TECHNISCHE UNIVERSITÄT DARMSTADT

PUMA-related activities planned during YETS

Alexandre Obertelli, TU Darmstadt

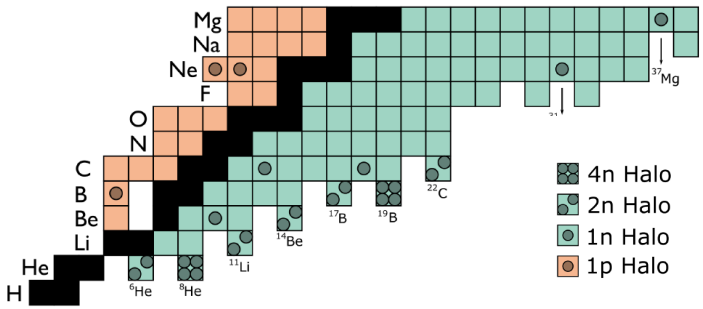
ADTC / YETS follow-up meeting

December 2, 2021

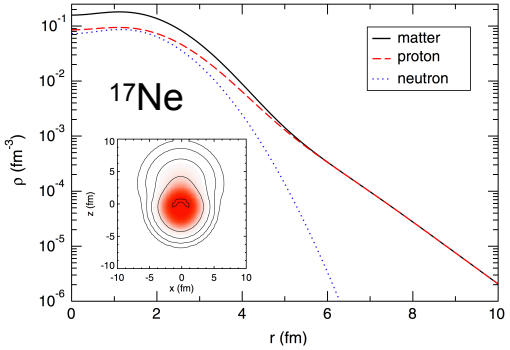
The physics of PUMA

PUMA is a nuclear physics experiment, aiming at the density tail of rare isotopes:

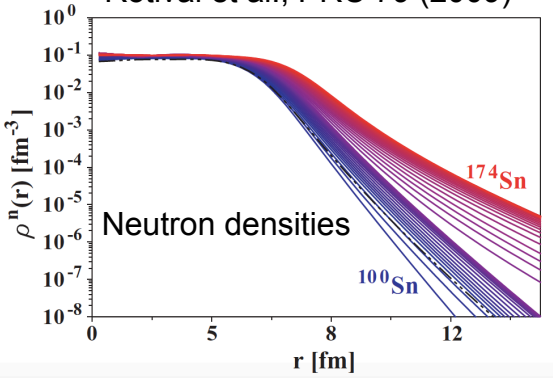
- ❑ Are there medium-mass neutron halos?
- ❑ Are there proton halos?
- ❑ How neutron skins grow towards the drip line?



Geithner et al., PRL 101 (2008)



Rotival et al., PRC 79 (2009)



Theory predictions

Low-energy antiprotons for nuclear physics

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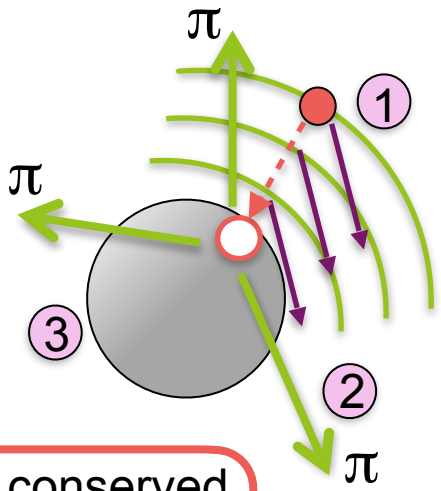
- Past works at BNL and CERN on antiproton annihilation from stable nuclei
  Bugg et al., PRL 31 (1973), Eades and Hartmann, Rev. Mod. Phys. 71 (1999)

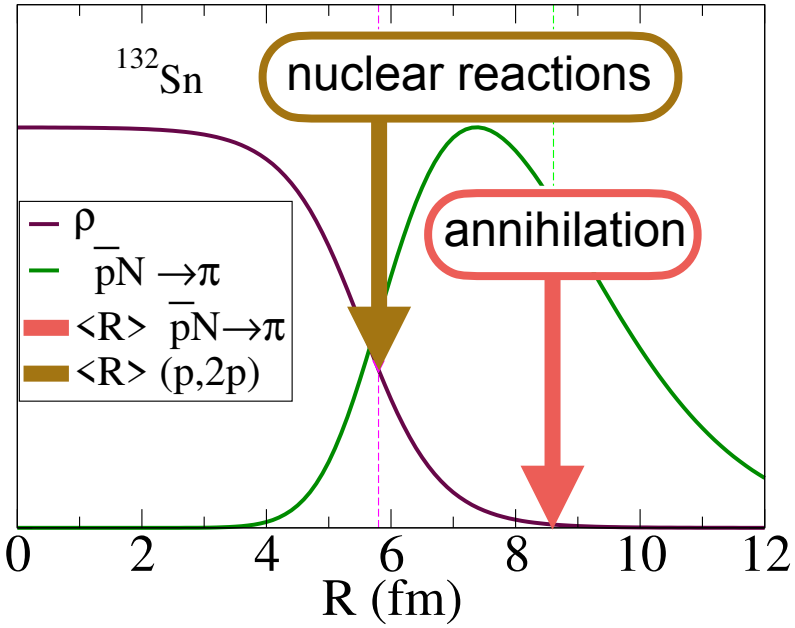
- Antiprotons and radioactive nuclei?
  Wada and Yamazaki, NIMB 214 (2004)
  FLAIR TDR - Widmann et al., Physica Scripta 72 (2005)



Electric charge conserved

$$\sum \pi^+ + \sum \pi^- = 0 \quad \text{for } p\bar{p}$$

$$\sum \pi^+ + \sum \pi^- = -1 \quad \text{for } n\bar{p}$$



Overview of PUMA

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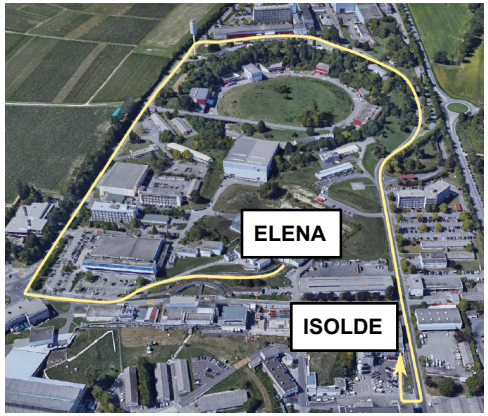
- **Transport antiprotons** from ELENA to ISOLDE
- Storing **10^9 antiprotons** at **ELENA** (10^7 at first step)
- Antiproton plasma **half-life > 30 days**
- Introduce low energy (< 100 eV) ions at **ISOLDE**
- Measure charged pions resulting from annihilations
- Charge conservation: neutron-to-proton annihilation ratio

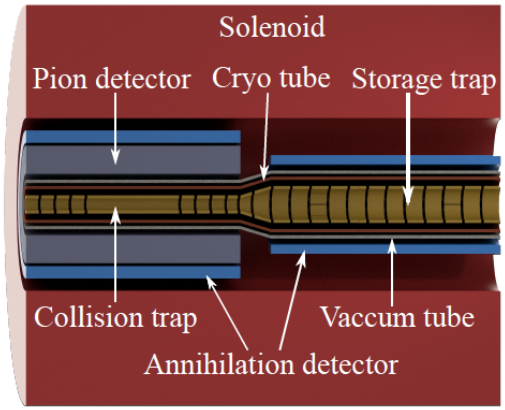


Extracted from data

Emitted pions
Multiplicity M
Total charge Σ

$$\frac{N_n}{N_p} \longleftrightarrow \left.\frac{\rho_n}{\rho_p}\right|_{surface}$$

Wada and Yamazaki, NIMB 214 (2004)



Status of the experiment

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- ☑ LNE51 experimental zone is complete
- ☑ ELENA beam line designed and elements purchased at 95%
- ☐ ISOLDE beam line to be designed

- ☑ Transportable magnet is delivered
- ☐ TPC is designed
- ☐ Trap is designed at 90%

- ☐ Plasma manipulation to develop
- ☐ Theory developments ongoing

Status of the experiment

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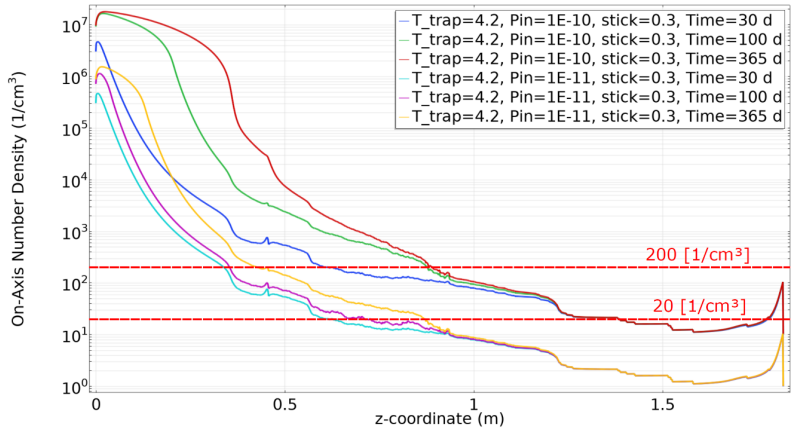
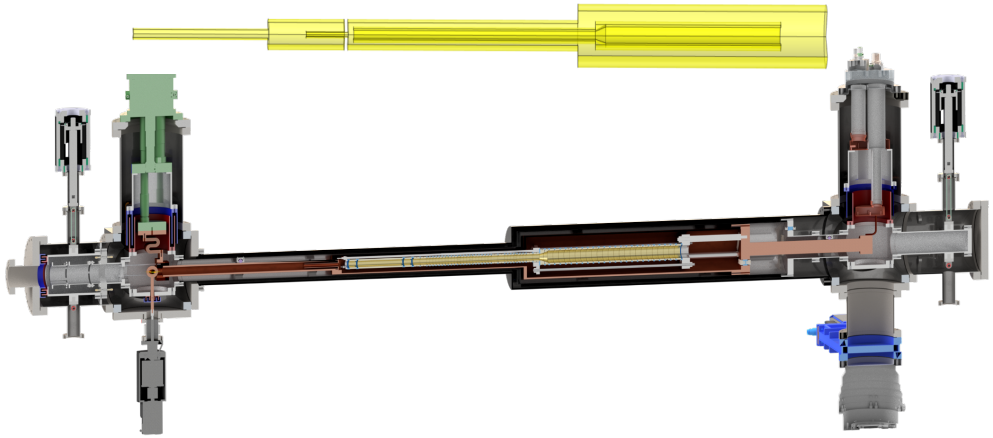
10^{-11} mbar at entrance required





A. Schmidt (TUDa), J. Ferreira-Somoza (CERN/TE-VSC)

Operations at ELENA

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1) Slowing (4 keV) and focusing of antiprotons (**pulse drift tube**)

2) Storage of antiprotons (trap)

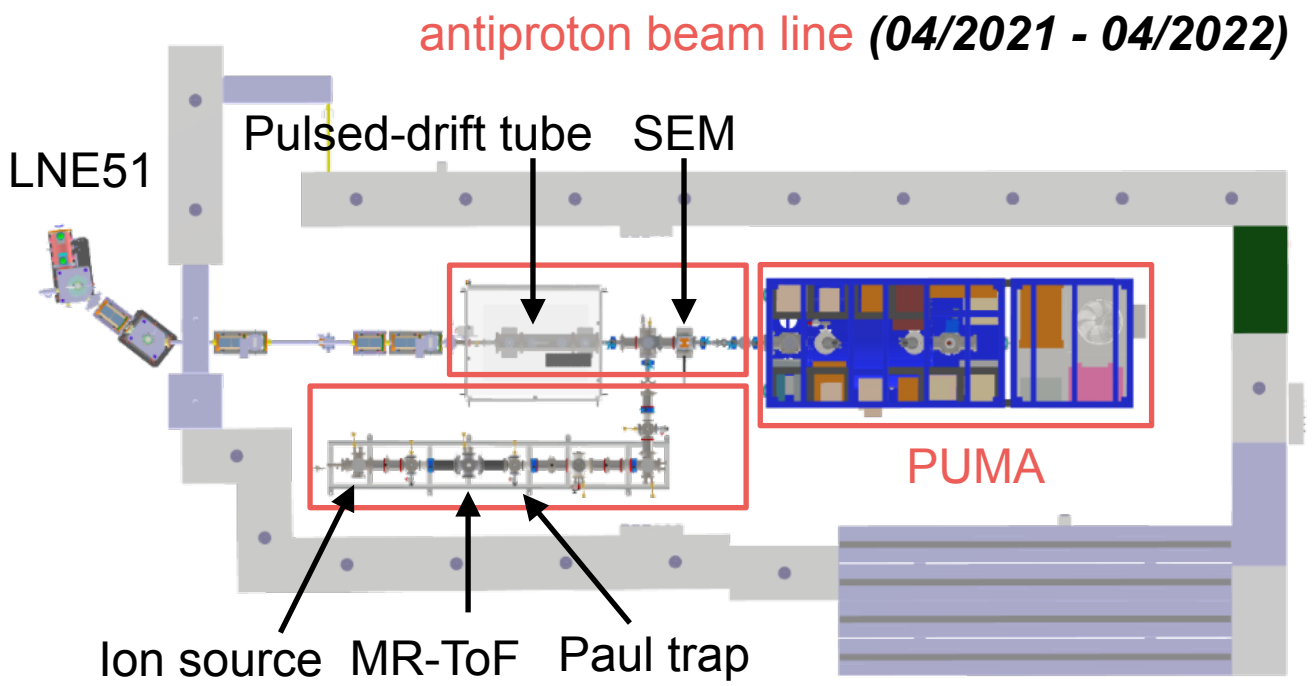
3) Physics with stable nuclei (**offline ion source**)

Also

4) characterization of pion detection (**time-projection chamber**)

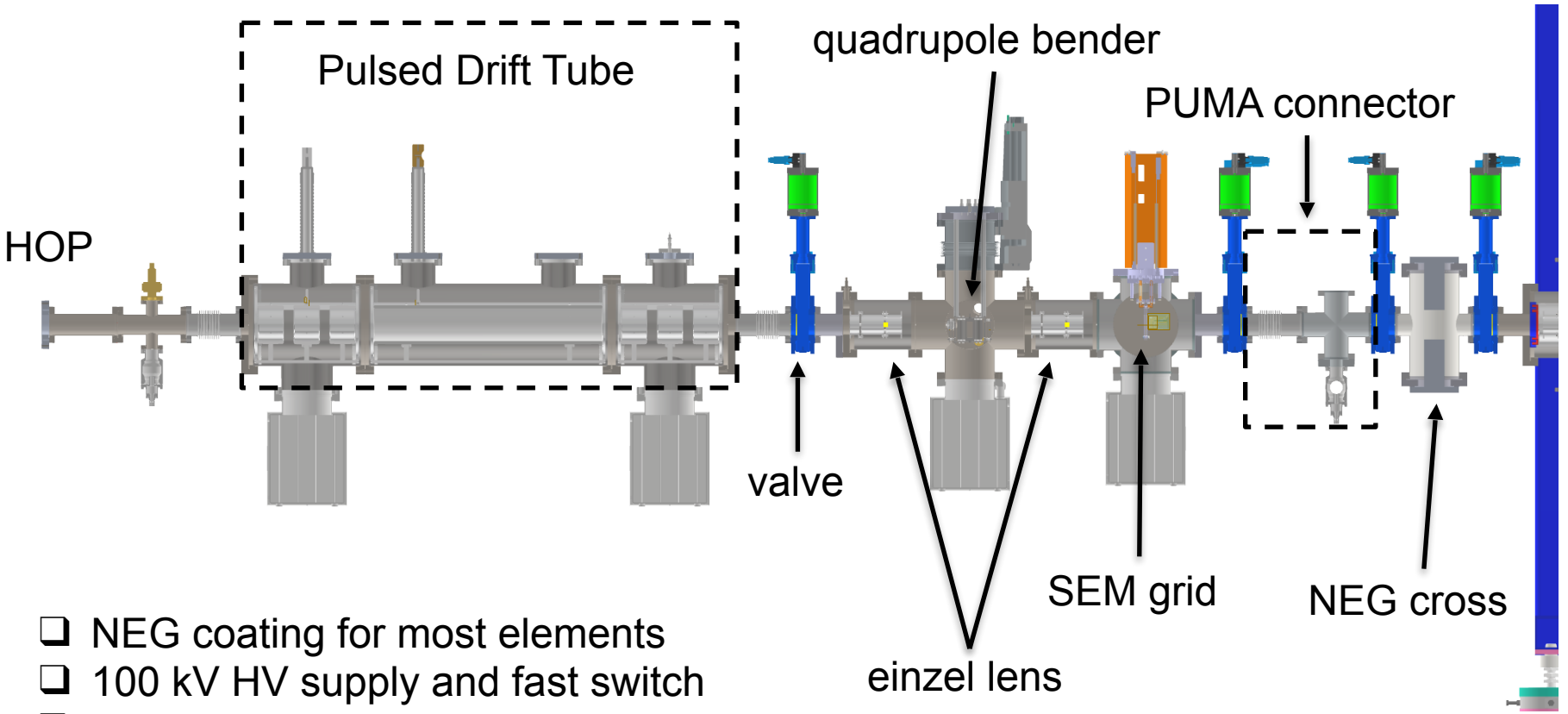
5) XHV validation (**TPC**)

PUMA@ELENA: overview



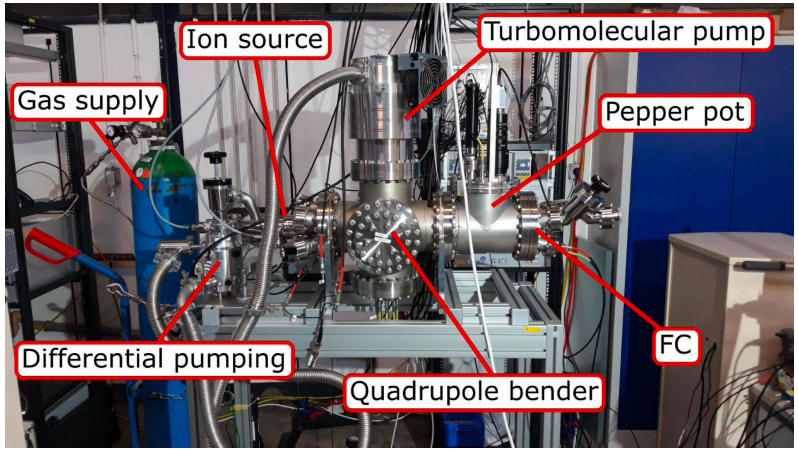
3-month delay due to late delivery of target support elements (alignement)
end of October 2021 → end of January 2022

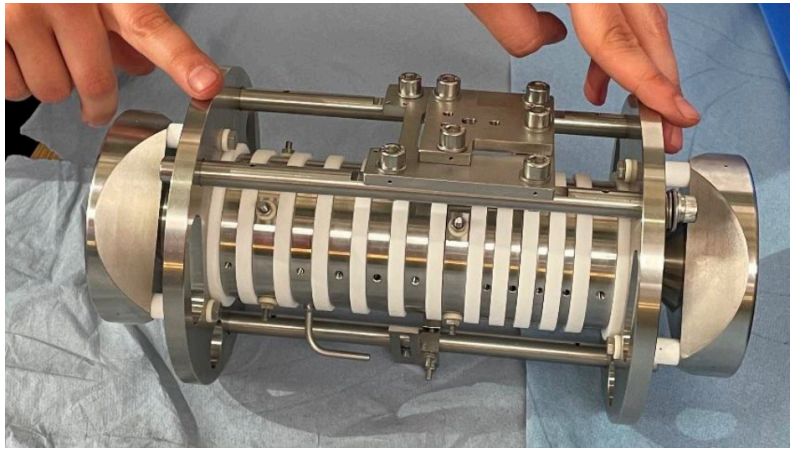
The antiproton beam line

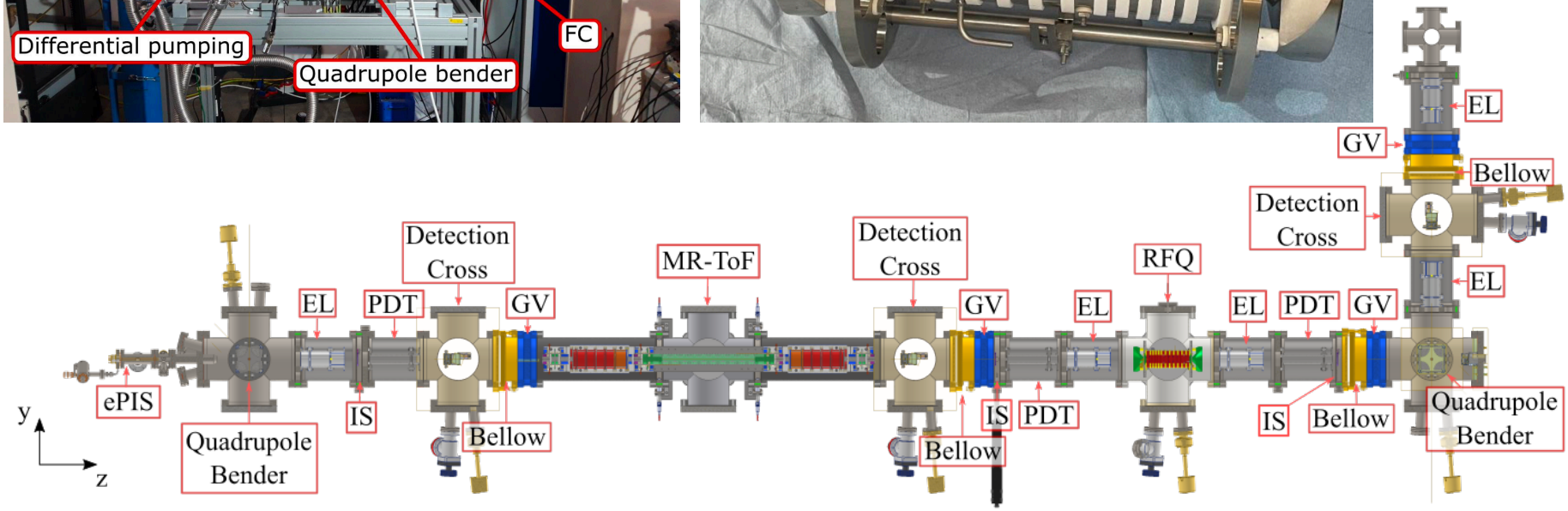


- ❑ NEG coating for most elements
- ❑ 100 kV HV supply and fast switch
- ❑ Faraday cage (not shown)
- ❑ Safety
- ❑ still missing SEM grid for experiment (expected 03/2022, possible delay)

The offline ion source







C. Klink, M. Schlaich, F. Wienholtz (TU Darmstadt)

Agenda @ ELENA

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		3/1	10/1	17/1	24/1	31/1	7/2	14/2	21/2	28/2	7/3	14/3	21/3	28/3	4/4	11/4	18/4	25/4	2/5	9/5	16/5	23/5	30/5	06/6	13/6
Weeks		W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23	W24
Beam elem.	Firing and cleaning																								
	NEG coating																								
section 1 (PDT)	Installation beam elem.																								
	Alignement																								
	Blankets for activation																								
	Vacuum validation																								
	Zone and HV installation																								
	Faraday cage mounting																								
	Safety visit																								
	PDT HV tests																								
section 2	Optics elem. installation																								
	Alignement																								
	pumping, activation (no SEM)																								
	vacuum validation																								
	connection to section 1																								
End section for tests	design																								
	procurement																								
	simulations																								
	Tests at TUDa (ions)																								
	Validation																								
	Send to elements to CERN																								
	Installation																								
Beam time	PDT operation																								
	Optics and focusing																								
	Transmission																								
Ion source	Dismounting at TUDa																								
	Send elements																								
	Installation																								
TPC	TPC finalised																								
	Mounting on test bench																								
	Flushing																								
	Cosmic ray tests																								
	Installation on beam line																								

defines critical path