Stony Brook University

HEX Cascades

240m

300m

360m

NString >= 3

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Cascade Reconstruction in HEX **360m vs 240m**

Software + Codes:

- IceRec.release 04-08-00
- use Monopod (calibration scheme, calibration ..) from Jakob's analysis

$SVN/sandbox/jvansanten/projects/2013/monopod_recoperf/segments/BaseProc.py
$SVN/sandbox/jvansanten/projects/2013/monopod_recoperf/segments/Calibration.py
$SVN/sandbox/jvansanten/CascadeL3_IC79/trunk/resources/level4/redo_monopod_again.py

Reconstruct 3 Cascade Samples:

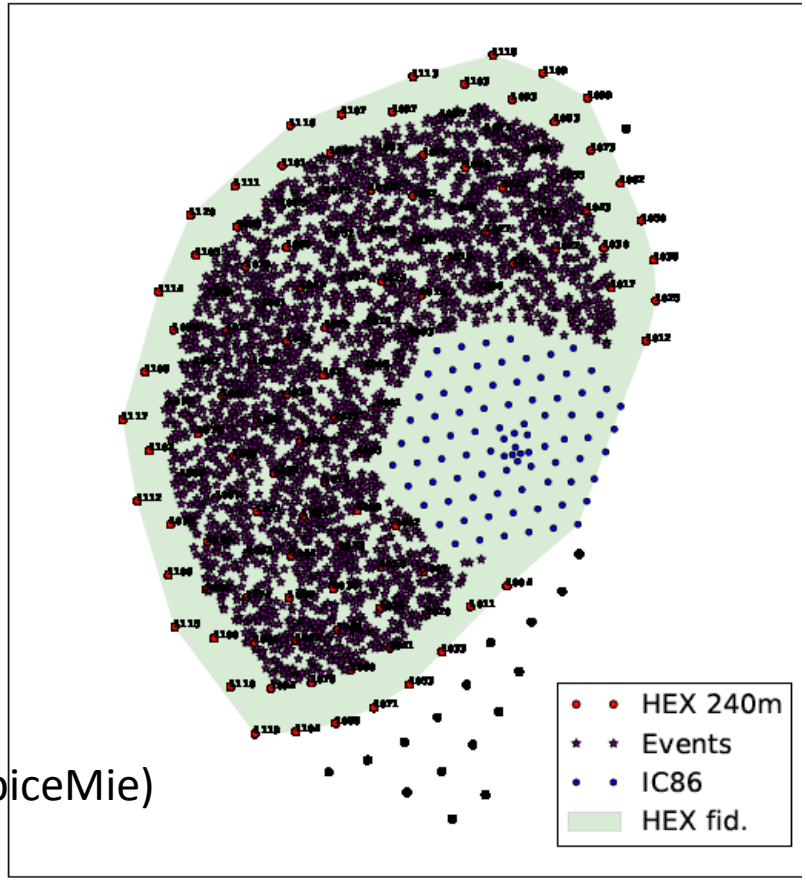
Visible Energy: **1-50TeV, 50-200 TeV** (near threshold)
and **1-10 PeV** (target signal)

Containment requirements:
(well-contained cascades, not in dustlayer)

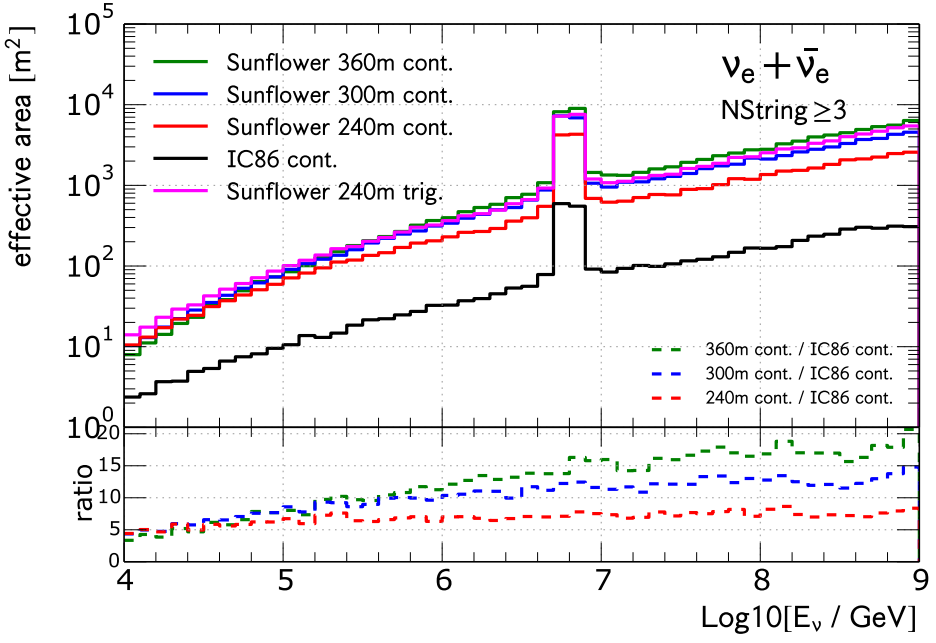
HEX_XYscale < 0.9
IC_XYScale < 1.2

-450m < Z < -150m or 0m < Z < 450m

Nstring >= 3.0

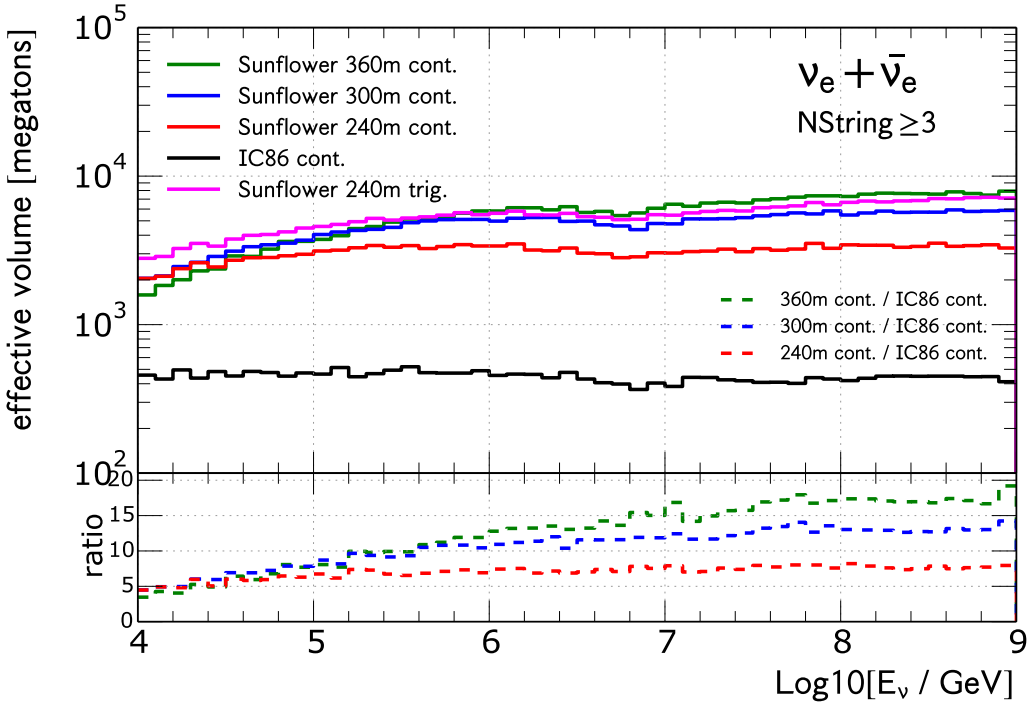


no icemodel systematics here. Use same icemodel (SpiceMie) during reconstruction that was used for simulation.


effective area [m^2]
Sunflower 360m cont.
Sunflower 300m cont.
Sunflower 240m cont.
IC86 cont.
Sunflower 240m trig.
$\nu_e + \bar{\nu}_e$
NString ≥3
360m cont. / IC86 cont.
300m cont. / IC86 cont.
240m cont. / IC86 cont.
ratio
Log10[E$_\nu$ / GeV]

Area

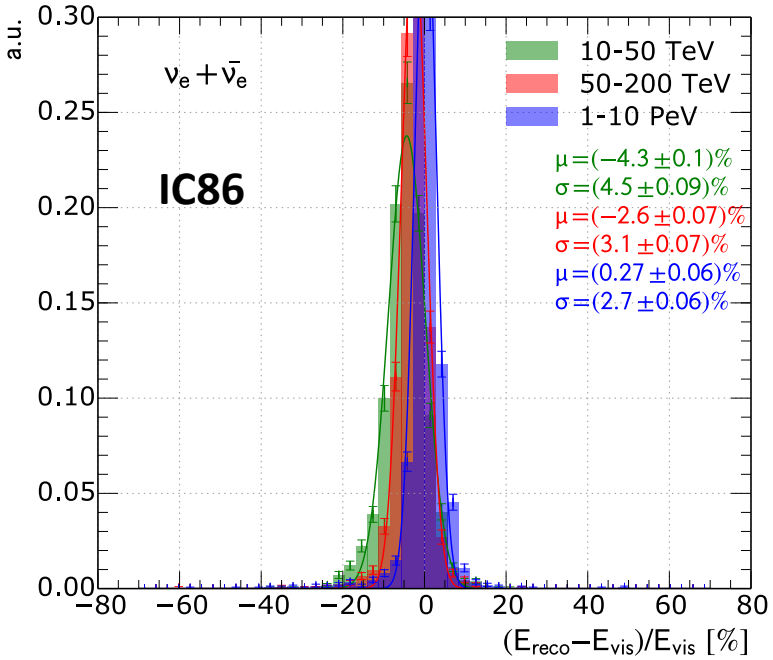
Volume

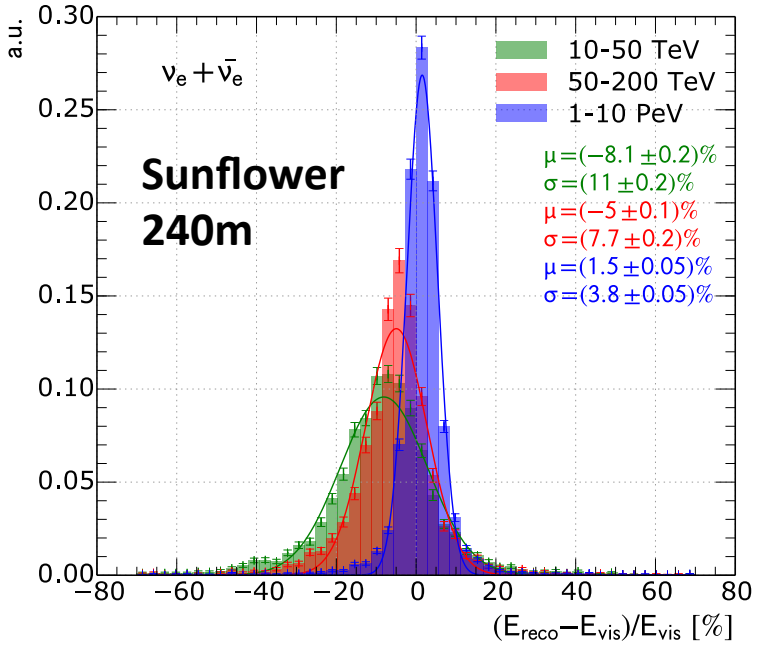

effective volume [megatons]
Sunflower 360m cont.
Sunflower 300m cont.
Sunflower 240m cont.
IC86 cont.
Sunflower 240m trig.
$\nu_e + \bar{\nu}_e$
NString ≥3
360m cont. / IC86 cont.
300m cont. / IC86 cont.
240m cont. / IC86 cont.
ratio
Log10[E$_\nu$ / GeV]

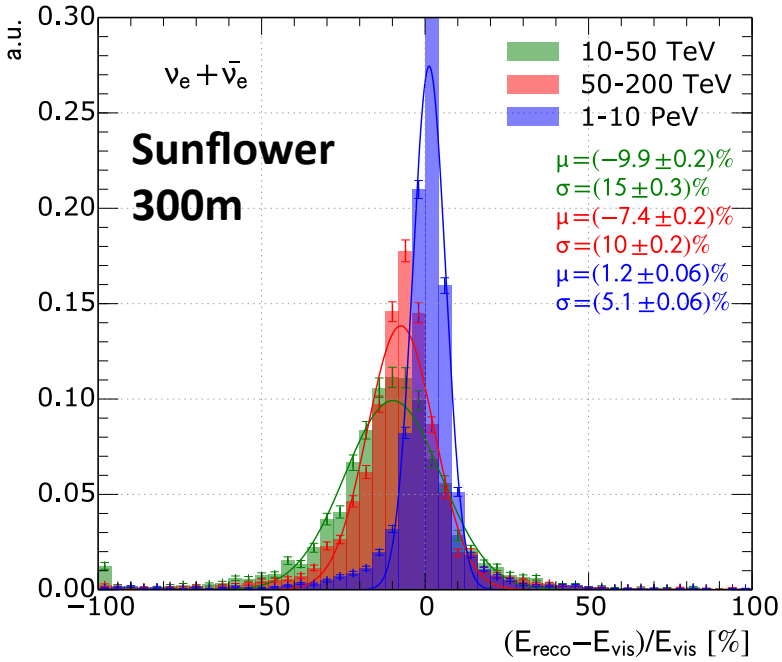
10 – 50 TeV (μ | σ)	Sunflower 240m	Sunflower 300m	Sunflower 360m	IceCube 86
Energy [%]	**(-8.1 | 11)**	**(-9.9 | 15)**	**(-13 | 21)***	**(-4.3 | 4.5)**
x [m]	(0.0| 9.3)	(0.2 | 14)	(0.6 | 18)	(0.1 | 2.9)
y [m]	(-0.1 | 9.6)	(0.1 | 14)	(0.2 | 18)	(0.0 | 2.9)
z [m]	(-0.2 | 5.2)	(-0.2 | 8.6)	(-0.2 | 12)	(0.1 | 1.9)
Zenith [deg]	**14**	**20**	**24**	**7**
Opening Angle [deg]	37	48	56	14

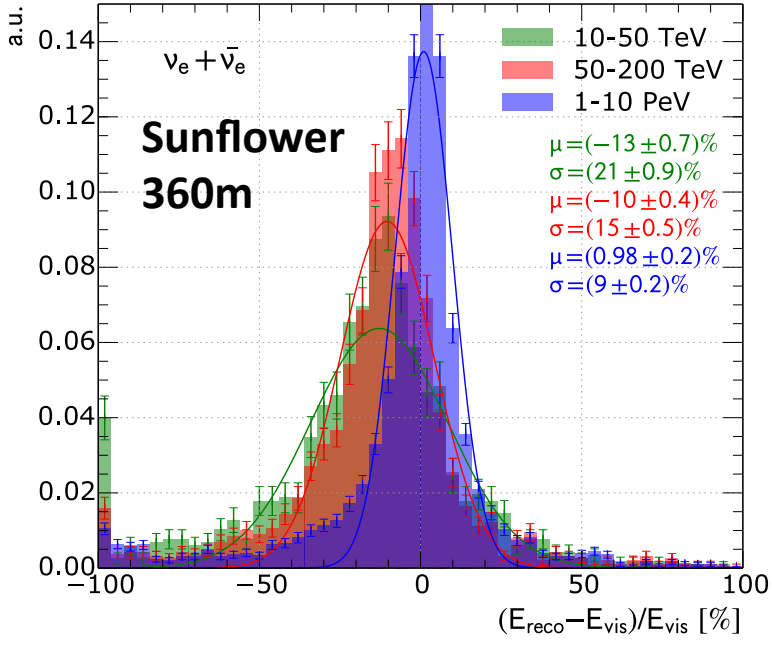
50 - 200 TeV (μ | σ)	Sunflower 240m	Sunflower 300m	Sunflower 360m	IceCube 86
Energy [%]	**(-5.0 | 7.7)**	**(-7.4 | 10)**	**(-10 | 15)**	**(-2.6 | 3.1)**
x [m]	(-0.1 | 7.4)	(0.0 | 11)	(0.8 | 14)	(-0.1 | 2.0)
y [m]	(0.3 | 7.4)	(0.0 | 10)	(0.2 | 14)	(-0.1 | 2.0)
z [m]	(0.2 | 3.9)	(0.2 | 6.2)	(0.2 | 10)	(0.0 | 3.3)
Zenith [deg]	**12**	**16**	**20**	**6.2**
Opening Angle [deg]	31	41	52	11

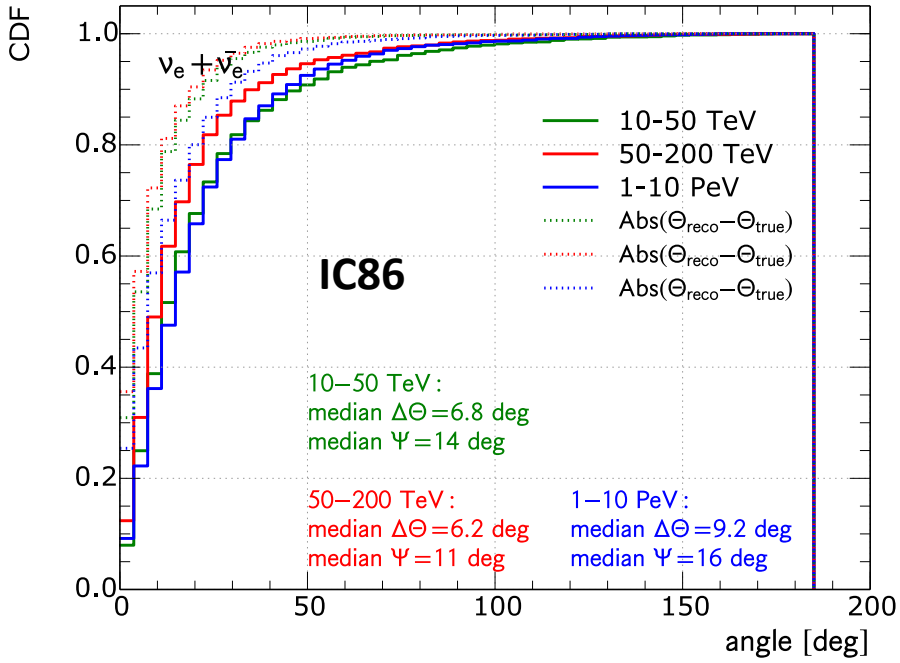
1 – 10 PeV (μ | σ)	Sunflower 240m	Sunflower 300m	Sunflower 360m	IceCube 86
Energy [%]	**(1.5 | 3.8)**	**(1.2 | 5.1)**	**(1.0 | 9.0)**	**(0.3 | 2.7)**
x [m]	(-0.1 | 4.3)	(0.1 | 7.0)	(0.3 | 9.8)	(-0.1 | 2.8)
y [m]	(-0.1 | 4.5)	(0.0 | 6.6)	(-0.2 | 10)	(0.1 | 2.6)
z [m]	(0.1 | 4.3)	(0.0 | 5.2)	(-0.1 | 6)	(0.0 | 3.3)
Zenith [deg]	**12**	**14**	**17**	**9.2**
Opening Angle [deg]	23	31	42	16

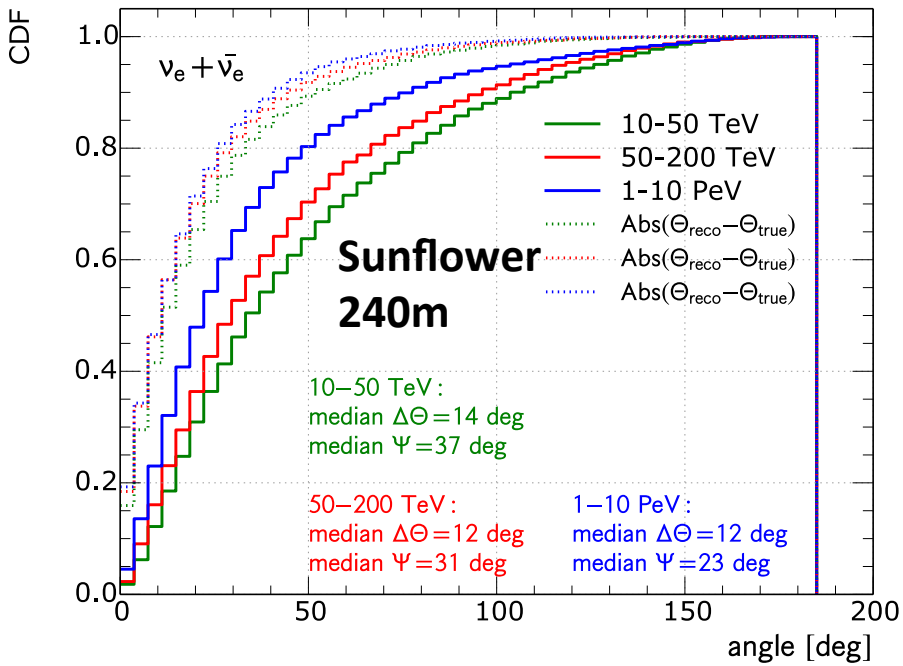

a.u.
$\nu_e + \bar{\nu}_e$
IC86
10-50 TeV
50-200 TeV
1-10 PeV
μ=(−4.3±0.1)%
σ=(4.5±0.09)%
μ=(−2.6±0.07)%
σ=(3.1±0.07)%
μ=(0.27±0.06)%
σ=(2.7±0.06)%
$(E_{reco}-E_{vis})/E_{vis}$ [%]

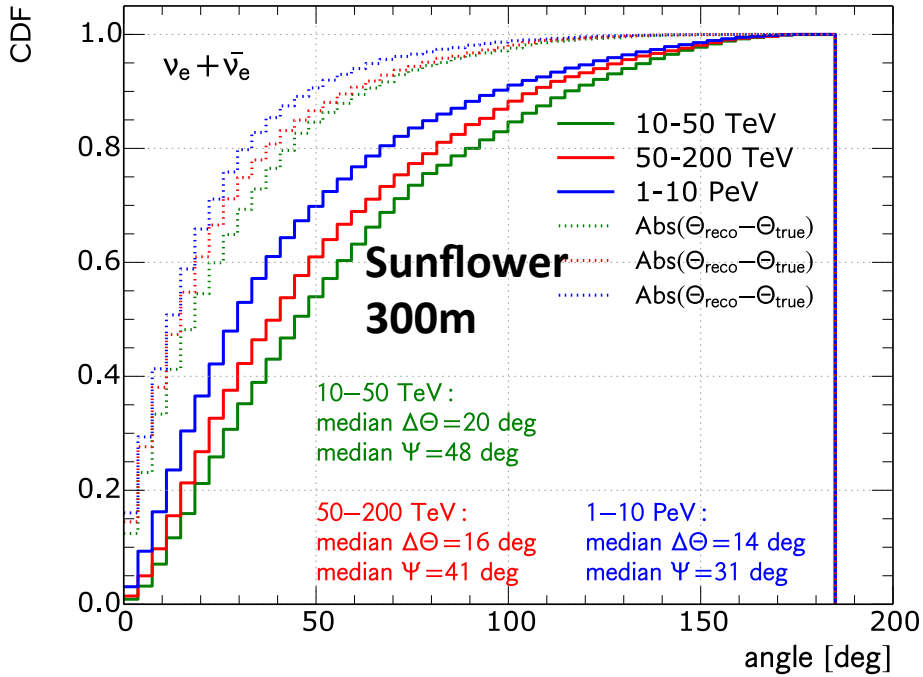

a.u.
$\nu_e + \bar{\nu}_e$
Sunflower
240m
10-50 TeV
50-200 TeV
1-10 PeV
μ=(−8.1±0.2)%
σ=(11±0.2)%
μ=(−5±0.1)%
σ=(7.7±0.2)%
μ=(1.5±0.05)%
σ=(3.8±0.05)%
$(E_{reco}-E_{vis})/E_{vis}$ [%]

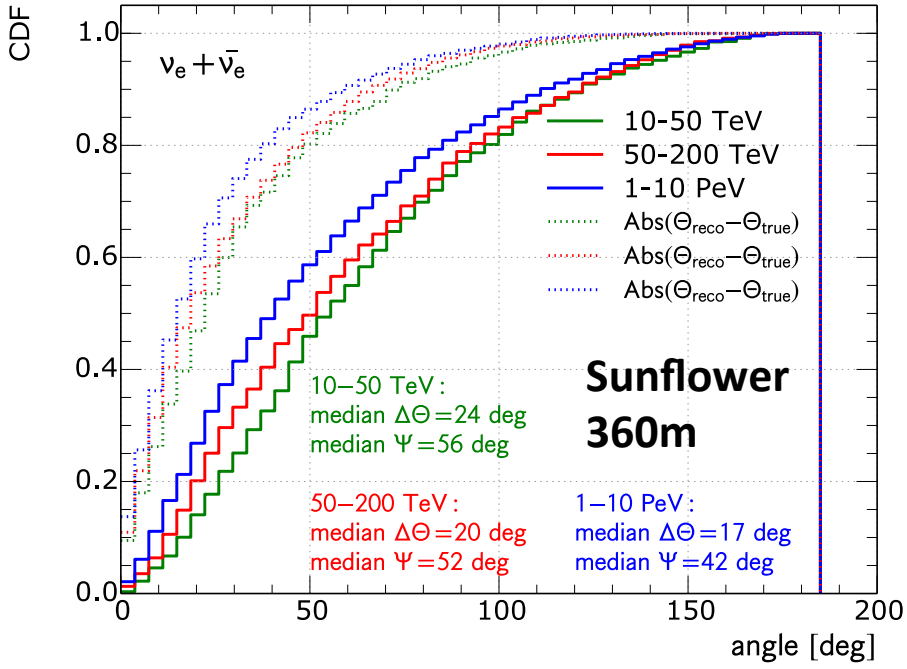

a.u.
$\nu_e + \bar{\nu}_e$
Sunflower
300m
10-50 TeV
50-200 TeV
1-10 PeV
μ=(−9.9±0.2)%
σ=(15±0.3)%
μ=(−7.4±0.2)%
σ=(10±0.2)%
μ=(1.2±0.06)%
σ=(5.1±0.06)%
$(E_{reco}-E_{vis})/E_{vis}$ [%]


a.u.
$\nu_e + \bar{\nu}_e$
Sunflower
360m
10-50 TeV
50-200 TeV
1-10 PeV
μ=(−13±0.7)%
σ=(21±0.9)%
μ=(−10±0.4)%
σ=(15±0.5)%
μ=(0.98±0.2)%
σ=(9±0.2)%
$(E_{reco}-E_{vis})/E_{vis}$ [%]

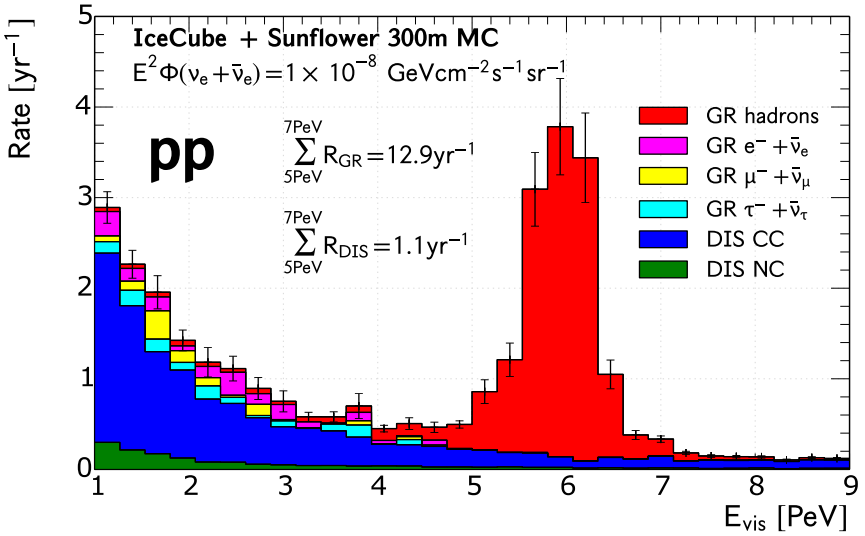

CDF
$\nu_e + \bar{\nu}_e$
IC86
10-50 TeV
50-200 TeV
1-10 PeV
Abs($\Theta_{reco}-\Theta_{true}$)
Abs($\Theta_{reco}-\Theta_{true}$)
Abs($\Theta_{reco}-\Theta_{true}$)
10–50 TeV :
median $\Delta\Theta$=6.8 deg
median Ψ=14 deg
50–200 TeV :
median $\Delta\Theta$=6.2 deg
median Ψ=11 deg
1–10 PeV :
median $\Delta\Theta$=9.2 deg
median Ψ=16 deg
angle [deg]

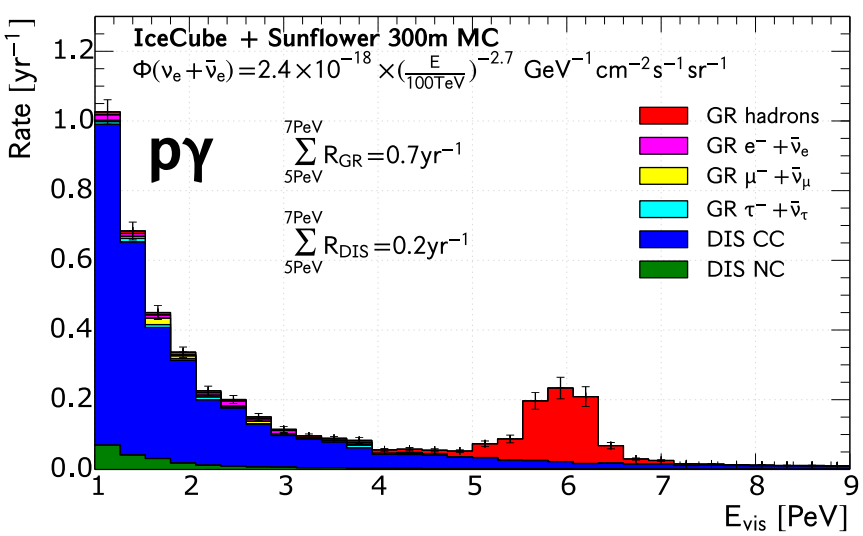

CDF
$\nu_e + \bar{\nu}_e$
Sunflower
240m
10-50 TeV
50-200 TeV
1-10 PeV
Abs($\Theta_{reco}-\Theta_{true}$)
Abs($\Theta_{reco}-\Theta_{true}$)
Abs($\Theta_{reco}-\Theta_{true}$)
10–50 TeV :
median $\Delta\Theta$=14 deg
median Ψ=37 deg
50–200 TeV :
median $\Delta\Theta$=12 deg
median Ψ=31 deg
1–10 PeV :
median $\Delta\Theta$=12 deg
median Ψ=23 deg
angle [deg]


CDF
$\nu_e + \bar{\nu}_e$
Sunflower
300m
10-50 TeV
50-200 TeV
1-10 PeV
Abs($\Theta_{reco}-\Theta_{true}$)
Abs($\Theta_{reco}-\Theta_{true}$)
Abs($\Theta_{reco}-\Theta_{true}$)
10–50 TeV :
median $\Delta\Theta$=20 deg
median Ψ=48 deg
50–200 TeV :
median $\Delta\Theta$=16 deg
median Ψ=41 deg
1–10 PeV :
median $\Delta\Theta$=14 deg
median Ψ=31 deg
angle [deg]


CDF
$\nu_e + \bar{\nu}_e$
Sunflower
360m
10-50 TeV
50-200 TeV
1-10 PeV
Abs($\Theta_{reco}-\Theta_{true}$)
Abs($\Theta_{reco}-\Theta_{true}$)
Abs($\Theta_{reco}-\Theta_{true}$)
10–50 TeV :
median $\Delta\Theta$=24 deg
median Ψ=56 deg
50–200 TeV :
median $\Delta\Theta$=20 deg
median Ψ=52 deg
1–10 PeV :
median $\Delta\Theta$=17 deg
median Ψ=42 deg
angle [deg]

GR in 300m detector





Flux (pp source)	Sunflower 240m Rate [yr^{-1}] (IC86)	Sunflower 300m Rate [yr^{-1}]	Sunflower 360m Rate [yr^{-1}]
std. E-2 g=2.0	7.2 (0.88)	12.9	16
HESE 3yr g=2.3	3.1 (0.38)	5.6	6.8
MLB g=2.7	0.9 (0.12)	1.7	2.1
Flux (pγ source)	**Sunflower 240m**	**Sunflower 300m**	**Sunflower 360m**
std. E-2	3.2 (0.39)	5.7	6.9
HESE 3yr	1.4 (0.17)	2.4	3.0
MLB	0.4 (0.05)	0.7	0.9

Φ_{ν_e}	interaction	pp source		pγ source	
$[\mathrm{GeV}^{-1}\mathrm{cm}^{-2}\mathrm{s}^{-1}\mathrm{sr}^{-1}]$	type	IC-86	HEX-240m	IC-86	HEX-240m
$1.0 \times 10^{-18}(E/100\,\mathrm{TeV})^{-2.0}$	GR	0.88	7.2	0.39	3.2
	DIS	0.09	0.8	0.10	0.8
$1.5 \times 10^{-18}(E/100\,\mathrm{TeV})^{-2.3}$	GR	0.38	3.1	0.17	1.4
	DIS	0.04	0.3	0.04	0.3
$2.4 \times 10^{-18}(E/100\,\mathrm{TeV})^{-2.7}$	GR	0.12	0.9	0.05	0.4
	DIS	0.01	0.1	0.01	0.1

TABLE II. Expected number of contained neutrino-induced cascades [year^{-1}], for $5\,\mathrm{PeV} < E_{vis} < 7\,\mathrm{PeV}$.

Summary

- added Sunflower 300m and IC86@SMT8 to reconstruction performance comparison
- reconstruction of 300m not much worse compared to 240m (e.q. energy res. still much smaller than typical bin size in energy histograms)
- 300m has about >~50% larger effective area/volume than 240m

- Depending on needs on directional resolution (atm. veto) and assuming background rejection above 100 TeV to be easy**, one may conclude that 300m is preferable**

- Location of files: /data/ana/HEX/NuE/floral_*m/ (* = {240, 300, 360})