supernemo collaboration

Tracker gas composition analysis

2026/06/30 Bratislava, collaboration meeting

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Motivation

- Alpha track length discrepancy coming from tracker gas composition ?
- Alpha track length strongly affected by element present in the gas.
- Tracker gas mix : He (95%) + ethanol (4%) and Ar (1%)

Plan

1. Gas mixture scan without air (He between 90 – 100 %)

2. Gas mixture scan with air !

Tracker gas without air

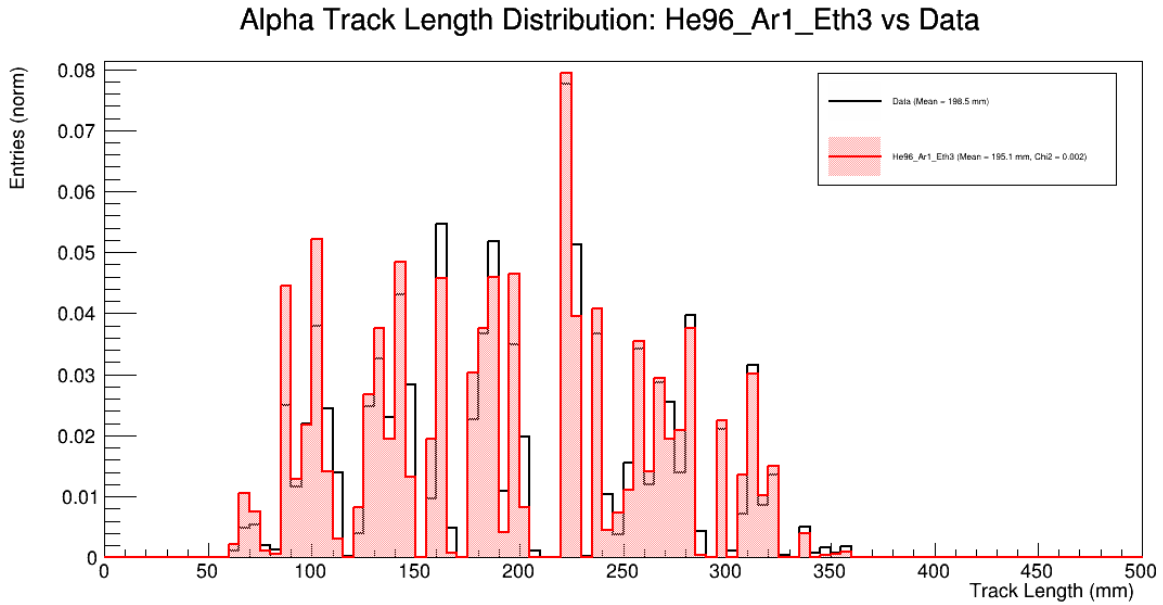
- Changing in Falaise the gas mixture ➔Falaise uses mass fraction
- $P = 880\ mbar, T = 293\ K$
- Example : He (95%) + ethanol (4%) and Ar (1%) need to compute mass fraction

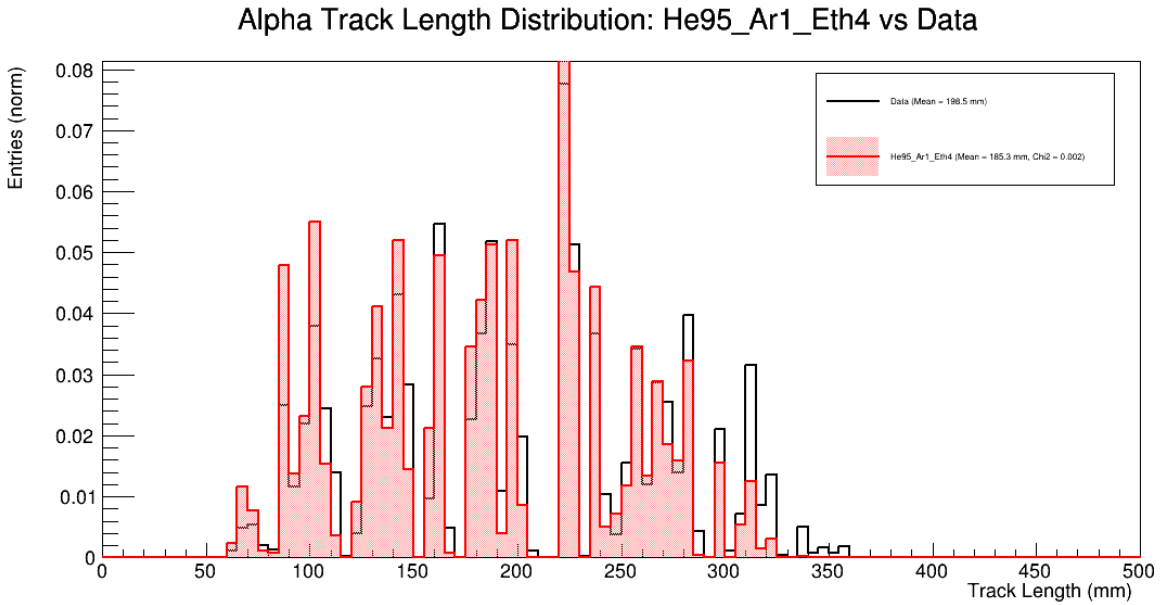
Element	Mass fraction	Percentage
Helium	0.95	95 %
Argon	0.01	1 %
Carbon	0.020856	2.0856 %
Hydrogen	0.005252	0.5252 %
Oxygen	0.013892	1.3892

- Ethanol : C_2H_5OH
- Using Falaise script : https://github.com/SuperNEMO-DBD/Falaise/blob/develop/resources/materials/tracking_gas_mix.py

Gas mix result

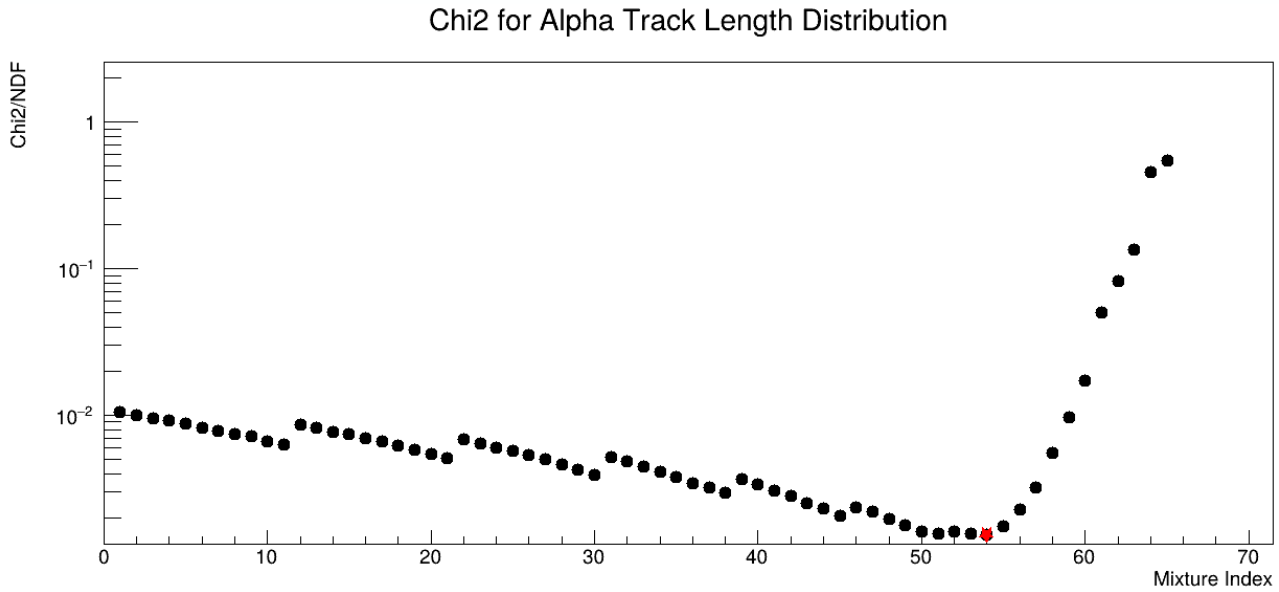
- 66 gas mix, each 100 simulation of 50 000 BiPo event Simulated from field wires surfaces
- Comparing with 2D alpha track length (x,y)

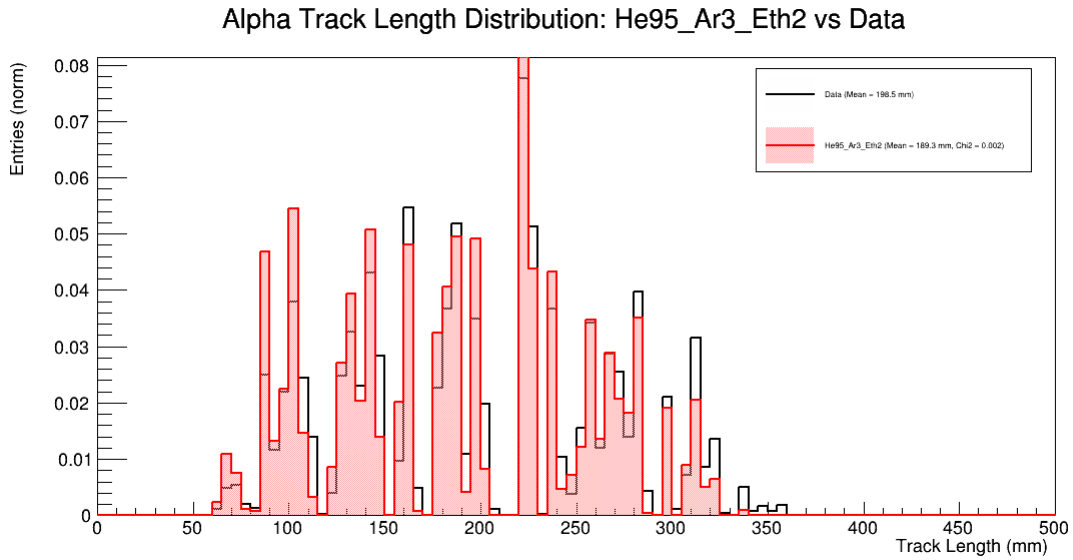




- Minimizing Chi2 between data & MC

Chi2 minimization





- Still discrepancy between data & MC
- Need to add Air !

Gas Mix with Air

- 2 gas : Tracker gas & Air gas, $P = 880\ mbar$, $T = 293\ K$
- Tracker gas : He, Ar & ethanol ➔ $\Sigma = 100\%$
- Air gas (CO_2 + O_2 + Ar + N_2) ➔ $\Sigma = 100\ \%$

CO_2	0.04 %
O_2	20.95 %
Ar	0.93 %
N_2	78.08 %

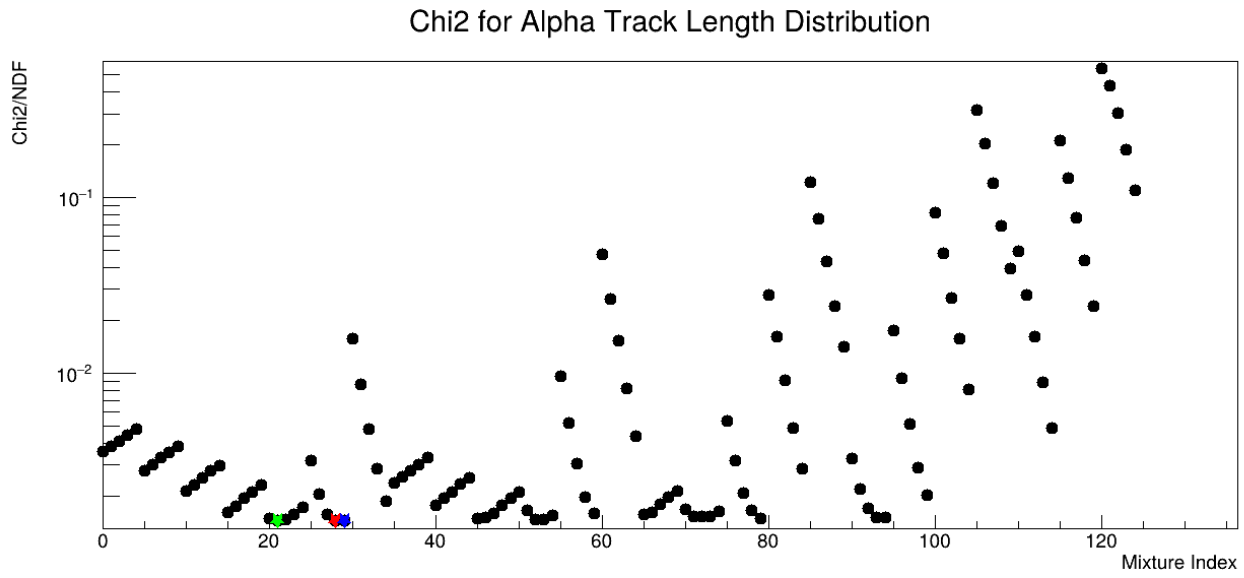
Air mixture used

- He : 94-98 %
- Ar: 0% to 100 – He%
- Ethanol: fill remaning percentage
- Air : 0%, 0.5%, 1%, 1.5%, 2%

Chi2 minimization

20 best gas mix with air

Rank	He (%)	Ar (%)	Eth (%)	Air (%)	χ^2
1	94	4	2	0.5	1.4378×10^{-3}
2	94	5	1	1.5	1.4335×10^{-3}
3	94	5	1	2.0	1.4353×10^{-3}
4	94	4	2	1.0	1.4556×10^{-3}
5	95	3	2	1.5	1.4573×10^{-3}
6	95	3	2	1.0	1.4627×10^{-3}
7	94	4	2	0.0	1.4831×10^{-3}
8	95	2	3	0.0	1.4837×10^{-3}
9	96	2	2	2.0	1.4913×10^{-3}
10	97	0	3	2.0	1.5044×10^{-3}
11	95	2	3	0.5	1.5040×10^{-3}
12	97	0	3	1.5	1.5047×10^{-3}
13	96	1	3	1.0	1.5207×10^{-3}
14	96	1	3	0.5	1.5222×10^{-3}
15	96	1	3	1.5	1.5247×10^{-3}
16	95	3	2	2.0	1.5378×10^{-3}
17	96	0	4	0.0	1.5576×10^{-3}
18	94	4	2	1.5	1.5646×10^{-3}
19	94	5	1	1.0	1.5654×10^{-3}
20	95	4	1	2.0	1.5752×10^{-3}



Chi2 minimization

20 best gas mix with air over 125 combinations

Rank	He (%)	Ar (%)	Eth (%)	Air (%)	χ^2
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Does it match with mass spectrometer measurements ?

Chi2 minimization

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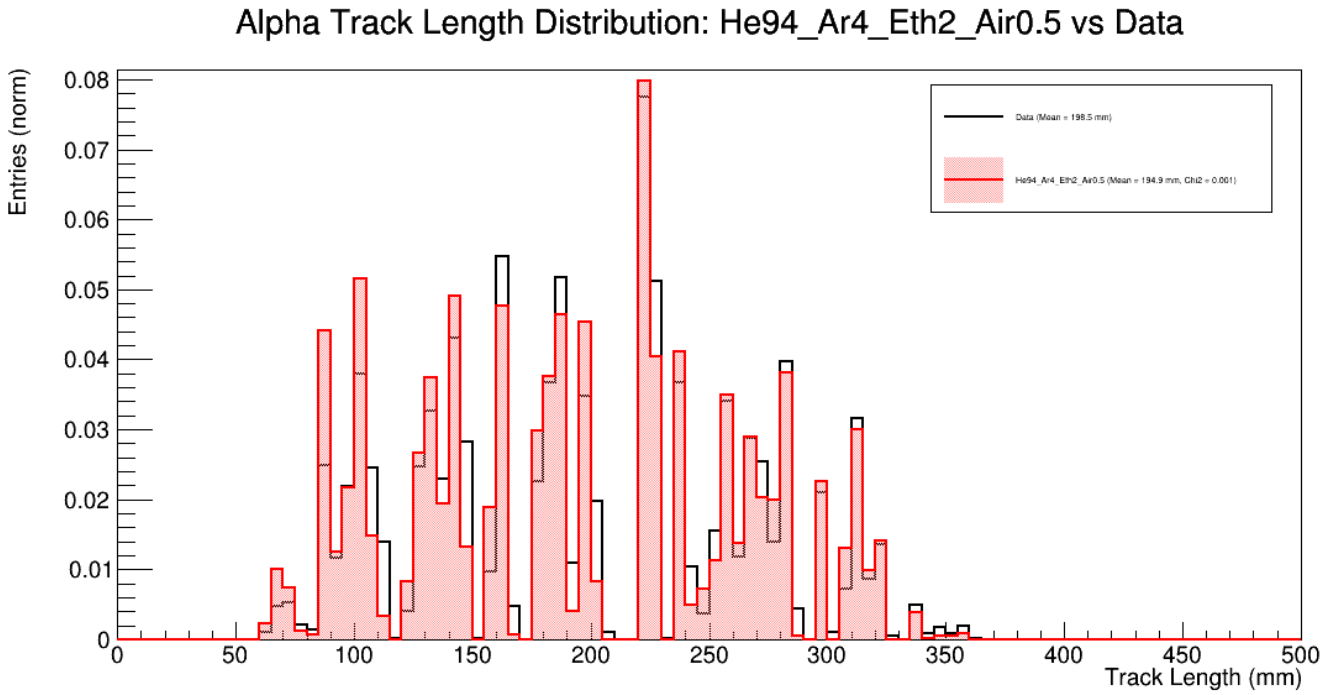

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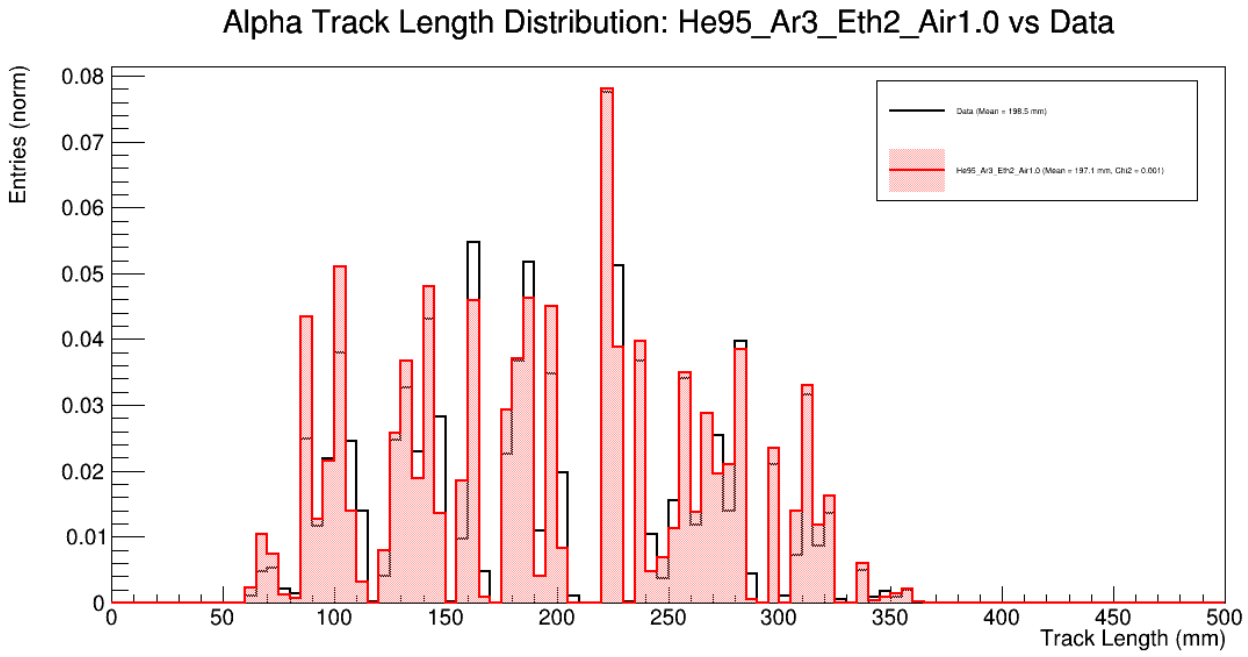

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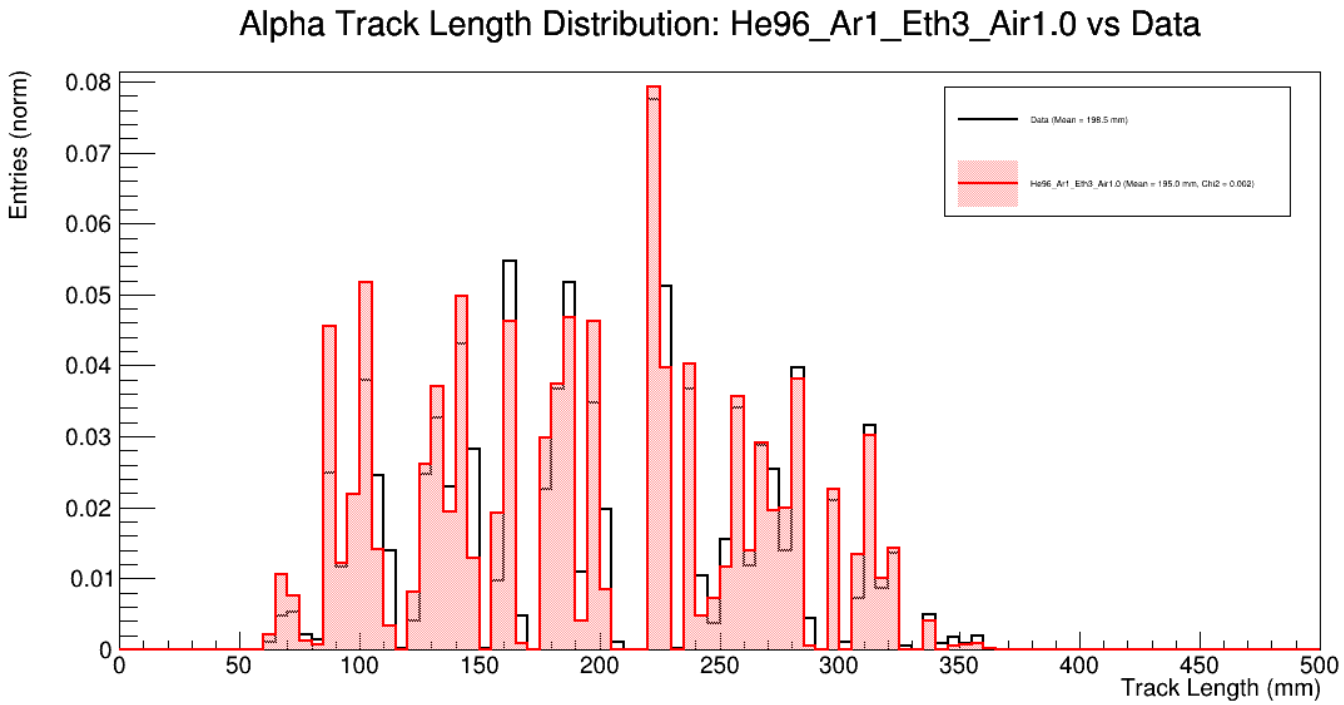
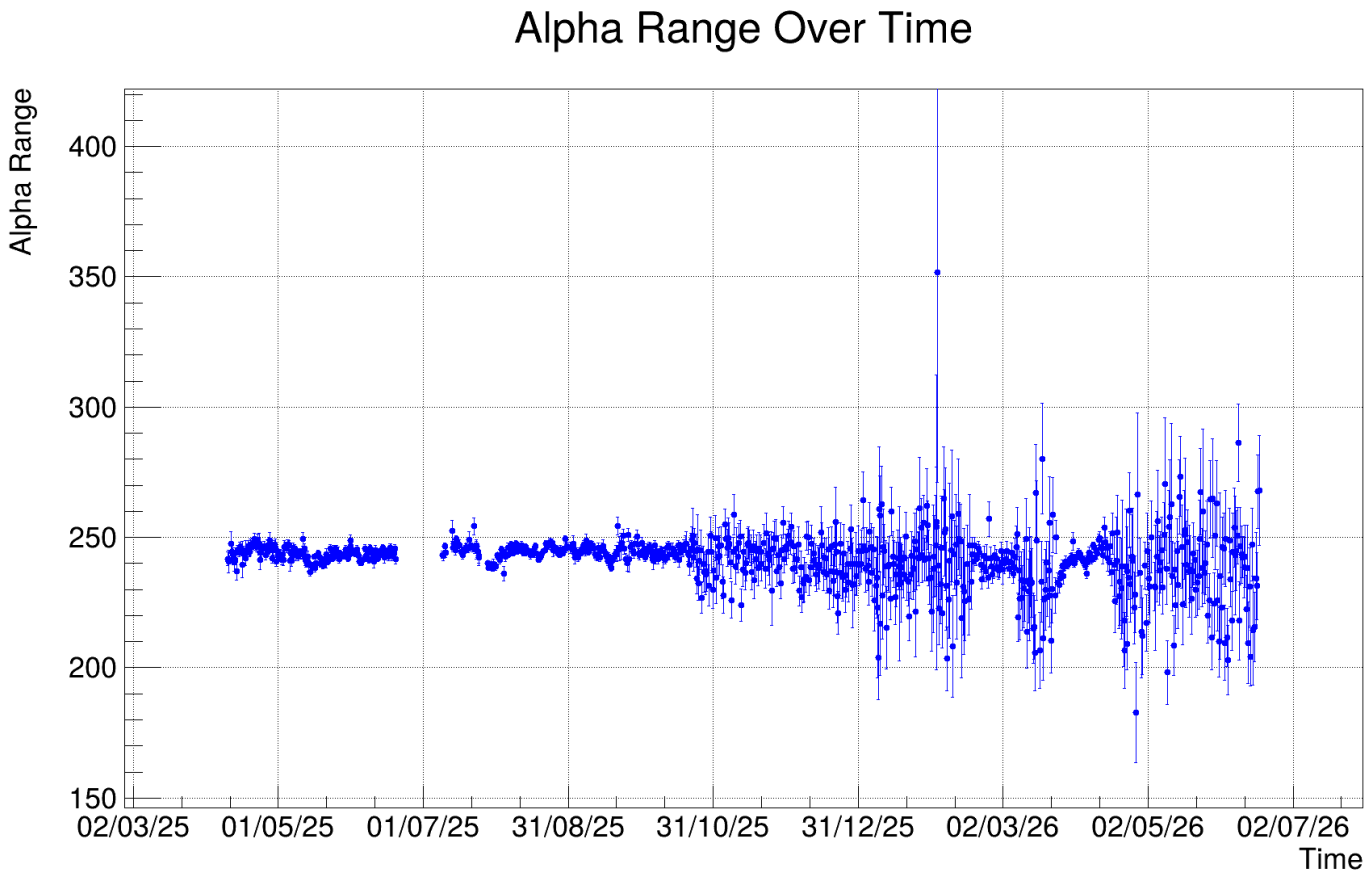
More probable



Evolution of mean alpha track length over time



Some alpha track length are correlated with Anti-radon factory issues !

Conclusion

- Huge dependency of alpha track length with gas mix
- From radon presentation, there are several effects mixed that make alpha track length shorter in MC than data !
- This analysis is the key for gas mixture control over time !