KM3NeT multiPMT DOM: First Results

VLVνT Workshop, Stockholm

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The KM3NeT multiPMT DOM

- 31 PMTs
- 5 rings á 6 PMTs + 1
- mounted on 1st floor of Antares IL ($100\ \mathrm{m}$ above sea floor)

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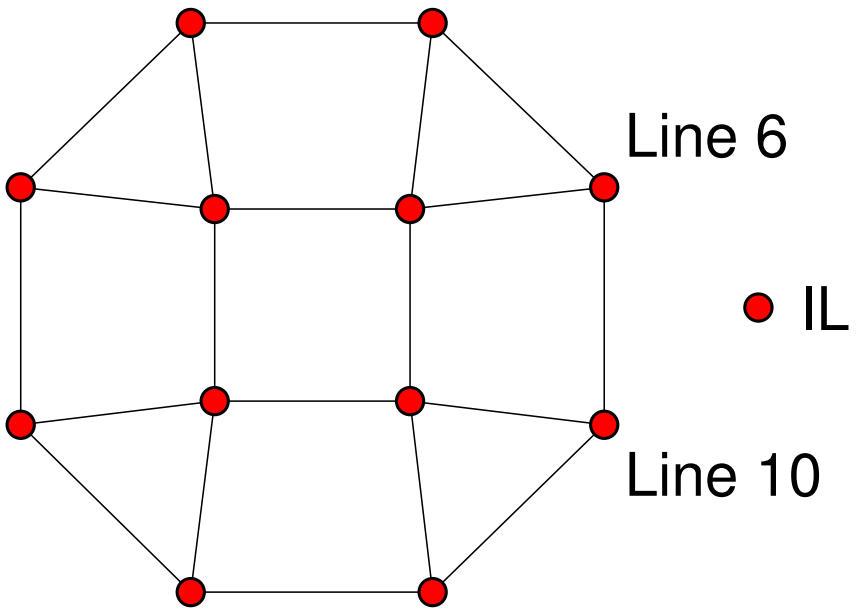
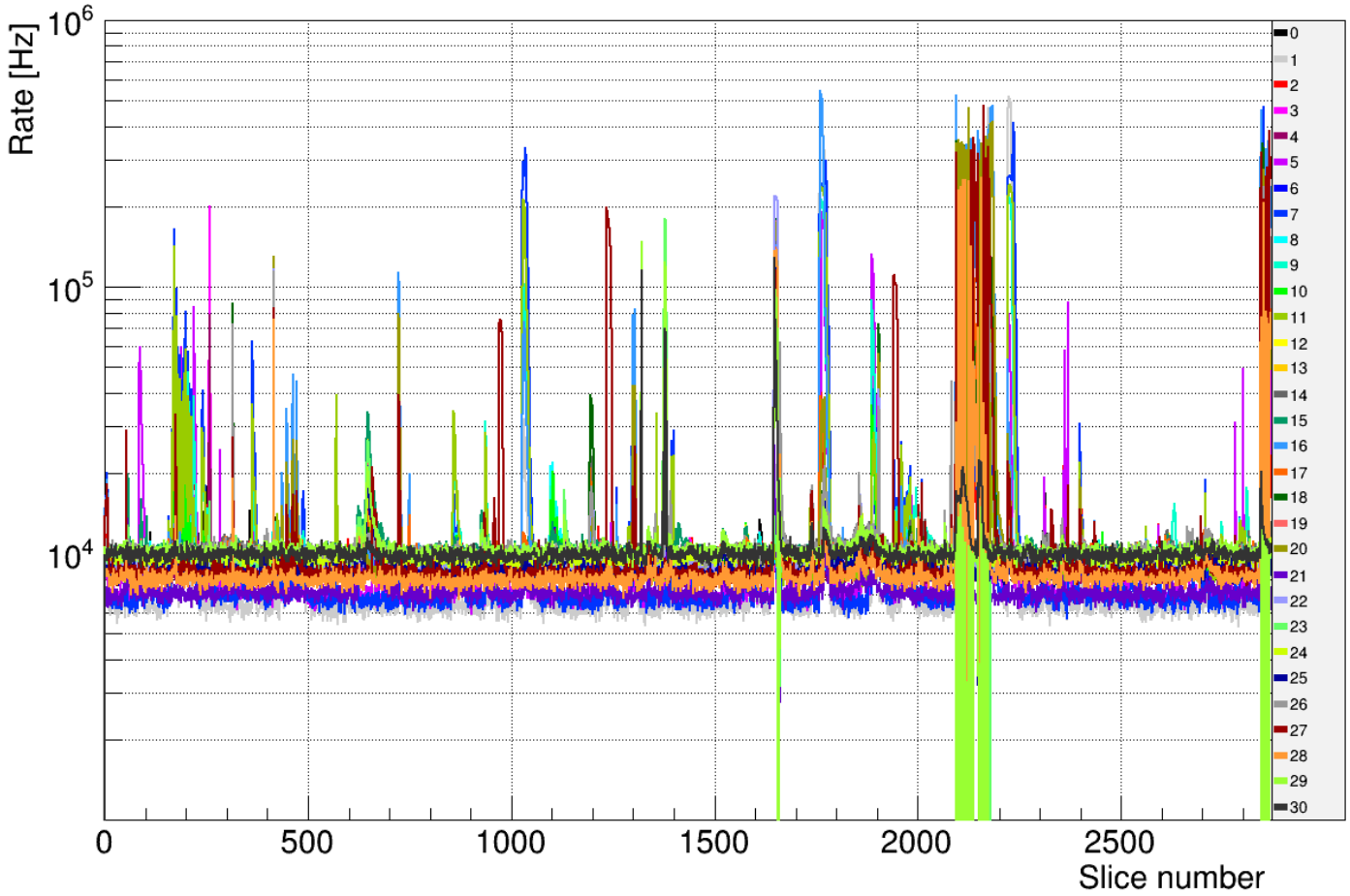
The KM3NeT multiPMT DOM

- multiPMT DOM deployed with Antares IL in mid-April
- A lot of data taken since then (4 runs a day á $2\ \mathrm{GB}$)
- depending on background rate $\rightarrow 1 - 3\ \mathrm{min/GB}$

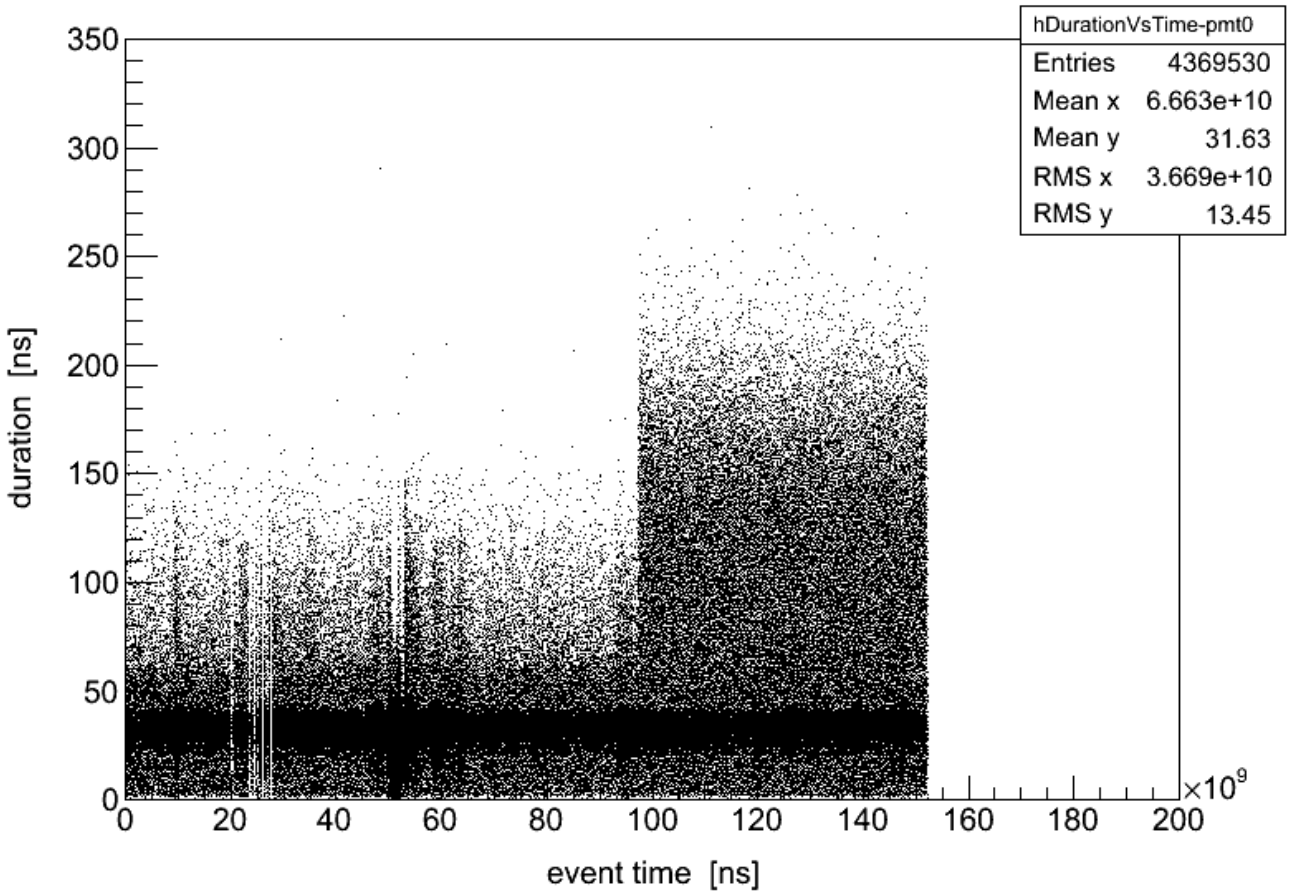


PMT Rates



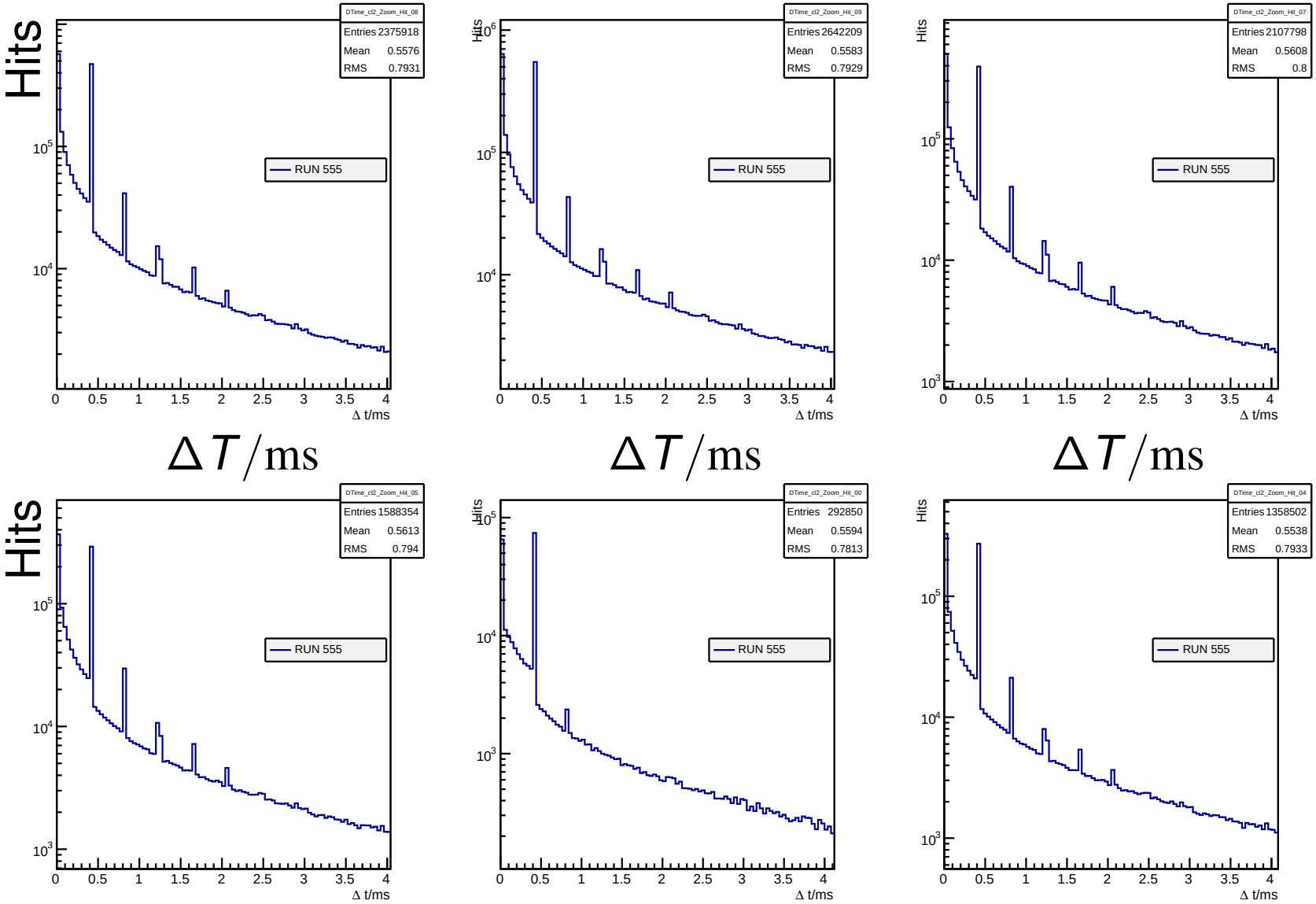
Baseline of $6 - 10$ kHz per PMT
Bursts of up to 500 kHz

Time over Threshold - ToT



Antares LASER Calibration Run starts after ≈ 100 s

Antares Double LED beacon Run (L10F2+L10F15)



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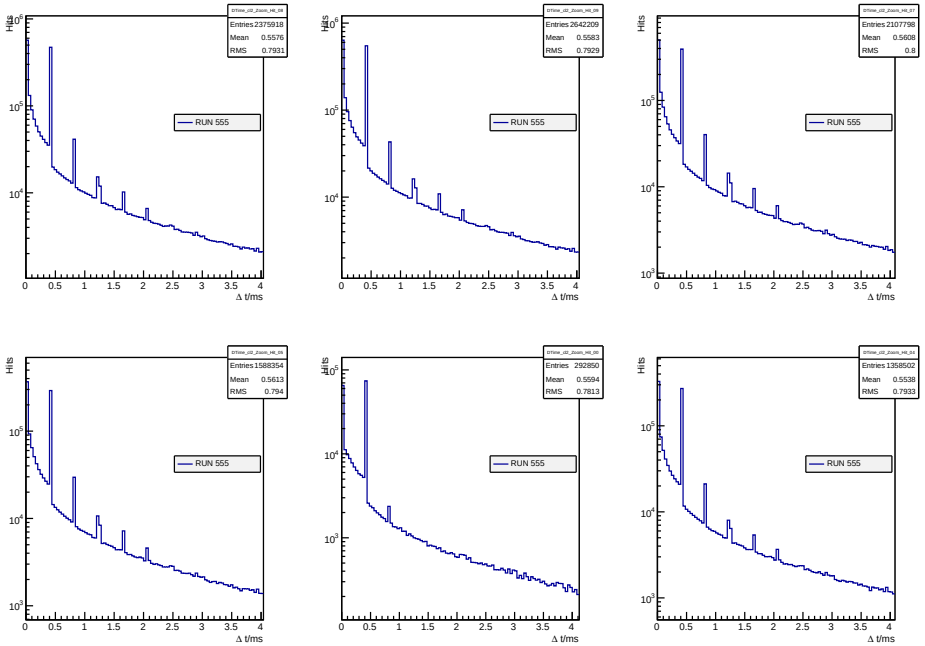
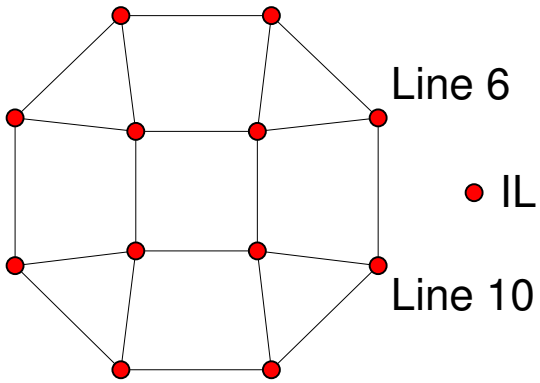
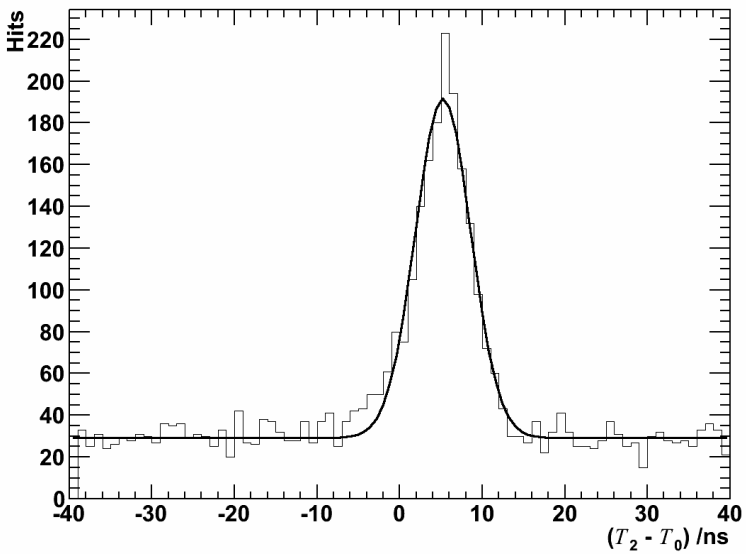
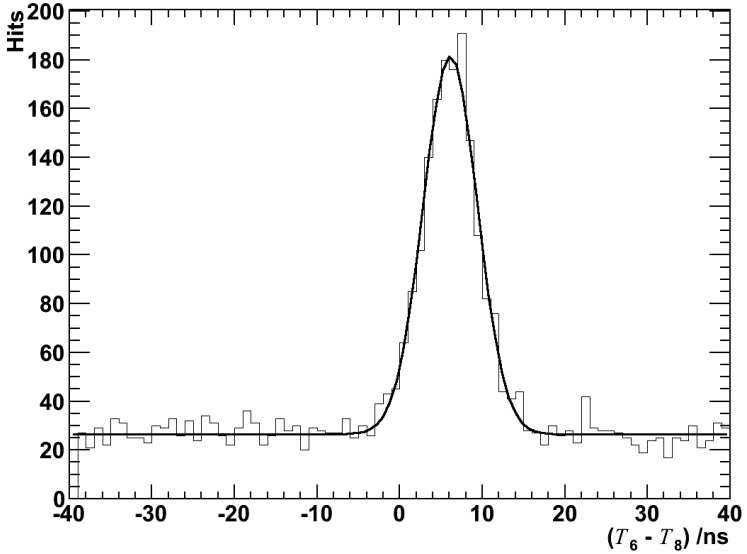


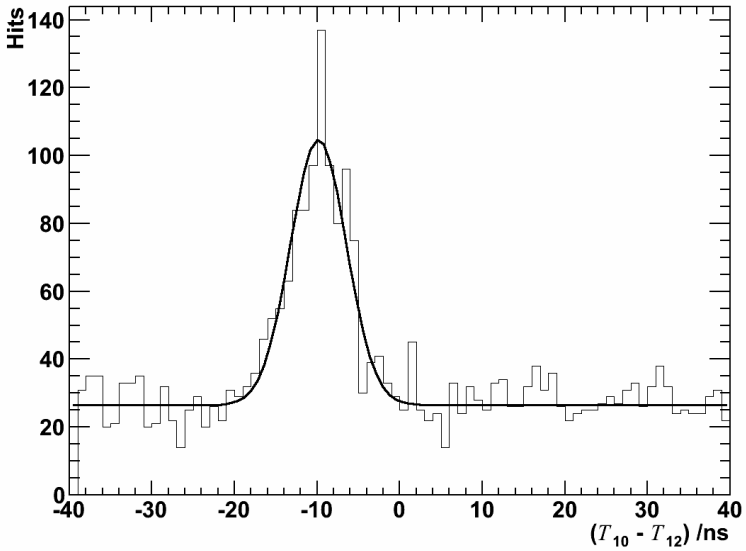


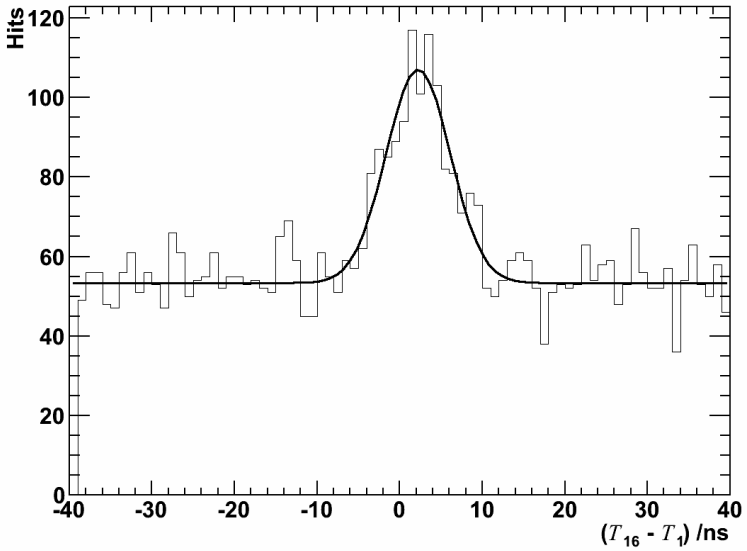
- ΔT of consecutive hits
- Coincidence Level = 2
- PMTs of the uppermost ring
- several peaks due to PMT inefficiency
- $\rightarrow$ DOM sees Antares' LASER and LED beacons

ΔT between PMTs - uncalibrated

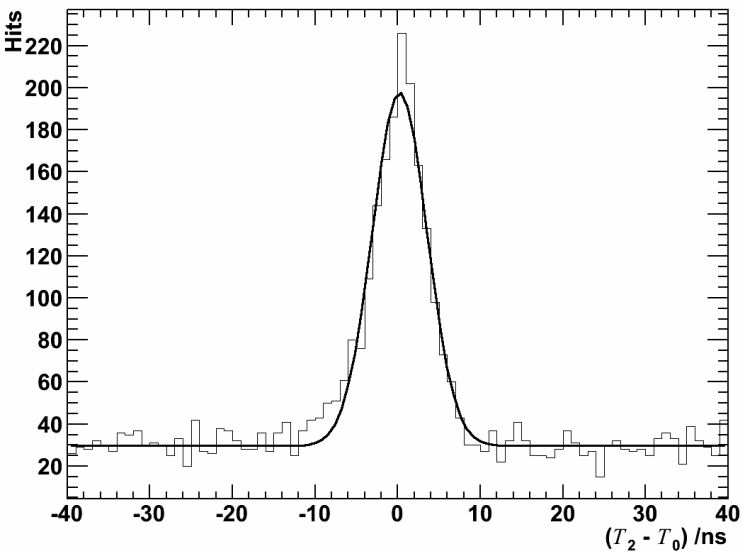


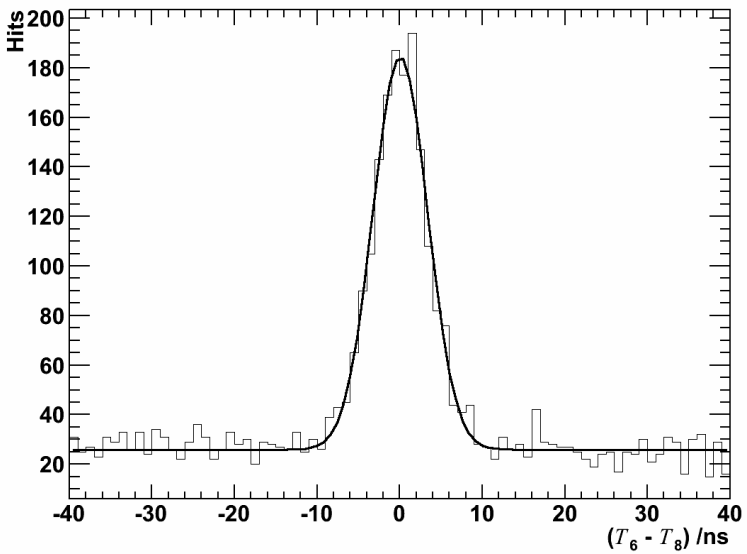


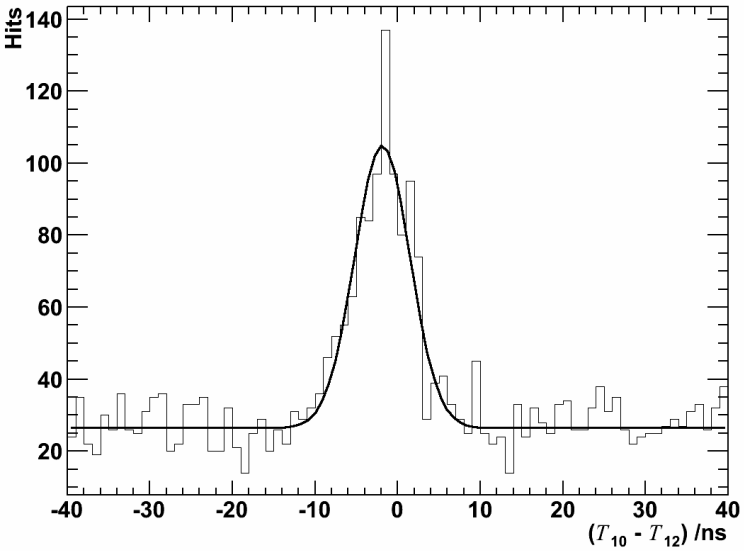


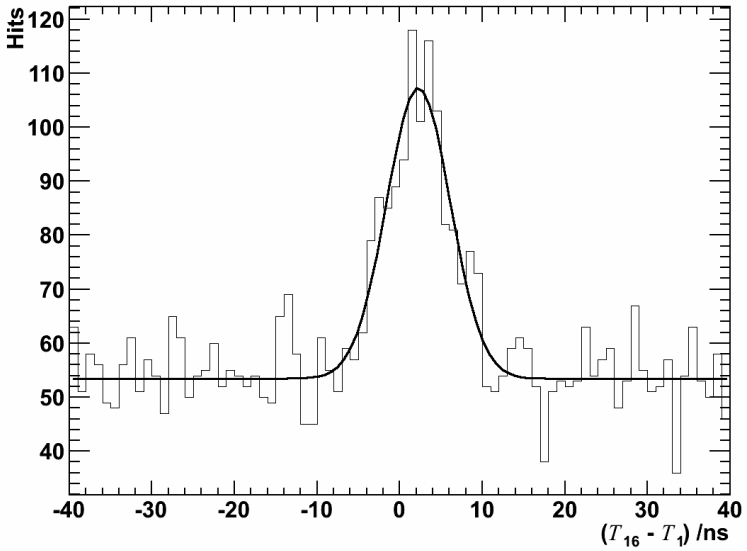


ΔT between PMTs - calibrated

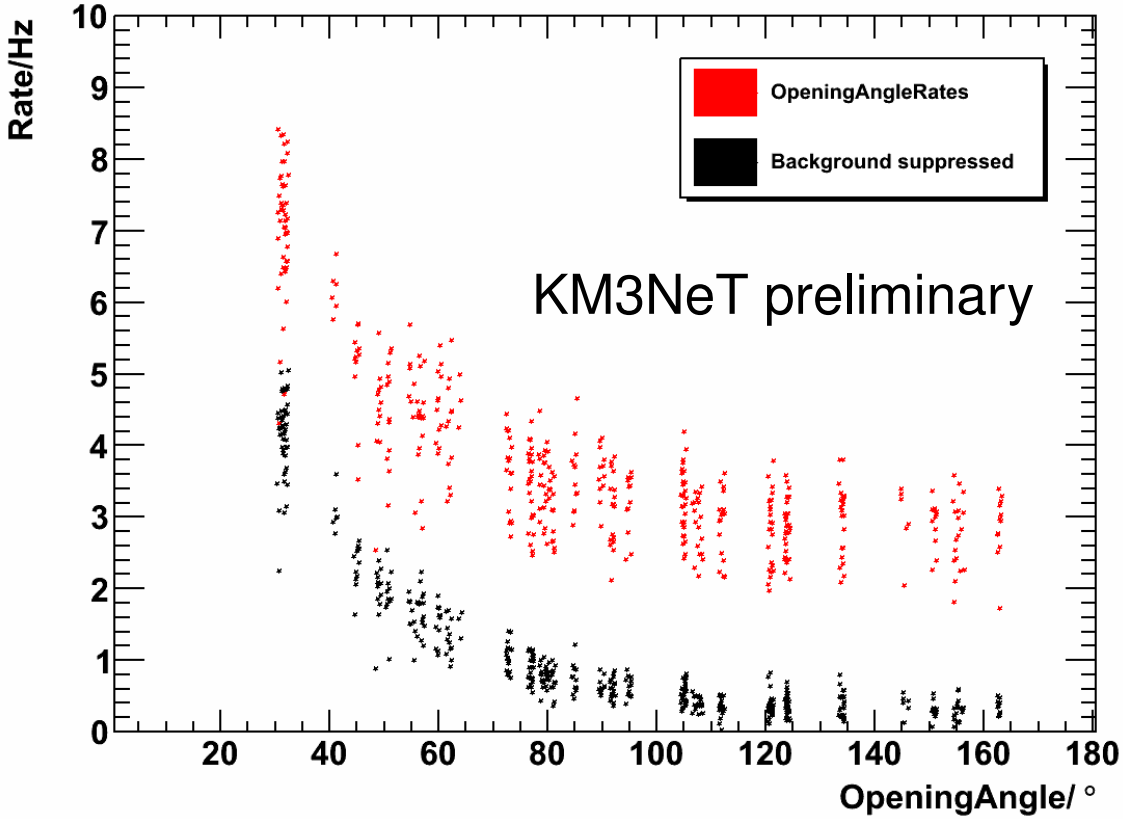






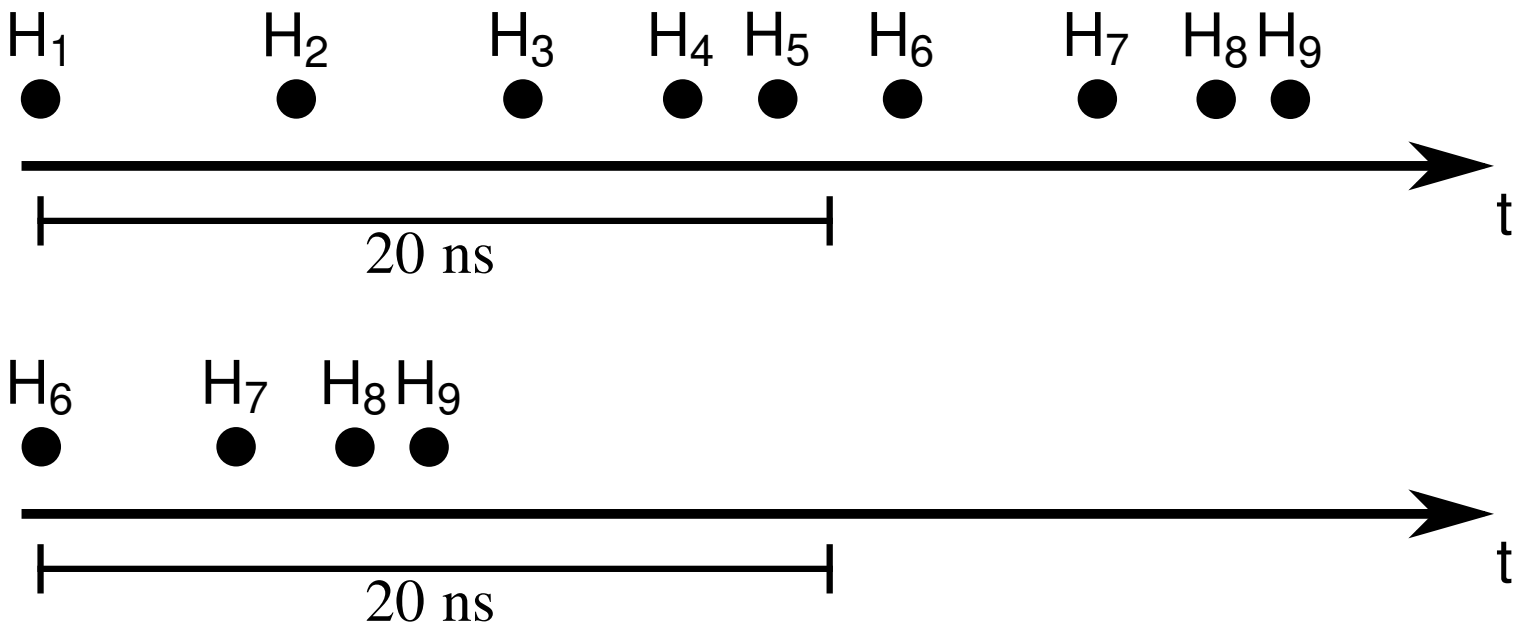


Coincidence Rates between PMT Pairs



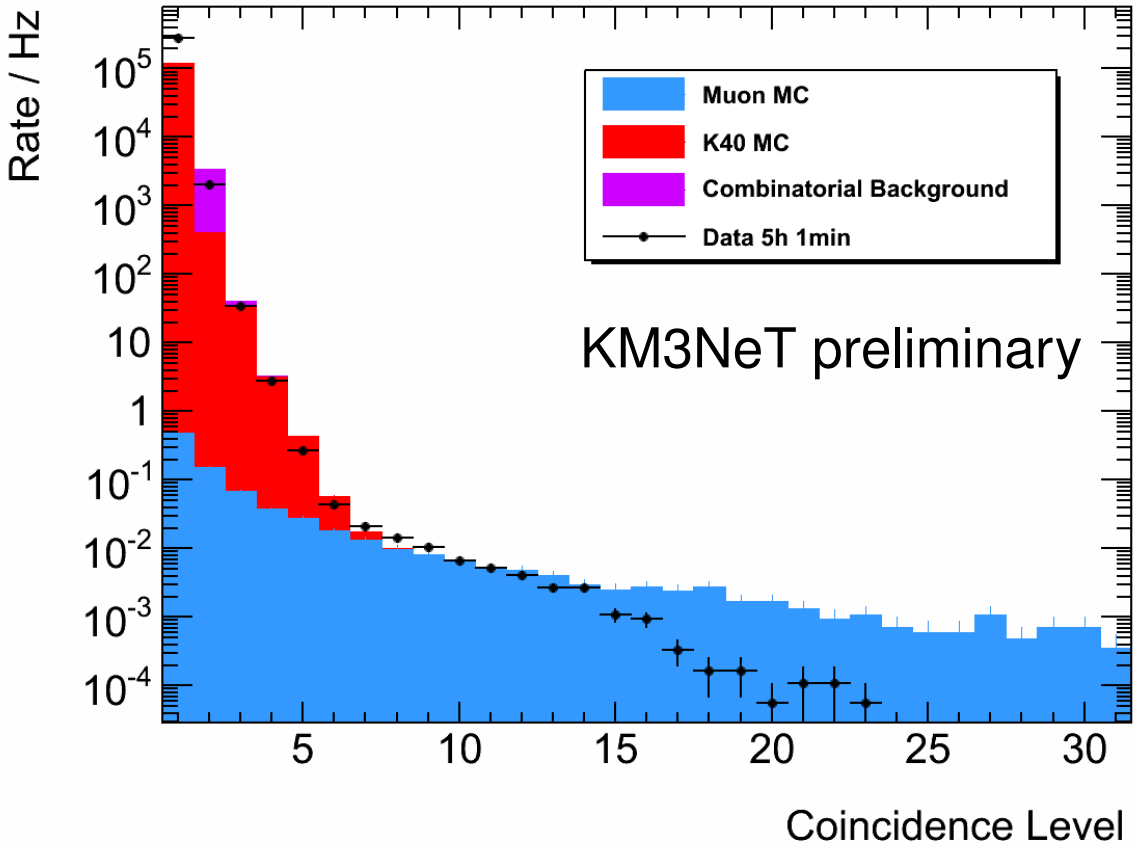
- each point
  1 specific PMT-pair
- Background subtraction
  from Gauß+Offset Fit

counting Coincidences



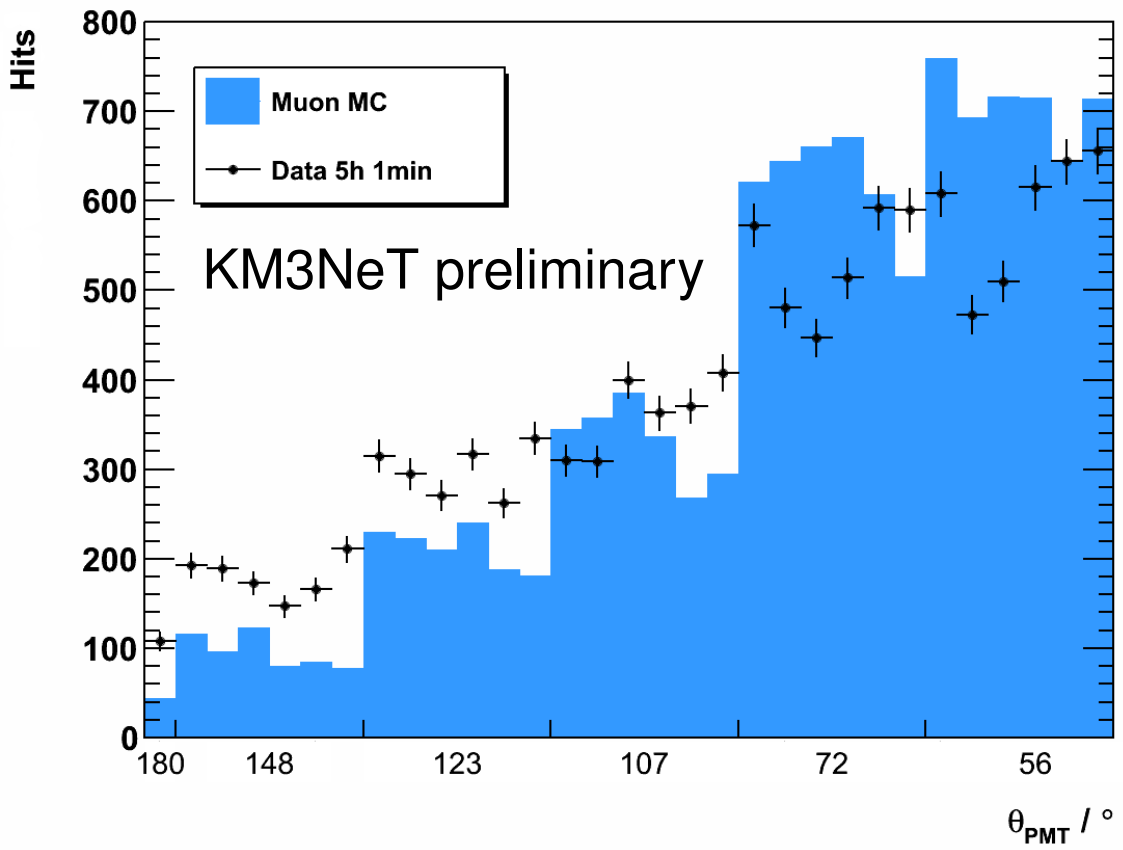
- Put all hits in time-sorted order
- Take the first hit, H_1
- Count the number of hits within $[t_{H_1}, t_{H_1} + 20\ \mathrm{ns}]$
- Repeat with first hit after this interval
- First: 5-fold coincidence; second: another, 4-fold coincidence

Coincidence Rates



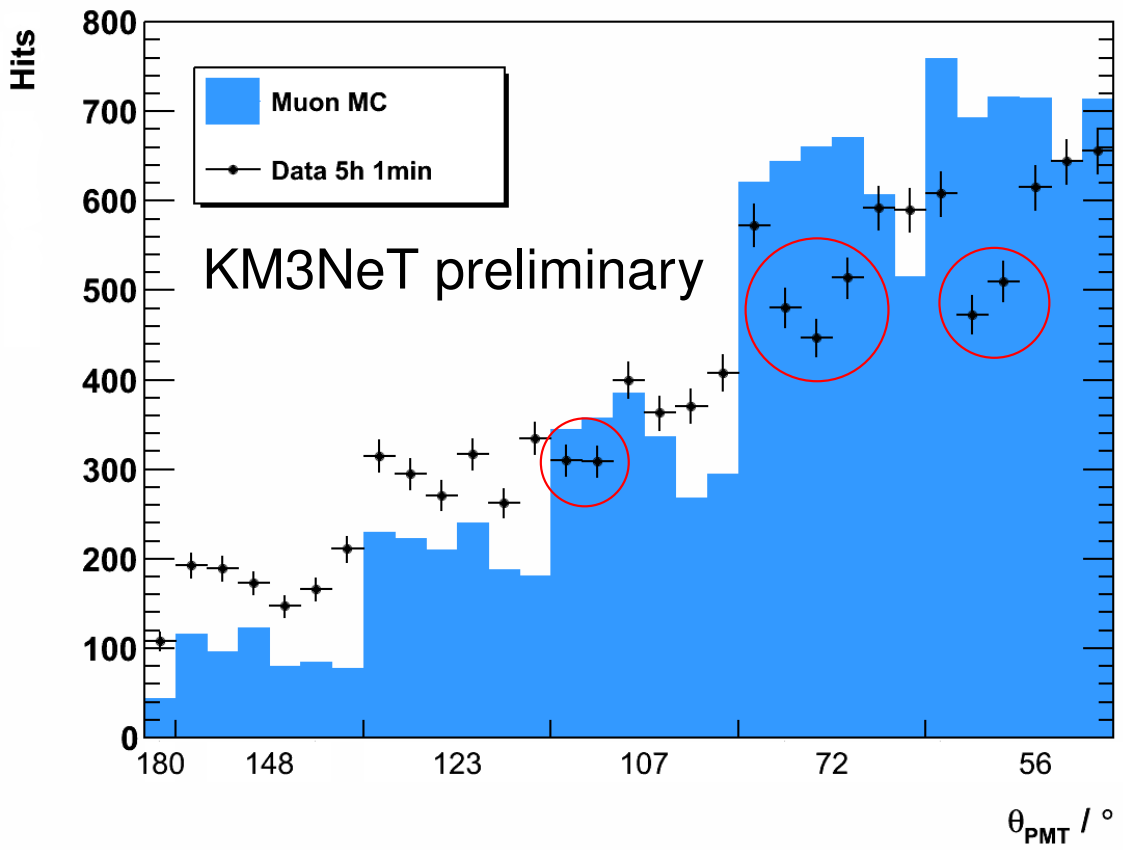
- Time Window: $20\ \mathrm{ns}$
- Combinatorial Background: coincidences faked by multiple single hits
- derived from average PMT rate in data
- Discrepancy in high CL bins under investigation

Hit Count according to PMT Zenith



- $N_{\text{Coince}} > 6$
- Drops due to LCM shadowing
- clear asymmetry towards upwards looking PMTs

Hit Count according to PMT Zenith



- $N_{\text{Coince}} > 6$
- Drops due to LCM shadowing
- clear asymmetry towards upwards looking PMTs

Conclusion

Summary

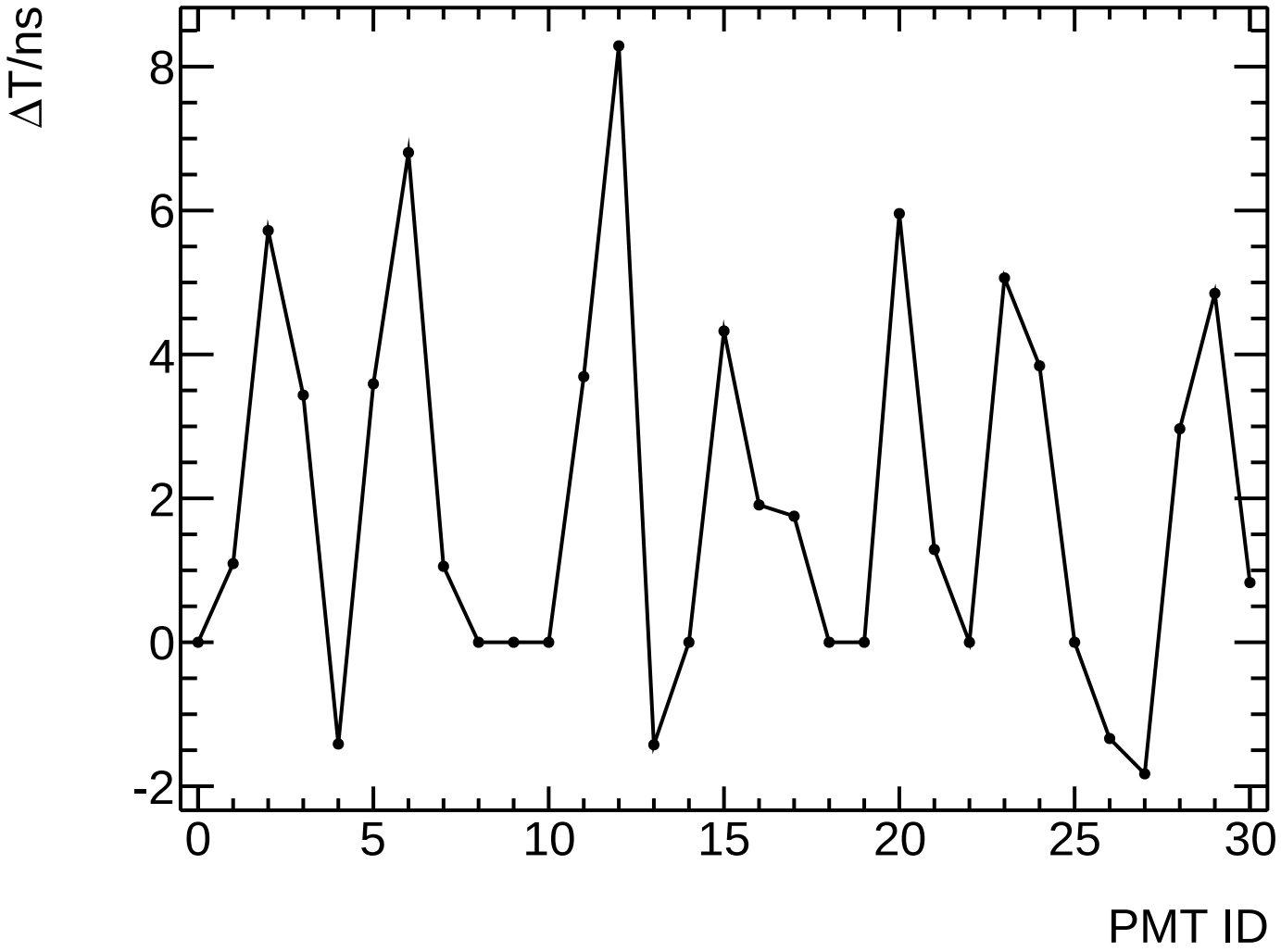
- Local Coincidences suppress combinatorial Background
- Cut on CoinceLevel $\gtrsim 7$ for sure Muon identification
- They come from above

Outlook

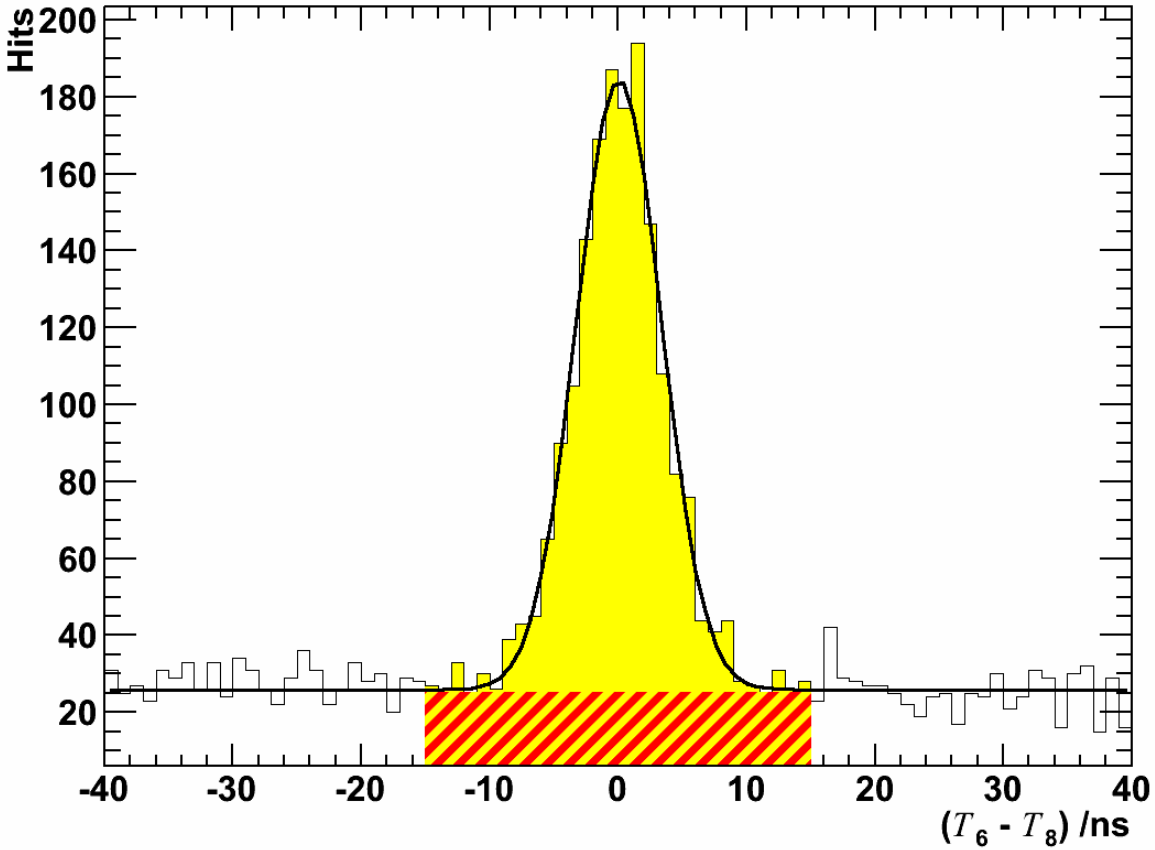
- Prototype KM3NeT Detection Unit is in assembly
- Will host 3 additional multiPMT DOMs
- Deployment at Capo Passero planned for this fall

Backup

PMT Timeoffsets



Background Suppression on slide 10



yellow – Signal+Background: Entries within ± 15 ns
red – Background: fitted Background-Offset $\times$ 30 ns

The ϕ and θ angles of the 31 PMTs–according to Saclay numbering

$\theta/\phi/^\circ$	0	30	60	90	120	150	180	210	240	270	300	330
50		8		9		7		5		0		4
65	6		10		11		1		2		3	
115		15		12		16		27		30		23
130	21		13		17		20		28		29	
147		19		14		18		26		24		25
180							22					

counting Coincidences

```
// allHits: time sorted vector of Hits from all PMTs

std::vector< MHit* >::iterator hit_iterator1 = allHits.begin();
std::vector< MHit* >::iterator hit_iterator2 = hit_iterator1 + 1;
do {
    if ( (*hit_iterator2)->Time() >
            (*hit_iterator1)->Time() + CoinceWindow){

        HitCount = std::distance(hit_iterator1, hit_iterator2);

        NCoincidences->Fill(HitCount);
    }

    do { /* DeltaT stuff */ }
    while (++hit_iterator1 != hit_iterator2);

} while (++hit_iterator2 != allHits.end());
```

Combinatorial Background

```
double RandomCoinceRate(short N, double rate,
                        double dt = 20e-9 , short npmt = 31){

    if (N == 1) return npmt * rate;

    // probability to have another hit in coincidences
    double p =  dt * rate * npmt;

    return p * RandomCoinceRate( N-1, rate, dt , npmt-1);
}
```