A novel standalone track reconstruction algorithm for the LHCb upgrade
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on behalf of the LHCb collaboration

**Scintillating fibre tracker at the LHCb upgrade**

LHCb is a single arm forward spectrometer to study b and c hadrons.

LHCb detector will be upgraded during LS2 (2018-2020)
- Further precision improvements on J/ψ observables [1].
- Full software event reconstruction and read-out at collision rate (30 MHz) [2].
- Real-time calibration and alignment as in Run II.

Too high occupancy in current downstream tracker.
- Replaced by twelve scintillating fibre planes (SciFi) [3].
- 2.5 m Scintillating fibres as active material (d250 µm).
- Readout by Silicon Photomultipliers (SiPM) arrays (250 µm channel pitch)
- High detection efficiency (>99%), low material budget <1% X0/layer.
- Uniform resolution r0 ~ 100 µm.

**SciFi tracking @ LHCb**

![SciFi tracking diagram](image)

Designed as a tracking in projection track reconstruction algorithm.
- Able to cope with hit inefficiencies and low momenta (<5 GeV/c) tracks at a low ghost rate.
- Hit flagging leads to cleaner environment for low momentum tracks search.
- Improved track fit model accounts for local (SciFi region) magnetic field.
- Track reconstruction introduced, new parameterisation of search windows, fast stereo hit strategy.

**SciFi stand-alone track reconstruction algorithm**

Add stereo hits to xz projections

Given a xz candidate x-positions are predicted in u/v layers.
- Δx = 2.5 m hits stored and sorted by t, 1-0 clusters search: stored by smallest-
spread criteria (3x3 matrix).
- In situ y-segmentation: candidates having less than eleven hits are
found.

**Bending plane: xz track projection search algorithm**

Hit candidates are sorted by quality (p2, max) are compared to each other and clones are removed.

**Performance**

- | | TDR feeding (x clone rate) | Hybrid feeding (x clone rate) |
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<tr>
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<tbody>
<tr>
<td>In flight B</td>
<td>0.44 ± 0.10</td>
<td>0.54 ± 0.10</td>
</tr>
<tr>
<td>In flight B</td>
<td>0.36 ± 0.10</td>
<td>0.46 ± 0.10</td>
</tr>
<tr>
<td>Downstream p &gt; 5 GeV/c</td>
<td>0.52 ± 0.10</td>
<td>0.62 ± 0.10</td>
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<tr>
<td>Downstream p &gt; 5 GeV/c</td>
<td>0.67 ± 0.10</td>
<td>0.77 ± 0.10</td>
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<td>Fake track rate</td>
<td>21.2 ± 0.1</td>
<td>7.9 ± 0.1</td>
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Avg. Timing [ns/evt]: 79.44 22.86

**Conclusions**

Large boost of performance in all track categories w.r.t. TDR [4].
- Improved tracking efficiencies: +5% (p > 5GeV/c), +25% (p < 5GeV/c).
- 3 times less fake tracks rate and 4 times faster.
- Further improvements and dedicated tunings expected before Upgrade (Run III).

**References**


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Connecting the Dots 2018
Seattle, University of Washington, USA