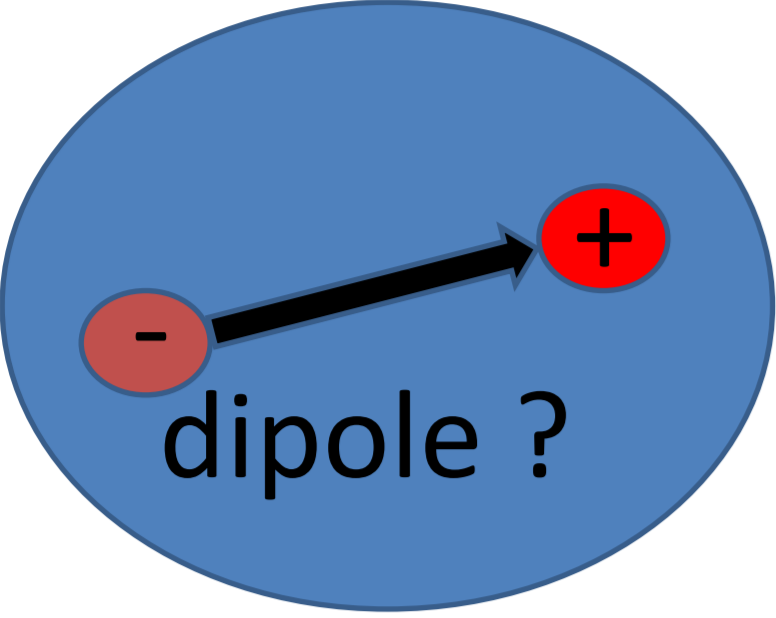


Patrick Cheinet, Daniel Comparat, Hans Lignier, Bruno Viaris, Thomas Battard (LAC), Wutharath Chin, Claudine Crépin-Gilbert (ISMO), Benoit Gervais (CIMAP), Chloé Malbrunot (CERN), Benoit Darquié (LPL)

Introduction

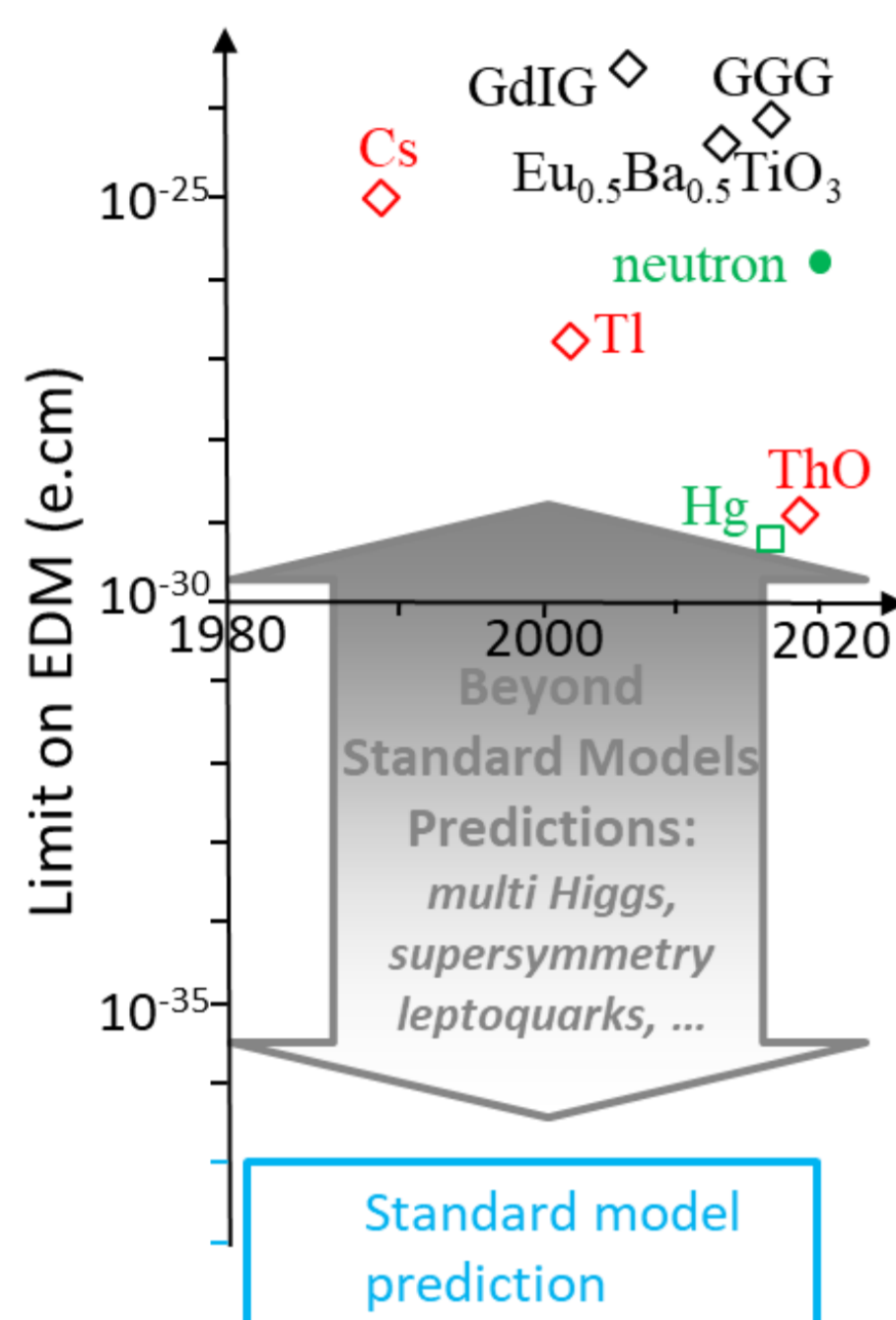
électron



Electric Dipole Moments (EDM) are sensitive probes for physics beyond the Standard Model. We propose to measure the electron-EDM using Cs atoms embedded in a cryogenic solid matrix of inert gas or hydrogen.

State of the art

Historical perspective on selected EDM measures



Proposal in matrix

Electron EDM sensitivity

$$\sigma_d = \frac{\hbar}{\epsilon E_{eff} \tau \sqrt{N_T}}$$

Method	System	N_T time integrated	Time τ [s]	Polarization ϵ	Eff. Field E_{eff} (V/cm)	EDM e.cm
Solid	Eu _{0.5} Ba _{0.5} TiO ₃	10 ²⁵	0.2	<10 ⁻¹⁰	10 ⁷	6 · 10 ⁻²⁵
Gas	ThO	10 ¹¹	0.002	0.1	10 ¹¹	10 ⁻²⁹

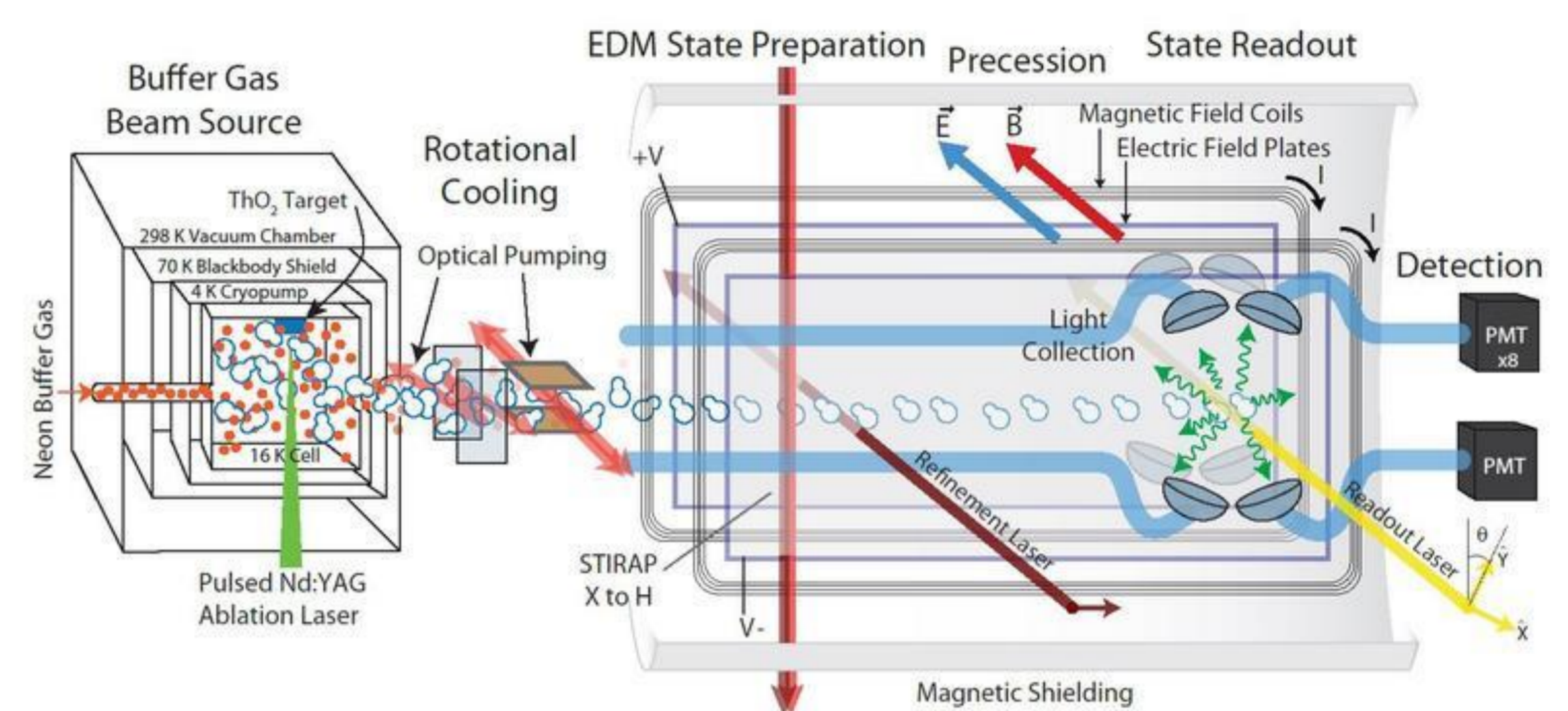
Proposed system in inert matrix

Method	System	N_T	τ [s]	ϵ	E_{eff} (V/cm)	EDM e.cm
Atom EDMMA	Cs (Conservative)	~10 ¹⁸	0.001	0.1	10 ⁶	~10 ⁻²⁷
	Cs (optimal)	~10 ²²	1	1	10 ⁹	~10 ⁻³⁶
Molecule (EDM ^f)	BaF	~10 ²⁰	0.1	0.1	10 ¹⁰	~10 ⁻³⁴

Usual method : gas phase measurement

Improved limit on the electric dipole moment of the electron

ACME Collaboration., Andreev, V., Ang, D.G. *et al.* Improved limit on the electric dipole moment of the electron. *Nature* **562**, 355–360 (2018).



Moving atoms, Low density

Vacuum simulation with inert solid matrix

“ARTIFICIAL VACUUM” FOR T-VIOLATION EXPERIMENT

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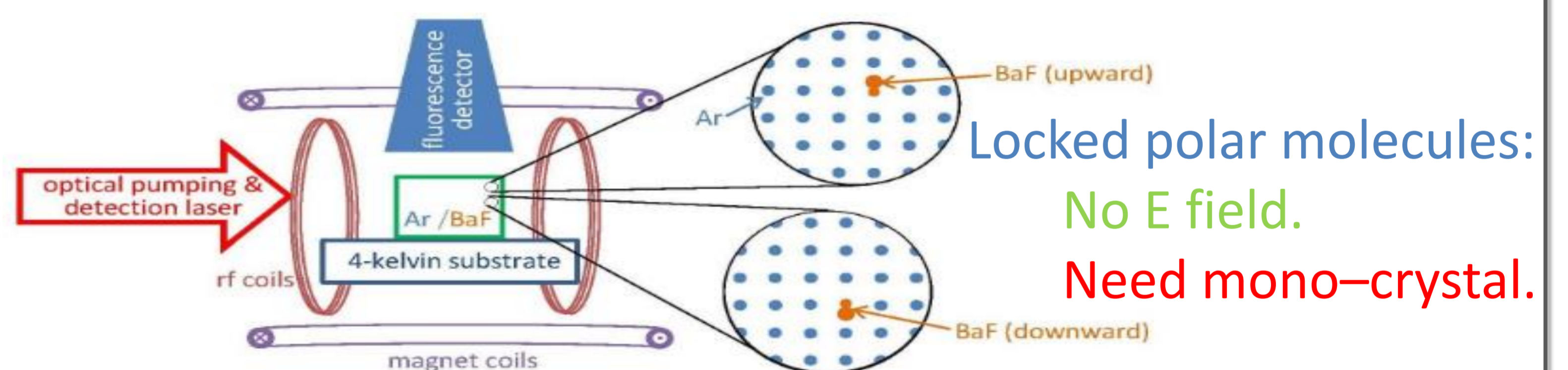
Lots of particles trapped “like” in gas phase : High density, Long coherence time



<http://www.yorku.ca/edmcubed>

Article
Oriented Polar Molecules in a Solid Inert-Gas Matrix: A Proposed Method for Measuring the Electric Dipole Moment of the Electron

A. C. Vutha^{1*}, M. Horbatsch² and E. A. Hessels²



EDM measurement using Cs atoms

Spin coherence (100 ms) optical pumping 10% in solid parahydrogen (PRA 100, 063419 (2019))

At more than 10¹⁶ cm⁻³ density

