

# Physics Plans until 2025 within the ATLAS experiment at the LHC

Norwegian High Energy Particle Physics

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# Standard Model measurements

## ❖ Higgs boson physics

- Precision measurements of Higgs production mechanisms in the  $H \rightarrow \gamma\gamma$  channel with Run 2 and then Run 3 data
- Studies of  $H \rightarrow \tau\tau$  and search for lepton-flavour-violating Higgs decays
- Precision measurement of the different Higgs production mechanisms (GGF, VBF, Higgsstrahlung, ttH) for Run 2 and Run 3 data using the  $H \rightarrow ZZ^* \rightarrow 4\text{-lepton}$  channel ( $l=e,\mu$ )
- For Run 3 shift some focus to searching for di-Higgs production, exploiting  $H \rightarrow \gamma\gamma$  for one of the decays
- Search for  $H \rightarrow \mu^+\mu^-$  in Run 3 data (as part of the search for high- and low-mass exotic di-lepton resonances) and measurement of the Higgs Yukawa coupling to muons

## ❖ B physics

- Study of  $B_c$  meson with Run 2 data (lifetime, fragmentation fraction ratio  $f_c/f_u$ , decay modes)
- Search for lepton flavor violation in  $B_s \rightarrow \varphi l^+l^-$ ,  $B^+ \rightarrow K^+ l^+l^-$  with Run 2 and Run 3 data
- Search for  $B_s \rightarrow \mu^+\mu^-$  and  $B_d \rightarrow \mu^+\mu^-$  with Run 2 and Run 3 data

# Supersymmetry and Dark Matter searches

- ❖ Search for supersymmetric particles in leptonic final states with missing  $E_T$  in Run 2 and 3 data ( $l=e, \mu, \tau$ )
  - Strong production involving staus (search for squarks and gluons)
    - design of a specific tau trigger for Run-3
    - Involvement in Combined performance (tau and muon CP) and trigger (tau) groups
  - Electroweak production of direct sleptons ( $\tilde{e}, \tilde{\mu}, \tilde{\tau}$ ) and electroweakinos ( $\chi_{1,2}^{\pm}, \chi_{1,2}^0, \chi_{1,2}^{\pm}$ ) in final states with  $l^+l^-(l^{\pm}) + \text{MET} (+\text{jets})$ 
    - stau pair + ISR jet topology with Run 2 (and Run 3) data (ditau trigger + L1 jet).
- ❖ Phenomenological studies
- ❖ DM interpretation within specific SUSY models

# Exotics searches

- ❖ Searches for exotic phenomena in dilepton ( $l^+l^-$ ,  $l^\pm\nu_l$ ;  $l=e,\mu$ ) final states with Run 2 and Run 3 data
  - Extended gauge sector with new resonances  $W' \rightarrow l^\pm\nu$ ,  $Z' \rightarrow l^+l^-$
  - Extra dimensions with graviton excitations, showing up as  $G^* \rightarrow l^+l^-$  resonance
  - Contact interactions, non-resonant high-mass  $l^+l^-$  excess
  - Dark Matter: mono  $Z/Z'$ , mono  $W$ , simplified models with new scalars and/or gauge bosons
- ❖ Model-independent search for exotic phenomena in di-lepton final states using multivariate / machine learning methods
- ❖ Exotic searches with taus
  - Excited taus - compositeness

# Dark Matter searches

- ❖ Search for dark-matter signals with Run 2 and then Run 3 data
  - In final states with taus
  - in events with mono Higgs, involving  $H \rightarrow \gamma\gamma$  and  $H \rightarrow \tau\tau$  decays
  - In mono-Z and mono-Z' final states leading to  $l^+l^-$  and missing  $E_T$ 
    - simplified models with new scalars and/or gauge bosons
- ❖ Interpretation of ATLAS and other DM searches (direct, indirect) in particular common DM models

# Research-based education

- ❖ Sharing ATLAS data (Run 2 and Run 3) and discoveries with high-school and university students
  - International Master Classes, development of educational material (ZPATH) and analysis tools, explaining new physics concepts
  - Research-based student projects and lectures