Experimental study of Ar ion drift and feedback from gas to liquid phase

(and more)

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on behalf of the CIEMAT-DM group
CIEMAT / Canfranc Underground Lab

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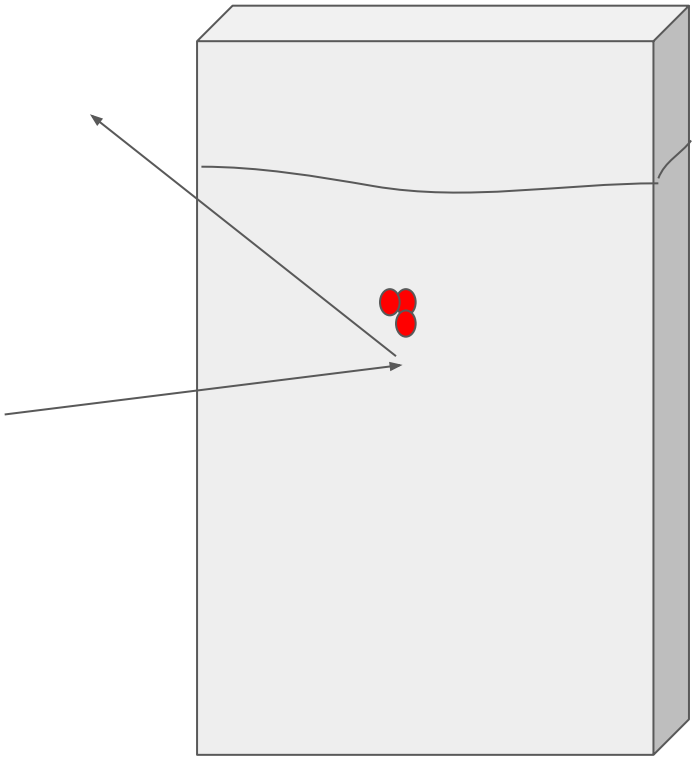
LSC Laboratorio Subterráneo Canfranc

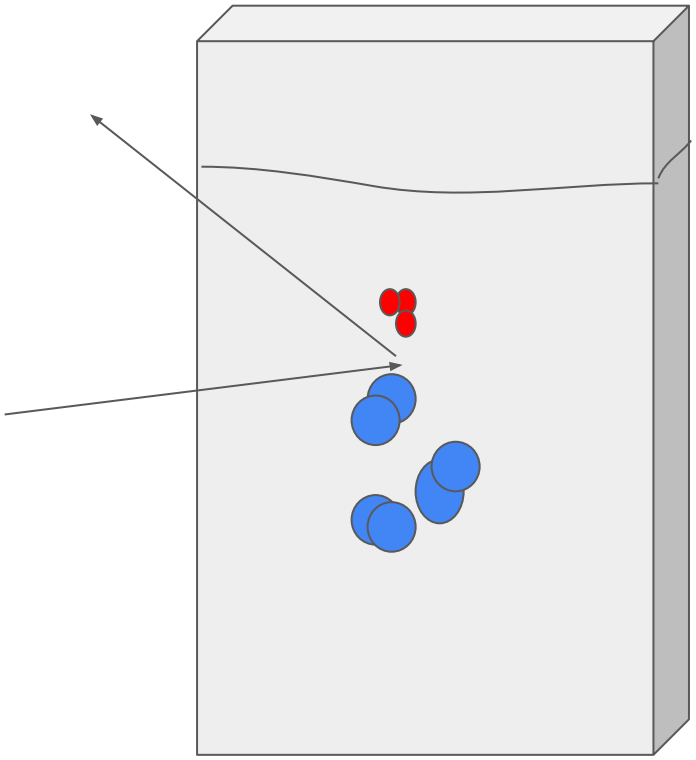
What about the ions?



Reminders:

We like drifting electrons

What about the ions?

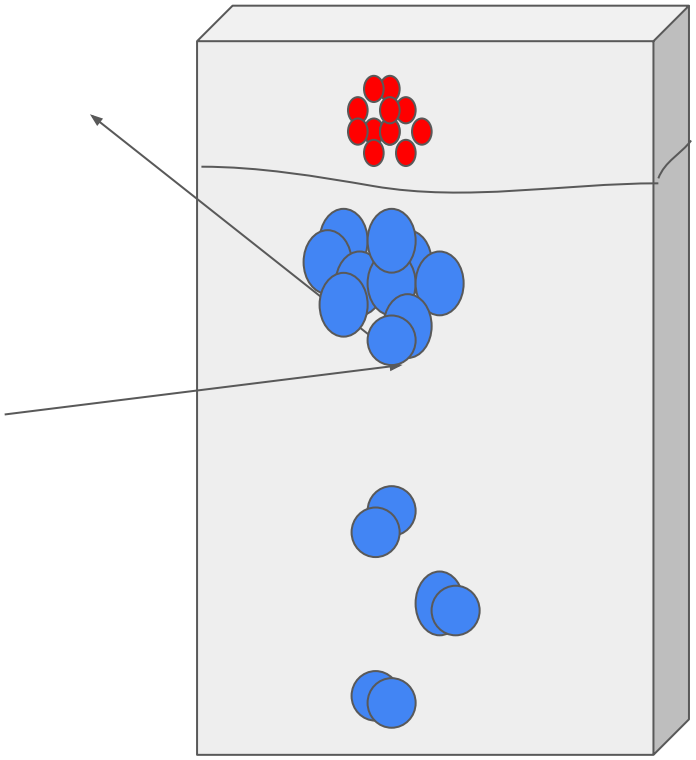


Reminders:

We like drifting electrons

We are not violating charge conservation all the time

What about the ions?



Reminders:

We like drifting electrons

We are not violating charge conservation all the time

We induce avalanches in the surroundings of the EL grid

The potential risks

L. Romero et al. Astroparticle physics 92 (2017) 11-20

ions modifying the field lines

recombination

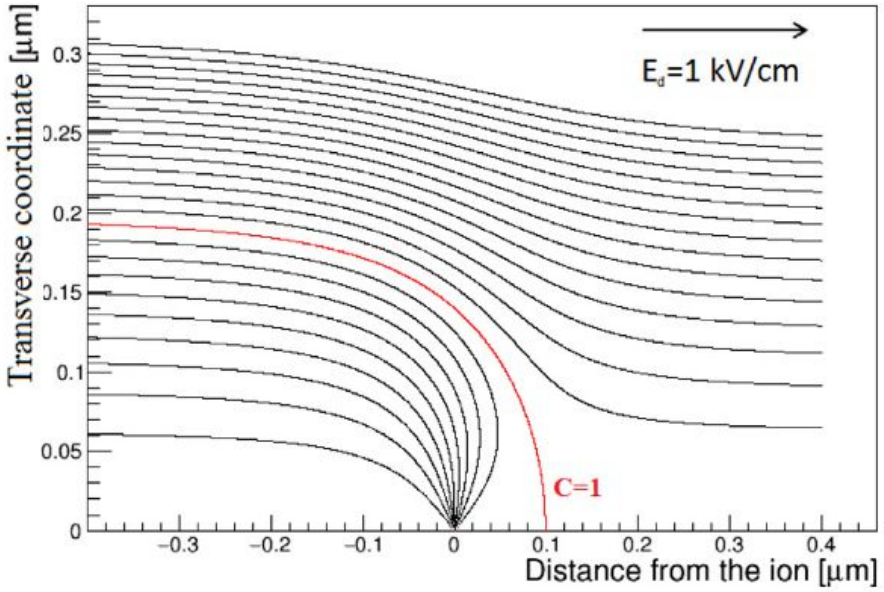
stray light

Loss of e-

$$\frac{1}{\tau} = \frac{1}{\tau_A} + \frac{1}{\tau_R}$$

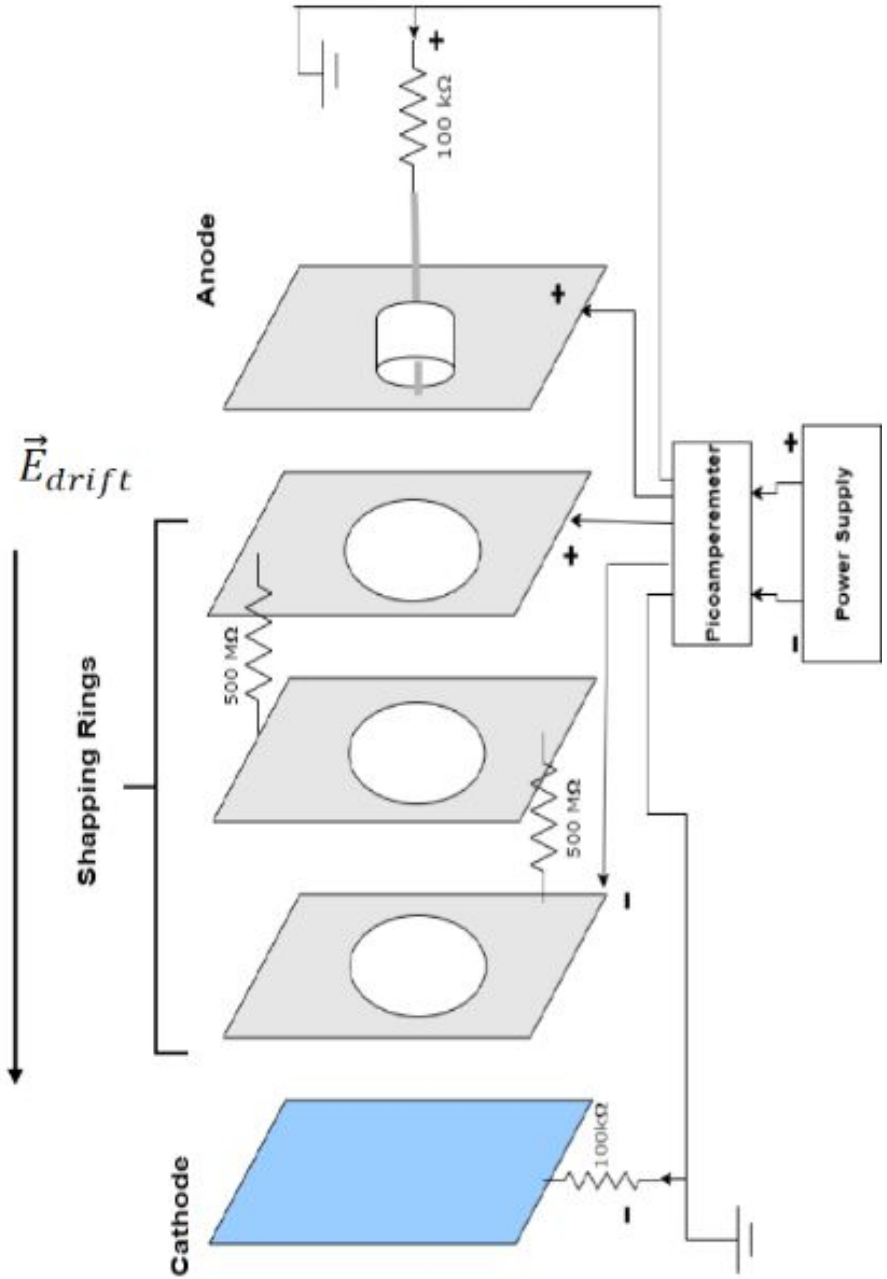
resolution

tracks



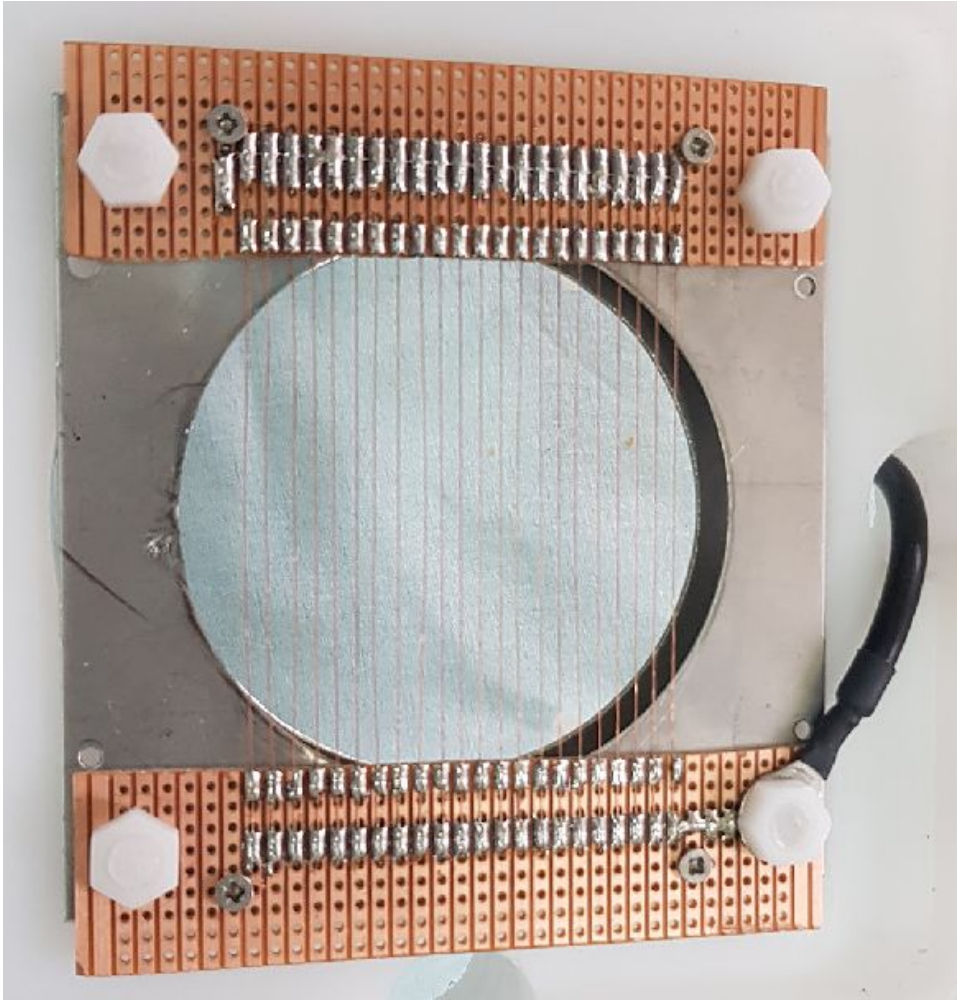
The ARION setup

L.Romero. et al. Universe 2022, 8, 134



The ARION setup

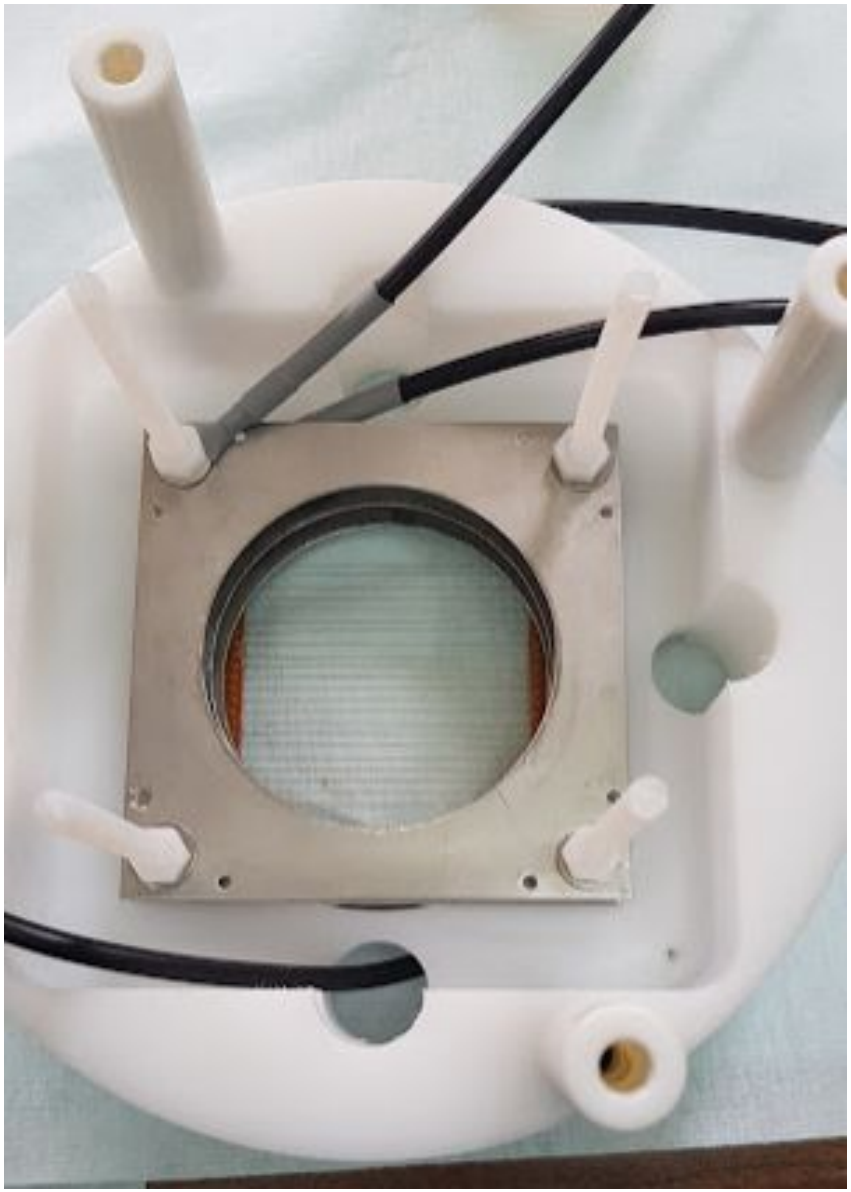
Cathode (collection)



The ARION setup

Cathode

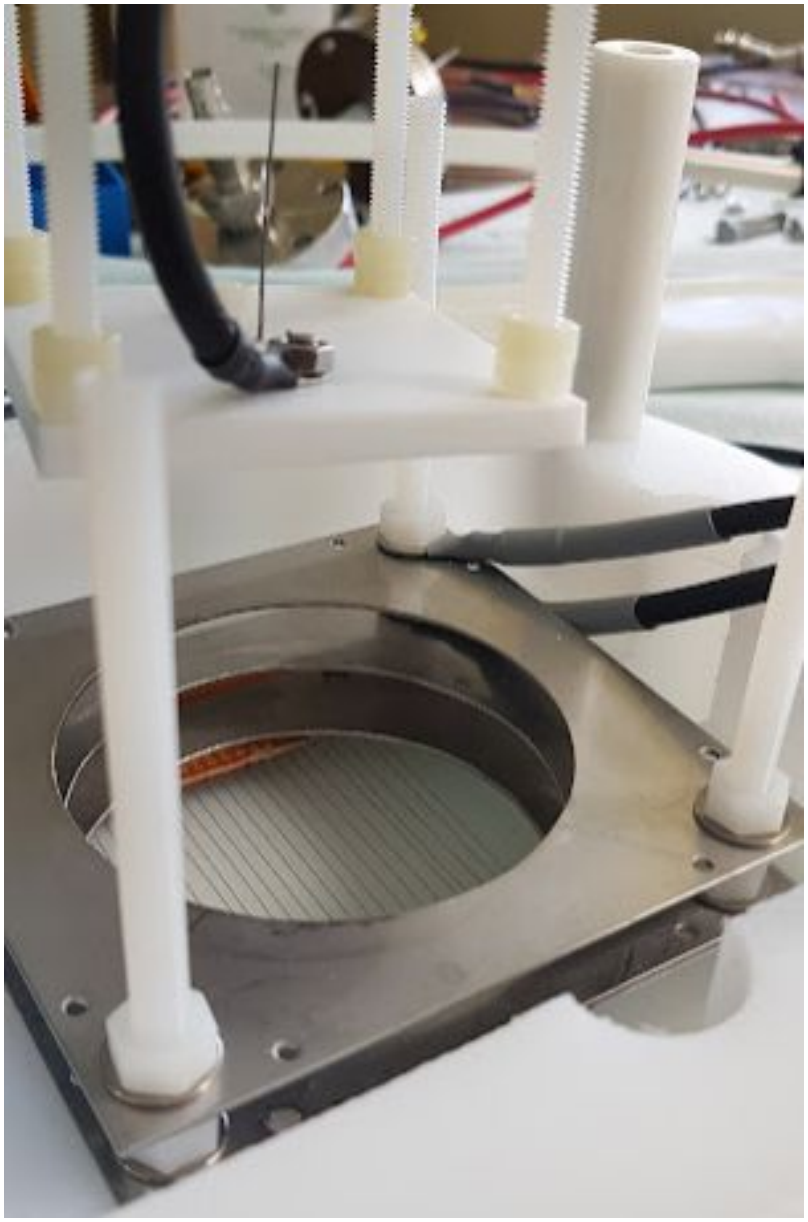
Shaping rings



The ARION setup

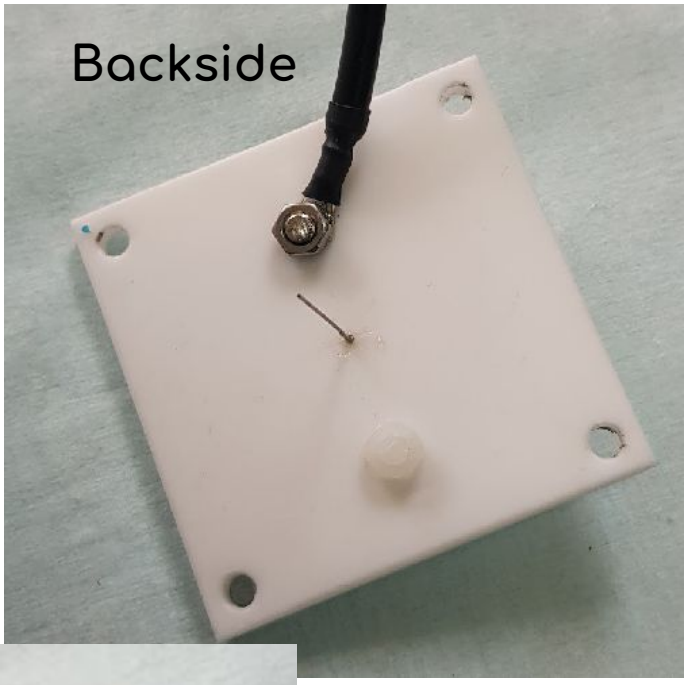
Cathode

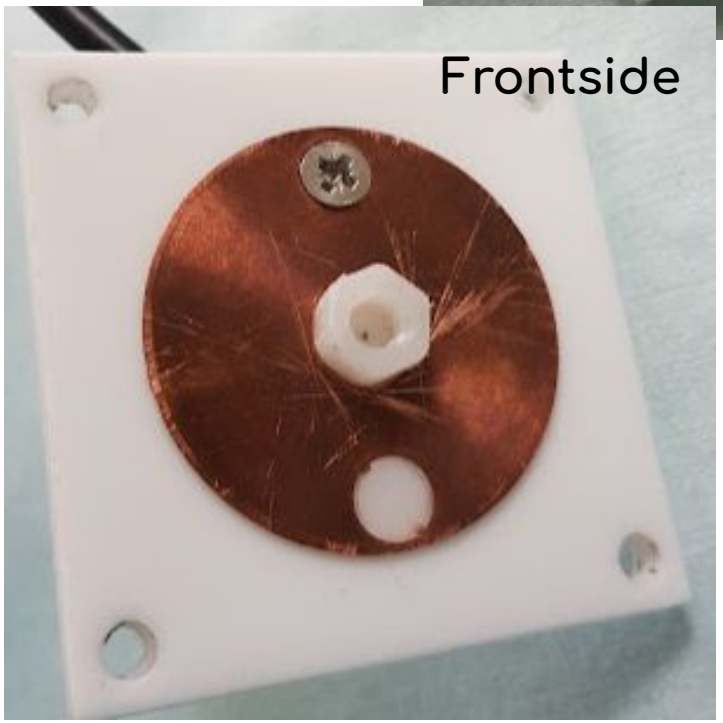
Shaping rings



The ARION setup

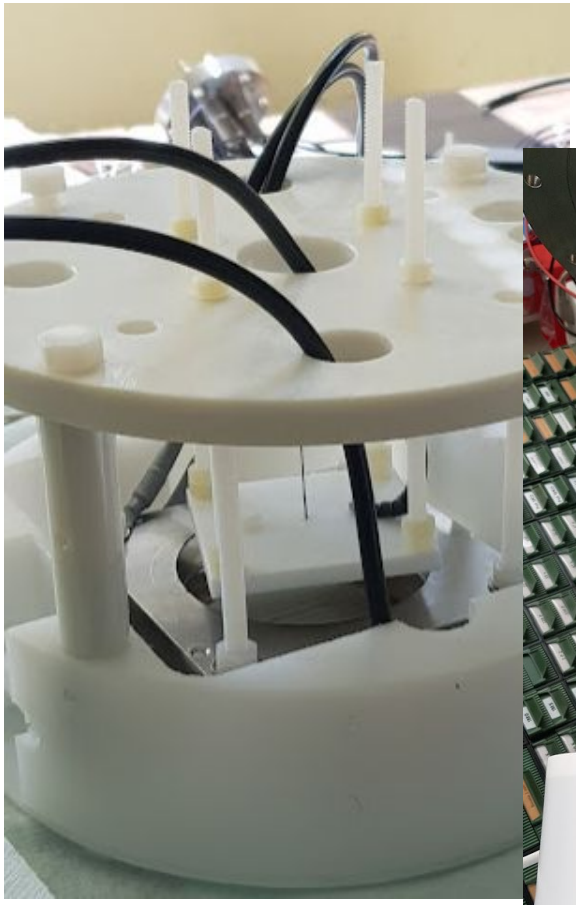
- Cathode
- Shaping rings
- Needle (production)
- Plane





The ARION setup

- Cathode
- Shaping rings
- Needle
- Plane
- Ertalyte structure



The ARION setup

- Cathode
- Shaping rings
- Needle
- Plane
- Ertalyte structure
- Cryostat + gas system
- Picoammeter

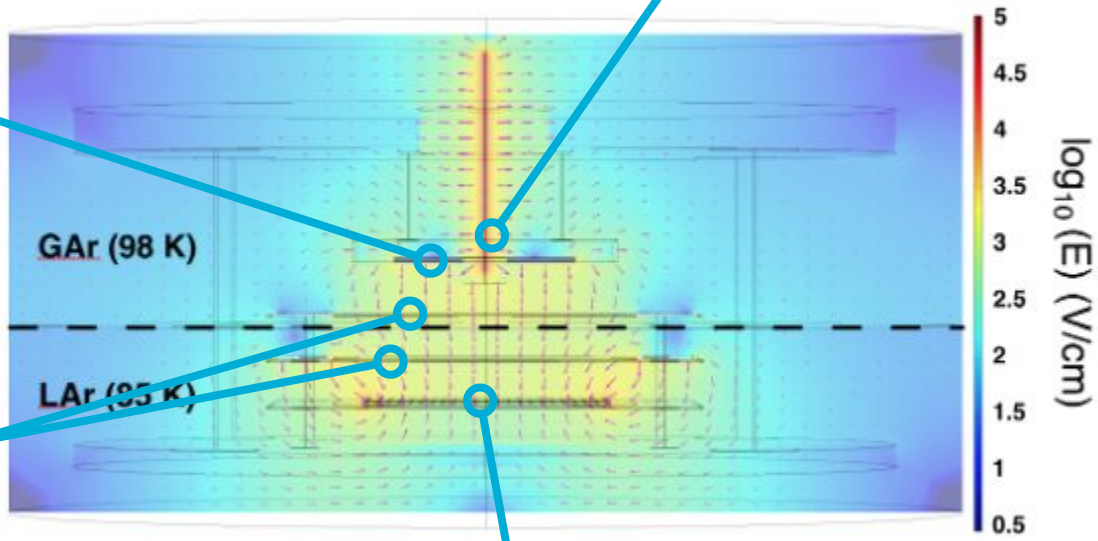
ARION: setup to study dynamics of ARgon IONs

Needle @ 2 kV

Grounding plane @ 0.5 kV

shaping rings @ 0.7 kV

@ 0 V

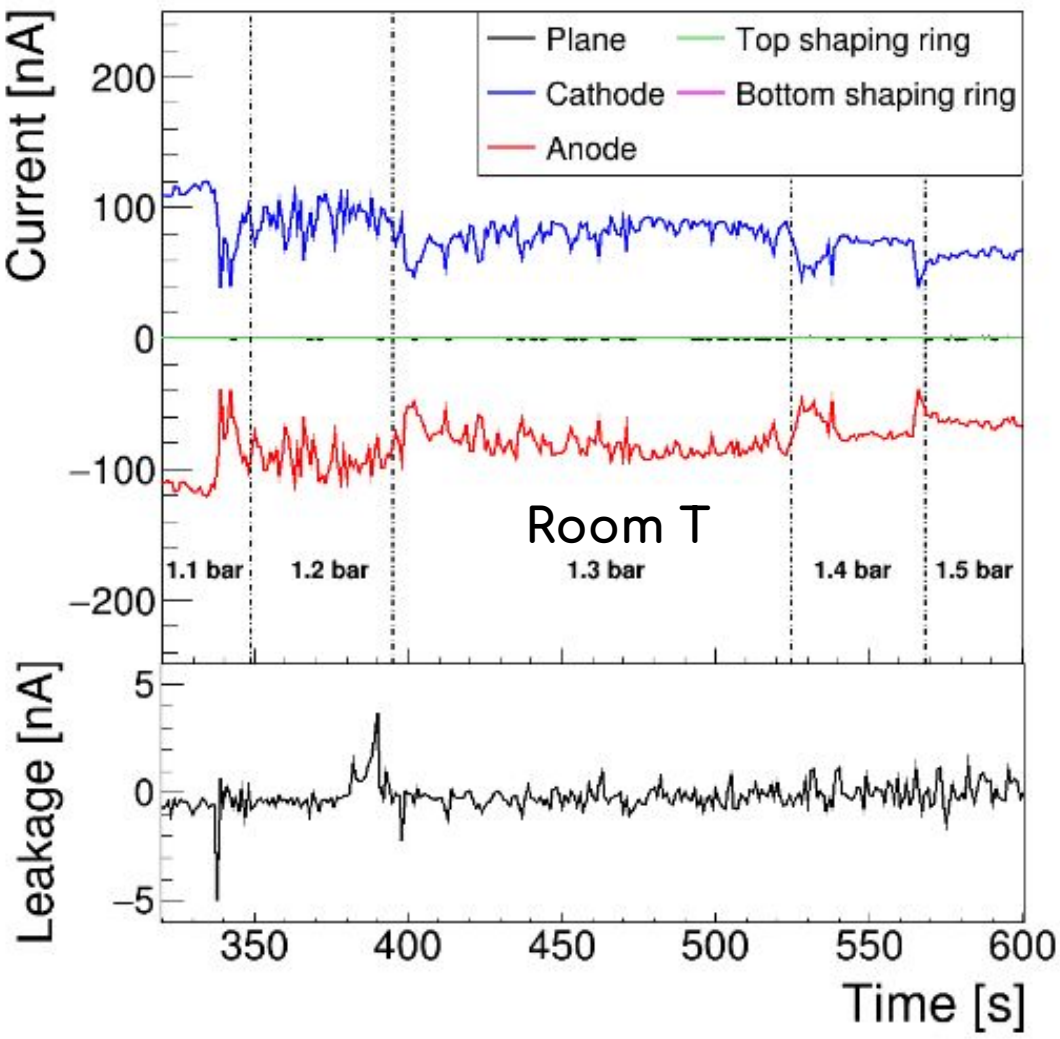


cathode (collection) @ -3 kV

Gas measurement

Collection efficiency: 98%

Ionization reduced with pressure



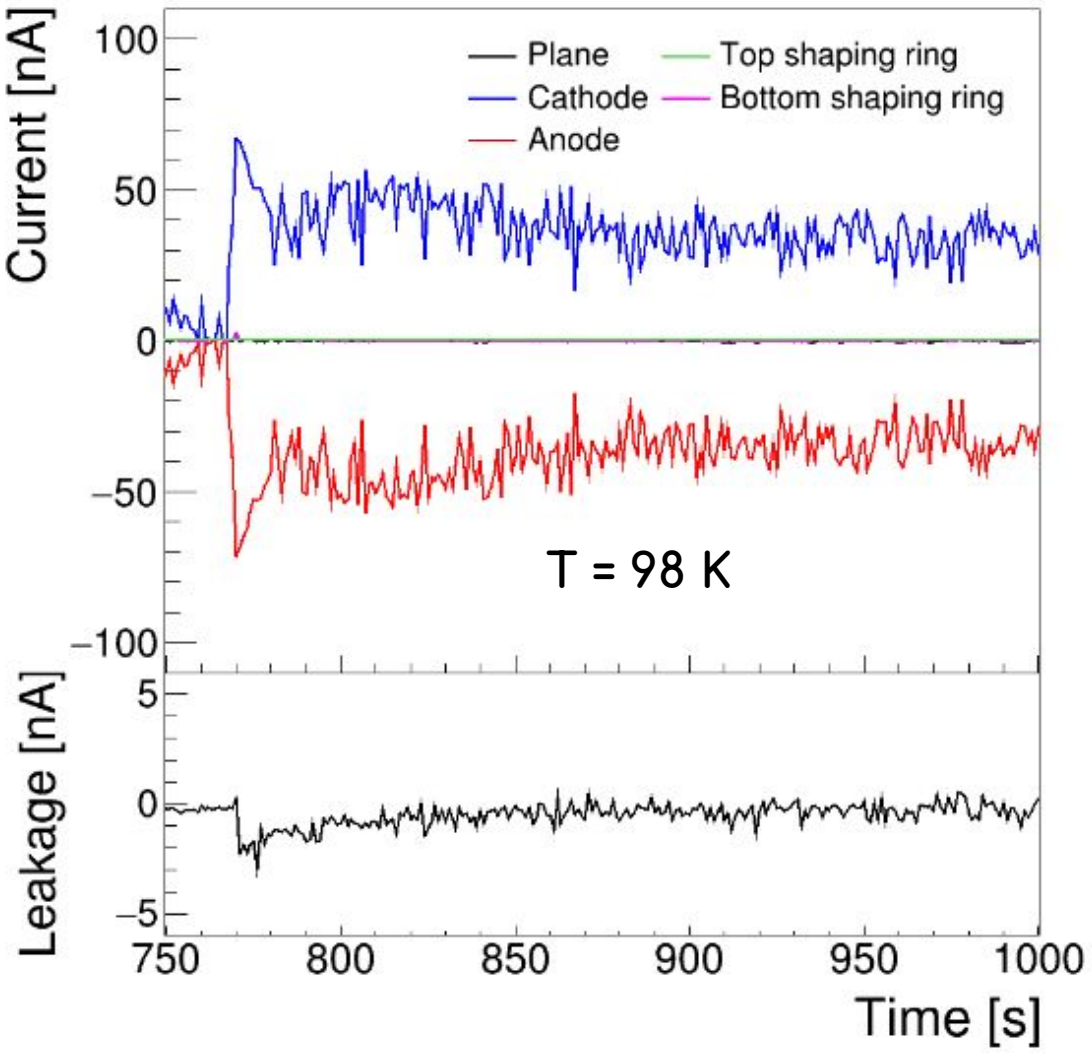
Gas measurement

Collection efficiency: 98%

Ionization reduced with pressure

Ionization reduced in cold (higher ρ)

Otherwise, all good

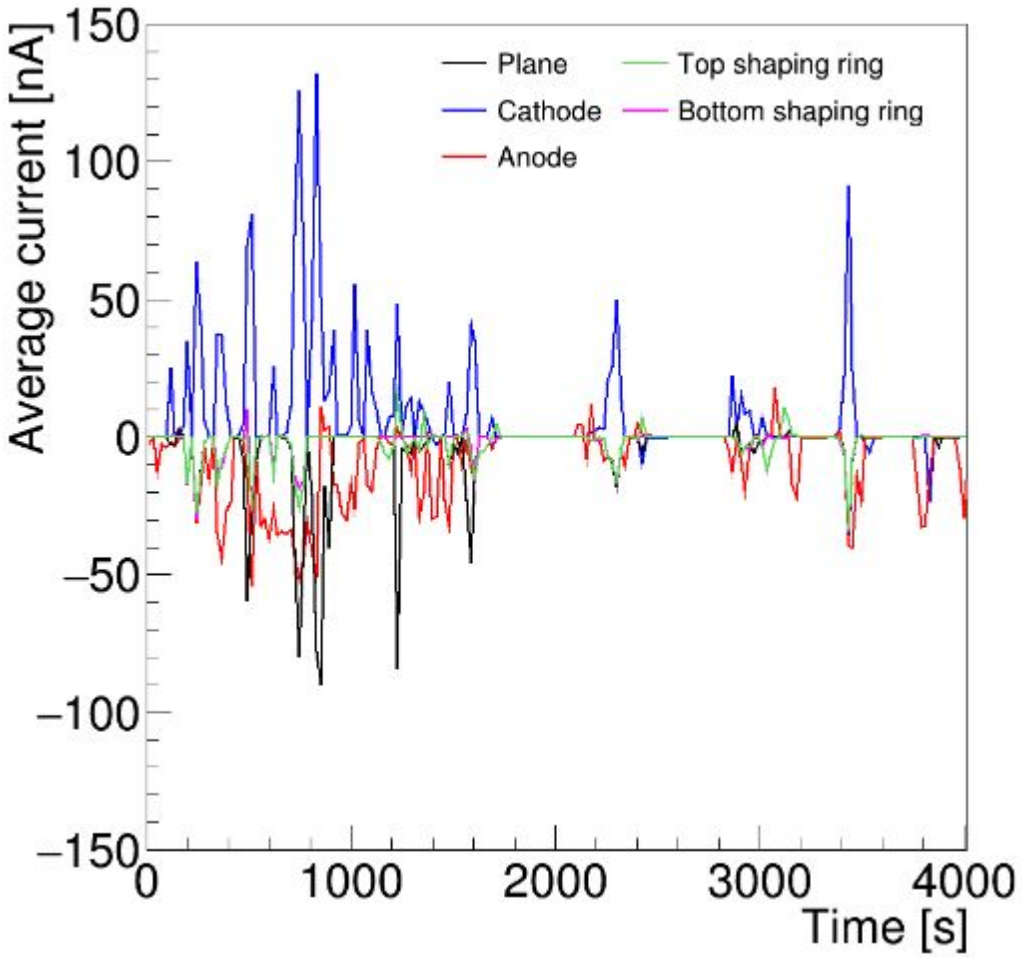


Liquid measurement

Not possible to set continuous current

Regardless the E field!

Variable field lines



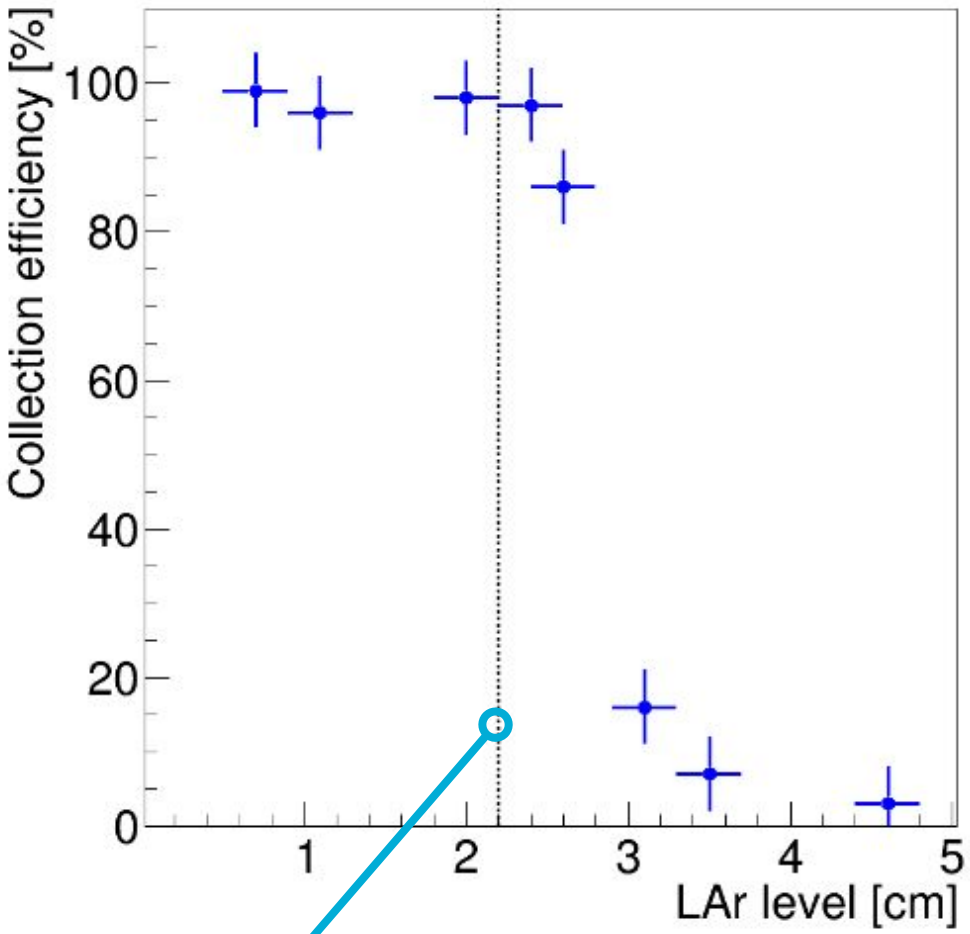
Liquid measurement

Not possible to set continuous current

Regardless the E field!

Variable field lines

Space charge prevents discharges!

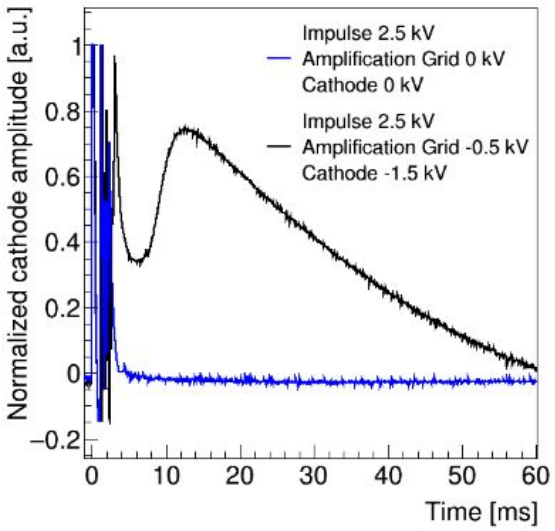


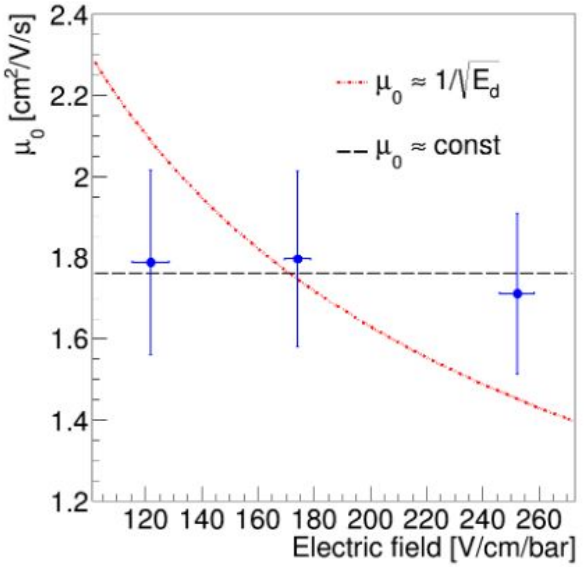
Mobility measurement

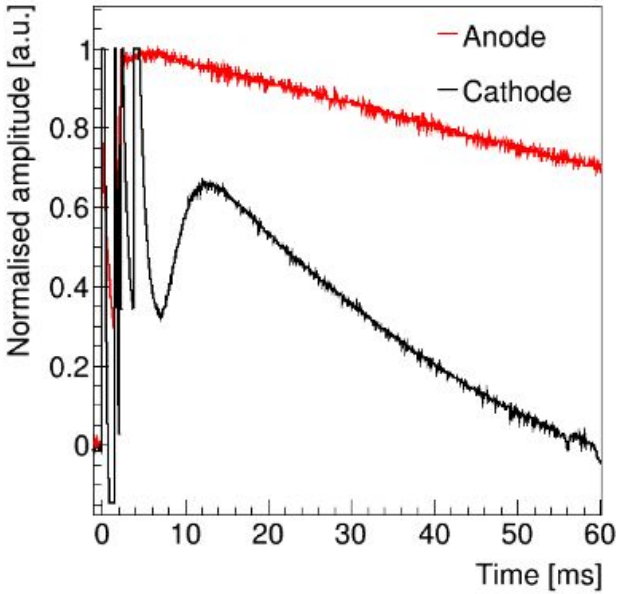
Add Firsch grid to prevent slow raising time (resolution)

KV custom pulse generator + scope

Arrival time characterized w + wo biasing K







Mobility field independent!

$$E_d \ll kT/2\ell e,$$

Summary and prospects

ARION is a tabletop compact setup able to study the processes of ions in noble gases + liquefied Ar.

Mobility of ions has been measured to be constant.

Ions get into the LAr and are able to prevent the production of discharges

Large detectors @ shallow depths or in-beam @ moderate currents will continuously have sizable effects.

Coming soon:

Measurements of the ion drift velocity in liquid

Thank you for your attention

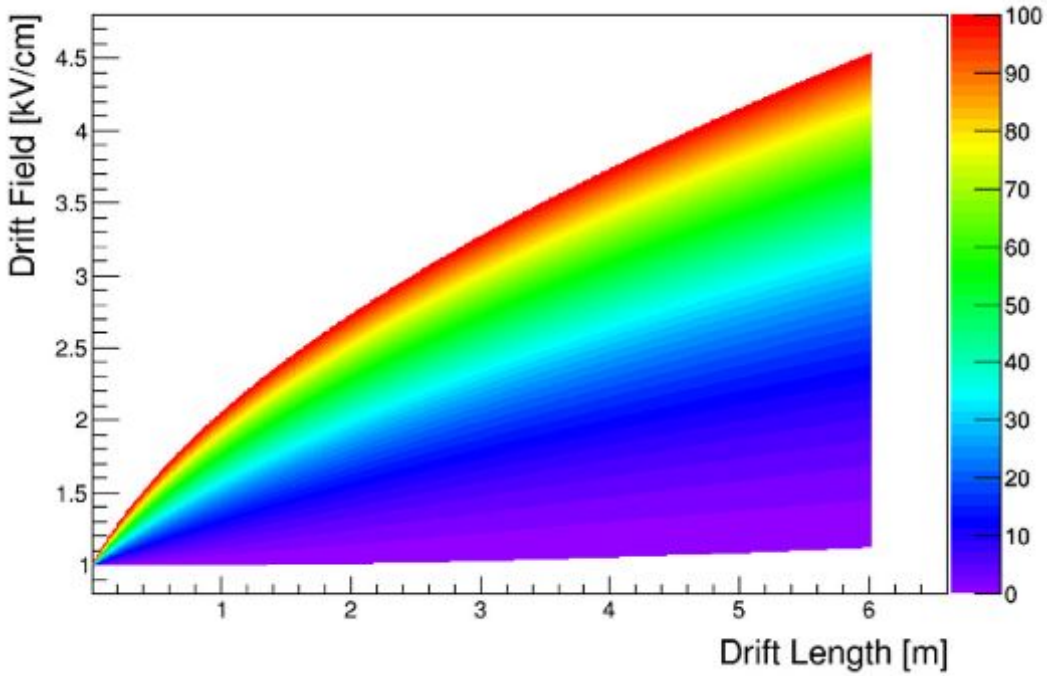
Authors:

Luciano Romero, Roberto Santorelli, Edgar Sánchez García, Thorsten Lux, Michael Leyton, Silvestro di Luise, Pablo García Abia, Rodrigo López Manzano, José Manuel Cela Ruiz, Sebastián Quizhpi, Vicente Pesudo

Backup

backup

Needed field depending on Drift length and multiplication



backup

Mirror charge approximation vs effective potential energy

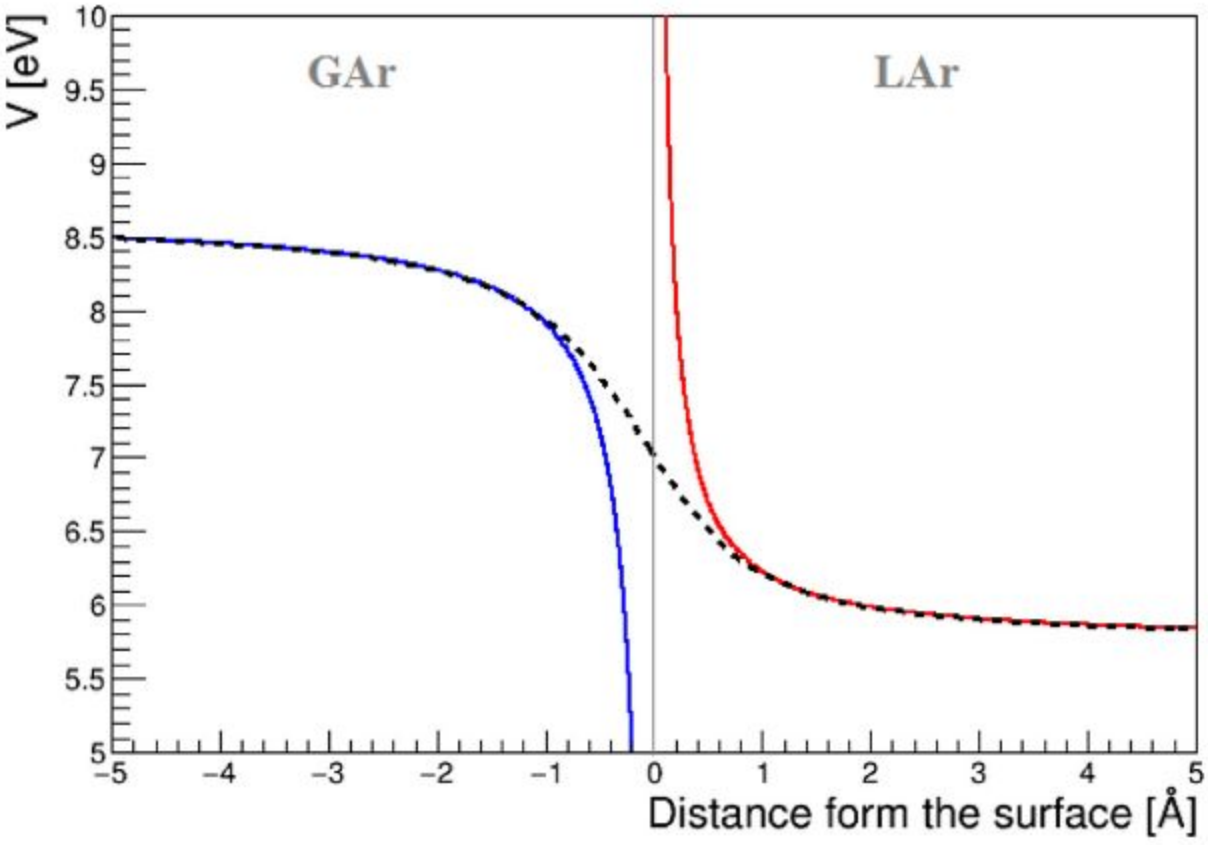


Fig. 1. Potential energy (solid lines) at the liquid (right-red) / vapor (left-blue) interface in the mirror charge approximation and possible effective potential energy (dashed line, see text for details). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)