The aim of b-tagging is to identify jets originating from the fragmentation of b-quarks. In ATLAS, different b-tagging algorithms are used to identify jets originating from b- or light-flavour quarks. Their efficiencies as well as their mistag rates are being measured with several methods.

### Measurement of the b-tagging performance of the ATLAS detector

#### The importance of b-tagging
- **The knowledge of the tagging performance is crucial for:**
  - search for a light Higgs boson
  - cross section measurement
  - search for SUSY, 4th generation...
  - suppression of background...

#### The b-hadrons properties
- Long lifetime: a b-hadron in a jet of p_T=50 GeV flies ~3 mm in Rp before decaying
- Displaced secondary vertex (SV) from primary vertex (PV)
  - Large transverse impact parameter \( d_0 \) of tracks in jets from the SV
  - Semileptonic decay (~40% of b-jets): \( BR(b \to \tau \nu X) + BR(b \to \mu \nu X) \approx 71\% + 10\% (\text{iso}, \mu)

#### The ATLAS inner detector
- is the most important detector used for the identification and reconstruction of secondary vertices from b-hadrons
- very high granularity
- very high resolution
- 3-dimensional vertexing capabilities

#### Early b-tagging algorithms SV0 and JetProb
- The SV0 tagging algorithm relies on reconstructed secondary vertices from the tracks associated to jets.
  - uses of the signed decay length significance \( L/\sigma \).
- The JetProb tagging algorithm
  - Uses the signed transverse impact parameter significance \( p_T/d_0 \) of charged tracks.
  - Computes the probability for each track and combines them into a jet probability to originate from the primary vertex using \( \sum \sigma_0 \).
- The jet probability to be compatible with a light jet for data (black points). Superimposed, the expectation from simulated events.
- Both algorithms, JetProb and SV0, have been commissioned, calibrated and are being used in ATLAS physics analyses.

#### Measurement of the b-tagging efficiency
- 2 methods based on jets containing muons
  - The \( p_T^m \) method:
    - \( p_T^m \) is the transverse momentum of a muon with respect to the jet axis.
    - Using the \( p_T^m \) distribution fit to data, the b-tagging efficiency is the ratio between:
      - the number of b-jets and
      - the number of b-quark jets.
    - High jet purity (99%) to direct access to b-tagging efficiency
  - The \( D^\star \mu \) method:
    - A pure sample of jets can be selected by reconstructing the semi-leptonic decay of b-hadrons to \( D^\star \)-final states.
    - \( b\rightarrow l\nu X \):\( D^\star \rightarrow \mu \nu X \) or \( D^\star \rightarrow l\nu X \)
    - High jet purity (99%) to direct access to b-tagging efficiency

#### Measurement of the mistag rate
- The mistag rate is the rate by which light-flavour jets are identified as b-jets by a b-tagging algorithm.
- The SV0 mass fits method:
  - \( d_0 \) is the transverse impact parameter.
  - for leptonic jets: \( d_0 \) is the distance between the muon and the reconstructed SV.
  - for hadrons: \( d_0 \) is the distance between the hadron and the reconstructed SV.
- \( d_0 \) and \( L/\sigma \) are expected to be symmetric around 0 for light-jets.
- \( d_0 \) and \( L/\sigma \) are expected to be asymmetric around 0 for b-jets.

#### Advanced b-tagging algorithms
- Much better b-tagging performance can be achieved by more sophisticated algorithms!
- Expected to be calibrated very soon for future physics analyses which will improve ATLAS physics discovery potential!

ATLAS has an excellent b-tagging performance providing a light quark rejection of 100 for a 50% efficiency operating point (ex. JetProb). However, this rejection is expected to reach 600 for the same efficiency, (up to ~6 times better!) with the use of the advanced tags!