

VMB@CERN: update

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On behalf of VMB@CERN

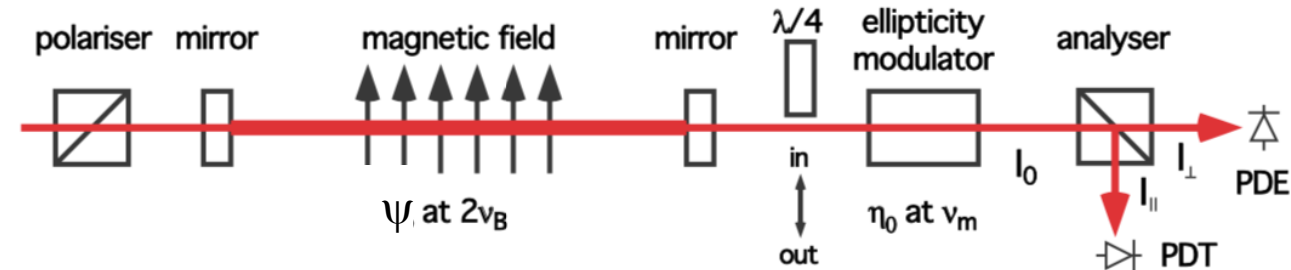
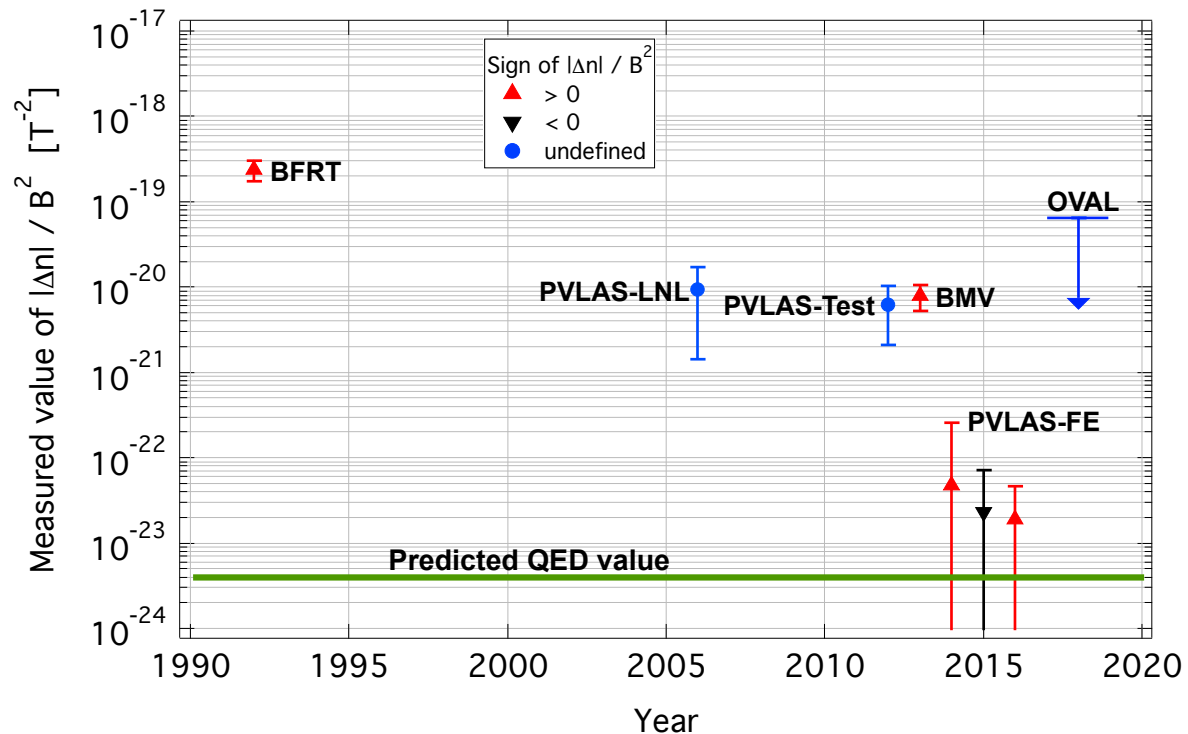
Pre-PBC meeting, Feb. 25th 2021

VMB@CERN: Aim

- Measure vacuum magnetic birefringence (VMB) for the first time
- Predicted by the Euler-Heisenberg-Kockel Lagrangian (confirmed by QED)

$$\Delta n = 3A_e B^2 \quad \text{with} \quad A_e = \frac{2}{45\mu_0} \frac{\lambda_e^3}{m_e c^2} \alpha^2 = 1.32 \times 10^{-24} \text{ T}^{-2}$$

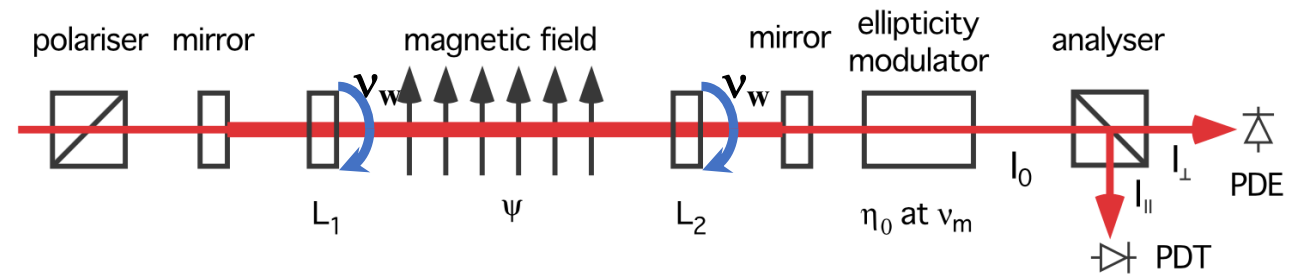
- Present best experimental limit has been set from polarimetry - PVLAS



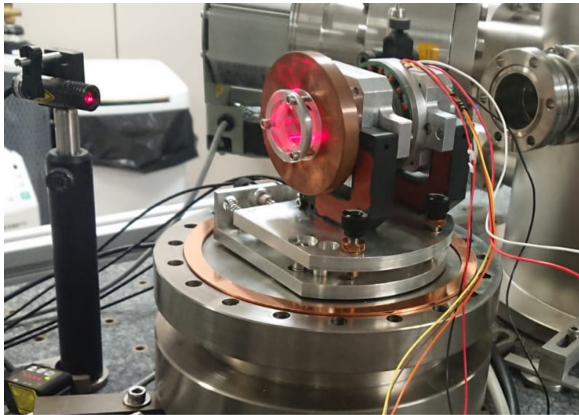
The PVLAS experiment was limited by the intrinsic noise coming from the Fabry-Perot mirrors.

VMB@CERN: Method and first test

- The polarisation modulation scheme allows the use of static superconducting fields such those generated by an LHC dipole: up to 9T
- Rotate the polarisation inside the magnetic field using two HWPs inside the Fabry-Perot cavity

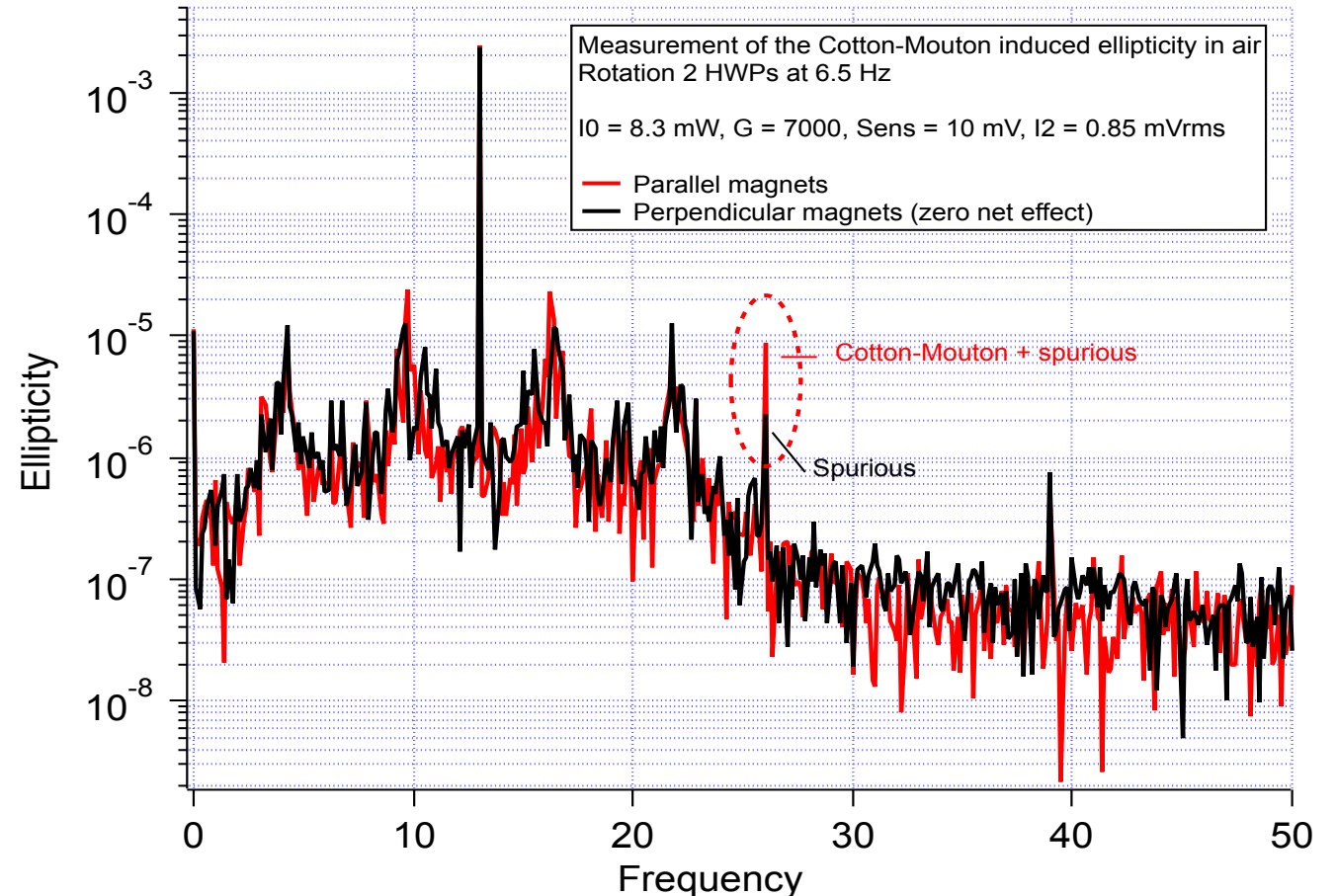


Rotation stage with a 4 degrees of freedom control of the rotation axis



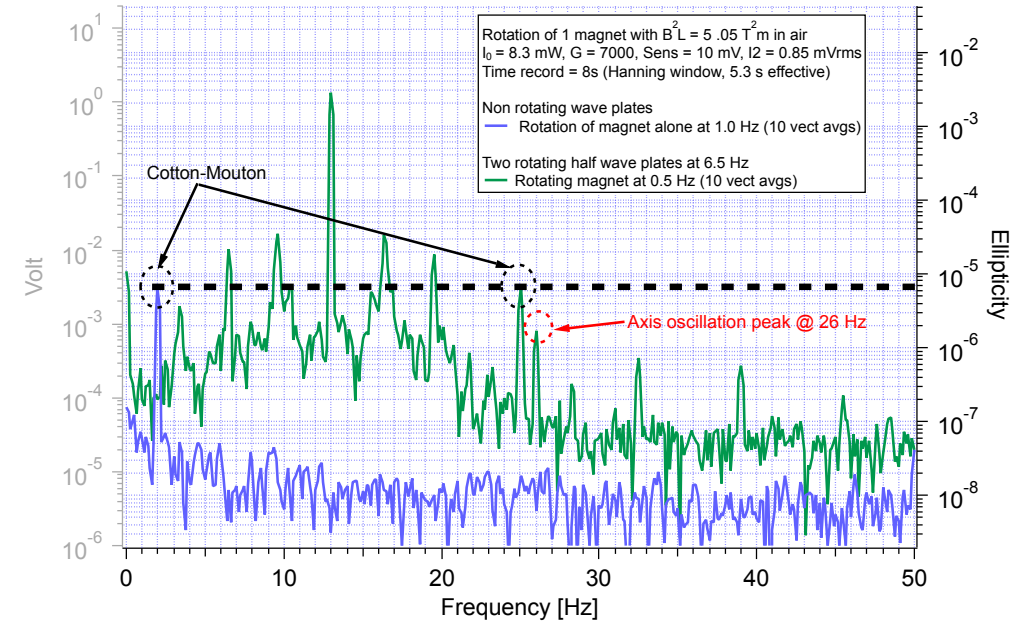
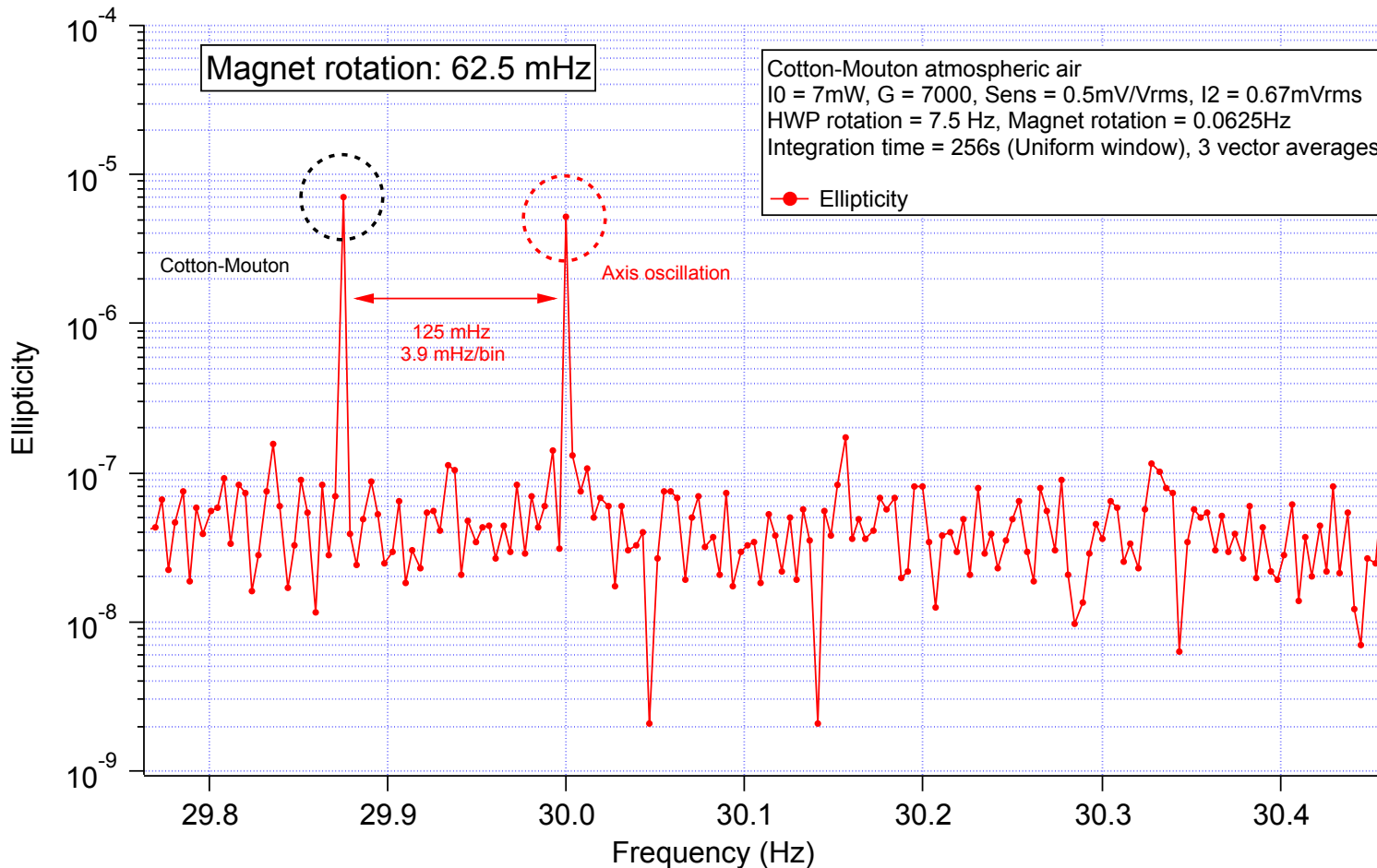
First test without the Fabry-Perot

- Method works: signal appears at the 4th harmonic of the HWP rotation (red)
- Problem: presence of a spurious signal with perpendicular magnets (black). Also observed when rotating a single full wave plate
- (The structures around the 2nd harmonic are due to slight phase fluctuations between the motors: necessity of phase locked motors)



VMB@CERN: Problem and possible workaround

- Study of systematics is in progress
 - Signals induced by wave plate defects
 - Signals induced by mechanical rotation
 - The coupling between the two above spurious causes results in a dominant contribution: wave plate wedge + axis oscillation



- Possible workaround: modulate the magnetic field generating sidebands around the 4th harmonic of the rotating wave plates
- Question: which is the fastest modulation frequency of an LHC dipole?
- Next step: install the Fabry-Perot cavity