Water properties with the DU-2 nanobeacon runs

Yes we can (at least maybe)

Water properties

- Absorption length
- Scattering properties
- Essential input for simulations
- Not very precisely known at the moment

Why we should not do it

- Many have tried (with ANTARES data) and failed

- Horribly complicated

- Nanobeacon angular spectrum is not known ==> can mimic many effects

Why I want to do it

- We have **multi-pmt** DOMs (see next slides)
- We have great time resolution
- Water has better scattering properties than ice and **we want to show that**
- Nanobeacon time calibration turned out to be super-easy
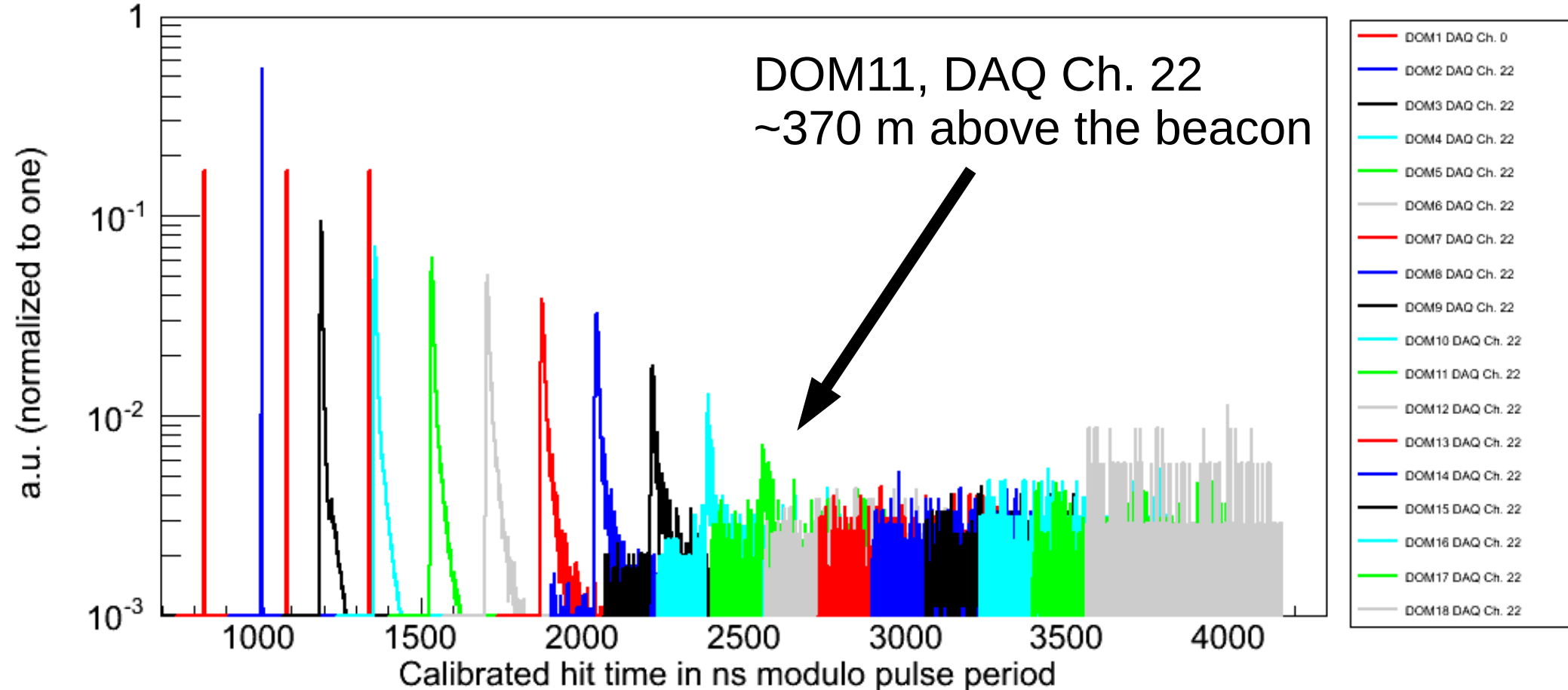- We have new L0 runs that show some **very promising features**
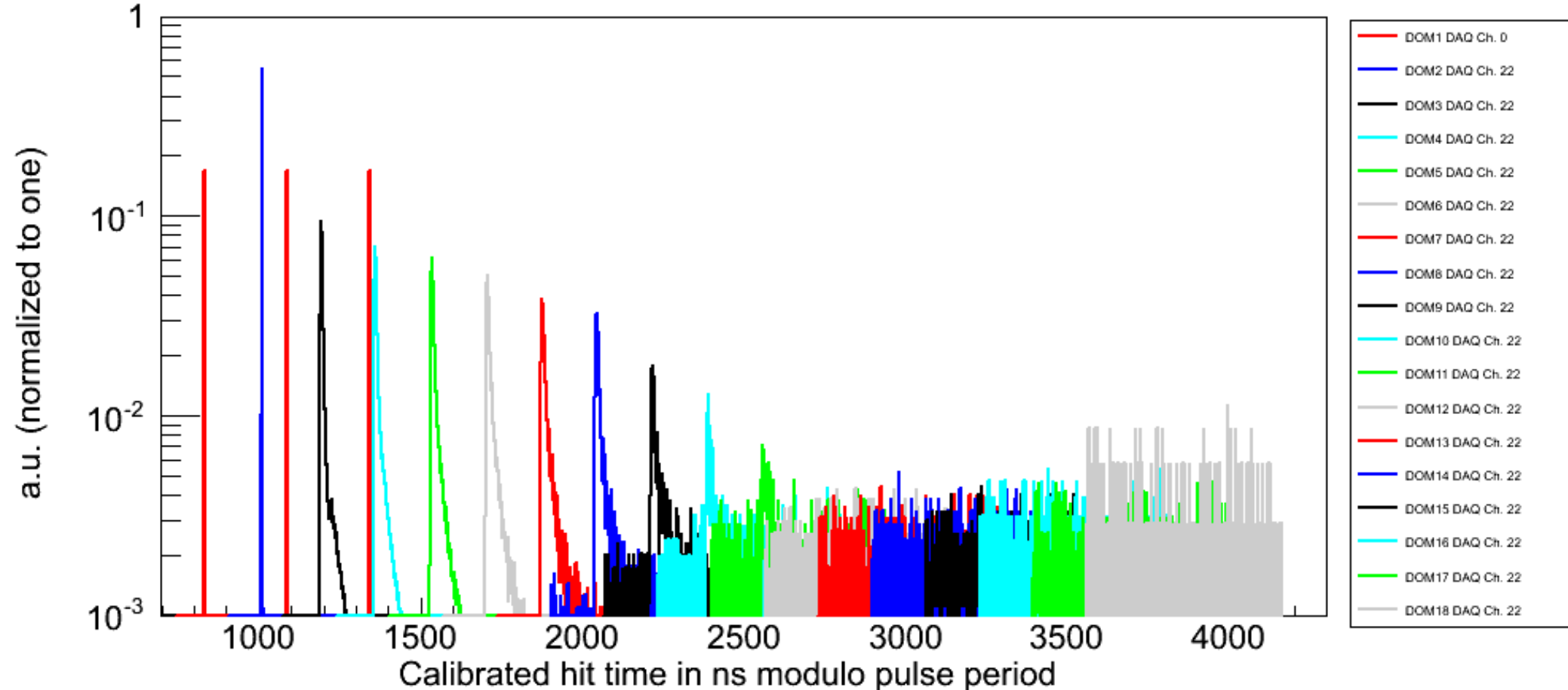
Nanobeacon pulses

Nanobeacon pulse from DOM1 is visible up to DOM11.
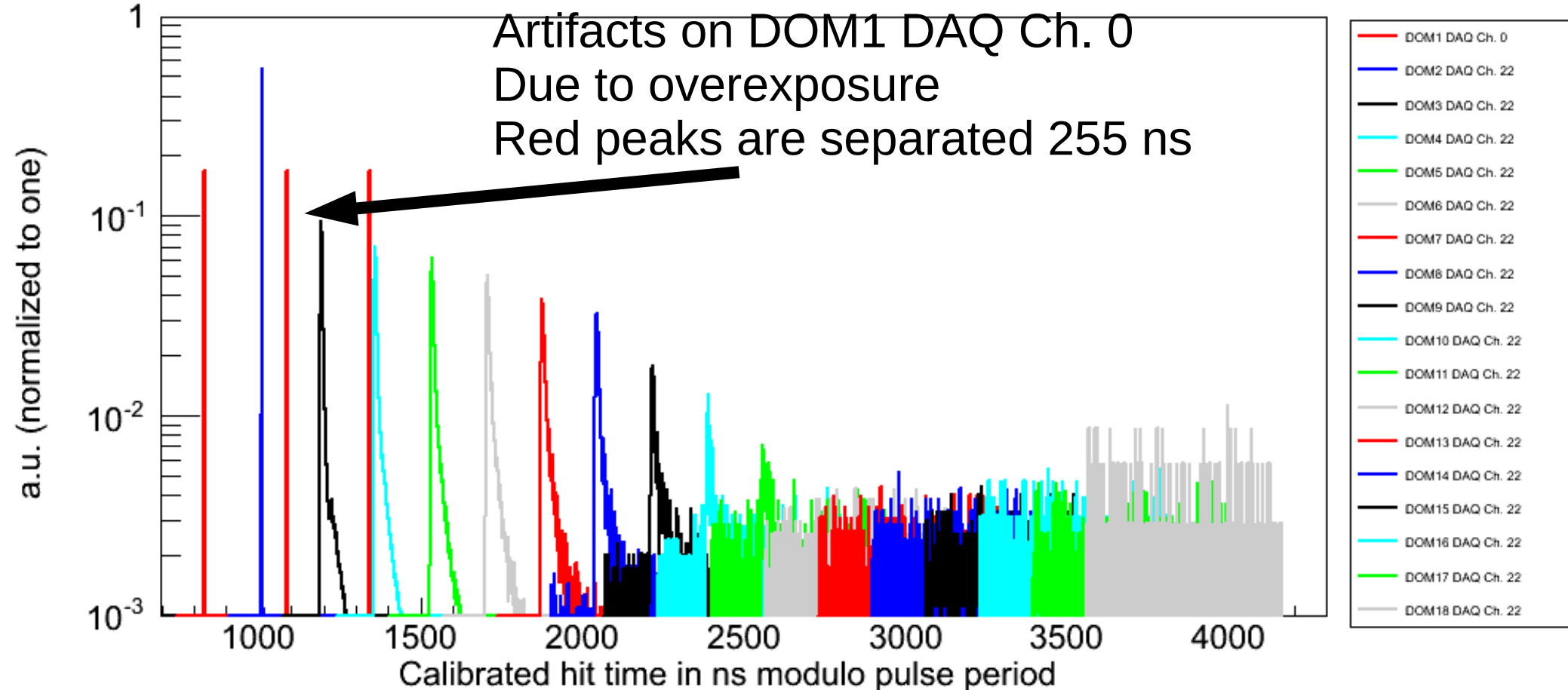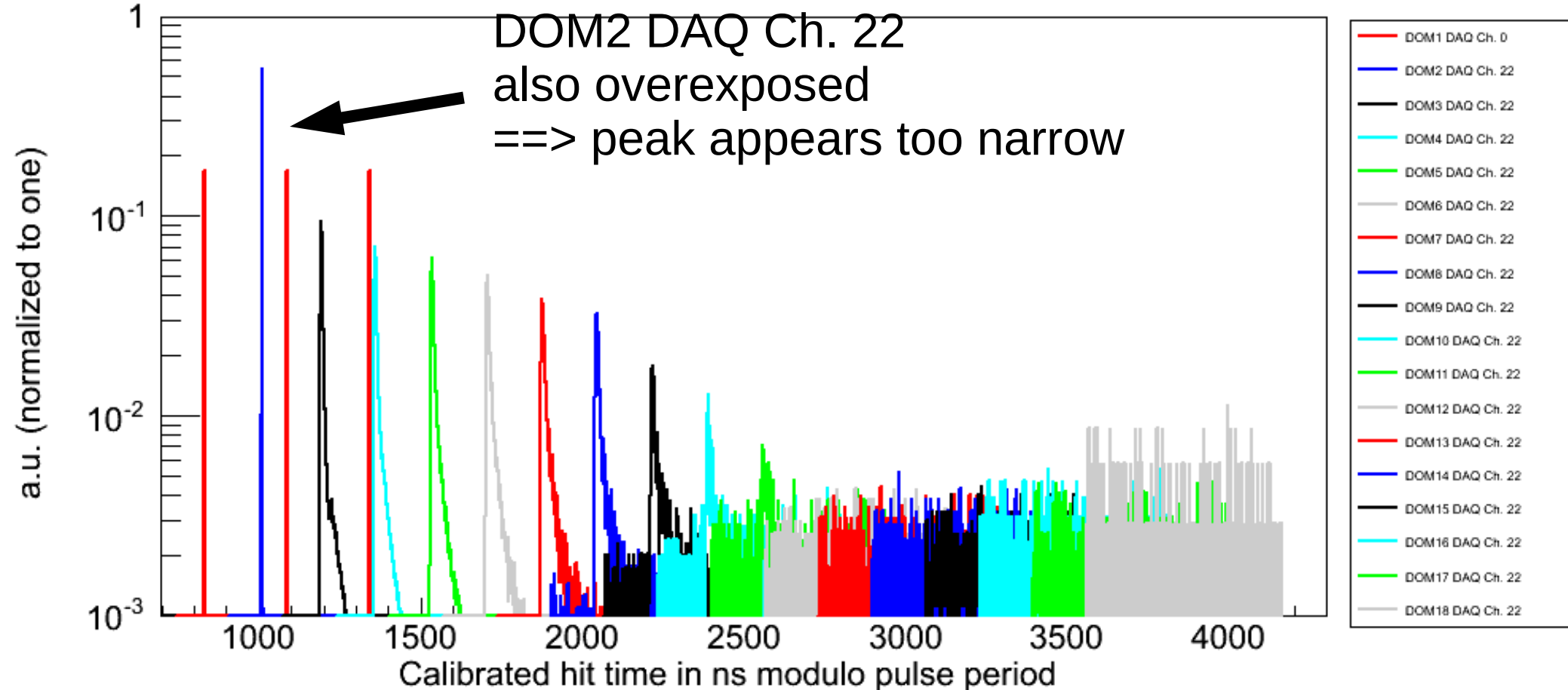This is from run #2621 with a high voltage on the NB.
~8 minutes of data.
See http://elog.km3net.de/Analysis/83

Nanobeacon pulses

DOM11, DAQ Ch. 22
~370 m above the beacon

Legend:
- DOM1 DAQ Ch. 0
- DOM2 DAQ Ch. 22
- DOM3 DAQ Ch. 22
- DOM4 DAQ Ch. 22
- DOM5 DAQ Ch. 22
- DOM6 DAQ Ch. 22
- DOM7 DAQ Ch. 22
- DOM8 DAQ Ch. 22
- DOM9 DAQ Ch. 22
- DOM10 DAQ Ch. 22
- DOM11 DAQ Ch. 22
- DOM12 DAQ Ch. 22
- DOM13 DAQ Ch. 22
- DOM14 DAQ Ch. 22
- DOM15 DAQ Ch. 22
- DOM16 DAQ Ch. 22
- DOM17 DAQ Ch. 22
- DOM18 DAQ Ch. 22

Y-axis: a.u. (normalized to one)

X-axis: Calibrated hit time in ns modulo pulse period

Nanobeacon pulse from DOM1 is visible up to DOM11.
This is from run #2621 with a high voltage on the NB.
~8 minutes of data.
See http://elog.km3net.de/Analysis/83

Nanobeacon pulses

Artifacts on DOM1 DAQ Ch. 0
Due to overexposure
Red peaks are separated 255 ns

Nanobeacon pulse from DOM1 is visible up to DOM11.
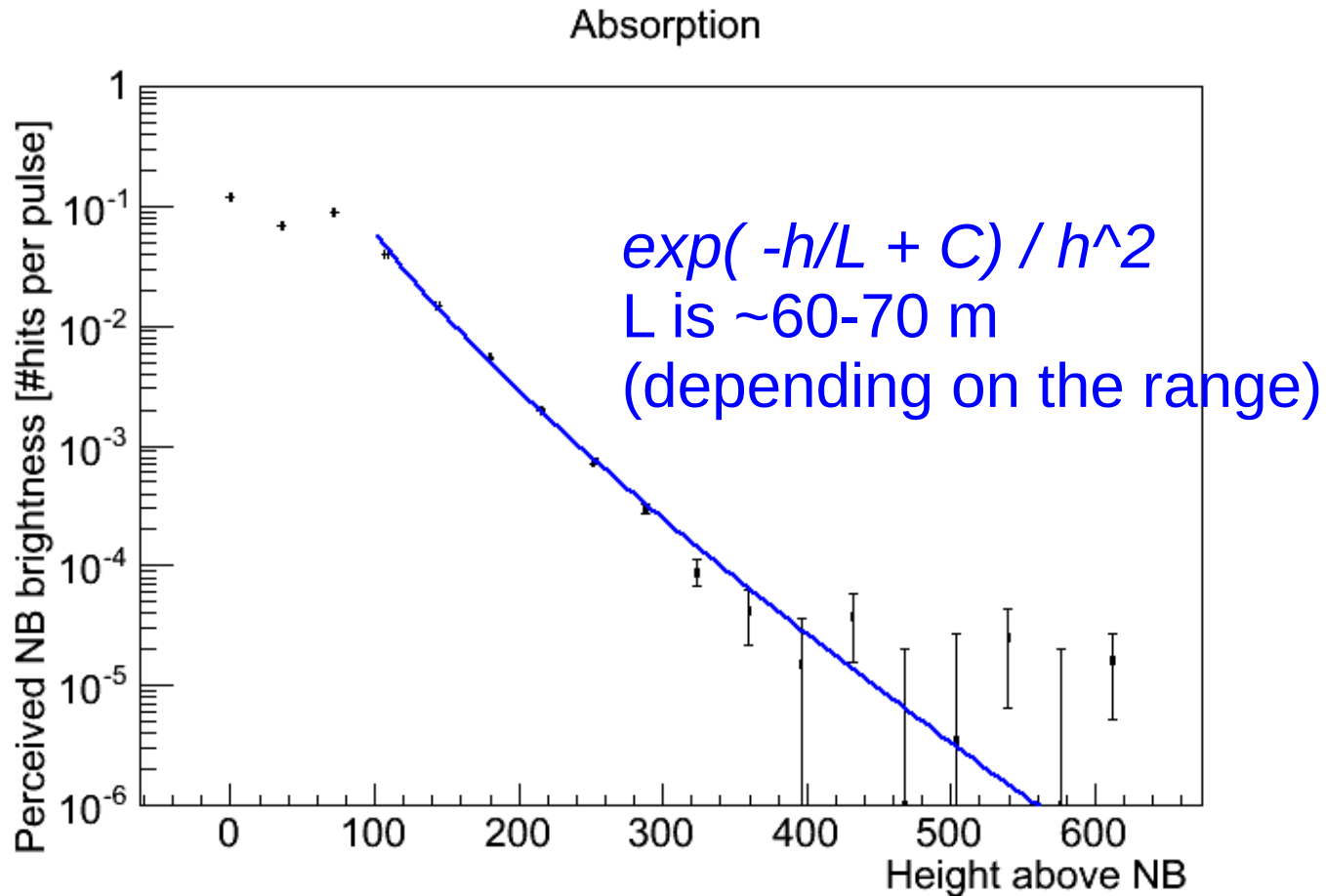This is from run #2621 with a high voltage on the NB.
~8 minutes of data.
See http://elog.km3net.de/Analysis/83
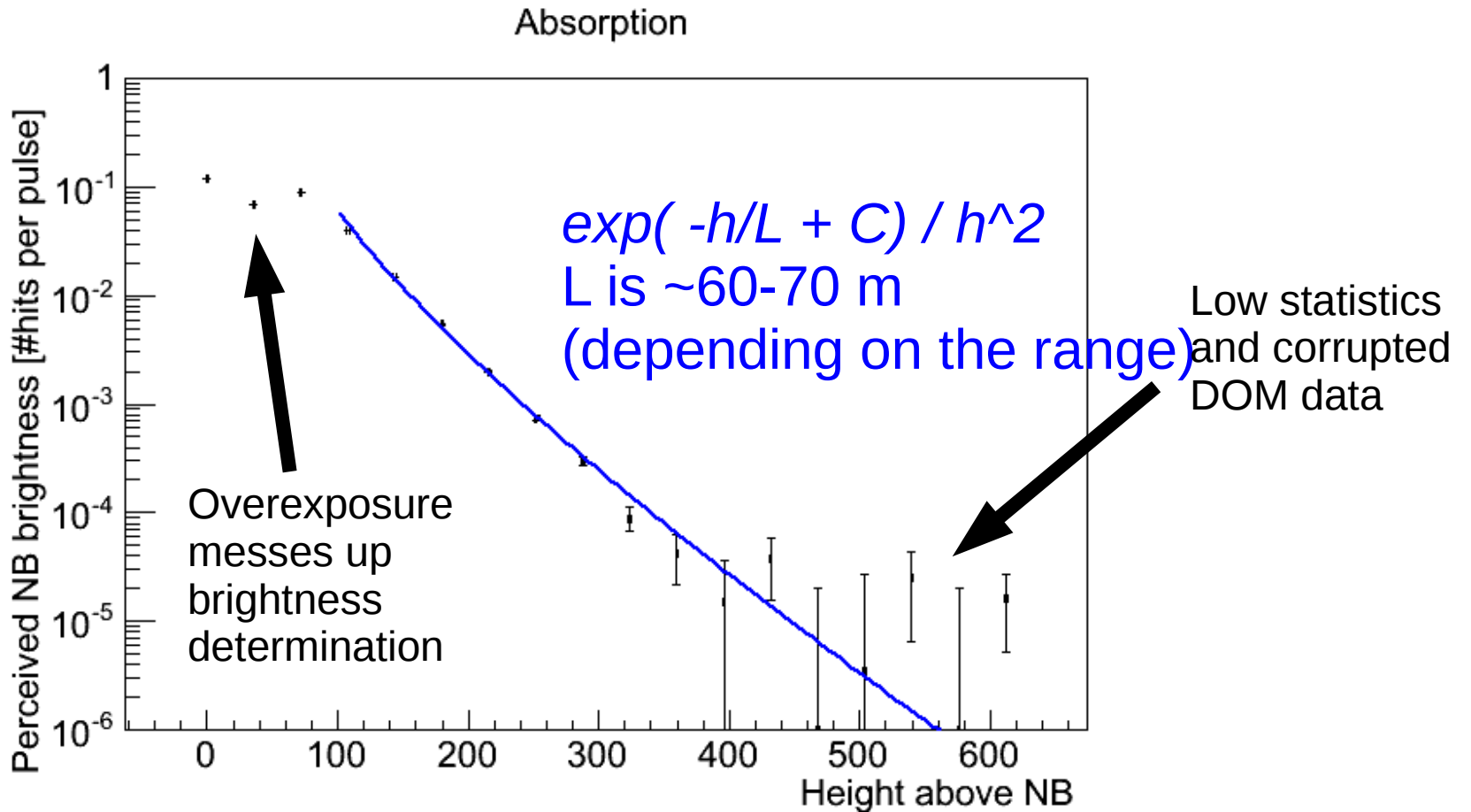
Nanobeacon pulses

DOM2 DAQ Ch. 22
also overexposed
==> peak appears too narrow

a.u. (normalized to one)

Calibrated hit time in ns modulo pulse period

- DOM1 DAQ Ch. 0
- DOM2 DAQ Ch. 22
- DOM3 DAQ Ch. 22
- DOM4 DAQ Ch. 22
- DOM5 DAQ Ch. 22
- DOM6 DAQ Ch. 22
- DOM7 DAQ Ch. 22
- DOM8 DAQ Ch. 22
- DOM9 DAQ Ch. 22
- DOM10 DAQ Ch. 22
- DOM11 DAQ Ch. 22
- DOM12 DAQ Ch. 22
- DOM13 DAQ Ch. 22
- DOM14 DAQ Ch. 22
- DOM15 DAQ Ch. 22
- DOM16 DAQ Ch. 22
- DOM17 DAQ Ch. 22
- DOM18 DAQ Ch. 22

Nanobeacon pulse from DOM1 is visible up to DOM11.
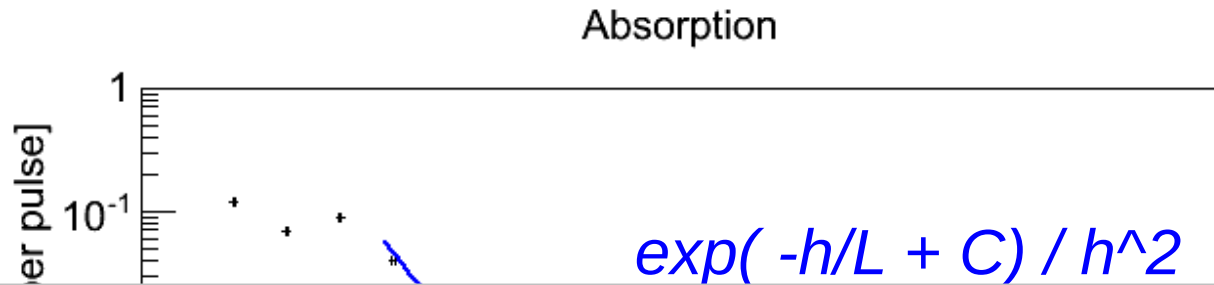This is from run #2621 with a high voltage on the NB.
~8 minutes of data.
See http://elog.km3net.de/Analysis/83

Naive fit of eff. absorption length

Absorption

exp(-h/L + C) / h^2
L is ~60-70 m
(depending on the range)

Same run as before (#2621)

Naive fit of eff. absorption length

Absorption

exp(-h/L + C) / h^2
L is ~60-70 m
(depending on the range)

Low statistics and corrupted DOM data

Overexposure messes up brightness determination

Perceived NB brightness [#hits per pulse]

Height above NB

Same run as before (#2621)

Naive fit of eff. absorption length

Absorption

exp(-h/L + C) / h^2

Very crude and naive approach already yields very reasonable results!

Height above NB
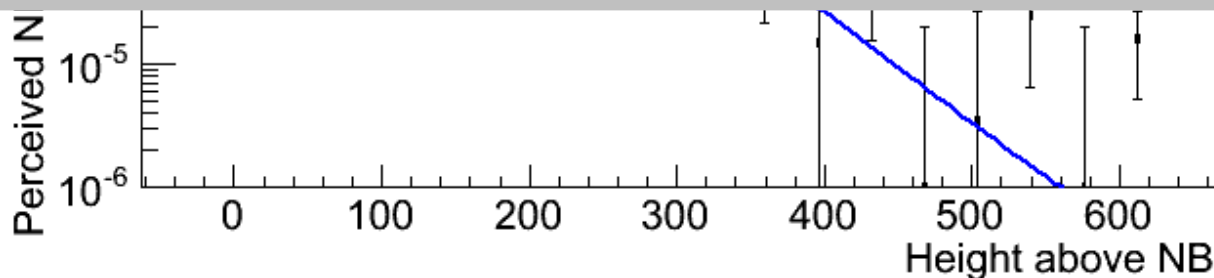
Same run as before (#2621)

NB visible on DOMs <u>below</u>

NB brightness on DOM1

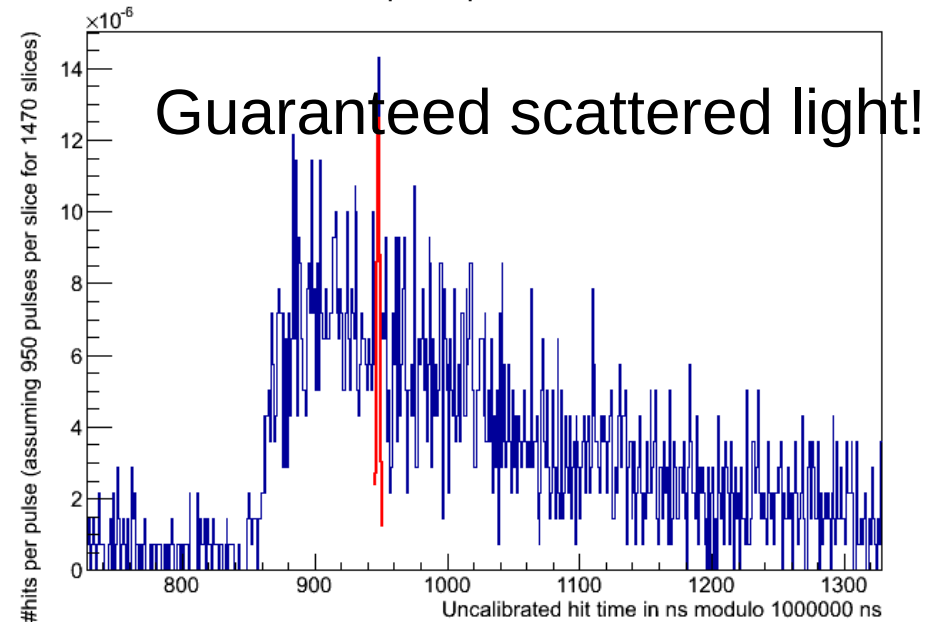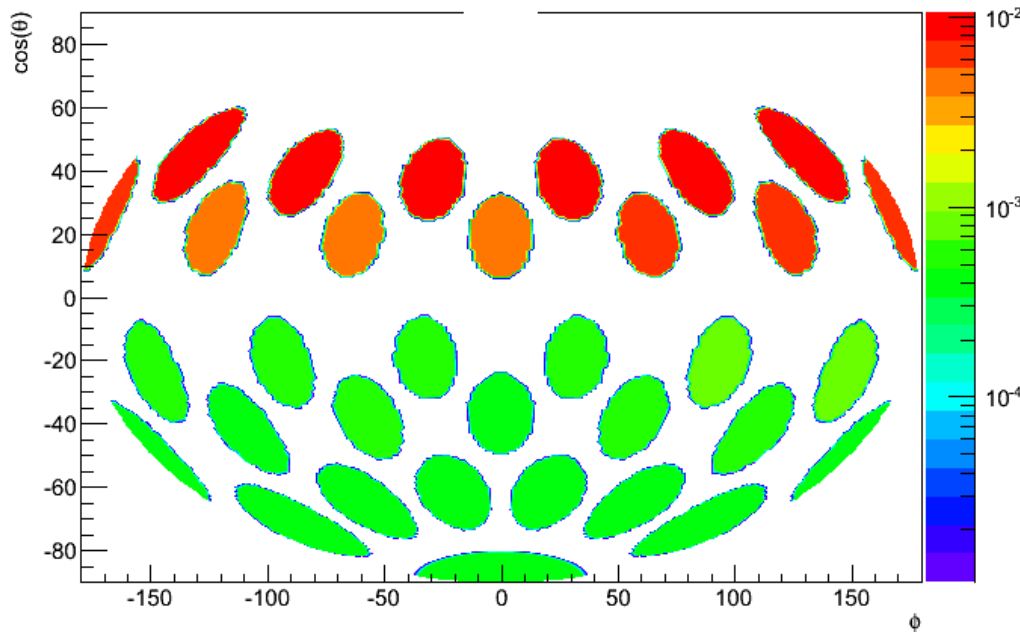NB pulse on DAQ. Ch. 0 of DOM1
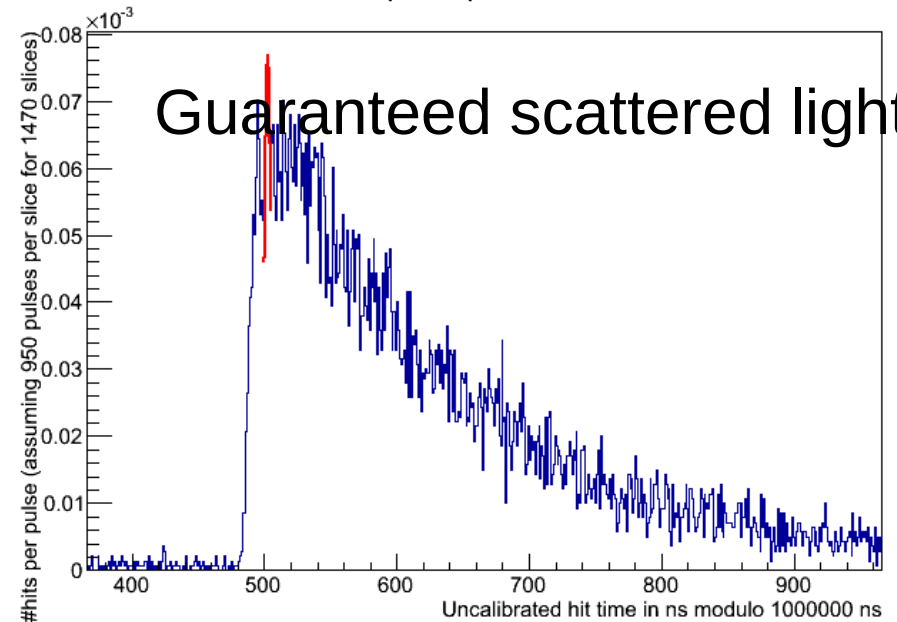
Run #2422, NB on <u>DOM3</u> is on!

NB visible on DOMs <u>below</u>

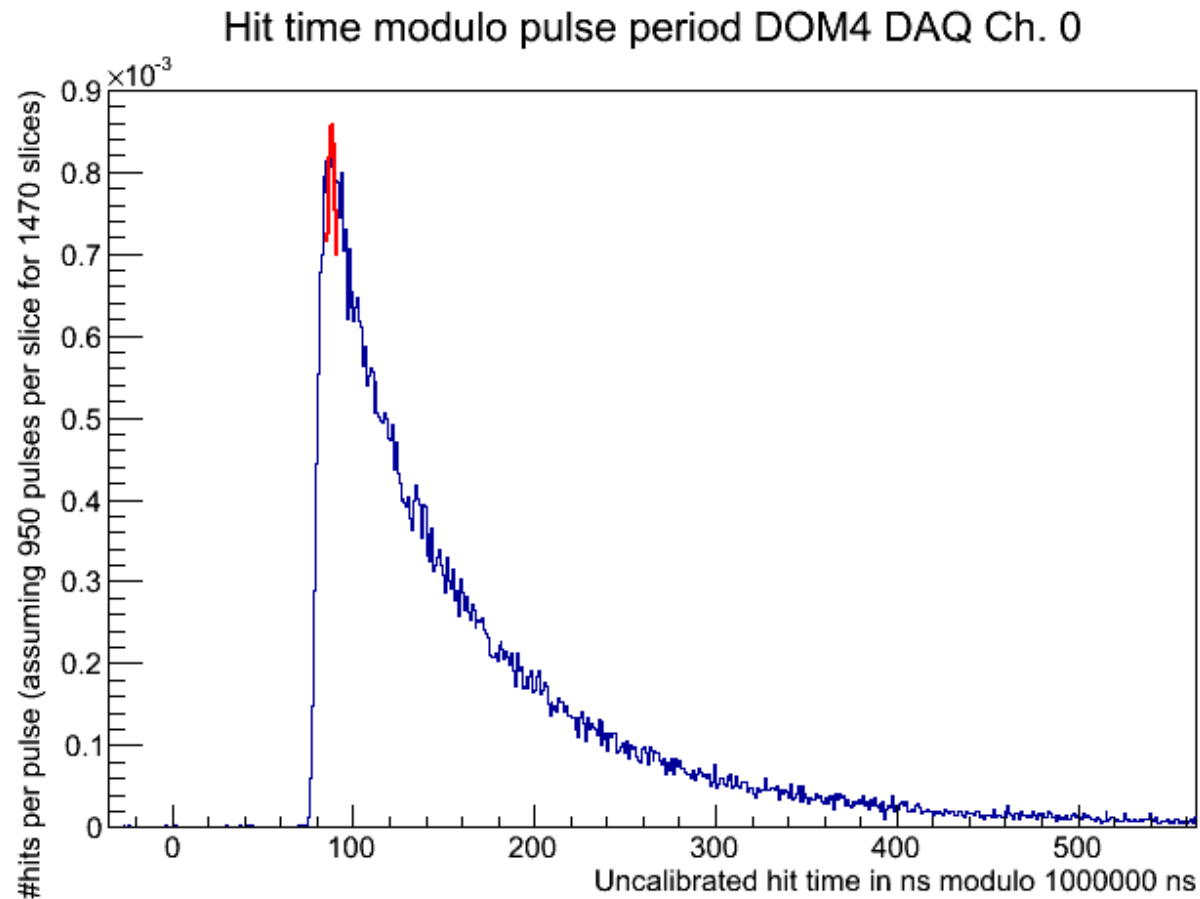Nanobeacon brightness (#hits per pulse) of DOM2

NB brightness on DOM2

Hit time modulo pulse period DOM2 DAQ Ch. 0

Guaranteed scattered light!

NB pulse on DAQ. Ch. 0 of DOM2

Run #2422, NB on <u>DOM3</u> is on!

NB visible on upward looking PMTs on DOMs <u>above</u>

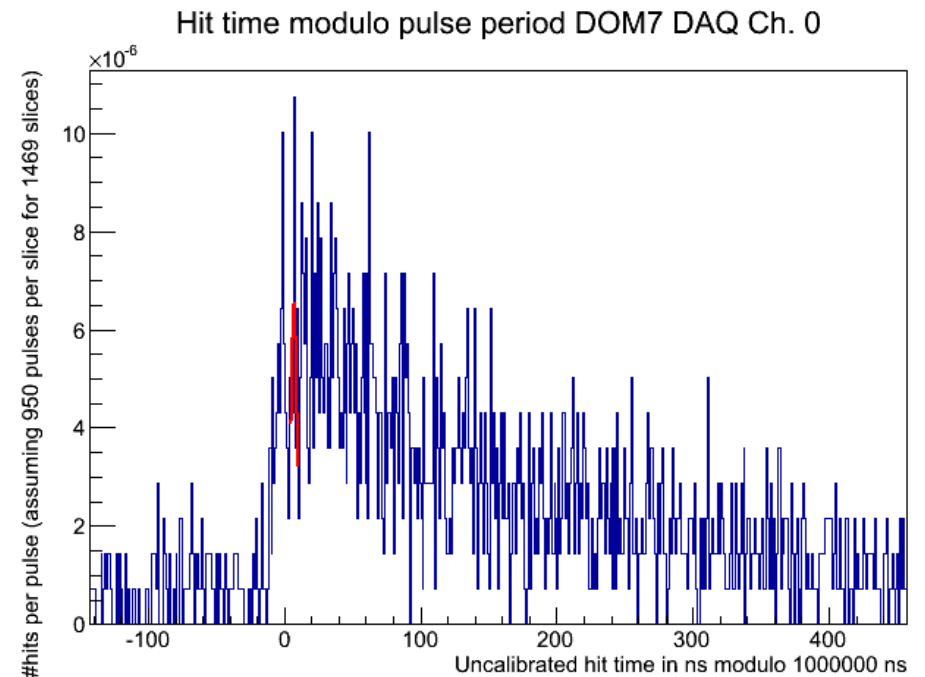Hit time modulo pulse period DOM4 DAQ Ch. 0

Nanobeacon pulse on channel 0 of DOM4 (directly above the NB)

Run #2422, NB on <u>DOM3</u> is on!

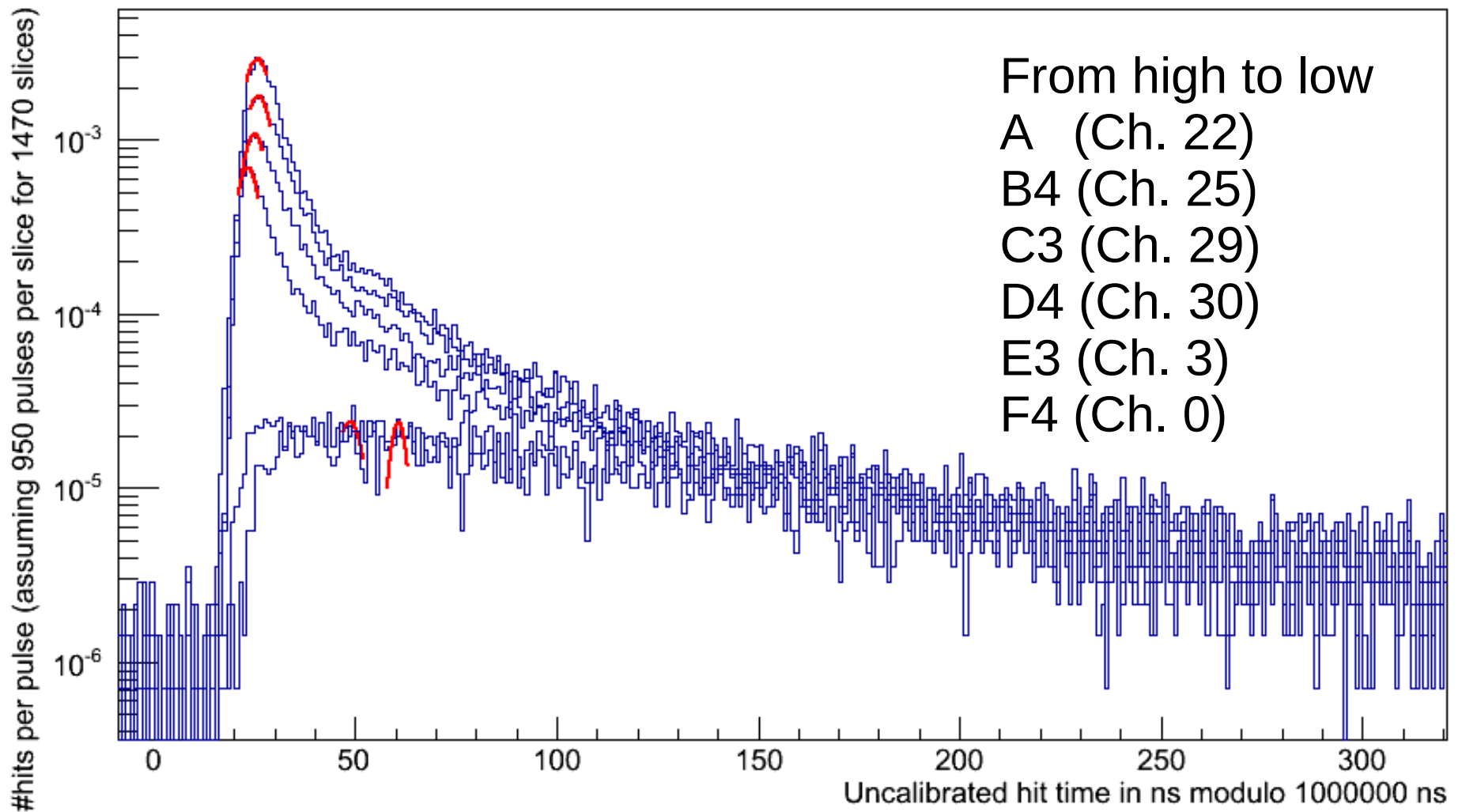# NB visible on upward looking PMTs on DOMs <u>above</u>
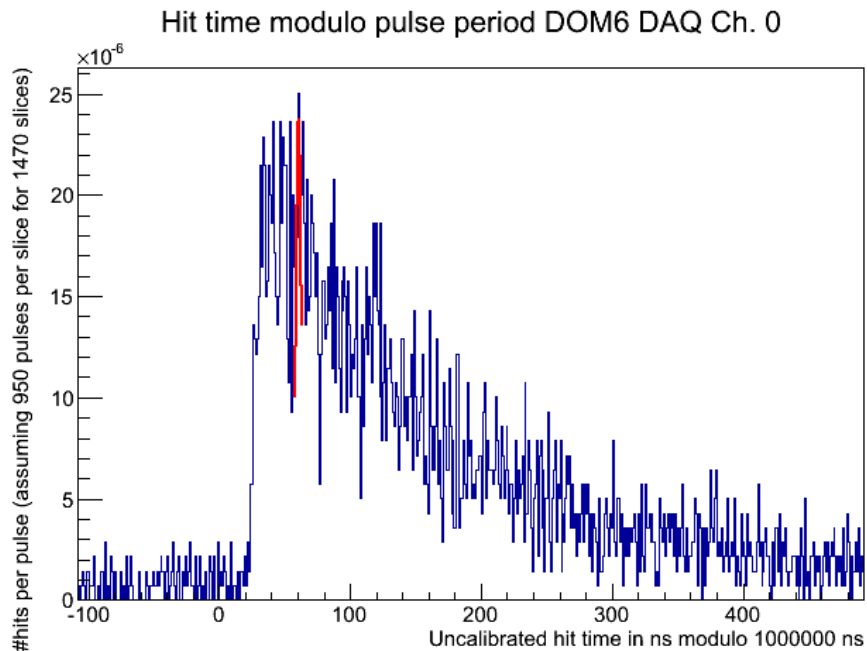
Channel 0 of DOM6
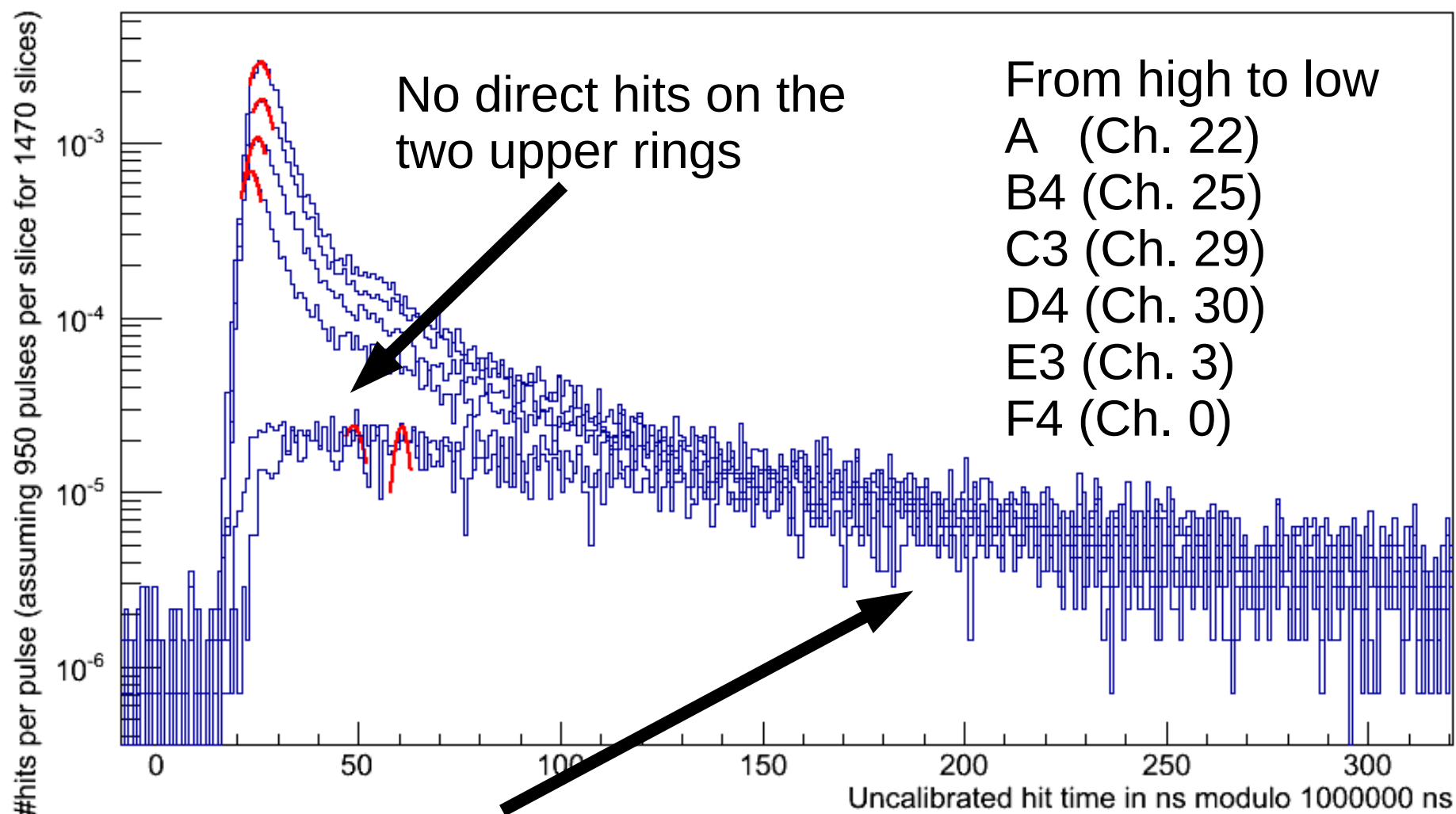(3 DOMs above the NB)

Channel 0 of DOM7
(4 DOMs above the NB)

Run #2422, NB on <u>DOM3</u> is on!

Hit time modulo pulse period DOM6

From high to low
A (Ch. 22)
B4 (Ch. 25)
C3 (Ch. 29)
D4 (Ch. 30)
E3 (Ch. 3)
F4 (Ch. 0)

Run #2422, NB on DOM3 is on!

Hit time modulo pulse period DOM6

No direct hits on the two upper rings

From high to low
A (Ch. 22)
B4 (Ch. 25)
C3 (Ch. 29)
D4 (Ch. 30)
E3 (Ch. 3)
F4 (Ch. 0)

#hits per pulse (assuming 950 pulses per slice for 1470 slices)

Uncalibrated hit time in ns modulo 1000000 ns

Tails of scattered light, easily visible for >200 ns
Converge ==> multiply scattered light loses direction information

Run #2422, NB on <u>DOM3</u> is on!

Tails

- PMT direction allows to separate direct light from scattered light

- Exponential tails could provide a lot of information on scattering

- Bonus: source angular spectrum is less important for multiply scattered light