

Preliminary studies towards spectroscopic-based particle discrimination in Ar

Vicente Pseudo (CIEMAT / LSC)

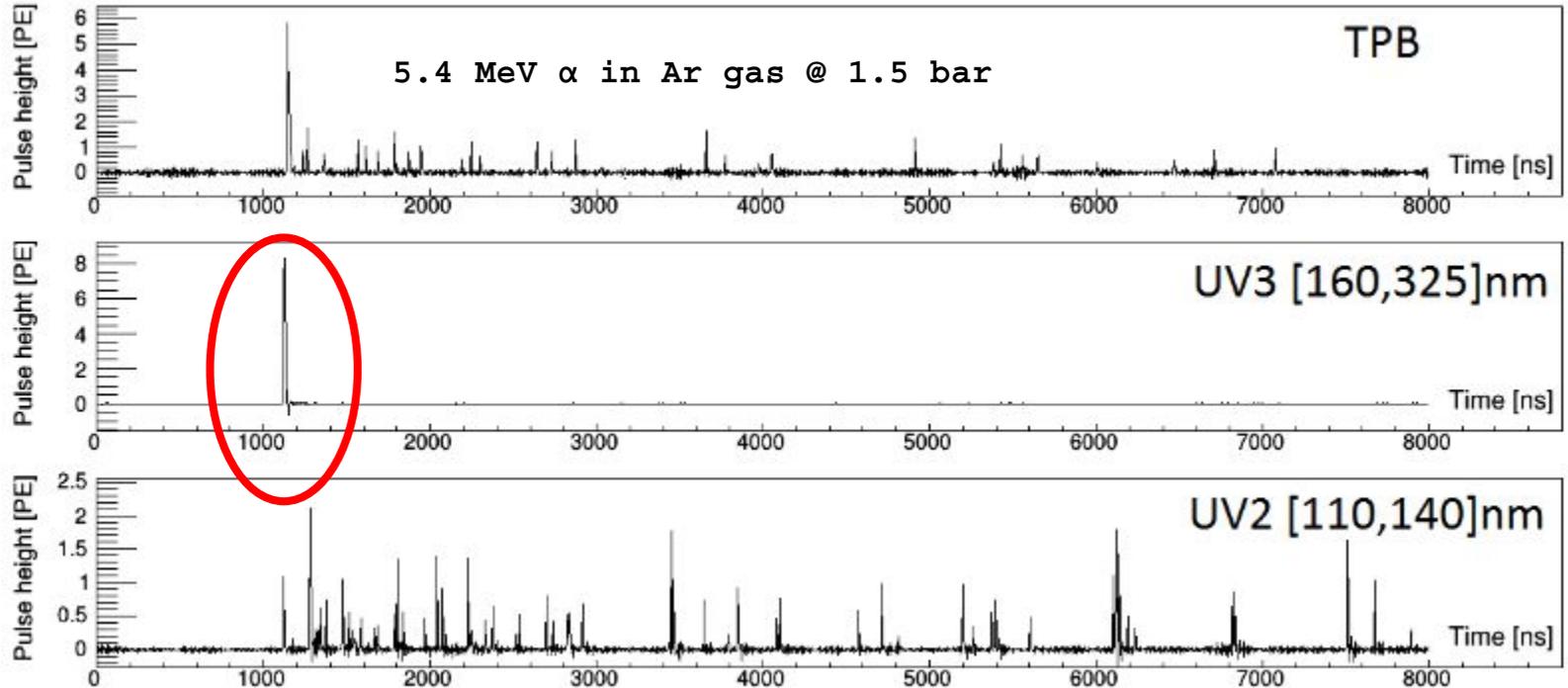
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J.J. Martínez Morales, L. Romero

LIDINE 2021

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Summary

R. Santorelli et al. Eur. Phys. Journal C 21, 622 (2021)



3rd continuum, produced in presence of high ionization yields is spectroscopically distinct and its relative intensity is sizable event-by-event.

Why not using this in our detectors?

Detector concept

Compact central cubic volume:

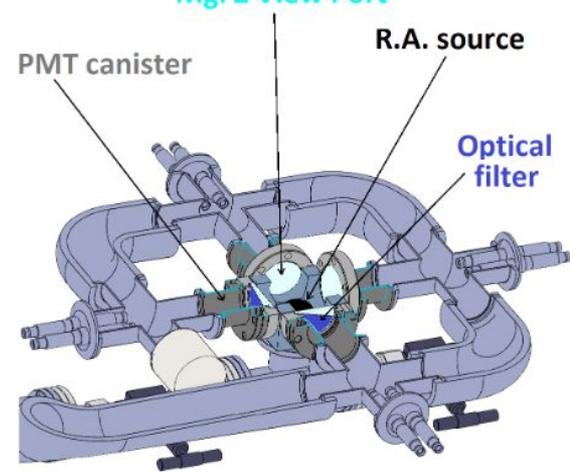
- with 4 MgF_2 viewports mounted on CF40 flanges.
- validated to hold 21 bar
- Maximize light collection
- Minimize reflections and cross-talk

Decoupled volume for PMTs, working in vacuum.

Radioactive source at the bottom:

- ^{241}Am [5.5 MeV α @ 500 Bq]
- $^{90}\text{Sr}/\text{Y}$ [$Q_\beta = 546$ keV & $Q_\beta = 2280$ keV @ 100 Bq]

Combination of PMTs and filters to control the spectral range.



Detector concept

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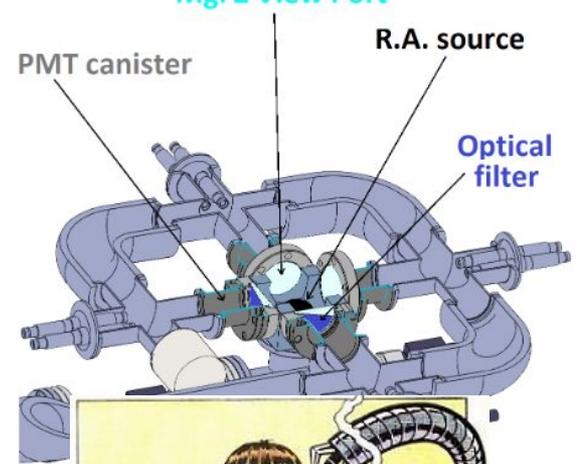
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Combination of PMTs and filters to control the spectral range.



Detector concept

Combination of different PMTs and filters to control the spectral range:

- R7378A x2 (UV3): [160, 325] nm
- R6095 + TPB (TPB): integral range
- R6835 (UV2): [110, 140] nm

[naming after the index of the continuum]

R7378A + XUL0325



no light

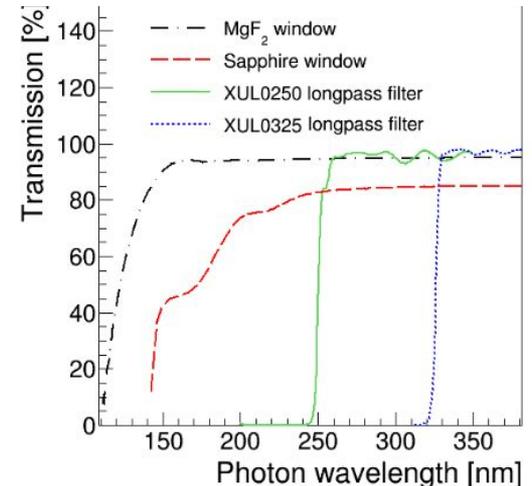
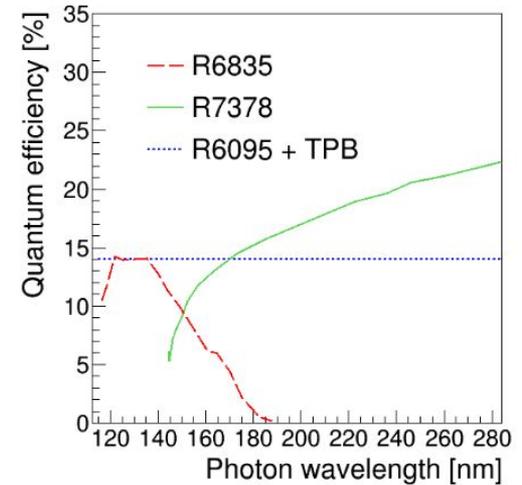
R6835 + Sapphire



no light

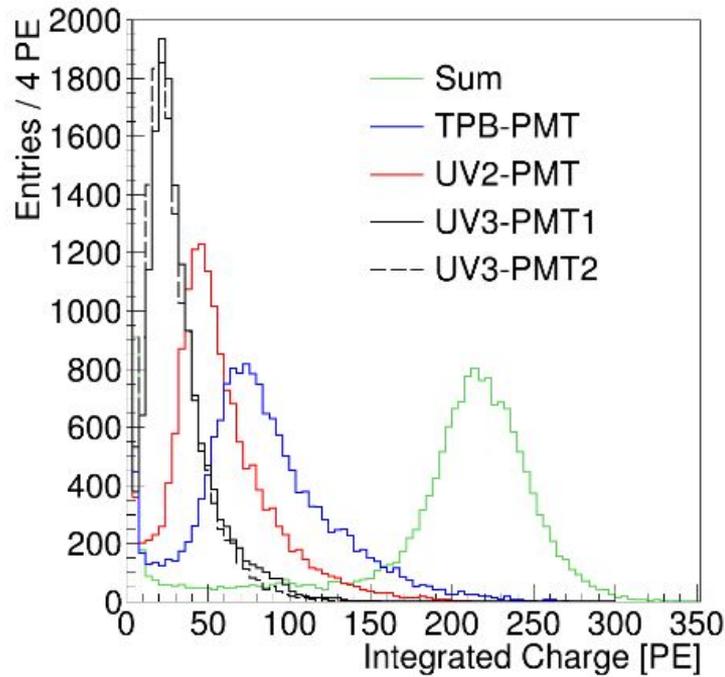
We are certain the light they are getting are at shorter wavelength than those filters.

Once verified, we operate without filters.

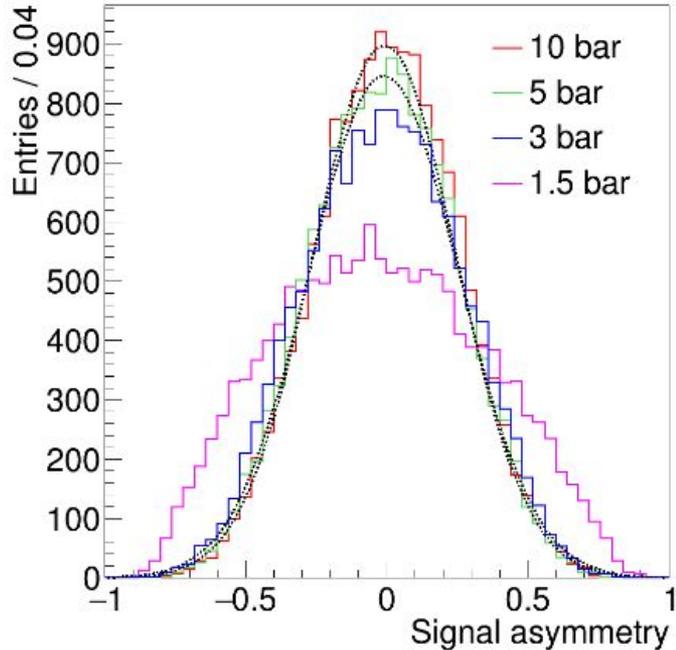


Order 0 cross checks

Amount of light in all PMTs is large enough



Asymmetry goes down at higher pressure (shorter path)

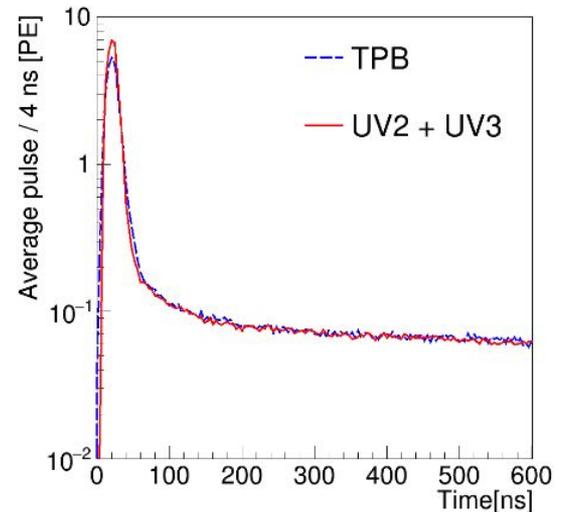
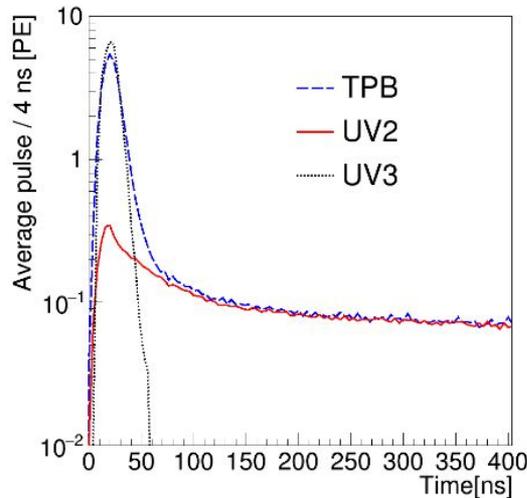
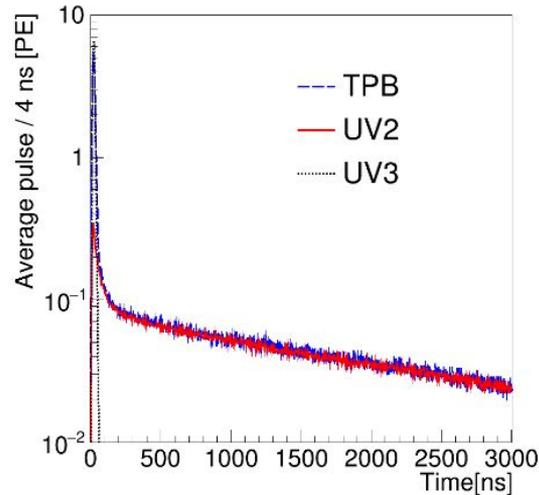


Average pulse shapes @ 1.5 bar

Prompt light not so prominent in the UV2 region!

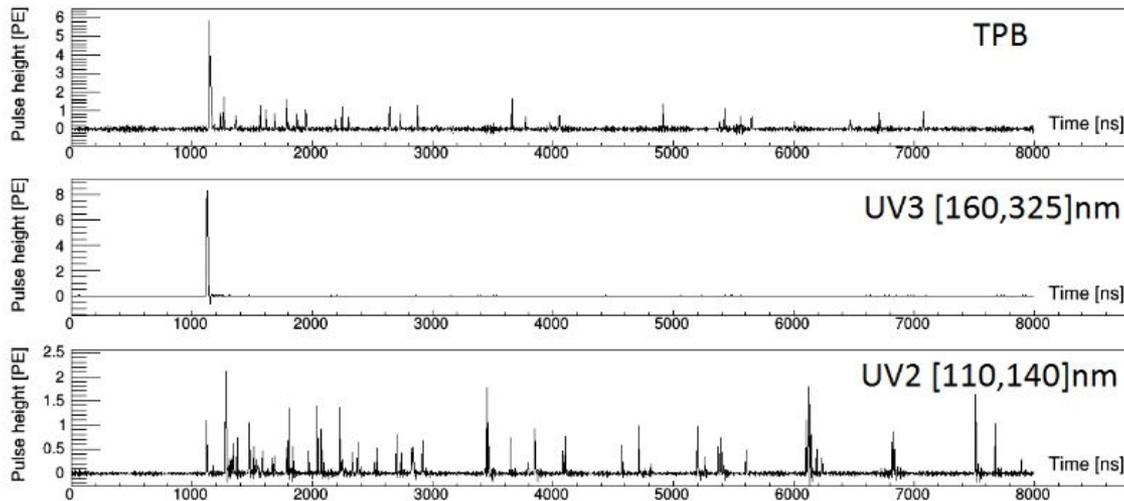
A lot of light in the UV3 region

All the light in the UV3 is prompt

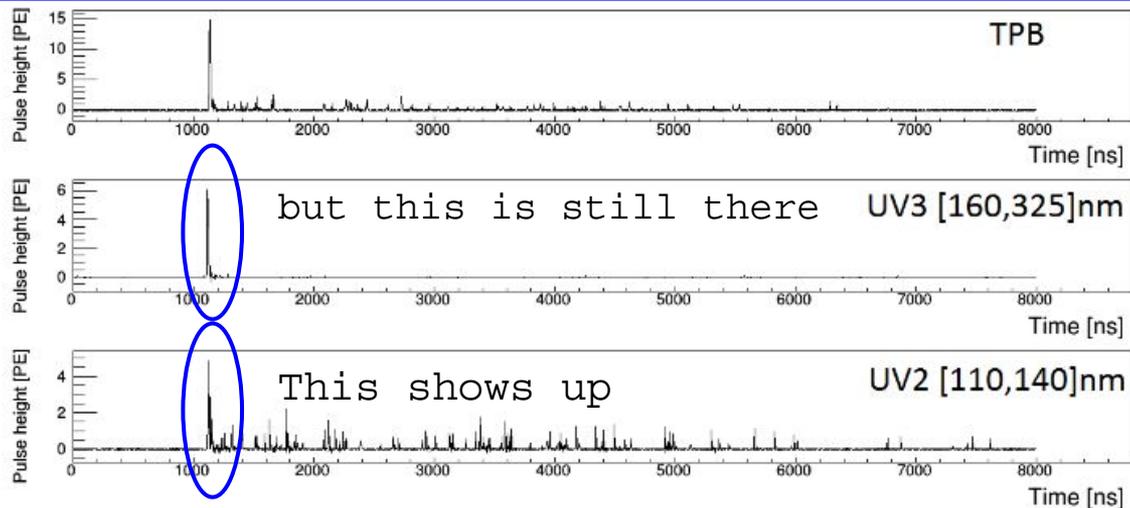


(still 5.5 MeV alphas in gas)

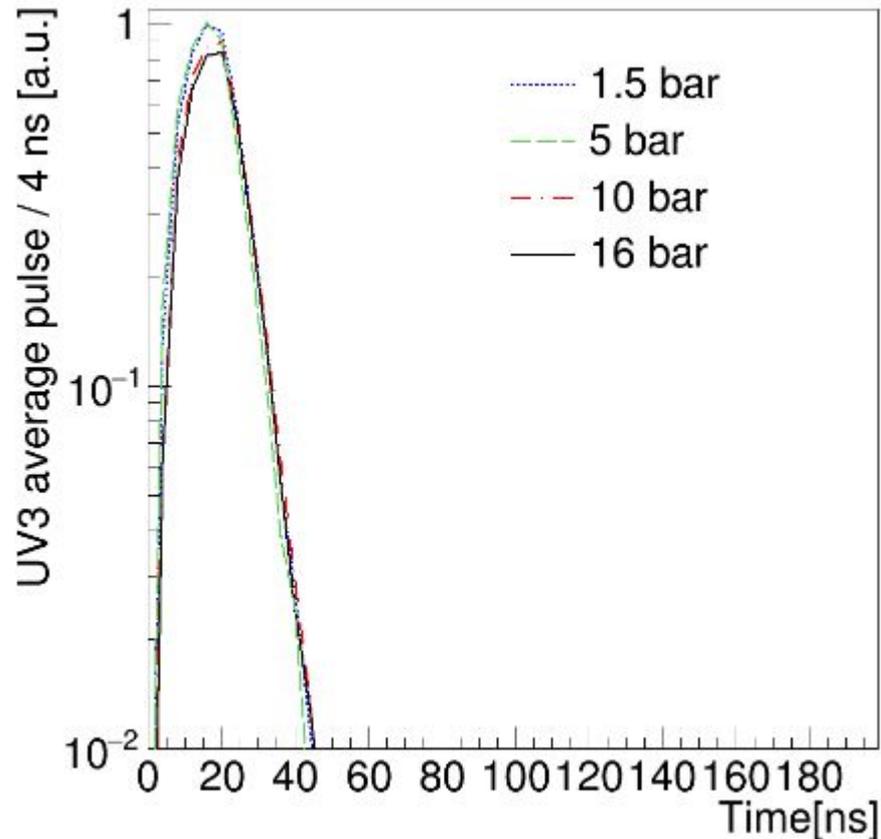
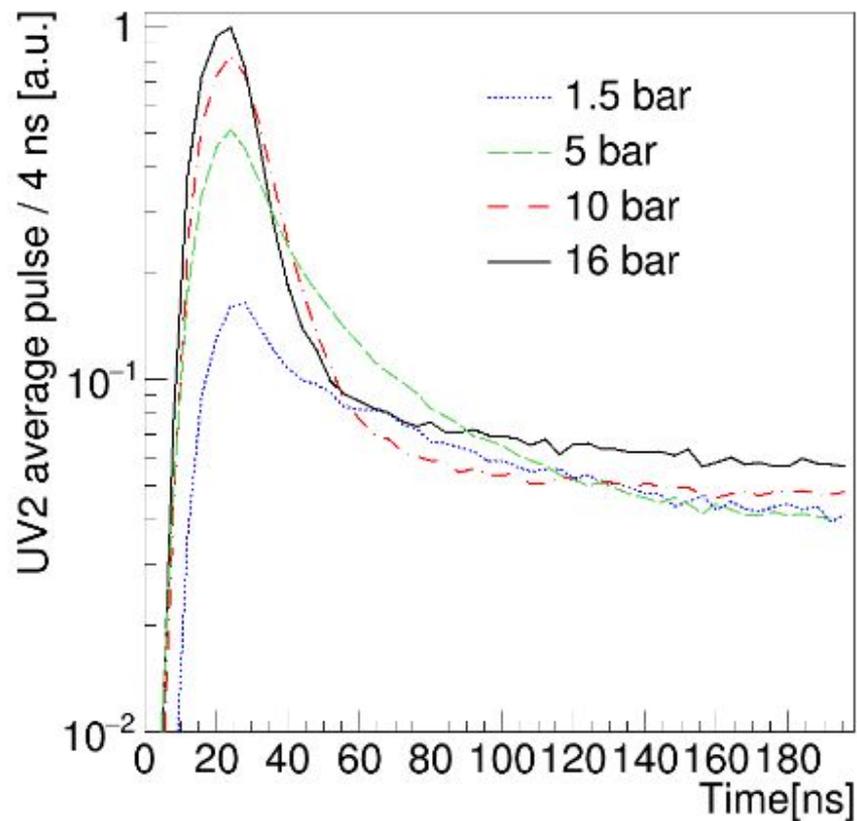
1.5 bar



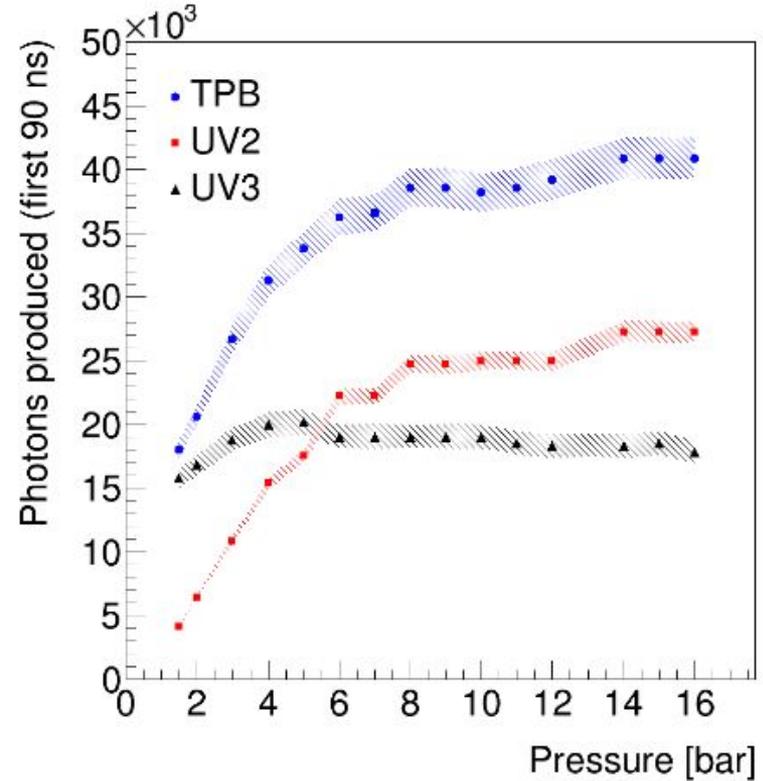
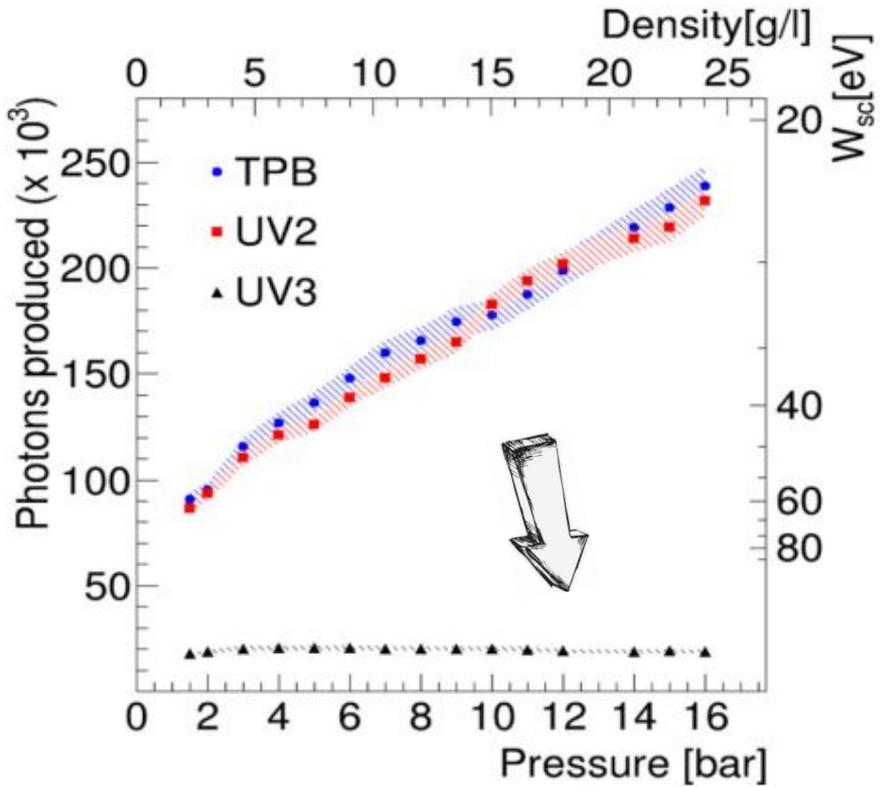
16 bar



Average pulse for different pressures



Light yield as a function of P



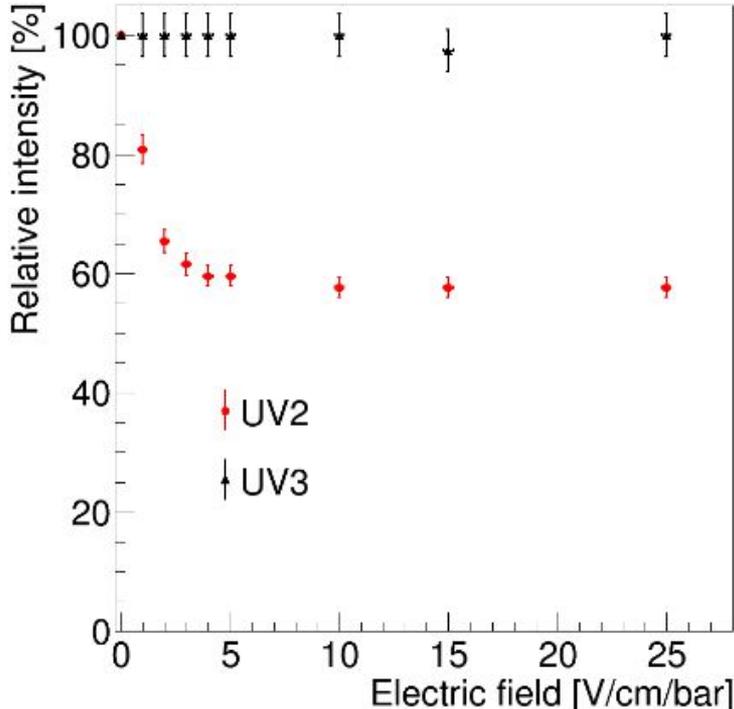
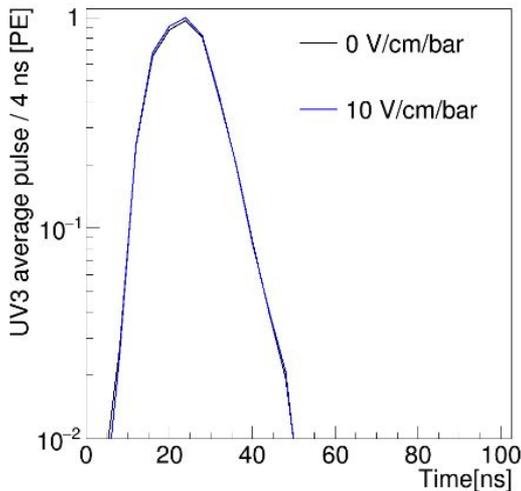
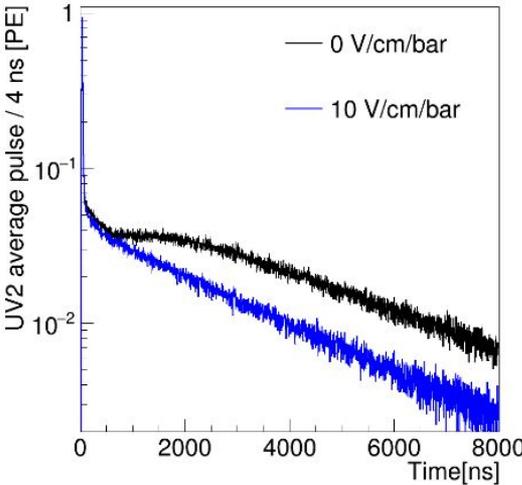
Field dependence

UV2 decreases with field

UV3 says "what field?"



Recombination happens in UV2



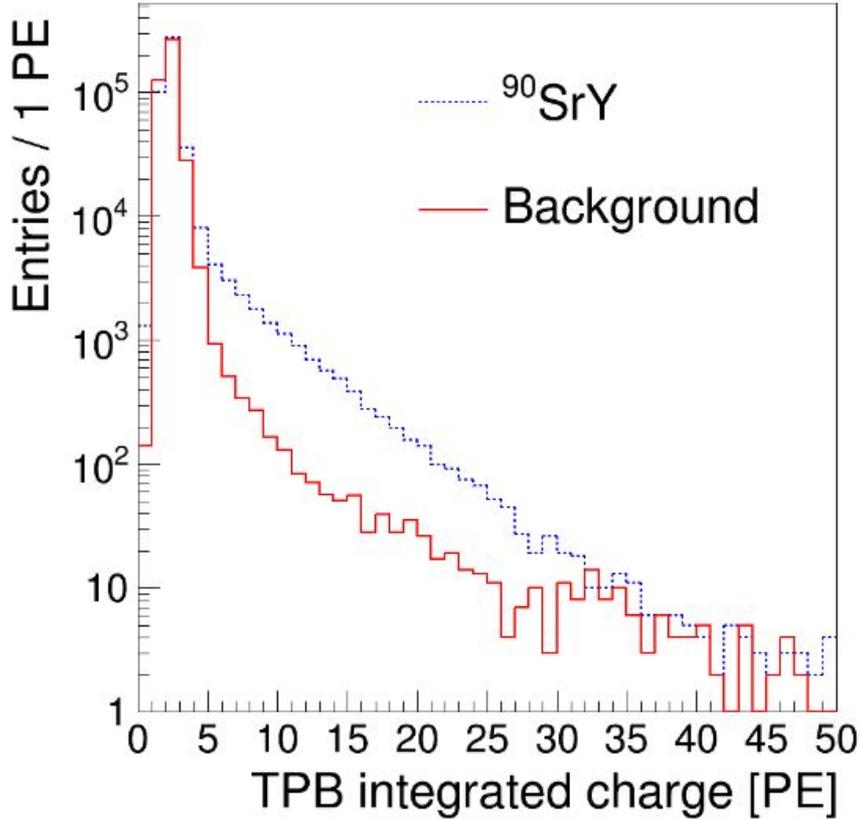
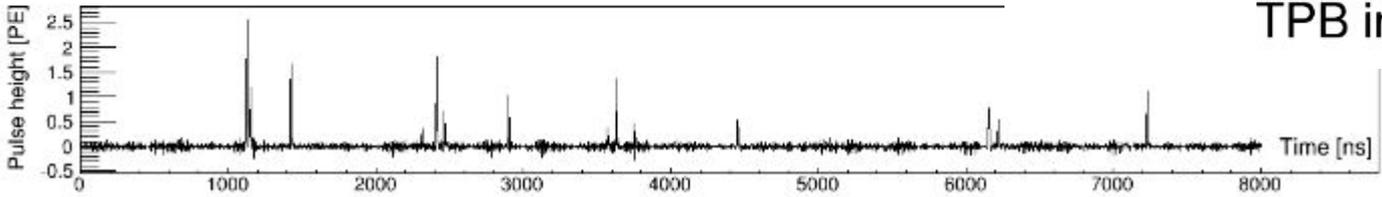
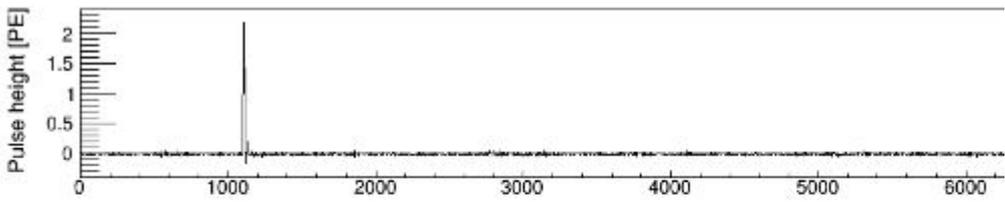
What about betas?

Clear light yield increase

UV3 light is there

Instrumental effects do not allow more
conclusive statements (yet)

-E uncertainty, long path,
asymmetry...



Next steps

Measuring in liquid Ar: LArDis, already operative at Laboratorio Subterráneo de Canfranc.

Light observed with R6041-506 (UV3 PMT operative @ 85 K).

Setup being fine tuned and long data taking starting in 2 weeks.

Conclusions

Wavelength shifters maximize the light collection efficiency, but hide the spectral richness of Ar scintillation.

We have built and operated a wavelength sensitive detector at pressures up to 21 bar

For alphas @ 5.5 MeV in Ar gas:

- @ 1.5 bar **20% of the light is in [160, 325] nm.**
- **This light emission is always prompt.**
- This photon yield is **neither affected by pressure nor field** in studied ranges.
- @1.5 bar there is **negligible prompt emission at 128 nm.**

For betas in Ar gas:

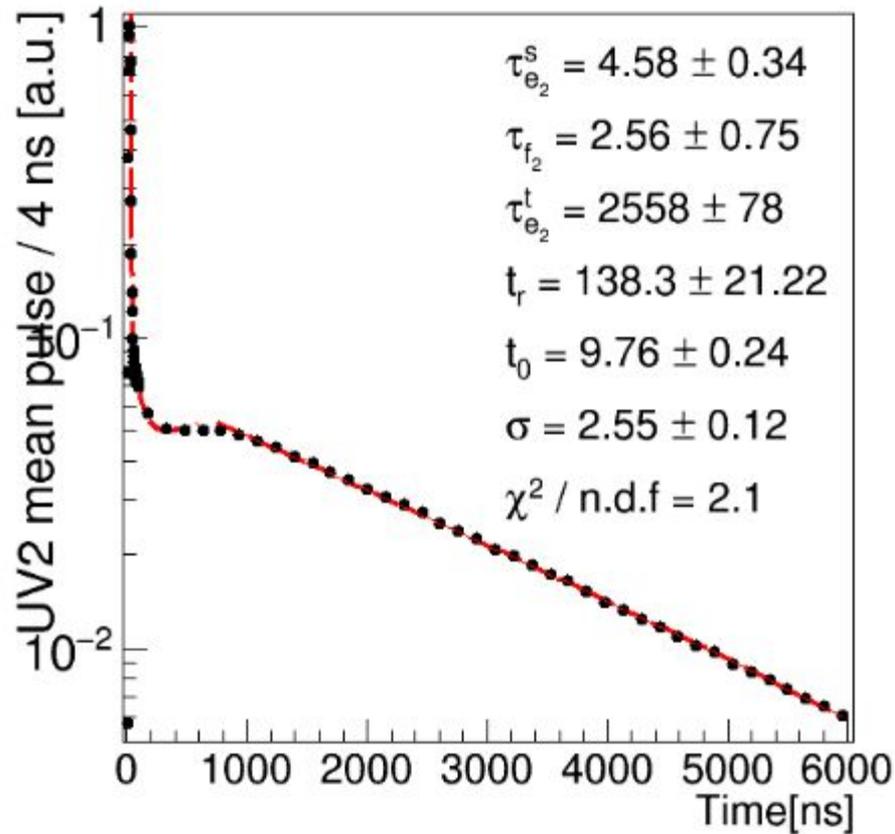
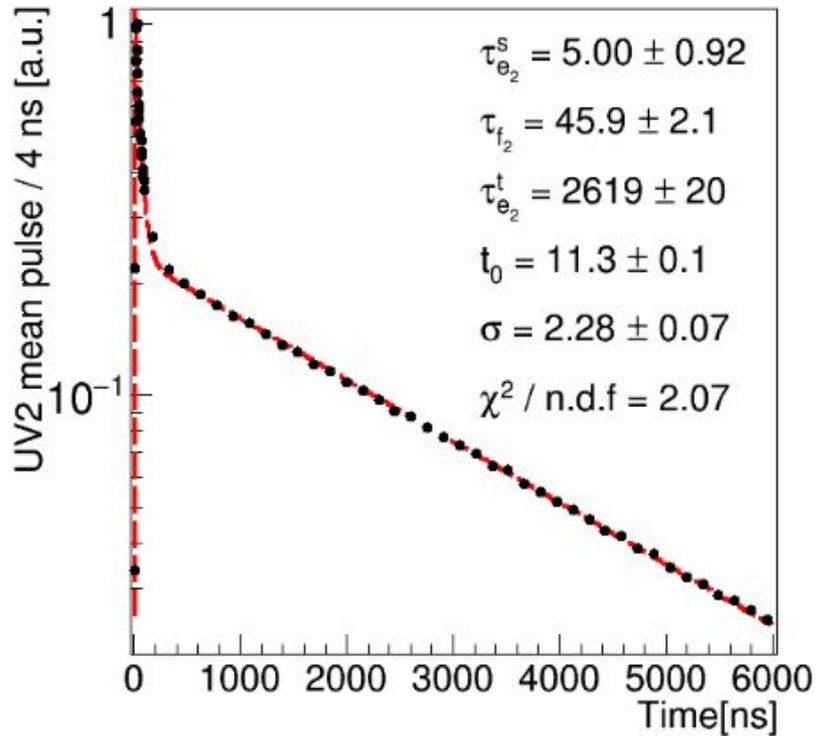
- We observe presence of UV3. Correlation with E needs setup upgrades

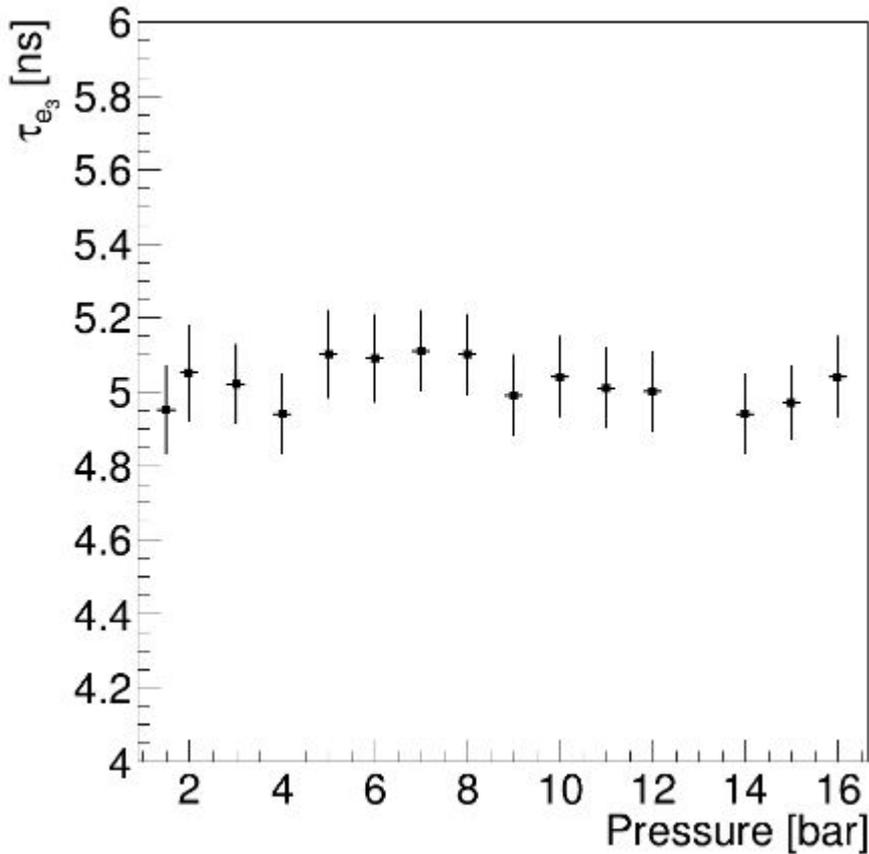
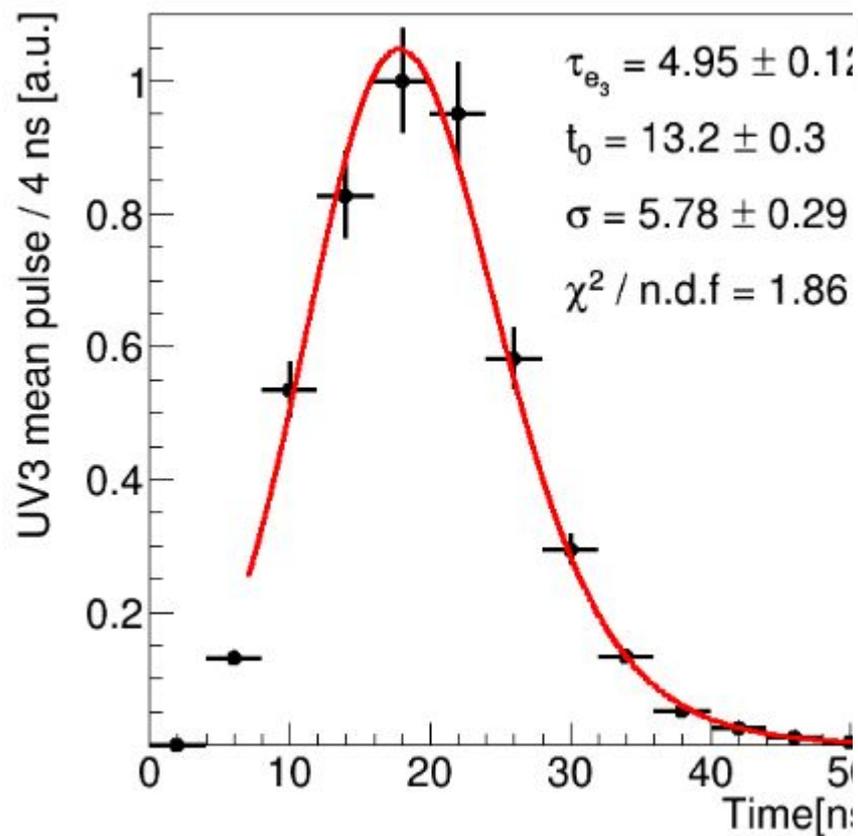
This points **towards feasible particle discrimination** techniques based on light spectroscopy only.

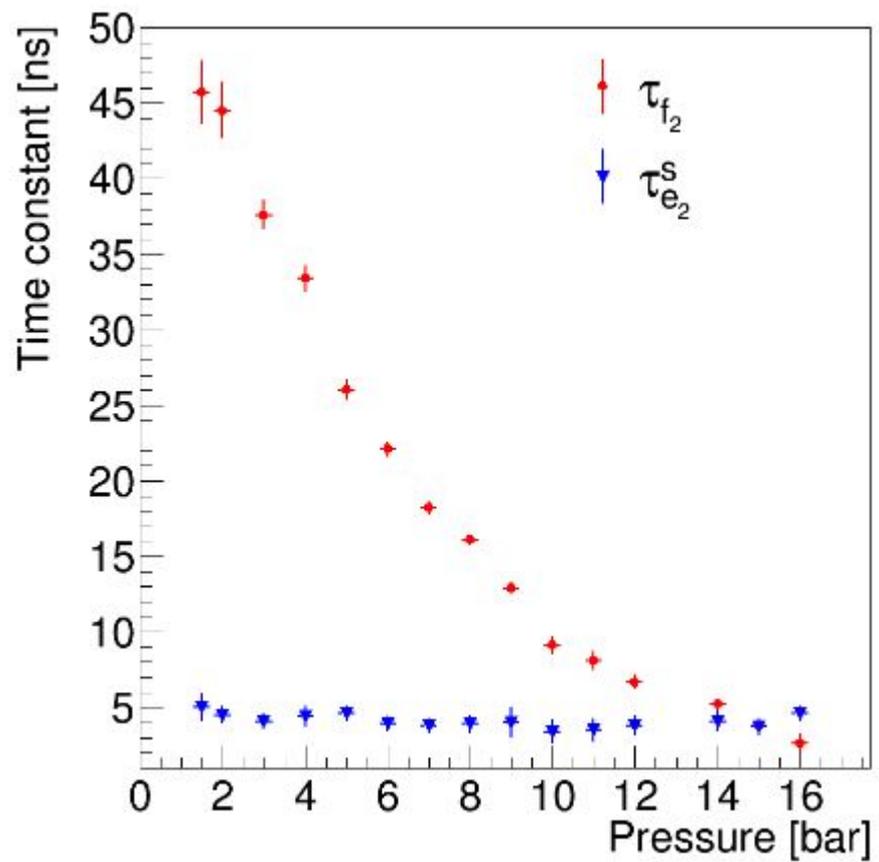
Currently studying the spectral + time features in liquid

**Thanks for your
attention!**

BACKUP









$$I_{UV2}(t) = \left[\frac{L_1}{\tau_{f2} - \tau_{e2}^s} (e^{-t/\tau_{f2}} - e^{-t/\tau_{e2}^s}) + \frac{L_2}{\tau_{f2} - \tau_{e2}^t} (e^{-t/\tau_{f2}} - e^{-t/\tau_{e2}^t}) \right] \otimes G(t - t_0, \sigma)$$

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