Recent developments on electromagnetic moment measurements using plunger techniques at ALTO and LNL

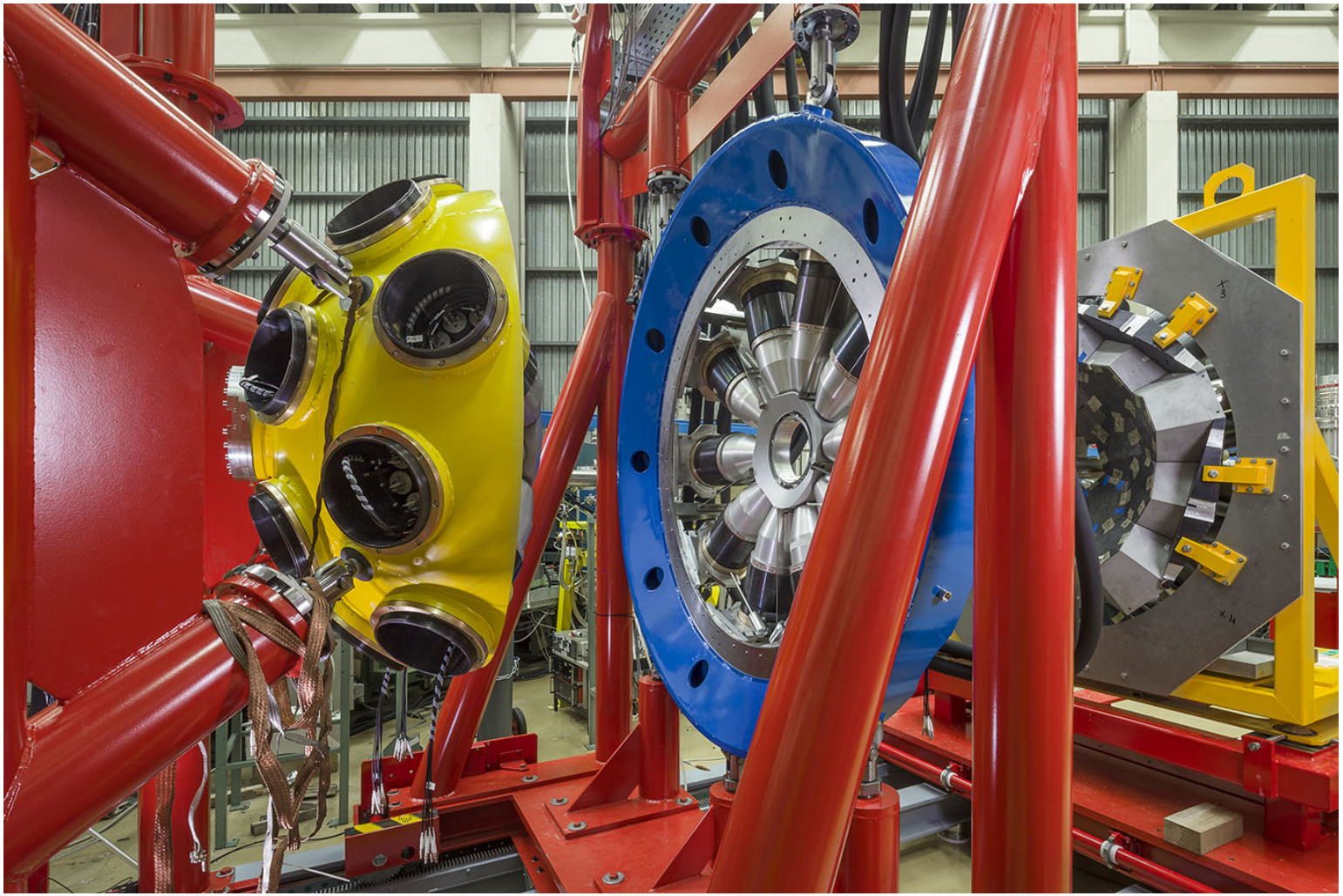
Alain Goasduff

INFN, Laboratori Nazionali di Legnaro, Legnaro, Italy

Joint LIA COLL-AGAIN COPIGAL POLITA WORKSHOP
April 27, 2016

γ-spectroscopy at LNL - The GALILEO project

25 HPGe (GASP) + AC + Complementary detectors



See D. Megoni's talk on Thursday afternoon

GALILEO complementary detectors

Study of weak reaction channels with stable beams :
High efficiency + High resolving power + High CR capabilities

- Light charged particle detectors :
  Euclides, TRACE
- Neutron detector :
  NeutronWall
- High-energy γ-ray detector :
  $LaBr_3$ detectors
- Heavy-ion detectors :
  RFD, Spider[1]

Commissioned dets
Near future dets

[1] See K. Hadynska's talk

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- Lifetime measurements :
  New dedicated plunger IKP-LNL

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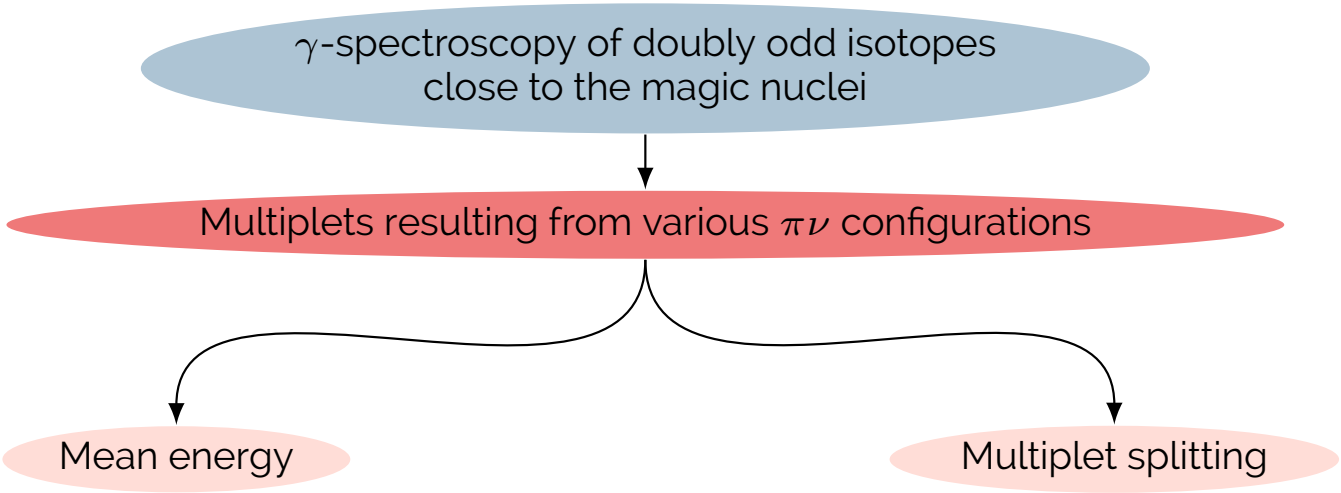

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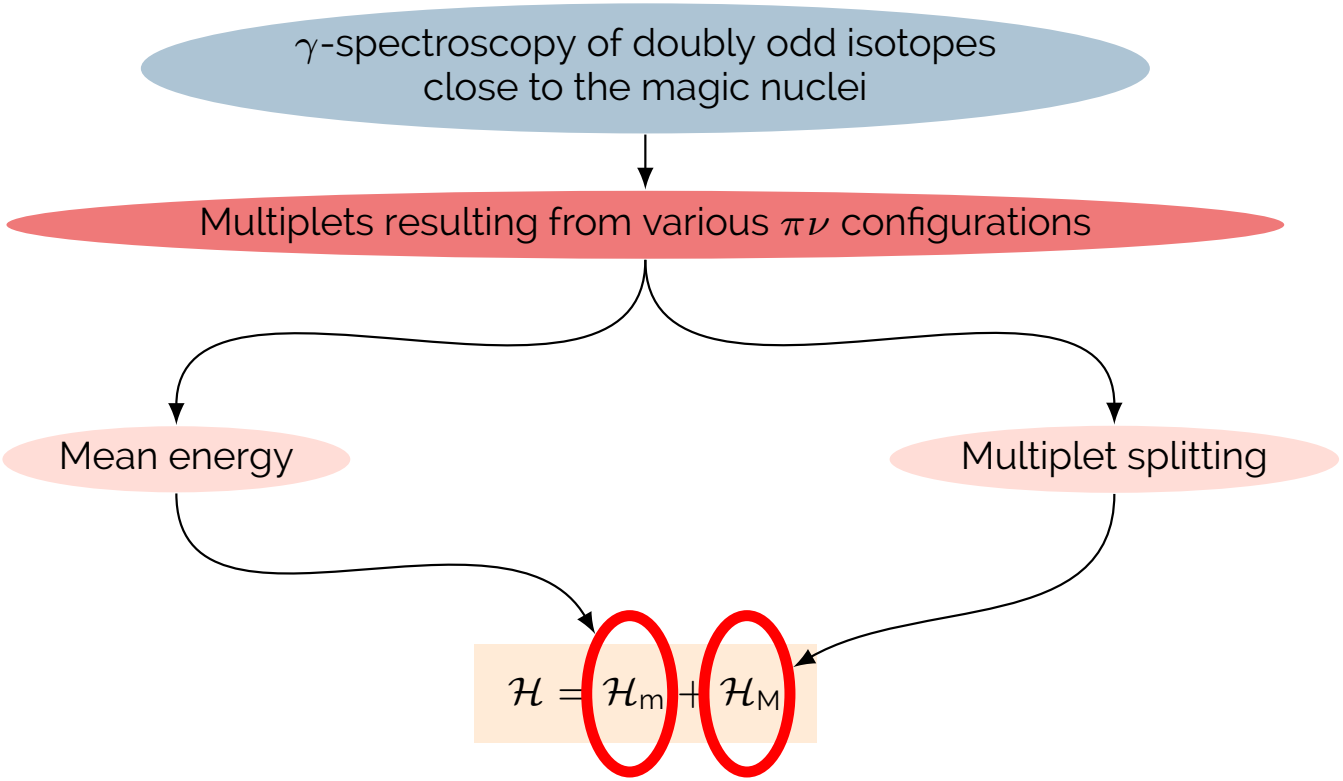

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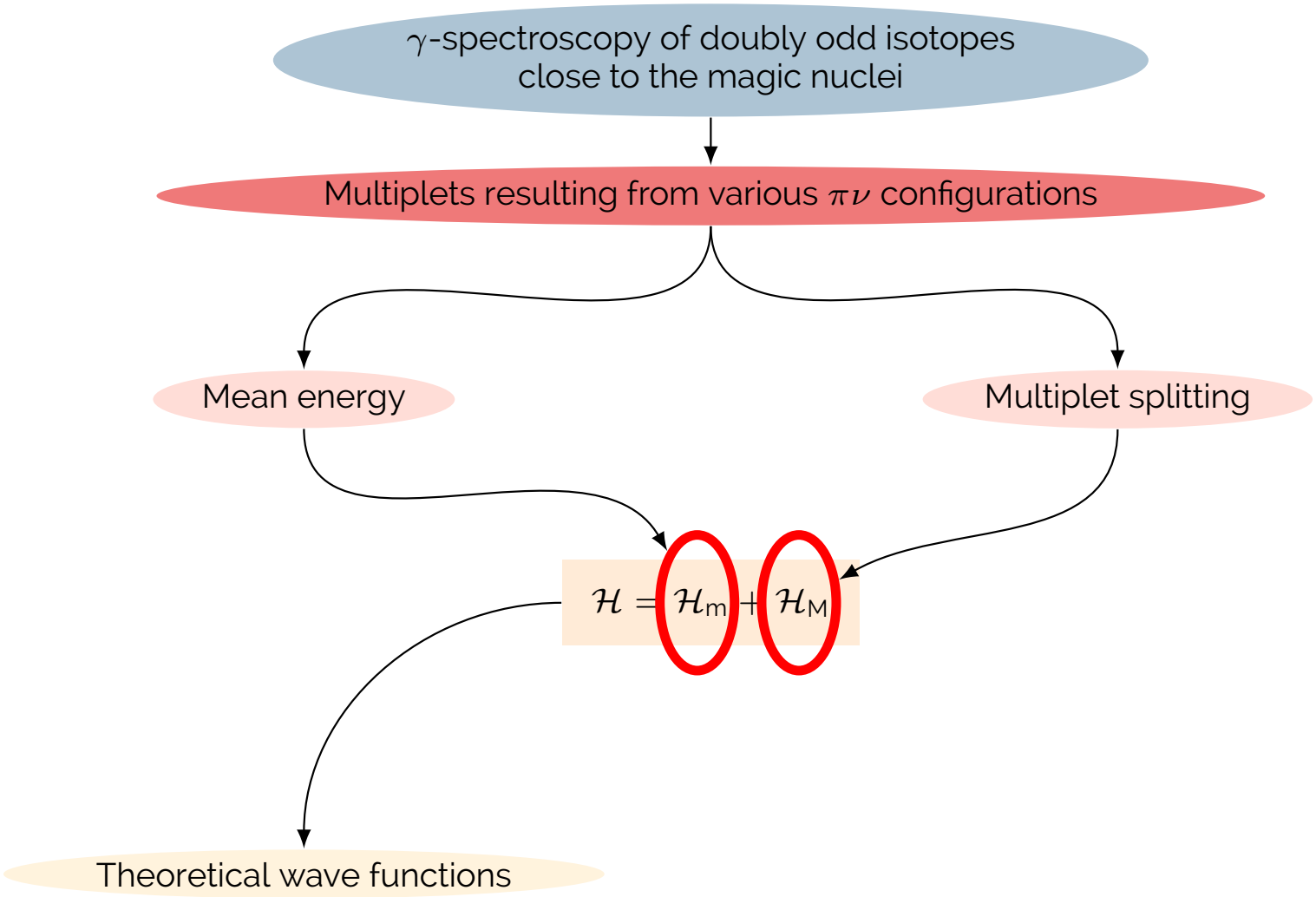

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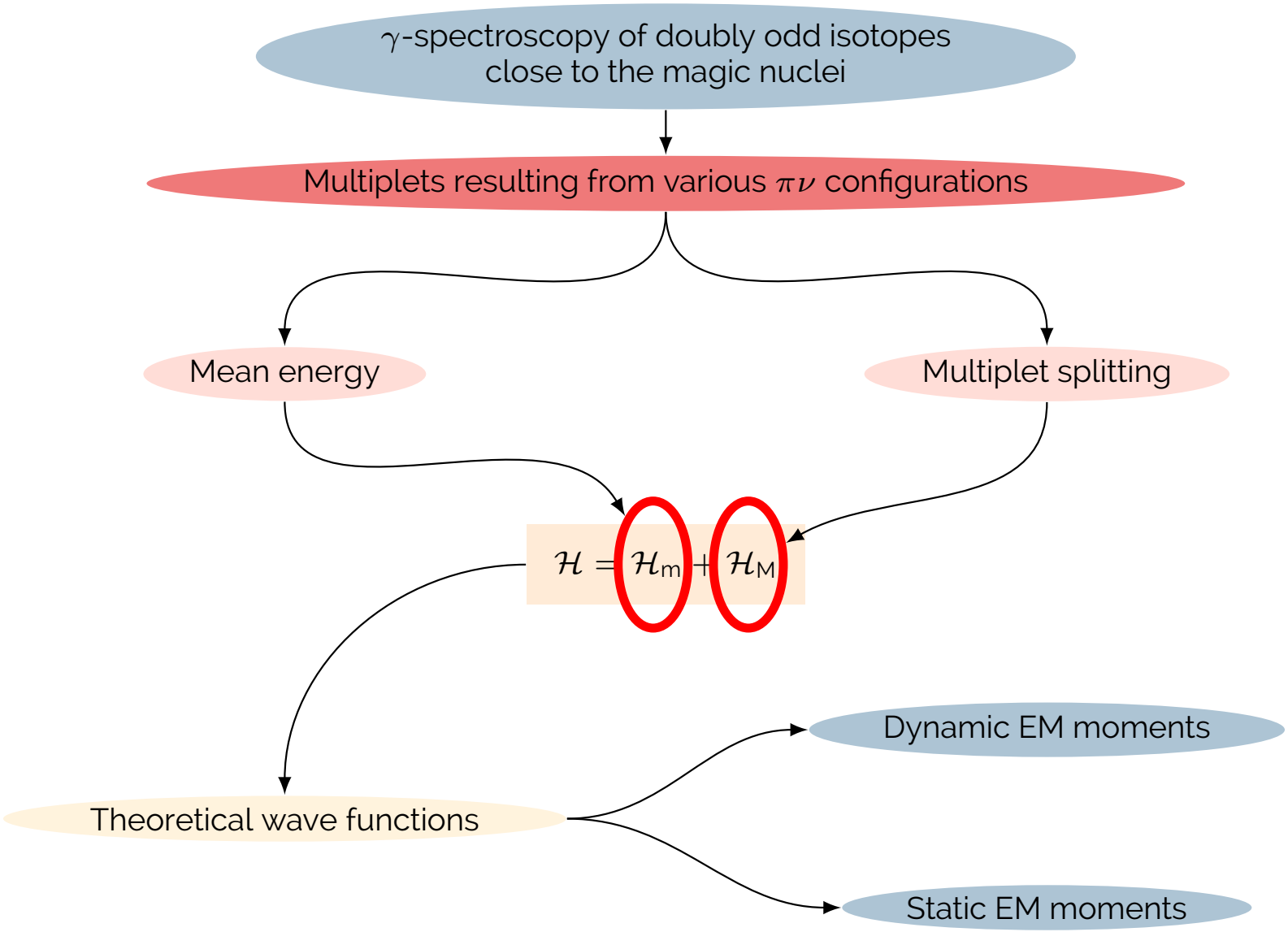

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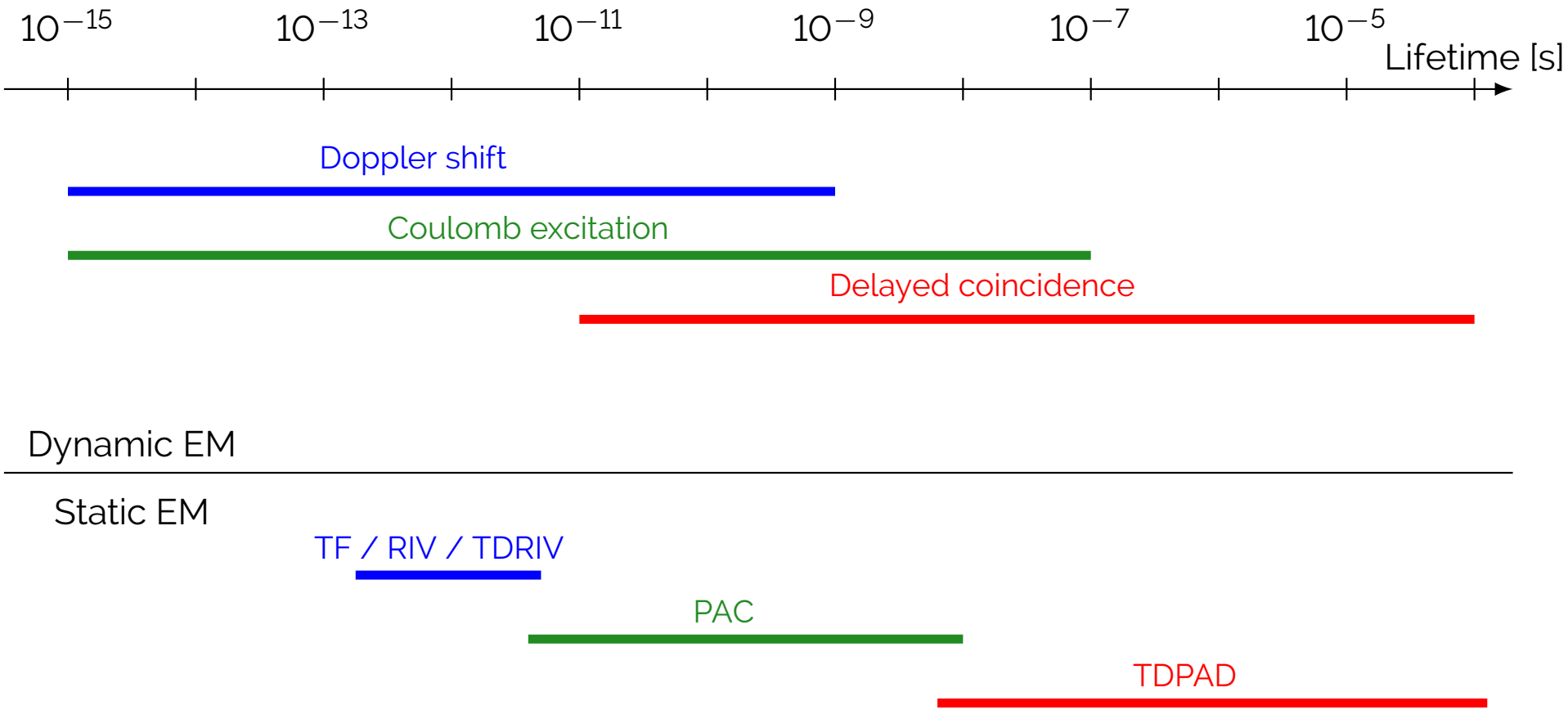

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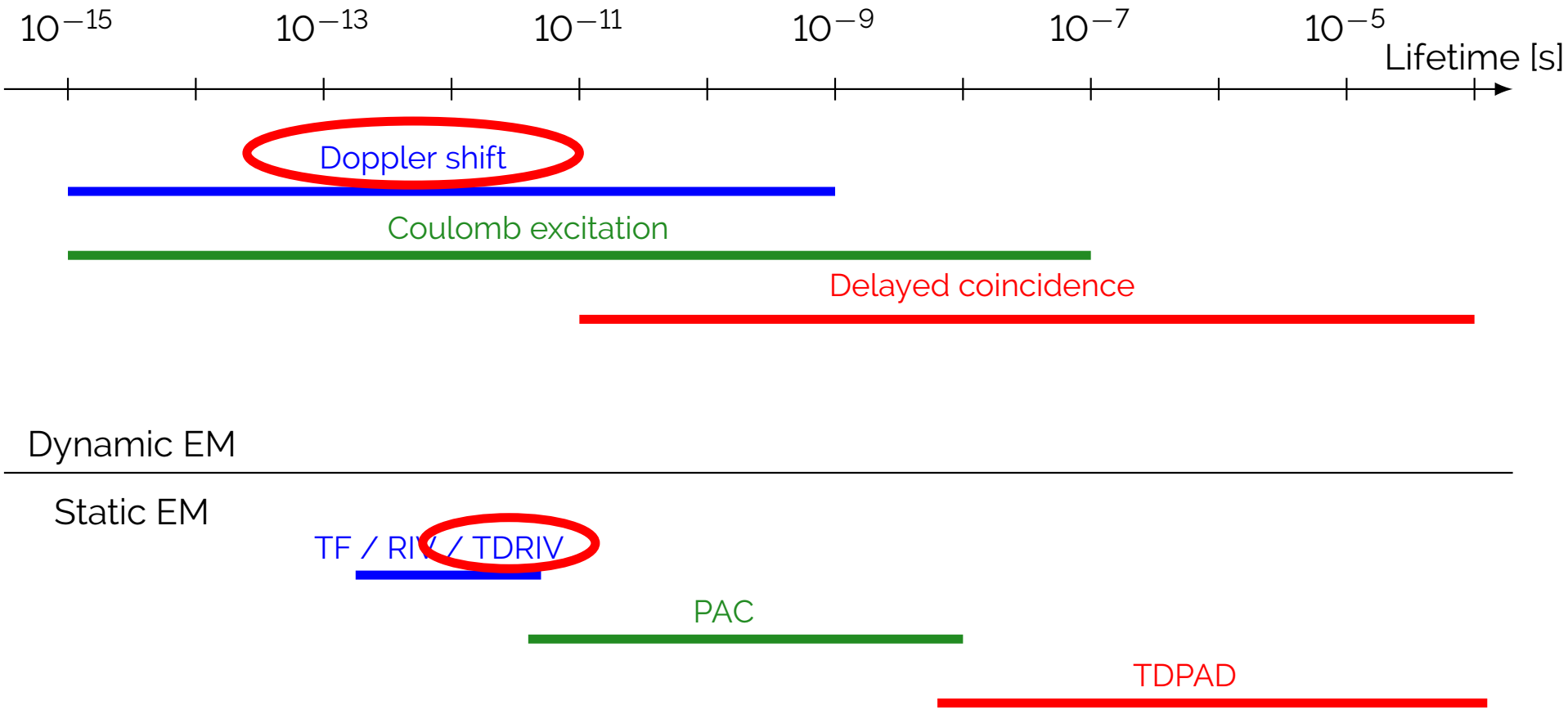
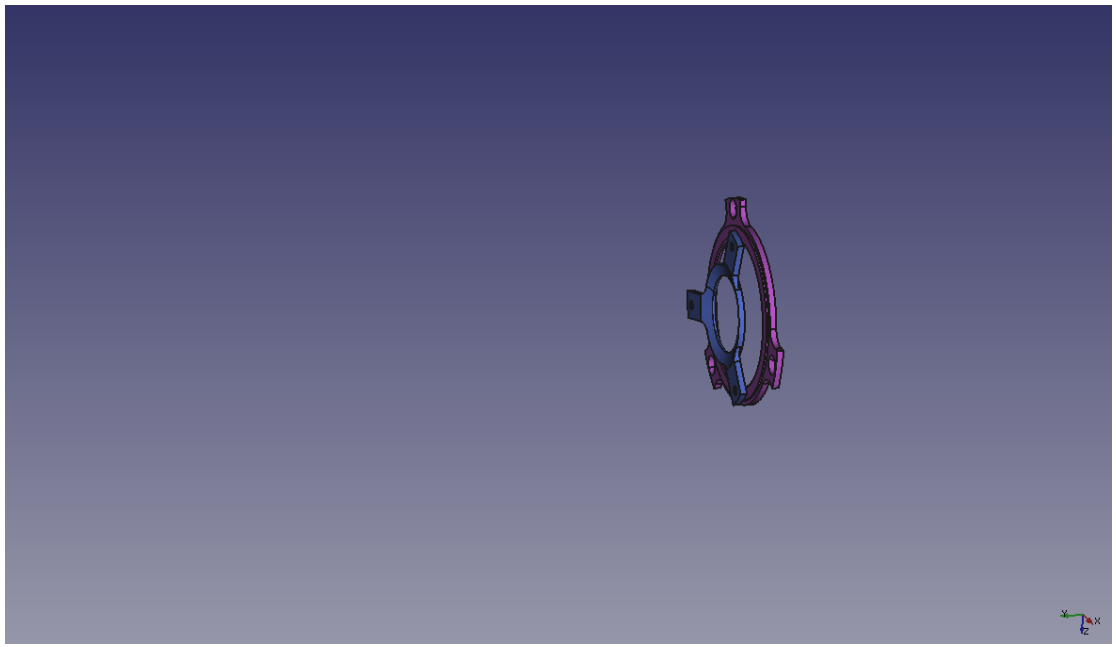


The plunger device : Building a new plunger for GALILEO

Essential ingredients :

- One Target and one Stopper/Degrader,



Collaboration IKP Cologne - INFN LNL - Based on OUPS developments

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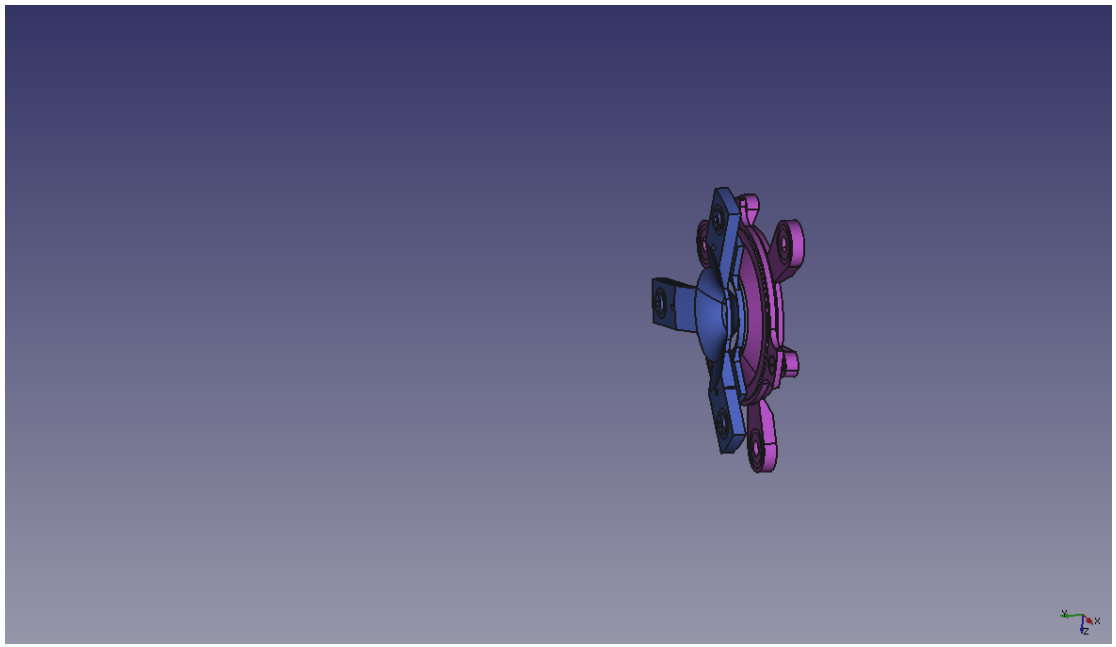

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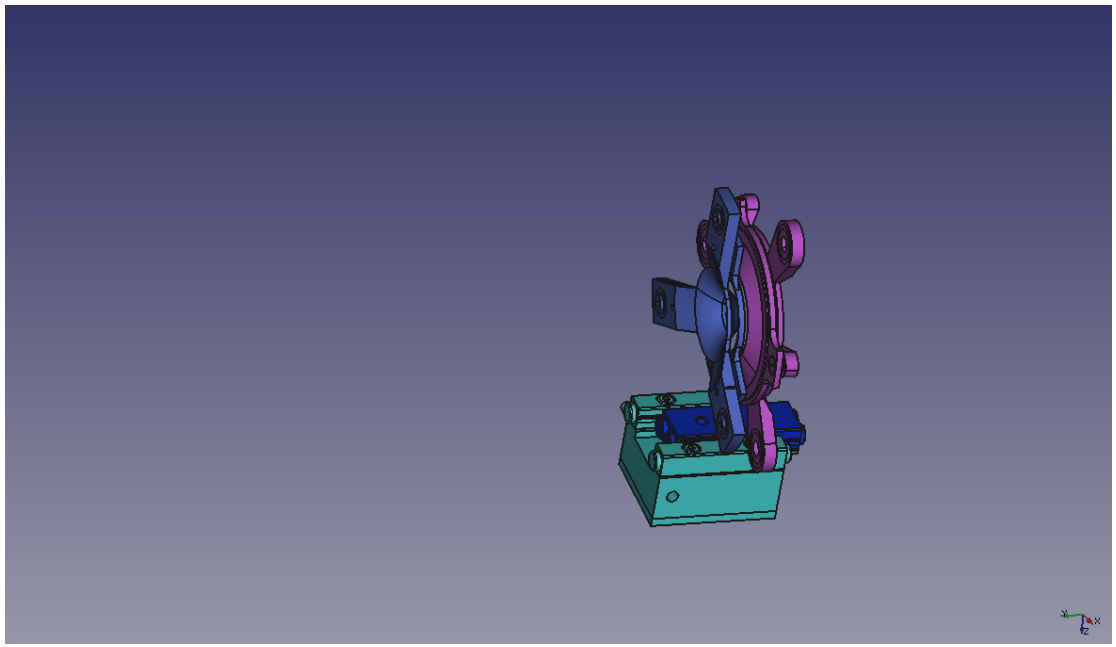

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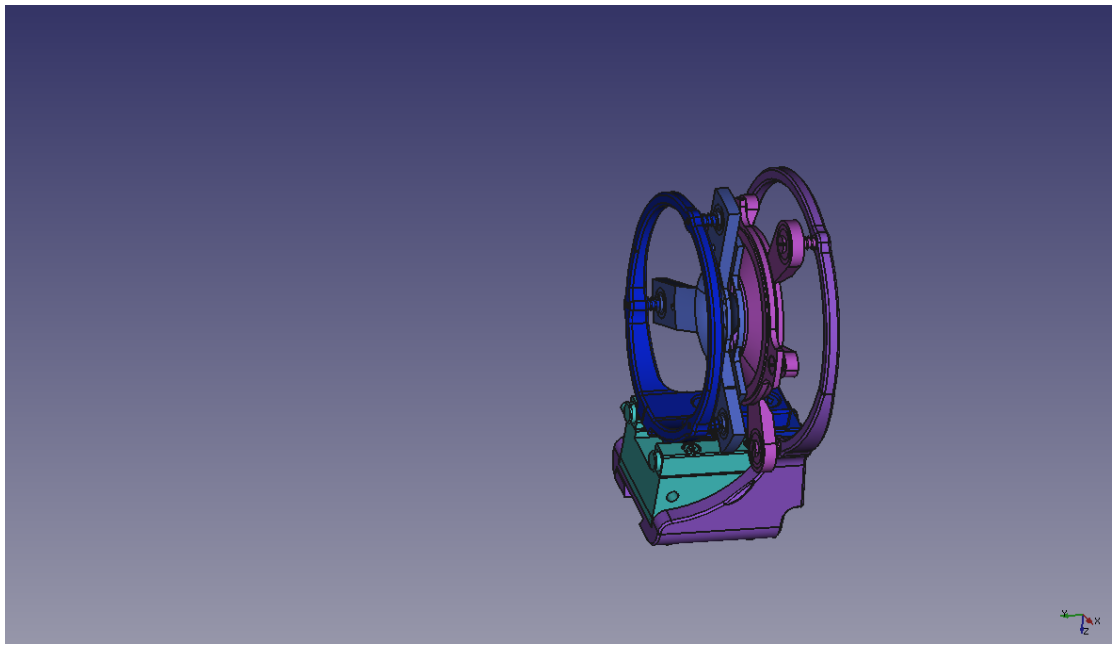

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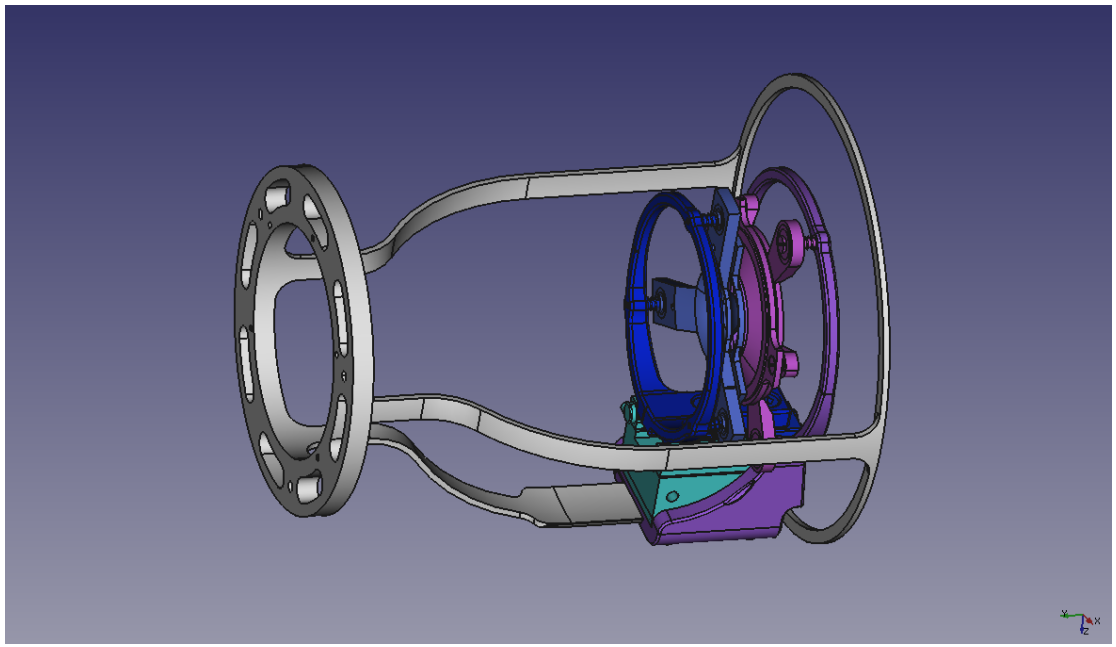

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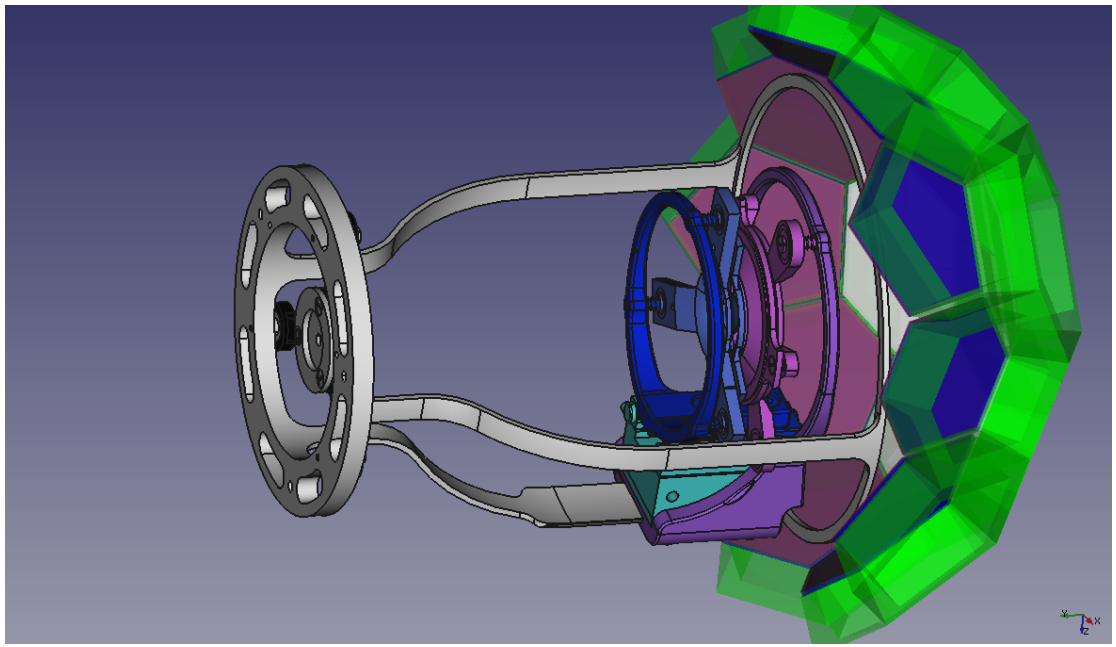

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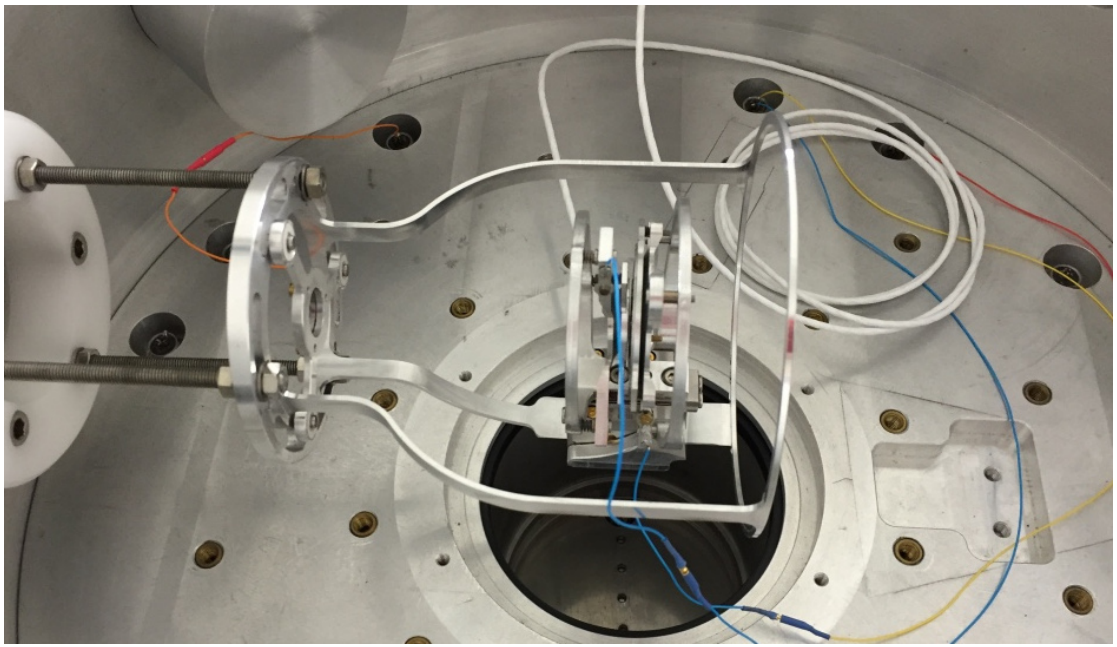

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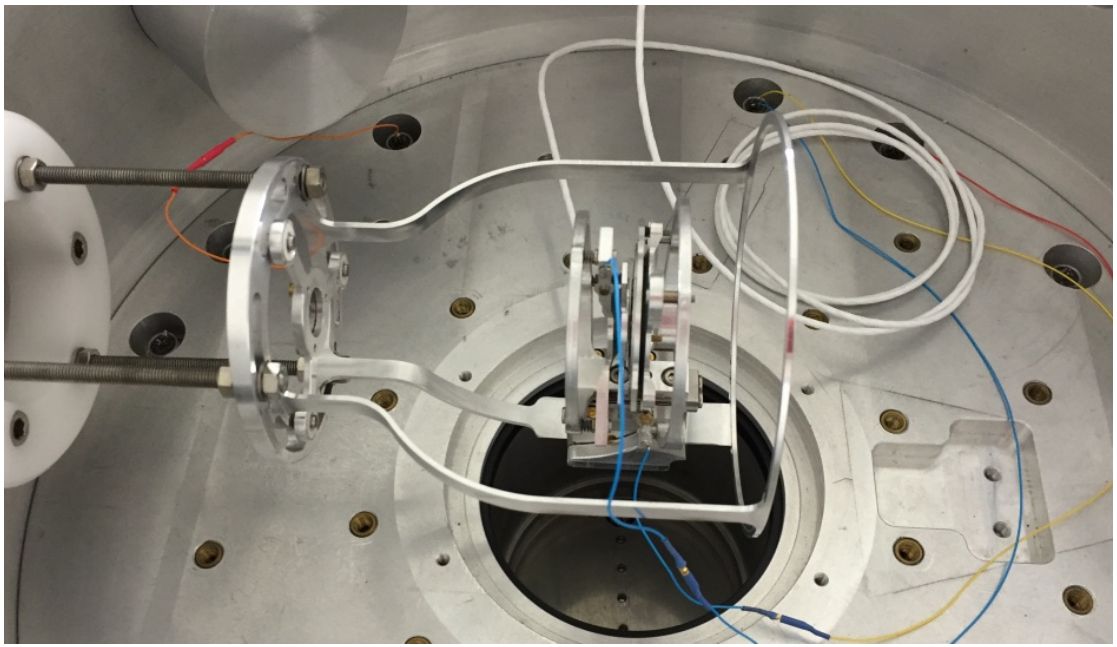
- Feedback-system

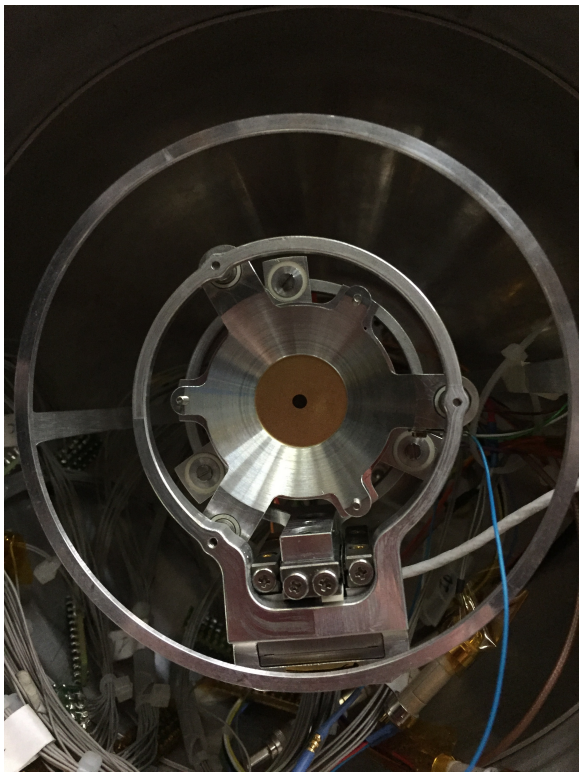


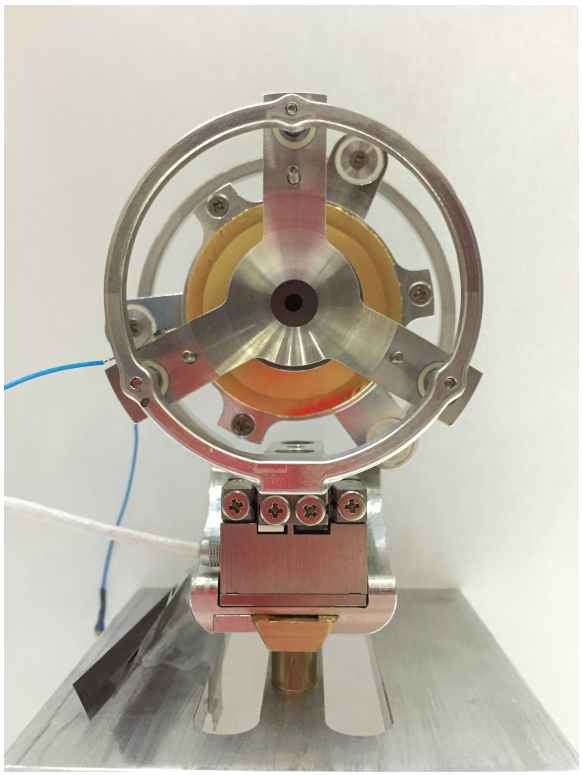
Collaboration IKP Cologne - INFN LNL - Based on OUPS developments

Commissioning of LNL plunger

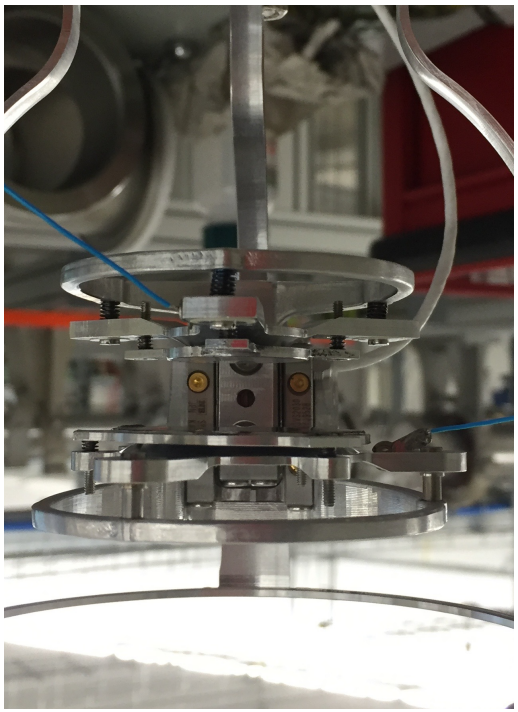
Plunger tested with GALILEO and NeutronWall : $^{32}S(^{154}Sm,6n)^{180}Pt$

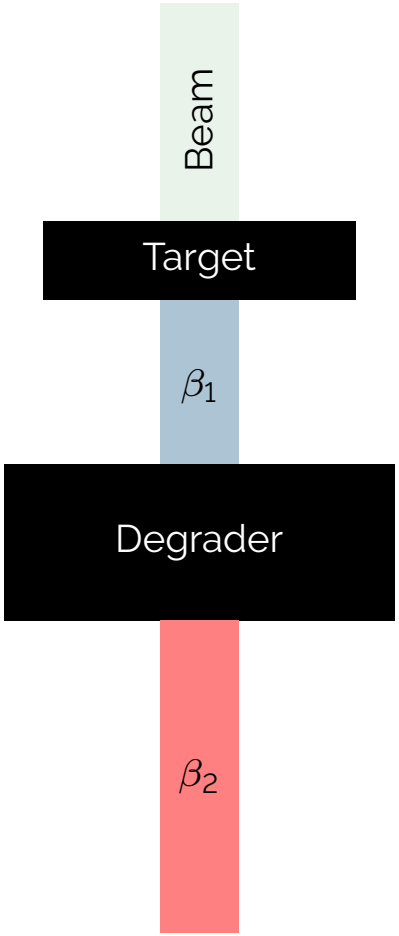
- ^{154}Sm target (1 mg/cm^2) on 2 mg/cm^2 Ta
- Au stopper (10 mg/cm^2)

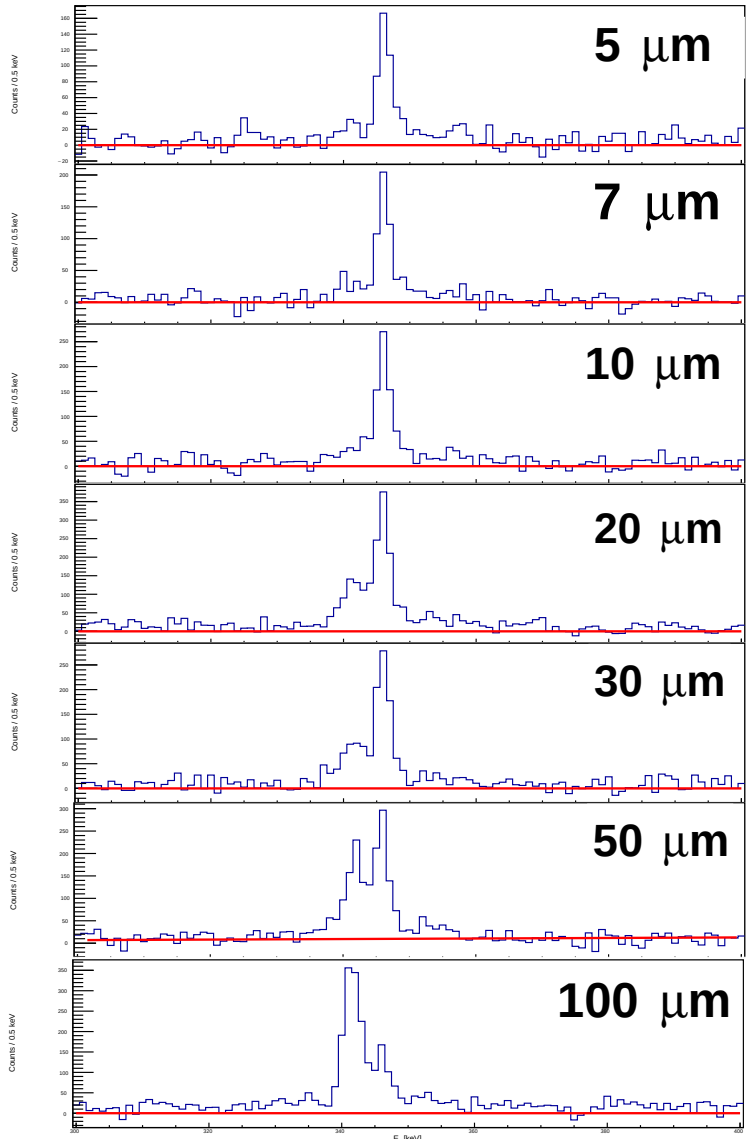




First gated spectra of ^{180}Pt







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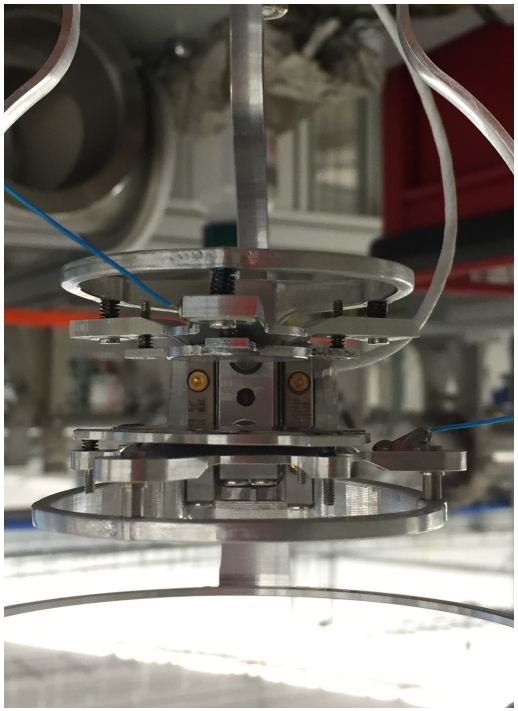
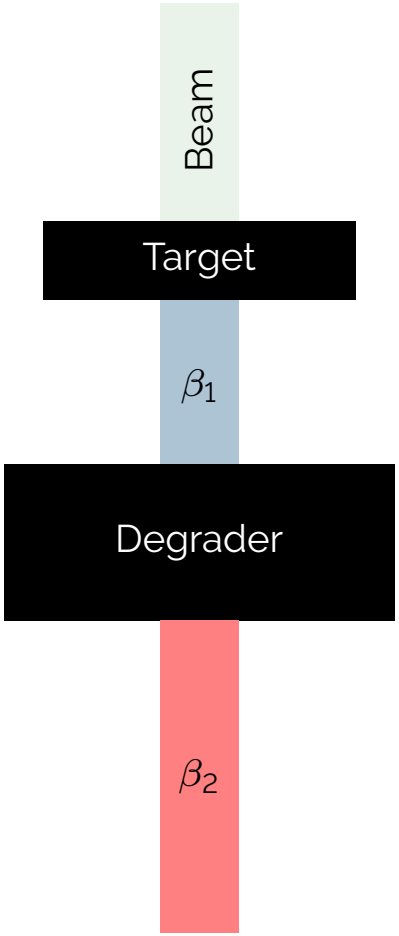
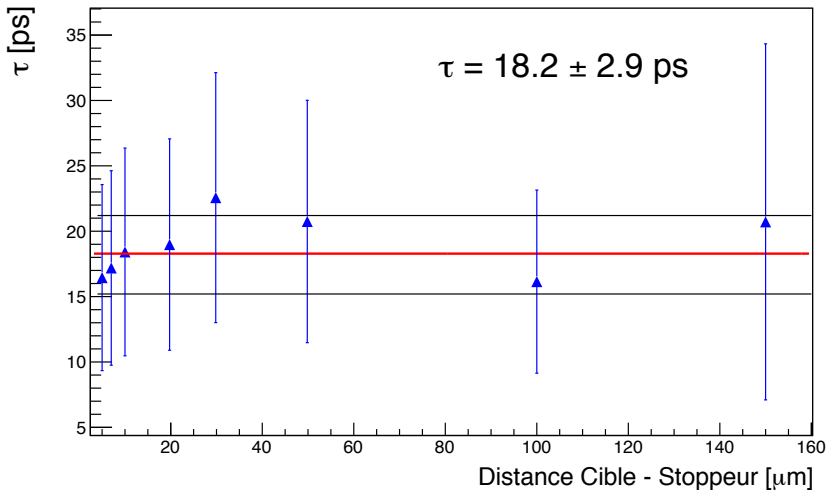
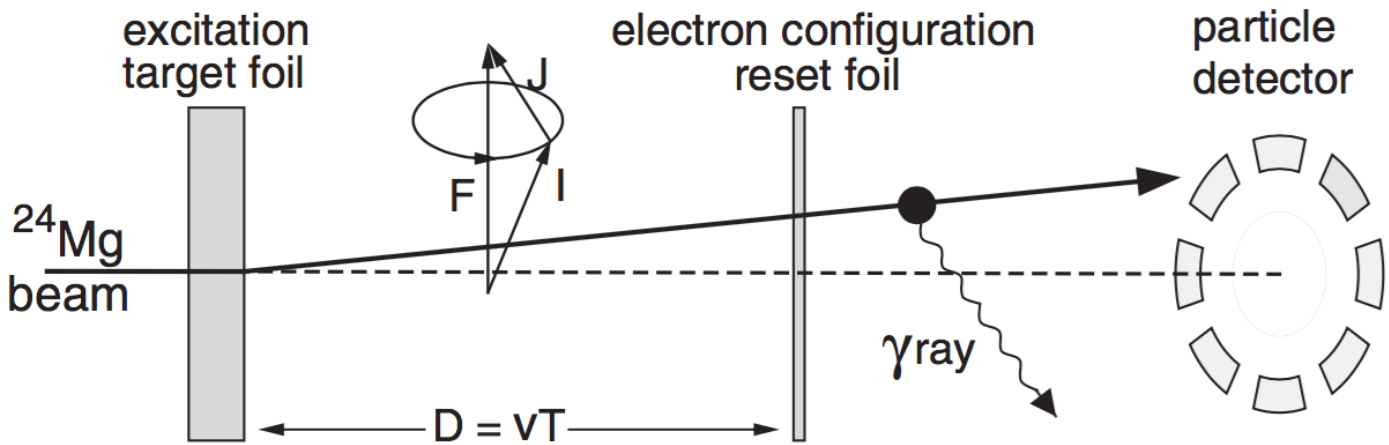






Static EM measurements : RIB geometry of the TDRIV technique

A. E. Stuchbery et al. Phys. Rev. C **71**, 047302 (2005)



First test experiment at ALTO :

- **Beam :** ^{24}Mg @ 120 MeV, 0.3 pnA
- **Target :** 2.4 mg/cm^2 ^{93}Nb
- **Reset foil :** 1.7 mg/cm^2 Au
- ORGAM γ-ray array : 13 detectors
- 8-fold segmented plastic detector
- Plunger OUPS

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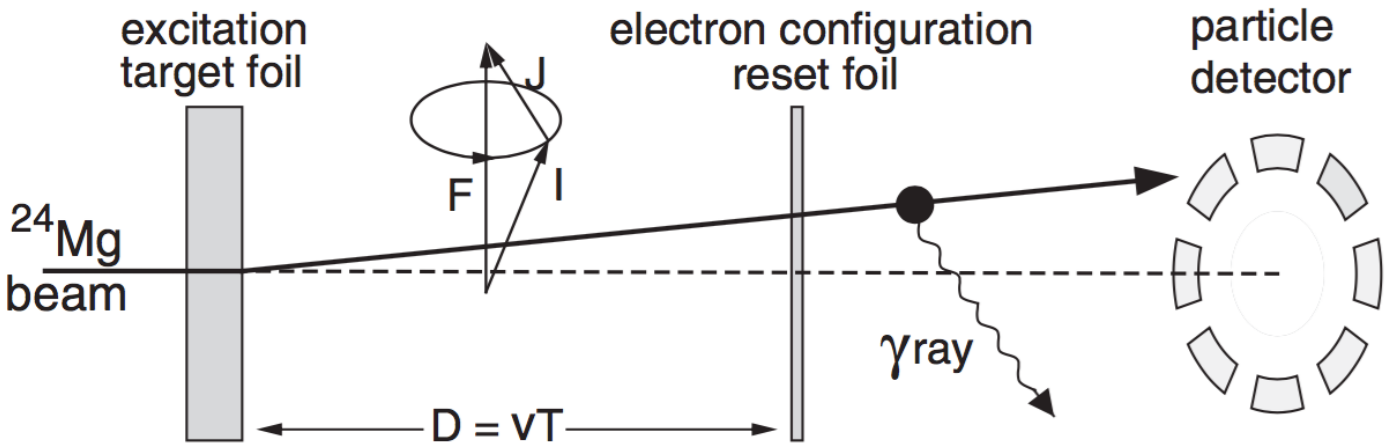
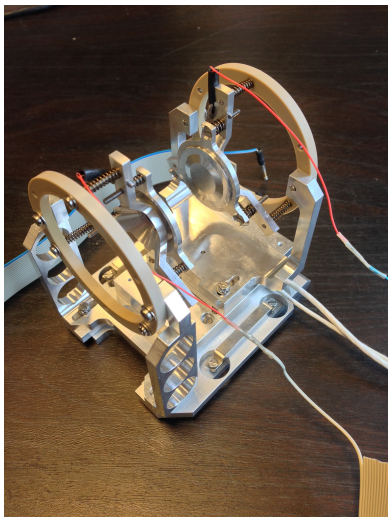
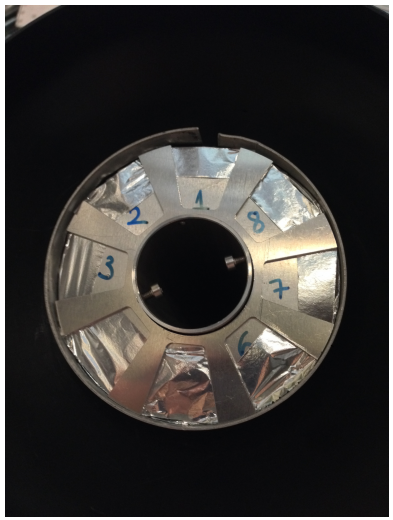
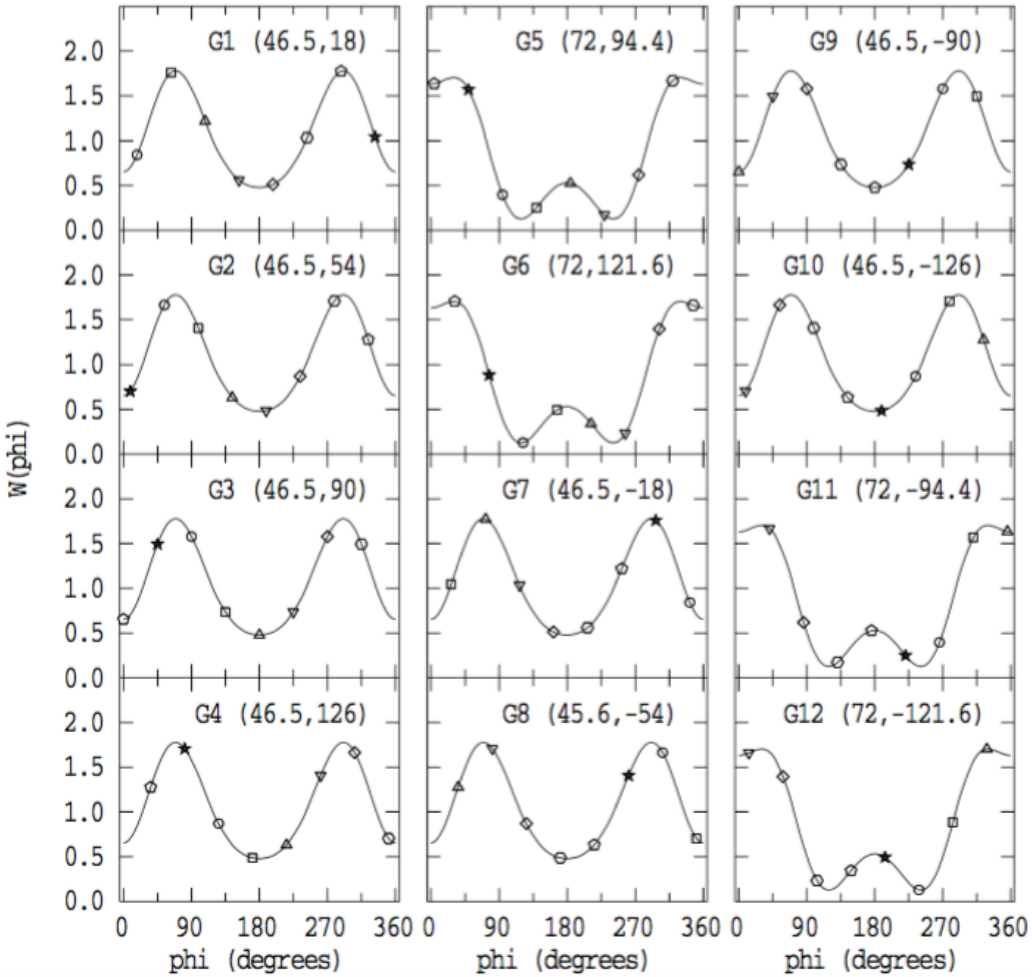






Angular correlation analysis

$$W(\theta_p, \theta_\gamma, \Delta\Phi, t) = \sum_{kq} a_{kq}(\theta_p) \mathbf{G_k(t)} D^{k*}_{q0}(\Delta\Phi, \theta_\gamma, 0)$$



Courtesy of A. Stuchbery and A. Kusoglu

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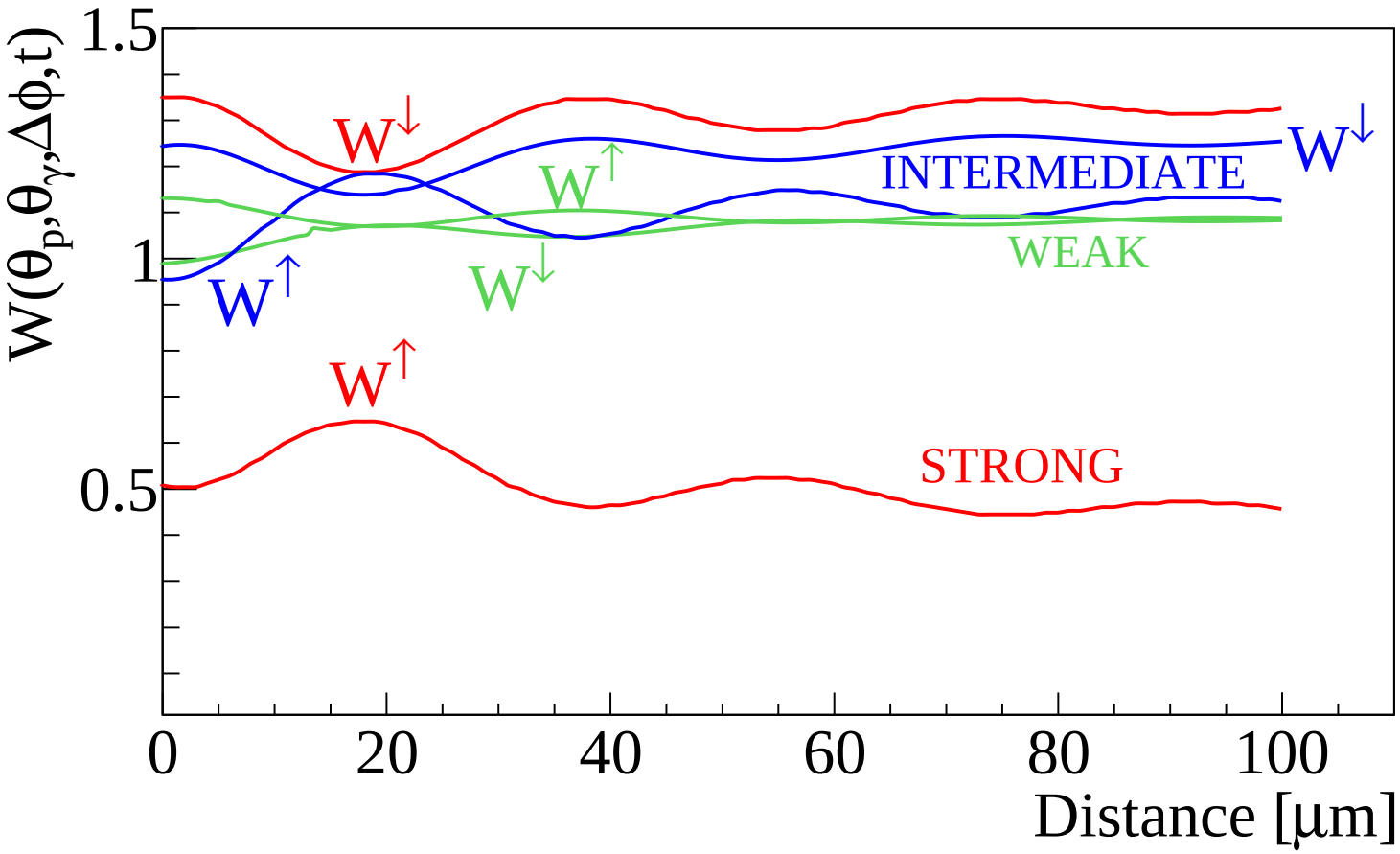
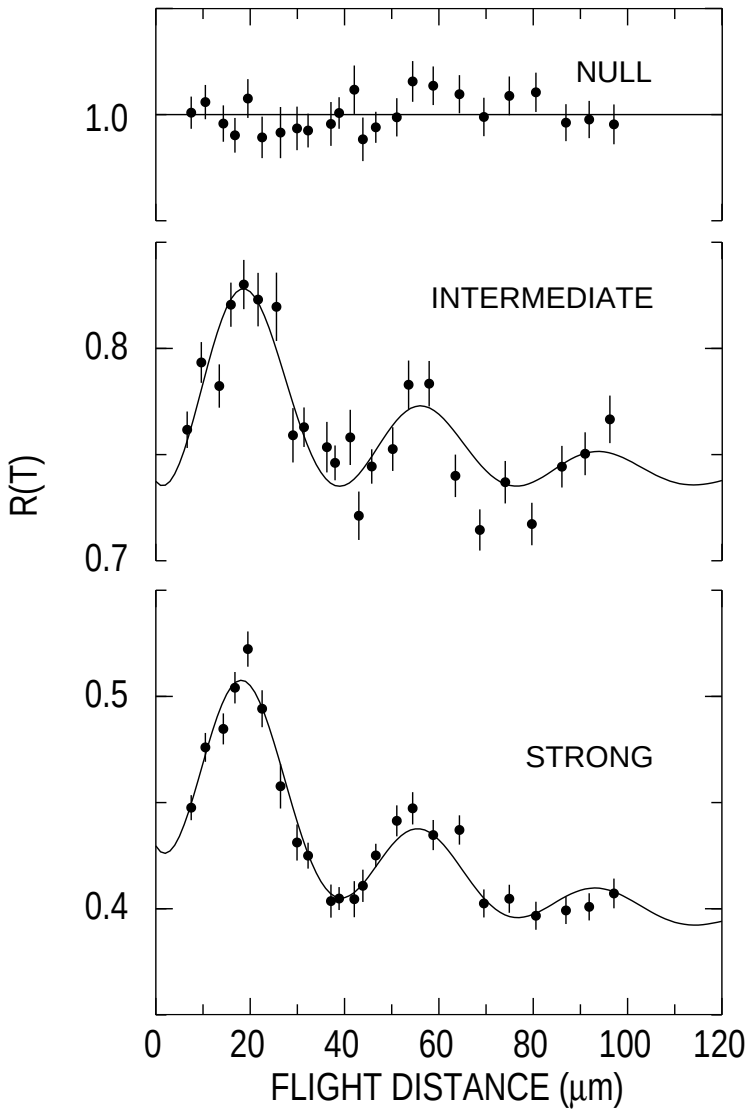


$$R(t) = \left(\Pi_{i=1}^{n} \frac{W_i\uparrow}{W_i\downarrow} \right)^{1/n}$$

Courtesy of A. Stuchbery and A. Kusoglu

Results from ALTO and the OUPS Plunger



A. Kusoglu et al. PRL **114** 062501 (2015)

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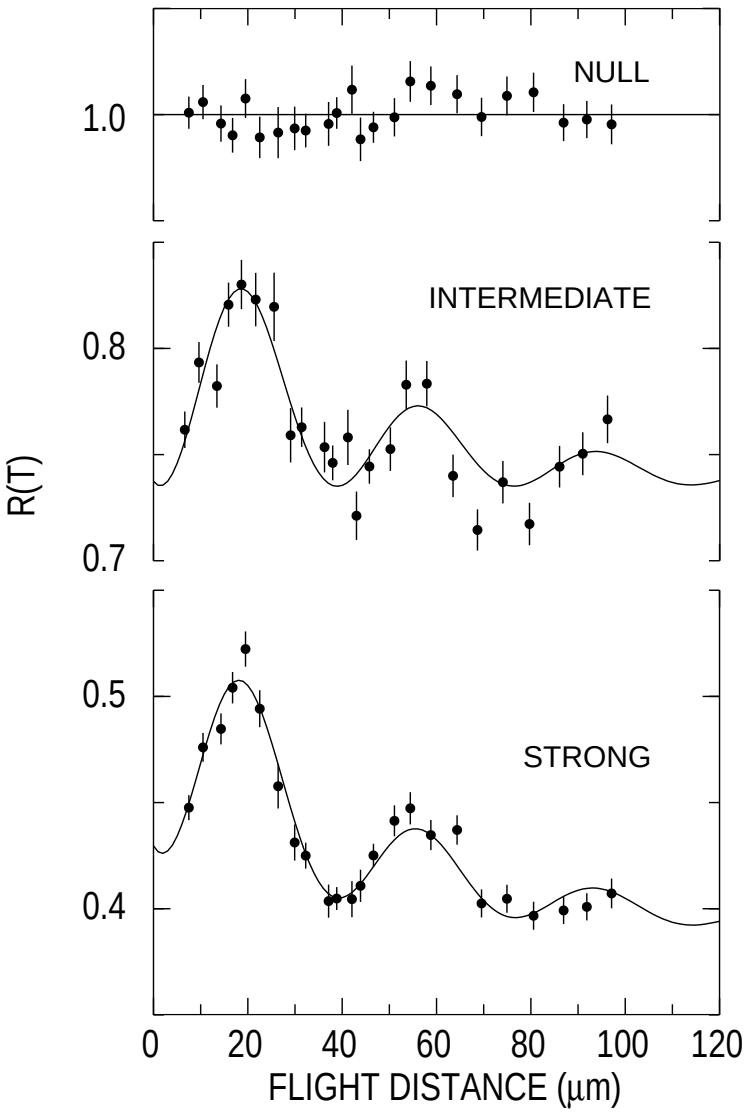
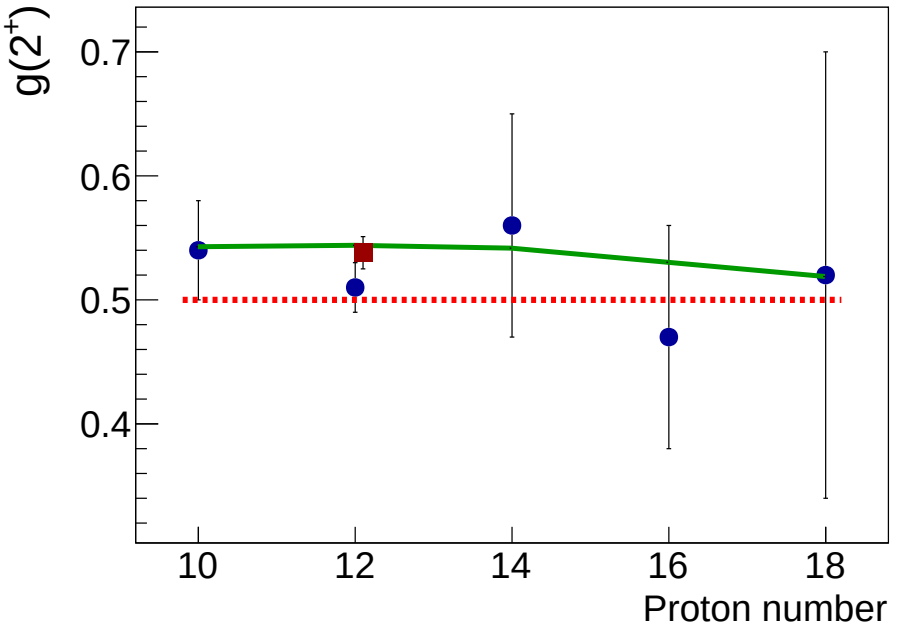




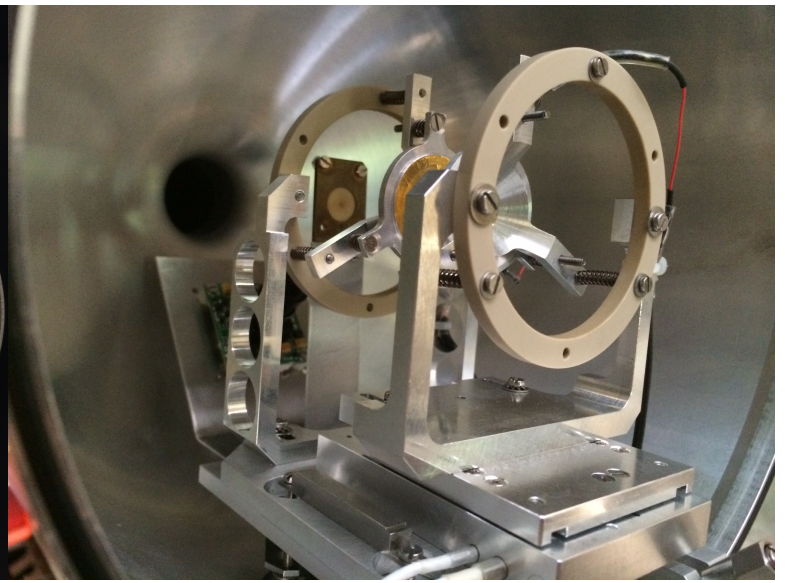
A. Kusoglu et al. PRL **114** 062501 (2015)

Extension to Na-like electronic configuration

Method works for H-like ion
$\Downarrow$
Does it work for ions with more than 1 electron ?

Proposed experiment with Na-like ions using $^{56}Fe^{15+}$:

- Is it possible to observe oscillations ?
- (if yes) Precise and independent g-factor measurement of ^{56}Fe, 2^+
- (if yes) Confront ab initio hyperfine field calculations

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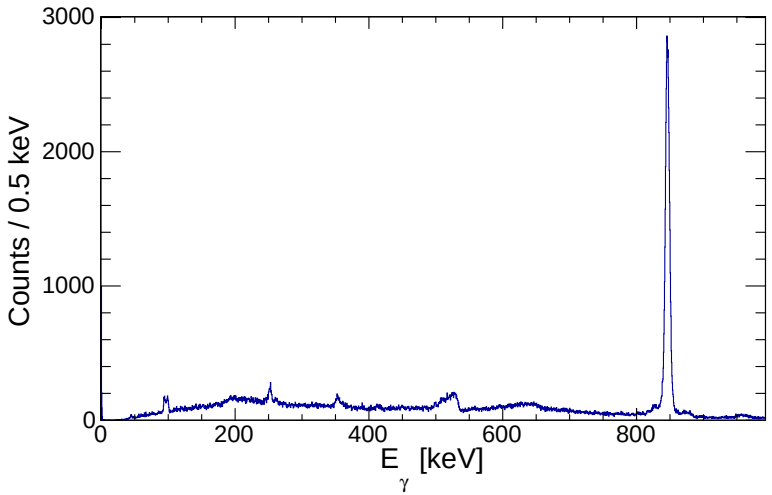

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  - 230μg/cm^2 ^{12}C on 0.5 μm Ni
- Beam energy tuned to optimize the charge state distribution
- Several conditions to clean the spectrum from :
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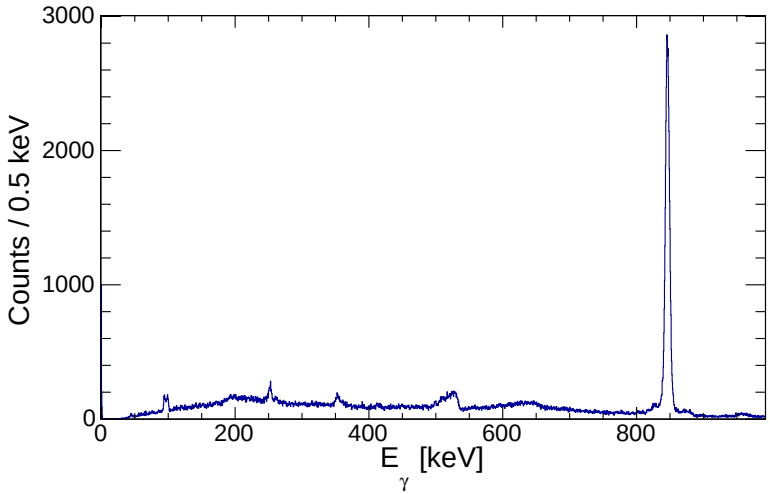

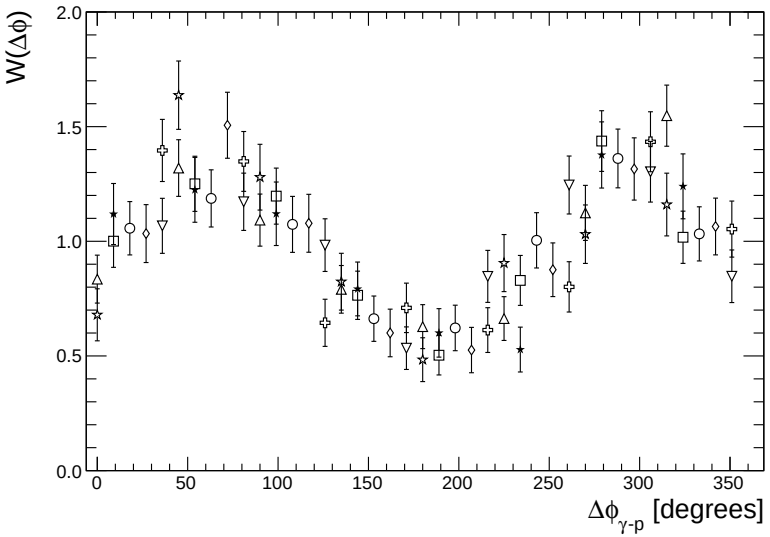

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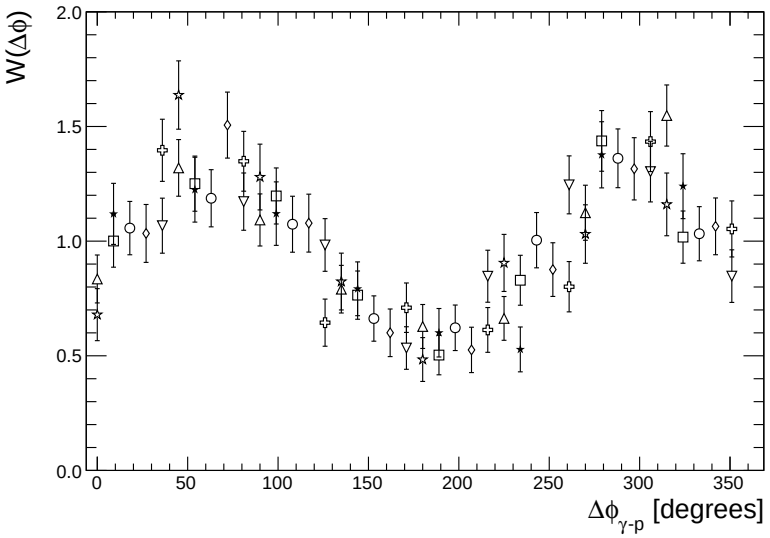

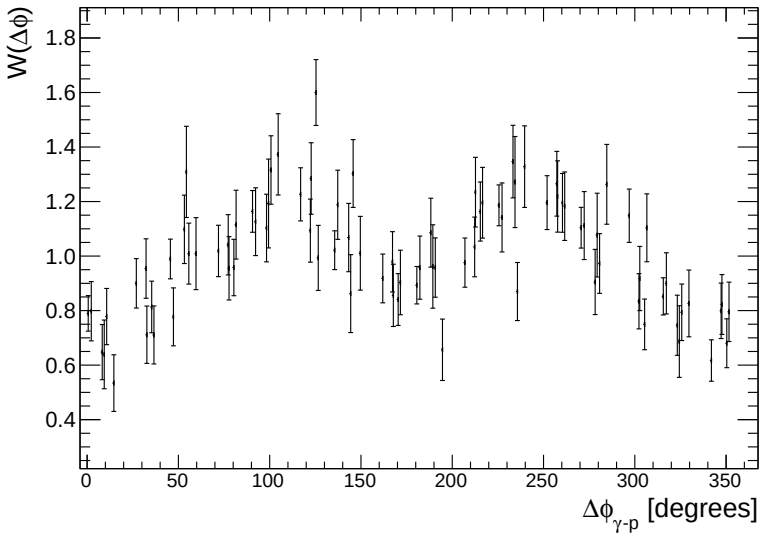

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- Analysis of MINIBALL performed segment by segment

Summary and perspectives

- **OUPS plunger** has demonstrate its reliability during the ORGAM / MINORCA campaigns at ALTO and AGATA@GANIL
- We have successfully build and commissioned a dedicated **GALILEO plunger device** :
  - possibility to accommodate up to 30 Si telescopes from EUCLIDES array
  - possible coupling with RFD for differential plunger technique
- First experimental campaign with this new plunger is on-going
- Development of new forward plastic detector will open the way to high precision g-factor measurement at LNL taking advantage of the ALPI accelerator

THANK YOU VERY MUCH