Constraining the Dark Sector with the Mono-jet signature with the ATLAS detector at the LHC

Motivations:

Long Lived Particles (LLPs) are foreseen by many BSM scenarios.

ISR + undetected LLPs =

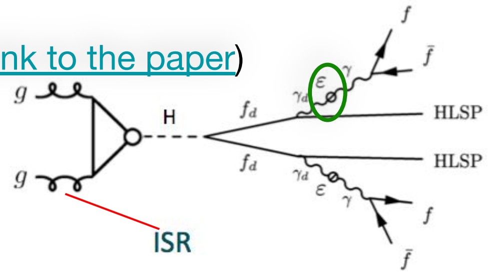
Mono-jet topology (energetic jet recoiling against high E_T^{miss})

→ The Mono-jet analysis is a powerful tool to study models predicting the existence of LLPs, providing **complementary sensitivity** compared to the dedicated searches.

Models studied:

- FRVZ (Link to the paper)

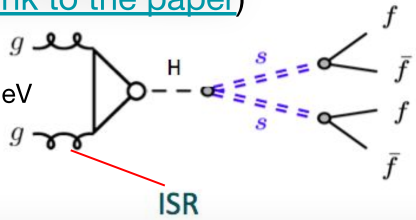
$\tau_{\gamma d} \propto \varepsilon^{-2}$



Model with a heavier mediator H' is considered too.

- H → ss (Link to the paper)

m_S= 5,35,55 GeV



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Mono-jet in a nutshell (Link to the paper)

Signal Region (SR) definition:

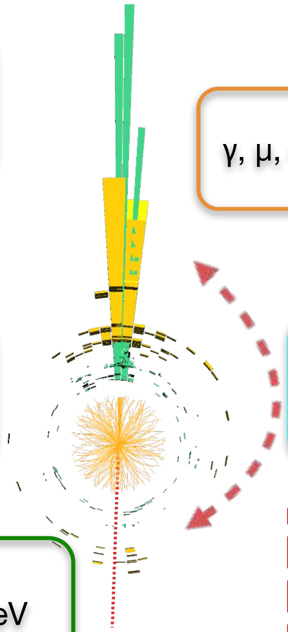
Leading jet
pT ≥ 150 GeV
|η| < 2.4

γ, μ, e veto

Up to three
additional jets
(pT ≥ 30 GeV)

Min $\Delta\phi_{jet-ETmiss}$ > 0.4
(0.6 for E_T^{miss} < 250 GeV)

E_T^{miss} ≥ 200 GeV



In CRs $p_T^{recoil} = \Sigma_{leptons} p_T + E_T^{miss}$

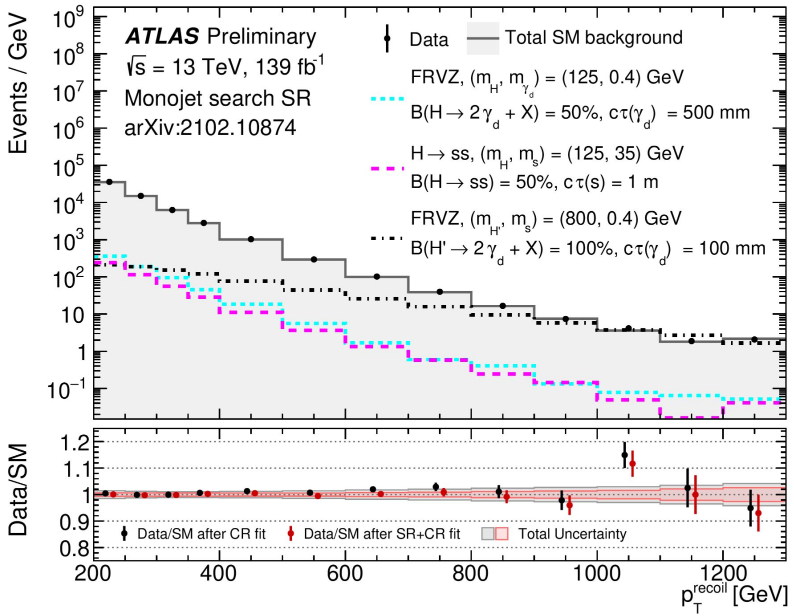
In **SR** (lepton veto) $p_T^{recoil} = E_T^{miss}$

Main backgrounds:

- QCD (low E_T^{miss})
- V+jets

Background uncertainty reduced to the percent level, thanks to a likelihood fit of the p_T^{recoil} spectrum performed simultaneously on Control Regions (CRs) and SR.

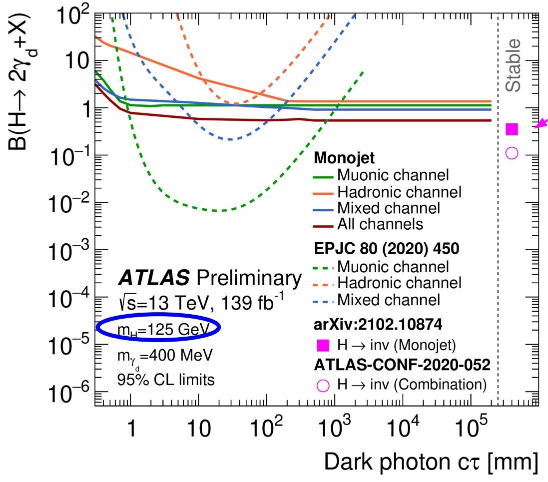
Signals, data and background p_T^{recoil} distribution in SR



Agreement between data & MC after fit on the p_T^{recoil} spectrum → constraints are set on the free parameters of the studied models!

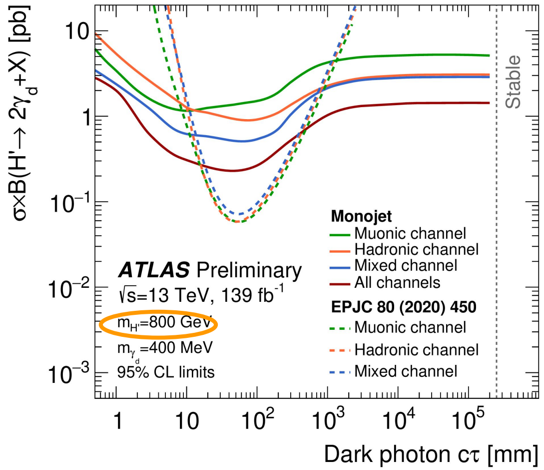
Results (FRVZ model)

Prompt | Displaced | Very displaced (Mono-jet)

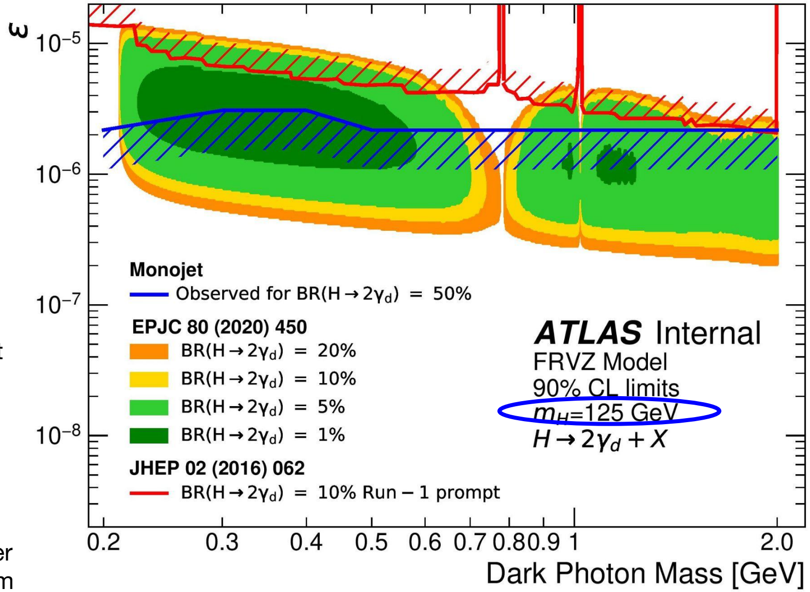


$B(H_{inv})$ (=34% by Mono-jet) is approached but not reached ($B(H\rightarrow 2\gamma_d+X)$ tends to 50% at large $\tau_{\gamma d}$), due to the fact that to obtain the limit on $B(H_{inv})$ all the productions mechanism of the Higgs boson are considered, while here only ggF is taken into account.

Model with heavier mediator



The limits on the $B(H'\rightarrow 2\gamma_d+X)$ at given proper $\tau^*_{\gamma d}$ are obtained through a life-time reweighting procedure, that assigns to each event a weight representing the probability that such event could have been originated from a different sample with mean proper life-time $\tau^*_{\gamma d}$. When $\tau^*_{\gamma d}$ is far from the $\tau_{\gamma d}$ of generation (here 10 and 100 mm), the MC statistical uncertainty of the events increases. For this reason the limits on $B(H'\rightarrow 2\gamma_d+X)$ worsen at high $\tau_{\gamma d}$, instead of reaching a plateau at their minimum.

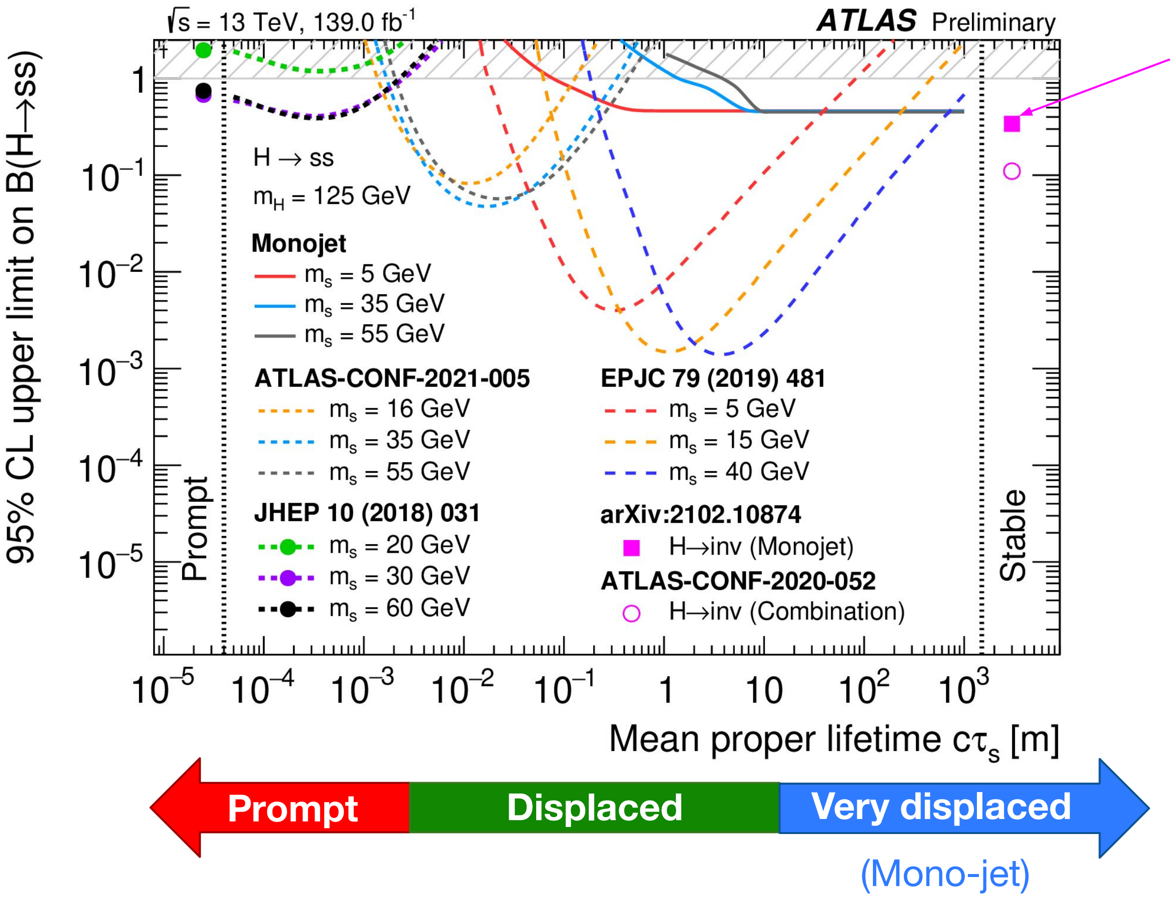


Prompt | Displaced | Very displaced (Mono-jet)

The Mono-jet analysis is **sensitive** to scenarios in which **dark photons decay outside the reach of the ATLAS detector**

→ **Complementarity** wrt **dedicated searches!**

Results (H→ ss model)



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The Mono-jet analysis is **sensitive** to scenarios in which **the s scalar particles decay outside the reach of the ATLAS detector**→ **Complementarity** wrt **dedicated searches!**