VMBCERN: Vacuum Magnetic Birefringence at CERN

H. Euler and B. Kockel (1935): effective Lagrangian density describing non-linear electromagnetic interactions in vacuum in the presence of the virtual electron-positron sea discussed a few years before by Dirac

$$\mathcal{L}_{EK} = \frac{1}{2\mu_0}\left(\frac{E^2}{c^2} - B^2\right) + \frac{A_e}{\mu_0}\left[\left(\frac{E^2}{c^2} - B^2\right)^2 + 7\left(\frac{\mathbf{E}}{c}\cdot\mathbf{B}\right)^2\right] + \dots$$

$$A_e = \frac{2}{45\mu_0}\frac{\alpha^2\hbar^3}{m_e^4 c^5} = 1.32 \times 10^{-24}\ \mathrm{T}^{-2}$$

Light propagation in vacuum is still described by Maxwell's equations in media but these are no longer linear due to Euler-Kockel correction.

The superposition principle no longer holds

$$n_{\parallel}^{(\mathrm{EK})} = 1 + 7A_e B_{\mathrm{ext}}^2 \qquad n_{\perp}^{(\mathrm{EK})} = 1 + 4A_e B_{\mathrm{ext}}^2$$

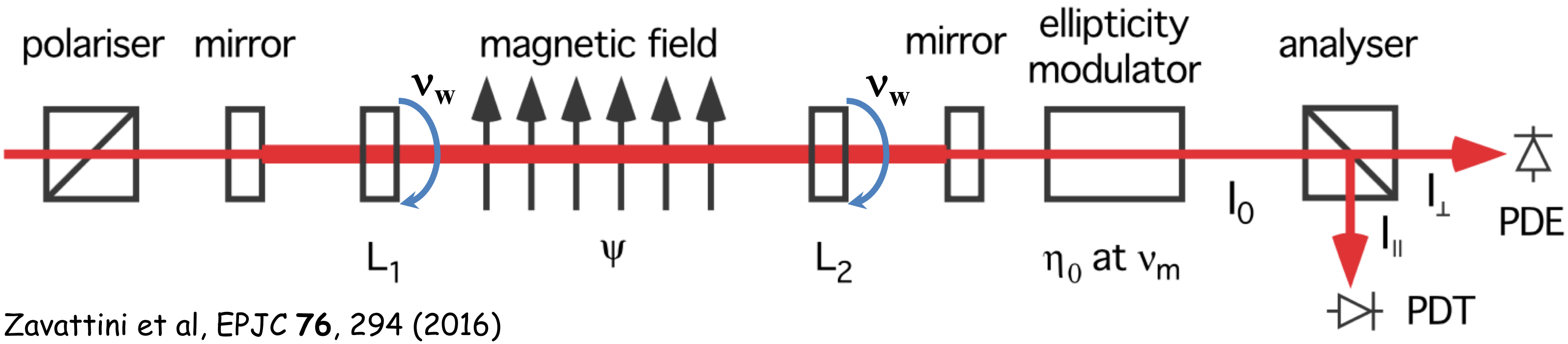
$$\Delta n_B = 2.5 \times 10^{-23} \quad @ \quad 2.5\ \mathrm{T}$$

$n > 1$ in vacuum!

VMBCERN. Experimental method for polarimetry

Polarization modulation scheme

- Two half-wave plates co-rotating @ ν_W with a fixed relative angle $\Delta\phi$
- Rotate polarization inside the magnetic field
- Employ a spare LHC dipole magnet
- Fix polarization on mirrors to avoid mirror birefringence signal
- Present knowledge indicates a measurement time of only 1 day



G Zavattini et al, EPJC **76**, 294 (2016)

New idea: use **two** wavelengths to study the defects of the waveplates

Contributo di Siena: progetto e realizzazione di prototipi di sistemi di rotazione con controllo di quattro gradi di libertà

VMBCERN. Numeri 2021

10 Ricercatori - 4.8 FTE

Ferrara:	M. Andreotti	10%
	P. Cardarelli	20%
	G. Di Domenico	40%
	G. Zavattini	70% Resp. Naz.
	G. Messineo	100% (Fellini)
LNL:	R. Pengo	40%
	G. Ruoso	40%
Pisa (Siena):	**F. Della Valle**	100%
	C. Marinelli	40%
	E. Mariotti	20%

Richieste finanziarie Pisa 17 k€

Missioni	12 k€ (10 k€ missioni + 2 k€ conferenze)
Consumo	10 K€ (meccanica)

Nessuna richiesta di servizi alla Sezione