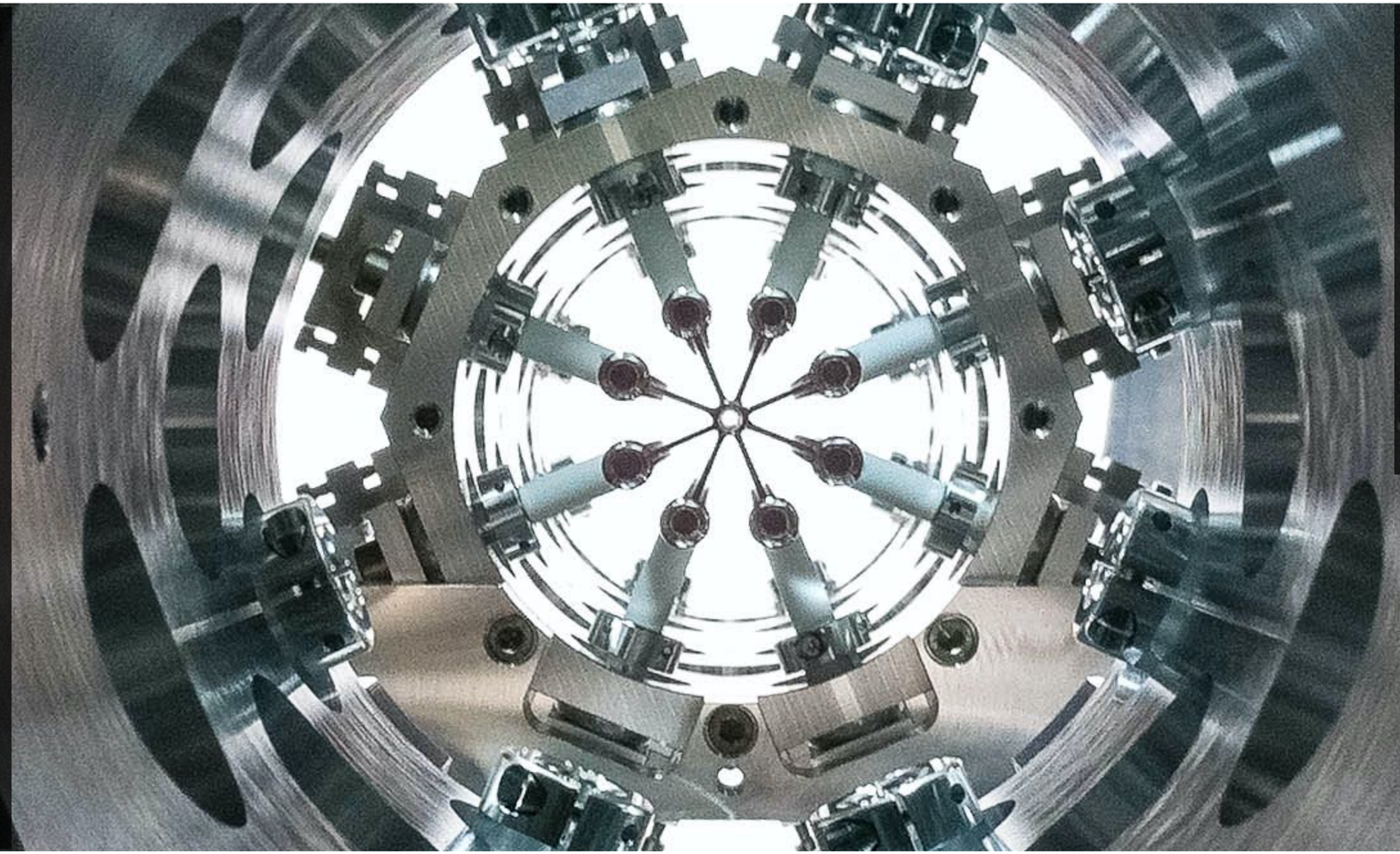
Tabletop particle physics:
Measuring the electron-EDM with cold molecules



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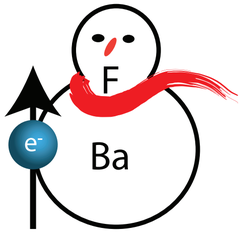


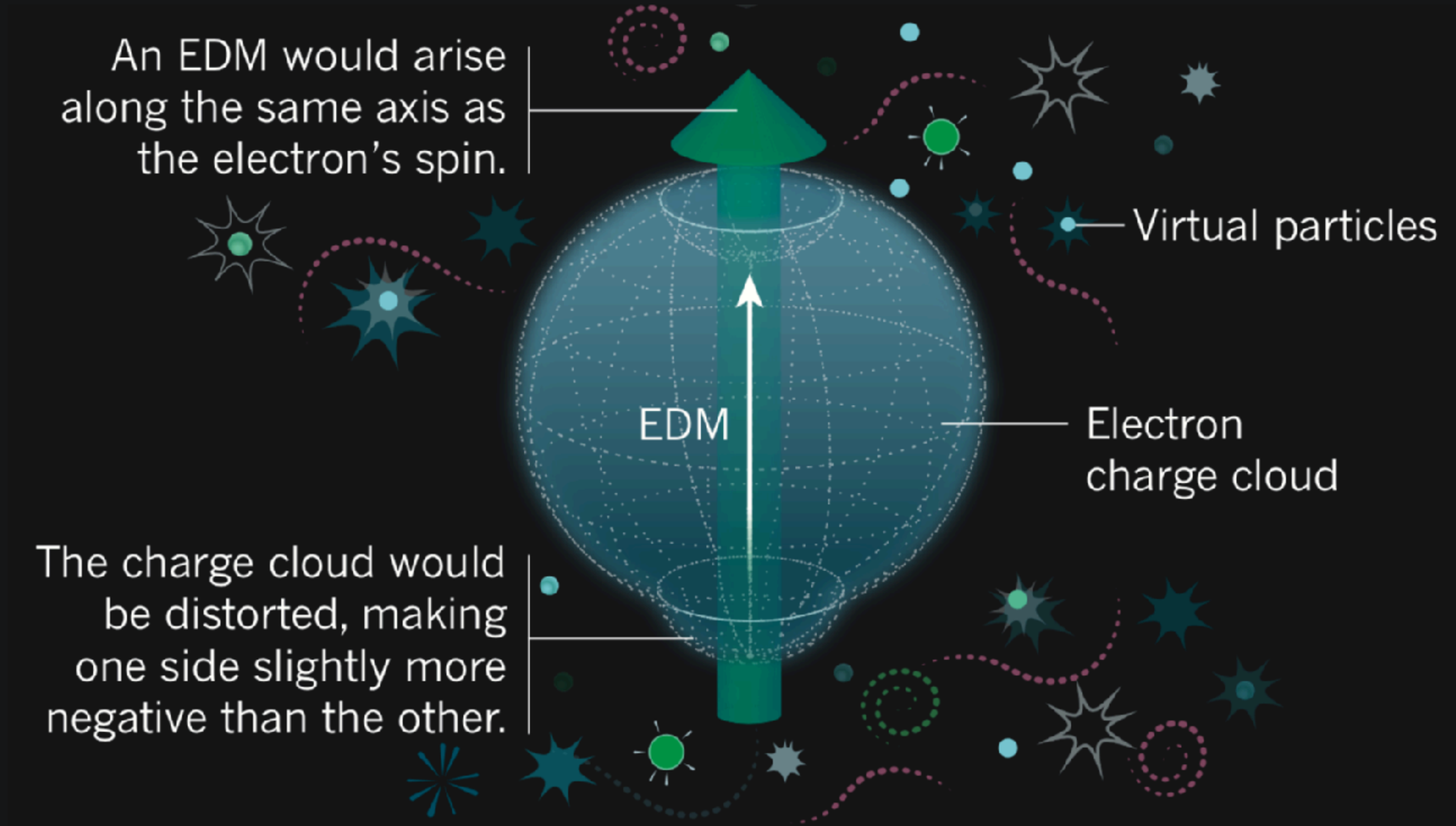
university of groningen
van swinderen institute for particle physics and gravity

Nikhef
Dutch National Institute for (astro)Particle Physics

VU VRIJE UNIVERSITEIT AMSTERDAM

Is the electron round?

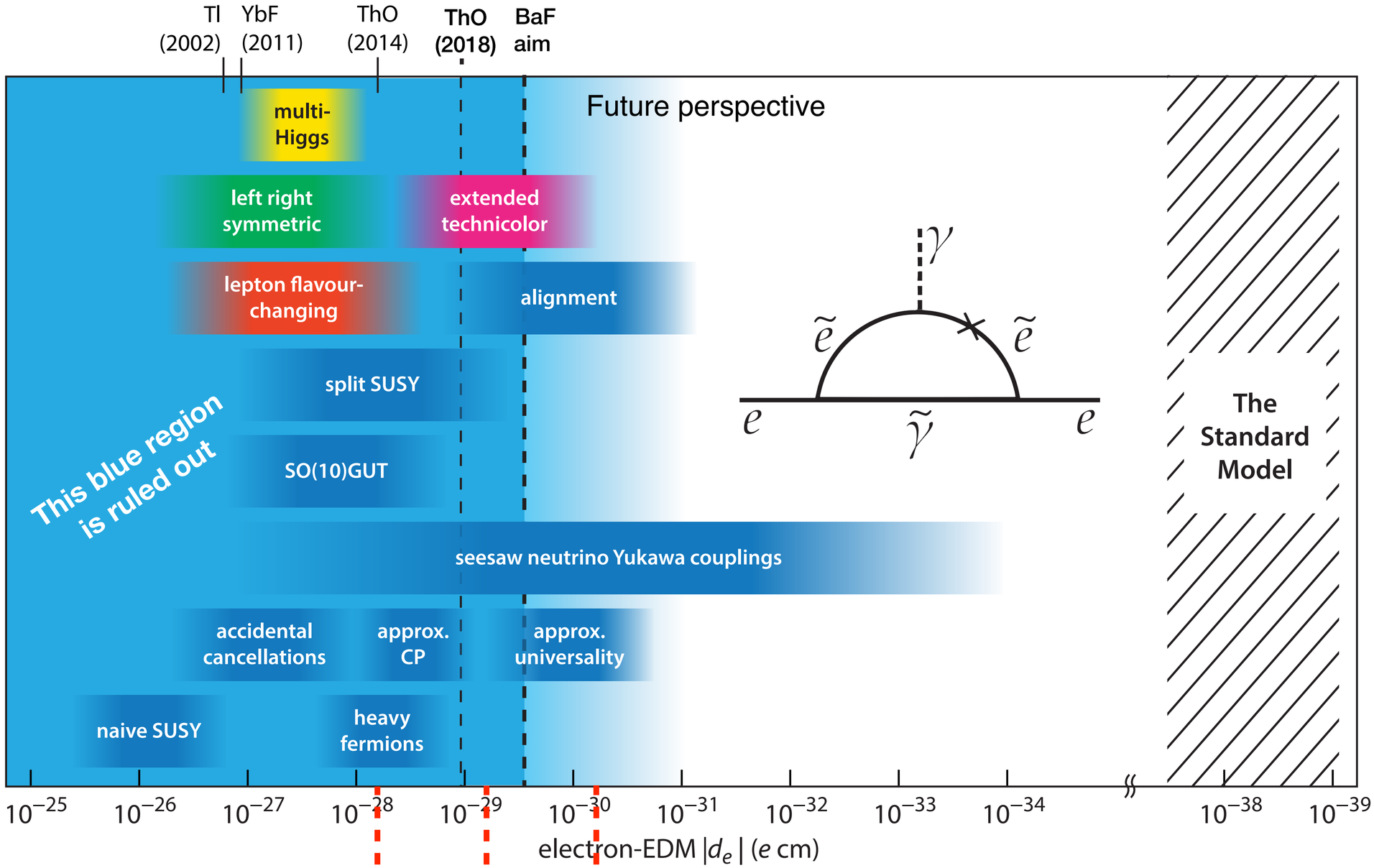
The Electric Dipole Moment of the electron (eEDM)



an eEDM violates time-reversal symmetry

figure reference:
Nature 553, 144 (2018)

The Standard Model has problems: it can not explain matter-antimatter asymmetry. electron-EDM experiments test the extensions that aim to fix this problem!



Huge progress on electron-EDM using molecules!

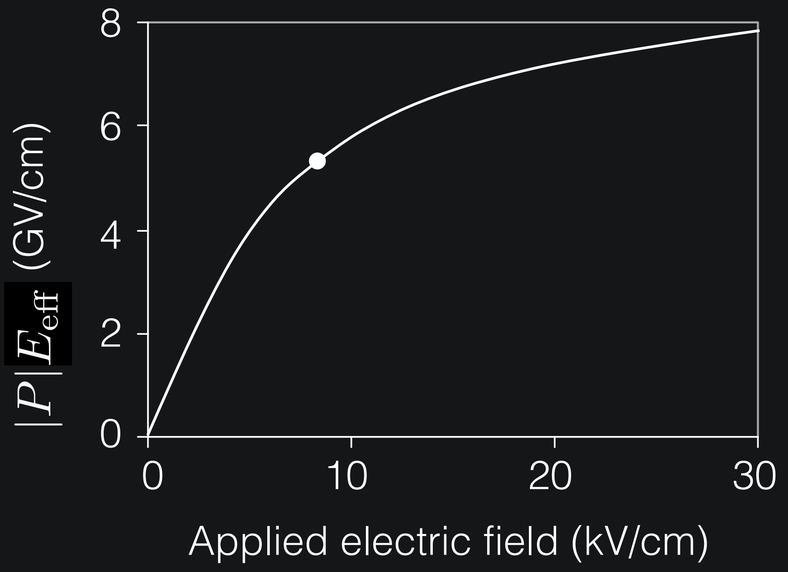
statistical error: $\sigma_d = \frac{\hbar}{e} \frac{1}{2|P|E_{\mathrm{eff}}\tau\sqrt{\dot{N}T}}$

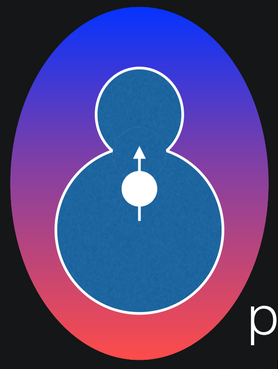
Cold Molecules

Number of detected molecules

Coherent interaction time

Effective electric field



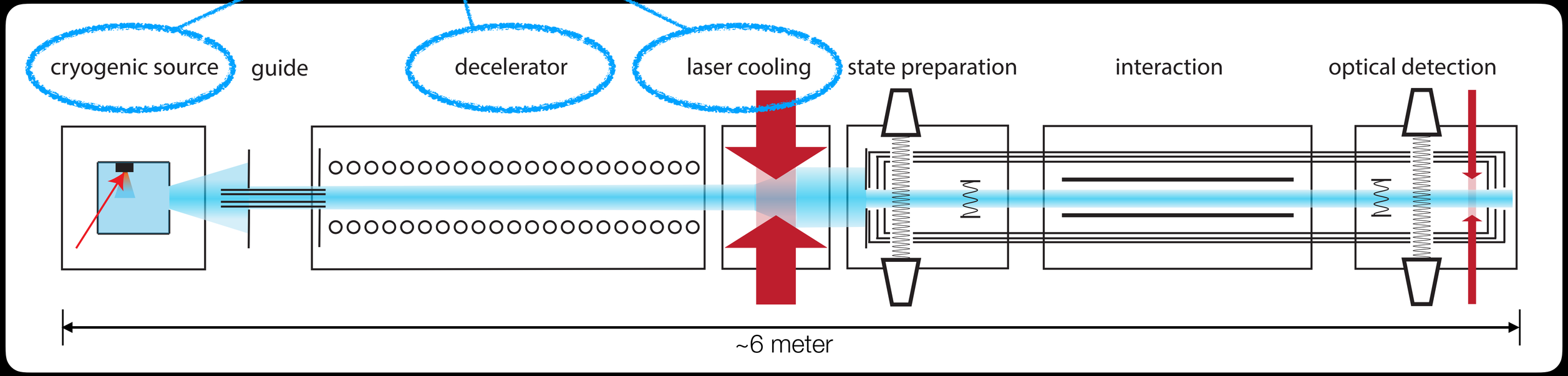


polar molecule

Measure shift of energy levels depending on molecule orientation. Non-zero shift: electron-EDM !

Our approach:

Combining three recent experimental breakthroughs



Using BaF molecules, we can create a very **intense, slow and cold** beam

paper with full details of experiment: Eur. Phys. J. D **72**:197 *(2018)*

The main challenges:

Rich quantum structure

Our focus in the last year:

Molecular spectroscopy and structure
Theory & experiment (2 papers)

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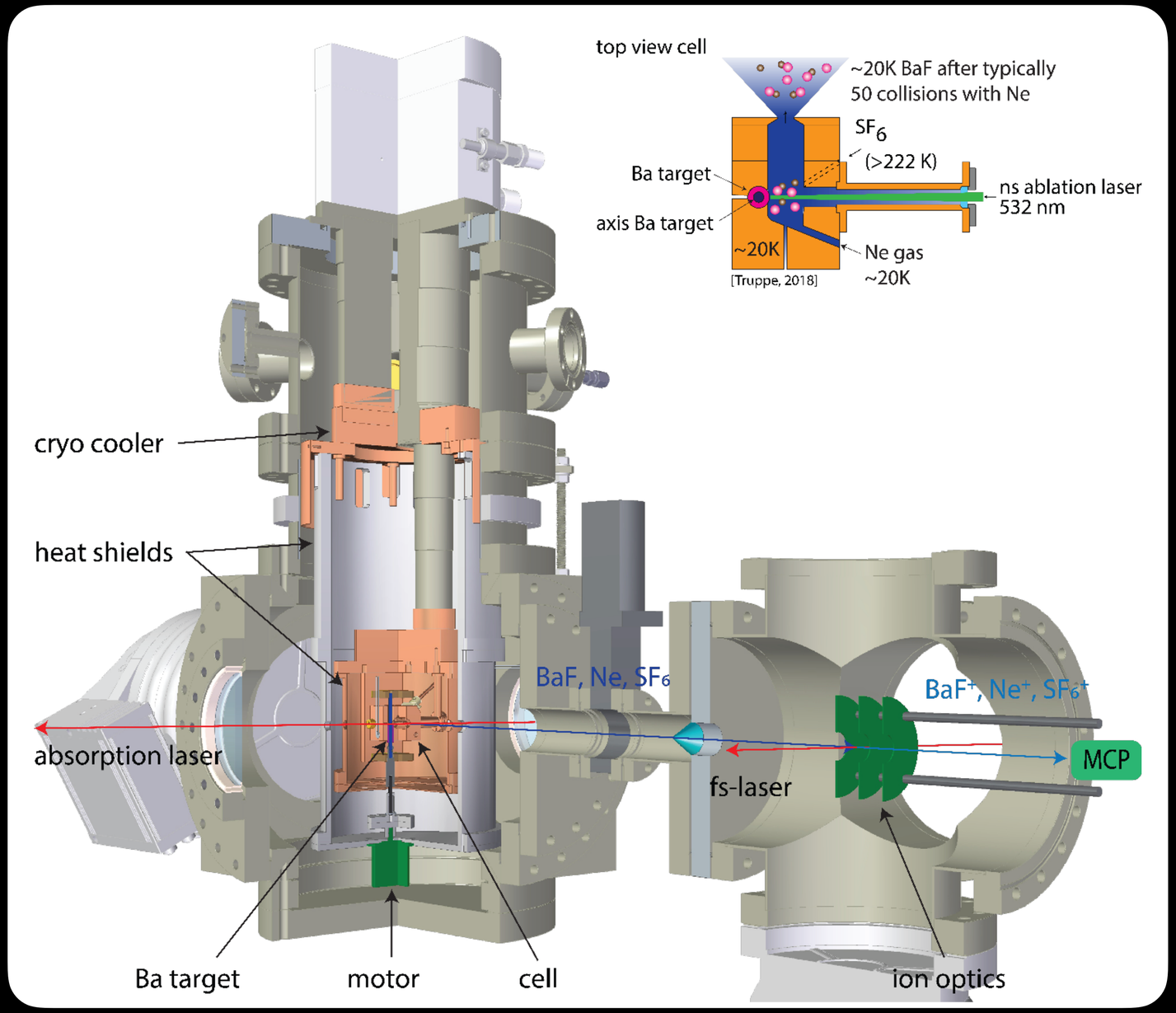
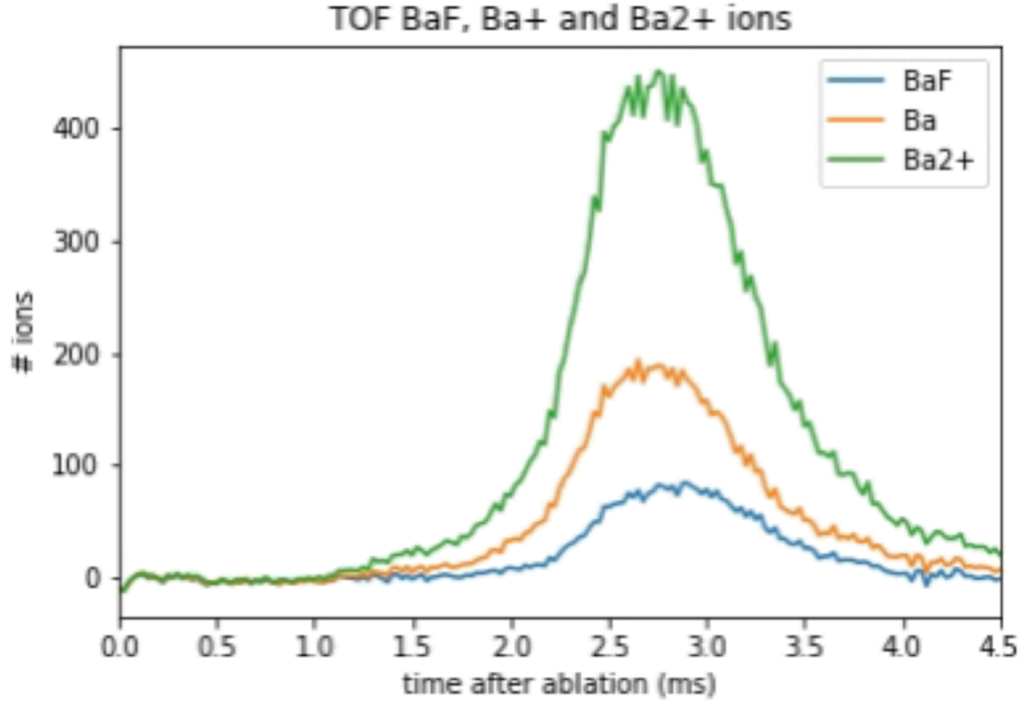
Intense ánd slow molecular beam

Cryogenic source & decelerator - Yanning (next talk)
Dedicated cryogenic source for optimisation

Cryogenic source @ VU

detection of all species in the beam





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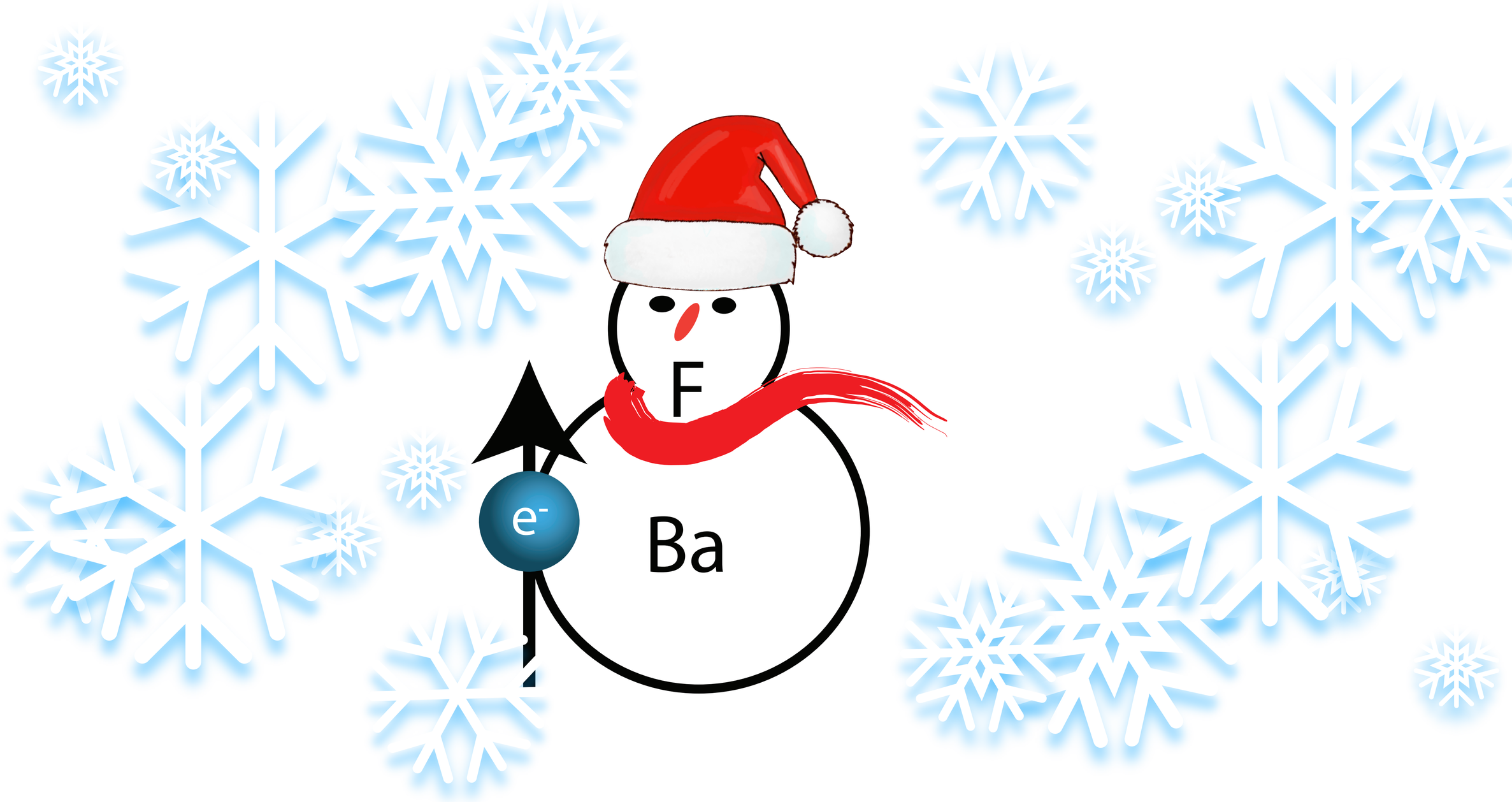
Systematic effects

Setting up a fast-beam EDM measurement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