

Development of a New L1 Muon Trigger System and New Readout Electronics for the ATLAS MDT Chambers at High LHC Luminosities

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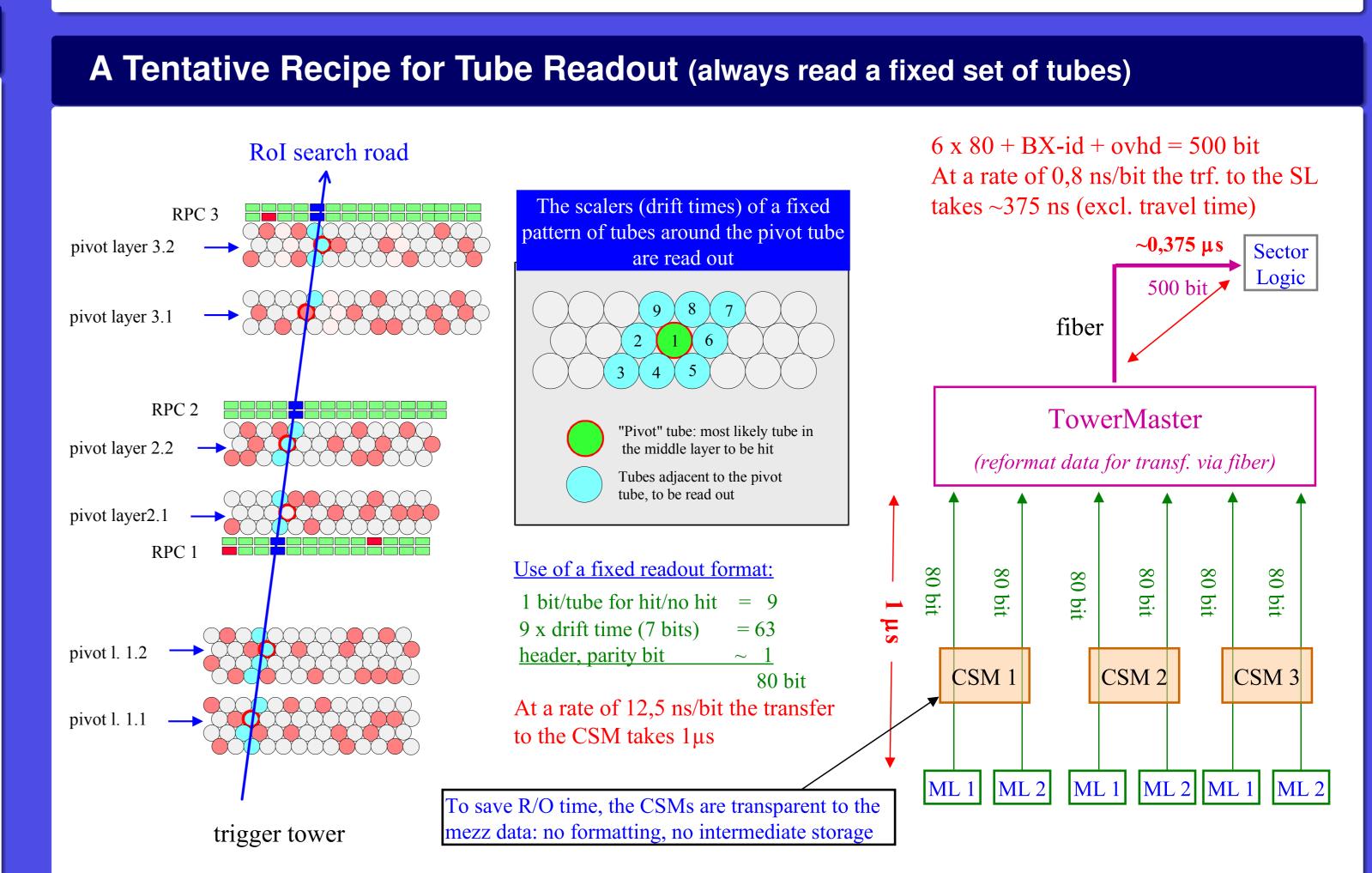
Abstract

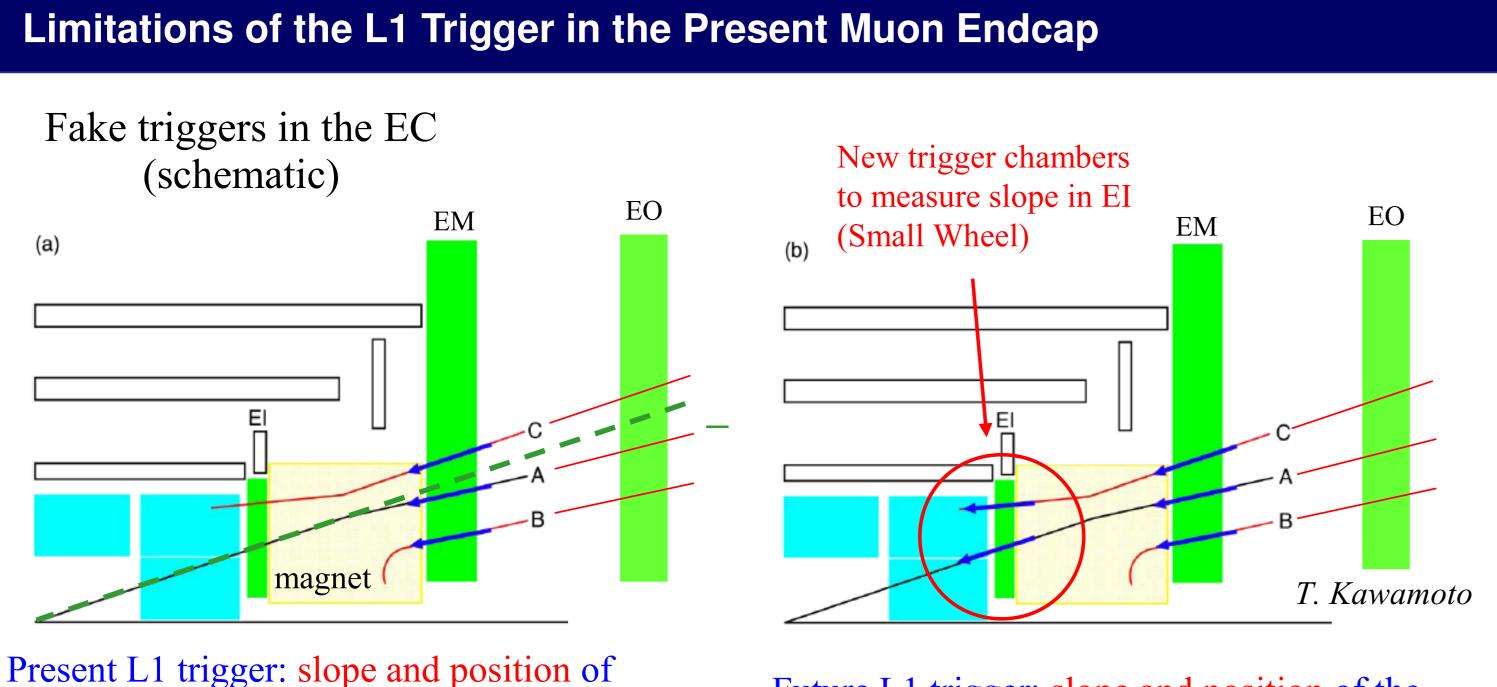
The planned upgrades of the Large Hadron Collider (LHC) towards higher luminosities require among other detector improvements also a significantly higher selectivity of the ATLAS level-1 muon trigger in order to efficiently reject the large low-momentum muon background without losing interesting signal events. The momentum resolution of the L1 muon trigger can be sufficiently improved by using the precision muon tracking detectors, the Monitored Drift Tube (MDT) chambers, in the trigger. This has the advantage that no new trigger chambers with higher spatial resolution need to be installed which is hardly possible for the largest part of the muon detector. A MDT chamber based muon trigger scheme has been developed and validated by simulation. Its implementation requires the replacement of the existing MDT on-chamber electronics which will also need higher radiation hardness and bandwidth. New readout chips in radiation hard technology and new frontend boards are under development.

Long Term Planning for the LHC Possible upgrade timeline transition \rightarrow 5x10³⁴cm⁻²s⁻¹ 7 TeV → 14 TeV period luminosity leveling $1x10^{34} \rightarrow$ ~2x10³⁴cm⁻²s⁻³ phase-2 $\rightarrow 1x10^{34} cm^{-2} s^{-1}$ ~300 fb⁻¹ $10^{27} \rightarrow$ phasę- $2x10^{33}cm^{2}s^{-1}$ ~50 fb⁻¹ L1 trigger phase-0 latency of ~ 6.4 Have to live μs will be Limit of nomin. with \sim 2,6 µs L1 ~10 fb⁻¹ available LHC operation trigger latency 2013/14 2018 ~2022 Year

Problem of the Muon Trigger: Diff. Cross Section vs. p_T ATLAS Muon TDR Integrated XS "Signal" $\Sigma(W, Z)$ 0,7344 0,0474 0,0102 0,0035 "BG" $\Sigma(b,c,\pi/K)$ "Signal / BG" 17,9% 54,9% 51,4% Trigger rate, theor. Triggerrate, real The width of the <u>real</u> p_T resol. curve combined with ---- Punch-through the steep slope of the p_T spectrum leads high trigger 10-1 $|\eta_{\mu}| < 2.7$ \rightarrow The <u>real</u> p_T-dependance of the trigger rate is determined by the spatial resolution of the trigger ¹dp/ωp 10-2 chambers along η . 10^{-4} 10-5 ● Threshold 4 = 11 GeV 10 Threshold 5 = 20 GeV p^μ (GeV/c) ▲ Threshold 6 = 40 GeV Efficiency at 40 GeV Threshold

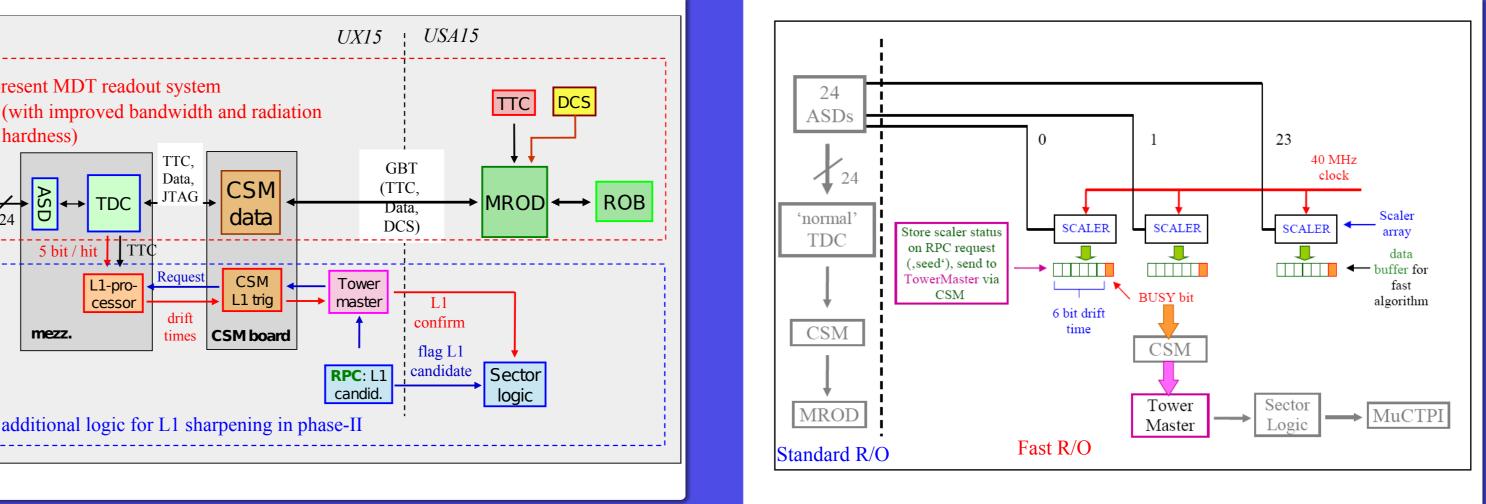
Overview of L1 Muon Upgrade, Phase-1 & Phase-2 Outer part of BW ($\eta = 1$ -2): sees moderate rates. Barrel (η =0-1): sees low-moderate Preserve MDTs + TGCs. rates. Preserve MDTs and RPCs. L1 upgrade in phase-2 L1 upgrade in phase-2 Tip of BW (η =2- 2.4/2.6): sees the highest rates. Present TGCs to be replaced for phase-2 Track angle behind EC toroid at EM Track angle before EC toroid needed existing TGC trigger: p_T determination → build new Sm. Wheel T.Kawamoto





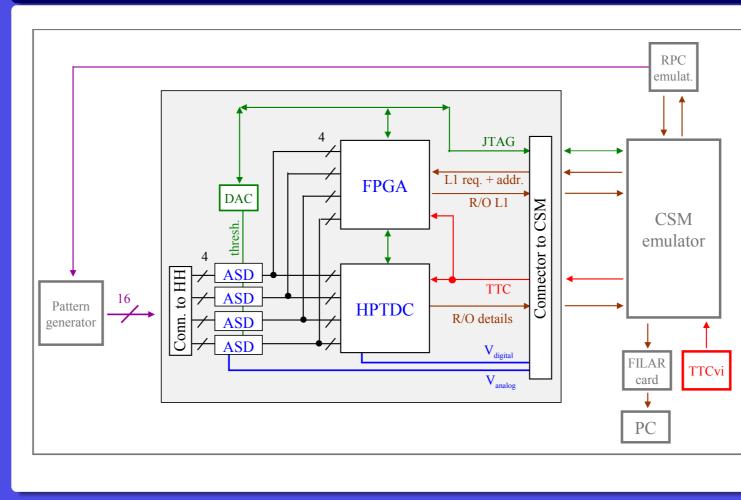
Architecture of MDT Readout Fast and Standard Readout

Future L1 trigger: slope and position of the muon will also be measured in the EI wheel. Fake triggers type C and B will be discarded. → slope diff. before and behind magnet defines momentum → The slope has to be measured with < 1 mrad



accuracy.

Mezz. Prototype with new ASD



Results of prototype: designed in 2009 by Brad Webe Came out like designed and simulated: Channel Analog parameters Channel 2 (risetime, linearity, shape) •Gain matching btw. channels: 2 %

Mesaured by S. Abovyan and V. Danielyan

•X-talk < 1.5 %

(30 mW/ch.)

Power consumption

Analog Performance of ASD2 vs. 1

Conclusions

create fakes (B).

the IP (A).

the muon are only measured in the EM

However, there are many fake triggers

not coming from the vertex (C).

from muons from decays and scattering,

Coiling tracks from the EC-magnet also

wheel. Tracks are assumed to come from

- ▶ The selectivity of the ATLAS L1 muon trigger needs to be improved for higher luminosities.
- ▶ Longer latency in phase-2 of \gtrsim 6.4 µs allows to use MDT information in L1.
- ▶ The proposed scheme does not need new trigger chambers to be installed.
- ▶ New radiation hard MDT readout electronics with L1 functionality are being developed and tested.