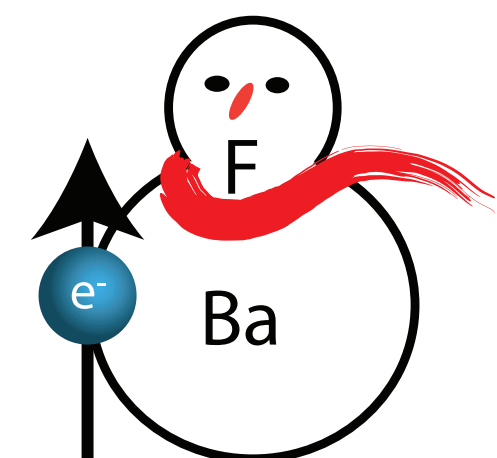
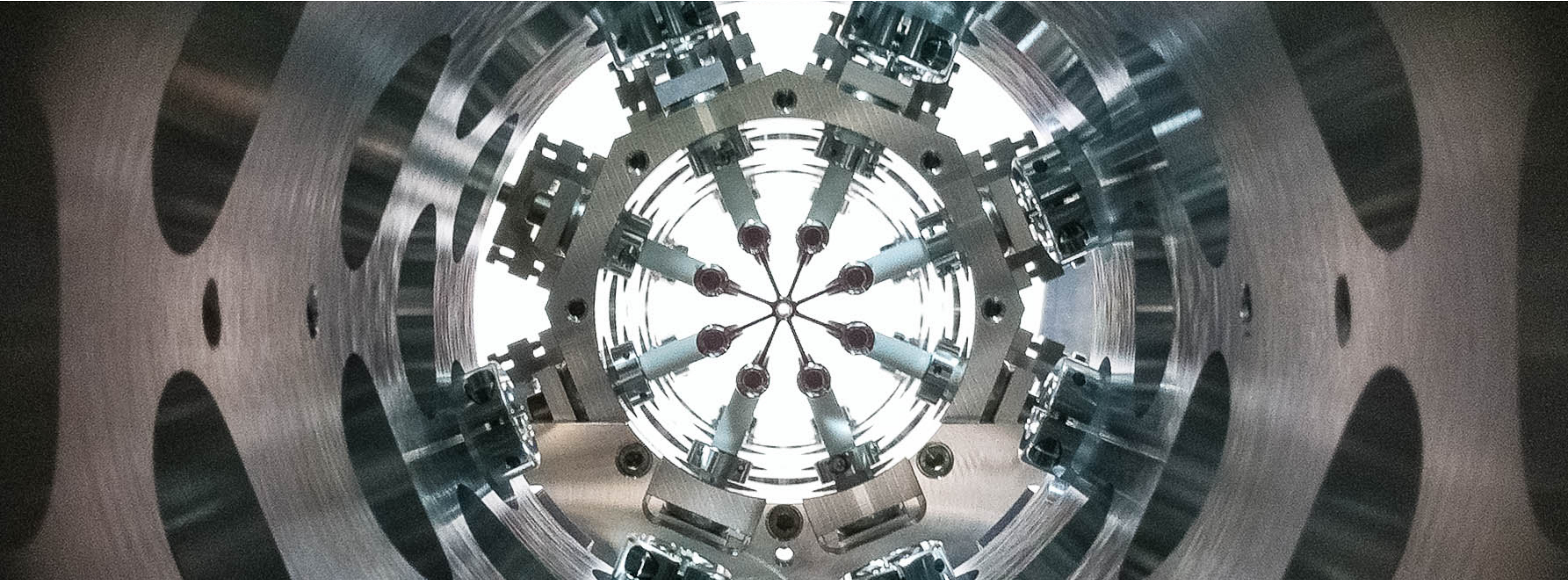


# NL-eEDM

## Measuring the electron-EDM with BaF molecules



university of  
 groningen  
 van swinderen institute for  
 particle physics and gravity

Nikhef

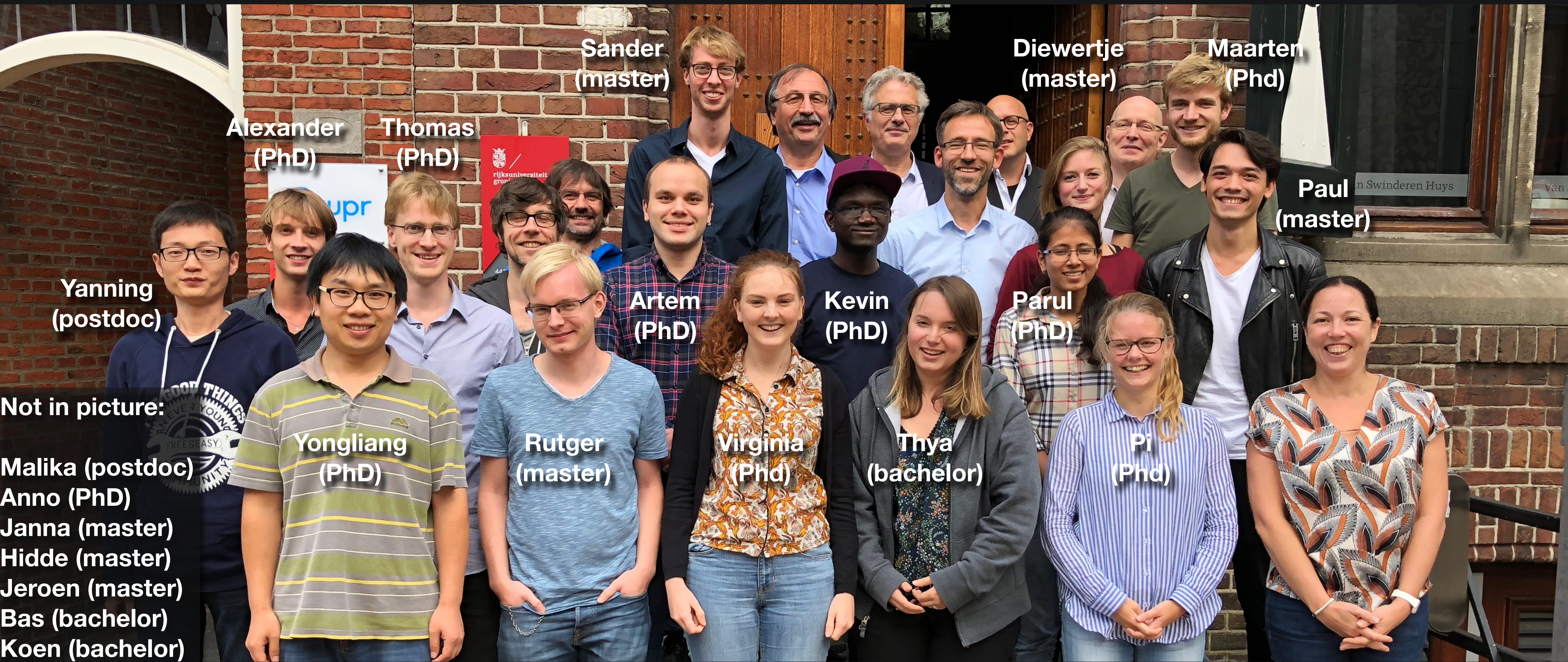
Dutch National Institute for (astro)Particle Physics



VRIJE  
UNIVERSITEIT  
AMSTERDAM



# The NL-eEDM team



Sander  
(master)

Diewertje  
(master)

Maarten  
(Phd)

Alexander  
(PhD)

Thomas  
(PhD)

Paul  
(master)

Yanning  
(postdoc)

Artem  
(PhD)

Kevin  
(PhD)

Parul  
(PhD)

Not in picture:

Yongliang  
(PhD)

Rutger  
(master)

Virginia  
(Phd)

Thya  
(bachelor)

Pi  
(Phd)

- Malika (postdoc)
- Anno (PhD)
- Janna (master)
- Hidde (master)
- Jeroen (master)
- Bas (bachelor)
- Koen (bachelor)



# The young generation



# The NL-eEDM team



Team electron-EDM

Nikhef  university of groningen  Vrije Universiteit Amsterdam

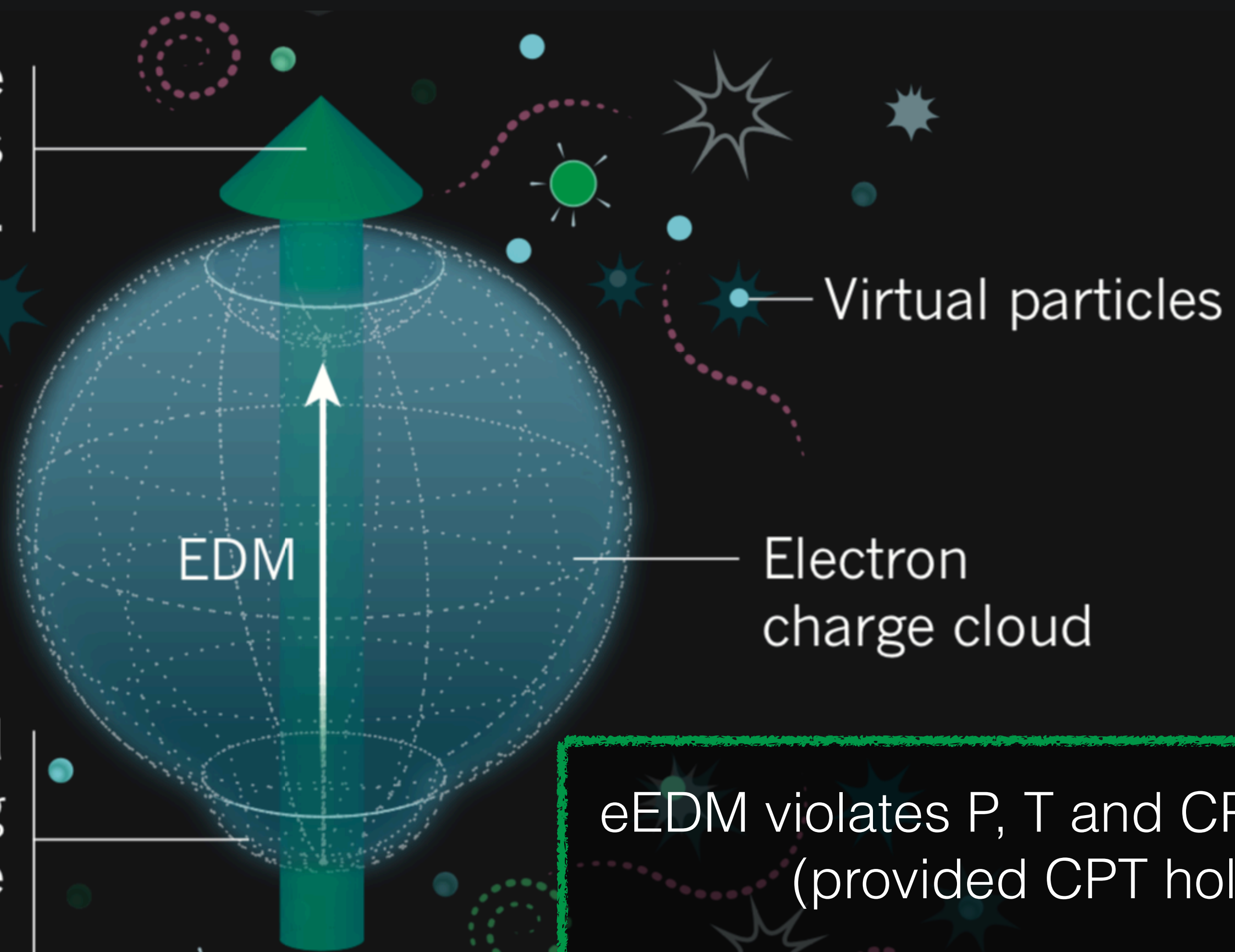
# The youngest generation



# The Electric Dipole Moment of the electron (eEDM)

An EDM would arise along the same axis as the electron's spin.

The charge cloud would be distorted, making one side slightly more negative than the other.



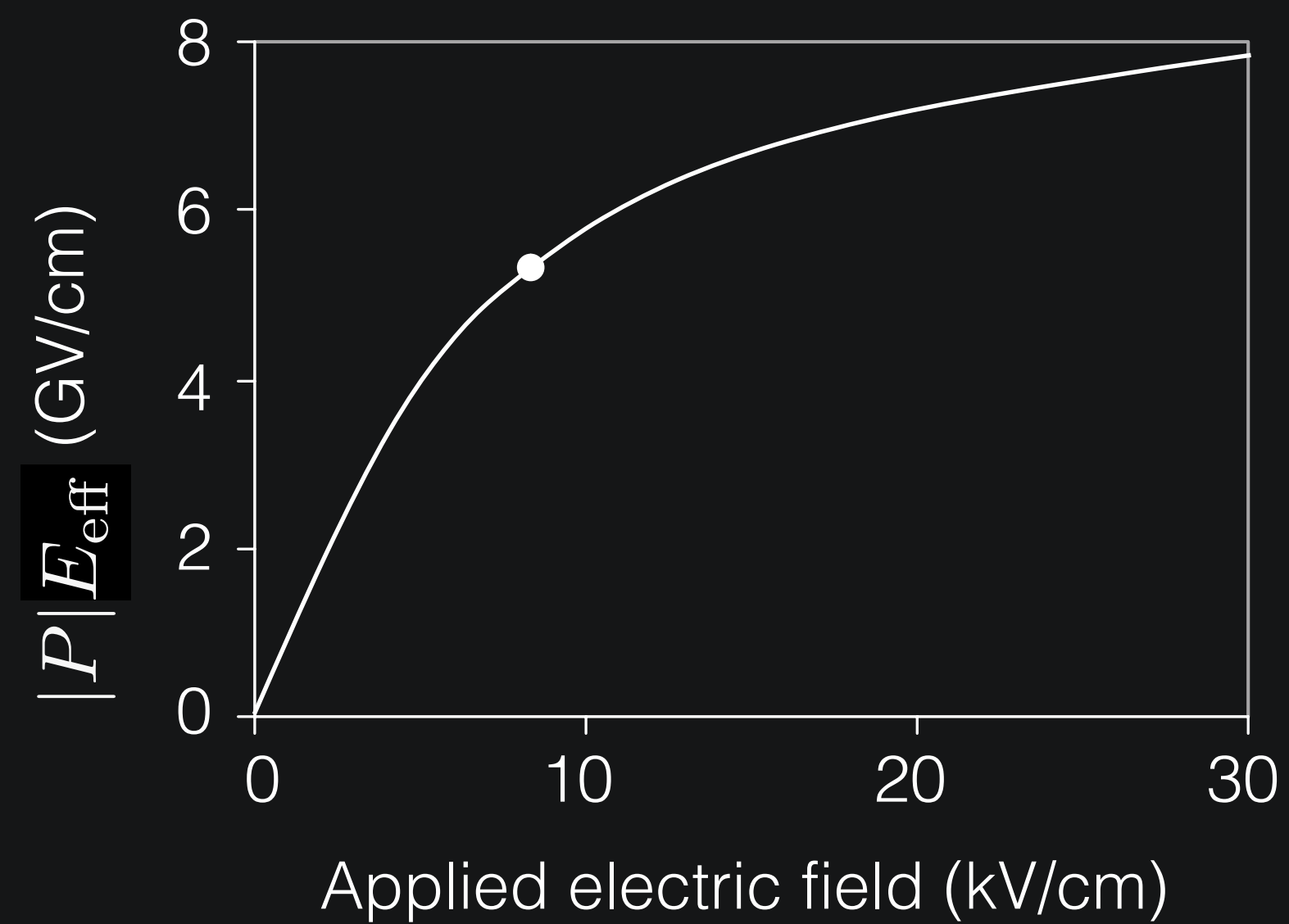
eEDM violates P, T and CP symmetry (provided CPT holds)

Current limit:  $d_e < 1.1 \times 10^{-29}$  e.cm  
probes new physics in range 3-30 TeV



# Measuring eEDM using molecules: sensitivity

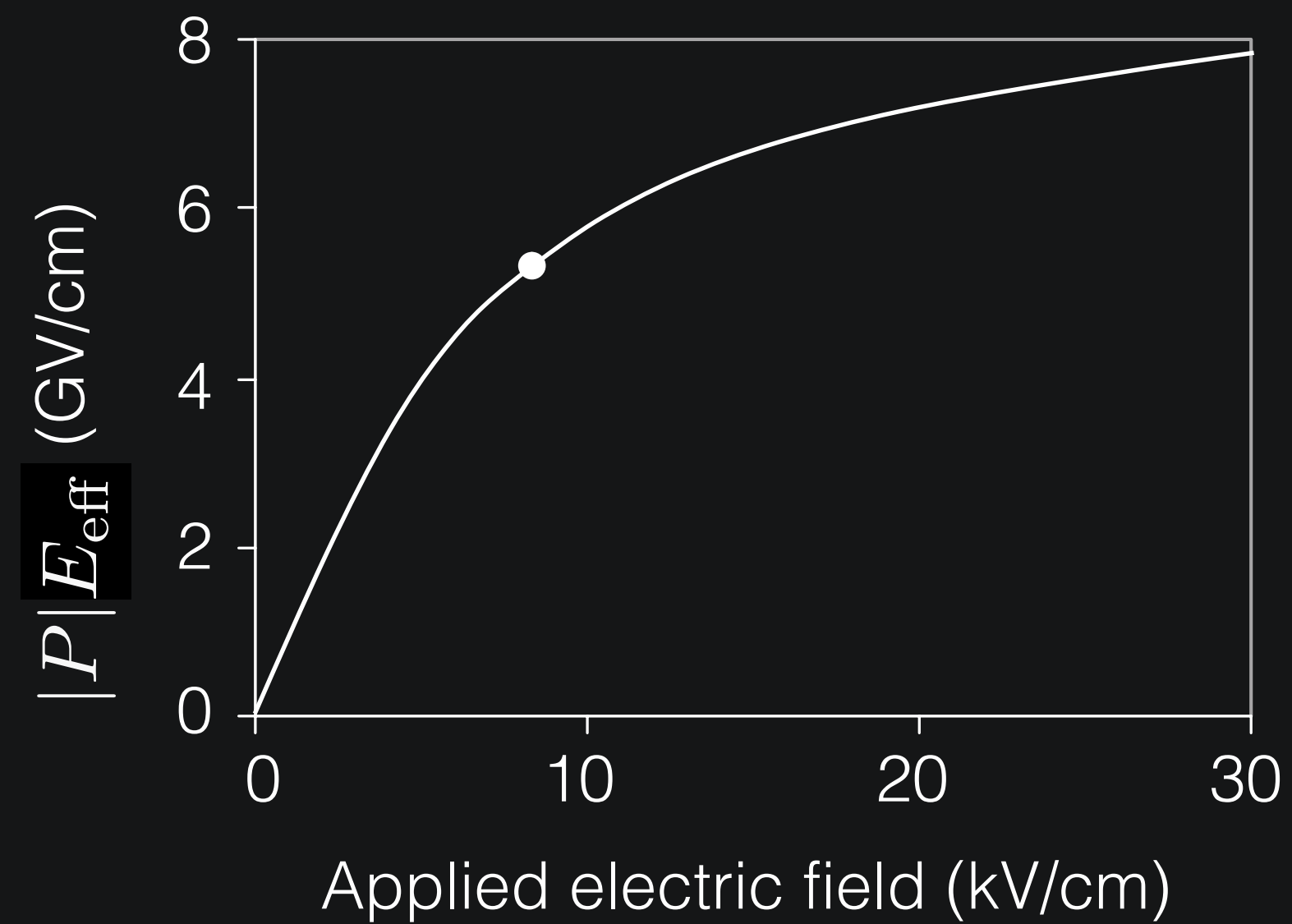
Effective electric field





# Measuring eEDM using molecules: sensitivity

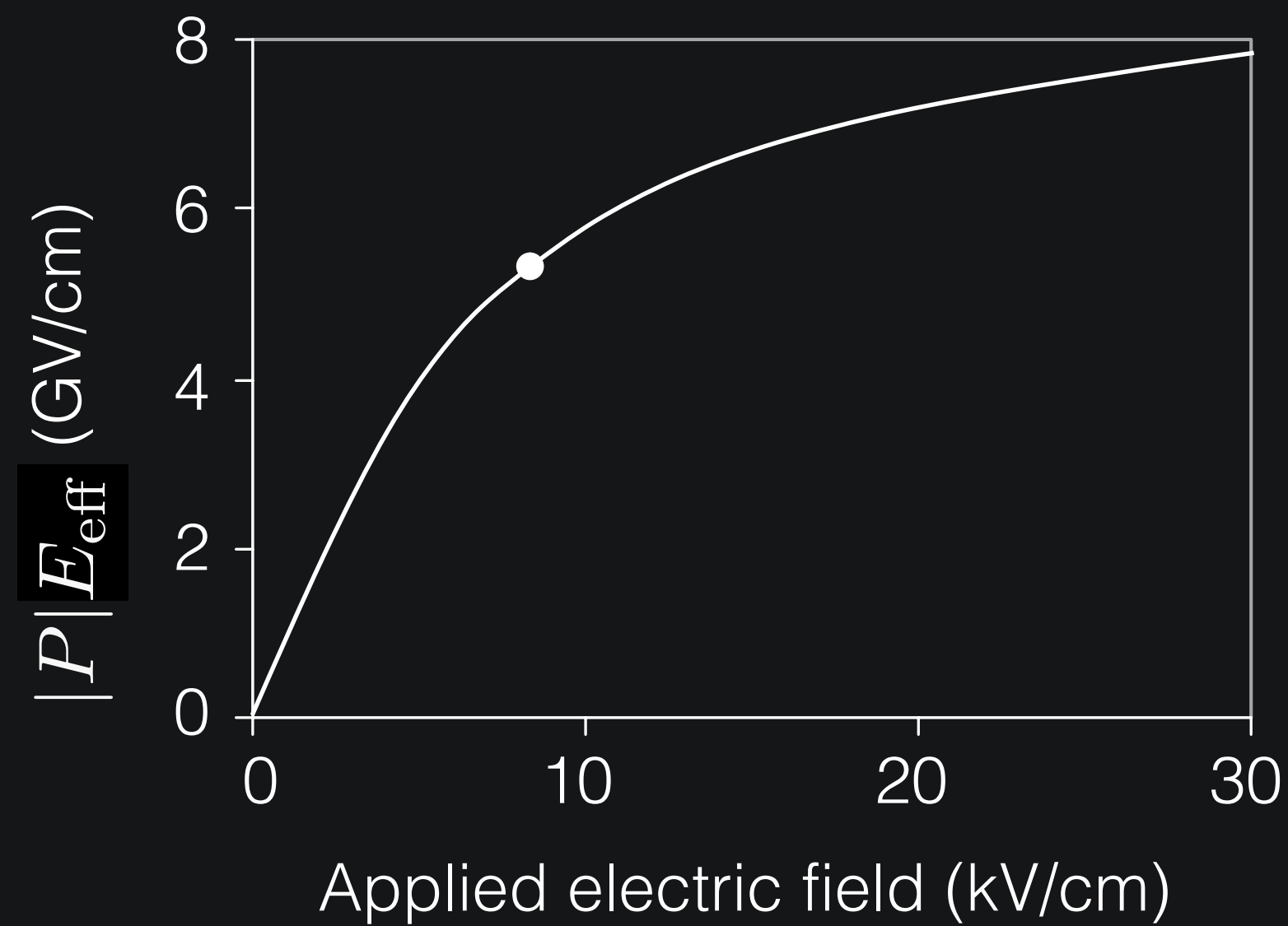
Effective electric field





# Measuring eEDM using molecules: sensitivity

Effective electric field



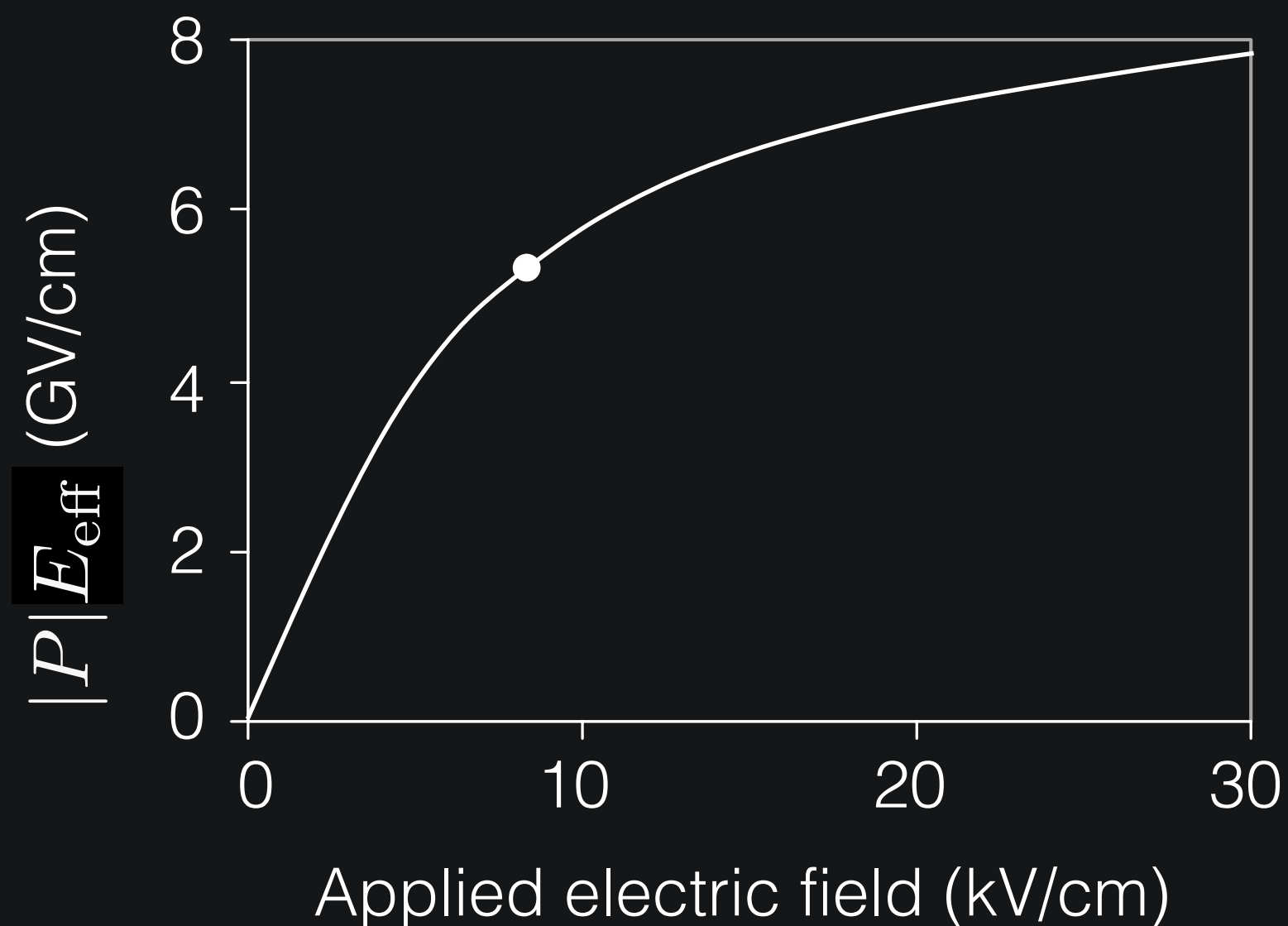
Measure shift of energy levels depending on molecule orientation. Non-zero shift: electron-EDM !



# Measuring eEDM using molecules: sensitivity

statistical error: 
$$\sigma_d = \frac{\hbar}{e} \frac{1}{2|P|E_{\text{eff}}\tau\sqrt{NT}}$$

Effective electric field



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



# Measuring eEDM using molecules: sensitivity

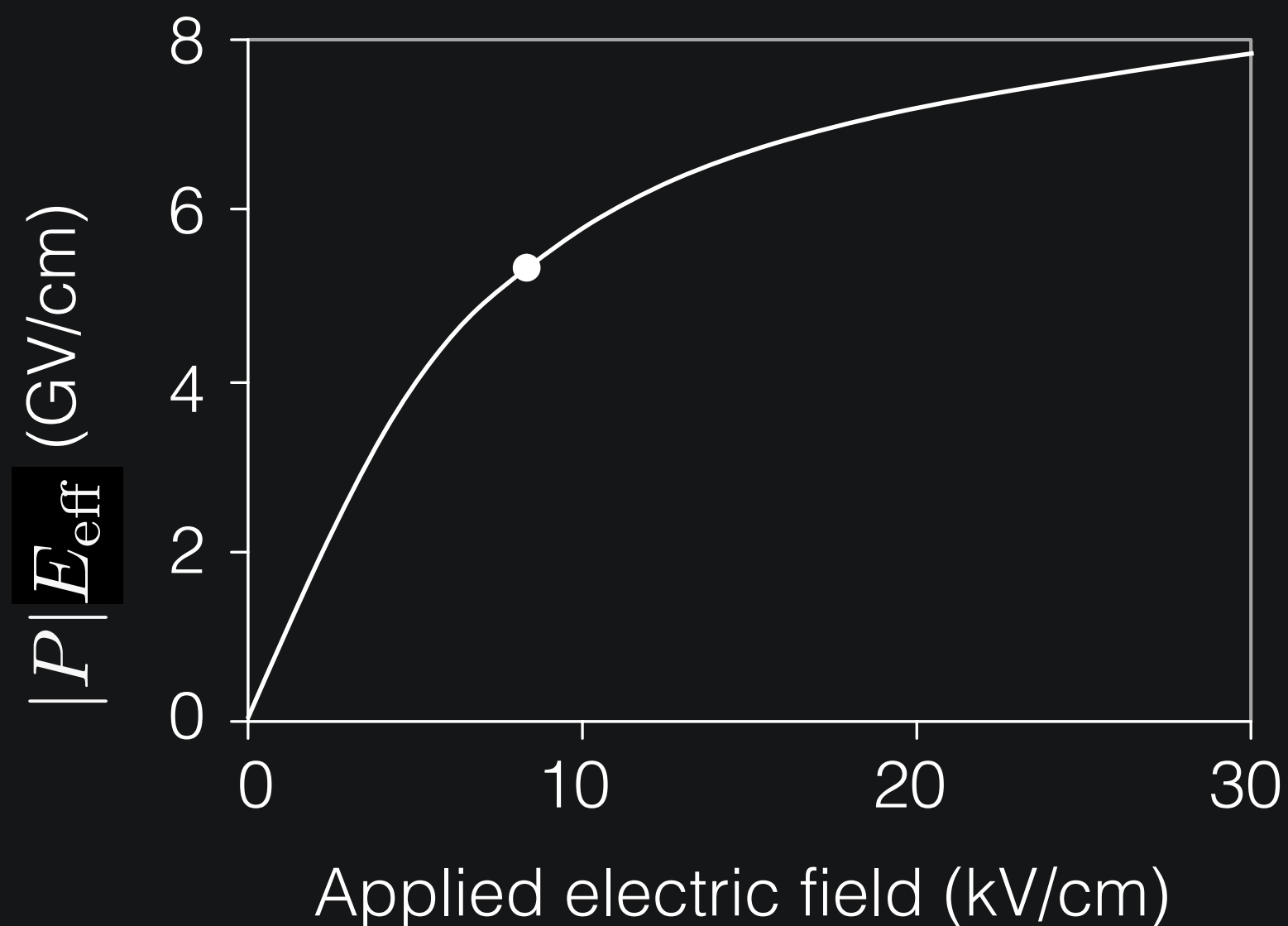
statistical error: 
$$\sigma_d = \frac{\hbar}{e} \frac{1}{2|P|E_{\text{eff}}\tau\sqrt{\dot{N}T}}$$

Cold Molecules

Number of detected molecules

Coherent interaction time

Effective electric field



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

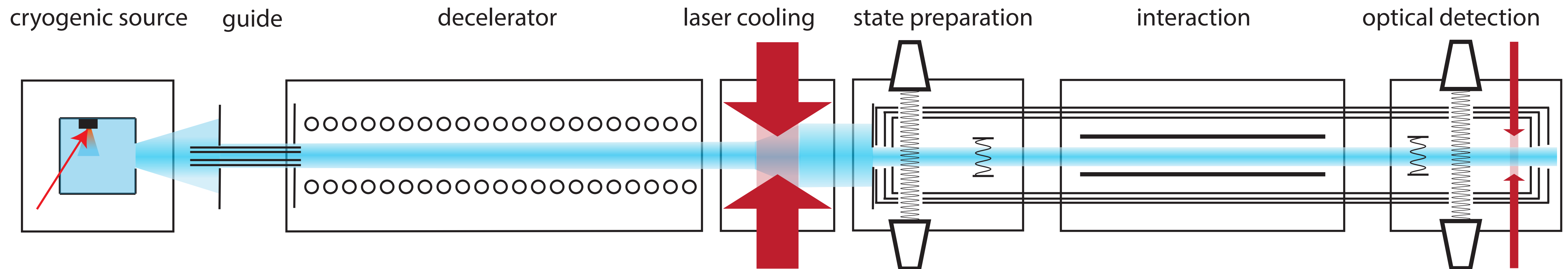


# Measuring eEDM using molecules: our approach

Combining three techniques:

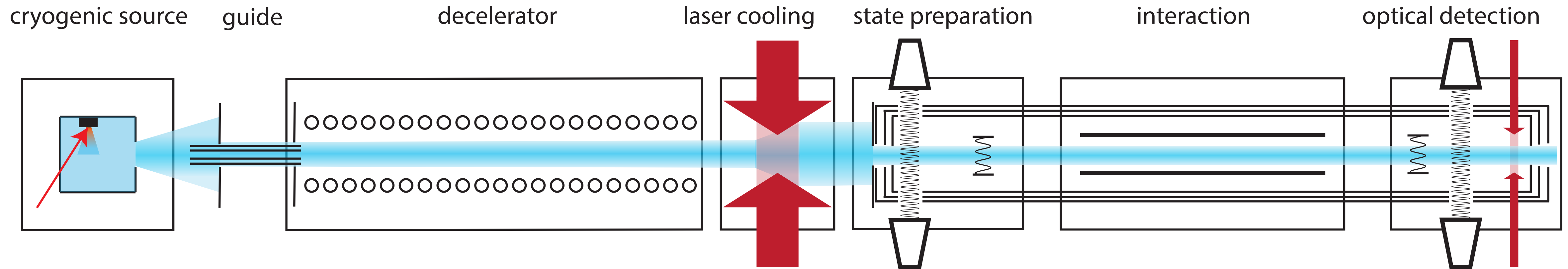
- 1) Cryogenic source
- 2) Stark deceleration
- 3) Molecular laser cooling

We can create a very **intense, slow and cold** beam



We aim for  $5 \cdot 10^{-30}$  e.cm in the first generation of the experiment  
Published paper with full details of proposal: EPJD **72**:197 (2018)





Past year:

- Team is working great together!
- Created intense supersonic beam of BaF molecules
- Set up flexible laser system for detection and cooling
- Cryogenic molecular beam source constructed and operational
- Calculated essential properties of BaF molecules
- Design interaction zone completed
- Prototypes high-voltage transformers tested

Anastasia

Kevin