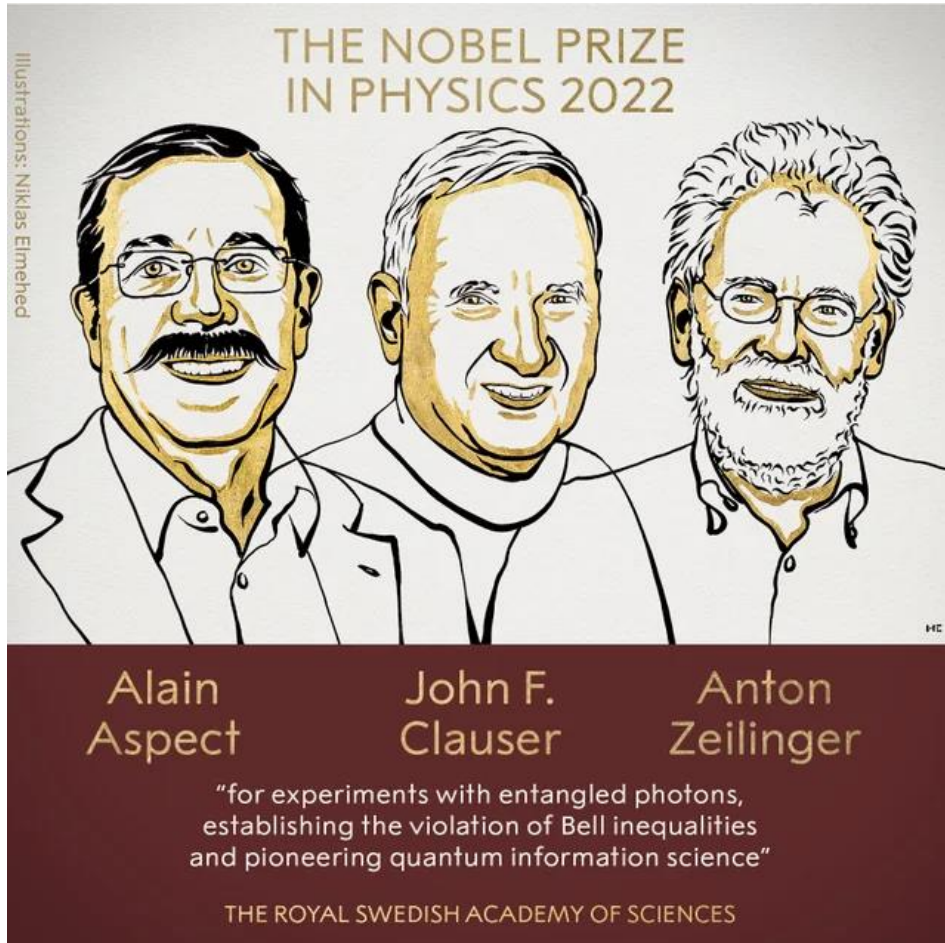


# Fundamental symmetries

Nuclear Physics Mid Term Plan in Italy - LNGS Session

11 October 2022

By using NUCLEAR AND ATOMIC PHYSICS techniques and technologies (at LNGS)



# Fundamental symmetries & Applications

Nuclear Physics Mid Term Plan in Italy - LNGS Session

11 October 2022

What we do:

**QUANTUM PHYSICS (BEYOND STANDARD MODEL)**

*Marciano  
Piscicchia*

*Napolitano*

*J-PET, Space  
& more*

**QUANTUM GRAVITY, CPT  
PEP VIOLATION**

**FOUNDATION QM  
COLLAPSE**

**QUANTUM APPLICATIONS  
TECHNOLOGY**

Phys. Rev. Lett. 129, 131301 (2022)

Nature Physics 17, pages 74, (2021)

Nature Com. 12, Art: 5658 (2021)

**Experiments at  
LNGS:  
VIP-2, VIP-3  
Ge detectors  
R&D Future**

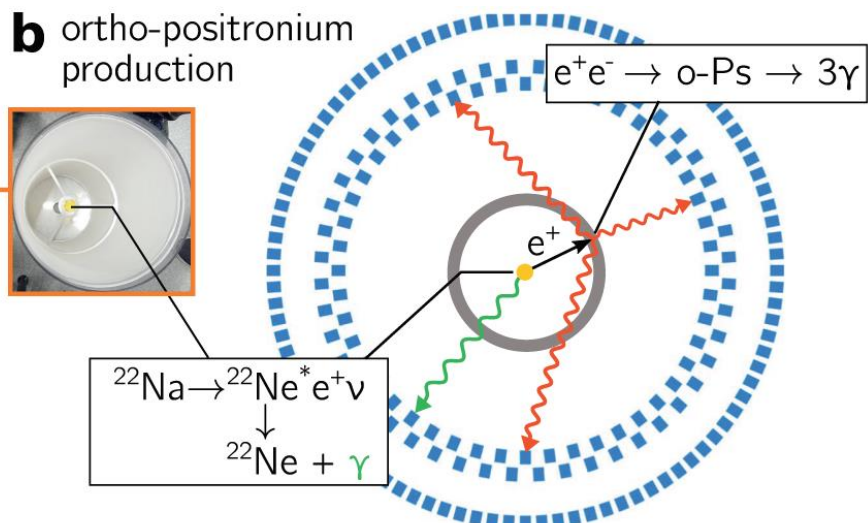
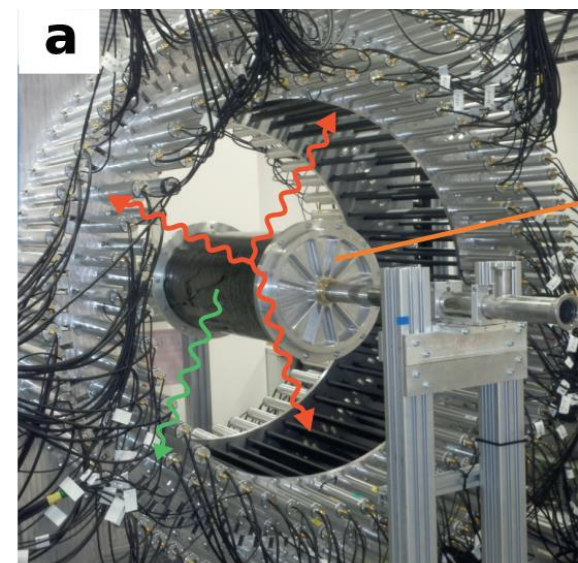
**Experiments at  
LNGS:  
BEGe  
Ge future  
R&D Future**

**J-PET - J.U.  
(Cracovia)  
TEQ – quantum  
optics...**

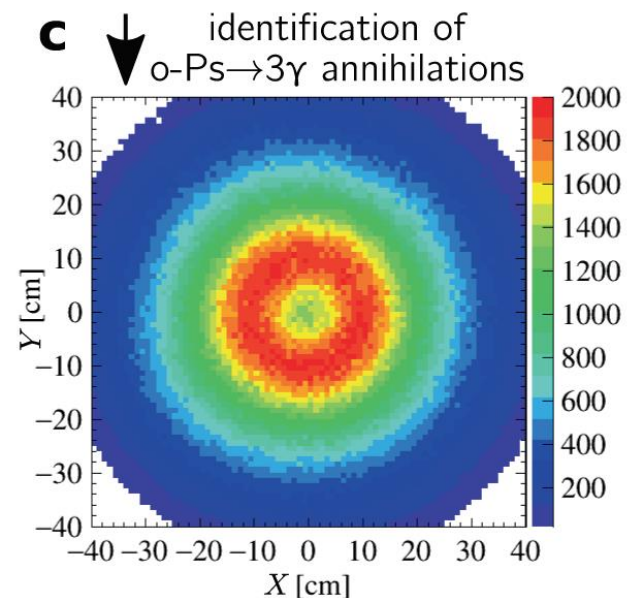
Snowmass 2021 Topical Report on Synergies in  
Research at Underground Facilities

C. Curceanu, D. Elsworth,  
J. Formaggio, J. Harms, D. Robertson,  
W. Roggenthen, H. Wang  
Oct 10, 2022  
e-Print:2210.03145

# J-PET (Cracovia): PET with quantum entanglement – CPT, Lorentz

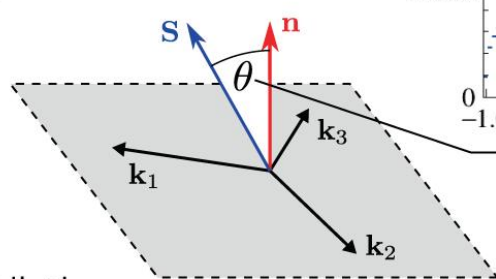


Schematic cross section of the J-PET detector

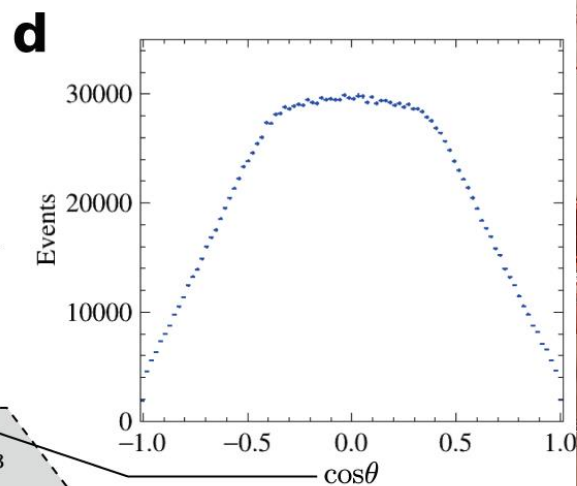


distribution of ortho-positronium annihilations

extraction of CPT-asymmetric angular correlation

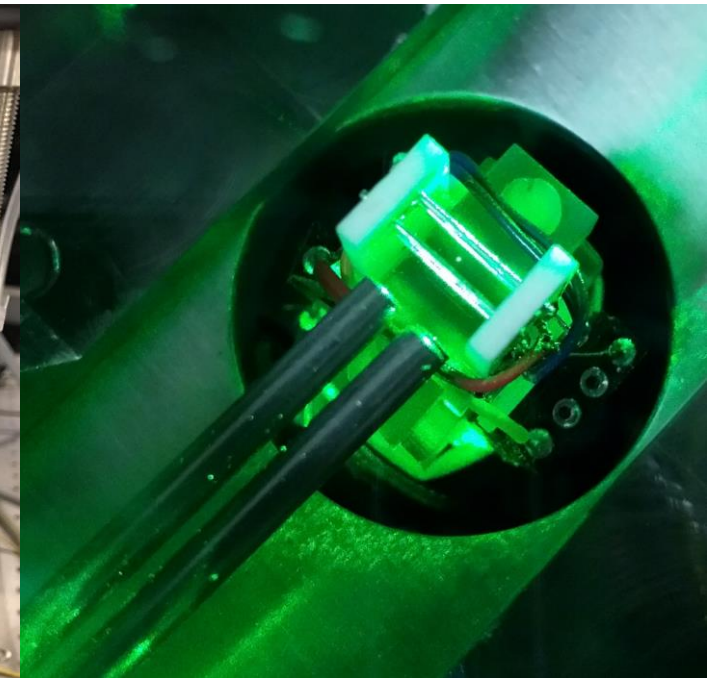
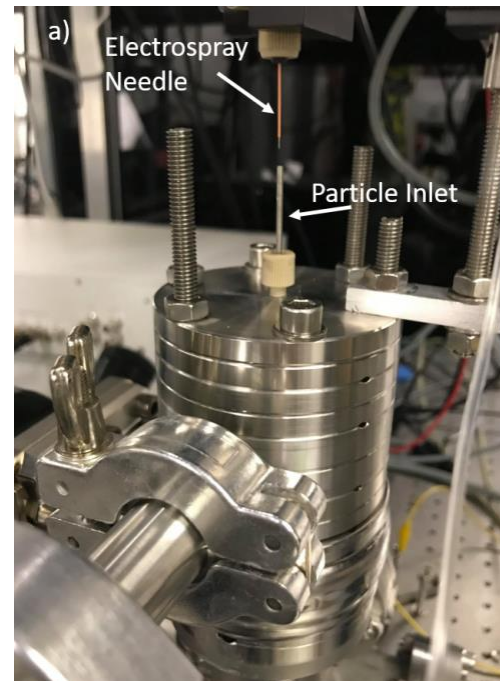
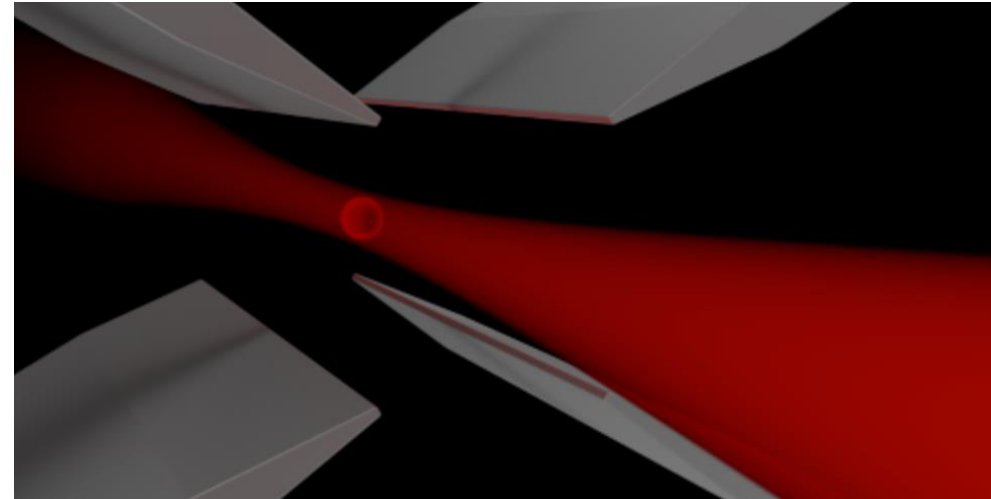
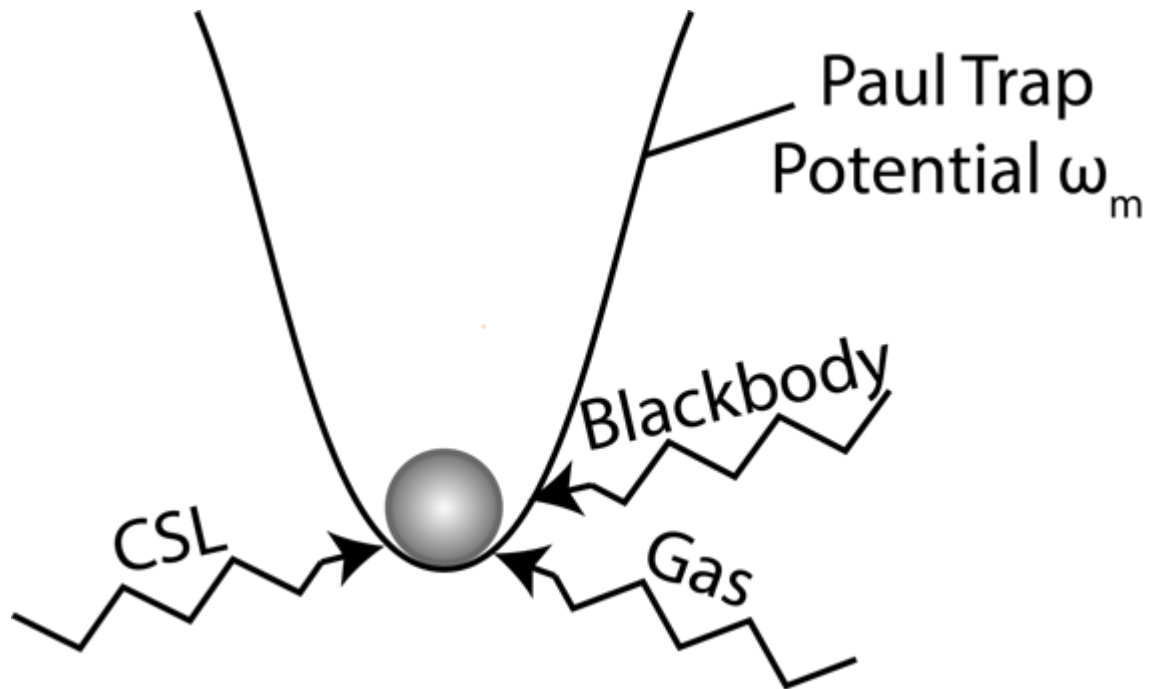


$o\text{-Ps}$  spin - decay plane correlation



# Quantum Collapse, Dark Matter and Quantum Sensors (TEQ)

- Using electrodynamic traps for exploring fundamental physics
  - testing collapse models
  - Dark Matter
  - Quantum Gravity
  - Quantum Sensors
  - Eventually in space (MAQRO)



# Structure of WP1 LNGS document:

- Introduction
- Quantum Gravity, CPT, Lorentz (Marciano, Piscicchia) – plan for: next 2 years; up to 4-5 years; Mid Term: up to 7/8 years
- Quantum collapse and technologies (Napolitano, Curceanu) – plan for: next 2 years; up to 4-5 years; Mid Term: up to 7/8 years
- Short Section: Technologies and Impact (Catalina)
- Conclusions
- Ganttchart (timeline); pert charts; financial?