Last week activities

- Topical Lectures Cosmology
  - Jan Willem van Holten
  - Jan Pieter Van der Schaar
  - Samaya Nissanke
  - Henk Hoekstra

- Prepare the exam

4 Hoog-energetische neutrino's detecteren (2 punten)

Beantwoord de vraag op een nieuw antwoordblad a.u.b.!
Lep op: bij deze vraag zijn de meeste punten te verdienen bij vraag d).

In een eerdere opgave in dit examen hebben we bekeken hoe neutrino's gevormd worden in het verval van geladen pionen. Deze kennis is niet alleen nodig om deze processen bij deeltjesversnellers op aarde te begrijpen. Ook in het heelal zijn objecten die extreem hoog energetische neutrino's produceren via pion verval. Om meer te leren over deze objecten proberen onderzoekers op aarde deze neutrino's op aarde te detecteren; bijvoorbeeld met behulp van de KM3NeT detector op de bodem van de Middellandse zee.

Detectie-principe:
Neutrino's vliegen door de aarde heen en zullen héél soms op een atoom in het zeewater botsen. In dit proces wordt een muon-neutrino omgezet in een muon dat op zijn beurt licht zal gaan uitstralen: de beroemde Cherenkov straling

- NWO course: Taking Charge of your PhD

- "De Wereld Draait Door" [20-03-2019]

https://dewereldraaitdoor.bnnvara.nl/media/686546

Binned likelihood

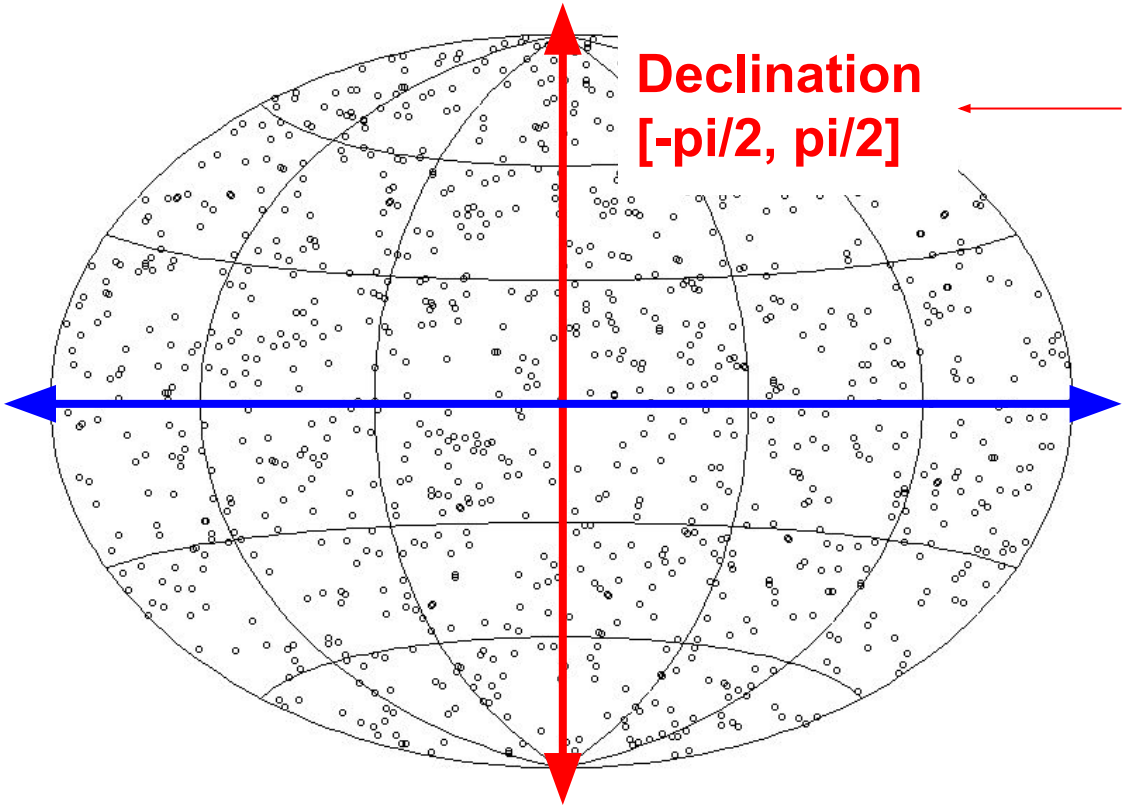
Pointsource searches

- **Path of mc files:**
  - /sps/km3net/repo/mc/atm_neutrino/KM3NeT_-00000001_20171212/v5.1/reco
- **MC chain of analysed files:**
  - mcv5.1.genhen_numuCC.km3_AAv1.jte.jchain.aashower
- **Detector file:**
  - /pbs/throng/km3net/detectors/KM3NeT_-00000001_20171212.detx

- **Further specifications:**
  - Muons
  - Nu & aNu
  - Upgoing ⇔ Up & Downgoing
  - Flux ~ E^ -2

1) Distribution per declination

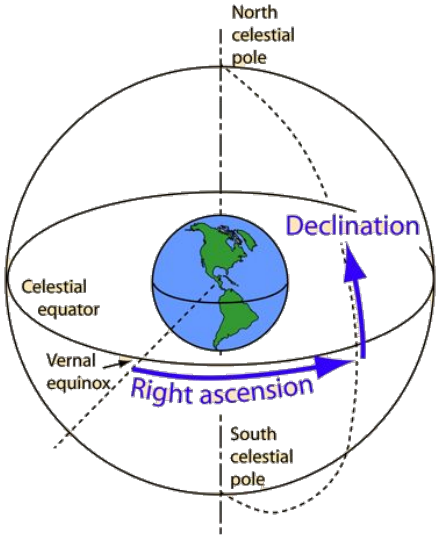
Distribution per declination



Declination
[-pi/2, pi/2]

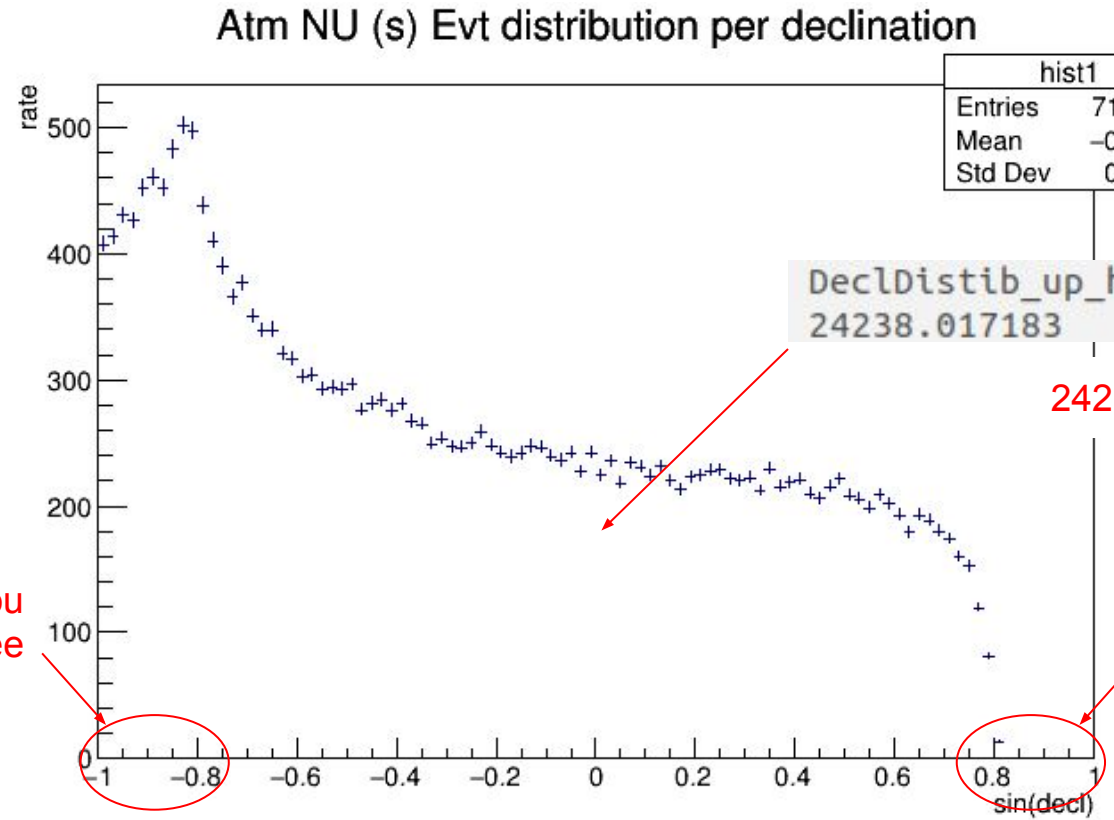
sin(decl)

Right Ascension
[0h - 24h]



Distribution per declination (rates per year)

UP
Going (a)nu's




```
DeclDistib_up_hist->Integral()
24238.017183
```

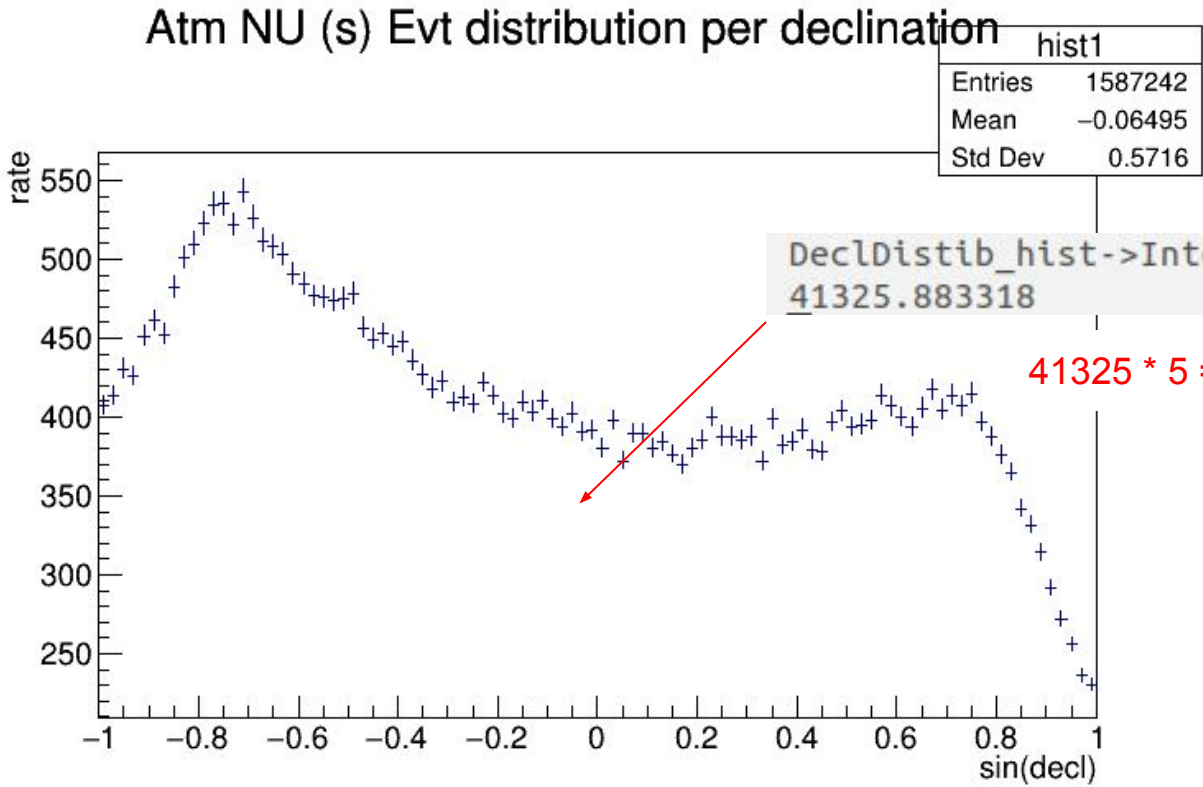
24238 * 5 = 1.2e5 in 5 years

Part of the sky you always see

Part of the sky you never see

Distribution per declination (rates per year)

UP & DOWN
Going (a)nu's



41325 * 5 = 2.1e5 in 5 years

LOI 2016

Factor ~ 2 difference?

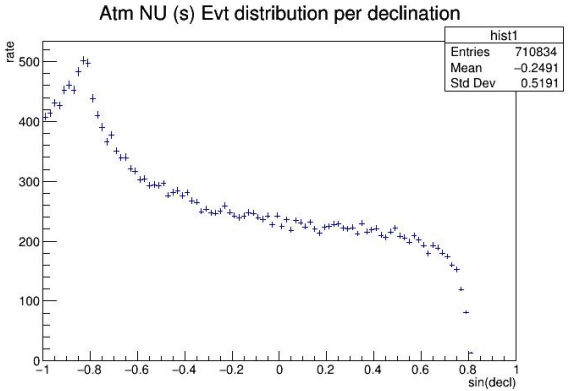
	reconstruction level	after preselection cuts	after final cuts
μ_{atm}	2.4×10^7	5.5×10^4	6
ν^{μ}_{atm}	1.0×10^5	49	20
ν^{e}_{atm}	7.1×10^3	23	19
ν^{μ}_{cosm}	352	34	11
ν^{e}_{cosm}	304	49	41
ν^{τ}_{cosm}	250	34	26

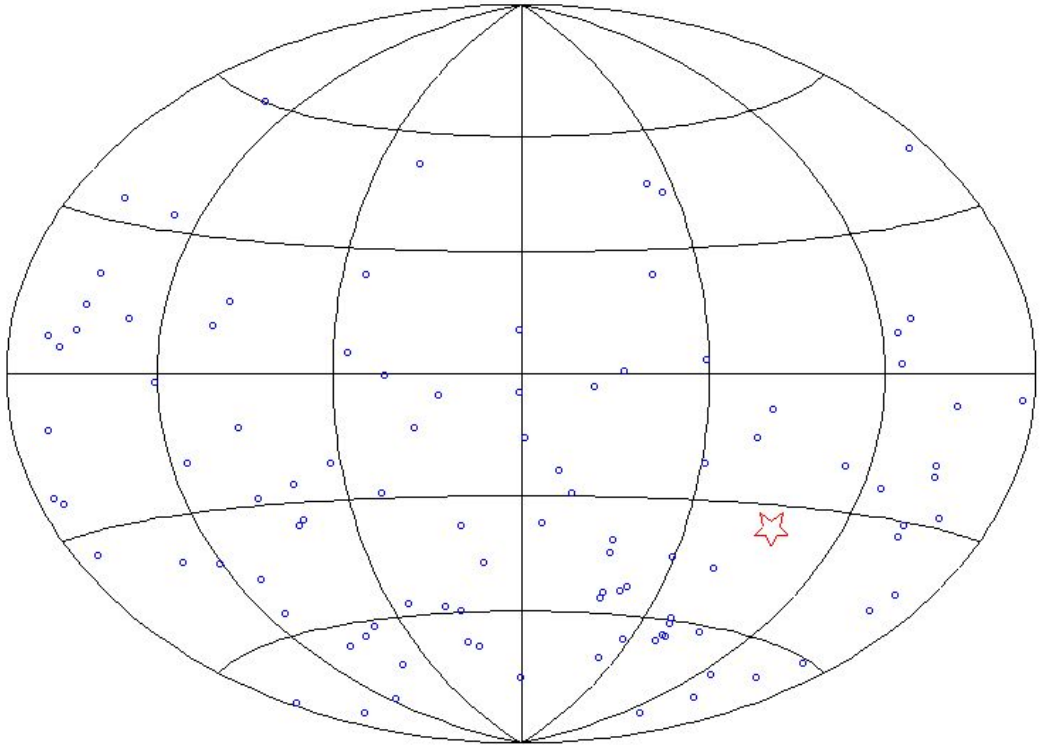
Table 3: Expected number of events for the KM3NeT/ARCA detector (2 building blocks) for the different event samples in 5 years of observation time. The cosmic events correspond to the source flux of Eq. 3.

Create 100 random background events according to distribution per declination

graph

UP
Going (a)nu's

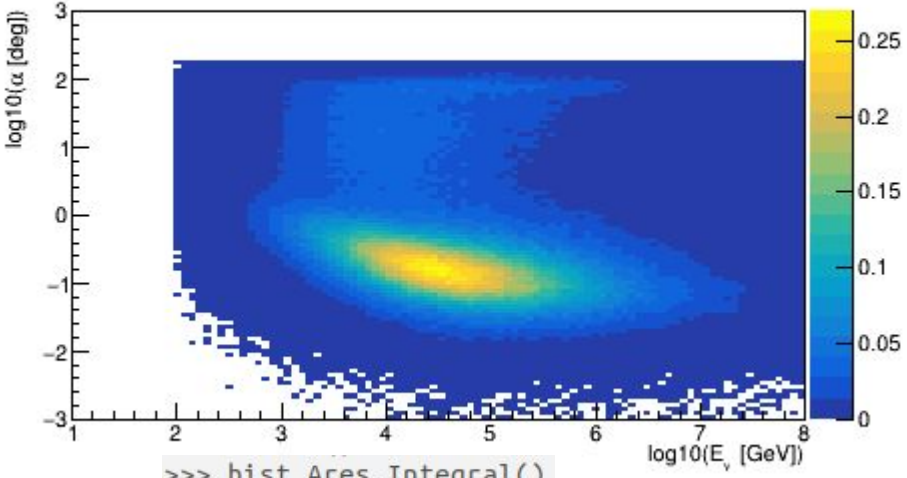




2) Angular Resolution

Up- & Downgoing

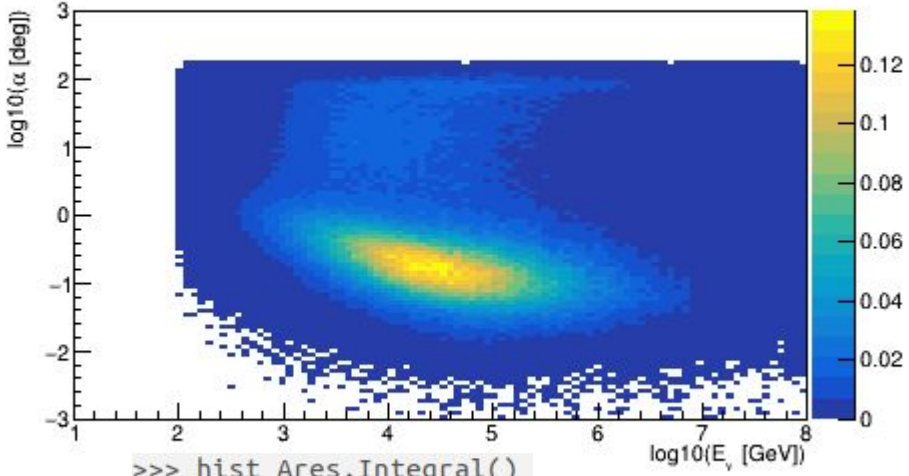
Angular resolution, flux E-2




```
>>> hist_Ares.Integral()
162.83380479545937
```

Upgoing only

Angular resolution, flux E-2




```
>>> hist_Ares.Integral()
76.89958261878233
```

LOI 2016

	reconstruction level	after preselection cuts	after final cuts
μ_{atm}	2.4×10^7	5.5×10^4	6
ν^{μ}_{atm}	1.0×10^5	49	20
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Factor ~ 2 difference?

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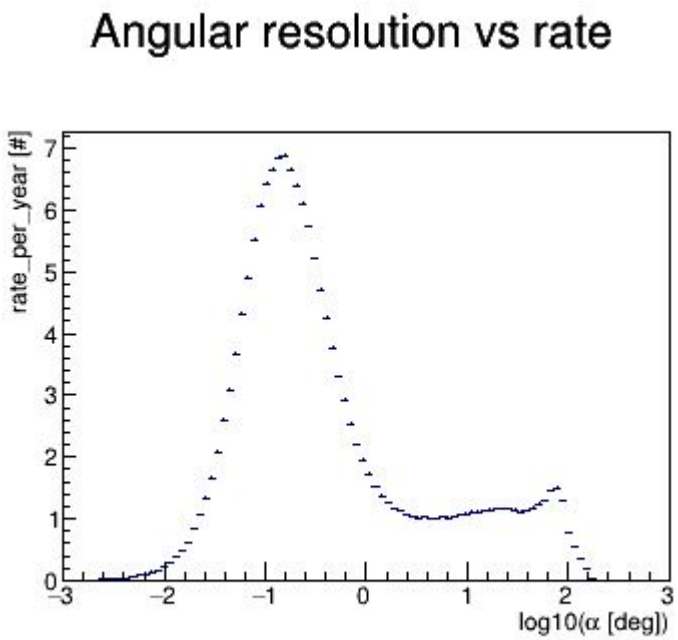
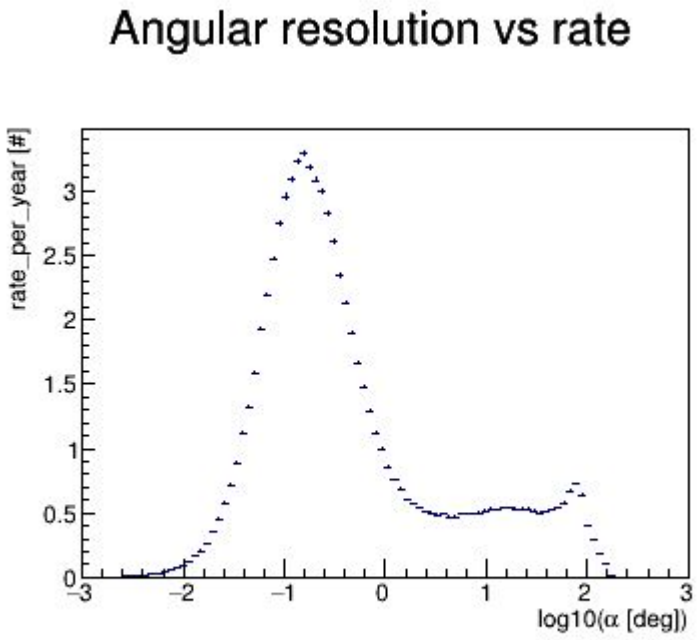
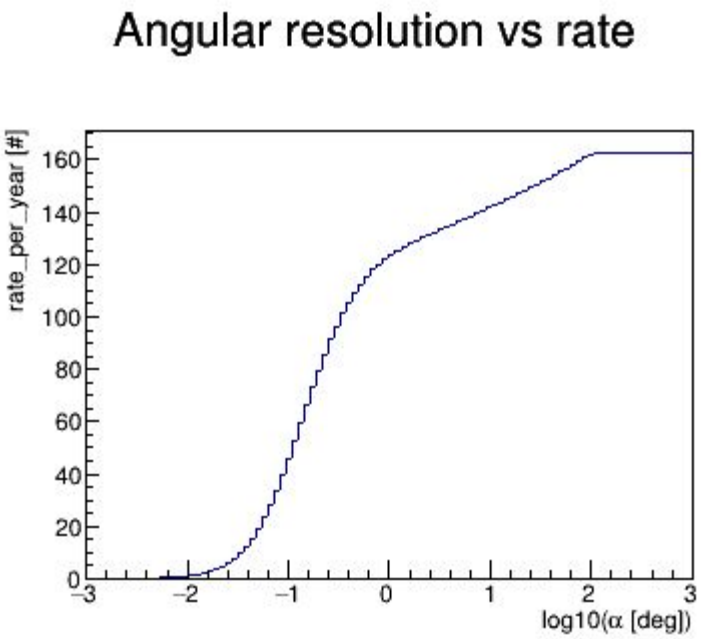
Up- & Downgoing



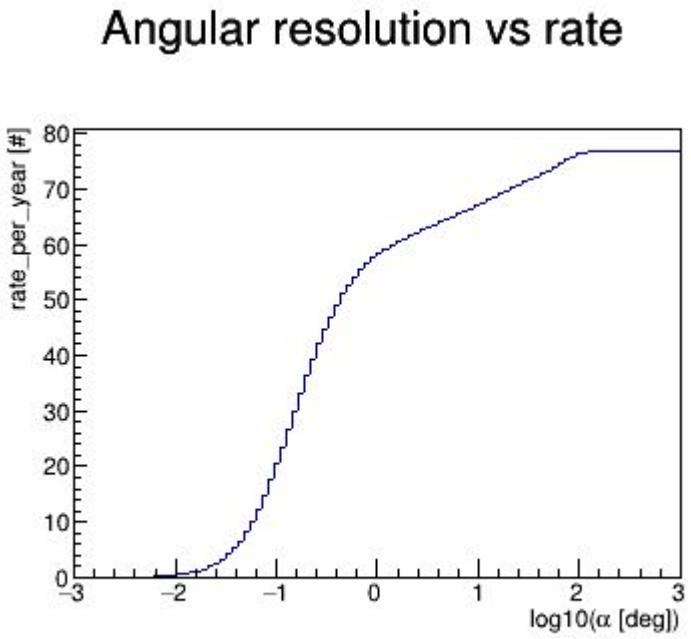
Upgoing only



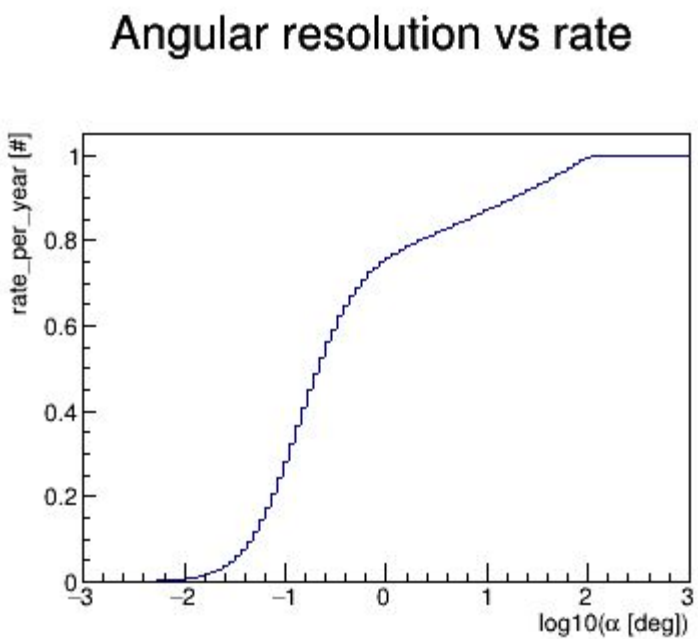
Up- & Downgoing



Upgoing only

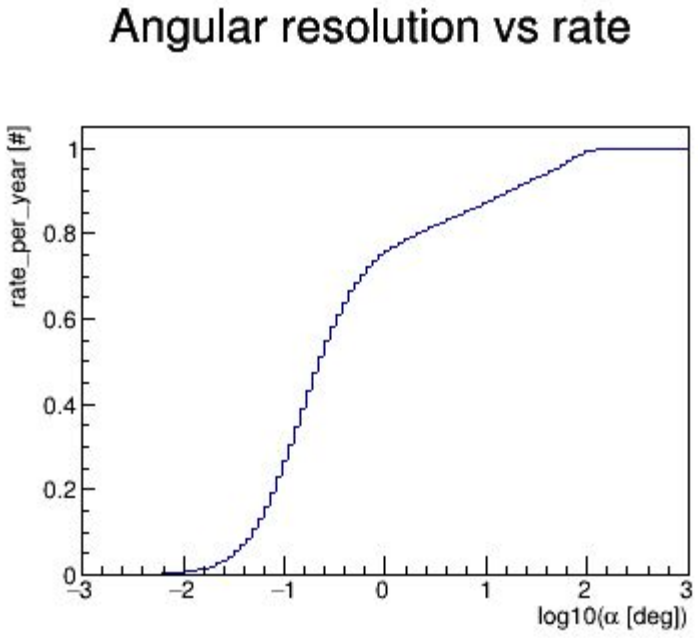


Up- & Downgoing



~80% better than 1 degree

Upgoing only

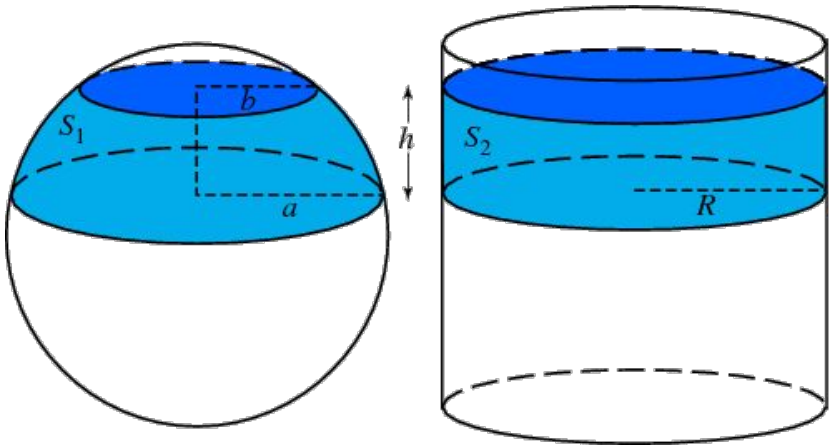


Backup

Archimedes' Hat-Box Theorem

“ Enclose a sphere in a cylinder and cut out a spherical segment by slicing twice perpendicularly to the cylinder's axis.

Then the lateral surface area of the spherical segment S_1 is equal to the lateral surface area cut out of the cylinder S_2 by the same slicing planes ”



<u>Thus:</u>

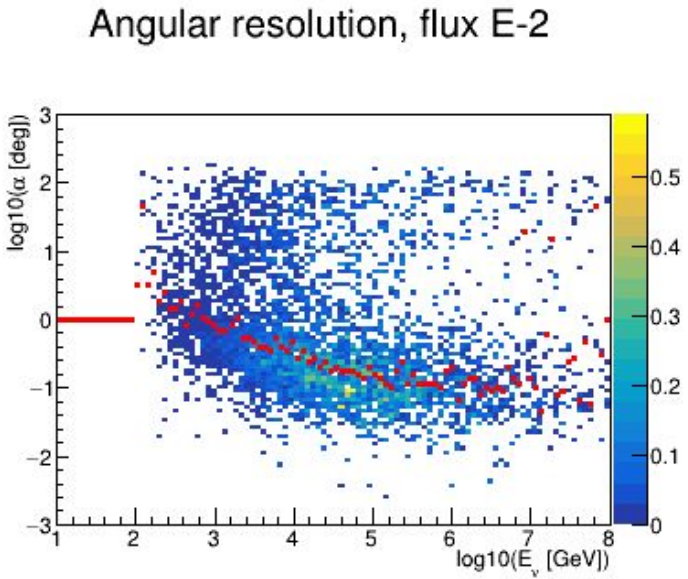
Same surface area’s on shpere, for same h

sin(decl) same binsize = h same size

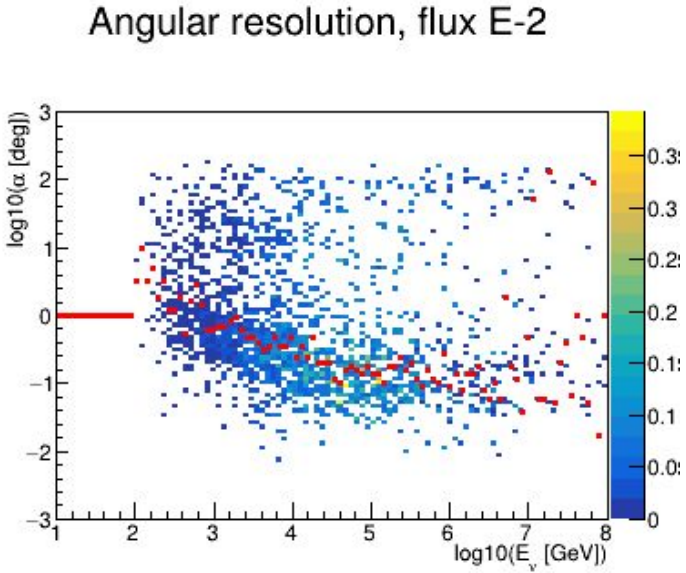
2) Angular Resolution

For only 1 file:
mcv5.1.genhen_anumuCC.km3_AAv1.jte.jchain.aashower.103.root

Up- & Downgoing

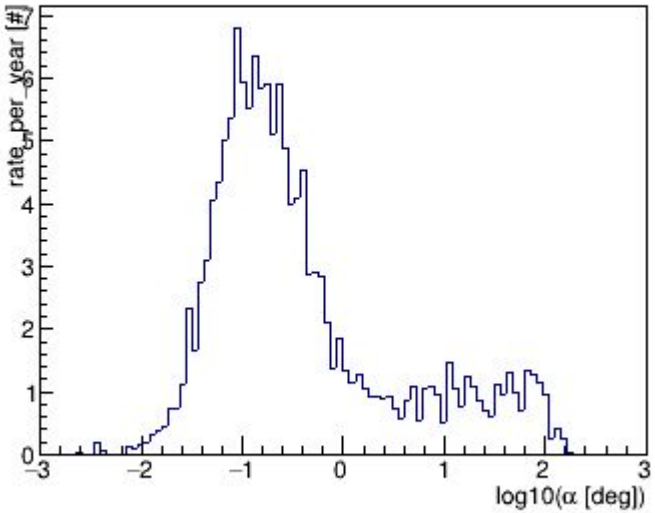


Upgoing only



Up- & Downgoing

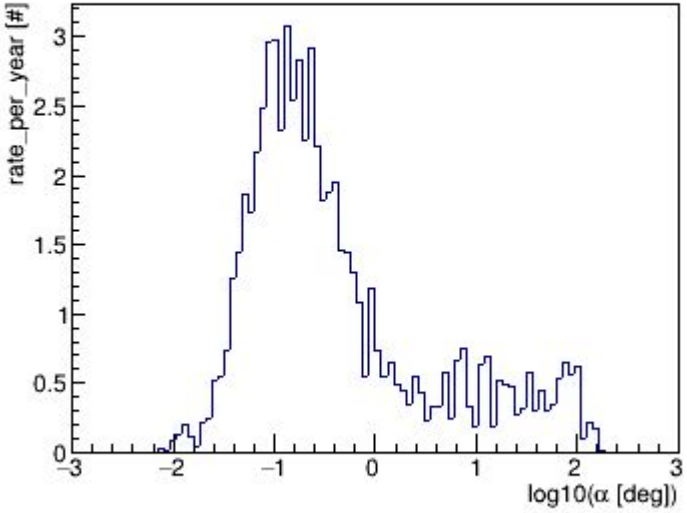
Projection hist_Ares




```
>>> hist_Ares_proj.Integral()
146.17705988274827
```

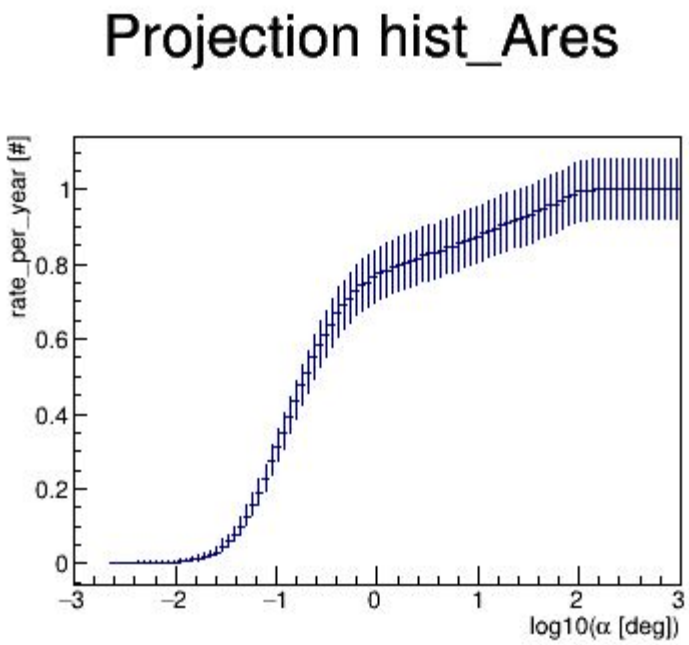
Upgoing only

ProjectionX hist_Ares



Up- & Downgoing

Upgoing only



~80%
better than
1 degree