C.A.S.T. (**C**ERN **A**xion **S**olar **T**elescope)

*Painting by **Firat Yilmaz***

1^{st} mystery: Strong CP problem

Q.C.D. -> Violation of CP symmetry in the strong interactions **but NOT** observed

↓

Peccei–Quinn mechanism

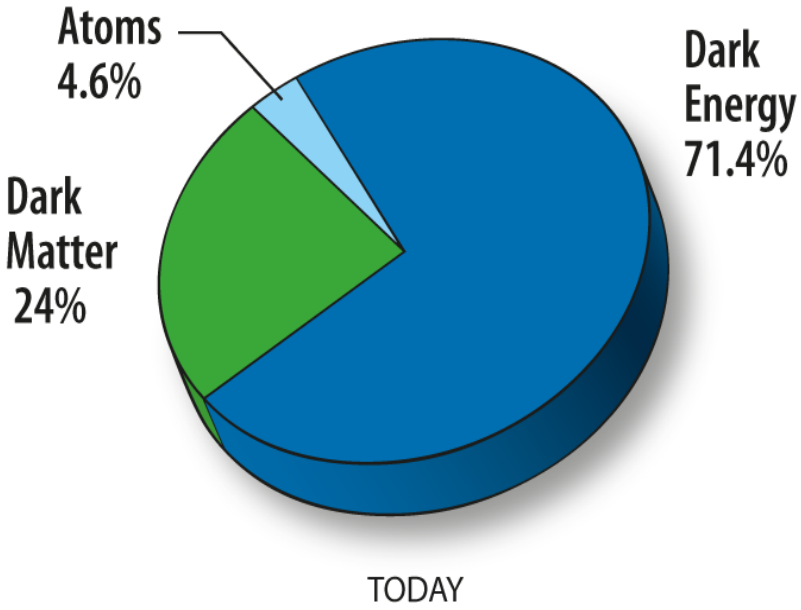
←

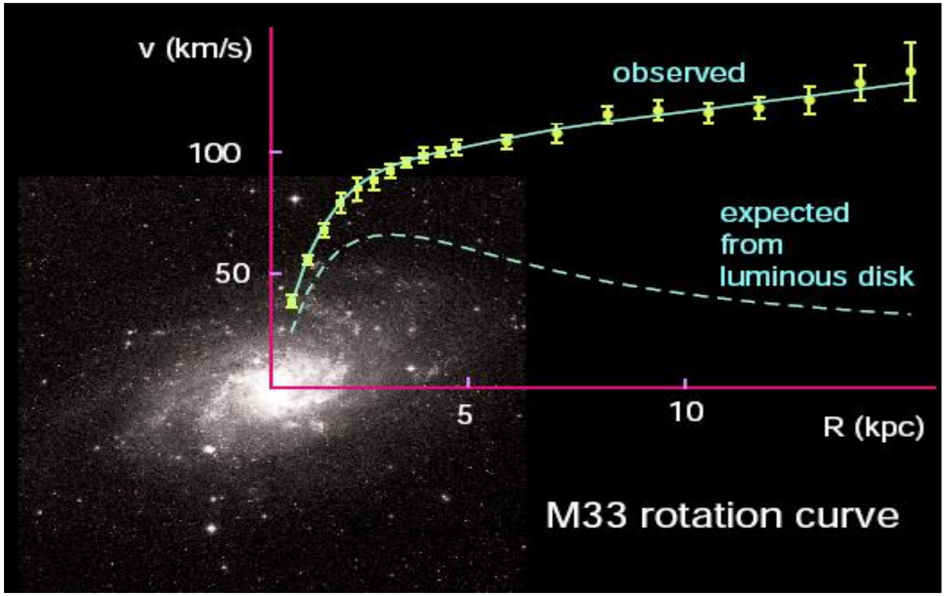
Axion (α):

- Neutral pseudoscalar boson
- Very weak interaction with matter

$$10^{-6}\,\frac{\mathrm{eV}}{\mathrm{c}^2} \leq \mathrm{m}_\alpha \leq 1\,\frac{\mathrm{eV}}{\mathrm{c}^2}$$

2nd mystery: Dark matter



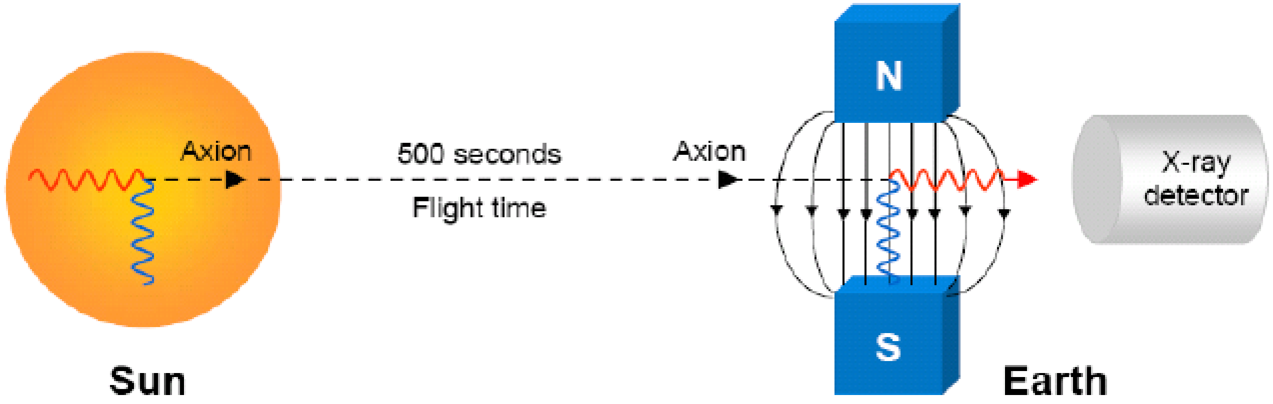


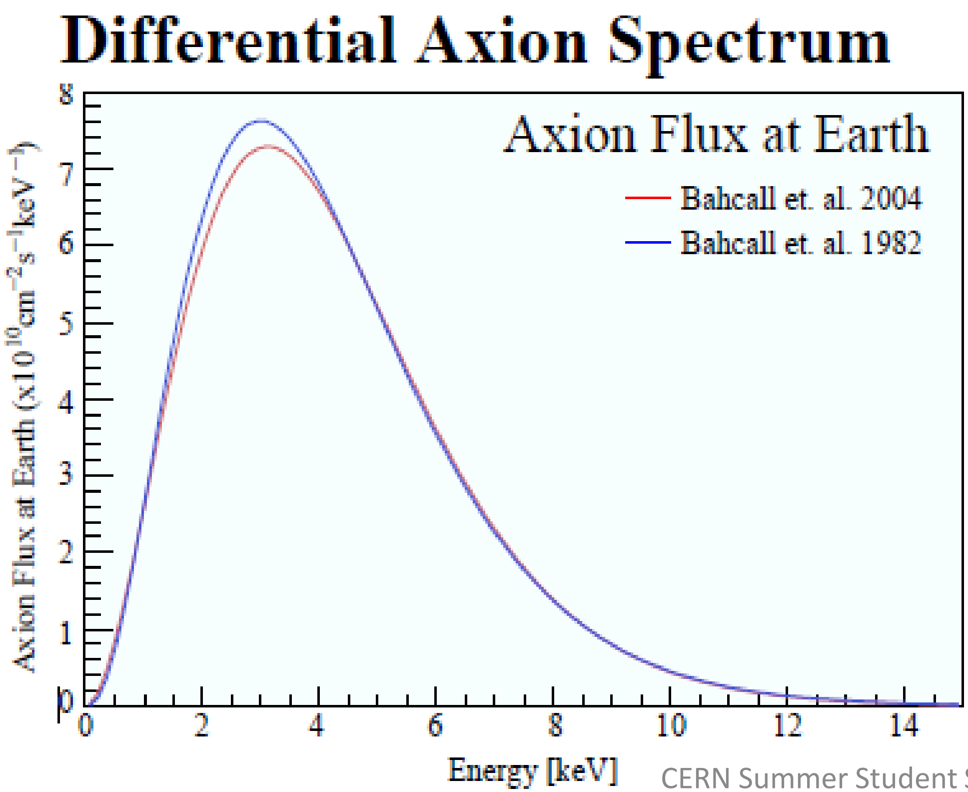
Also, axion (α):

- An extremely attractive dark matter candidate
- Puzzle piece explaining these two mysteries

Solar axions

- ➢Production: Thermal photons interact with nuclei (Primakoff effect)
- ➢Detection: Axion interacts coherently with a strong B and a photon is produced (inverse Primakoff effect)





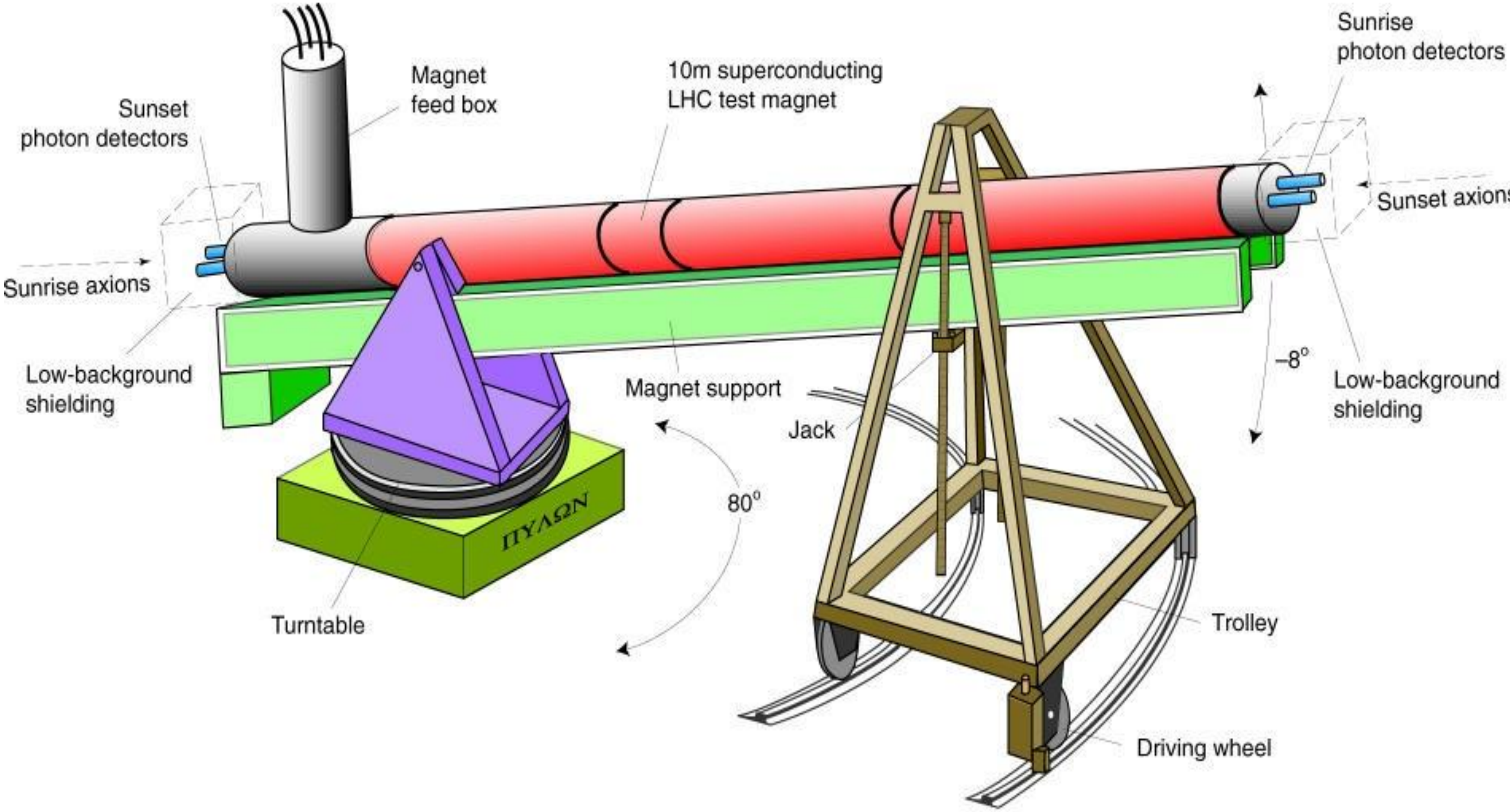
*Pictures by **Firat Yilmaz***

$$\langle E \rangle_{\alpha} = 4.2\,\mathrm{keV}$$

$$\mathrm{L}_{\alpha} = 1.9 \times 10^{-3}\,\mathrm{L}_{\odot}$$

$$\Phi_{\alpha} = 3.8 \times 10^{11}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$$

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



LHC prototype superconducting dipole magnet

L=9.26 m, T = 1.8 °K, I = 13 kA, B = 9 T

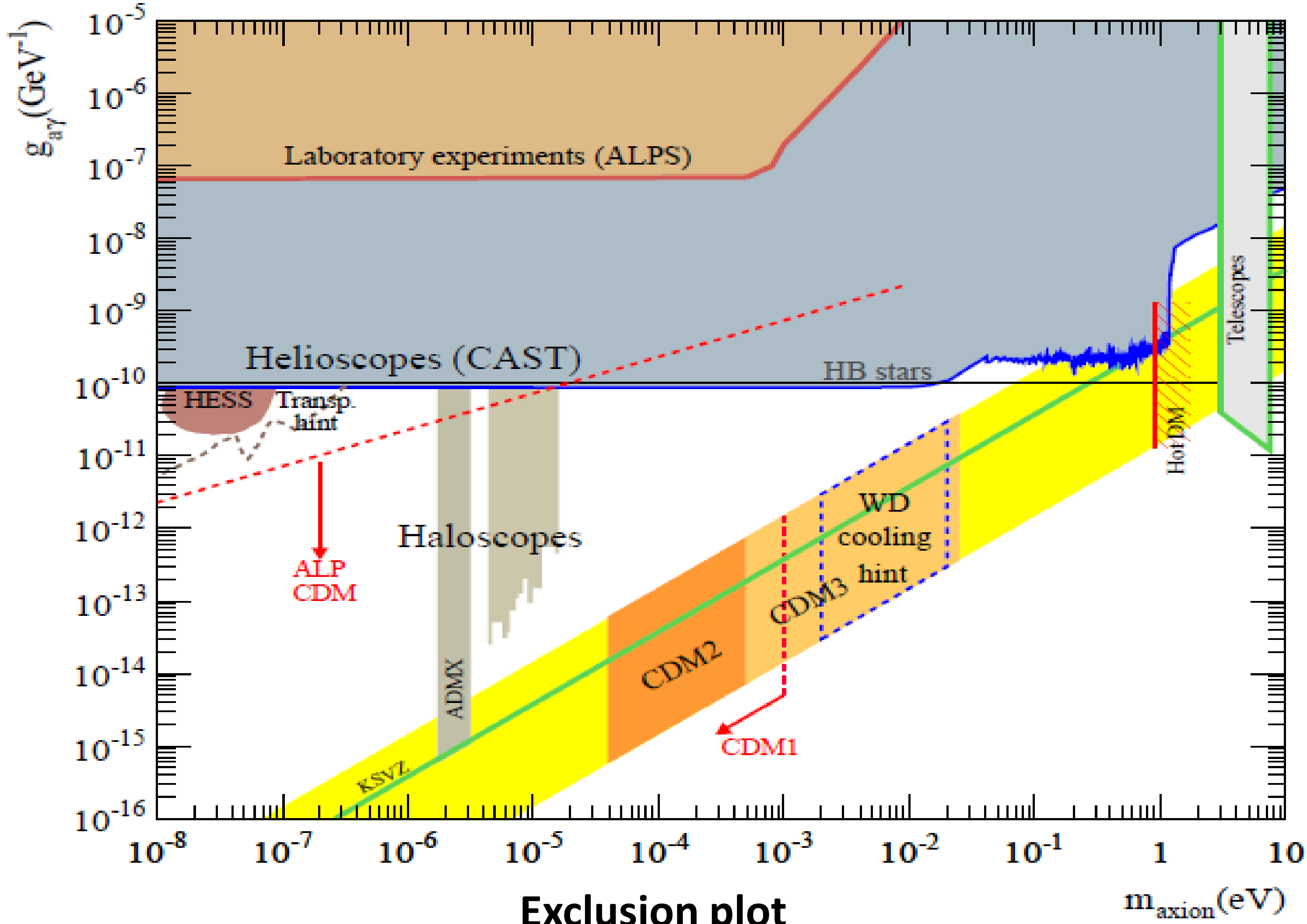
Vertical movement: ±8 °, Horizontal: 80 °

Daily tracking: 3 h

3 MM detectors, 1 CCD

The magnet on the move…

Results



Exclusion plot

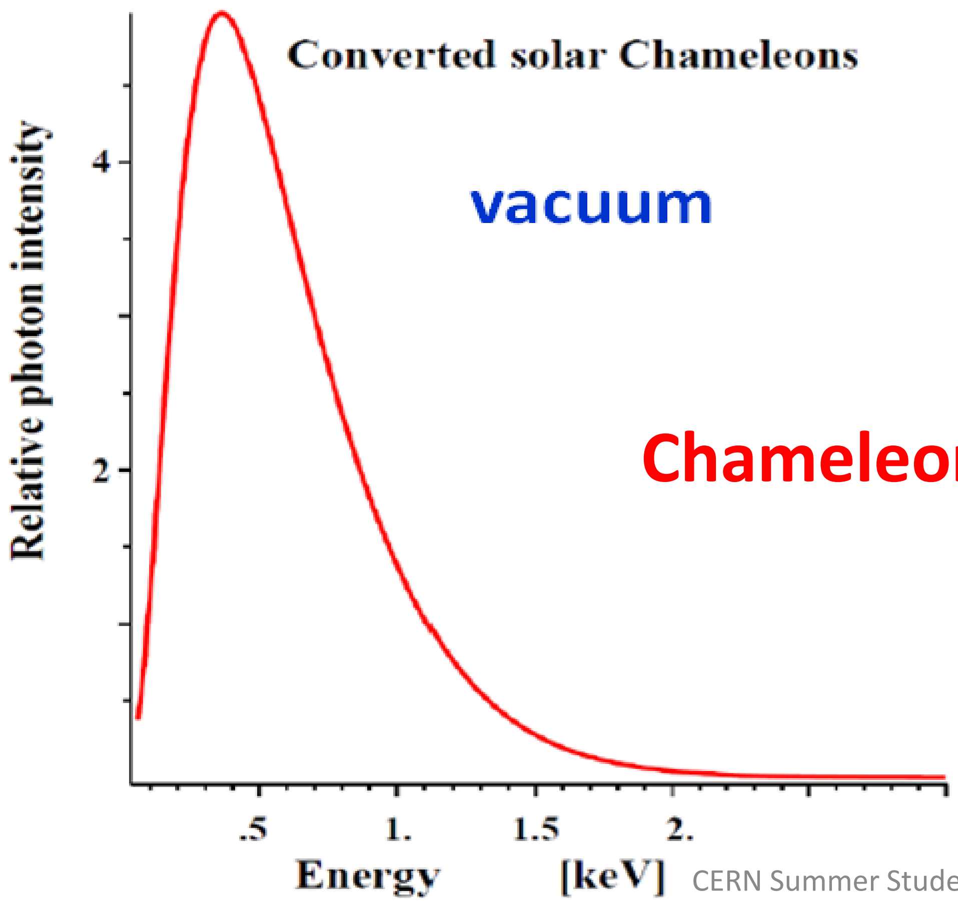
For a certain value of mass, the coupling constant is less than the measured value

Chameleon

- Neutral spinless scalar particle, possible candidate for dark energy
- Behaves like a lizard -> Adjusts its properties according to its local environment
  - Where the density of matter is ordinary or relatively high (e.g. on Earth), chameleons are massive particles that interact very weakly with other matter-> Difficult to detect on Earth
  - Where matter density is extremely low (e.g. vacuum, inter-galactic space), chameleons have small masses and interact much more strongly with other matter
- May contribute to cosmic inflation

Solar chameleons

Chameleon particles can be created by the Primakoff effect in a strong magnetic field, like in the Sun. Then, the ones, which eventually reach the Earth, can be back-converted to X-ray photons, like axions. So:



Axion Helioscope

↓

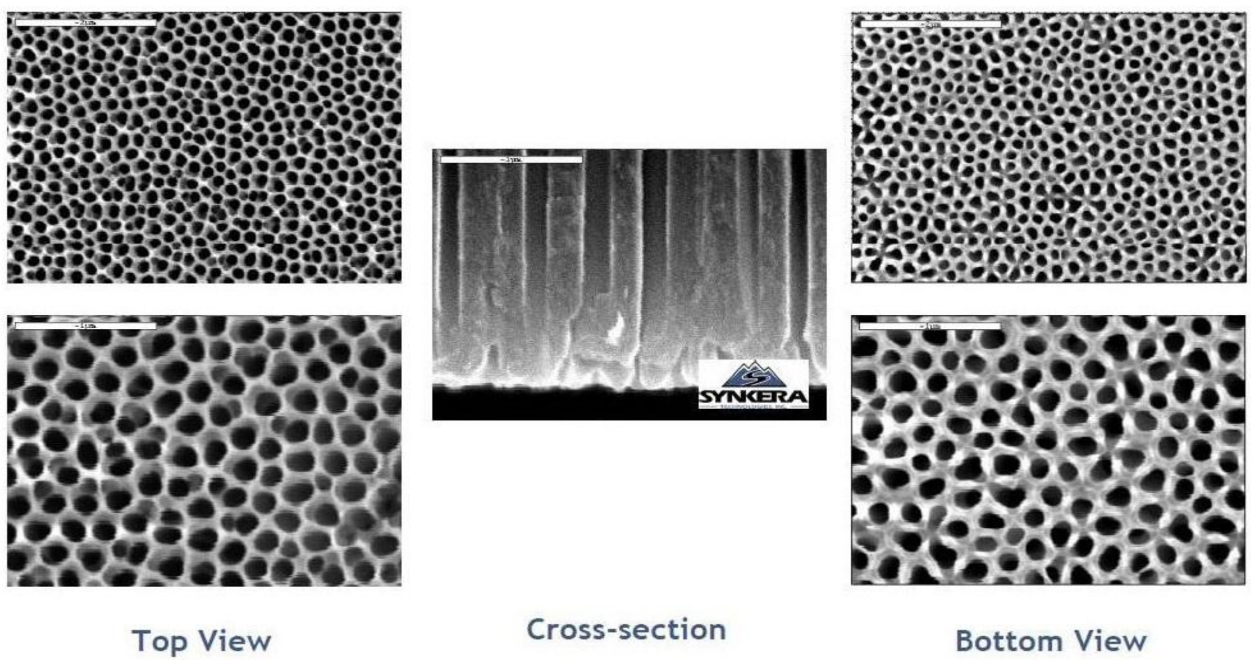
Chameleon Helioscope (at low energies)

But in order to detect at low energies ->

New transparent windows:

- Nanotubes material (Al_2O_3) -> <u>Tests in progress</u>
- Feasibility for kapton based using microbulk techniques (honeycomb)

AAO MEMBRANES WITH 150nm PORES



Thank you!

Special thanks to Sharon, Laura and Eva!!