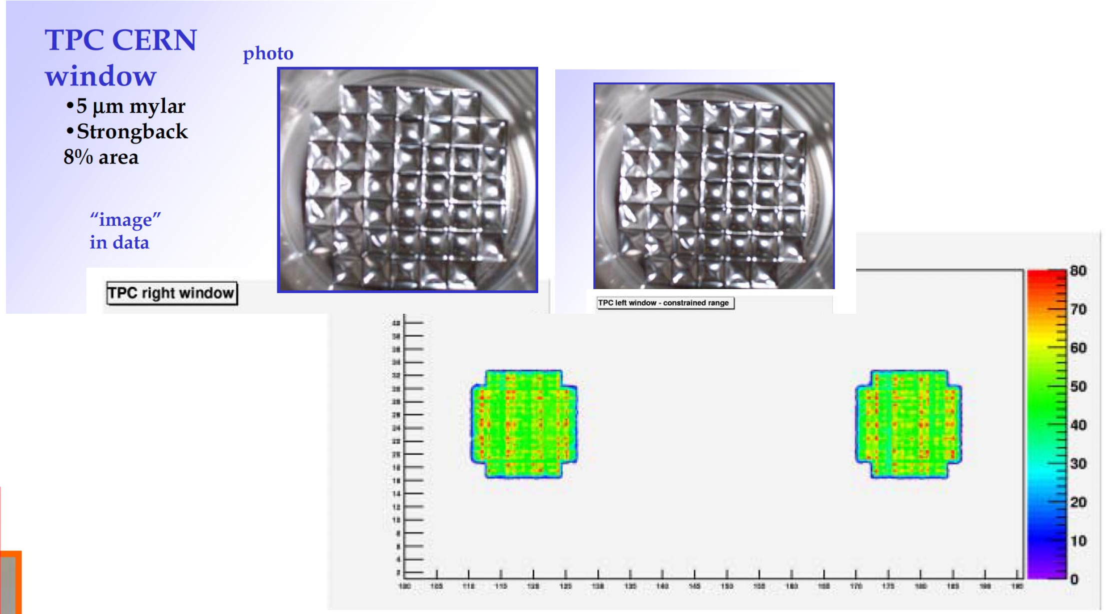
- Set of runs at fixed intensity and different energies
- 2nd set of runs at different energies
- Set of runs at fixed energy (4.5 keV) and varying intensity
- Very low energy run (0.3 keV) lowering software threshold at maximum
- Long 4.5 keV run
- Background run





Energies tested:

0.3 keV
0.9 keV
1.5 keV
2.3 keV
3 keV
4.5 keV
6.4 keV
8 keV



- The full efficiency of the TPC + CERN window is determined and compatible with expectations
- The chamber is sensitive to energies down to 0.3 keV
- The gain linearity has been proved down to the threshold

TPC was fully installed on the magnet and first data taken on Sept. 19, 2002.

1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | ...

approval, construction & commissioning

8) X-RAY FOCUSING

X-ray mirrors can focus the signal γ's from the 5 cm magnet aperture to a $\sim$ 1 mm spot.

A spare ABRIXAS module is being tested (MPE/Munich).

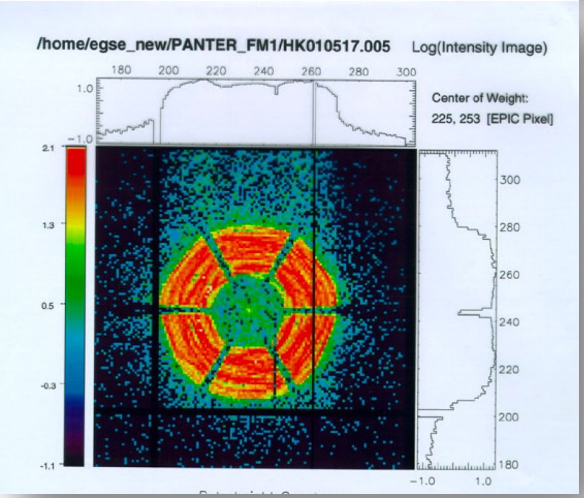
First tests confirm : *The mirrors are in best shape.*

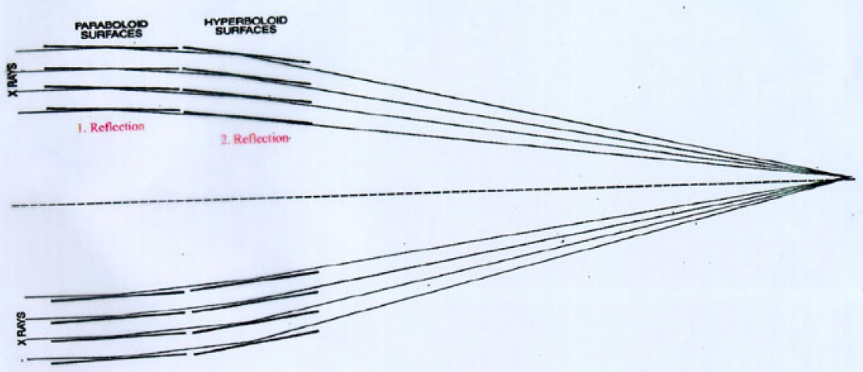
Miniature "lenses" can be incorporated to the other magnet apertures : delivery time 1-$1\frac{1}{2}$ years.

X-ray focusing : 50mm ϕ → 2 mm ϕ
50% focusing efficiency

$\frac{\text{SIGNAL}}{\text{NOISE}} \approx 250$ (± 20%)

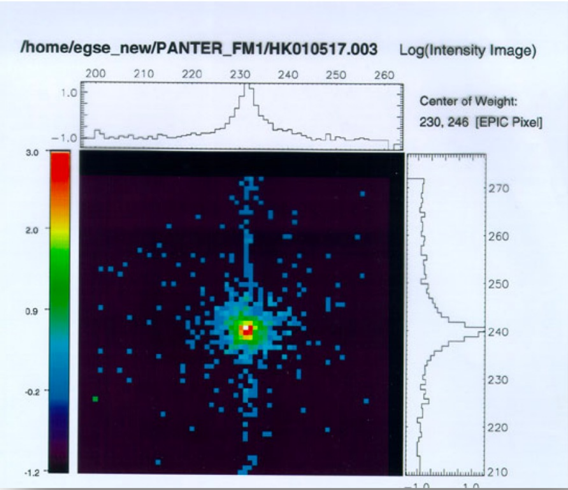
$\frac{\text{SIGNAL}}{\sqrt{\text{NOISE}}} \approx 10$ (± 20%)





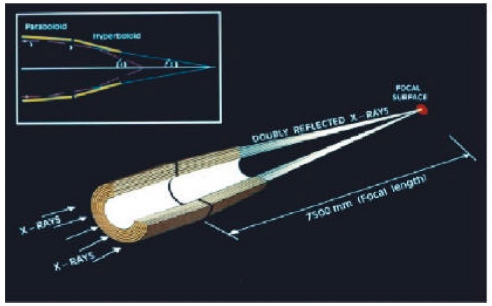
R. Giacconi
Sci. Amer. 242 (#2)(1980)70

CAST: 50 mm∅ → 0.3 mm ∅
LHC magnet aperture
focus at 1.7m FWHM



approval, construction & commissioning

Wolter telescope
With x-ray CCD



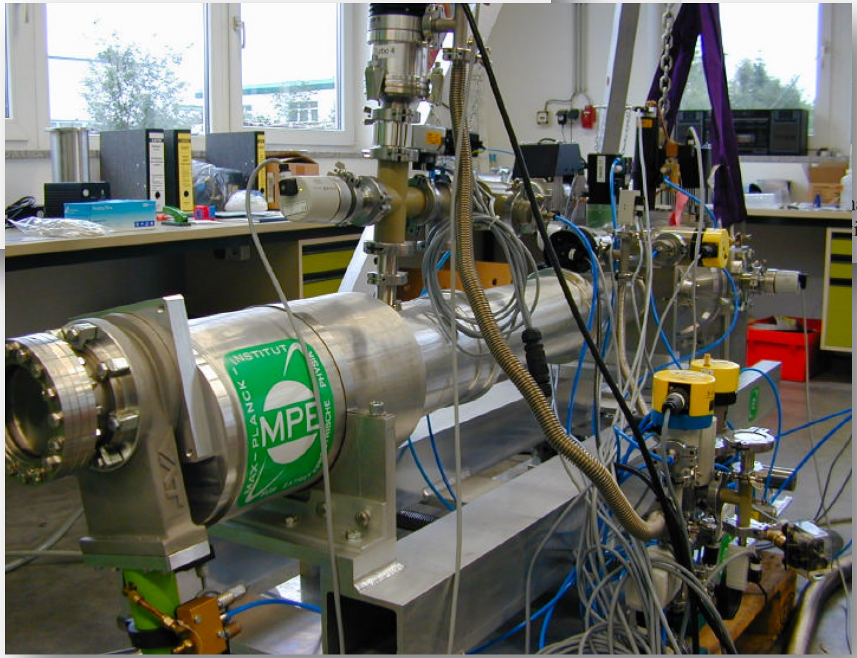
Mirror telescope

- **Reused from ABRIXAS**
- **Fully tested**

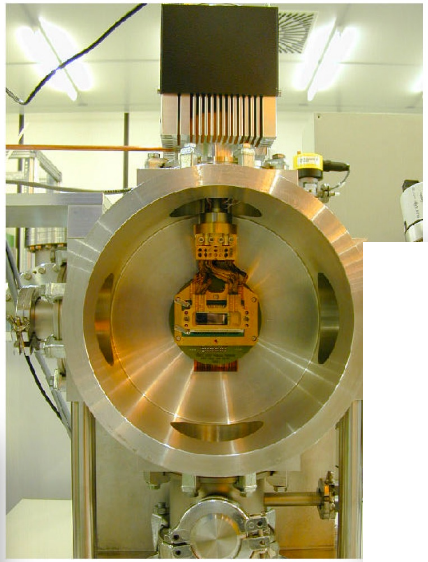
CCD camera

- **Copy of existing system**
- **Finished assembly**
- **Functionality tested**

G.Lutz for R.Hartmann, M.Kuster
23.9.2002 Halkidiki



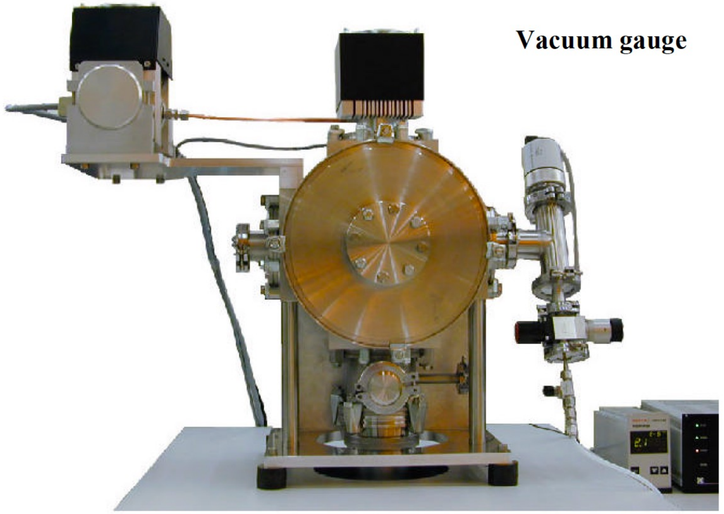
X-ray camera: view from radiation entrance



ann, M.Kuster

Stirling cooler

Vacuum gauge



G.Lutz for R.Hartmann, M.Kuster
23.9.2002 Halkidiki

Concluding remarks from the 16th Collaboration Meeting of CAST on May 30th, 2003:

CAST has started data taking with the TPC and the MM on May 1st, 2003.

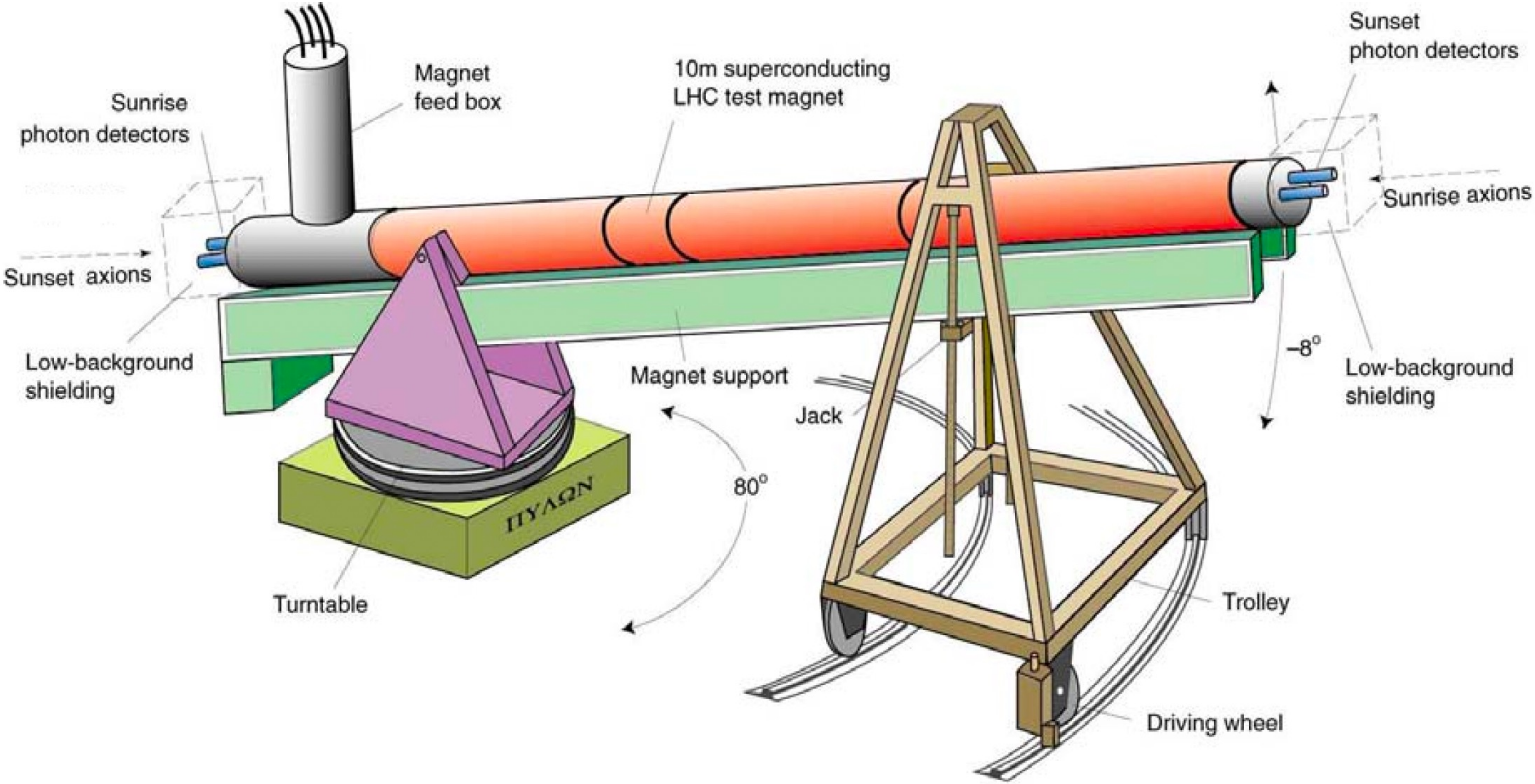
The first 2 runs with all 3 detectors working (including the X-ray telescope & the CCD) having all valves open were performed in the last 3 days (May 28-30).

To keep in mind:

The operation of the CAST experiment is performed in several phases with different conditions of the magnet pipes and different detector configurations.

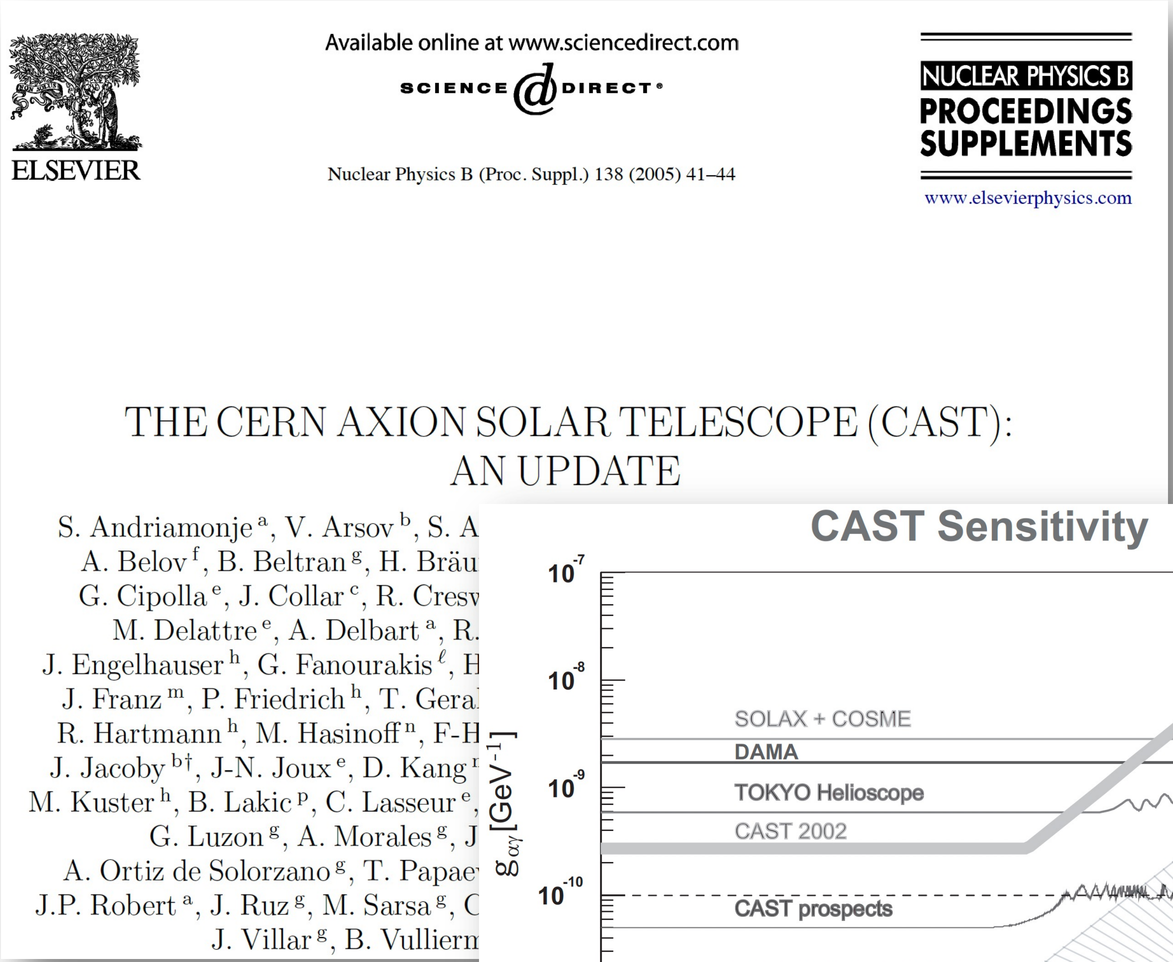
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 ...

Start of data taking



Start of data taking

Phase I (vacuum running)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Nuclear Physics B (Proc. Suppl.) 138 (2005) 41–44

NUCLEAR PHYSICS B PROCEEDINGS SUPPLEMENTS

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THE CERN AXION SOLAR TELESCOPE (CAST): AN UPDATE

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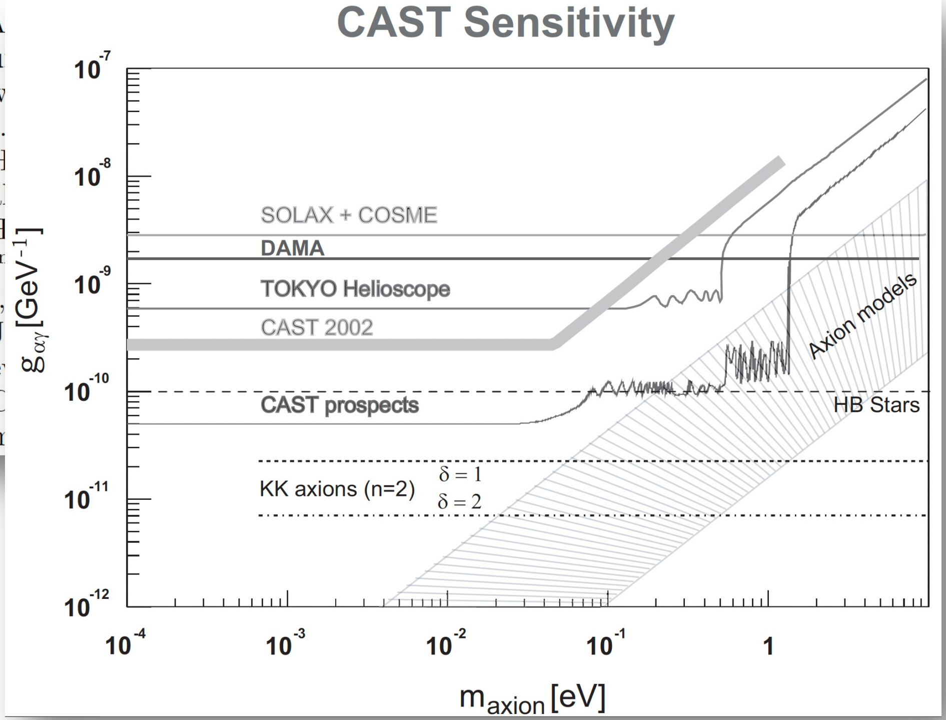
G. Cipolla[e], J. Collar[c], R. Cresw
M. Delattre[e], A. Delbart[a], R.
J. Engelhauser[h], G. Fanourakis[ℓ], H
J. Franz[m], P. Friedrich[h], T. Geral
R. Hartmann[h], M. Hasinoff[n], F-H
J. Jacoby[b†], J-N. Joux[e], D. Kang[r]
M. Kuster[h], B. Lakic[p], C. Lasseur[e],
G. Luzon[g], A. Morales[g], J
A. Ortiz de Solorzano[g], T. Papae
J.P. Robert[a], J. Ruz[g], M. Sarsa[g], C
J. Villar[g], B. Vullierm



CAST, a ~10 meters long LHC, ~9 Tesla, test magnet is mounted on a moving platform that tracks the sun about 1.5 hours during sunrise,and 1.5 hours during during sunset. It moves ±8^0 vertically & ±40^0 horizontaly.

Continuous data taking since July 10th, 2003 with the following detectors:

- TPC (sunset)
- Micromegas (sunrise)
- CCD camera via x-ray mirror telescope (sunrise)

The figure shows expected sensitivity of CAST. The loss of sensitivity with increasing m_a is simply due to the loss of coherence. Data analyzed thus far yield an upper bound on the photon-axion coupling constant, $g_{a\gamma\gamma} \leq 3 \times 10^{-10}$ GeV^{-1} for axion masses less than 5×10^{-2} eV.

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 ...

Phase I (vacuum running)

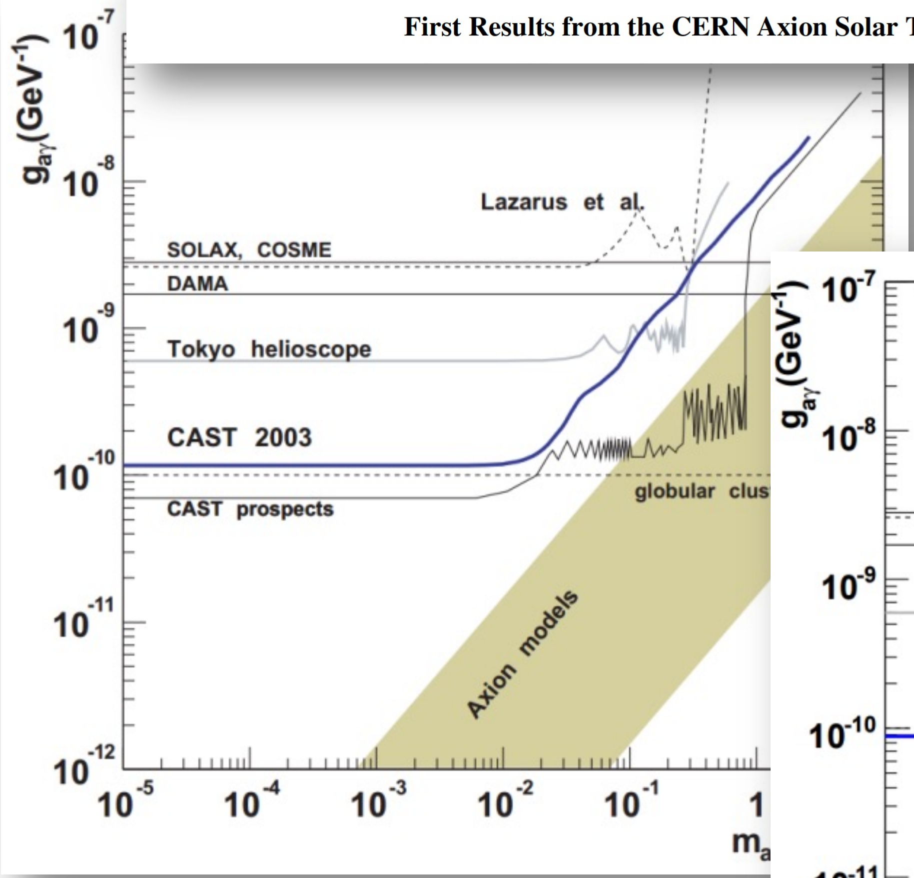
During 2003 and 2004 the experiment operated with vacuum inside the magnet bores (**Phase I**), thus exploring the axion mass range **up to 0.02 eV**.

Detectors:
On the sunset side a Time Projection Chamber (**TPC**) covering both bores. On the sunrise side one **Micromegas** and one pn-Charge Coupled Device (**CCD**) chip coupled to an X-Ray Telescope (**XRT**).

With the absence of signal over background, an upper limit on the axion-photon coupling constant of $g_{a\gamma\gamma} < 8.8 \times 10^{-11}$ **GeV^{-1}** at 95% C.L. was set. This result superseeds the astrophysical limit derived (at that time) from energy-loss arguments on horizontal branch stars.

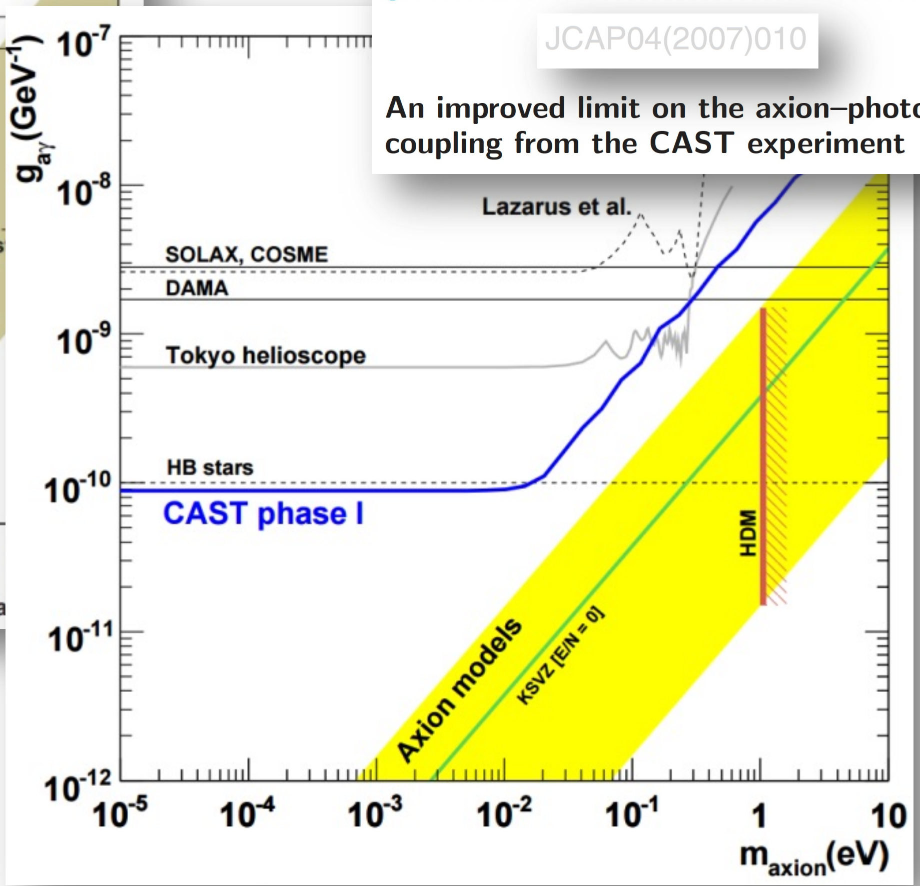
PRL 94, 121301 (2005) PHYSICAL REVIEW LETTERS week ending 1 APRIL 2005

First Results from the CERN Axion Solar Telescope



Journal of Cosmology and Astroparticle Physics
An IOP and SISSA journal
JCAP04(2007)010

An improved limit on the axion–photon coupling from the CAST experiment



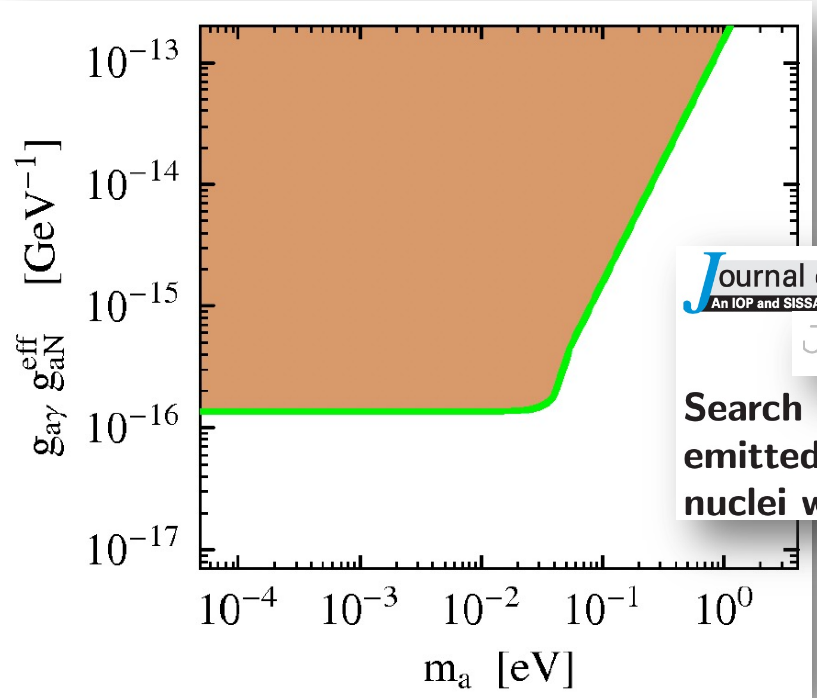
Other results from Phase I data

We searched for 14.4 keV solar axions or more general axion-like particles (ALPs), that may be emitted in the M1 nuclear transition of ^{57}Fe.

The signal we searched for, i.e., an excess of 14.4 keV X-rays when the magnet was pointing to the Sun was not found and we set model-independent constraints on the coupling constants of pseudoscalar particles that couple to two photons and to a nucleon at 95% CL: $g_{a\gamma}g_{aN} < 1.36 \times 10^{-16}$ GeV^{-1} for $m_a < 0.03$ eV.

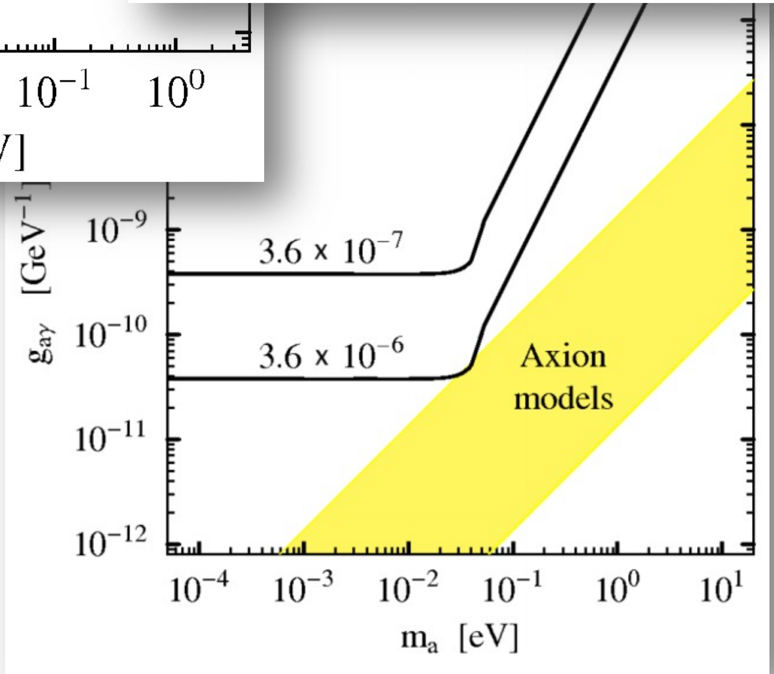
We explored the low mass region up to 0.03 eV, as a contrast to other experiments sensitive on these couplings that put some constraints in the ~ 10^2–10^6 eV axion mass range.

The axion-nucleon couplings can vary from 3.6 x 10^{-6} to 3.6 x 10^{-7} reflecting constraints due to the ^{57}Fe solar axion luminosity and detection sensitivity, respectively.



Journal of Cosmology and Astroparticle Physics
An IOP and SISSA journal
JCAP12(2009)002

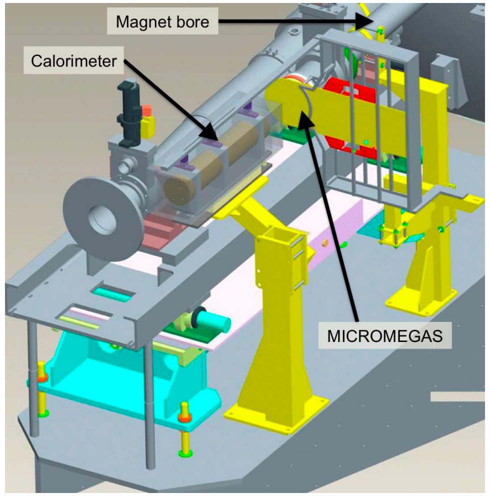
Search for 14.4 keV solar axions emitted in the M1-transition of ^{57}Fe nuclei with CAST



Other results from Phase I data

Another search was for a high-energy axion emission signal from ^{7}Li (0.478 MeV) and D(p,γ) ^{3}He (5.5 MeV) nuclear transitions.

To detect photons coming from conversion of these axions in the CAST magnet, we used a low-background high-energy photon calorimeter that was mounted on one end of the magnet during Phase I (6 months run in 2004).

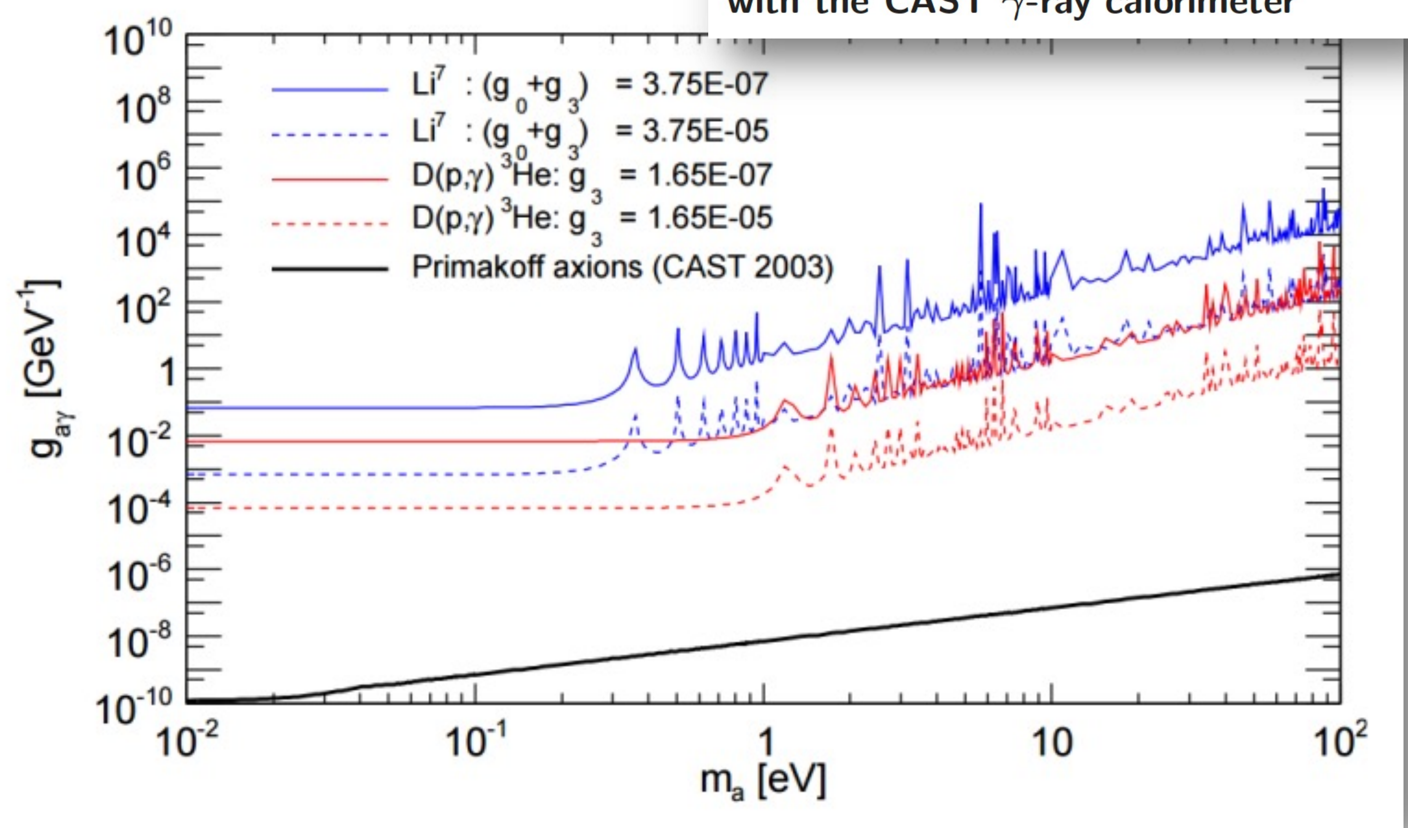


This was the first such search for high-energy pseudoscalar bosons with couplings to nucleons conducted using a helioscope approach.

No excess signal above background was found.

Journal of Cosmology and Astroparticle Physics
An IOP and SISSA journal
JCAP03(2010)032

Search for solar axion emission from ^{7}Li and D$(p,\gamma)^3$He nuclear decays with the CAST γ-ray calorimeter



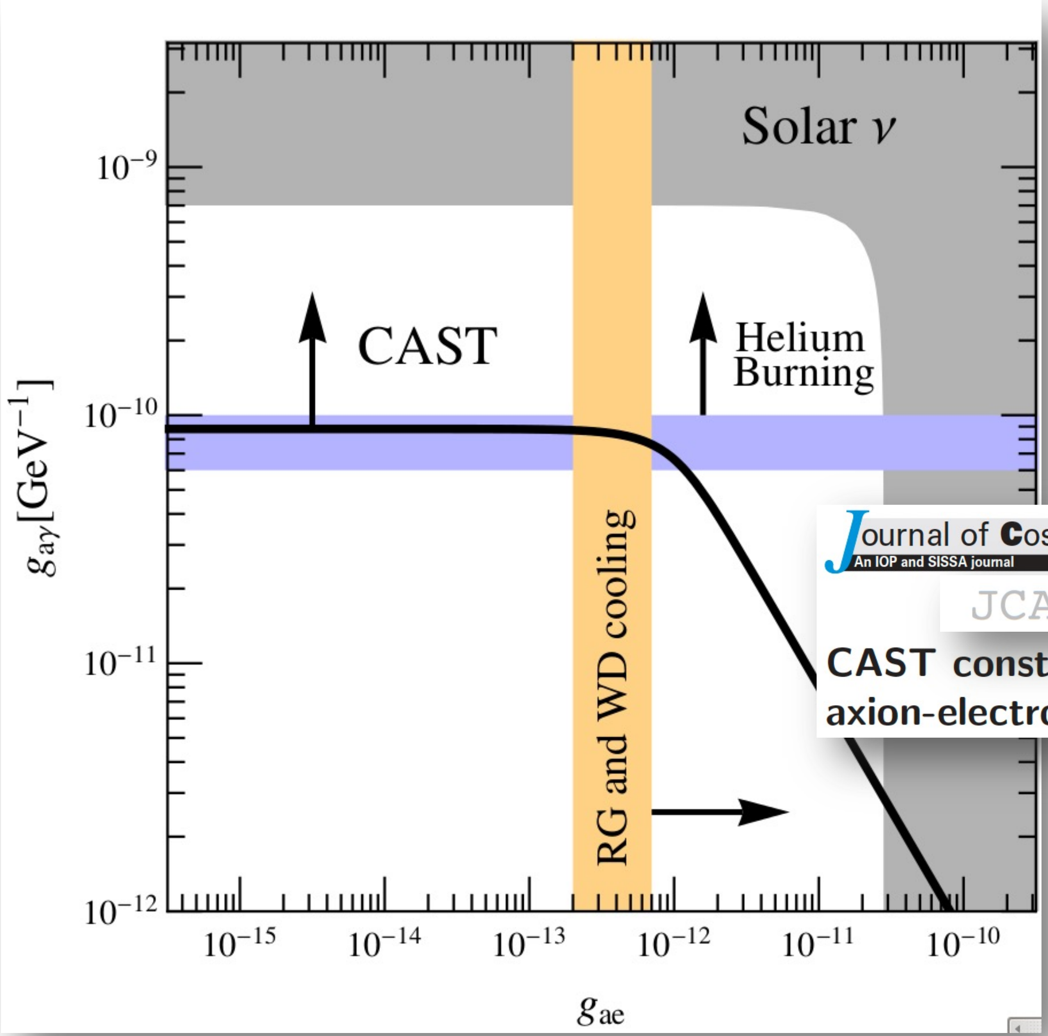
1999 > 2000 > 2001 > 2002 > 2003 > 2004 > 2005 > 2006 > 2007 > 2008 > 2009 > 2010 > 2011 > 2012 > 2013 > 2014 > 2015 > 2016 > 2017 > 2018 > 2019 > 2020 > 2021 > 2022 > 2023 > ...

Phase I (vacuum running)

Other results from Phase I data

In non-hadronic axion models, which have a tree-level axion-electron interaction, the Sun produces a strong axion flux by bremsstrahlung, Compton scattering, and axio-recombination, the "BCA processes." Based on a new calculation of this flux, including for the first time axio-recombination, **we derived limits on the axion-electron Yukawa coupling g_{ae} and axion-photon interaction strength $g_{a\gamma}$** using Phase-I data.

The sensitivity of CAST to non-hadronic axions allowed us to set a bound on the product of both coupling constants for $m_a \leq 10$ meV as $g_{a\gamma}\, g_{ae} < 8.1 \times 10^{-23}$ GeV^{-1} at 95% CL.



Journal of Cosmology and Astroparticle Physics
An IOP and SISSA journal

JCAP05(2013)010

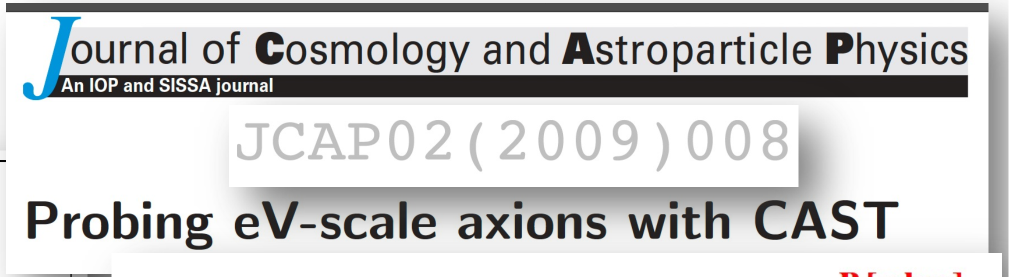
CAST constraints on the axion-electron coupling

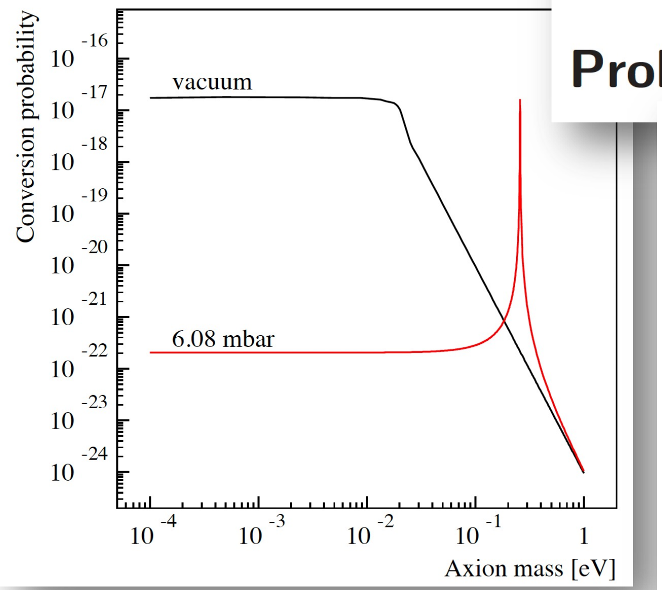
In order to extend CAST sensitivity to higher axion masses, magnet bores were filled with a gas. From 2005 to 2007 the magnet bores were filled with ^{4}He (**Phase II** with **^{4}He**).

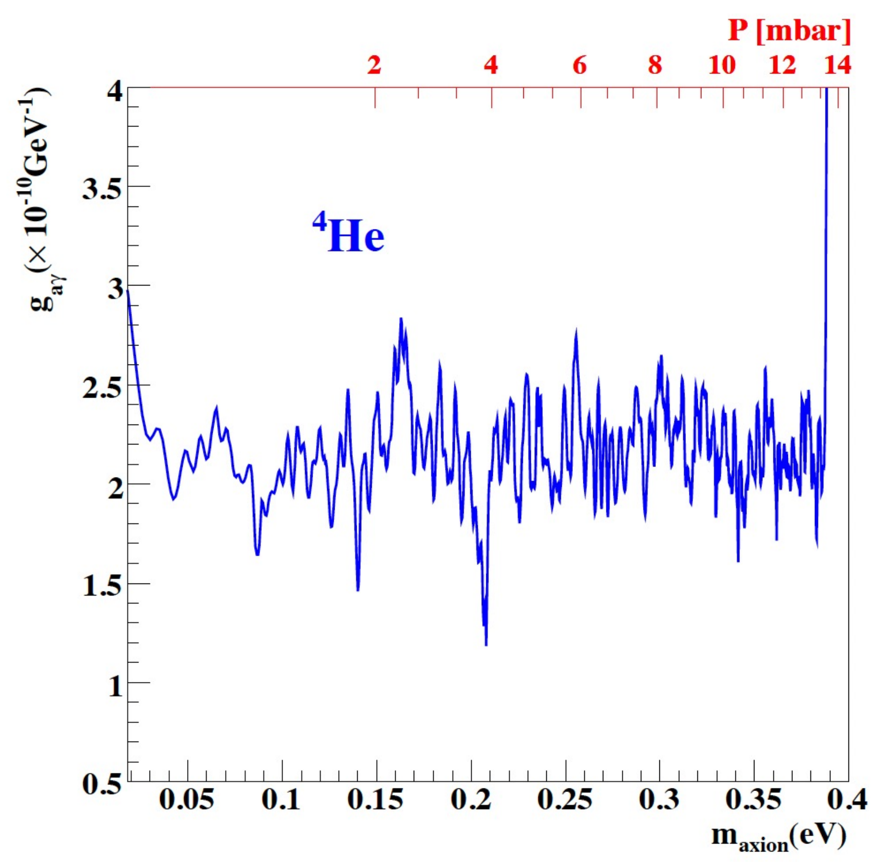
Detectors:
Same configuration as in Phase I, but having improvements on electronic noise of **TPC**, upgrades of vacuum system for **XRT+CCD** and new **Micromegas** with reduced detector background.

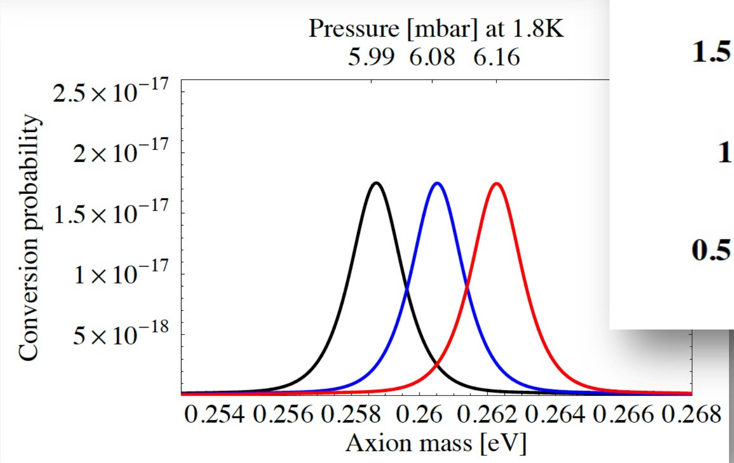
With 160 different pressure settings, the range of axion masses up to 0.39 eV was scanned. New upper limits on the axion-photon coupling constant were achieved.

The measurement time at each pressure setting was only a few hours, resulting in large statistical fluctuations of the exclusion limit.


Journal of Cosmology and Astroparticle Physics
An IOP and SISSA journal
JCAP02(2009)008
Probing eV-scale axions with CAST







Phase II (^{4}He running)

In order to extend CAST sensitivity to higher axion masses, magnet bores were filled with a gas. From 2005 to 2007 the magnet bores were filled with ^{4}He (**Phase II** with **^{4}He**).

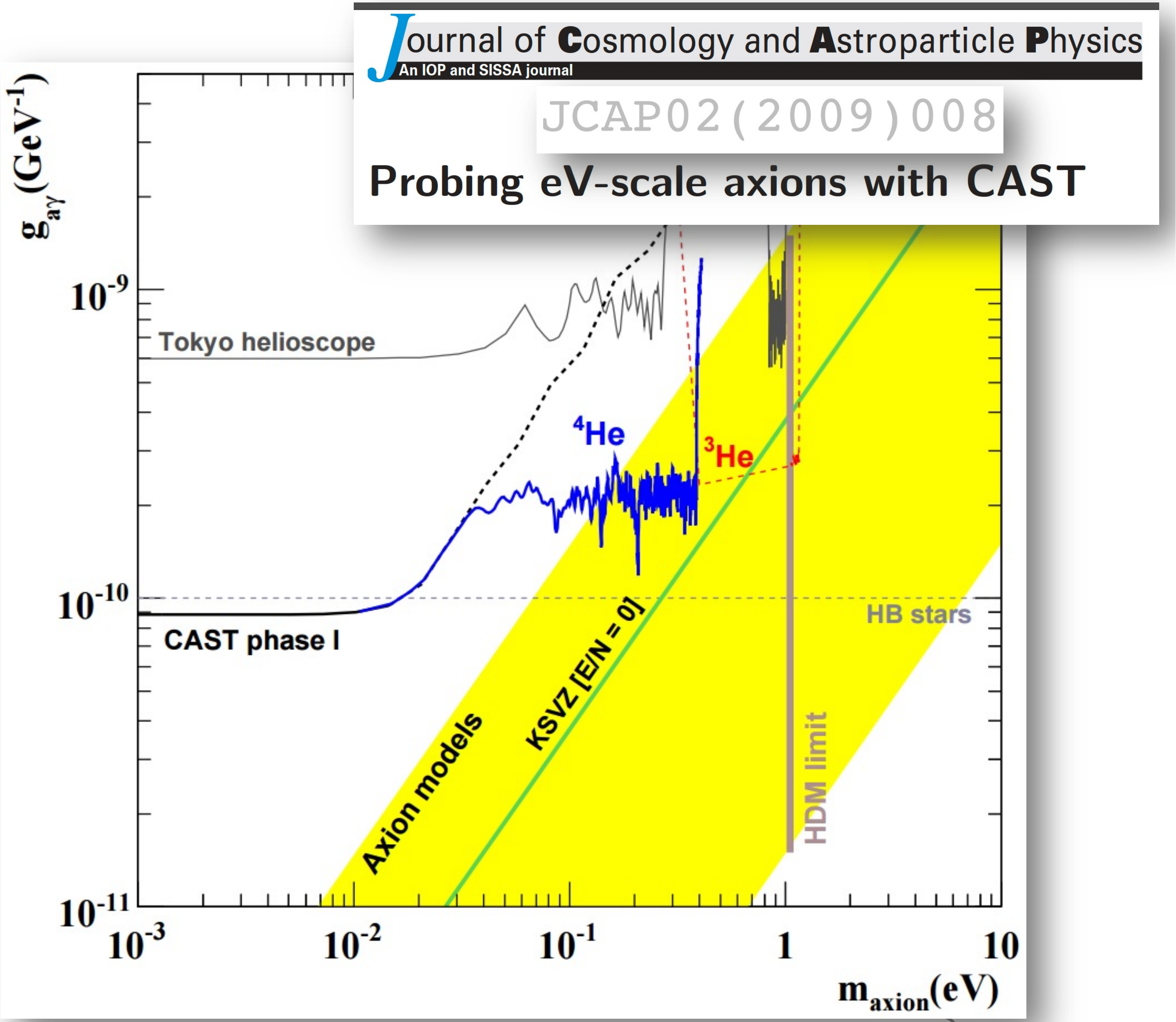
Detectors:

Same configuration as in Phase I, but having improvements on electronic noise of **TPC**, upgrades of vacuum system for **XRT+CCD** and new **Micromegas** with reduced detector background.

With 160 different pressure settings, the range of axion masses up to 0.39 eV was scanned. New upper limits on the axion-photon coupling constant were achieved.

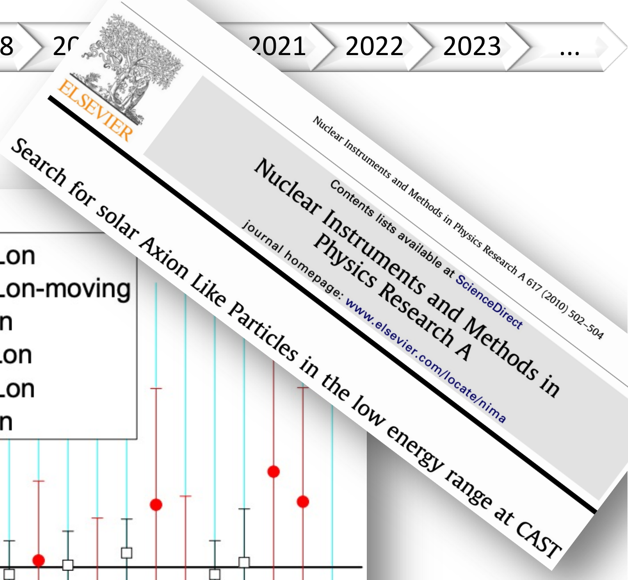
The measurement time at each pressure setting was only a few hours, resulting in large statistical fluctuations of the exclusion limit.

For the first time, the limit entered the QCD axion model band in the eV range.



1999 2000 2001 2002 2003 2004 2005 2006 **2007** **2008** 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 20… 2021 2022 2023 …

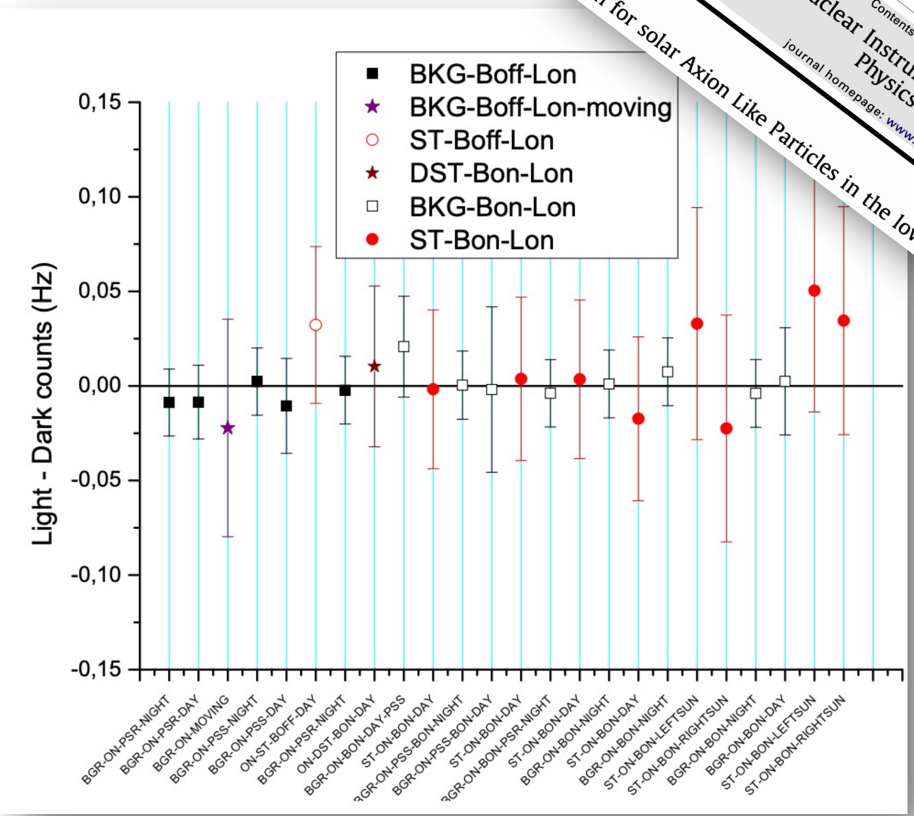
[4]BaRBE – Low energy run



The expected energy distribution of reconverted photons is peaked at 3 keV. There could be, however, a low energy tail due to various processes active in the Sun.

The **BaRBE** (Basso Rate Bassa Energia) experiment of INFN has been set-up to develop a low-background, single-photon counting system for low energy photons (in the visible band initially) with the aim of using such a detector in all those experimental situations where an extremely low rate of signal photons is expected.

The study of the low energy tail of the CAST spectrum is a prime example of such an application. The first measurements with the BaRBE detector system were performed at CAST using a Photo Multiplier Tube (PMT) and an Avalanche Photodiode (APD) optically coupled to the CAST magnet bore via a 40 m optical fiber. The observed Dark Count Rate (DCR) was 0.4 Hz with both detectors, and no excess of photons over background was observed around the 2 eV energy range for the runs taken in **Nov. 2007** and in **Mar. 2008**.

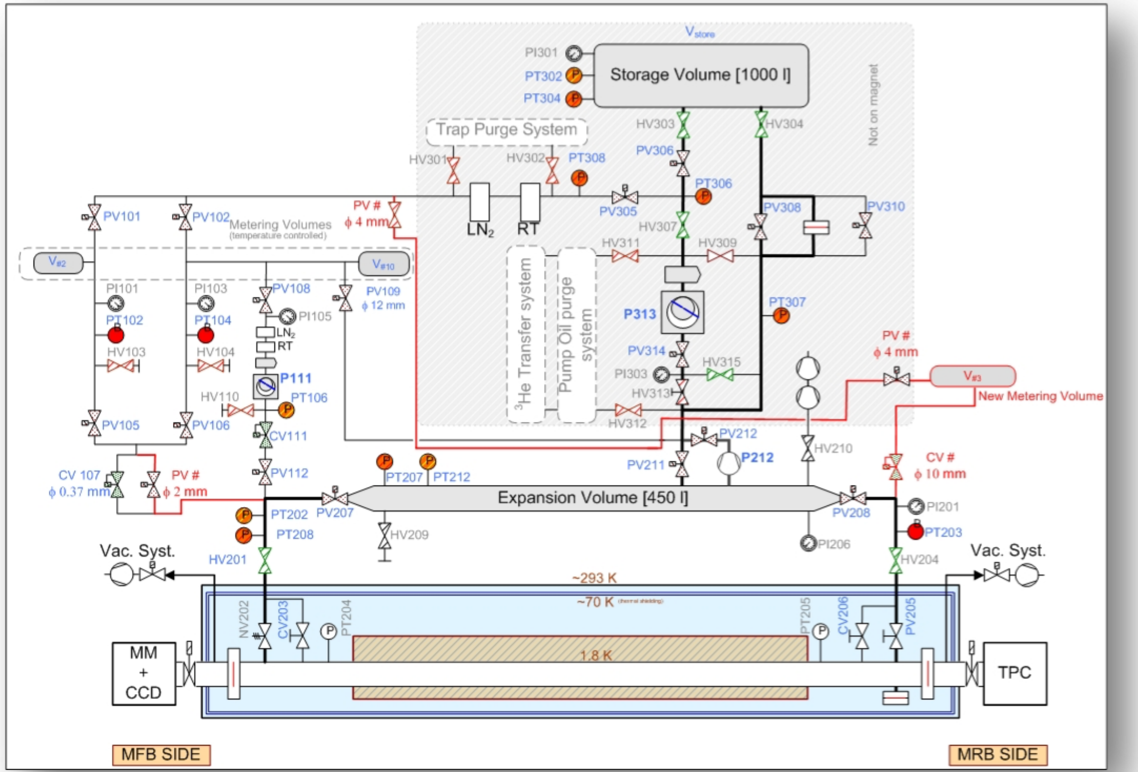


Difference between ”light” and ”dark” average count rates measured in the March 2008 run (PMT data only). Points on the axis correspond to different configurations, including background (BKG) tests and sun tracking (ST) periods with the magnet on (Bon). Error bars represent 1 σ intervals.

1999 2000 2001 2002 2003 2004 2005 2006 2007 **2008** 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 ...

^{4}He to ^{3}He preparation
+ LHC people busy with the recovery of the accident…

By the way;
the design, setup and initial operation of the magnet bores ^{4}He and ^{3}He gas filling was an engineering PhD thesis by itself…



ABSTRACT

Abstract

The axion was postulated after an elegant solution proposed by R. Peccei and H. Quinn to solve the strong CP problem of Quantum Chromodynamics.

The CAST experiment searches for axions created in the core of the Sun. It uses an LHC superconducting prototype magnet to trigger the axion conversion into detectable X-ray photons.

During its First Phase, with the magnetic field region kept under vacuum, CAST searched with high sensitivity for axion masses up to 0.02 eV/c^2, for higher values the conversion coherence is lost.

This thesis reflects the work that allows CAST to extend its search up to axion masses of 1 eV/c^2. To restore the lost coherence a buffer gas is introduced in the magnet cold bores, such that the photon arising from the Primakoff conversion acquires an effective mass. The axion mass can be effectively scanned by fine tuning the gas density.

The conversion of the experiment required the study, design and construction of a complex gas handling system to deal with a rare helium isotope, ^{3}He. It represents an important technological challenge and a major advantage, allowing the CAST experiment to extend its search into a new unexplored territory that is favoured by …ical models.

…ywords: CAST, Axion, ^{4}He, ^{3}He, gas system.

CERN-THESIS-2010-241
26/03/2010

INSTITUTO SUPERIOR TÉCNICO

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INSTITUTO SUPERIOR TÉCNICO

Conversion and Operation of CAST as a massive axion detector

Nuno Alexandre Rio Duarte Elias
(Licenciado)

Dissertação para obtenção do Grau de Doutor
em Engenharia Física Tecnológica

Phase II (^{3}He running)

From 2009 to 2011, CAST took data with ^{3}He inside the magnet bores and scanned the range of axion masses up to 1.18 eV (**Phase II** with **^{3}He**).

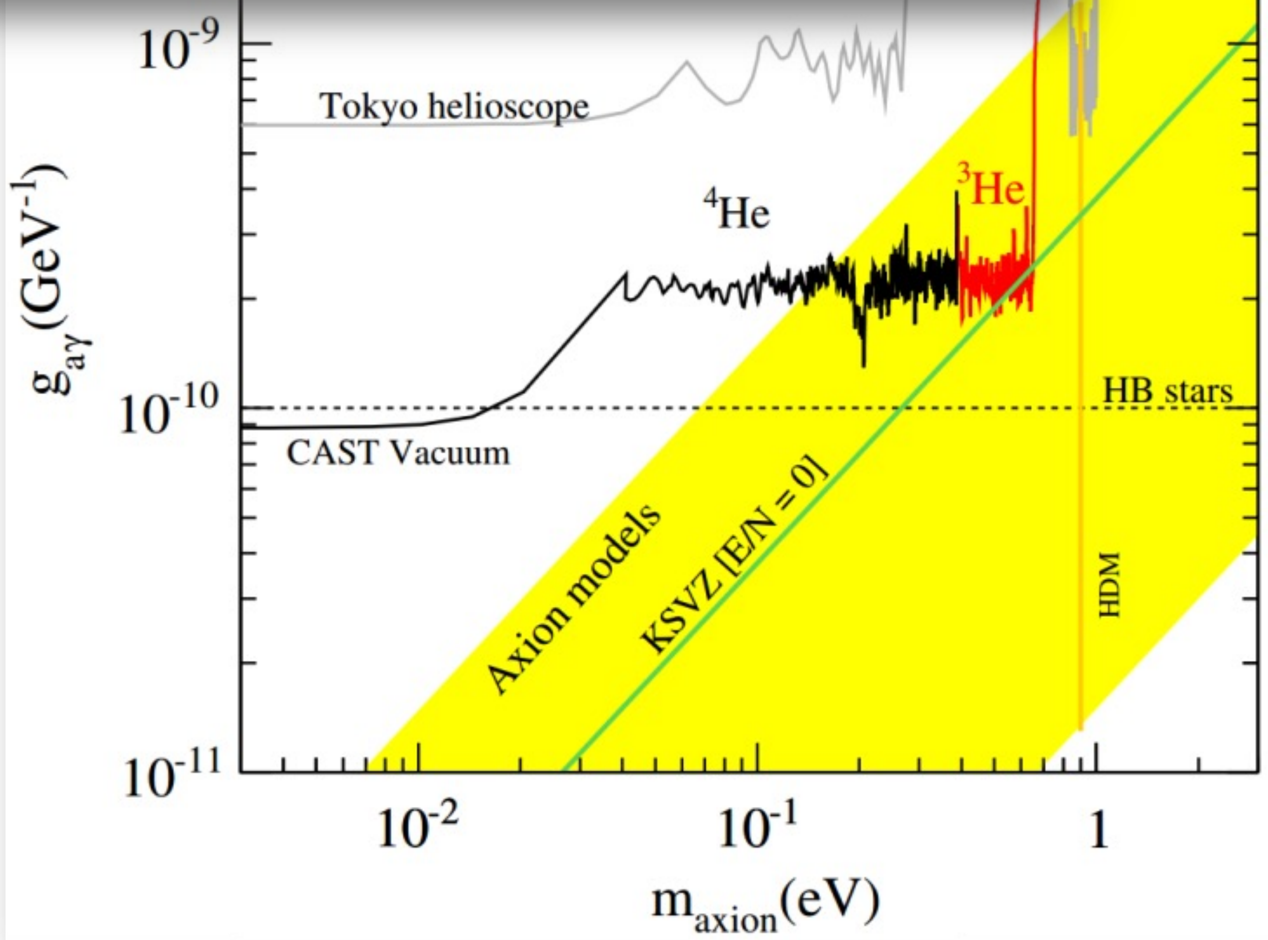
Detectors:

TPC is replaced with **two Micromegas** detectors of readouts fabricated with novel bulk and microbulk techniques. On the sunrise end a new shielded bulk (and later on microbulk) **Micromegas** replaced the unshielded one of our previous run. **XRT+CCD** remained unchanged.

The first results for the axion mass range **0.39 eV < m_a < 0.64 eV** enabled CAST to become the first axion helioscope experiment that crossed the KSVZ axion line.

PRL **107**, 261302 (2011) PHYSICAL REVIEW LETTERS week ending 23 DECEMBER 2011

Search for Sub-eV Mass Solar Axions by the CERN Axion Solar Telescope with ^{3}He Buffer Gas



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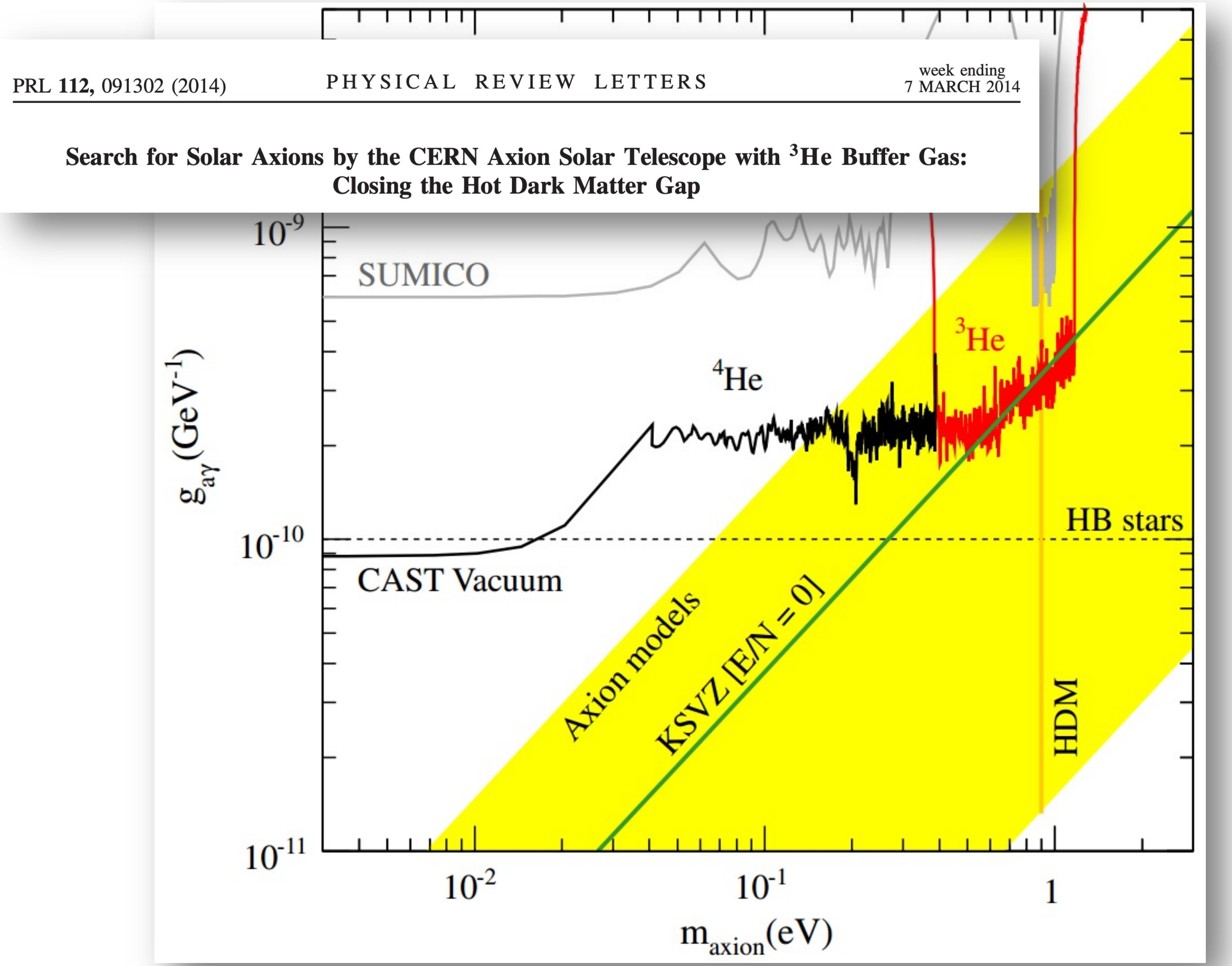
The first results for the axion mass range **0.39 eV < m_a < 0.64 eV** enabled CAST to become the first axion helioscope experiment that crossed the KSVZ axion line.

Then, covering the search range **0.64 eV ≲ ma ≲ 1.17 eV** closed the gap to the cosmological hot dark matter limit and actually overlapped with it.

From the absence of excess x rays when the magnet was pointing to the Sun, we set a typical upper limit on the axion-photon coupling of $g_{a\gamma\gamma} \lesssim 3.3 \times 10^{-10}$ GeV^{-1} at 95% C.L., with the exact value depending on the pressure setting.



PRL **112,** 091302 (2014) PHYSICAL REVIEW LETTERS week ending 7 MARCH 2014

Search for Solar Axions by the CERN Axion Solar Telescope with ^{3}He Buffer Gas: Closing the Hot Dark Matter Gap

In 2012, CAST has been using ^{4}He in order to revisit, with improved sensitivity and longer exposures, a narrow part at ~0.2 eV and a theoretically motivated range of axion masses around 0.4 eV.

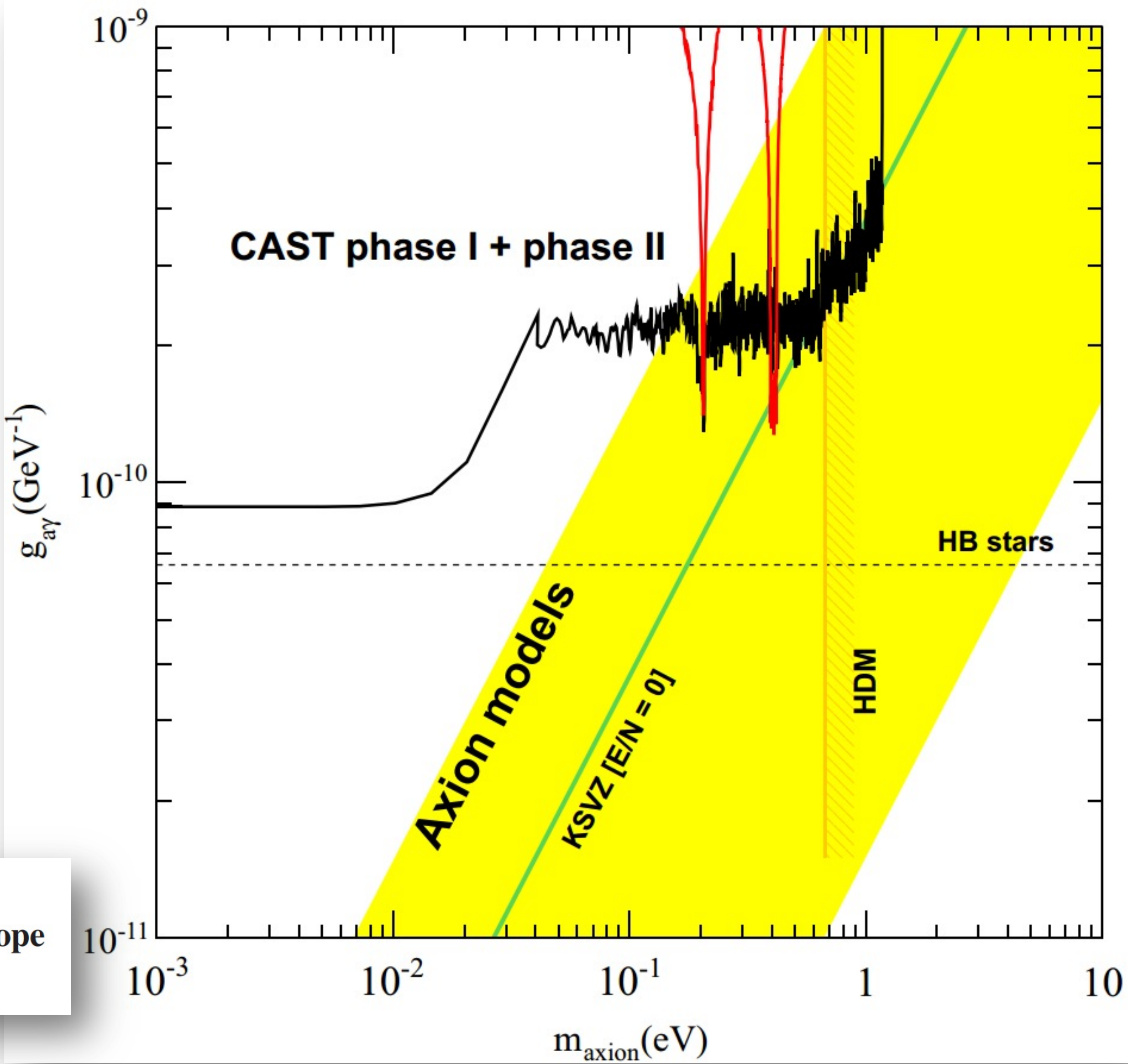
Phase II with ^{4}**He**

Detectors:

Three Micromegas detectors of the microbulk type (one in the sunrise and two in the sunset side) and **XRT+CCD** on the sunrise side. The detectors on the sunrise side remained unchanged since Phase II, but the Micromegas detectors on the sunset side were upgraded, improving the background levels of the detectors.

PHYSICAL REVIEW D **92**, 021101(R) (2015)

New solar axion search using the CERN Axion Solar Telescope with ^{4}He filling



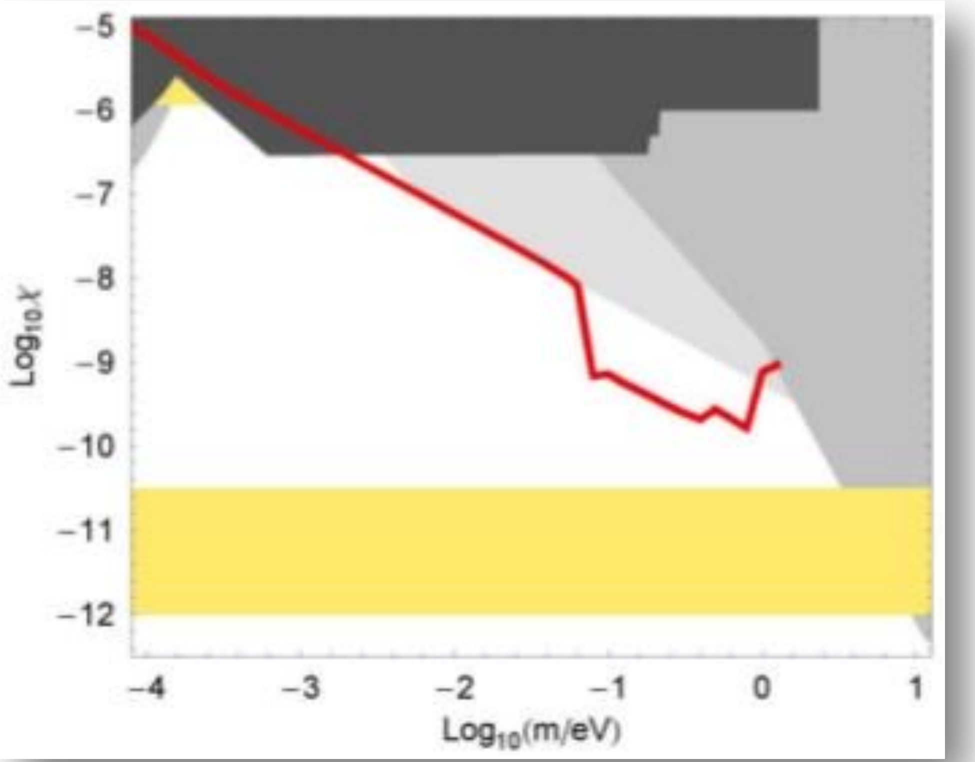
Paraphotons:

Hidden sector photons, or paraphotons, are massive equivalents of real photons, and an oscillation can occur between both.

Hidden sector photons can be produced also in the sun and propagate freely to the Earth where they can transform into real photons within a vacuum.

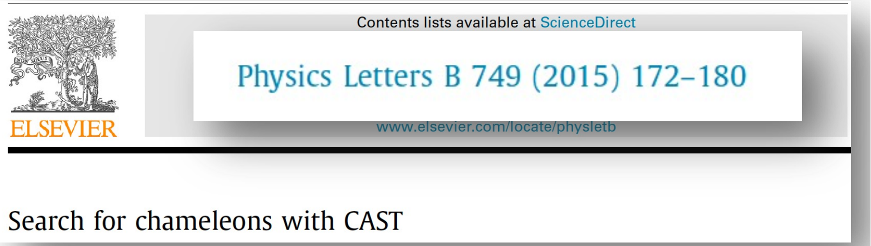
CAST searched for solar hidden sector photons using the **BaRBE** detector setup between **2010-2012**.

These measurements allowed CAST to place bounds on the coupling strength of paraphotons to real photons ("kinetic mixing") in the mass range up to 1 eV.



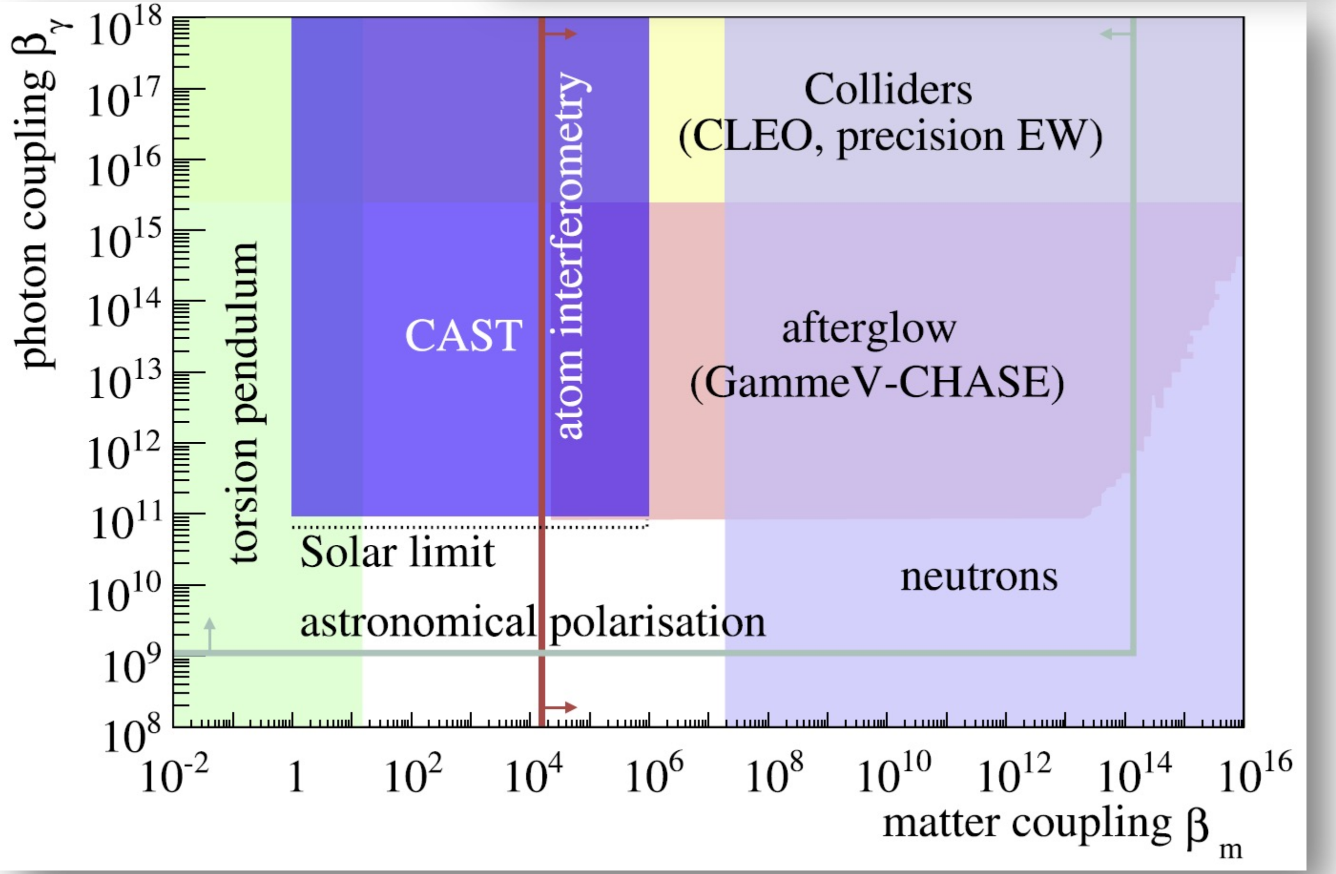
Phase III (vacuum running)

In **2013** and **2014** CAST took data with vacuum in the magnet pipes using for the first time sub-keV detectors: an SDD (Silicon Drift Detector) and in 2014 an InGrid (Integrated Grid) detector. By reducing the X-ray detection energy threshold used for axions from 1 keV to 400 eV CAST became sensitive to the converted solar chameleon spectrum which peaks around 600 eV.


Contents lists available at ScienceDirect
Physics Letters B 749 (2015) 172–180
ELSEVIER
www.elsevier.com/locate/physletb

Search for chameleons with CAST

Phase IV with **vacuum**.



Detectors:

A second X-ray optics was attached to the second sunrise side. X-ray detectors on CAST in the period from 2003 to 2012 have operated with energy thresholds above 1 keV to cover the solar axion energy spectrum. As of 2013, vacuum setup allowed sub-keV photons to exit the magnet cold bore and reach the X-ray detectors without absorption. Sub-keV sensitive detectors were then able to explore this energy range.

Not having observed any excess above background, we provided a 95% C.L. limit for the coupling strength of chameleons to photons of β_γ 10^{11} for $1 < \beta_m < 10^6$. With this study, CAST has made a first dedicated sub-keV energy search for solar chameleons based on the Primakoff effect.

1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | ...

Phase III (vacuum running)

In the **2013 - 2015** run, thanks to low-background detectors and a new X-ray telescope, the signal-to-noise ratio was increased by about a factor of three.

Phase IV with **vacuum**.

The new X-ray telescope used the design of NASA's NuSTAR satellite but was optimized by considering factors including: the physical constraints of the CAST experiment; the predicted axion spectrum; and the quantum effciency of the Micromegas detector.

Analyzing this data, **the best limit so far on the axion–photon coupling strength** (0.66 x 10^{-10} GeV^{-1} at 95% CL) was set.

Detectors:

The data used for this analysis were taken with three detection systems.:

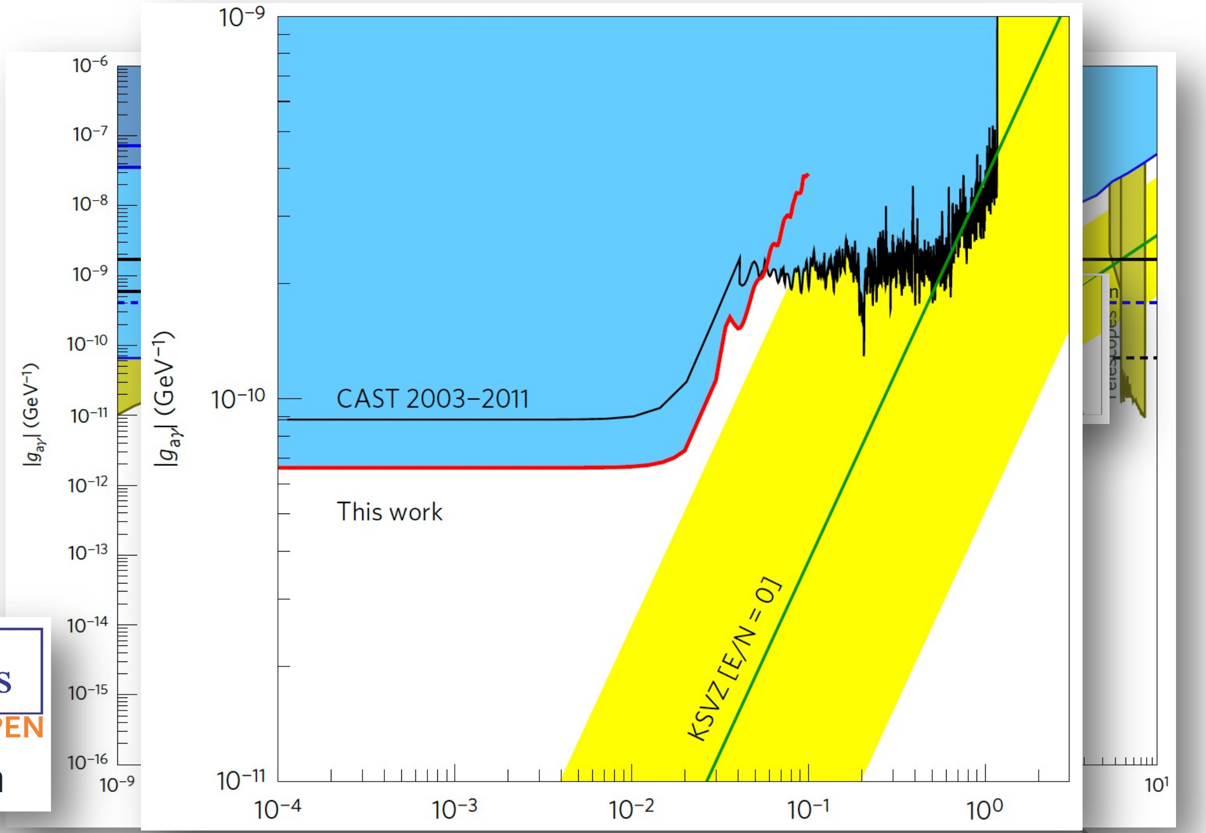
- On the sunset (SS) side of the magnet, **two** gas-based low background **Micromegas** detectors (SS1 and SS2) directly connected to each of the magnet pipes.
- On the sunrise (SR) side of the magnet, an **improved Micromegas** detector was situated at the **focal plane of the new XRT**.

The detector parts were built with carefully selected low-radioactivity materials and surrounded by passive (copper and lead) and active (5 cm thick plastic scintillators) shielding. The design choices of these detectors were the outcome of a longstanding effort to understand and reduce background sources in these detectors which led to the best background levels (10^{-6} keV^{-1} cm^{-2} s^{-1}) ever obtained in CAST.

ARTICLES
PUBLISHED ONLINE: 1 MAY 2017 | DOI: 10.1038/NPHYS4109

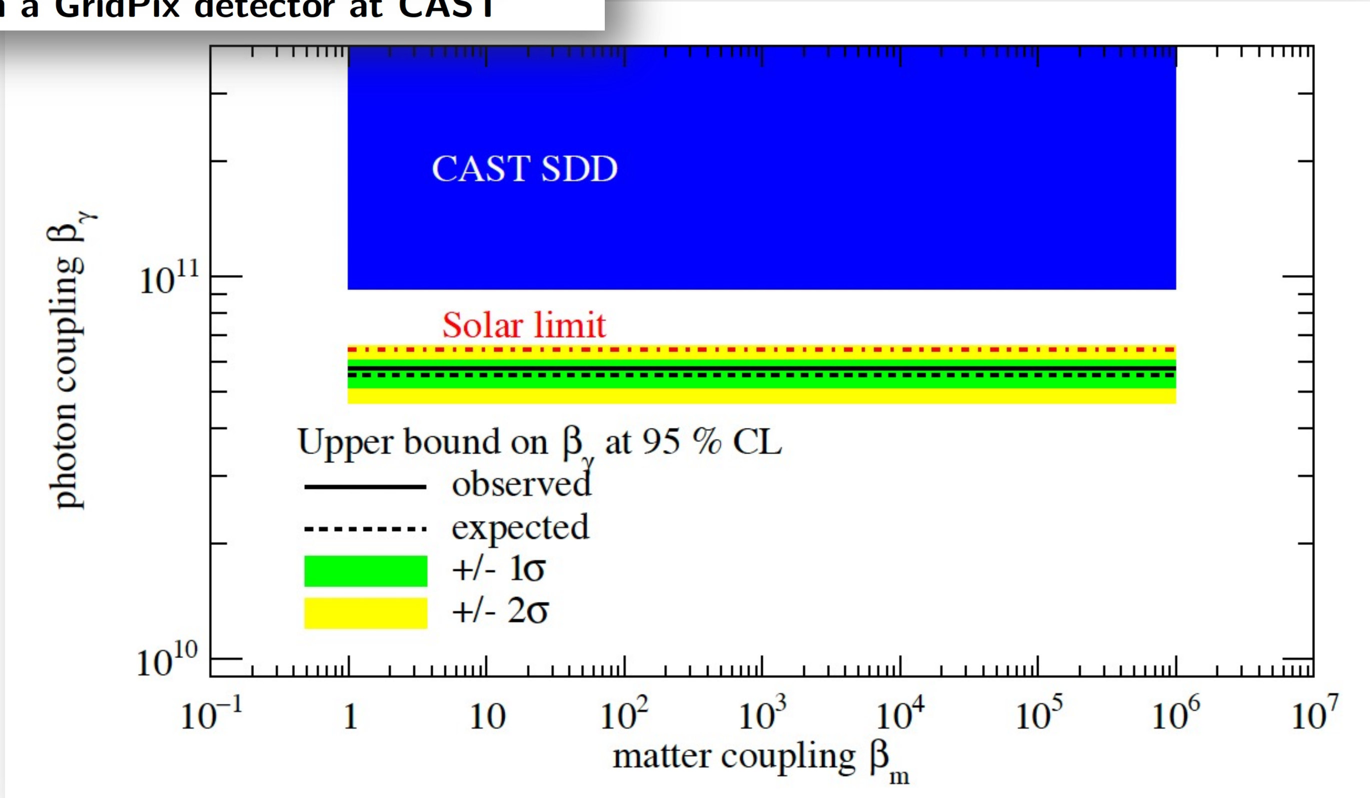
nature physics
OPEN

New CAST limit on the axion–photon interaction

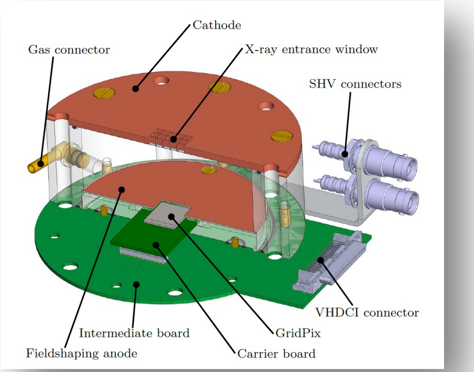


A GridPix detector was used to search for soft X-ray photons in the energy range from 200 eV to 10 keV from converted solar chameleons. No significant excess over the expected background has been observed in the data taken in **2014** and **2015**.

Journal of Cosmology and Astroparticle Physics
An IOP and SISSA journal
JCAP01(2019)032
Improved search for solar chameleons with a GridPix detector at CAST



Phase IV with **vacuum**.



The new X-ray detector, the "GridPix" detector (a combination of a Timepix ASIC and a Micromegas gas amplification stage), was installed in October 2014 behind the MPE X-ray telescope (XRT) of CAST.

We set an improved limit on the chameleon photon coupling, $\beta_\gamma \lesssim 5.7 \times 10^{10}$ for $1 < \beta_m < 10^6$ at 95% C.L. improving our previous results by a factor two thanks to the powerful combination of the GridPix detector with the X-ray optics.

This year, there was no long term data taking but many commissioning, integration, maintenance and upgrade studies:

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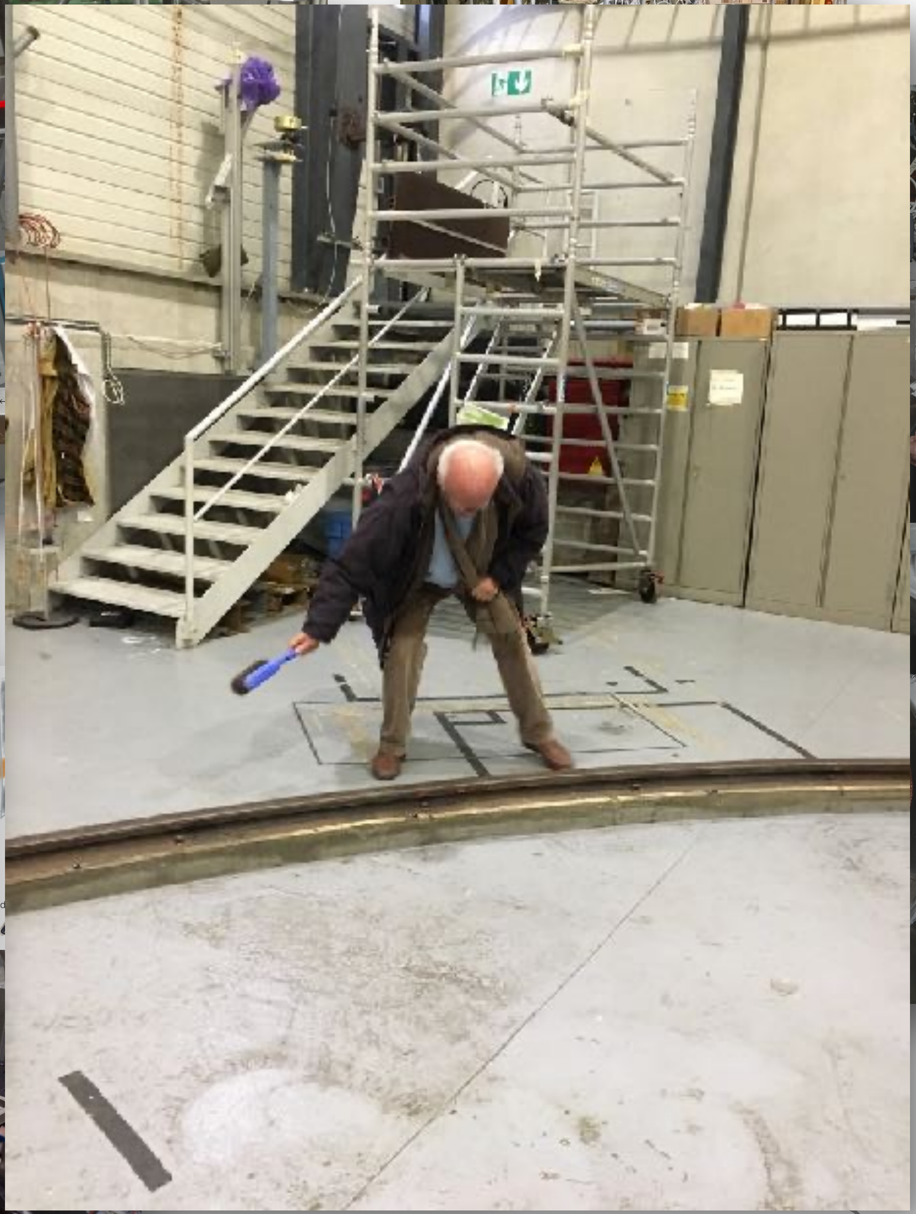
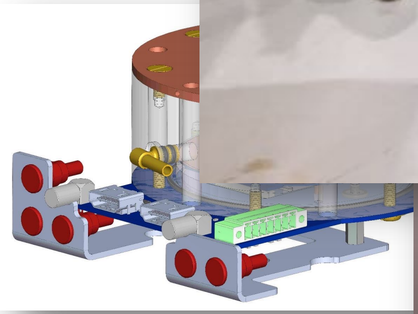
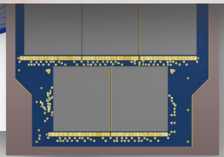
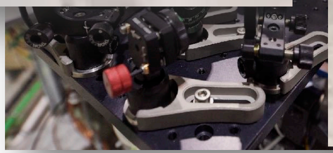
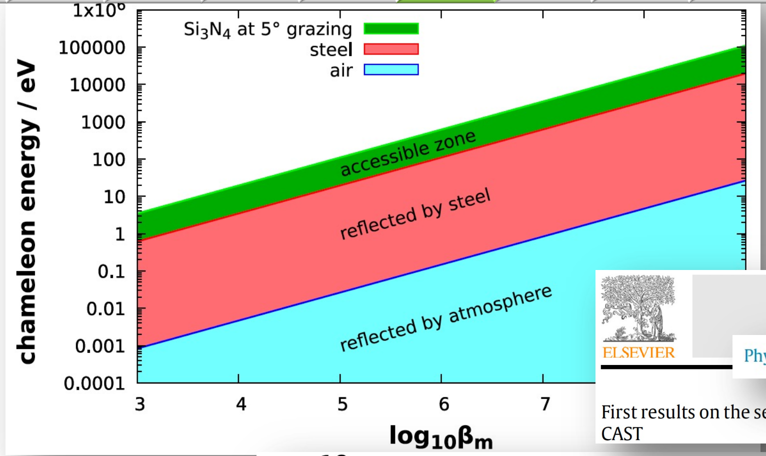
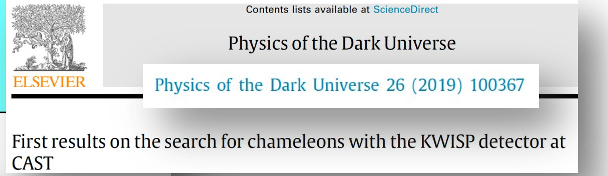




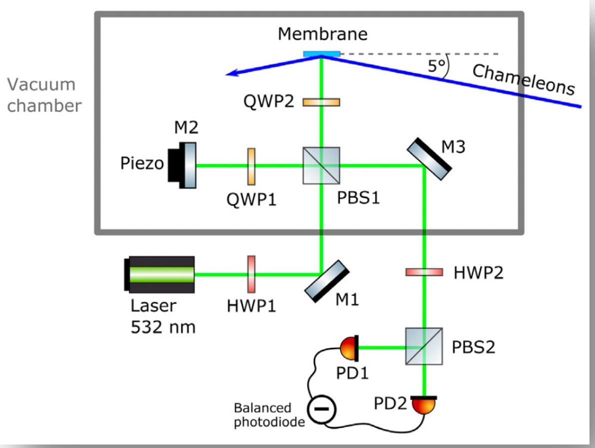




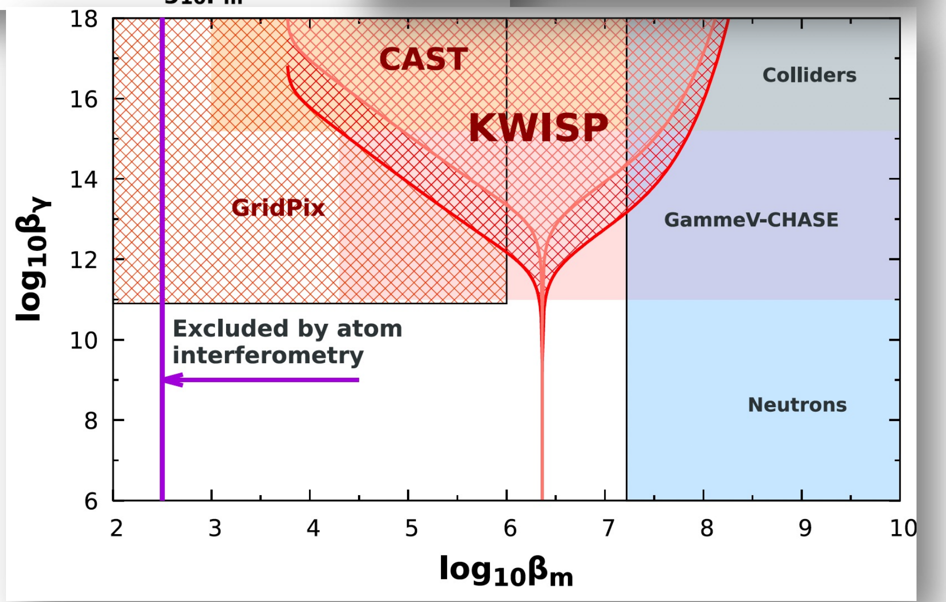



Contents lists available at ScienceDirect
Physics of the Dark Universe
ELSEVIER
Physics of the Dark Universe 26 (2019) 100367
First results on the search for chameleons with the KWISP detector at CAST

A first measurement in July 2017, with a sensitive **opto-mechanical force sensor** (KWISP – Kinetic WISP) designed for the direct detection of **coupling of chameleons to matter**.

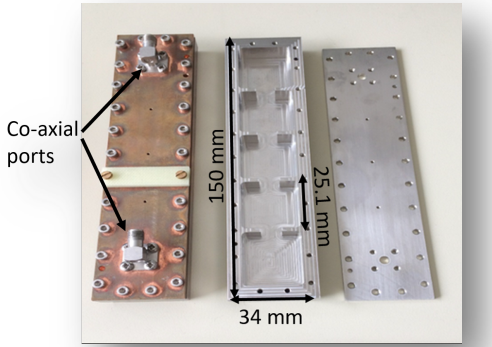


The KWISP detector installed on the CAST axion search experiment at CERN looked for tiny displacements of a thin membrane caused by the mechanical effect of solar chameleons. The displacements are detected by a Michelson interferometer with a homodyne readout scheme. The sensor benefits from the focusing action of the ABRIXAS X-ray telescope installed at CAST, which increases the chameleon flux on the membrane. A mechanical chopper placed between the telescope output and the detector modulates the incoming chameleon stream.

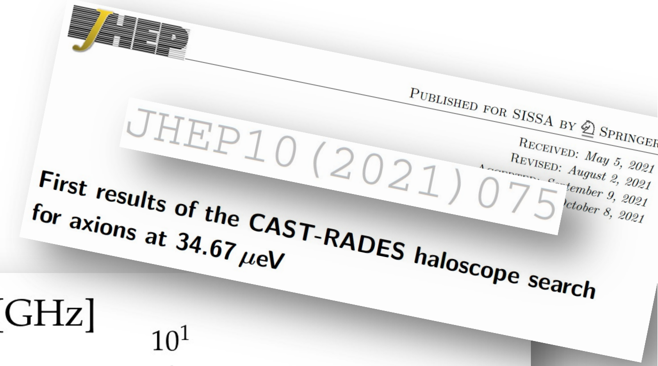


The results of the measurements put the limit on the force acting at the membrane at (44 ± 18) pN. Using this result, combined with the expected chameleon flux at the detector, allows one to define an exclusion region in the $\beta_m - \beta_\gamma$ plane as shown. The detector is sensitive for direct coupling to matter $10^4 \leq \beta_m \leq 10^8$, where the coupling to photons is locally bound to $\beta_\gamma \leq 10^{11}$.

The measurement with the KWISP detector is directly sensitive to real chameleon interactions, and in this sense, it is complementary to the previously existing exclusion limits.



The **Relic Axion Dark-Matter Exploratory Setup** (RADES), a detector which is installed in CAST, used a new type of cavity geometry where a long rectangular cavity is divided into smaller sub-cavities to search for axion masses above 30 μeV.


JHEP
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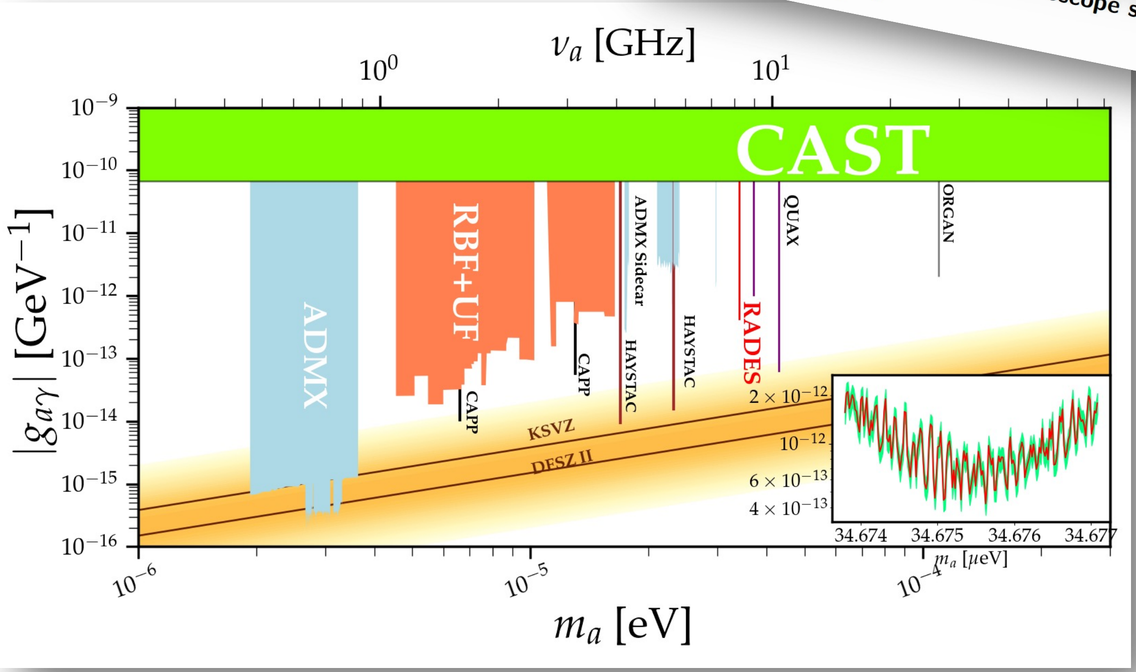
RECEIVED: May 5, 2021
REVISED: August 2, 2021
ACCEPTED: September 9, 2021
PUBLISHED: October 8, 2021
JHEP10(2021)075
First results of the CAST-RADES haloscope search for axions at 34.67 μeV

RADES started data taking on the 31st of October 2018; a total time of about 103 hours in 2018 were used for this analysis.

From this axion search at 34.67 μeV, no signal above noise was found in the data set. An exclusion limit with 95% CL on the axion-photon coupling constant of $g_{a\gamma\gamma} \geq 4 \times 10^{-13}$ GeV^{-1} over a mass range of 34.6738 μeV < m_a < 34.6771 μeV was set. This extracted upper limit of the axion-photon coupling for a narrow frequency band improves the previous CAST limit at the corresponding axion mass by more than 2 orders of magnitude.



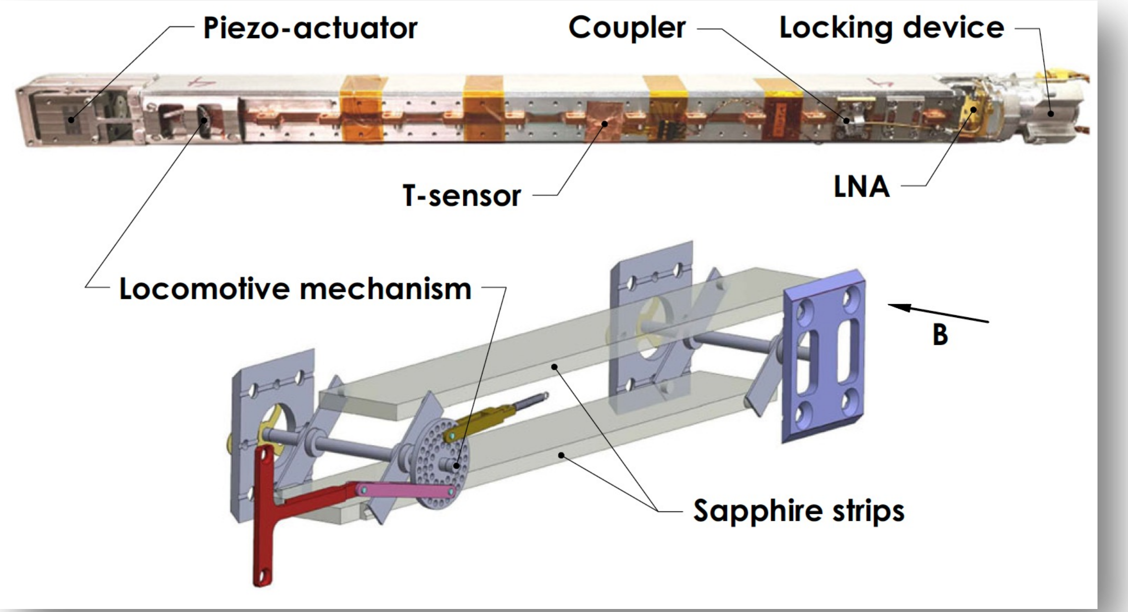
In the long term, the RADES cavities are envisioned to take data in the BabyIAXO magnet.

The **CAST-CAPP axion haloscope**, operating at CERN inside the CAST dipole magnet, searched for axions in the 19.74 μeV to 22.47 μeV mass range from **2019 to 2021**.

The detection concept follows the Sikivie haloscope principle, where Dark Matter axions convert into photons within a resonator immersed in a magnetic field.

The CAST-CAPP resonator is an array of four individual 23 x 25 x 390 mm rectangular cavities inserted in series inside one of the two bores of CAST's superconducting dipole magnet, phase-matched to maximize the detection sensitivity.

Each cavity consists of two pieces of stainless steel, coated with 30 μm of copper. Each cavity is equipped with a fast frequency tuning mechanism of 10 MHz/min between 4.774 GHz and 5.434 GHz.



A photograph of the elements of a single cavity assembly (top) and a technical drawing of CAST-CAPP tuning mechanism with the two sapphire strips (bottom).

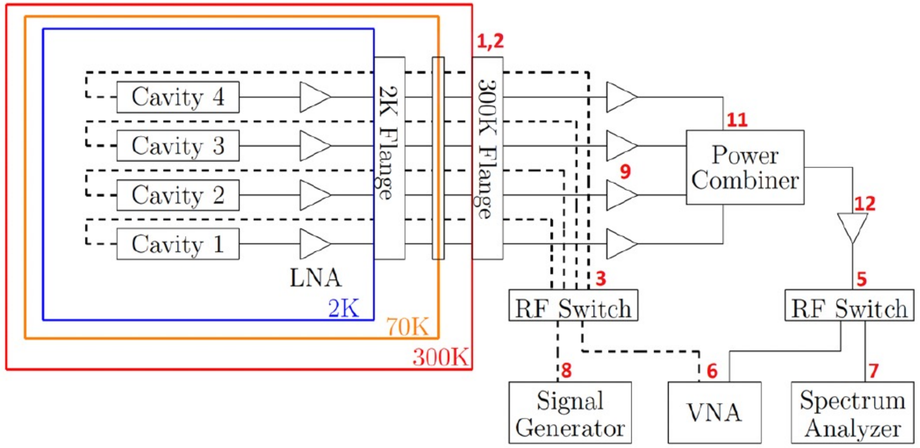
The static B-field is shown by the arrow and is parallel to the two axes of the tuning mechanism.

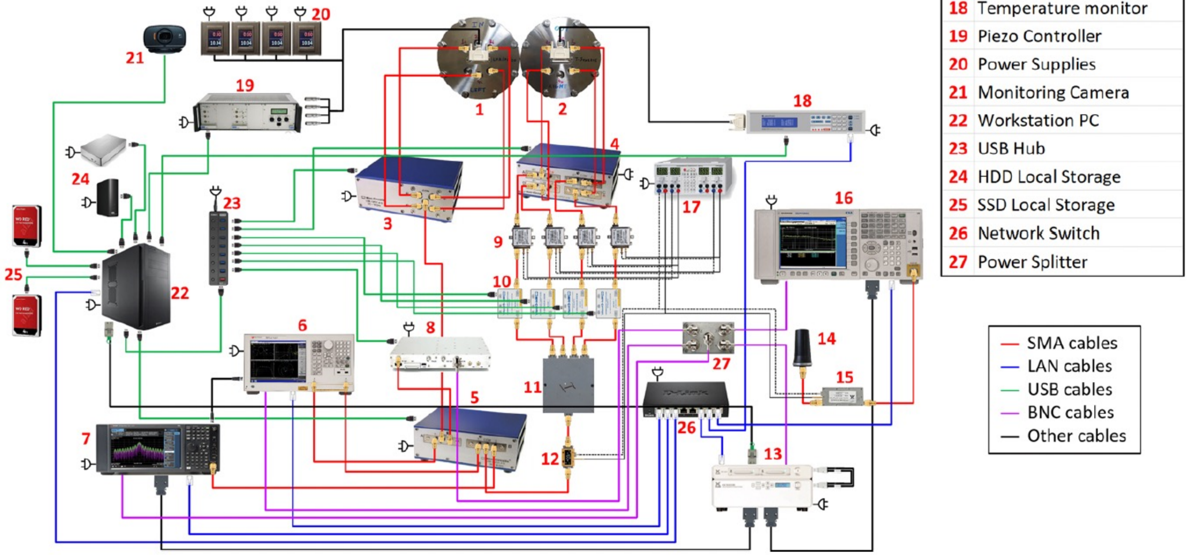
From 12 September 2019 to 21 June 2021, a total frequency range of 660MHz, from 4.774 to 5.434 GHz, in steps of 200 kHz for a total acquisition time of 4123.8 hours was scanned. The total frequency range corresponds to axion masses between 19.74 μeV and 22.47 μeV.

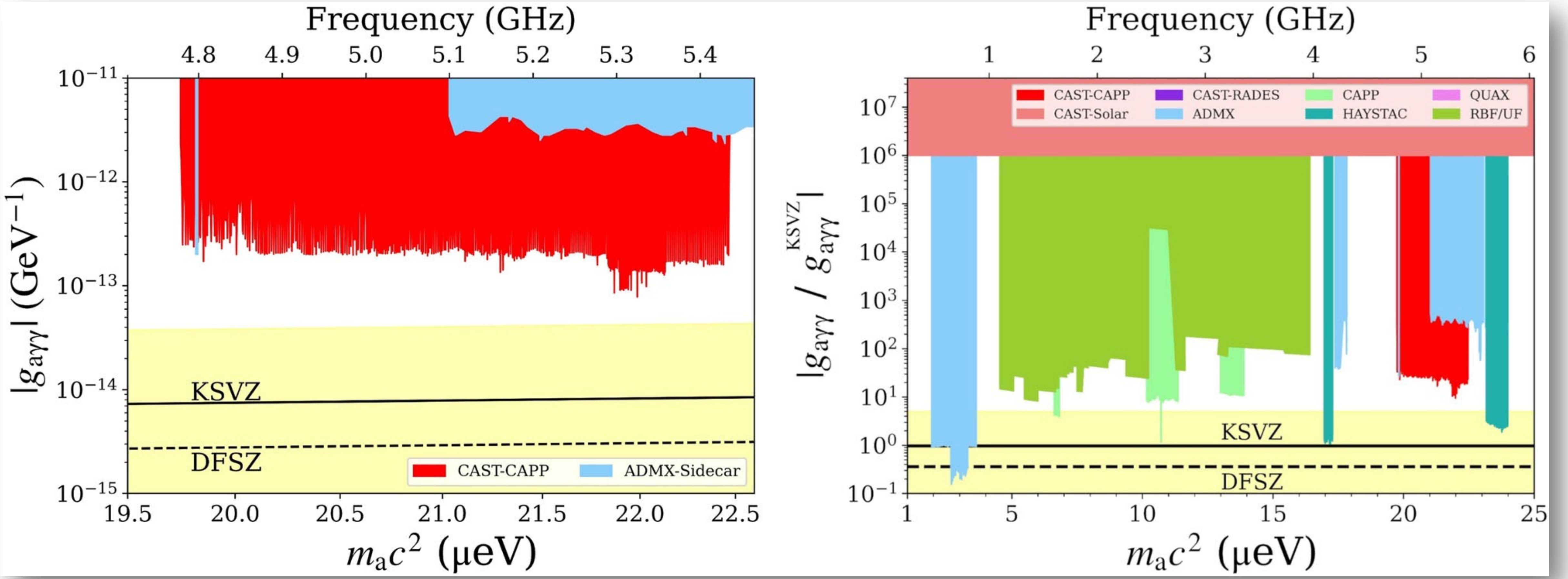
The duty cycle of the data-taking campaigns was approximately 20 hours per day. Background measurements were also performed for a total of 394.6 hours without magnetic field.

A parallel channel has been used to measure EMI/EMC ubiquitous parasites yielding 2140 hours of data between 4.798 GHz and 5.402 GHz.

Every candidate spectrum was compared to the simultaneously and independently measured spectrum from the second channel with the external antenna which is sensitive to the same frequency and searches for ambient EMI/EMC parasites.







In this search range, we exclude axion-photon couplings for galactic axions down to $g_{a\gamma\gamma} = 8 \times 10^{-14}$ GeV^{-1} at the 90% CL.

The here implemented phase-matching technique also allows for future large-scale upgrades.


nature communications

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Article

https://doi.org/10.1038/s41467-022-33913-6

Search for Dark Matter Axions with CAST-CAPP

In addition, the following novelties, of potential importance also for future DM axion searches, have been instrumented:

- ✓ **Four identical cavities** have been coherently combined through the **phase-matching** technique increasing significantly the SNR. Combining signals from individual cavities is shown to be feasible and still unique in DM axion search. This **can be extended in future large-scale axion haloscopes with a large number of small cavitie**s.

- ✓ The successful scan of a significant mass range showed that this experiment is at the **cutting-edge of cavity tunability in axion research**. This was achieved thanks to the unique design of the locomotive tuning mechanismand the cavity geometry. With an upgrade of the piezoelectric motors at cryo, the **tuning range can even further be extended** to 1 GHz and slightly beyond (4.6–5.8 GHz), shown by simulation and also demonstrated on the bench at room temperature.

- ✓ The **fast-scanning technique** includes a **fast change of resonance frequencies** (10 MHz/min) between 4.774 GHz and 5.434 GHz, which, combined with a high sensitivity, allows for 60 s short acquisition intervals for each 200 kHz tuning step. This also permits to **quickly re-tune the cavities to a frequency of interest**, for instance to investigate a stable and reproducible outlier.

- ✓ The raw data which are recorded in each interval consist of a “real and imaginary part” time domain trace allowing for easy **analysis of the traces for transient event search**. Together with the fast-scanning technique, it permits a **simultaneous search for halo DM axions and axion-caused electromagnetic transients originating for example from mini-clusters or streams**. It is challenging to separate non-stationary signals from axion streams against transient-type EMI/EMC perturbations. The very first adequate approach in this case is the comparison with the reference antenna output in the hall.

1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | **2022** | 2023 | ...

Status History

Status	Start Date	End Date
Preparation	13-04-2000	17-06-2003
Data Taking	18-06-2003	31-12-2022
Data Analysis	01-01-2023	

CAST

A Solar Axion Search Using a Decommissioned LHC Test Magnet

Synonym:
Research Programme: OTHER
Approved: 13-04-2000
Beam:
Status: Data Analysis

Overview | Teams | Participations

Spokesperson:	ZIOUTAS, Konstantin
Deputy spokeperson(s):	GARCIA IRASTORZA, Igor CANTATORE, Giovanni
Contact person:	VAFEIADIS, Theodoros
Technical Coordinator:	FUNK, Wolfgang
Deputy Technical Coordinator:	VAFEIADIS, Theodoros
Experimental Safety Officer (EXSO):	ZIOUTAS, Konstantin
Deputy Experimental Safety Officer (DEXSO):	FUNK, Wolfgang
Experiment secretariat e-mail:	yasemin.altinbilek@cern.ch

Number of Institutes:	23
Number of Countries:	14
Number of Participants:	53
Number of Authors:	21

Status History

Status	Start Date	End Date
Preparation	13-04-2000	17-06-2003
Data Taking	18-06-2003	31-12-2022
Data Analysis	01-01-2023	

cast.web.cern.ch/CAST/

CAST
CERN Axion Solar Telescope

MAIN MENU
- Home
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- Collaboration Members
- Publications
- Meetings
- Related Links
- Conferences
- Internal Information

EXPERIMENTAL HALL

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Contactperson: Theodoros Vafeiadis
Technical Coordinator: Wolfgang Funk
Deputy Technical Coordinator: Theodoros Vafeiadis

INSTITUTES COLLABORATING IN CAST

Athens NCSR Demokritos , Istinye University, Rheinisch-Friedrich-Wilhelms-Universitat Bonn , British Columbia University, CAPP, CERN, Chicago University, Columbia University, University Darmstadt, DTU Space, Albert Ludwigs Universitaet Freiburg, LLNL, Max-Planck Institut für Physik, Max-Planck MPE Institut für Extraterrestrische Physik, Max-Planck MPS Institut für Sonnensystemforschung , Moscow INR, NTUA National Technical University of Athens, University of Patras, University of Rijeka, Saclay CEA-DAPNIA, Thessaloniki University, Trieste INFN, Zagreb IRB, Zaragoza University.

LATEST NEWS

Webcasts from CAST Experimental Area

Conferences, Meetings, Publications
Snapshot of the Slow Control
Weather Forecast for Geneva
Shift Documentation: pdf, doc

Conception	**1997 Buenos Aires @ SOLAX meeting**
Rejection	**1997**
Approval	**1999**
Construction	**22 years**
Start data taking	**2003**
CAST as:	
Solar axion helioscope	**3rd generation >>> NATURE paper**
Solar chameleon helioscope	**1st generation**
DM haloscope	**1st generation >>> Nature paper?**
End	**2022**

State-of-the-art equipment & expertise

... 25 years since CAST' conception

21st May 1997

K. Zioutas, 80th CAST CM, May 2022

CAST - Farewell Meeting

23 June 2022
CERN
Europe/Istanbul timezone

Enter your search term

- Overview
- Registration
- Call for Abstracts
- Timetable
- Participant List
- Videoconference

This event is a gathering for one last time as a farewell to CAST:

All CASTers are welcome.

In order to be able to know the exact number of face to face participants, we kindly ask you to fill in the Registration Form at your earliest convenience and not later than June 10th.

If you wish to contribute to the event please fill the Call for Abstract Form as well.

Looking forward to see you at CERN on June 23rd, 2022, Thursday!

	Welcome and opening	*Konstantin Zioutas*	*3162/1-K01, CERN*	14:30 - 14:50
15:00	**Reflections on 13 years at CAST**	*Martyn Davenport*	*3162/1-K01, CERN*	14:50 - 15:10
	Personal Perspective on CAST	*Georg Raffelt*	*3162/1-K01, CERN*	15:10 - 15:30
	TBA	*Juan Collar*	*3162/1-K01, CERN*	15:30 - 15:50
16:00	**CAST, Solar Axions, Axion Dark Matter and my personal connection with Konstantin Zioutas**	*Yannis Semertzidis*	*3162/1-K01, CERN*	15:50 - 16:10
	Fast, Precisely and Wrong	*Fritz Caspers*	*3162/1-K01, CERN*	16:10 - 16:20
	-	*Theopisti Dafni*	*3162/1-K01, CERN*	16:20 - 16:40
	A farewell to KWISP ...	*Giovanni Cantatore*	*3162/1-K01, CERN*	16:40 - 17:00
17:00	**Short break**			
	A history of the Turkish team at CAST	*Serkant Cetin*	*3162/1-K01, CERN*	17:20 - 17:40
	Involvement of the Zaragoza team to the successful history of CAST	*Cristina Margalejo Blasco et al.*	*3162/1-K01, CERN*	17:40 - 18:00
18:00	**Sharing memories and experiences in CAST**	*Cenk Yildiz*	*3162/1-K01, CERN*	18:00 - 18:10
	CAST-CAPP Timeline and Achievements	*Kaan Ozbozduman et al.*	*3162/1-K01, CERN*	18:10 - 18:20
	CAST´s family, a tribute to science and friends	*Jaime Ruz Armendariz*	*3162/1-K01, CERN*	18:20 - 18:30
	Cast Celebration	*Louis Walckiers*	*3162/1-K01, CERN*	18:30 - 18:40
	Production and installation of the CAST mechanical system	*Andreas Gougas*	*3162/1-K01, CERN*	18:40 - 18:50
19:00	**Open floor for further contributiıns**	*All participants*	*3162/1-K01, CERN*	18:50 - 19:20
	Closing		*3162/1-K01, CERN*	

CAST has been a COSMIC LISTENer of the COSMIC WISPers for ~20 years…

With many opportunities, challenges, firsts and leading results…

In the end, the LHC test magnet paid off much more than it was built for!

1999 2000 2001 2002 2003 **2004** 2005 2006 **2007** 2008 **2009** 2010 2011 2012 2013 2014 2015 2016 **2017** 2018 2019 **2020** 2021 2022 2023 ...

Angel Morales
University of Zaragoza
Spain

Julio Morales
University of Zaragoza
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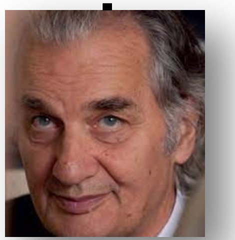

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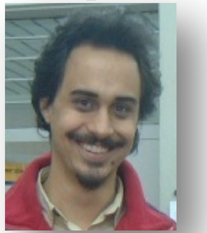
Max Planck Institute Garching
Germany

Biljana Lakic
Rudjer Boskovic Institute
Croatia

Engin Arik
Bogazici University
Turkiye

Fatma Senel Boydag
Dogus University,
Turkiye



Ozgen Berkol Dogan
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İskender Hikmet
Dogus Univeristy
Turkiye

In loving memory of our dear colleagues and friends; CASTers who passed away during the lifetime of CAST...

Teşekkürler !