UMD monitoring and characterization

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Hirsap meeting 25-27 Nov 2020

Mass composition analysis with the UMD

Time

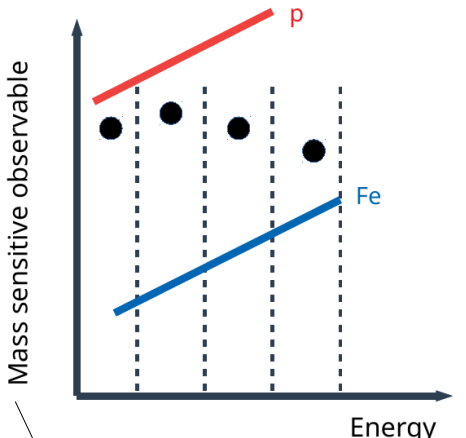
Monitoring (Offline)

Fiber attenuation analysis
(ongoing work)

This talk

Quality cuts

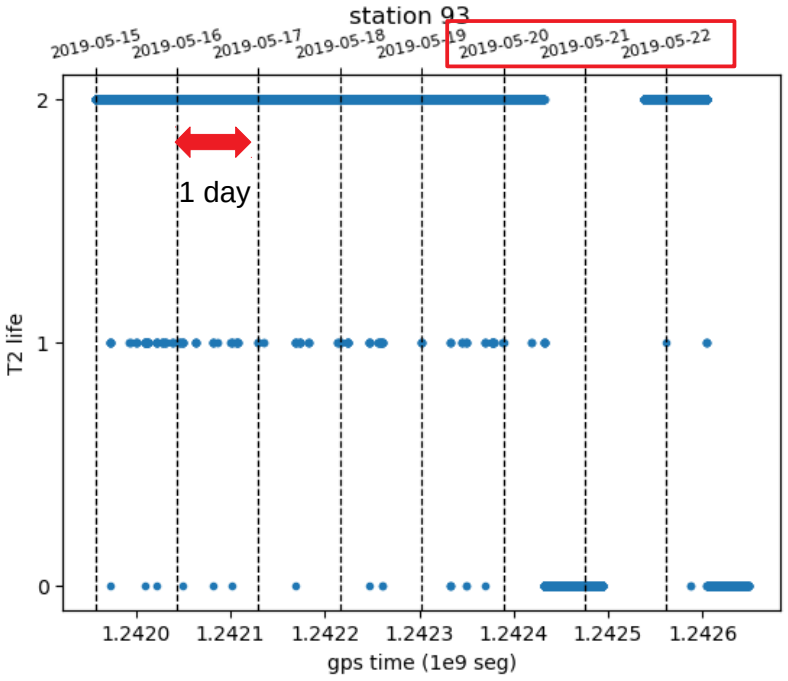
Reconstruction and physical analysis

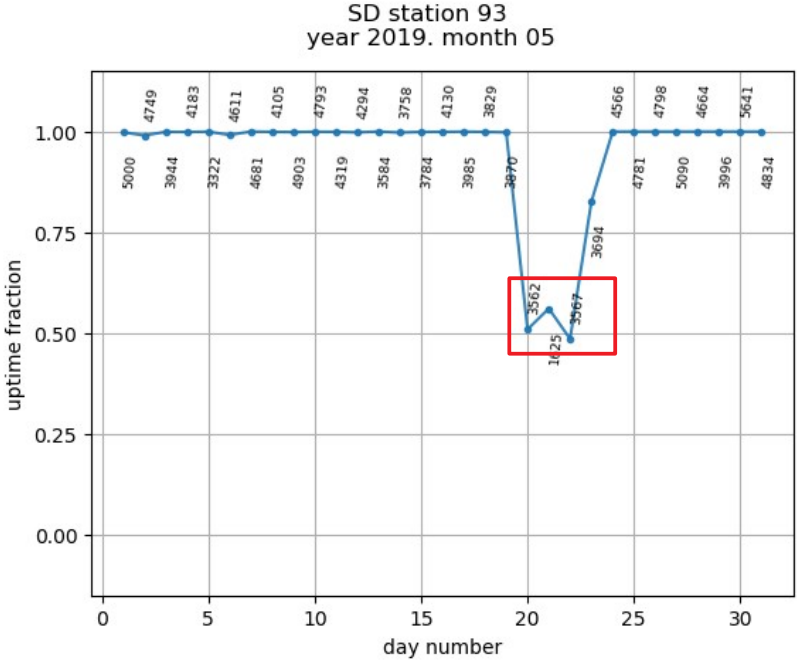


<ρ_{35}>, RMS(ρ_{35})

Monitoring: SD uptime

Station 93 – May 2019

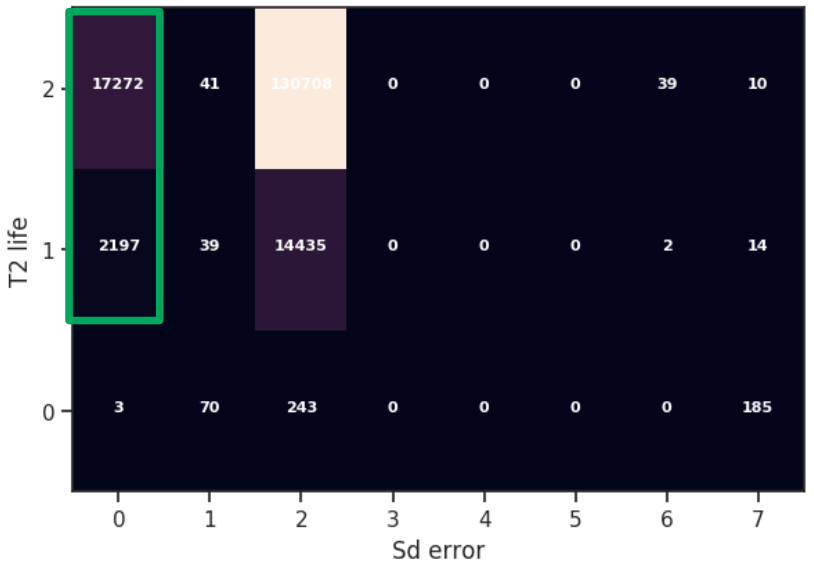


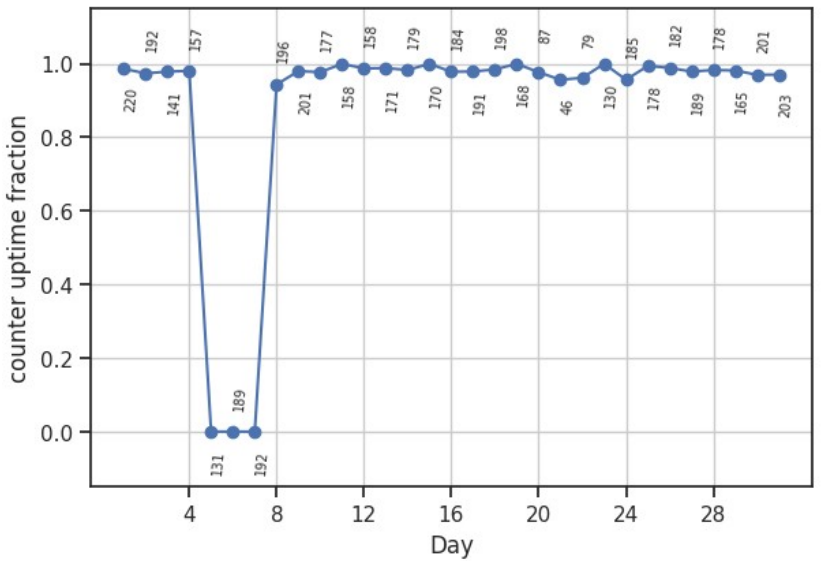


Every station in an event has a T2 life flag:

- ✗ 0 = Not functioning
- ✓ 1 = OK
- ✓ 2 = OK (and 120 sec before)

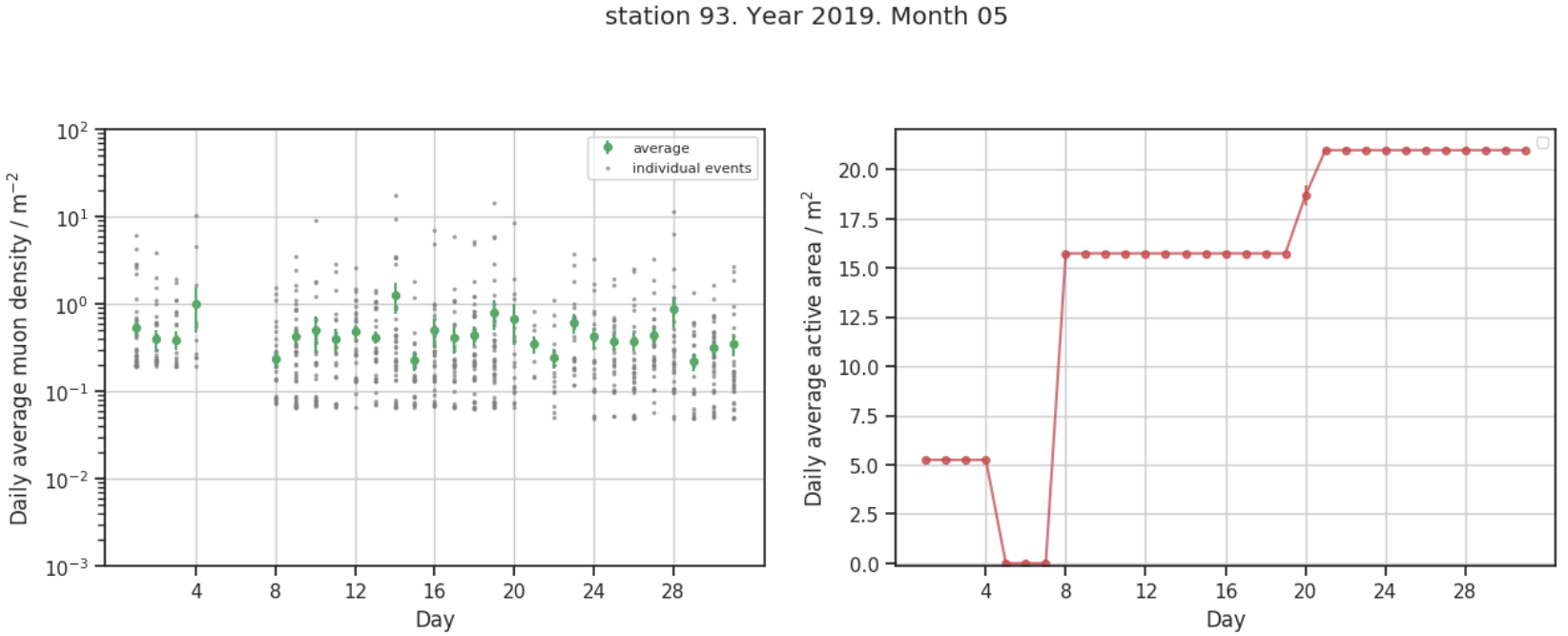
Monitoring: MD uptime






```
[INFO] MdMonitoring.cc:213: Run: Station 1773 has SDError=0 and T2life=2 ---> MD uptime analysis triggered
Counter 1773 module 101 --> Candidate. Nmu=0. ActiveArea=10.496
Counter 1773 module 102 --> NoModule
Counter 1773 module 103 --> SDError:0:SDWindow:30:MDWindow:30:T1NotFound
```

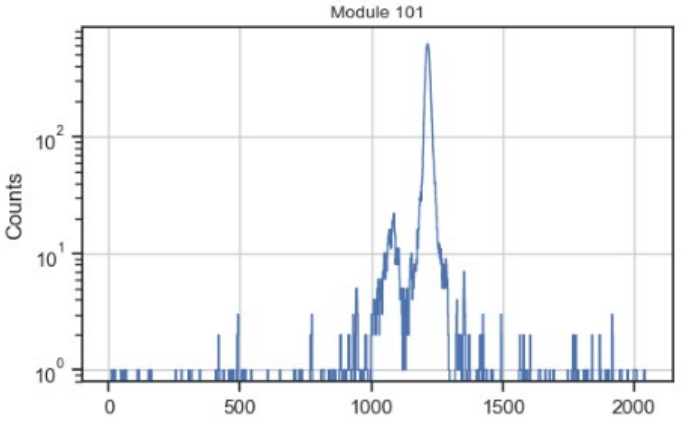
MD Monitoring: muon density and active area

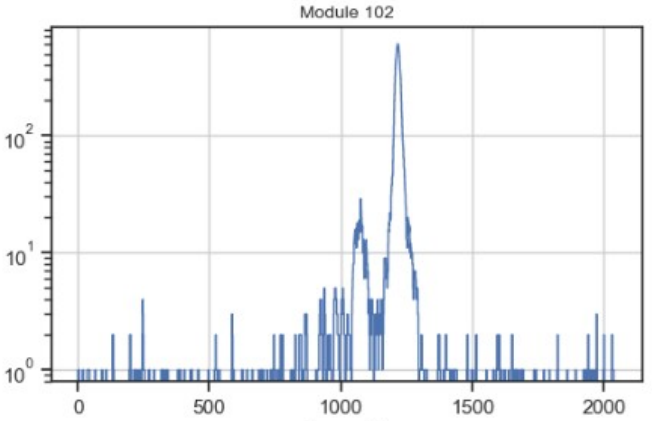


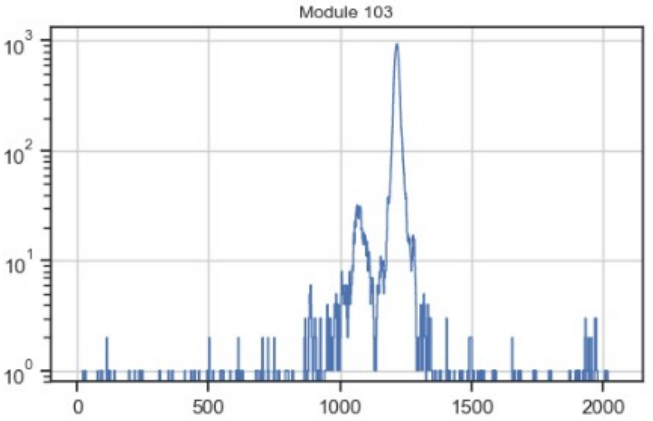
MD Monitoring: position of 1s in trace

MD counter 1764

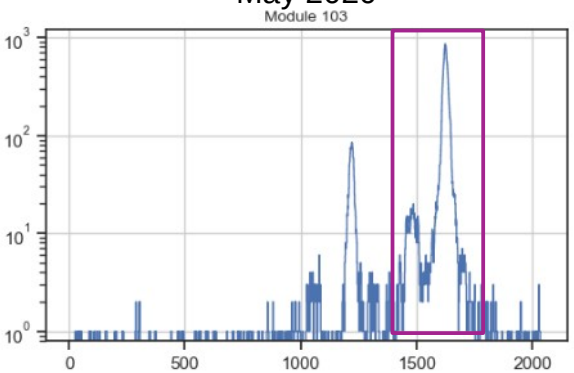
July 2020

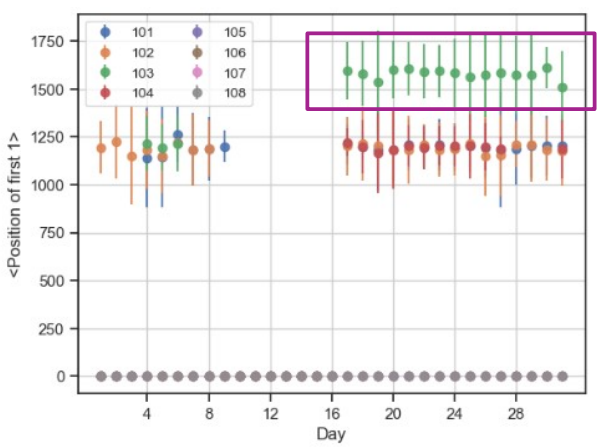




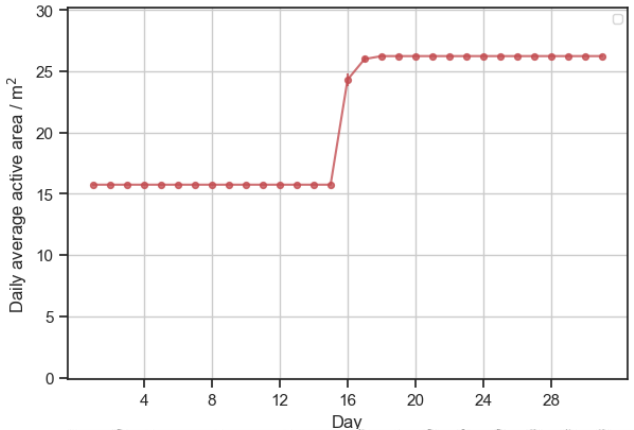


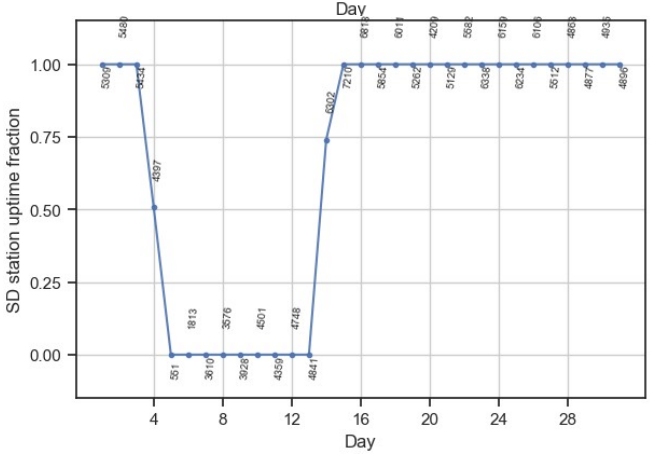
May 2020

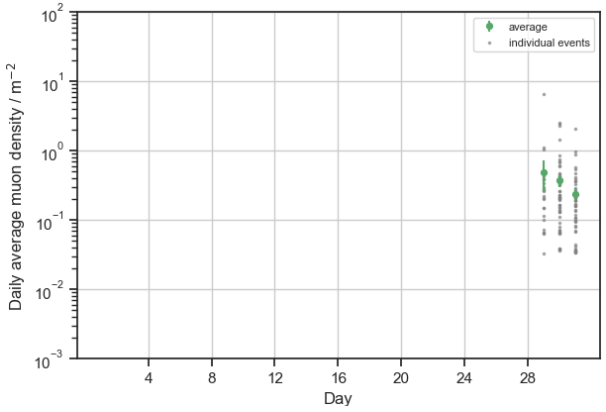


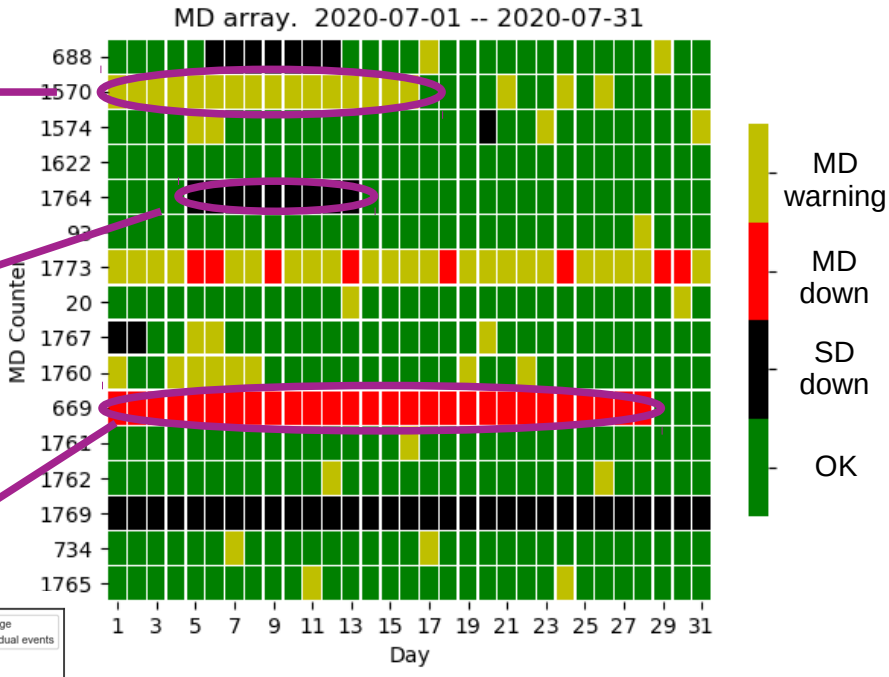


Combining all: MD array daily status

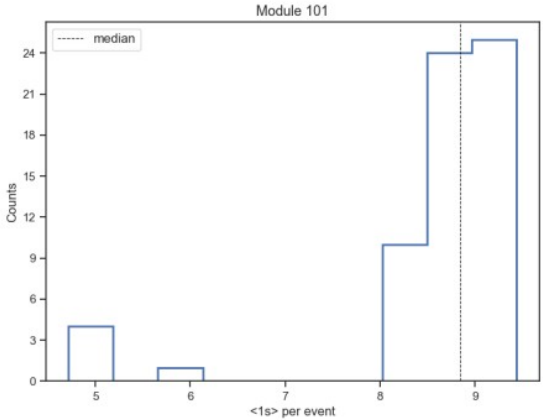


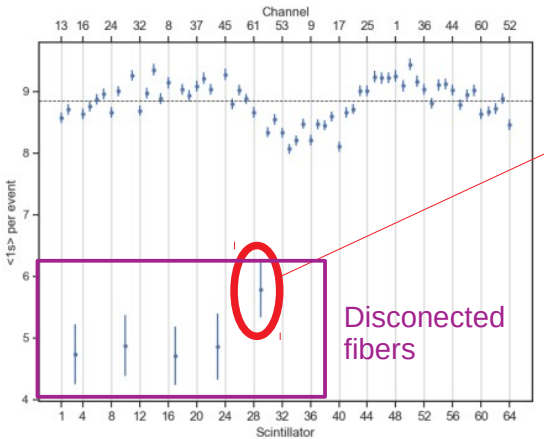


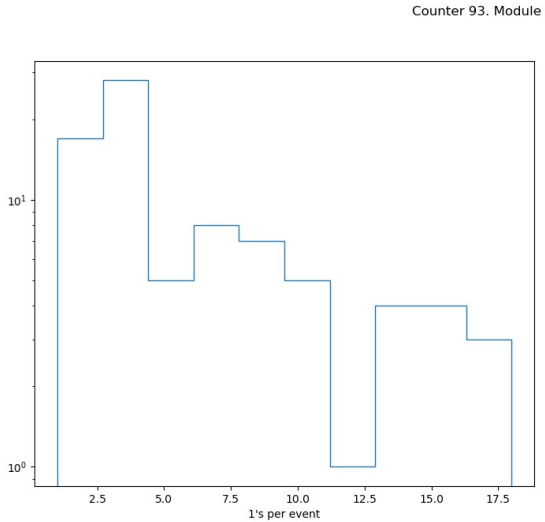


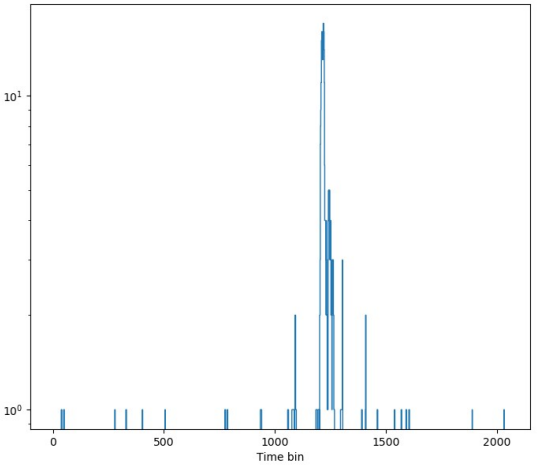


MD Monitoring: scintillators not conected





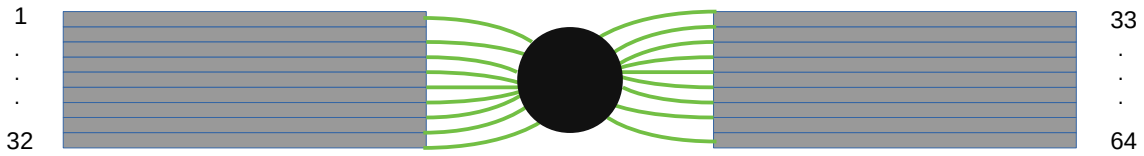




Muon hitting sipm?

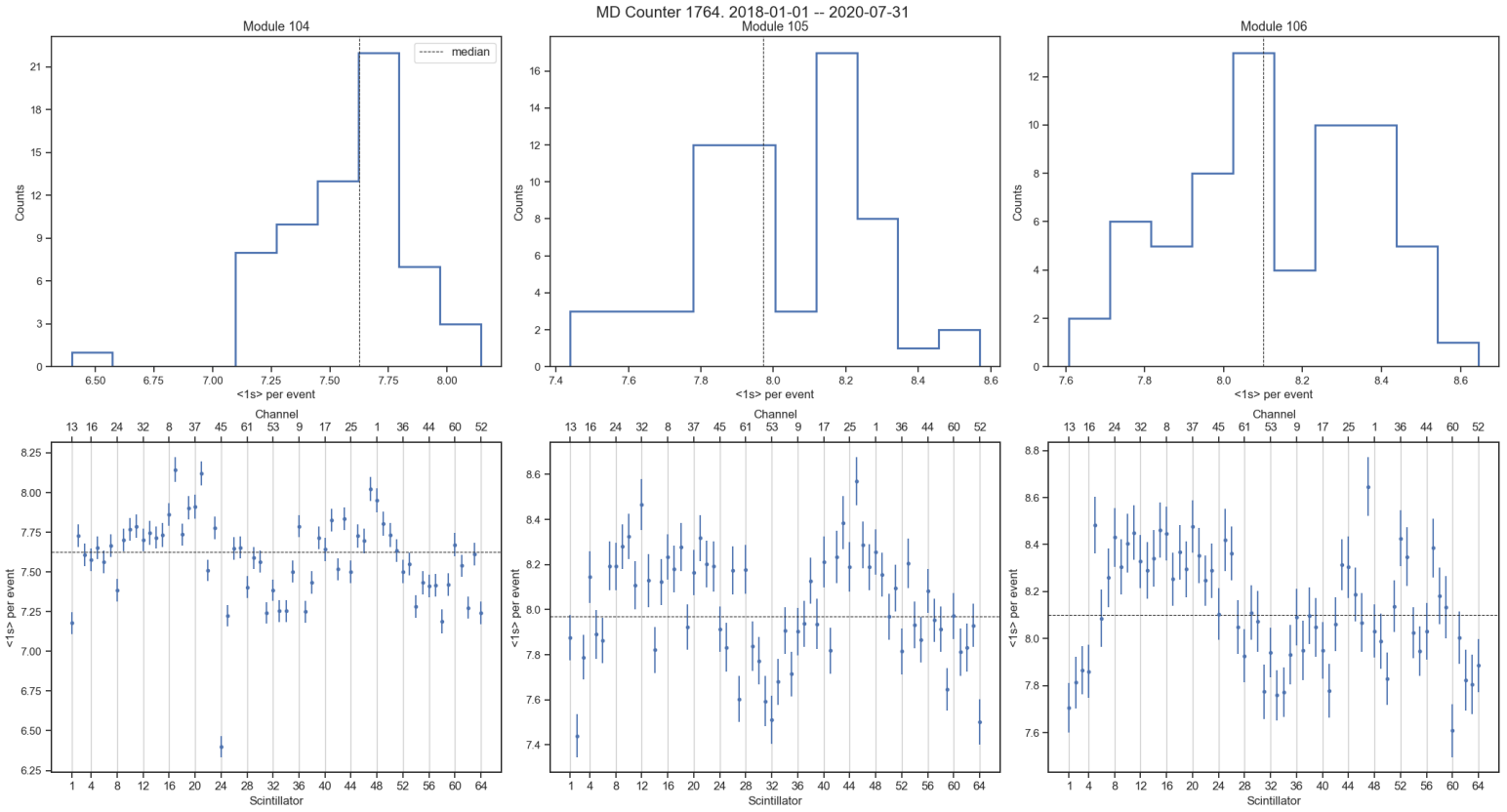
Crosstalk?

<u>To do</u>:
Check traces in ‘neighboring’ fibers
Check no muon is measured by the counting strategy



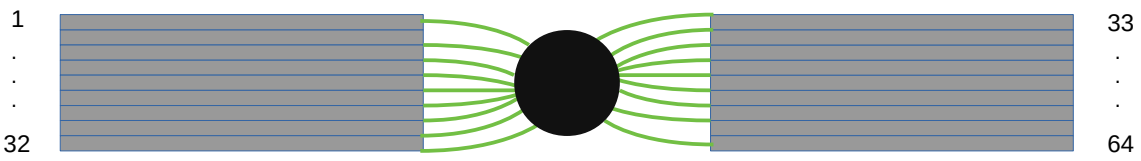
Counter 93, module 101.
Disconected bars: 3, 10, 17, 23, 29

MD Monitoring: scintillators

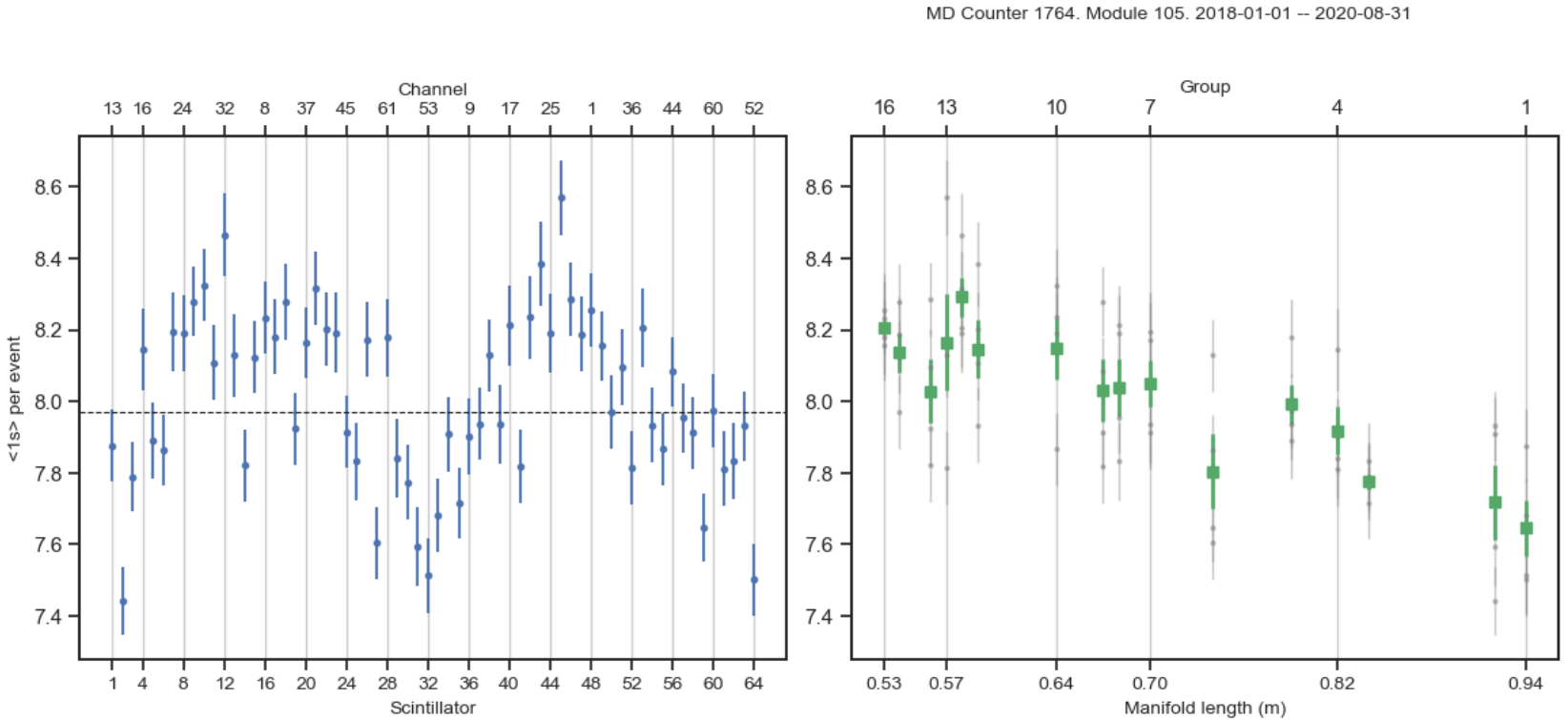


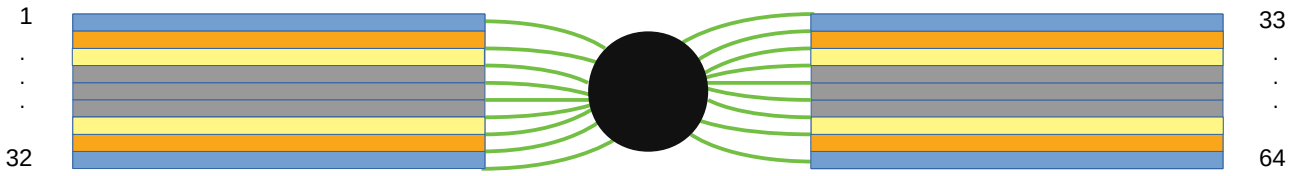
- Outliers are possible faulty scintillators
- Scintillators with longer fibers have, on average, less 1s in trace

Can we say something about fiber attenuation? (quantitatively)



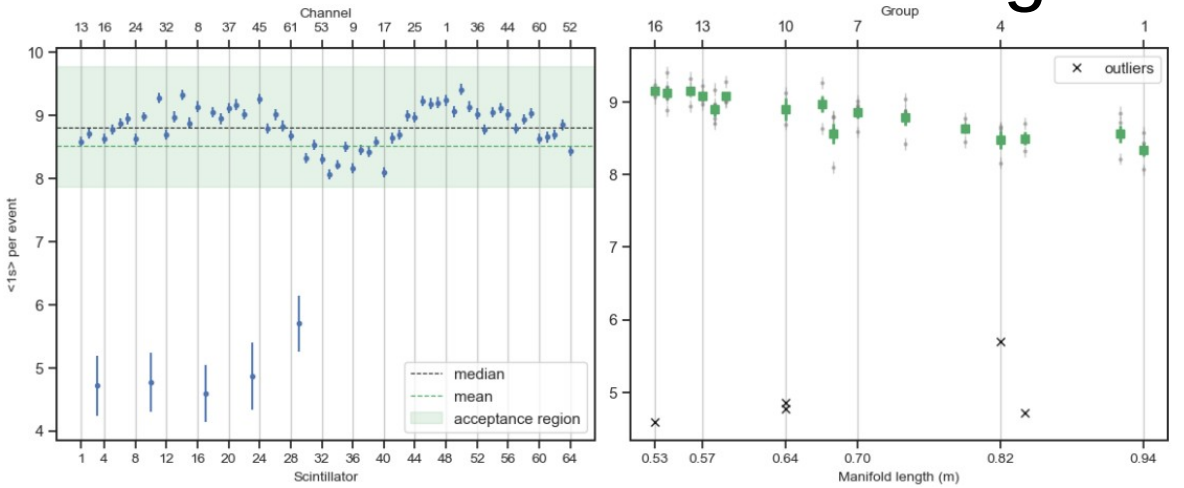
Fiber attenuation analysis (preliminary) reorganizing data

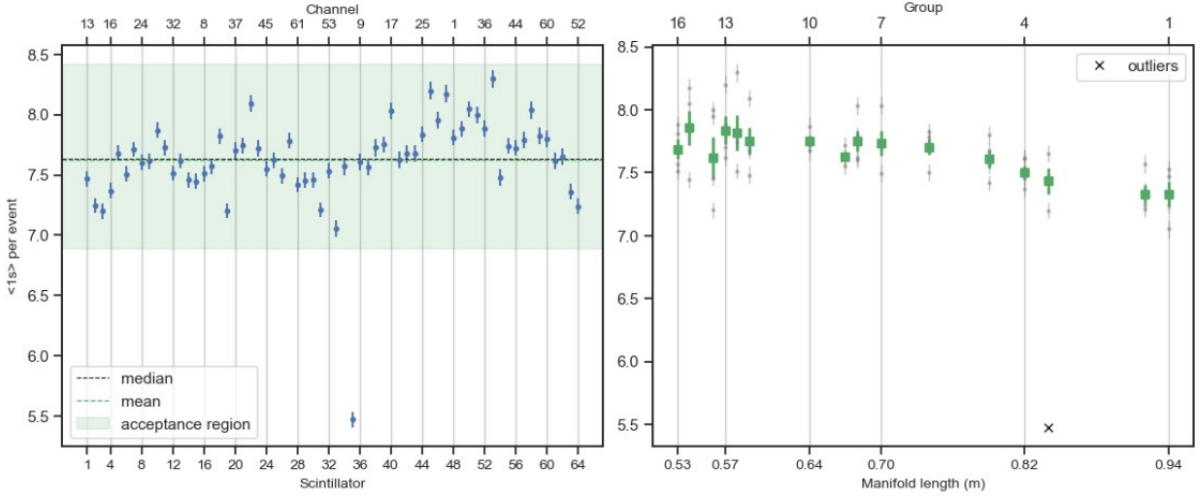




16 groups of scintillators according to their fiber length

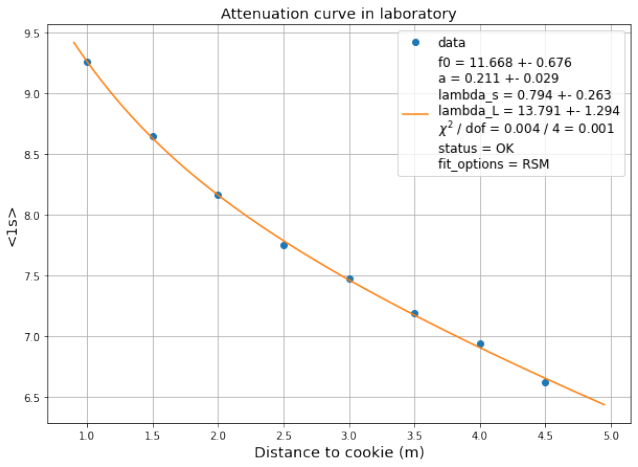
Fiber attenuation analysis (preliminary) cleaning the data



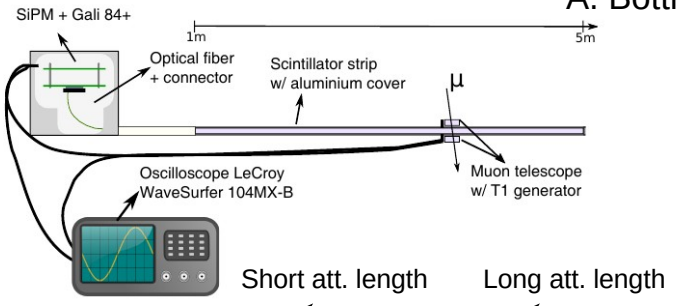


- Data from Jan 2018 to Aug 2020
- Only modules of 10 m² (44 modules)
- Reject faulty scintillators:
  Reject outliers (away from mean ± 3*sigma)
  Repeat until no new outlier is found
- 132 scintillators out of 2816 were excluded (~ 5%)

Fiber attenuation analysis (preliminary)
attenuation model

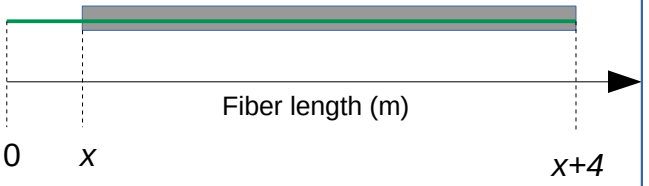


A. Botti



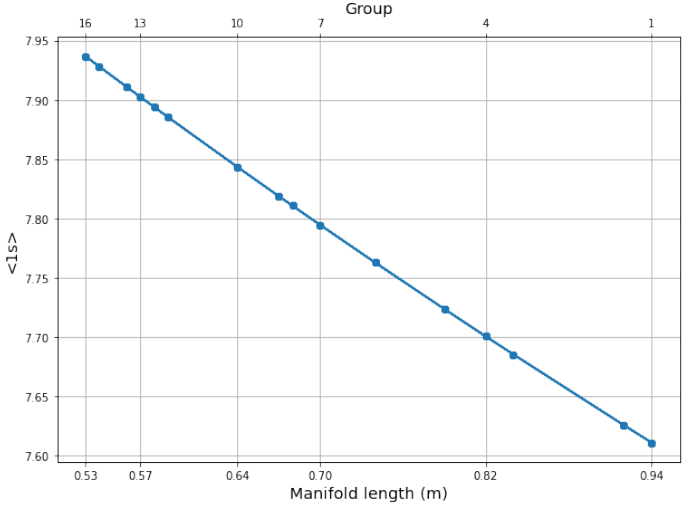
Short att. length Long att. length

$$f_{att}(d) = f_0\left(a * e^{-d/\lambda_s} + (1-a) * e^{-d/\lambda_L}\right)$$



For a scintillator with manifold length *x*, the expected value in the field is

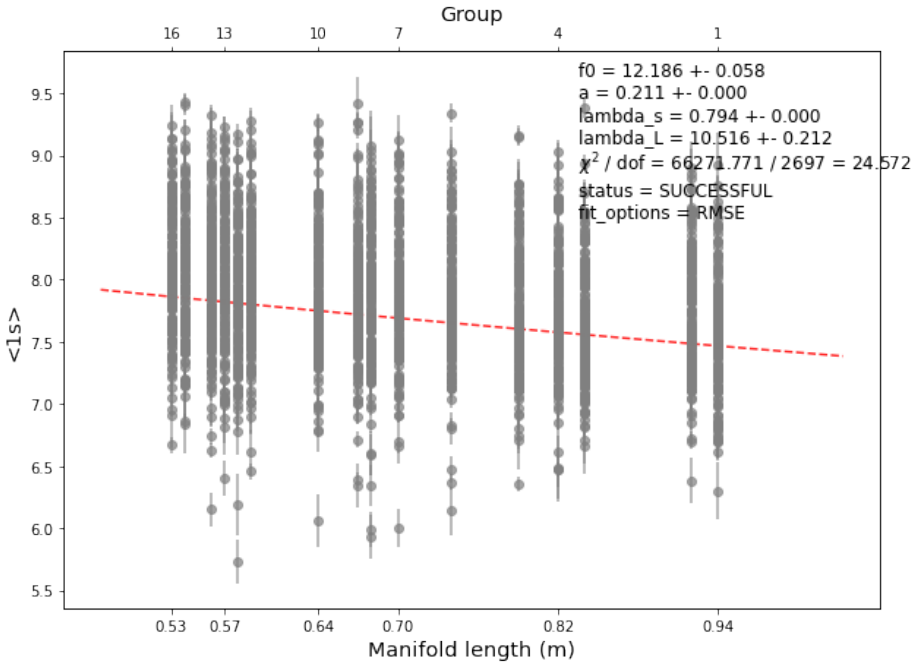
$$< f_{att} > (x) = \frac{1}{4}\int_x^{x+4} f_{att}(x')dx'$$

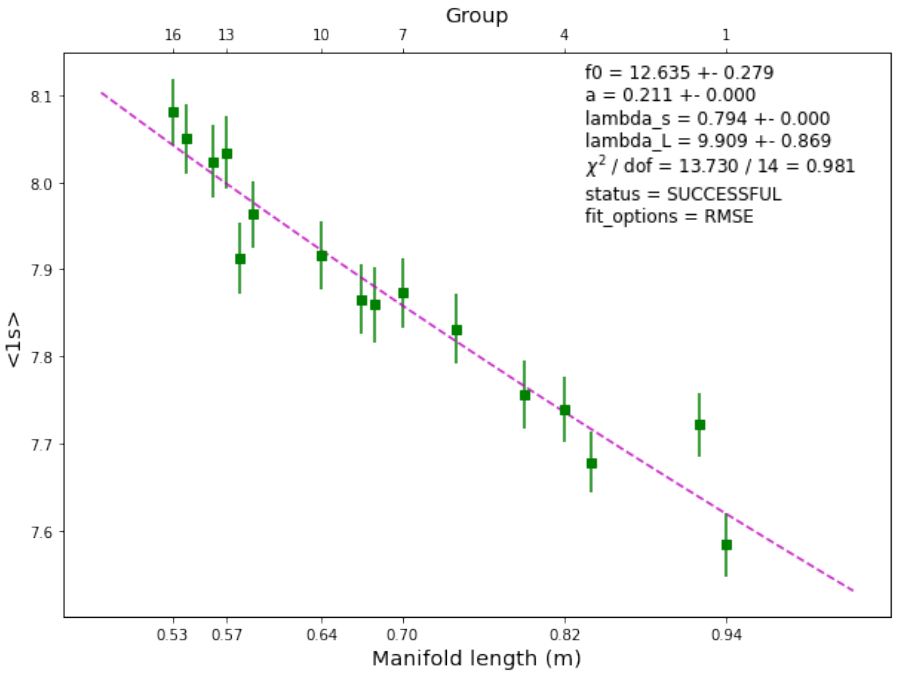


$$< f_{att} > (x) = \frac{f_0}{4}\lambda_s a(1-e^{-4/\lambda_s})e^{-x/\lambda_s} + \frac{f_0}{4}(1-a)\lambda_L(1-e^{-4/\lambda_L})e^{-x/\lambda_L}$$

Assuming all scintillators have the same $f_{att}(d)$

Fiber attenuation analysis (preliminary) fitting data





Parameters *a* and λ_S fixed to laboratory values

f_0 = 12,2 ± 0,1 and λ_L = (10,5 ± 0,2) m

f_0 = 12,6 ± 0,3 and λ_L = (9,9 ± 0,9) m

Fixing *a* and λ_S may introduce a bias in f_0 and λ_L → Study with simulations (ongoing work)

Summary and outlook

- Monitoring using data from 2018-2020
  - T2 life and SD errors → Sd/Md uptime fraction
  - Daily muon density and active area
  - Position of 1s in trace and <first bin with 1>
  - To do: crosstalk analysis

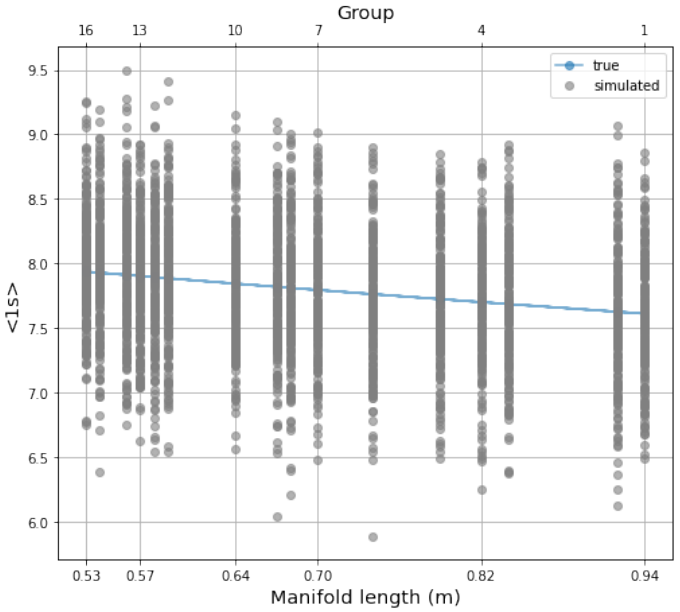
- Fiber attenuation analysis:
  - Preliminary study (stat. errors only): $f_0 = 12{,}6 \pm 0{,}3$ and $\lambda_L = (9{,}9 \pm 0{,}9)$ m
  - Ongoing: systematics estimation with simulations
  - To do: Try to fix 1 parameter (reparametrization of the fitting function)

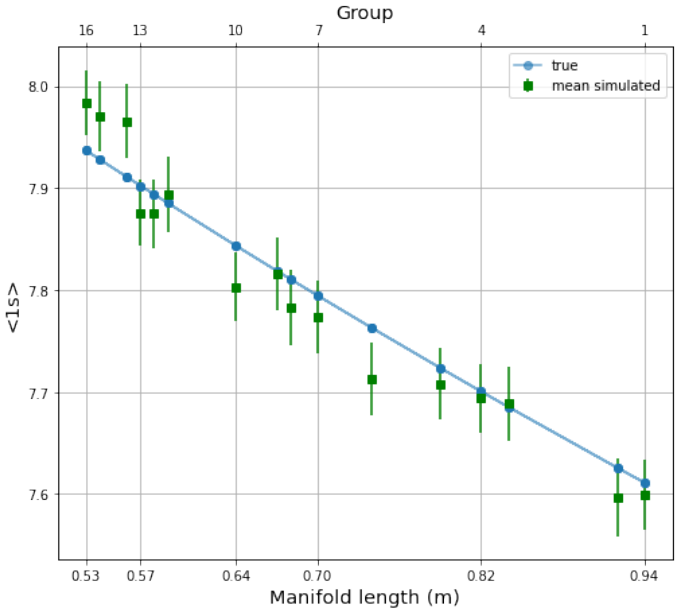
Back up slides

Fiber attenuation analysis (preliminary) simulations

Fixing *a* and λ_S can introduce a systematic in f_0 and λ_L → Study with simulations

Expected field values from lab (“true”) + gaussian noise





$f_{0\_true} = f_{0\_lab}$
$\lambda_{s\_true} = \lambda_{s\_lab}$
$\lambda_{L\_true} = \lambda_{L\_lab}$
$a_{true} = a_{lab}$

Fiber attenuation analysis (preliminary)
systematic because of fixing *a*

Sampling:

$f0\_true = f0\_lab$

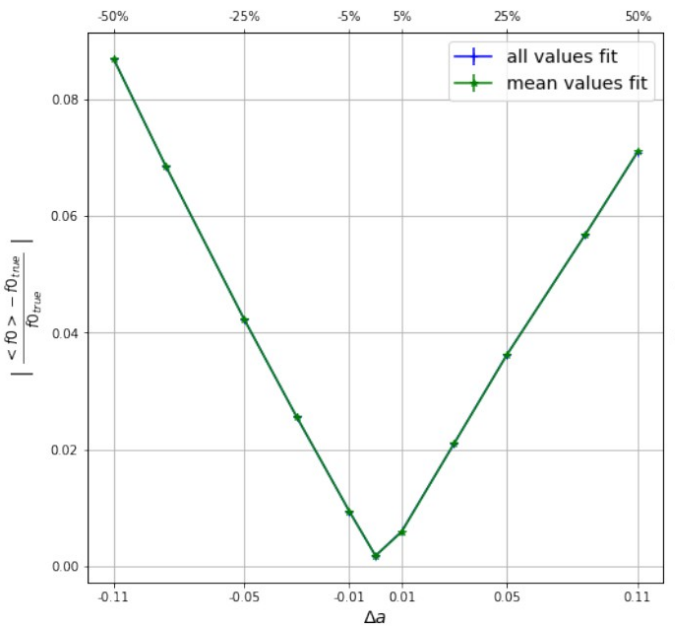
$\lambda s\_true = \lambda s\_lab$

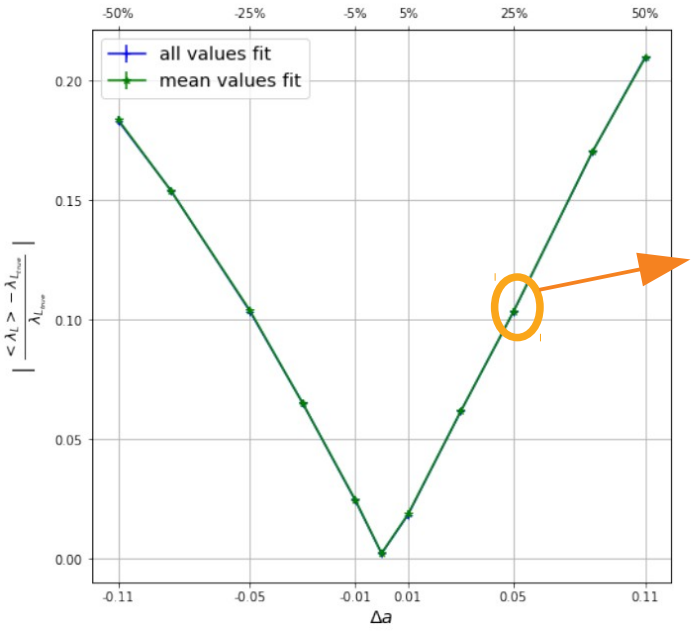
$\lambda L\_true = \lambda L\_lab$

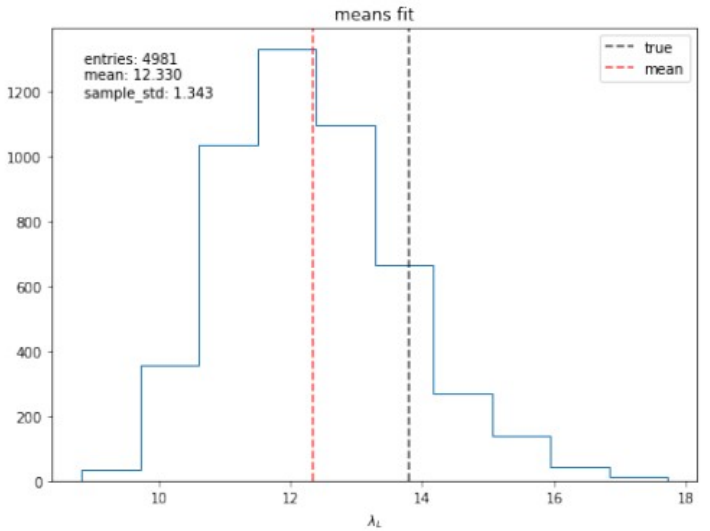
$a_{true} = a_{lab} + \Delta a$

Fit simulated data just as in reality (i.e. fixing $a=a_{lab}$, $\lambda s=\lambda s\_lab$)

Repeat many times and study bias in f_0 and λ_L







Fiber attenuation analysis (preliminary) systematic because of fixing λ_S

Sampling:

$f_{0\_true} = f_{0\_lab}$

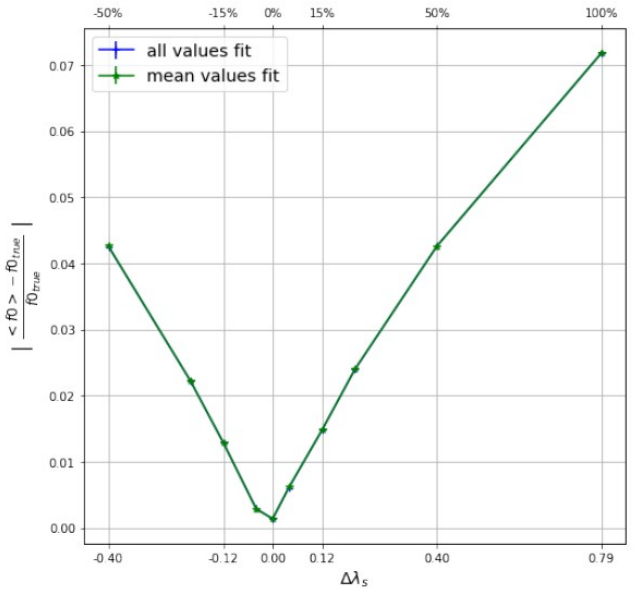
$\lambda_{S\_true} = \lambda_{S\_lab} + \Delta\lambda$

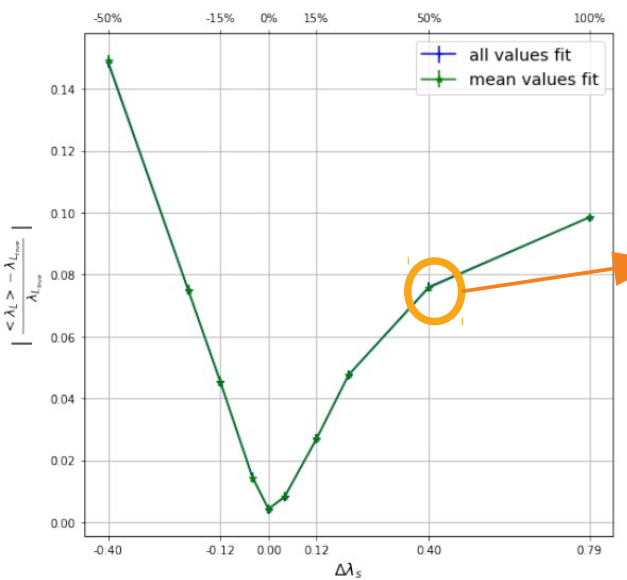
$\lambda_{L\_true} = \lambda_{L\_lab}$

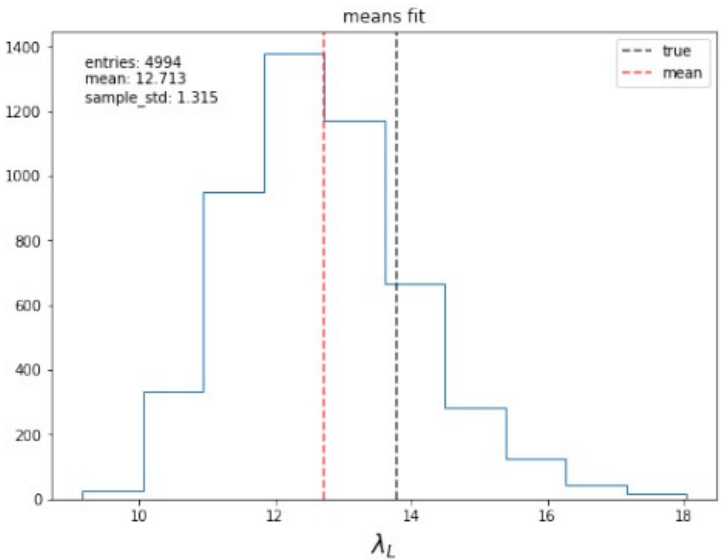
$a_{true} = a_{lab}$

Fit simulated data just as in reality (i.e. fixing $a=a_{lab}$, $\lambda_S=\lambda_{S\_lab}$)

Repeat many times and study bias in f_0 and λ_L





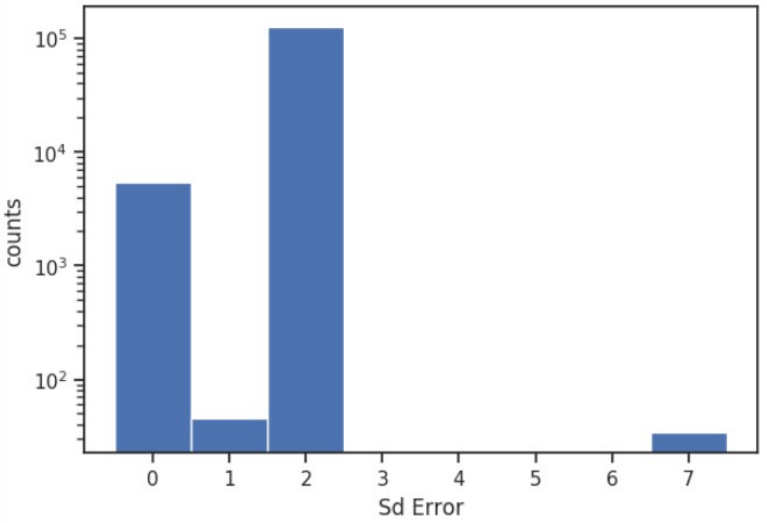


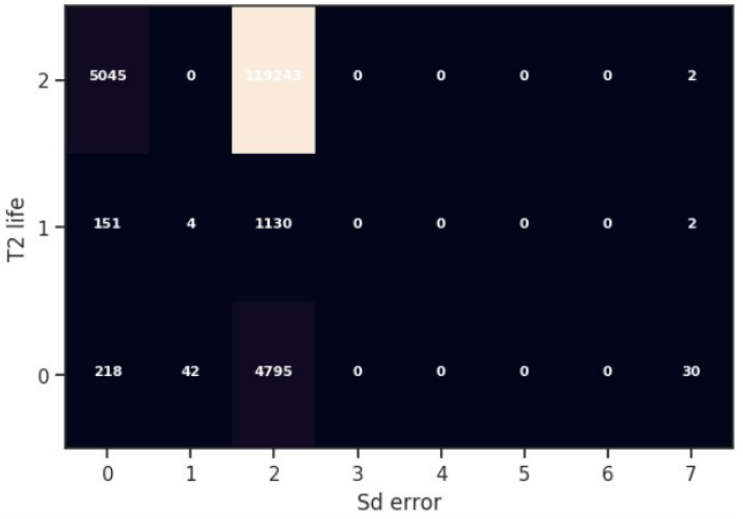
$$\sigma_{f_0}^{sys} = \sqrt{\Delta f_0|_a^2 + \Delta f_0|_{\lambda_s}^2} \qquad \sigma_{\lambda_L}^{sys} = \sqrt{\Delta\lambda_L|_a^2 + \Delta\lambda_L|_{\lambda_s}^2}$$

Correlation term?

Back up:
*) Monitoring: SD errors and T2 life

Station 93 – May 2019





Every station in an event has an SD error code 0-7:

- ✔ 0 = OK (expected for stations with T1)
- ✔ 2 = No T1 (expected for silent stations)
- ✔ 4 = Info already sent to CDAS
- ✘ Else = error

Every station in an event has a T2 life flag:

- ✘ 0 = Not functioning
- ✔ 1 = OK
- ✔ 2 = OK (and 120 sec before)