LHC-ATLAS実験アップグレードに向けたMicromegas検出器の性能評価

東京大学 理学系研究科
山﨑友寛

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LHC-ATLAS Upgrade

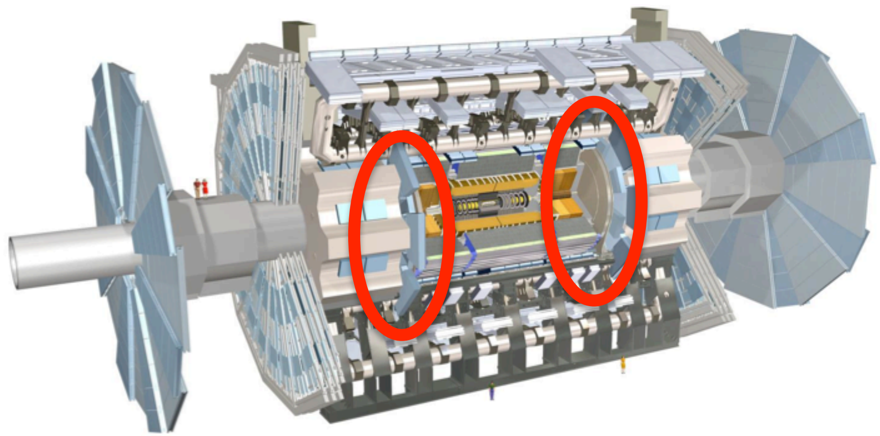
Year	Period	LHC	ATLAS
2009–2012		**RUN I** $\sqrt{s}$ = 7-8 TeV L = 0.7 ×10^{34} $cm^{-2}s^{-1}$	
2013–2014	LS1	phase 0 upgrade	IBL, FTK
2015–2018		**RUN II** $\sqrt{s}$ = 13-14 TeV L = 1 ×10^{34} $cm^{-2}s^{-1}$	
2018–2019	LS2	phase 1 upgrade	**New Small Wheel** LAr upgrade
2020–2023		**RUN III** $\sqrt{s}$ = 14 TeV L = 2-3 ×10^{34} $cm^{-2}s^{-1}$	
2024–2025	LS3	phase 2 upgrade	New Inner Tracker
2026 ⋮		**RUN IV** $\sqrt{s}$ = 14 TeV L = 5 ×10^{34} $cm^{-2}s^{-1}$	

Design luminosity will be exceeded at RUN III

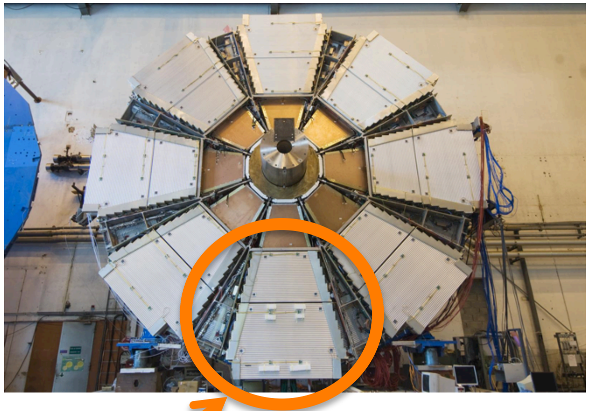
→ ATLAS detector upgrade is mandatory for High Luminosity

Present Muon Detectors (Small Wheel)

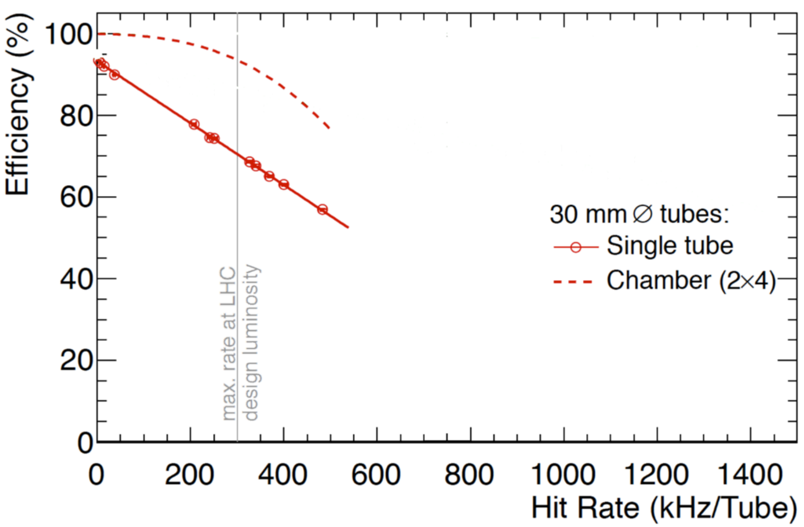
Innermost endcap muon system (SW) needs to be replaced



present SW



Monitored Drift Tube (MDT)



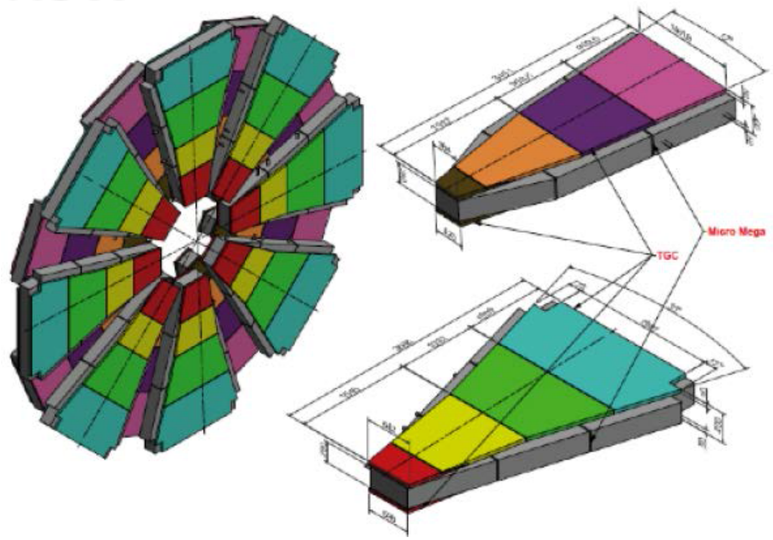
Rate capability limited
by long drift time (700 nsec)

Limit : 300kHz/Tube
↑max rate @ design luminosity

➡ **Upgrade to New Small Wheel**

New Small Wheel

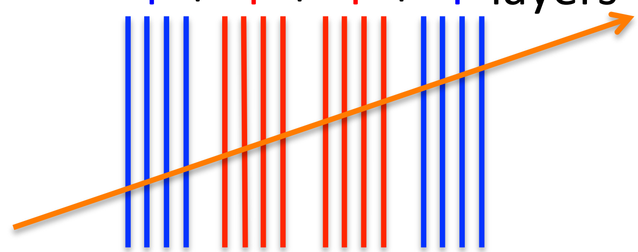
NSW



2 detector technologies for NSW

- **Micromegas** ・・・ Primary **tracking** detector
- **sTGC** ・・・ Primary **trigger** detector

4 + 4 + 4 + 4 layers



Stability at high luminosity is required

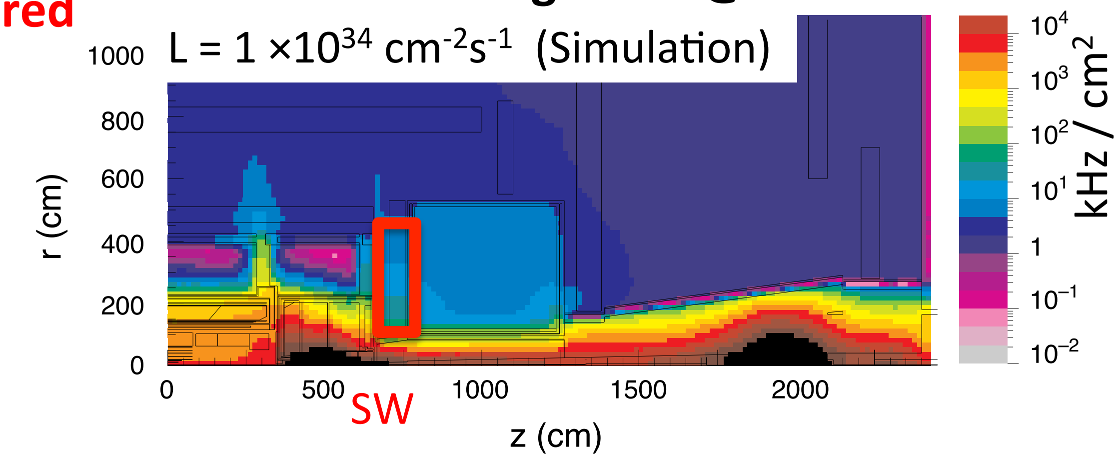
Hit rate (L = 7×10^{34} $cm^{-2}s^{-1}$)

15kHz/cm^2

Neutron flux

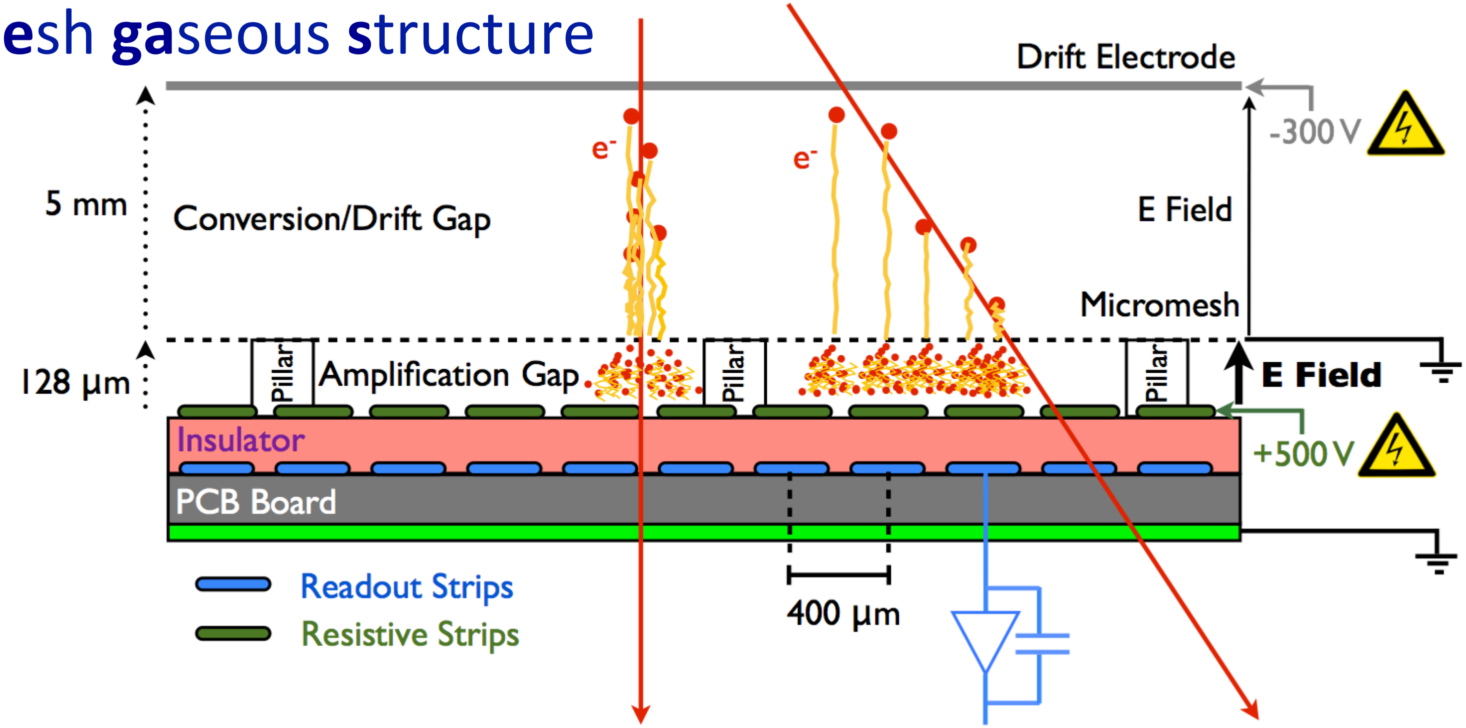
O(100) kHz/cm^2

Neutron background @ATLAS



Micromegas

Micro-mesh gaseous structure



✓ **Narrow amplification gap**

→ Stability at high rate

✓ **Resistive strips**

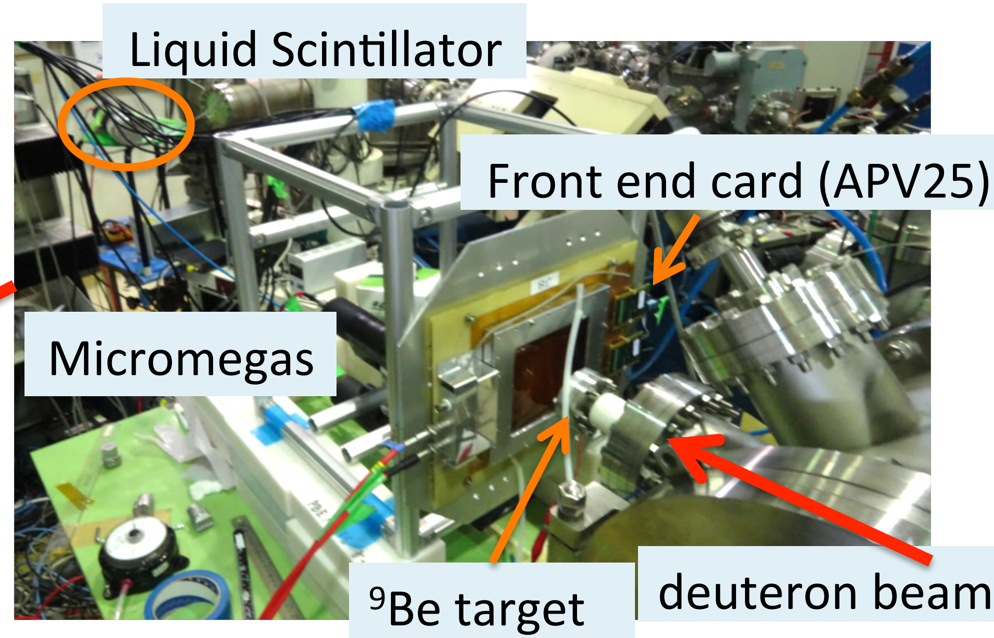
→ Spark-insensitive

Gas	**Ar 93 % + CO_2 7%**
Strip pitch	**400 μm**
Gain	**O(10^4)**
Drift velocity	**5 cm/μsec**

Neutron Test Beam

Neutron can induce spark by large energy deposit

Neutron test beam @ Kobe Univ.



$$^{9}\mathrm{Be} + d\ (3\mathrm{MeV}) \rightarrow {}^{10}\mathrm{B} + n$$

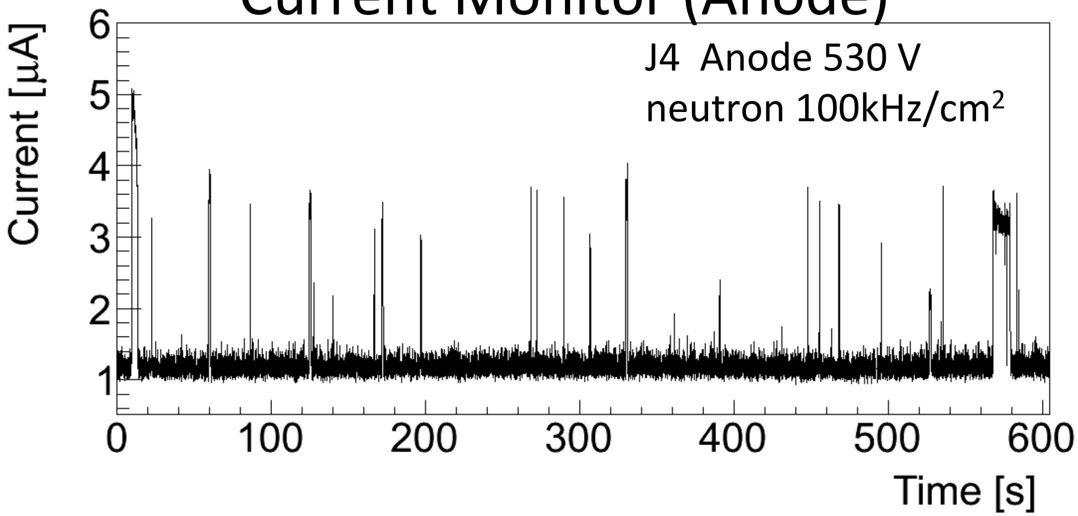
Neutron Energy ～ 5 MeV

2 types of tests

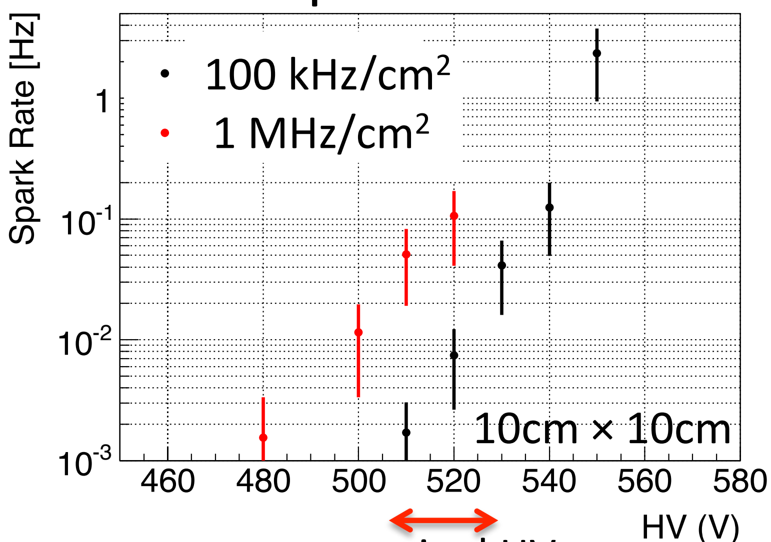
- Measuring spark rate
- Cosmic test in neutron environment

Spark Test

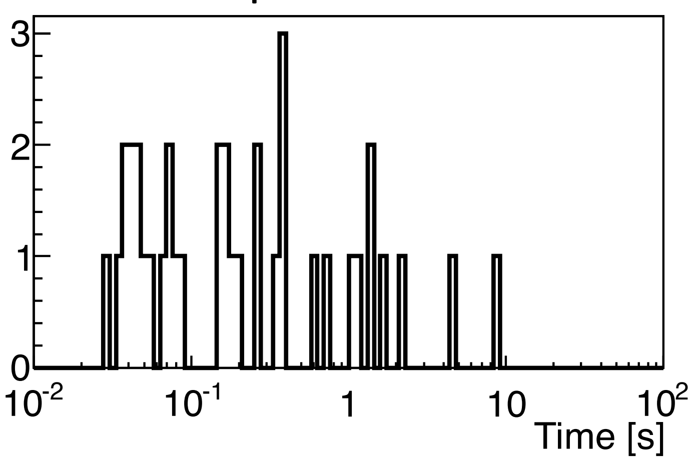
Current Monitor (Anode)



Spark Rate



Spark duration



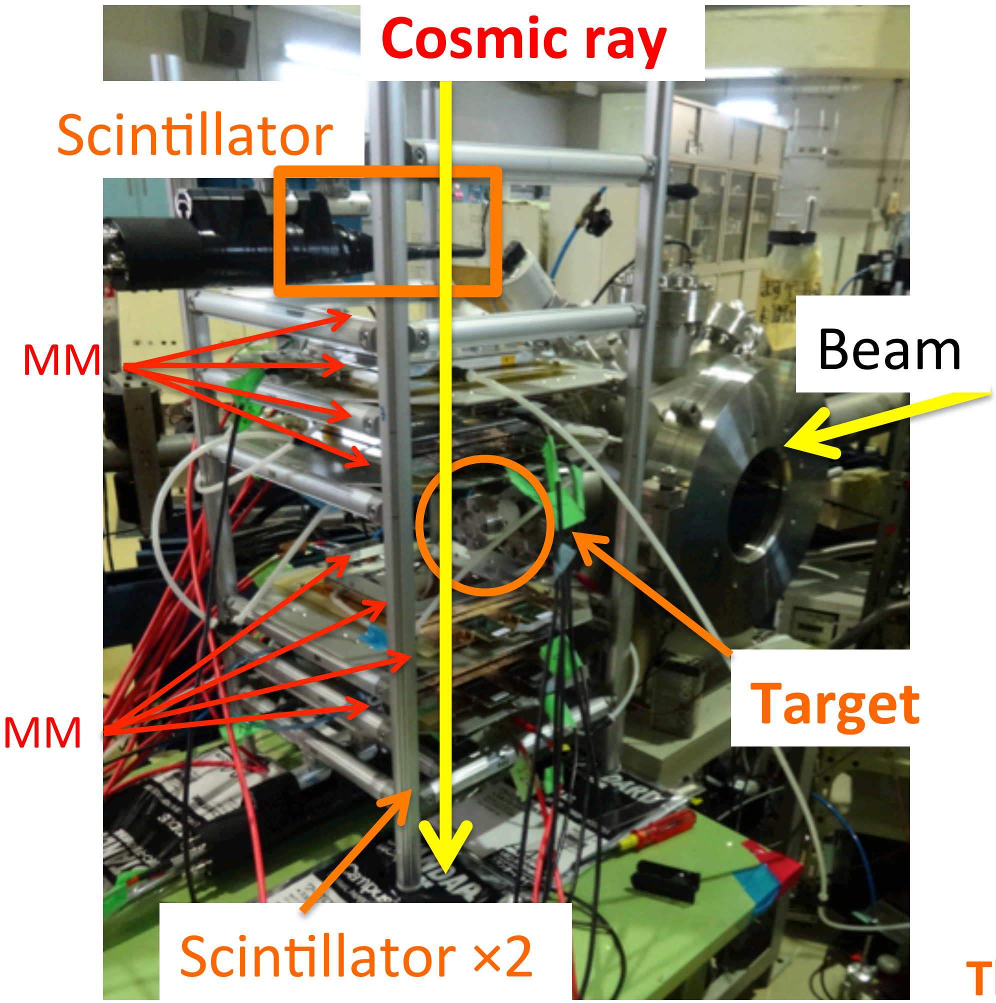
Spark rate 0.01 Hz
@ 100kHz/cm^2 (equivalent flux in ATLAS)

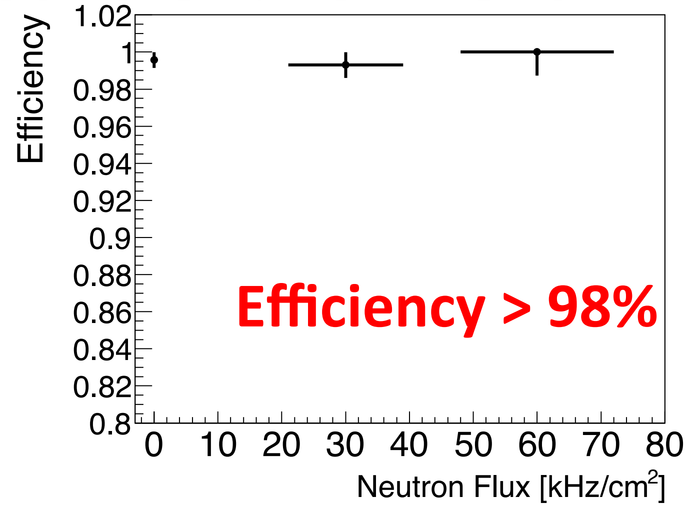
Sparks occur locally

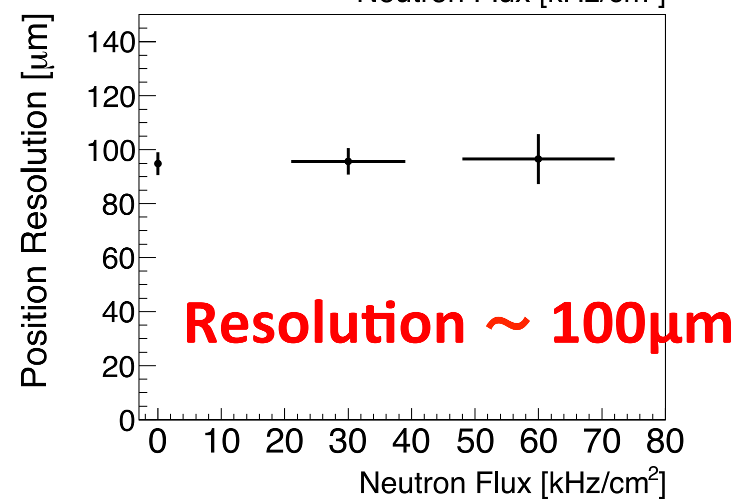
⇨ **Stable in ATLAS environment**

Tracking Performance

Cosmic test under neutron background environment







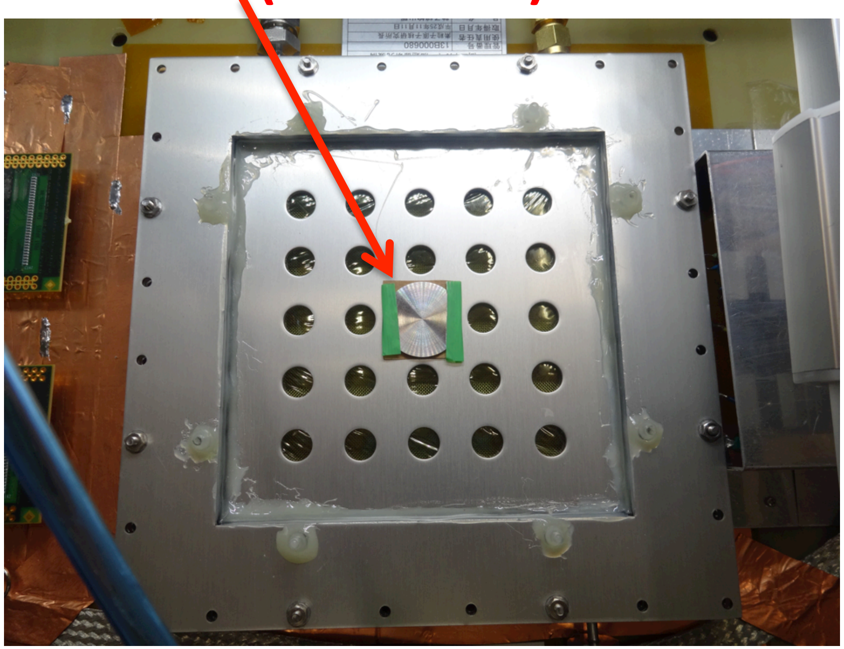
These results meet the requirements!

Alpha Exposure

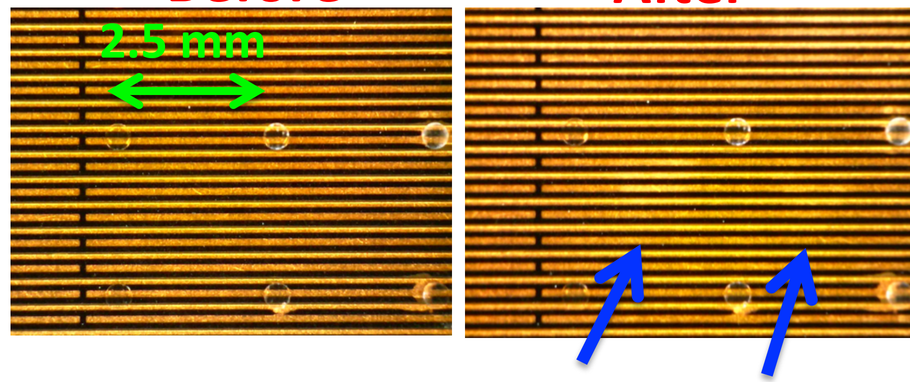
30 kHz × 4 days exposure

corresponding to neutron hits for 10 years in ATLAS

Am241 (5.5 MeV)

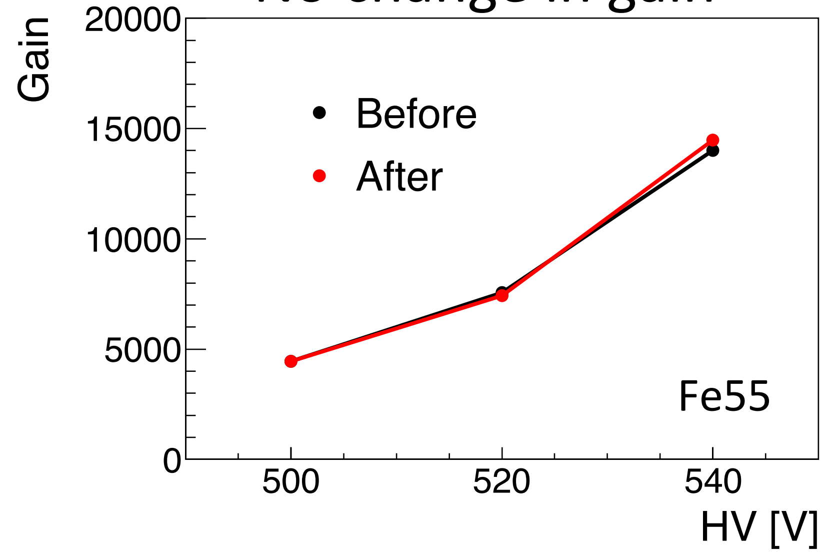


Before **After**



slight change in color (under investigation)

No change in gain



Summary & Future Plan

Summary

- Micromegas will be installed in 2018/19
- No performance degradation in neutron environment
- Ageing test with α exposure are under investigation

Future Plan

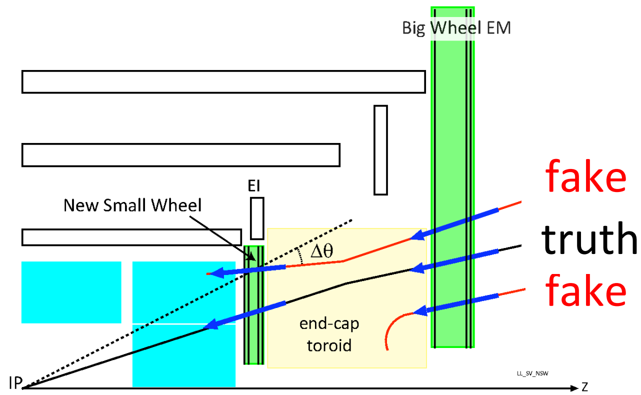
- Continue ageing tests (alpha, X-ray, etc) in final design
- At Run II, we have a plan to test Micromegas chambers in ATLAS environment

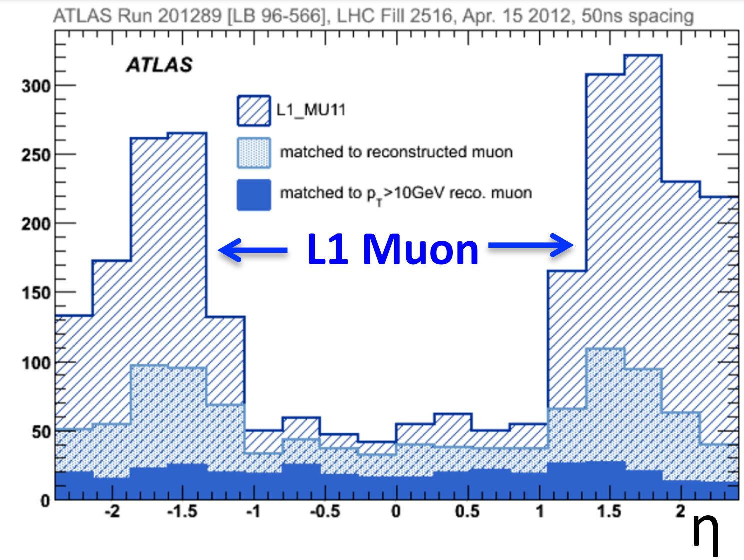
BACK UP

NSW for L1 Trigger

Status in Run I

Level 1 muon trigger dominated by fake

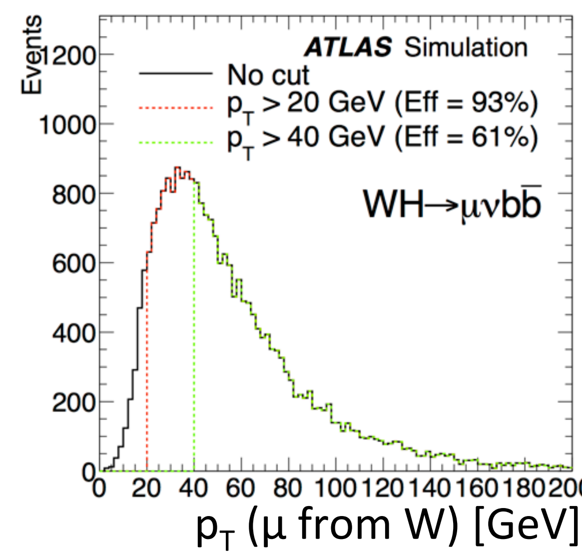




Increasing Luminosity will lead to raise threshold

but we want to keep threshold

e.g. WH → μνbb p_T (μ)



Reducing fakes by using NSW hit information

can keep L1 single muon threshold 20 GeV !