simulation software and simulation production in IceCube

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University of Wisconsin - Madison

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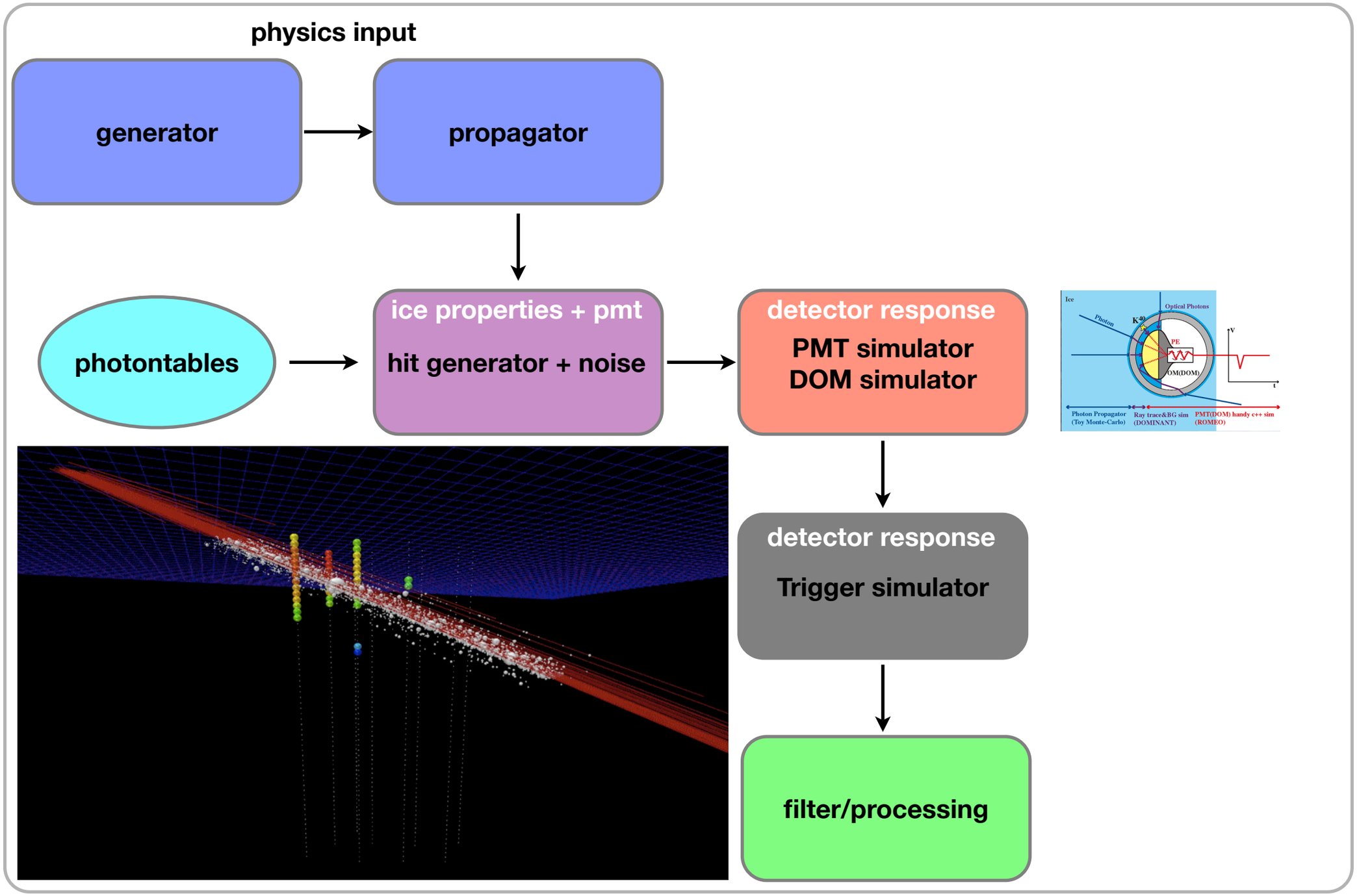
Berlin

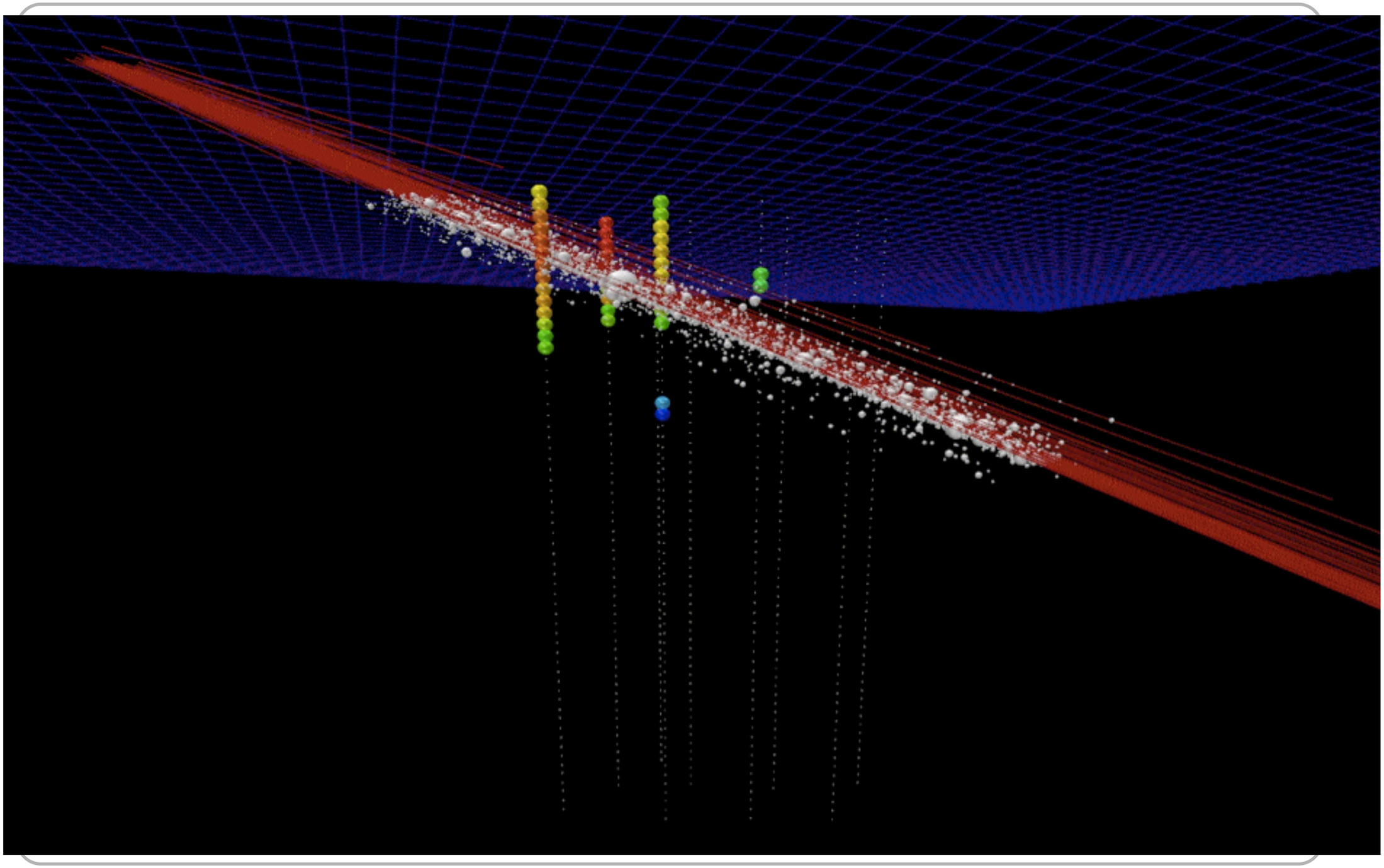
September 26th, 2009

simulation (coordinator Alex Olivas)

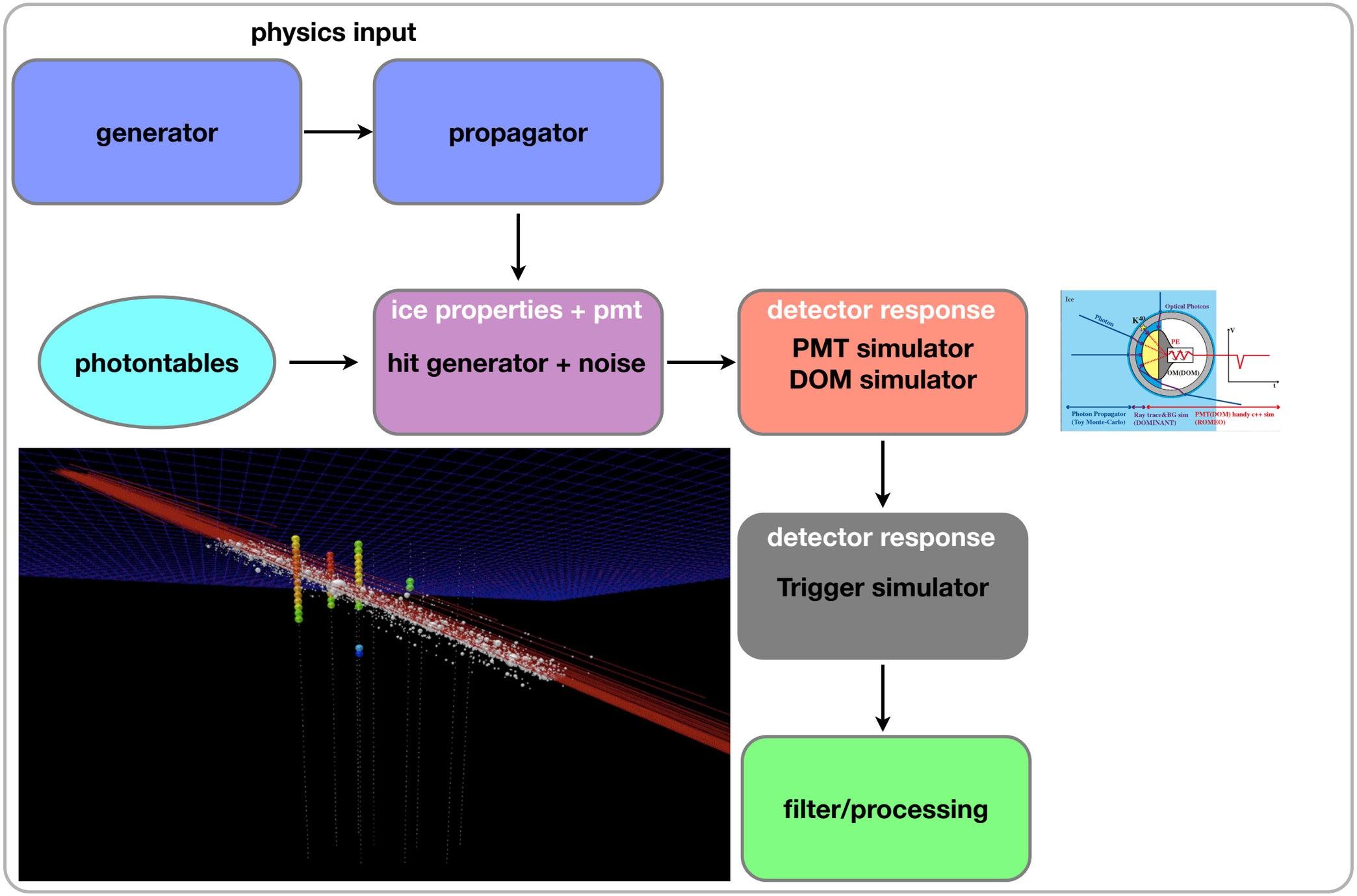
simulation chain



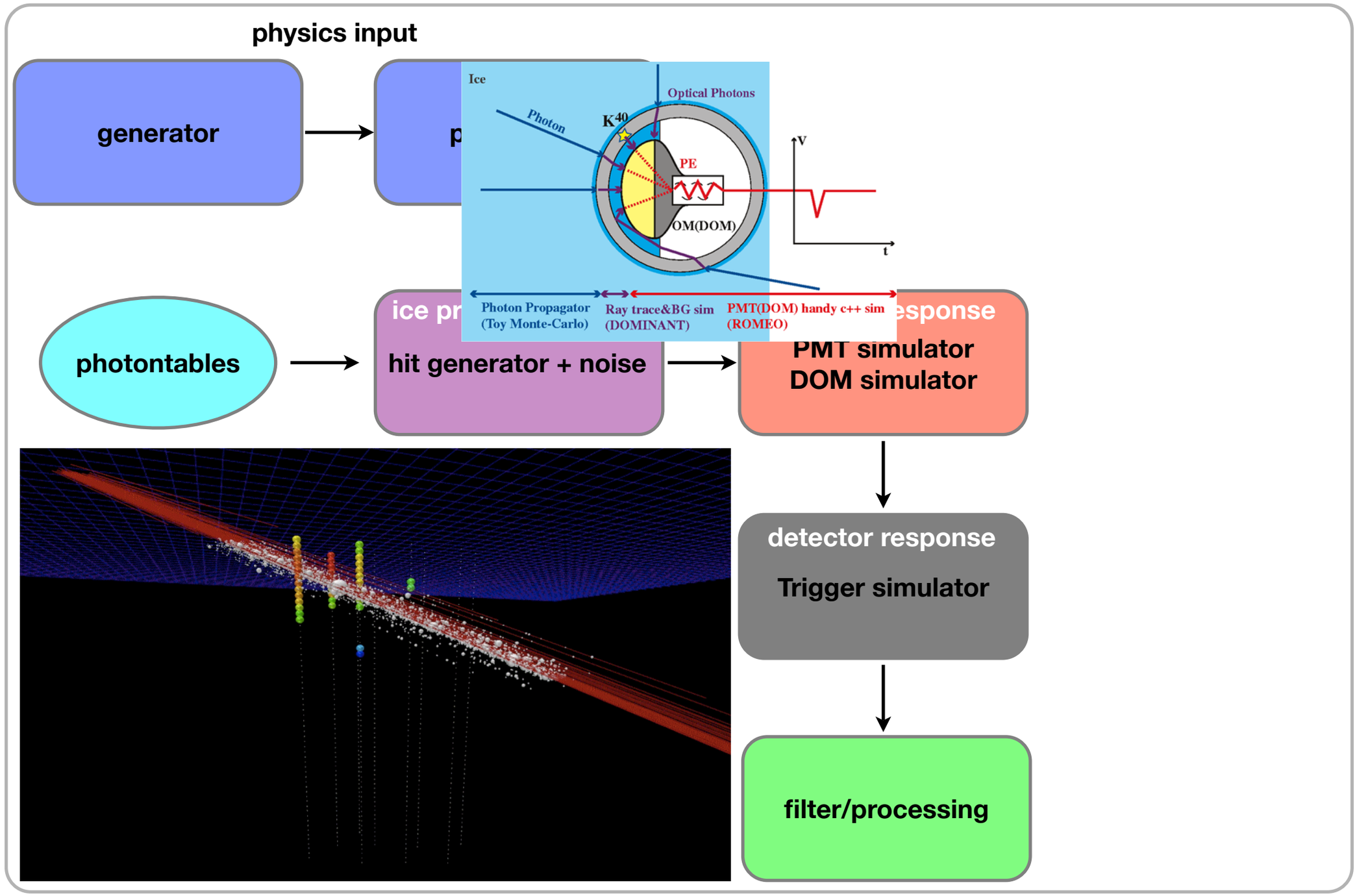
simulation chain



simulation chain



simulation chain



simulation chain

physics input

generator

propagator

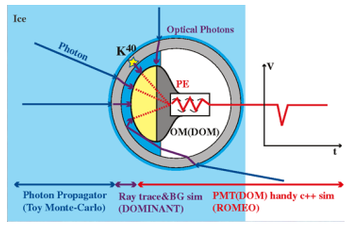
photontables

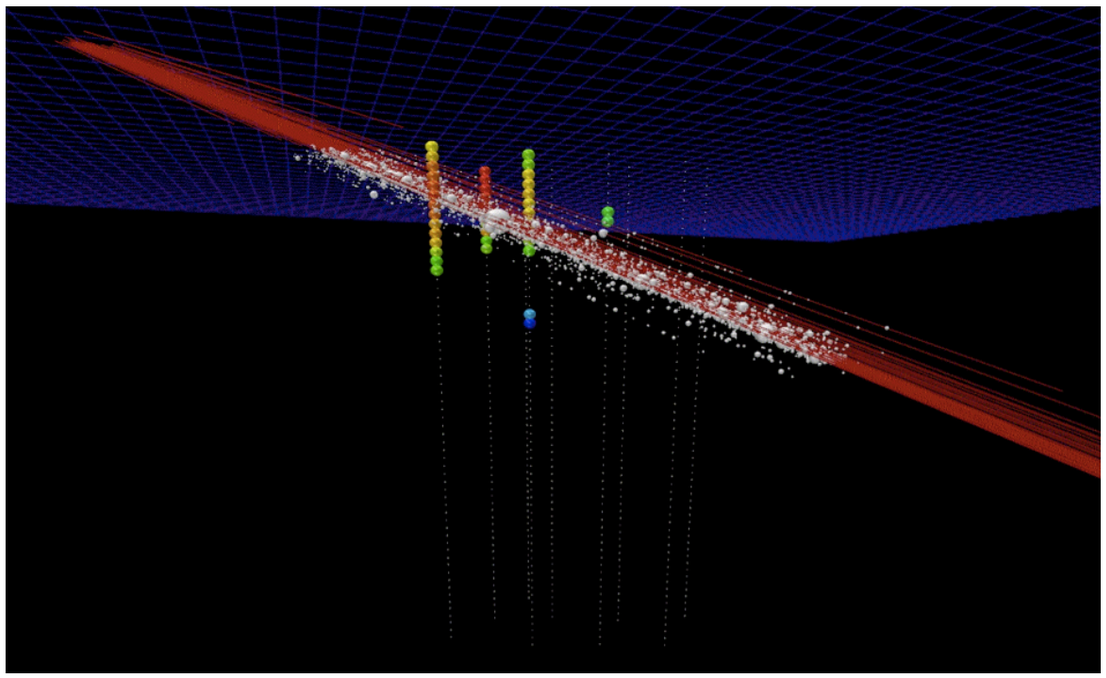
ice properties + pmt

hit generator + noise

detector response

PMT simulator
DOM simulator





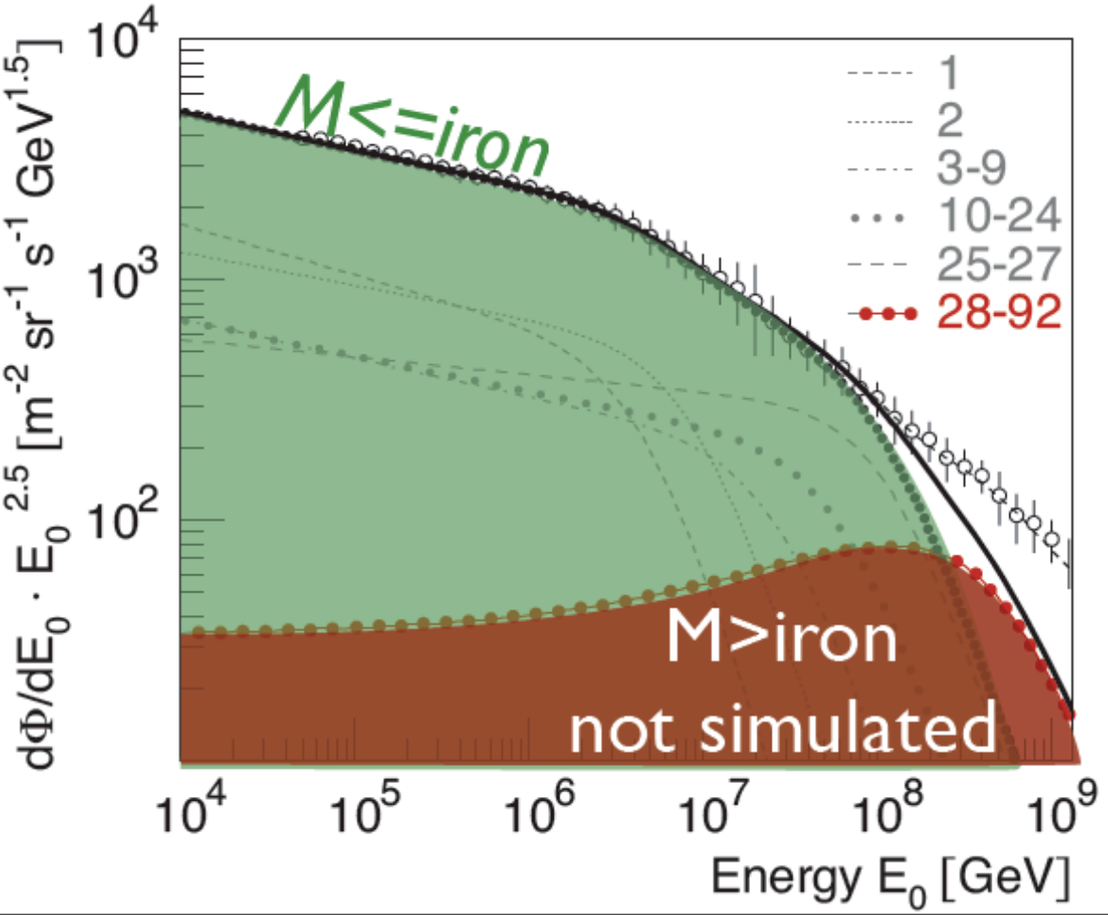
detector response

Trigger simulator

filter/processing

generators : CORSIKA

- currently using CORSIKA v6.720 (➙ v6.900)
  - QGSJET-II : ~30% lower μ rate than exp
  - ➡ SIBYLL v2.1 : within 10% of exp μ rate
  - EPOS v1.60 : ~30% higher μ rate than exp



poly-gonato model of CR

flux & composition (Hörandel)

CORSIKA up to Fe (27)

EGCR not modeled

generators : CORSIKA

- bulk μ energy ~ 1-5 TeV (➙ CR energy ~ 10-50 TeV)
  - poly-gonato model and easier to use

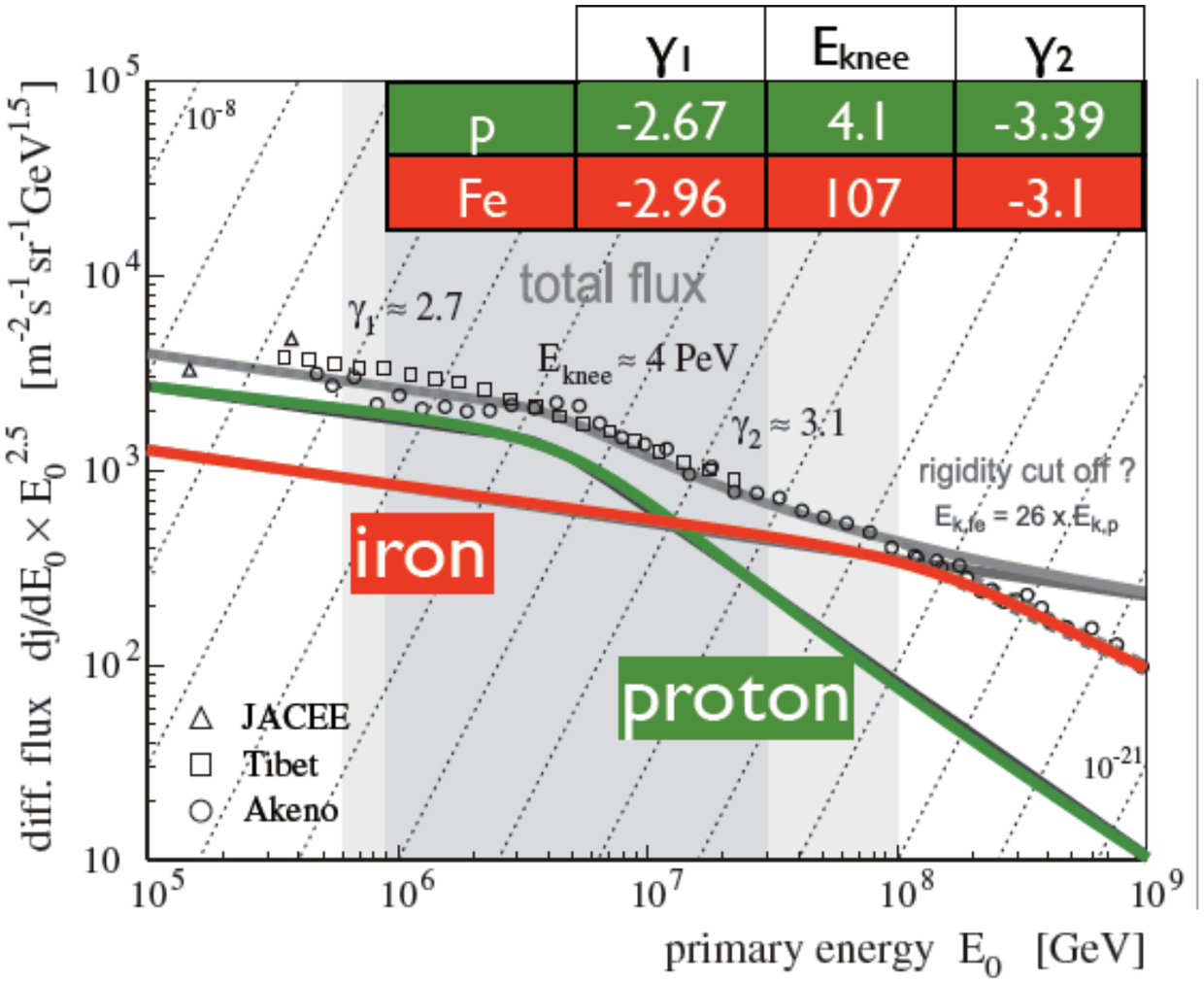
➡ weighted events : $\propto E^{-\gamma+1}$

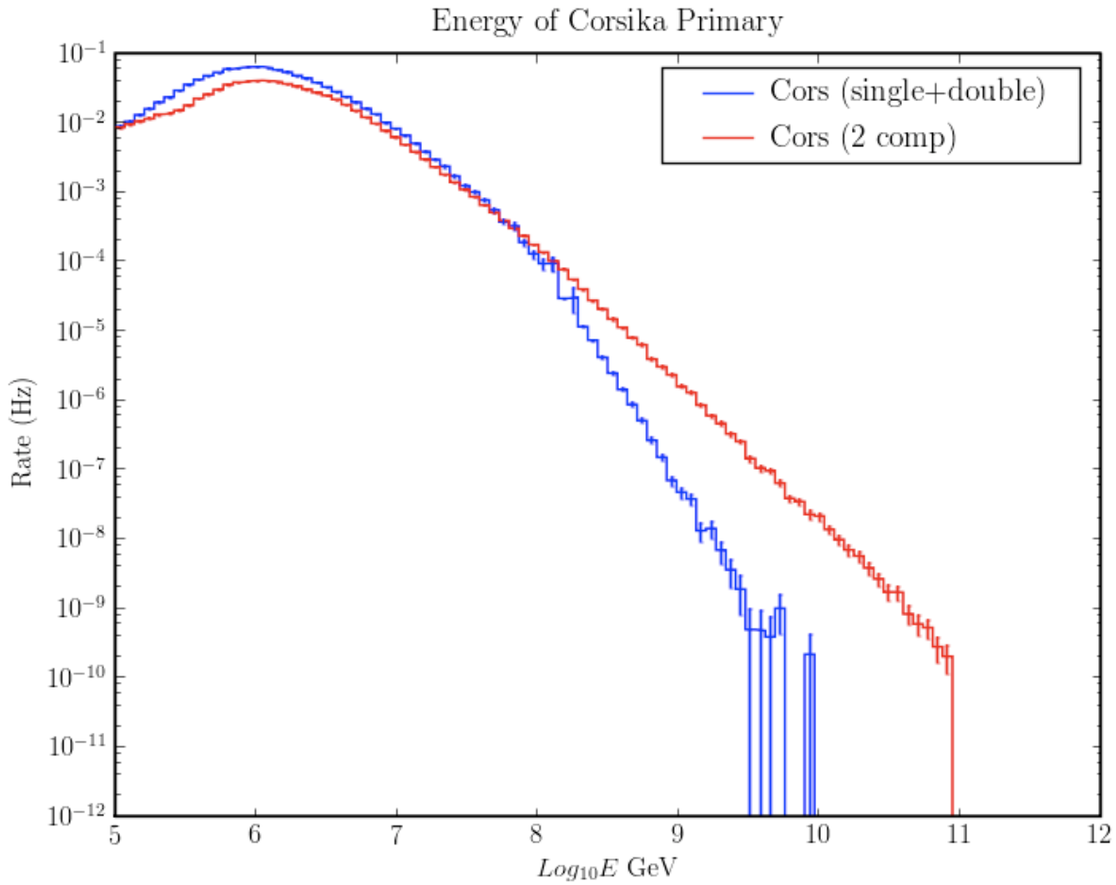
➡ better livetime efficiency @ 10 TeV but poor efficiency @ TeV

➡ energy-targeted generation of (H,He,CNO,Mg,Fe) with $E^{-1(2)}$

➡ coincidence of uncorrelated events contribute ~ 20% in IC40

➡ very important for physics analyses





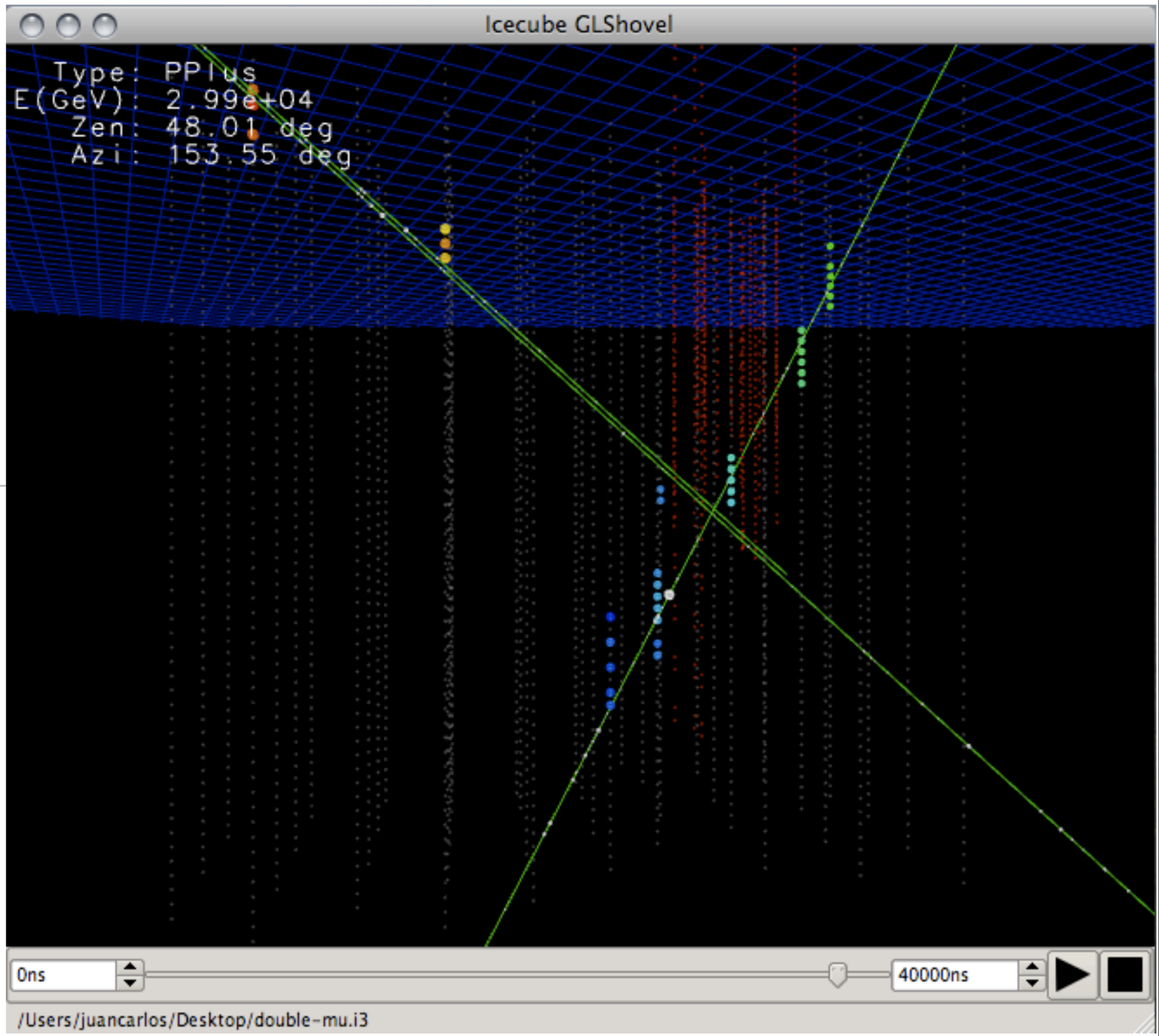
2-component by Glasstetter et al, 1999

Brian Christy, Henrike Wissing

poly-gonato model fails > 10-100 PeV & @ horizon

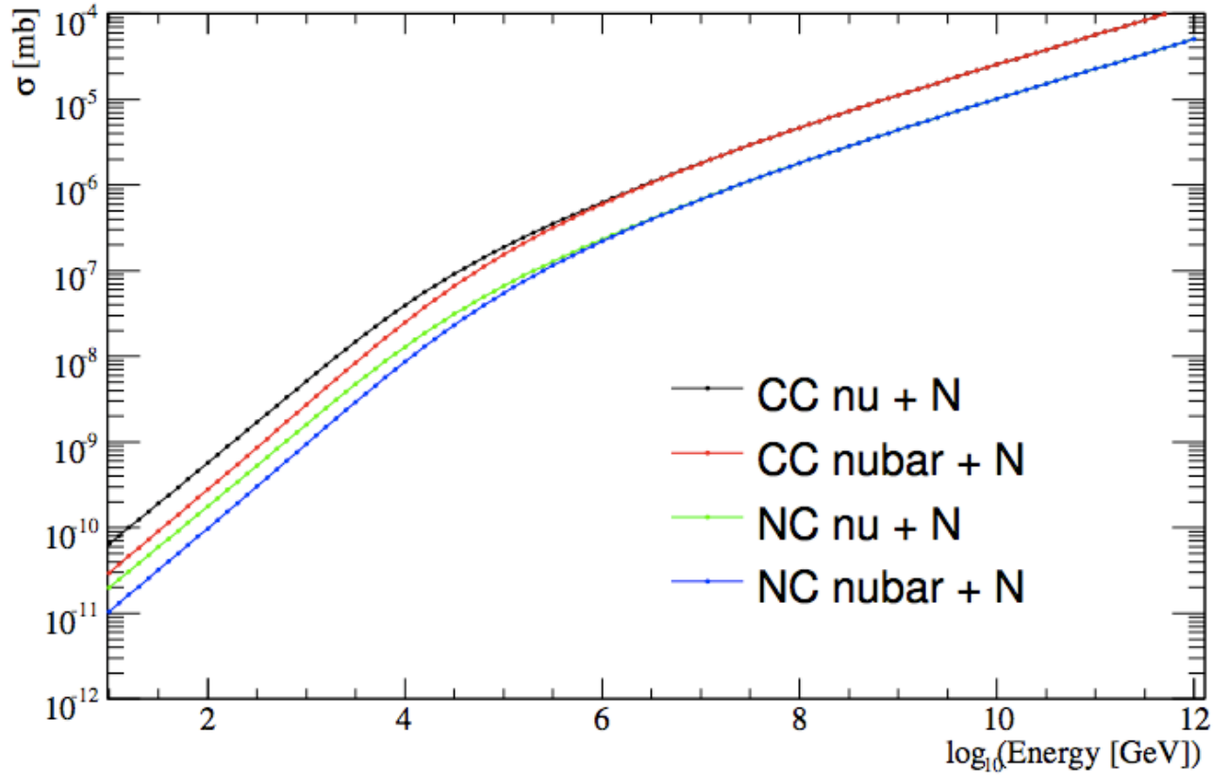
using individual CR masses for re-weighting

coincident atmospheric shower events in IceCube



generators : neutrino-generator, Juliet

- produces a $E^{-\gamma}$ ν_μ, ν_e, ν_τ with
  - PRELIM Earth's density model
    - homogeneous density
  - CTEQ5 parton distribution functions
  - CTEQ6 ~ 1% difference

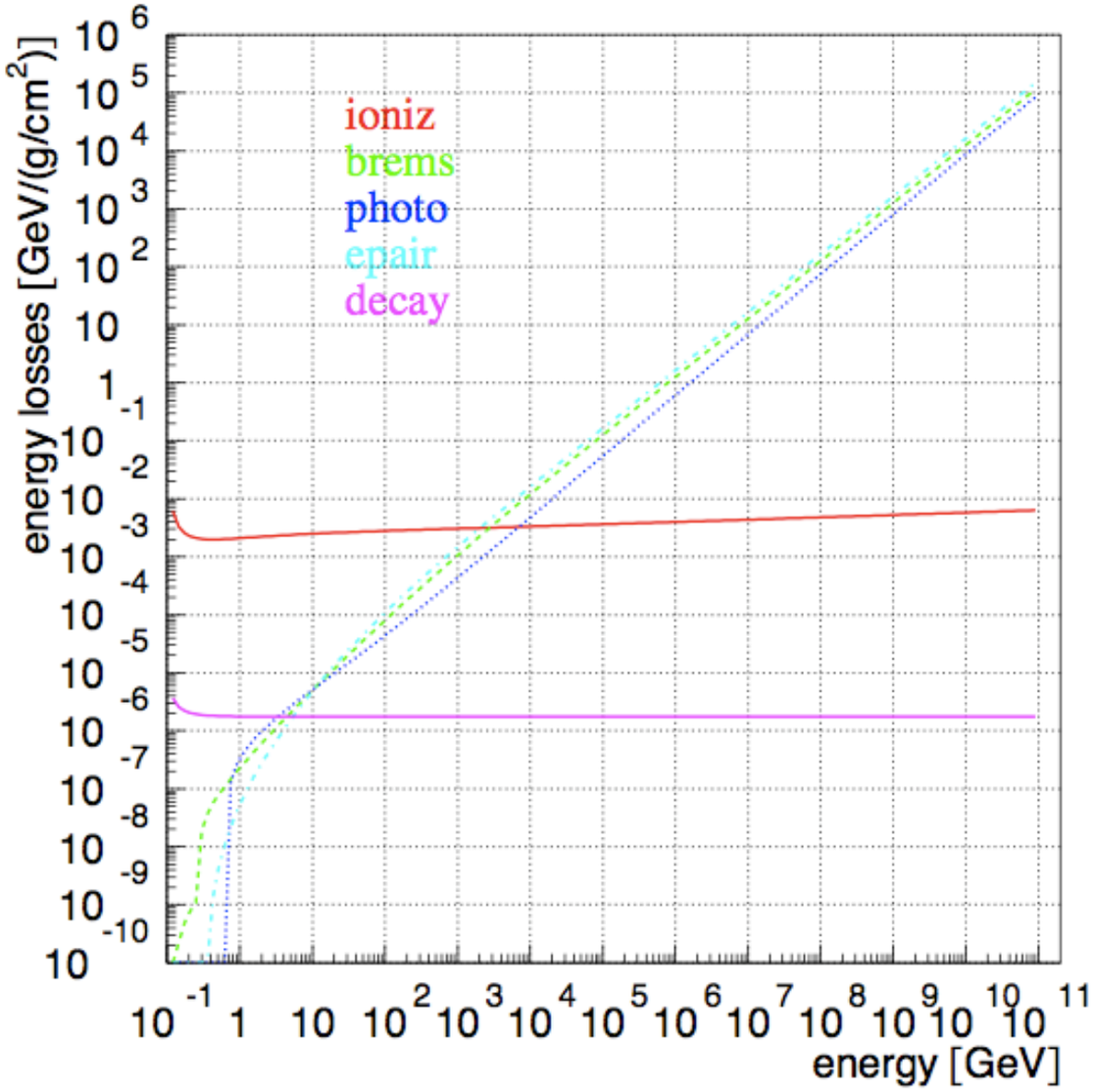


➡ cross section re-evaluation based on HERA data (Anchordoqui, Cooper-Sarkar, Sarkar)

- prop & interaction of neutrinos into a weight : flexible spectral weight
- Honda 2007, Bartol, extra-terrestrial fluxes, ...

propagator : MMC, Juliet

- also a neutrino generator it propagates μ, e, τ & monopoles



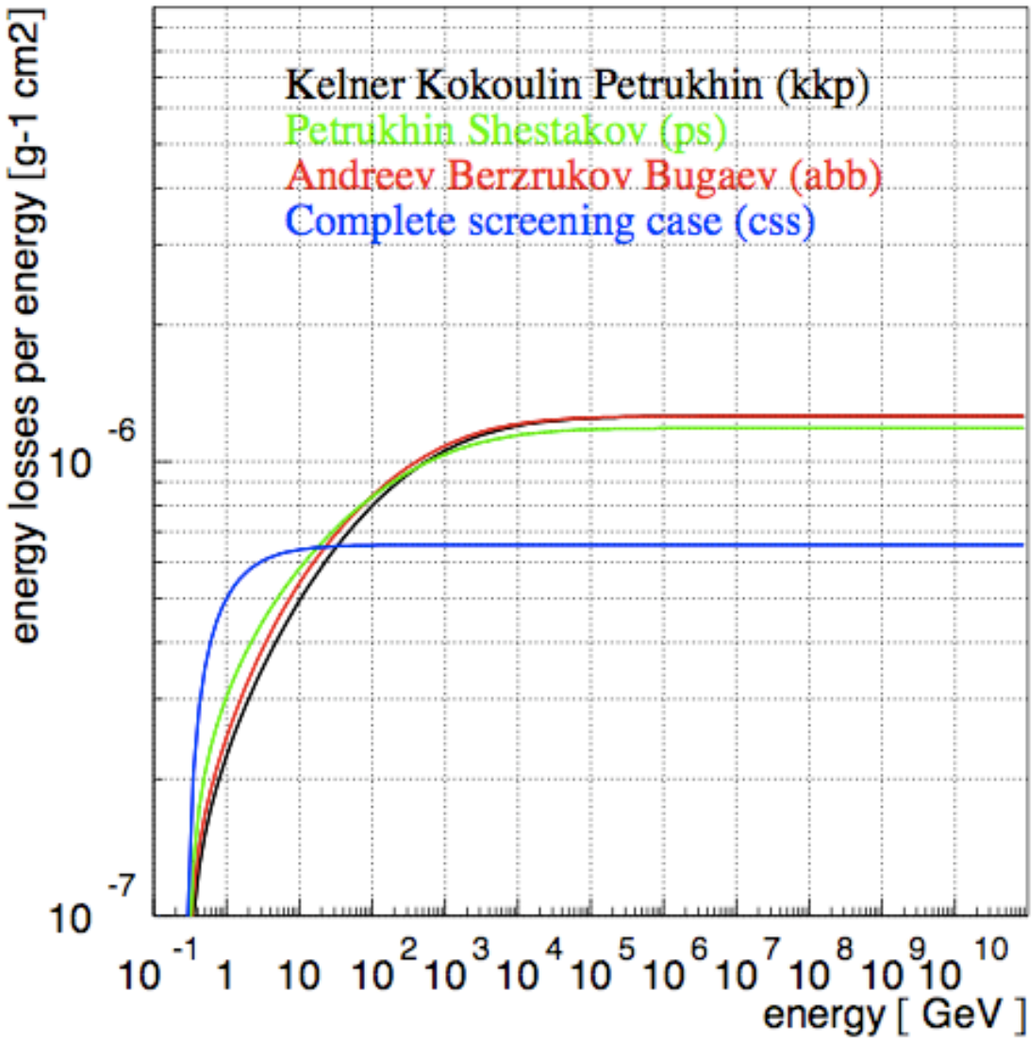


Figure 35: Bremsstrahlung cross section parameterizations for muons

propagator : MMC (Juliet)

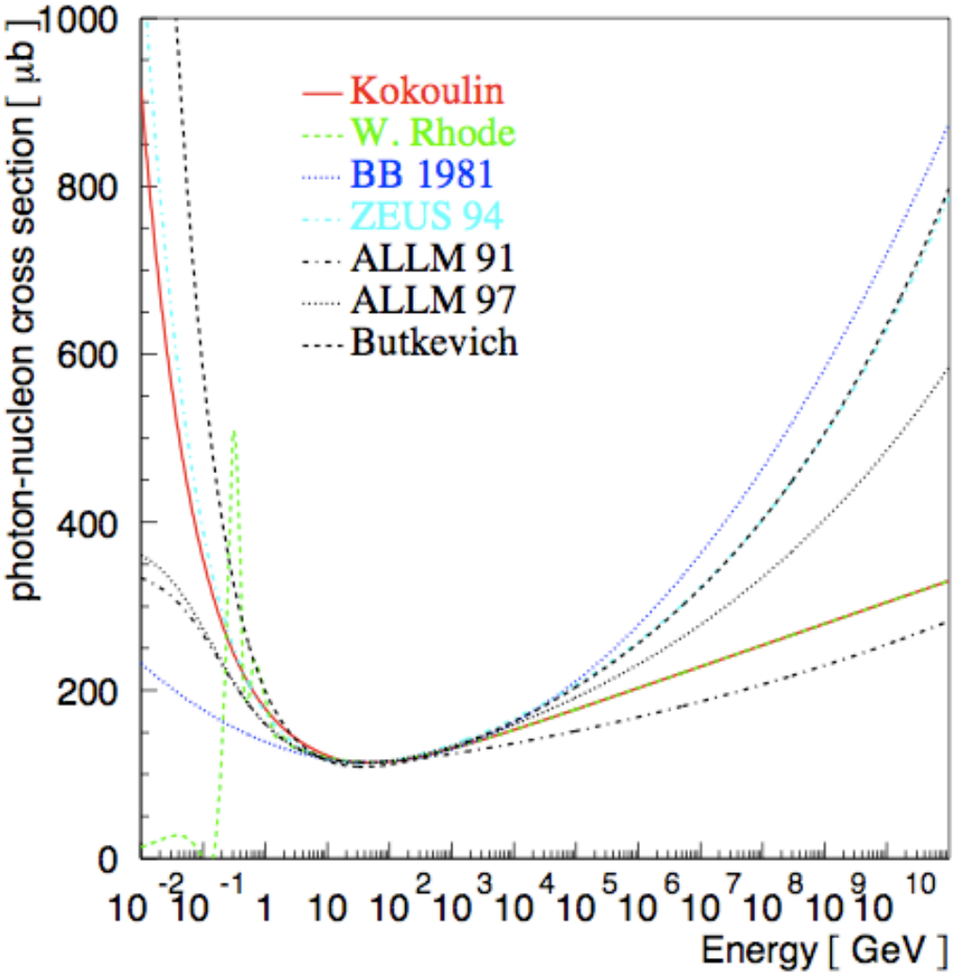


Figure 37: Photon-nucleon cross sections, as described in the text: Kokoulin [45], W. Rhode [46], BB 1981 [47], ZEUS 94 [48], ALLM 91 and 97 [49], Butkevich [50]. Curves 5-7 are calculated according to $\sigma_{\gamma N} = \lim_{Q^2 \to 0} \frac{4\pi^2 \alpha F_2^N}{Q^2}$

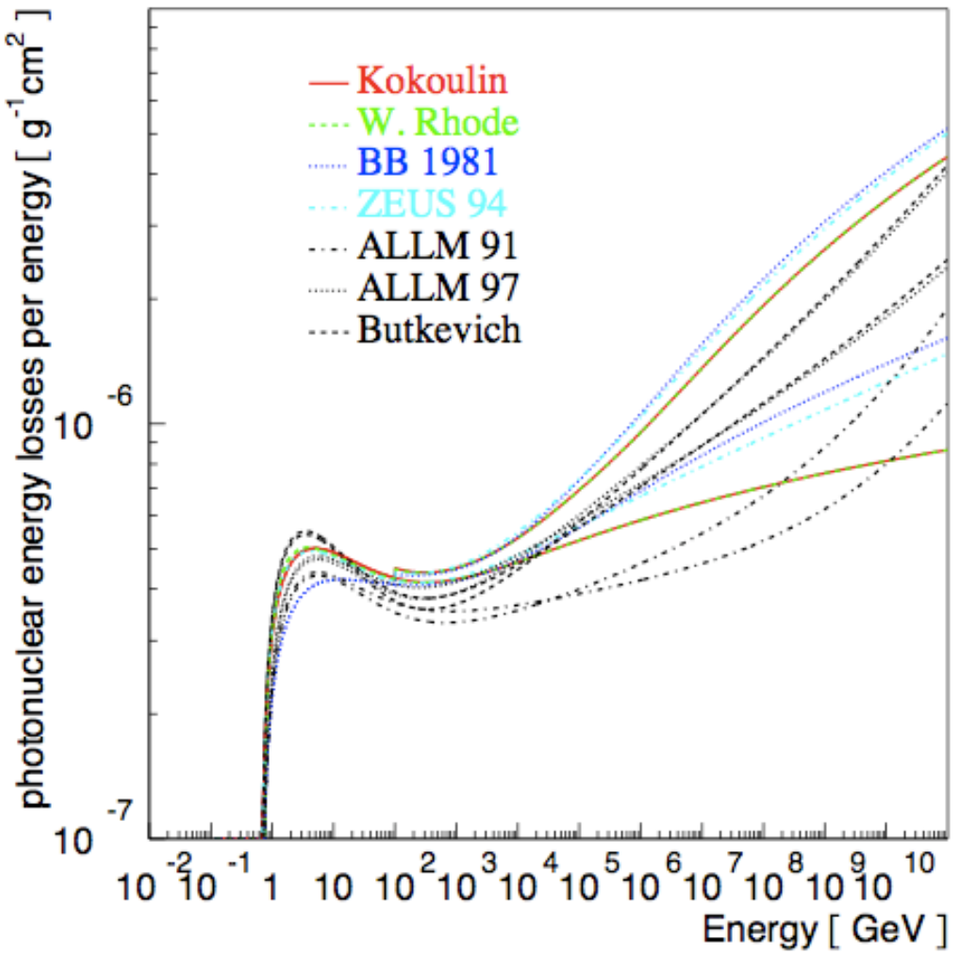
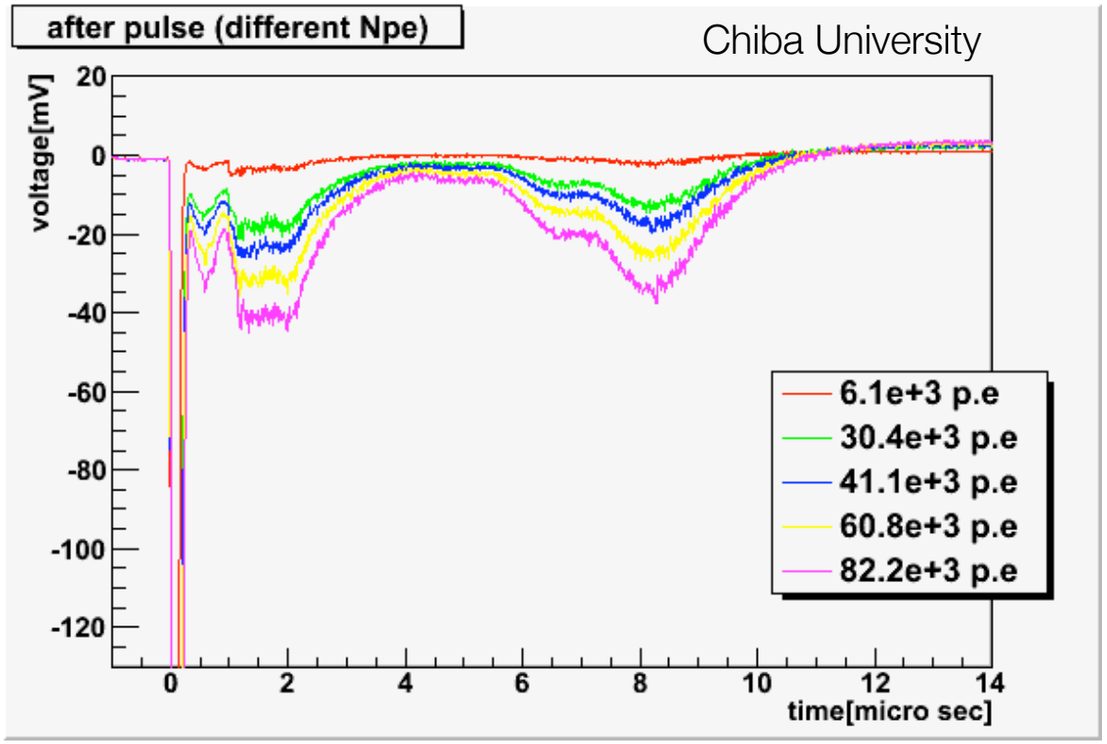
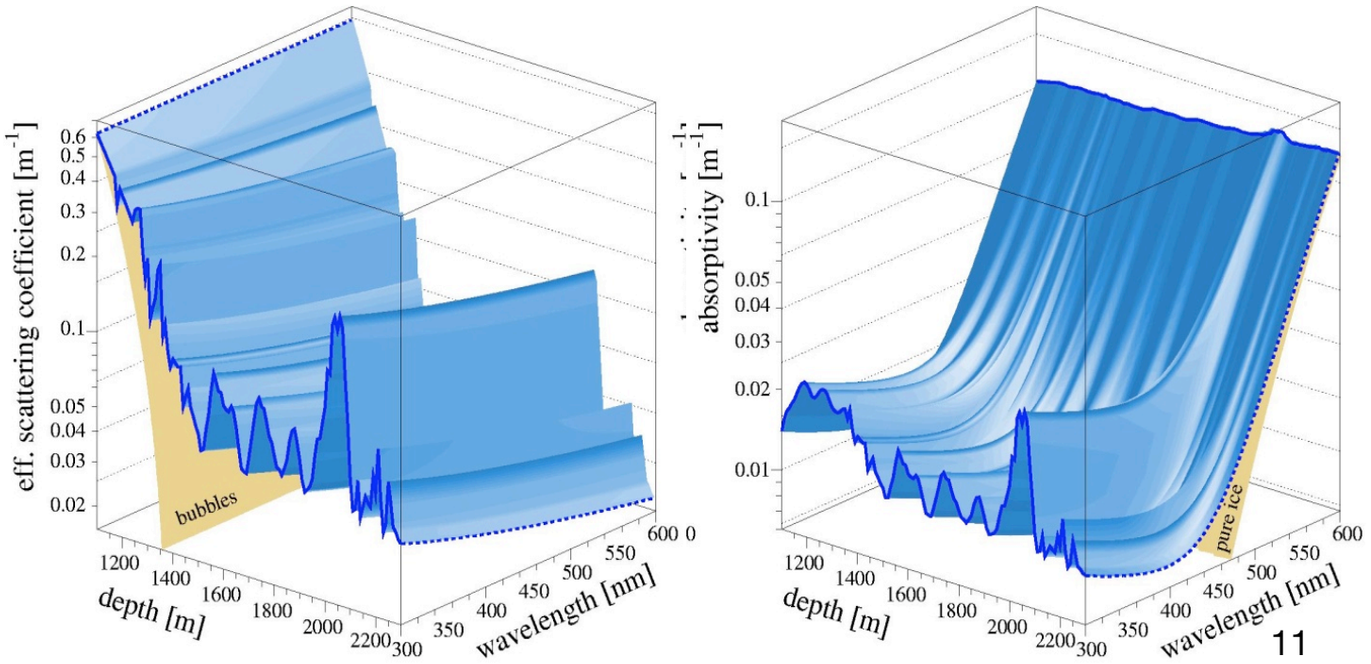


Figure 38: Photonuclear energy losses (divided by energy), according to formulae from Section 9.3. Higher lines for the parameterizations 1-4 include the hard component [51], higher lines for 5-7 calculate shadowing effects as in Section 9.3.3, lower as in Section 9.3.2

hit (i.e. p.e.) generator

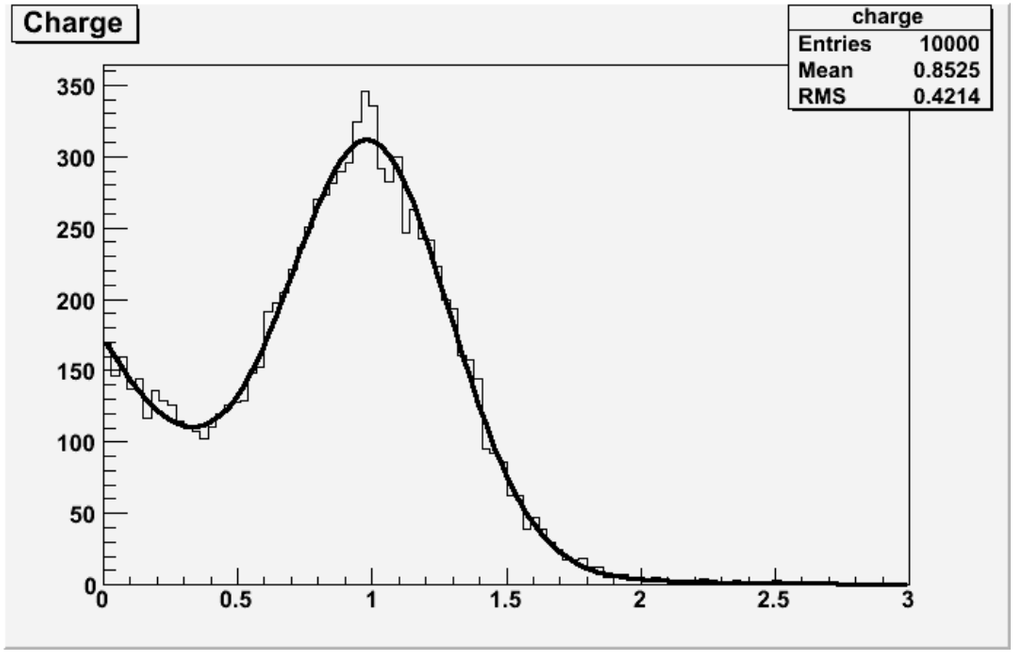
- μ energy lost + cascades ➙ photons ➙ p.e.
  - photon propagation : ice properties + PMT response + DOM glass/gel
  - pre-generated lookup table : amplitude ad time distribution



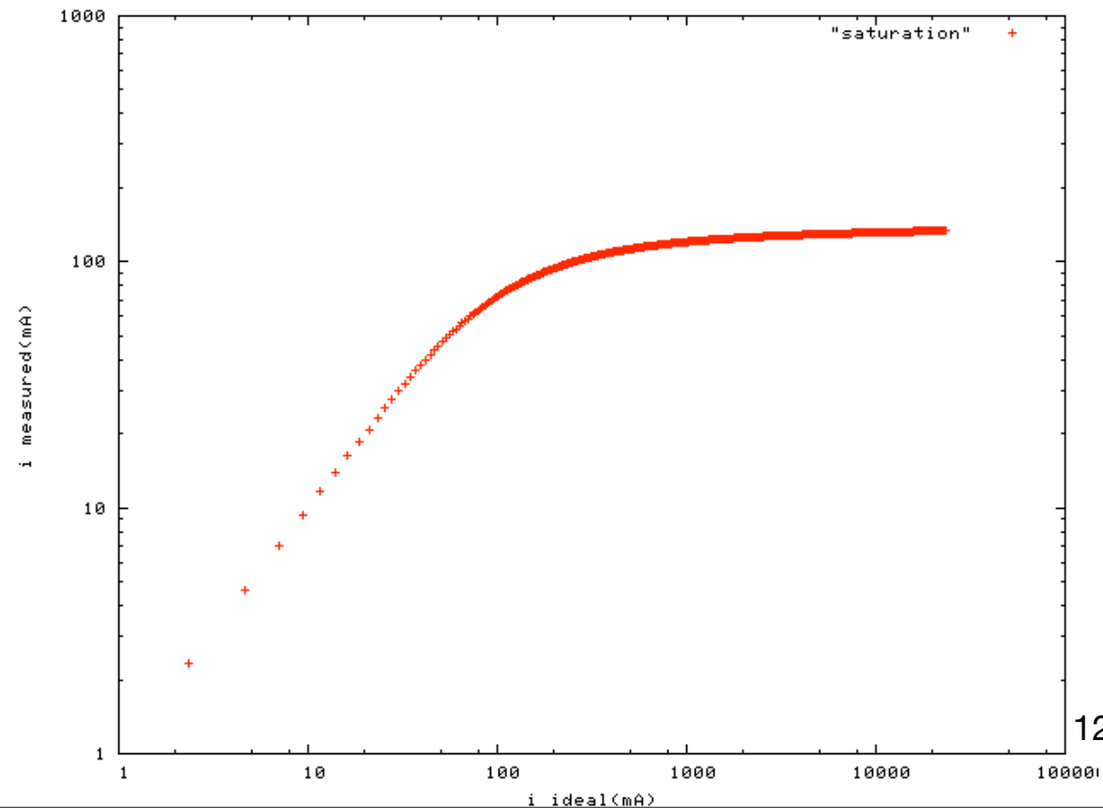


PMT simulator, romeo

- sigle photo electron template

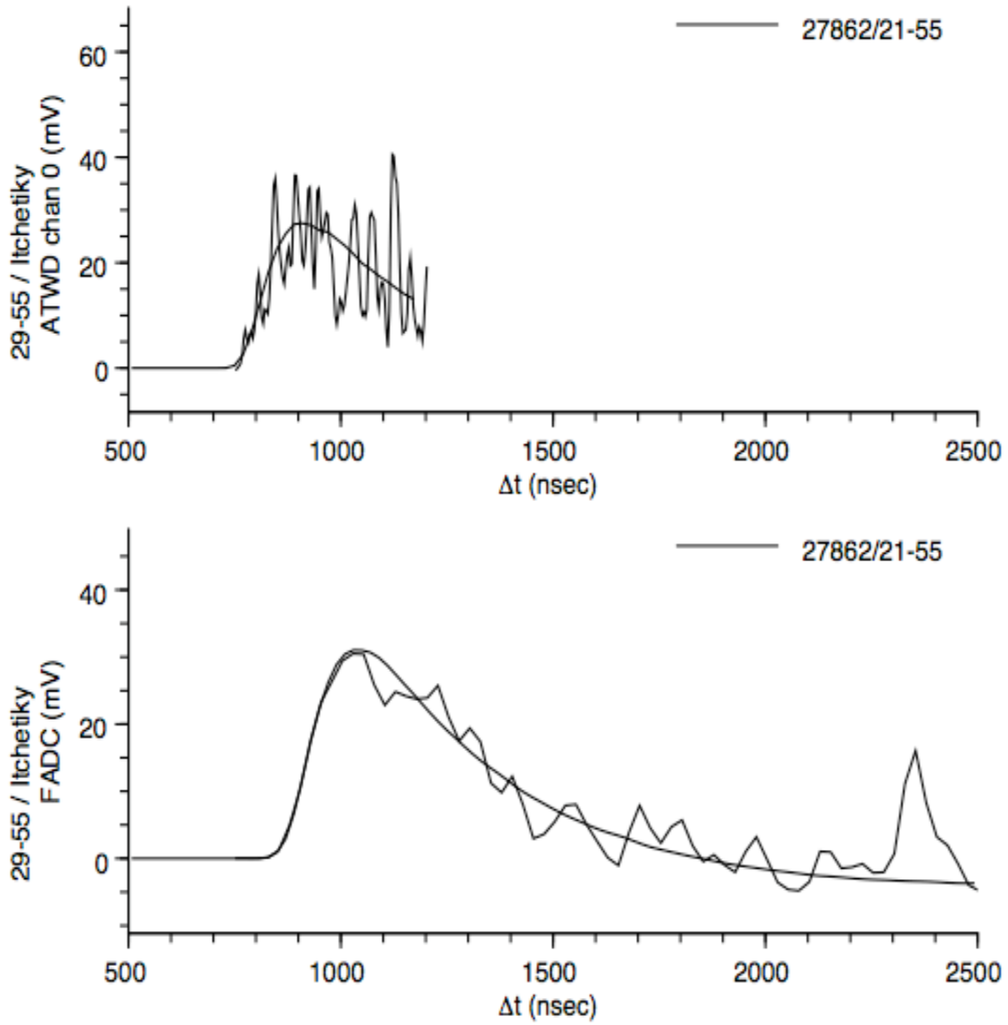


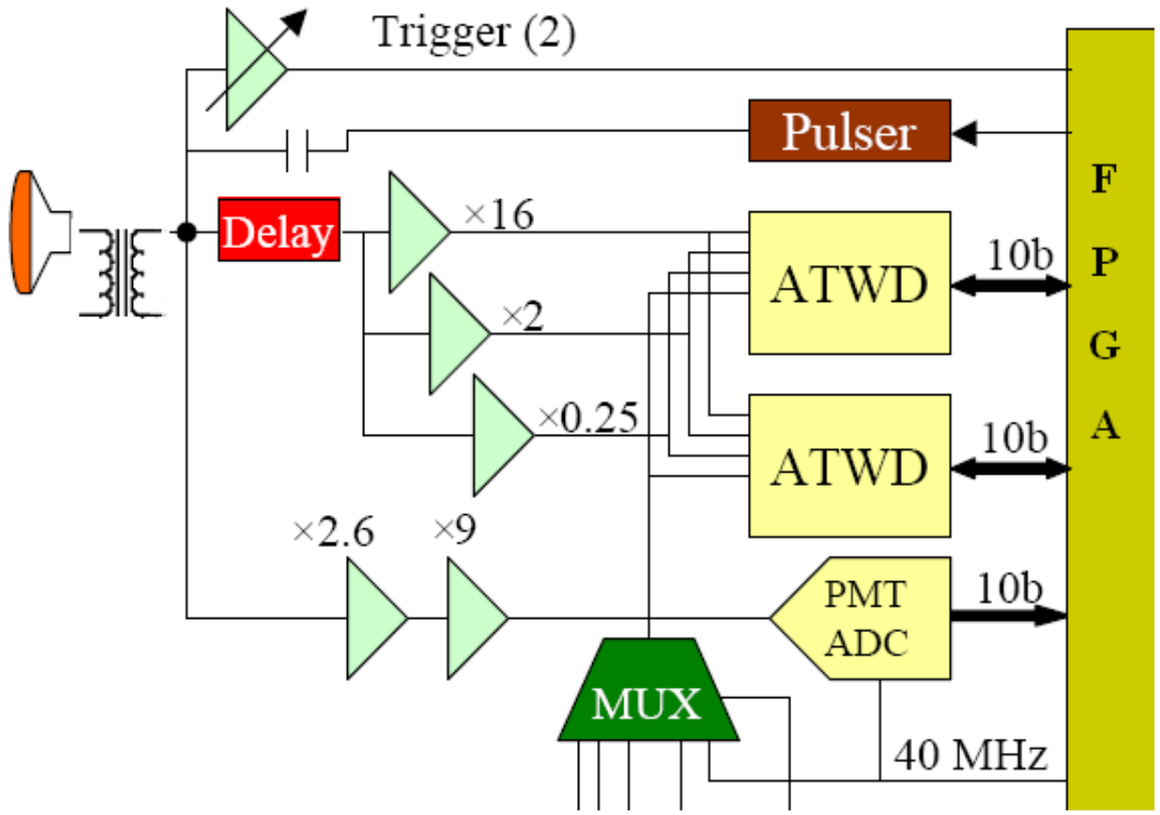
- PMT saturation model



DOM mother board simulation

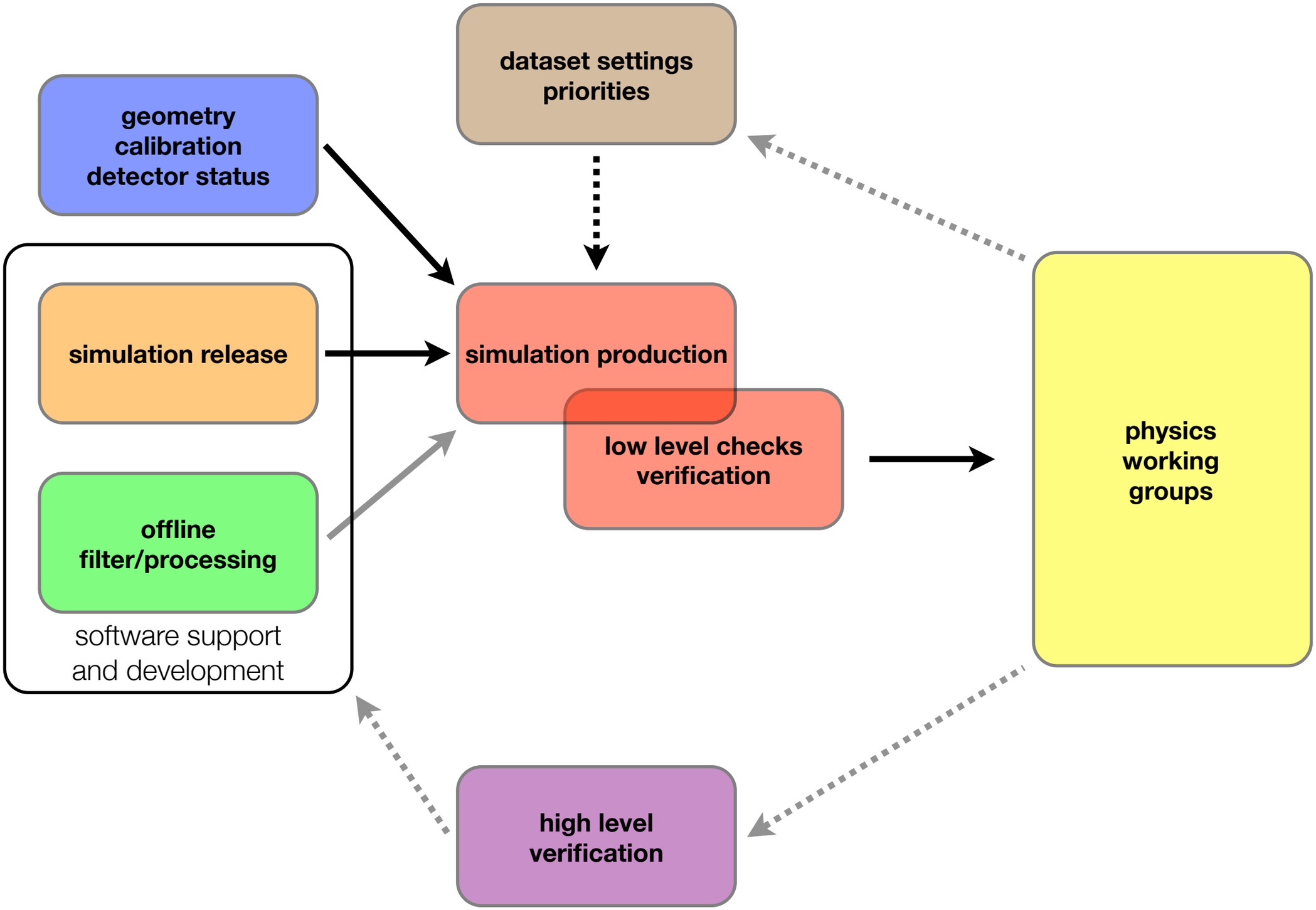
- core of detector simulation
  - digitization & timing @ MB



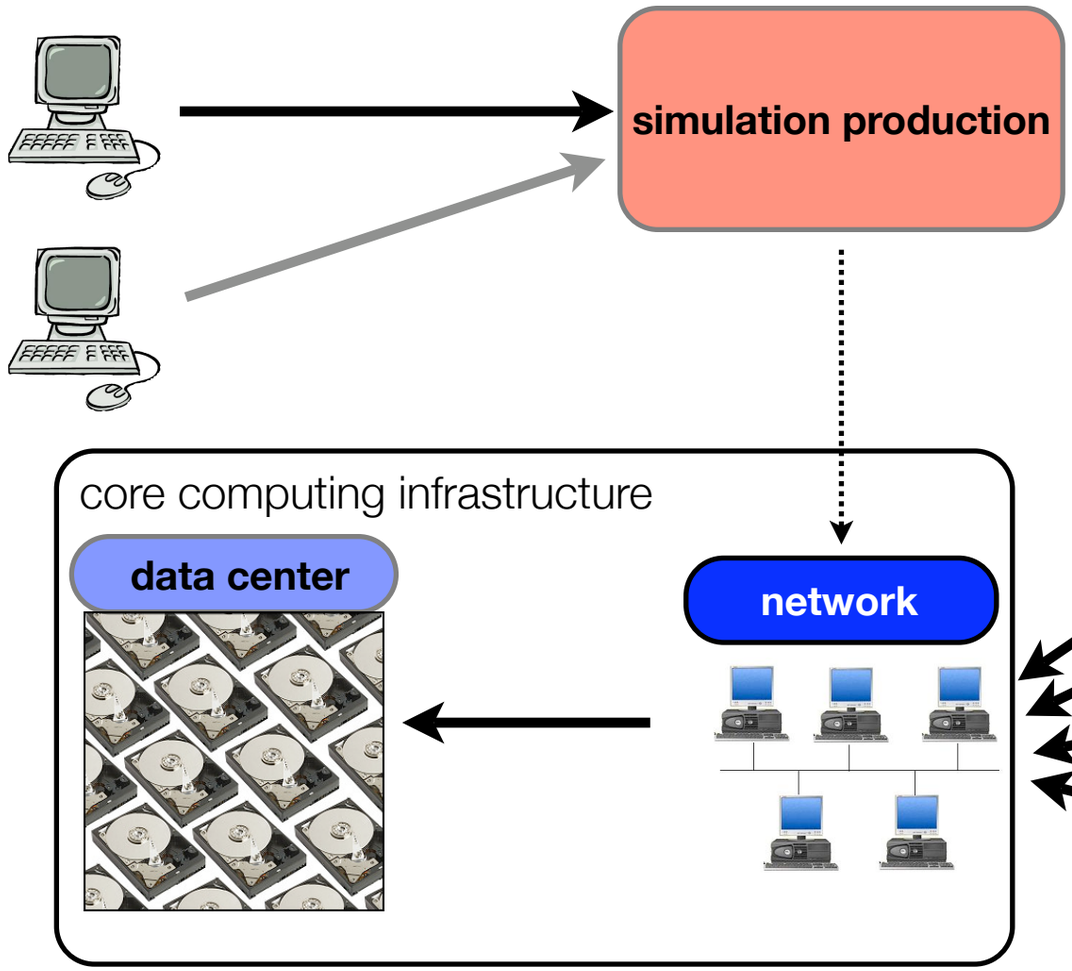


simulation production

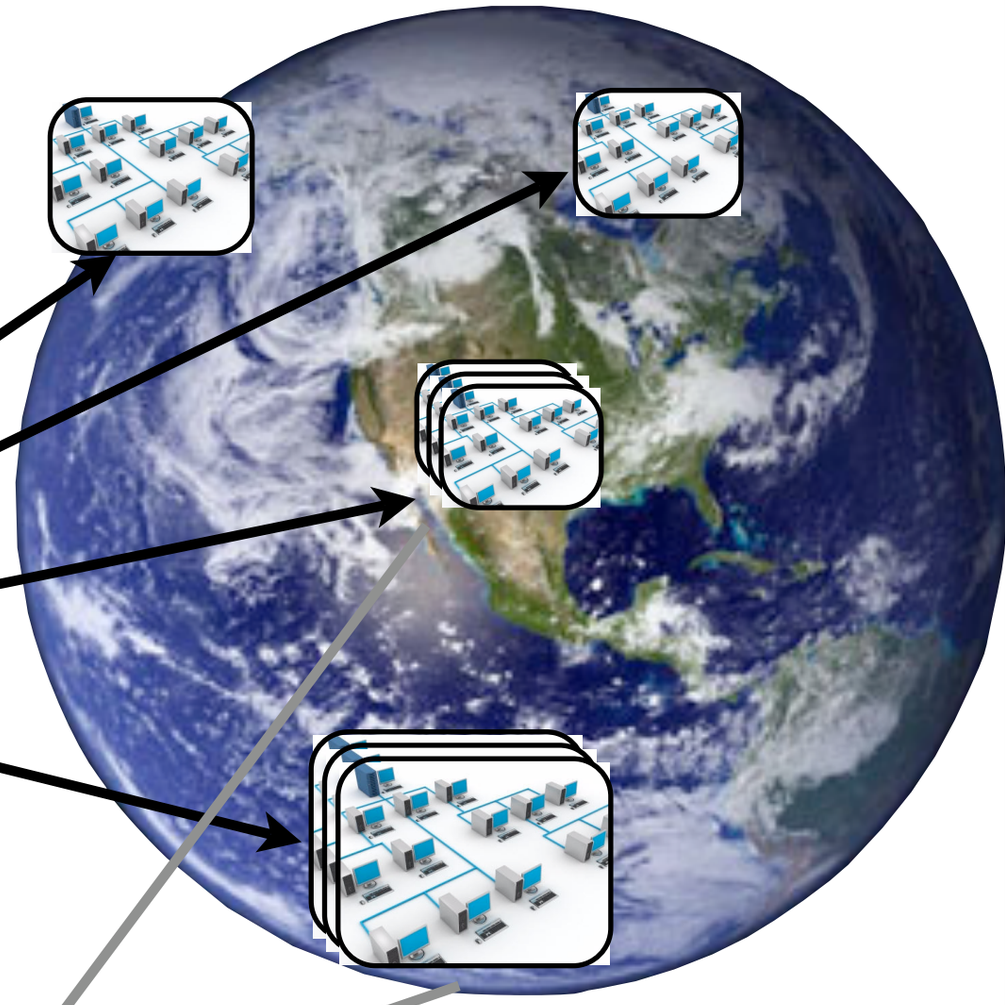
quick overview @ high level : where it stands



quick overview @ high level : how it runs



distributed computing infrastructure



from demand to production plan

➡ detector (geometry), calibration configuration defined

➡ simulation (filtering/processing) software are frozen and tested

- working group coordinators determine needs for physics analyses

- needs are quantified in terms of amount of background & signal to produce

  - physics parameters and det. configuration are determined (tested)

  - physics datasets (i.e. sim data for analyses) are defined

  - benchmark datasets (i.e. sim data for systematics) are determined

    ➡ set up simulation dataset configurations (templates)

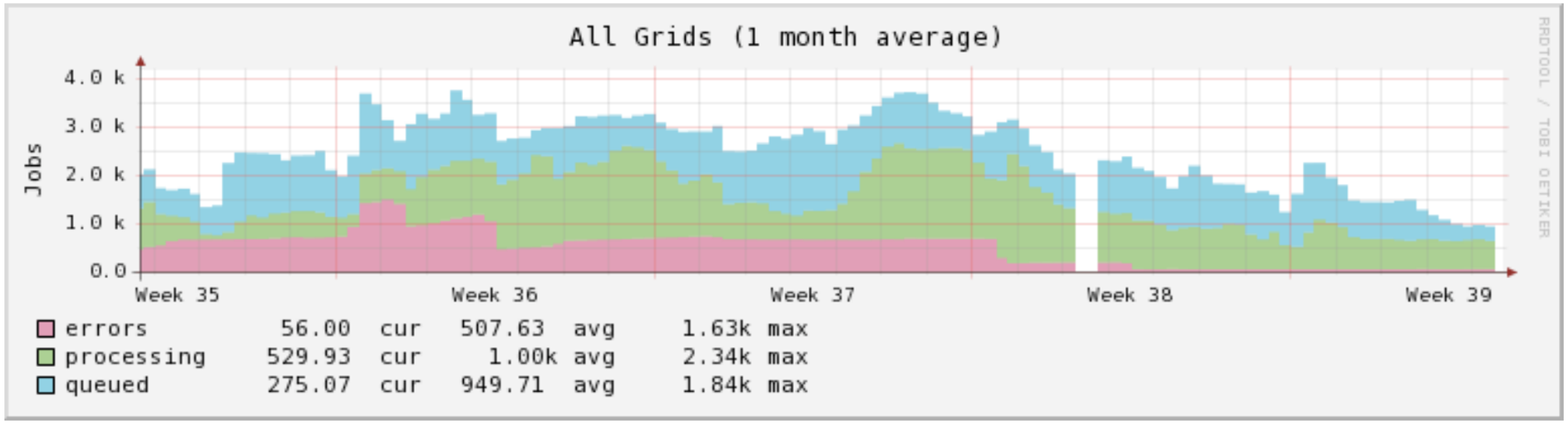
from plan to production : the sites

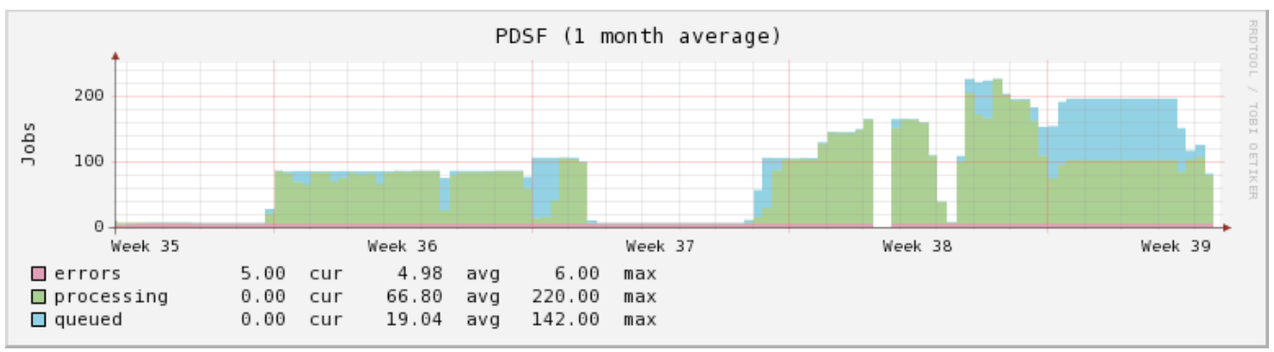
site	contact person	farm type	cpu type	#cores	core speed (GHz)	memory/core (GB)	staging storage (GB)	status
UW-GLOW	J.C. Díaz Vélez, P. Desiati	grid	Intel Xeon 32bit	60	2.80GHz	1	??	online
		grid	Intel Xeon 64bit	60	3.20GHz	2	??	online
UW-CHTC	J.C. Díaz Vélez, P. Desiati	batch	Intel Xeon E5440		2.8 GHz	1.5	??	online
		batch	another type		another speed	2	??	online
UW-NPX2	J.C. Díaz Vélez, P. Desiati	batch	Dual Core AMD Opteron		2.411 GHz	1-2	??	offline
UMD	B. Christy, E. Blaufuss	batch	AMD Opteron(tm) Processor	146	various	2	1000	online
			AMD Opteron(tm) Processor	120	2.50	4	1000	online
PSU	D. Grant	batch	Dual 3.0 GHz Intel Xeon 3160 (Woodcrest) Dual-Core Processors	560(xc) + 1100 (xj) + 560 (xi)	3.0	8 (50%)- 16 (50%) - 32(xj) -64(xi)	2-3k	online
LBNL-PDSF	J. Kiryluk	batch	Quad-Core AMD Opteron(tm) Processor 2350	200	2.01	2	??	online
		batch	Dual-Core AMD Opteron(tm) Processor 2220	52	2.81	2	??	online
		batch	AMD Opteron(tm) Processor 248	31	2.20	2	??	online
bartol	J. Eisch, X. Bai	batch	8-Core AMD Opteron	136	2.43 GHz	2	100GB/node	online
LONI	J.C. Díaz Vélez, P. Desiati	batch (Eric)	Intel Xeon 64bit	256	2.33 GHz	2	/work 100GB	online
		batch (Oliver)	Intel Xeon 64bit	256	2.33 GHz	2	/work 100GB	online
		batch (Louie)	Intel Xeon 64bit	256	2.33 GHz	2	/work 100GB	online
		batch (Pos.)	Intel Xeon 64bit	256	2.33 GHz	2	/work 100GB	online
Aachen	D. Boersma, M. Schunck	grid	Intel Xeon 64bit (E5345)	100 (max 2000)	2.33 GHz	2	15TB on SE	online
Dortmund	D. Pieloth	grid	Intel(R) Xeon(R) CPU X5355 64bit	2048 (max)	2.66	1.5	108TB on SE	online
		grid	Intel(R) Xeon(R) CPU 5130 32bit	200 (max)	2.00	1	6TB on SE	online
	F. Clevermann	batch		3328 (max)		2GB (92%) / 4GB (8%)	256TB	planned start Oct.
Mainz	K. Wiebe	grid	Intel Xeon E5345	240	2.33	2	20000	online
Wuppertal	T. Karg, K.-H. Becker	grid	Xeon E5440	128	2.8	2	2000	online
DESY	P. Majumbdar, J. Berdermann, M. Walter	batch	Glovertown 64bit	220	2.3	2	250/blade	online
		batch	Hapertown 64bit	300	2.8	4	250/blade	online
		grid	Glovertown 64bit	300	2.3	2	250/blade	online
SweGrid	H. Johansson	grid	Intel Xeon E5430	125 (allocated), 1950 (max)	2.66 GHz	2	??	online
Brussels	??	grid	??		??	??	??	offline

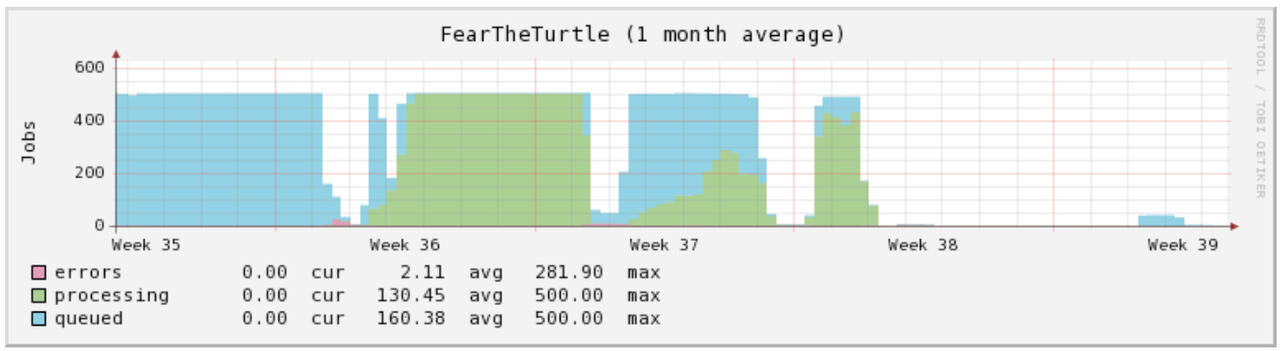
update table

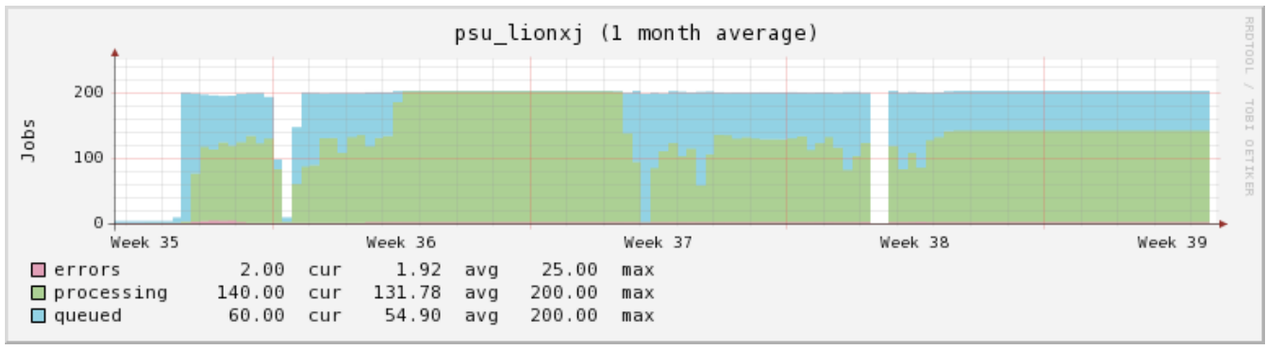
from plan to production : the sites

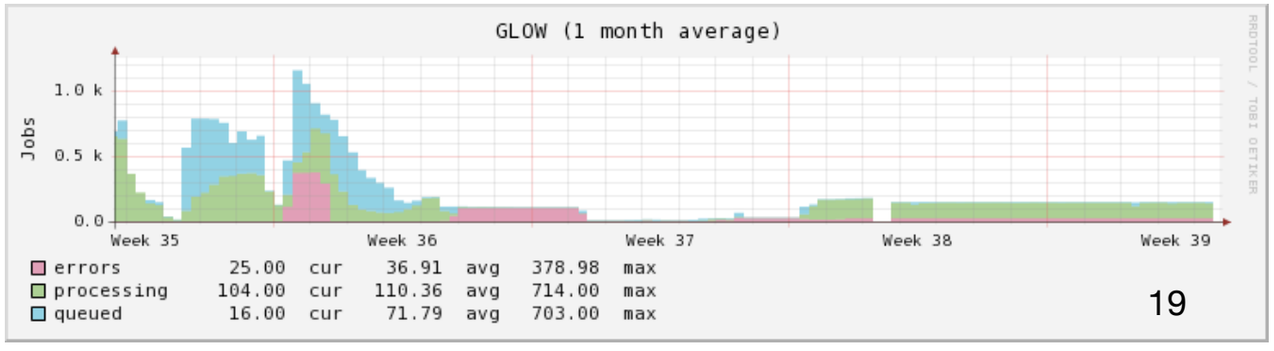
- assess data size and CPU time & distribute jobs throughout production sites





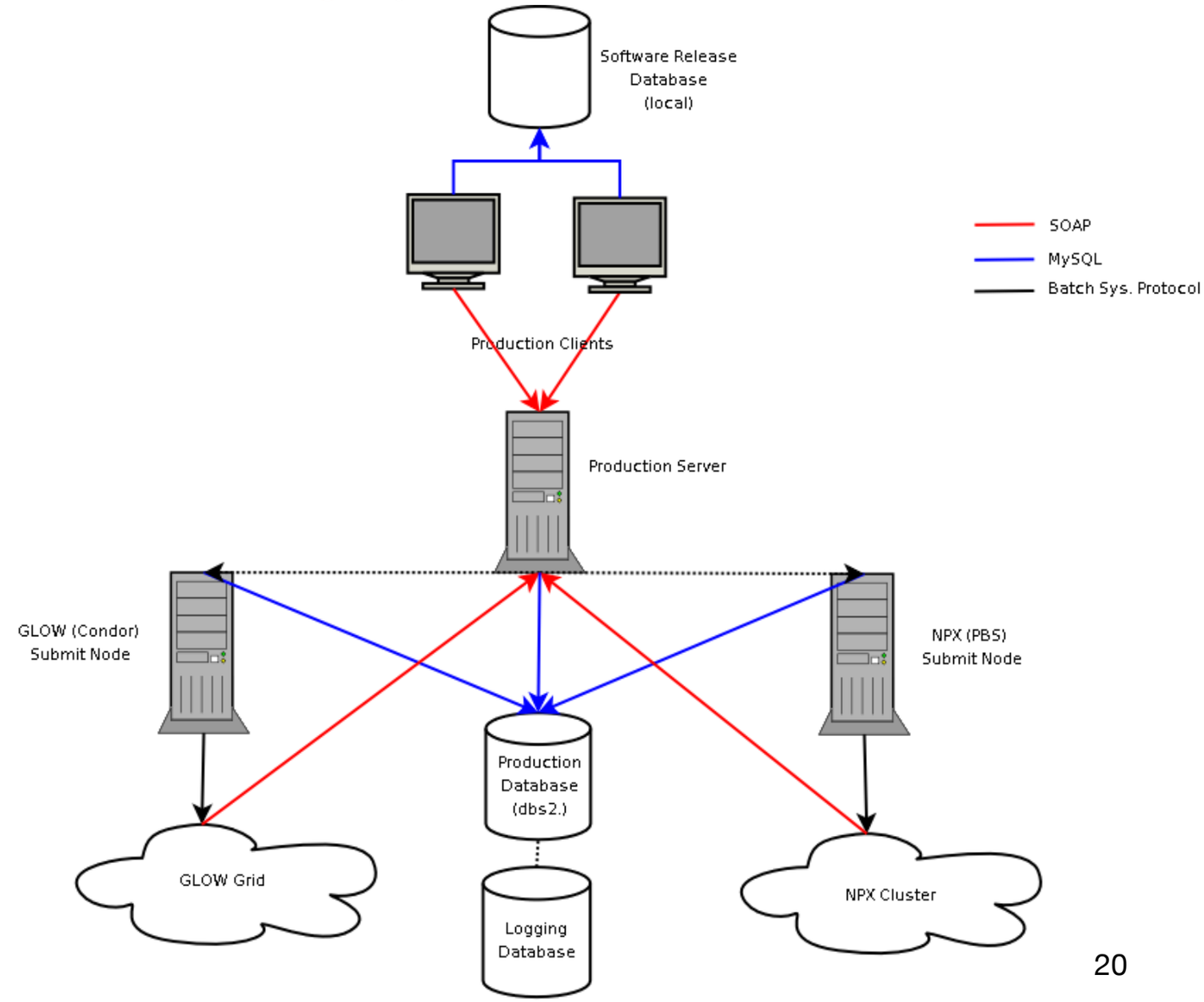




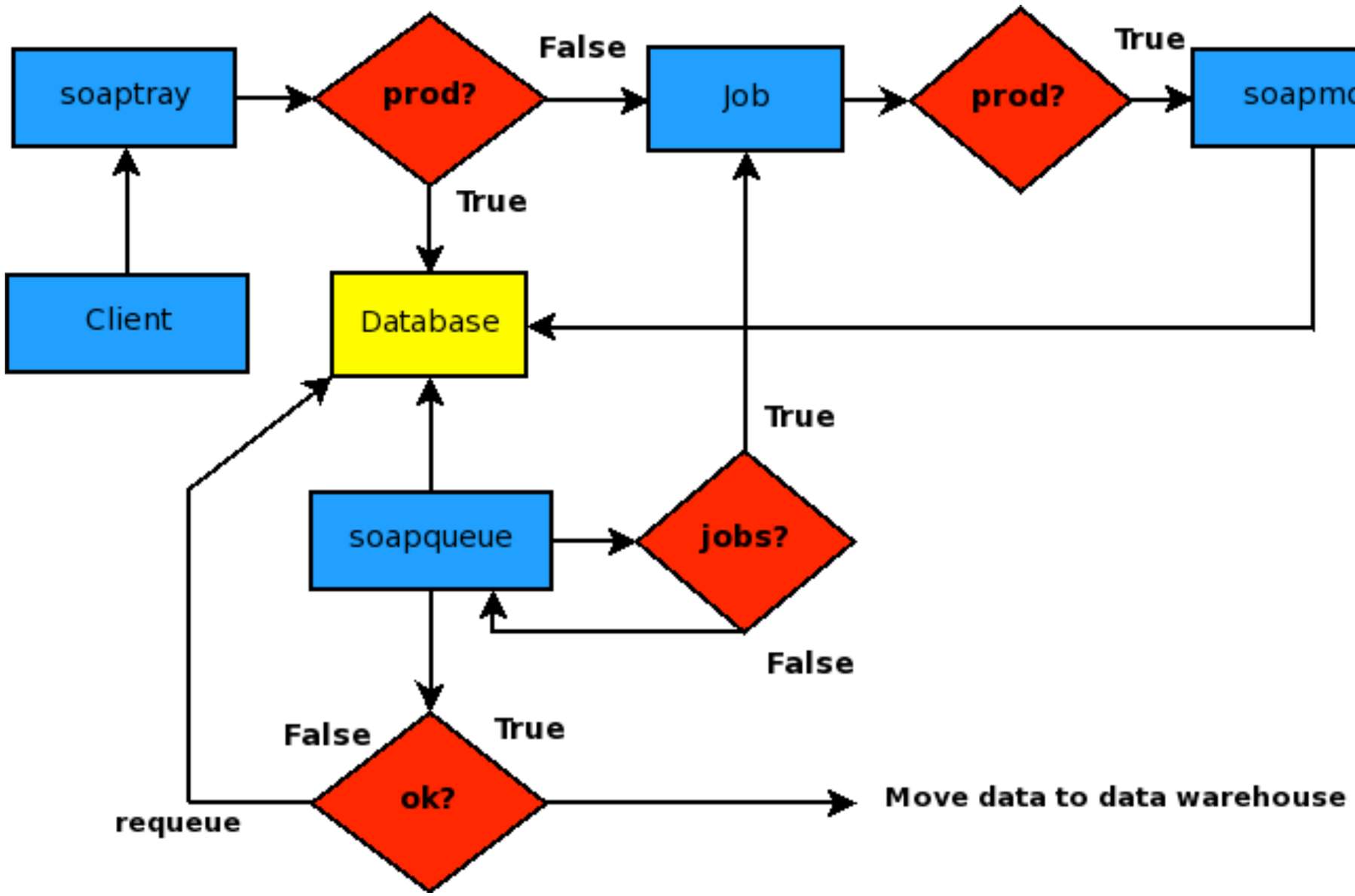


the production brain : IceProd (Juan Carlos Díaz Vélez)

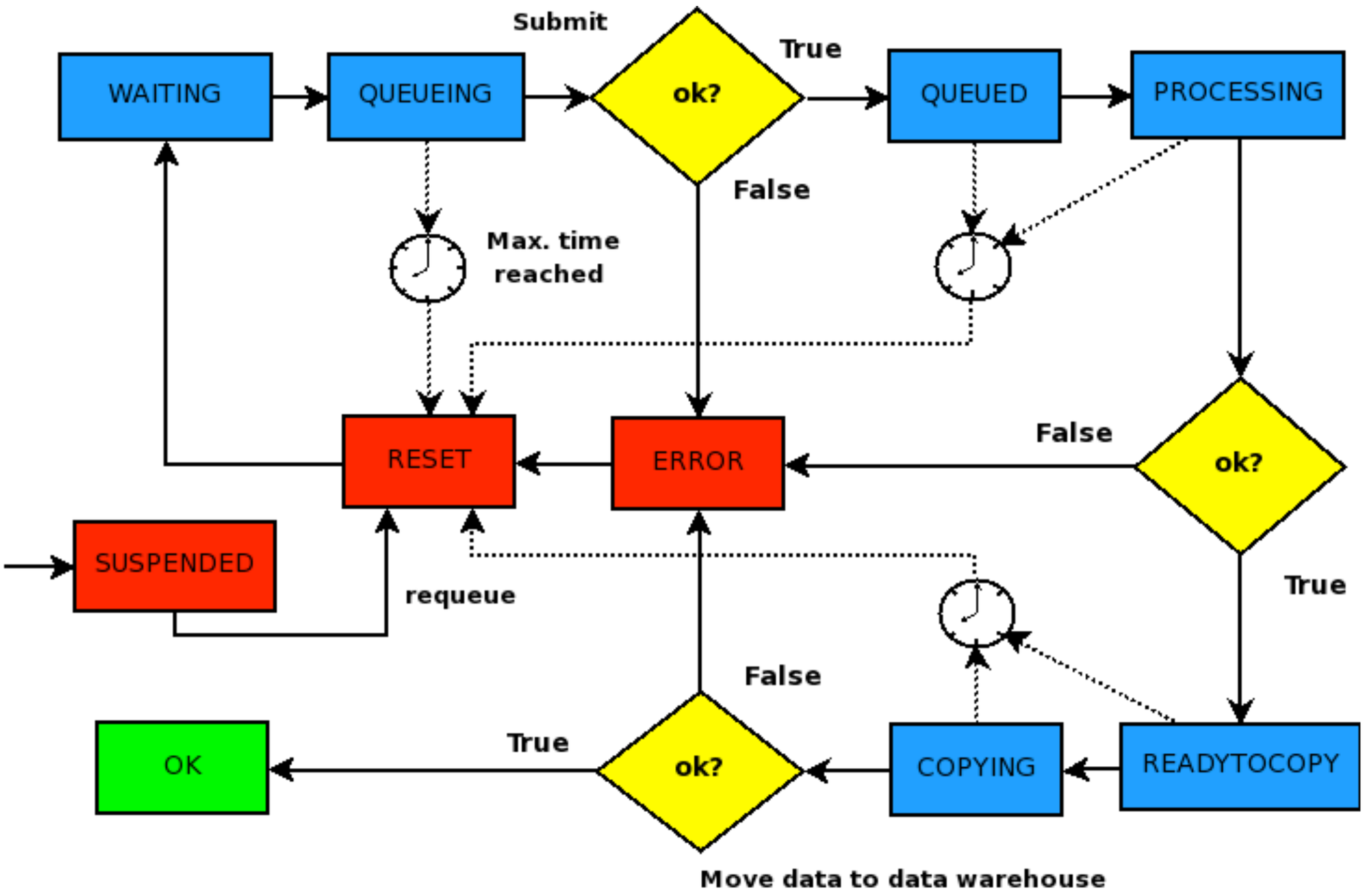
- cataloging steering params & software versions for simulation datasets
- distributed job management and monitoring system
- written in python
- daemons manage cluster job submission
- Jobs communicate to daemons via SOAP



IceProd : the daemons



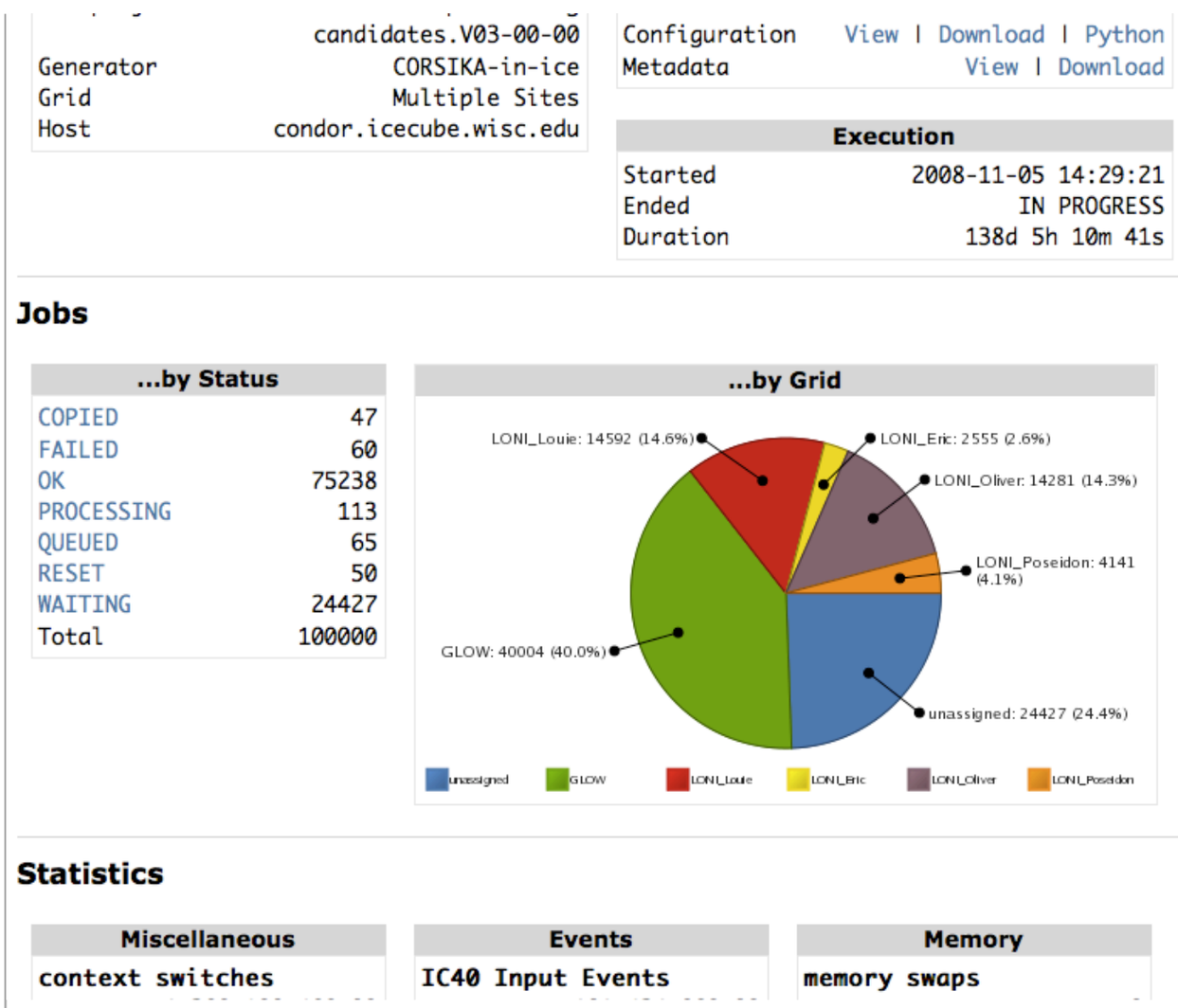
IceProd : job management



IceProd : distributed computing system

- adapt to different sites and batch and grid systems
  - PBS, sge, condor, ...
  - GLOW, Grid Engine, Nordugrid (Swegrid), Open Science Grid, LONI

ID	Name	Institution	System Type	Version	soaptray (pid)	soapmon (pid)	soapqueue (pid)	soapdh (pid)	soaphisto (pid)	Last Update
123	aachen-grid	RWTH Aachen	glite.gLite	1.2.3	RUNNING (23639)	RUNNING (23642)	RUNNING (23641)	RUNNING (23637)	DISABLED (N/A)	2009-09-17 15:17:45
24	ALiCEnext	BU-Wuppertal	alicenext	1.0.5	STOPREQUEST (15759)	STOPPED (15761)	STOPREQUEST (15760)	STOPREQUEST (15758)	DISABLED (N/A)	
78	bartol	Bartol	sge	trunk	RUNNING (28867)	RUNNING (28869)	RUNNING (28868)	RUNNING (28865)	DISABLED (N/A)	2009-09-17 15:20:44
77	CHTC	UW-Madison	condor.Condor	trunk	RUNNING (17572)	RUNNING (18365)	RUNNING (17573)	RUNNING (17571)	DISABLED (N/A)	2009-09-17 15:17:33
9	desy	DESY	sge	1.1.5	RUNNING (6690)	RUNNING (6693)	RUNNING (6692)	RUNNING (6688)	DISABLED (N/A)	2009-09-17 15:17:38
79	EGEE	Dortmund grid	glite.gLite	trunk	RUNNING (2676)	RUNNING (2679)	STOPREQUEST (2678)	RUNNING (2674)	DISABLED (N/A)	2009-06-26 18:45:06
92	EGEE.Madison	EGEE	glite.gLite	trunk	DISABLED (N/A)	DISABLED (N/A)	RUNNING (14985)	RUNNING (14956)	DISABLED (N/A)	2009-09-17 15:20:14
8	FearTheTurtle	UMD	sge	1.2.3	RUNNING (25508)	RUNNING (25518)	RUNNING (25509)	RUNNING (25507)	DISABLED (N/A)	2009-09-17 15:21:16
1	GLOW	UW-Madison	condor.Condor	trunk	RUNNING (27144)	RUNNING (27146)	RUNNING (27145)	RUNNING (27143)	DISABLED (N/A)	2009-09-17 15:17:40
126	gloworm	UW-Madison	condor.Condor	trunk	RUNNING (18374)	RUNNING (19333)	RUNNING (18375)	RUNNING (18372)	DISABLED (N/A)	2009-09-17 15:18:58
26	katrina	Southern University	pbs	1.1.2	DISABLED (N/A)	RUNNING (15170)	STOPREQUEST (15169)	RUNNING (15167)	DISABLED (N/A)	2009-05-04 13:17:18

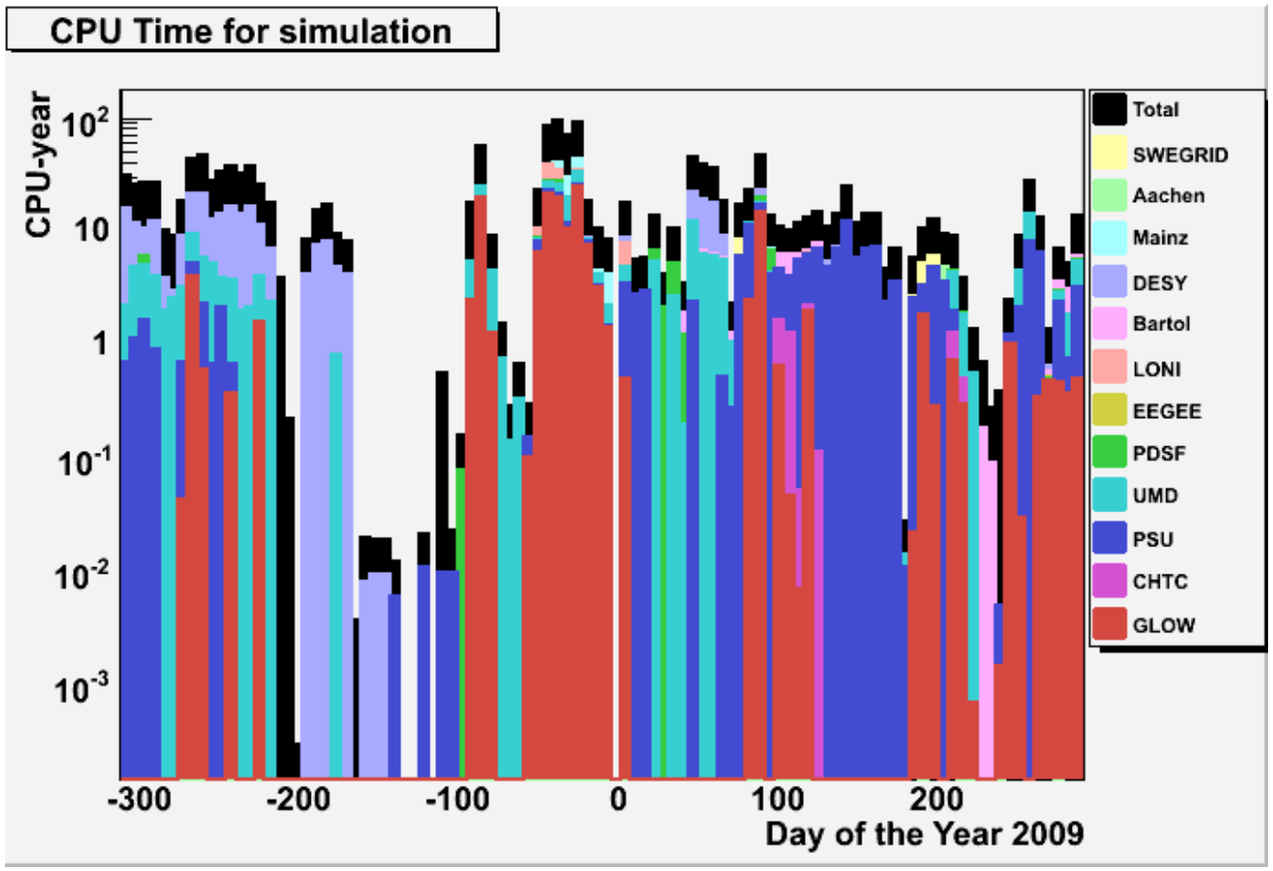


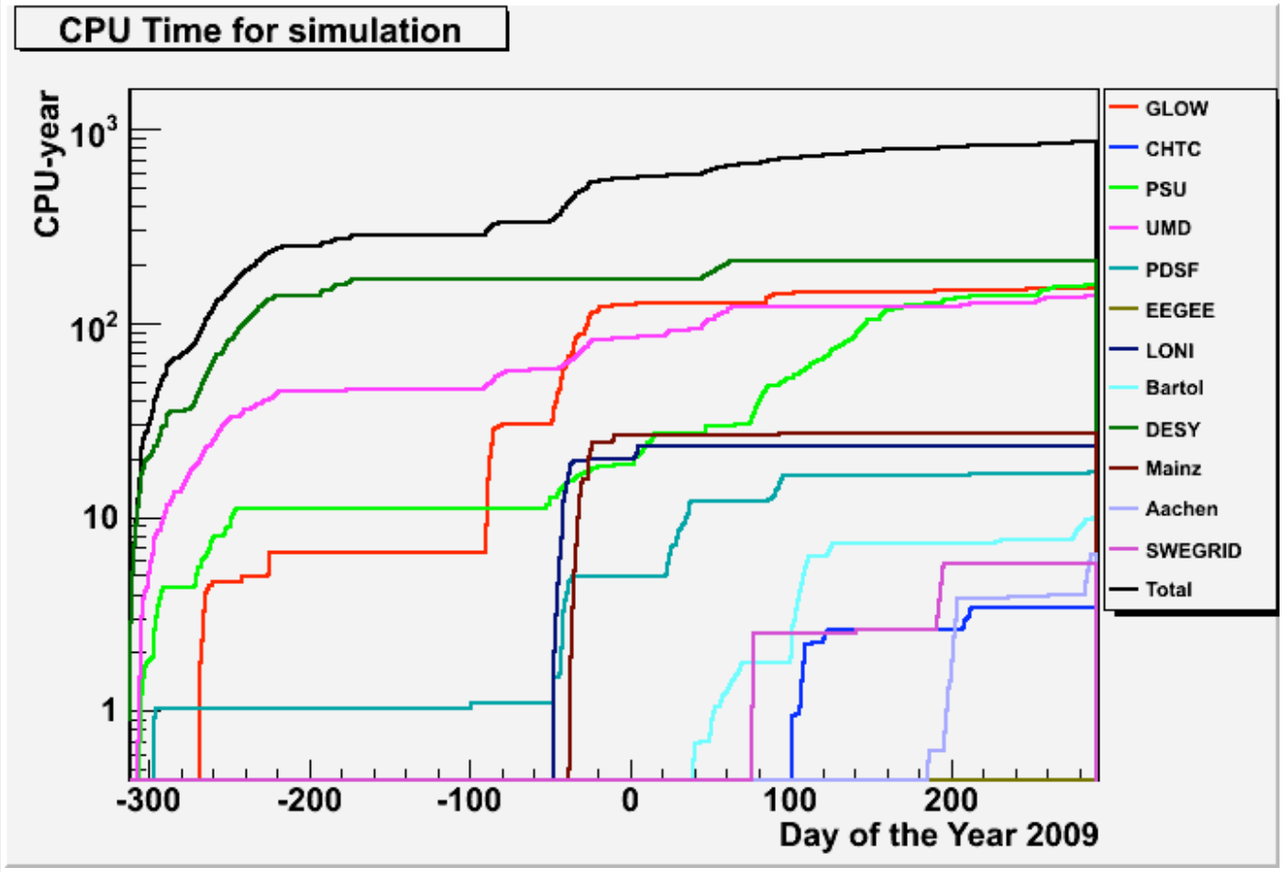
Ian Rae

IceProd : web interface

production monitoring and statistics collection

production history and configurations search engine





IceProd : running on the sites

Tickets

Number	Requestor	Subject	Status	RT Link
Ticket 10964	silvestr	Re: [icecube-c] Simulation production status August 4, 2009	new	RT#10964
Ticket 10963	desiati	Re: [icecube-c] Simulation production status August 4, 2009	new	RT#10963
Ticket 10934	mdagost	Re: [Simprod] IC22 NuE with stretched tables	open	RT#10934
Ticket 10931	desiati	Re: [Simprod] IC22 NuE with stretched tables	resolved	RT#10931
Ticket 10929	desiati	benchmark dataset for Earth's core analysis	resolved	RT#10929
Ticket 10804	desiati	[Fwd: Re: [Simprod] request for nugen_numu E^-2 simulation using "stretched ice"]	resolved	RT#10804
Ticket 10802	whuelsnitz	Re: nugen_numu for OM sensitivity sytematics study	resolved	RT#10802
Ticket 10801	desiati	Re: nugen_numu for OM sensitivity sytematics study	resolved	RT#10801
Ticket 10765	juancarlos	Benchmark datasets with PPC	new	RT#10765
Ticket 10667	seo	Re: IC22 NuTau production without CMC	resolved	RT#10667
Ticket 10666	desiati	Re: IC22 NuTau production without CMC	open	RT#10666
Ticket 10586	desiati	Re: [icecube-c] Brief production status	resolved	RT#10586
Ticket 10235	juancarlos	Simluation Data Cleanup	new	RT#10235
Ticket 10197	juancarlos	binning bug: re-simulate detector for high cut level events.	resolved	RT#10197
Ticket 9761	juancarlos	Produce samples of in-ice CORSIKA with different atmospheric models	resolved	RT#9761
Ticket 9705	Elisa.Resconi	Re: Request for nugen_numu simulation with different DOM sensitivities	resolved	RT#9705
Ticket 9702	whuelsnitz	Re: Request for nugen_numu simulation with different DOM sensitivities	resolved	RT#9702
Ticket 9700	SRKlein	Re: Request for nugen_numu simulation with different DOM sensitivities	resolved	RT#9700

ticket system :

- document discussions on requests
- link to a given dataset

[Simprod] SimProd Usage Summary for Thu Apr 26 10:00:0... ice3simusr@icecube.wisc.edu 9:59 PM

Asunto: [Simprod] SimProd Usage Summary for Thu Apr 26 10:00: De: ice3simusr@icecube.wisc.edu 9:59 PM

```
------------ monthly summary  ------------
sys_t = 637934.749814
ok = 7045.0
usr_t = 72976855.6935
real_t = 119045455.388
suspended = 430.0
error = 0.0
events = 1210641.0
```

grid	sys_t	ok	usr_t	real_t	grid_id	suspend	error	events
GLOW	5.6e+04	5.2e+02	2.6e+06	2.9e+06	1	1.7e+02	0	8.4e+04
PDSF	1.2e+04	93	1.9e+06	2.3e+06	3	0	0	3.1e+05
Katrina	2.7e+05	2e+03	5.7e+07	1e+08	4	52	0	2e+05
FearThe	2.7e+05	3.9e+03	1.1e+07	1.3e+07	8	1.7e+02	0	4.8e+05
desy	0	0	0	0	9	20	0	0
npx2	3.6e+04	5.2e+02	7.6e+05	1e+06	14	20	0	1.4e+05

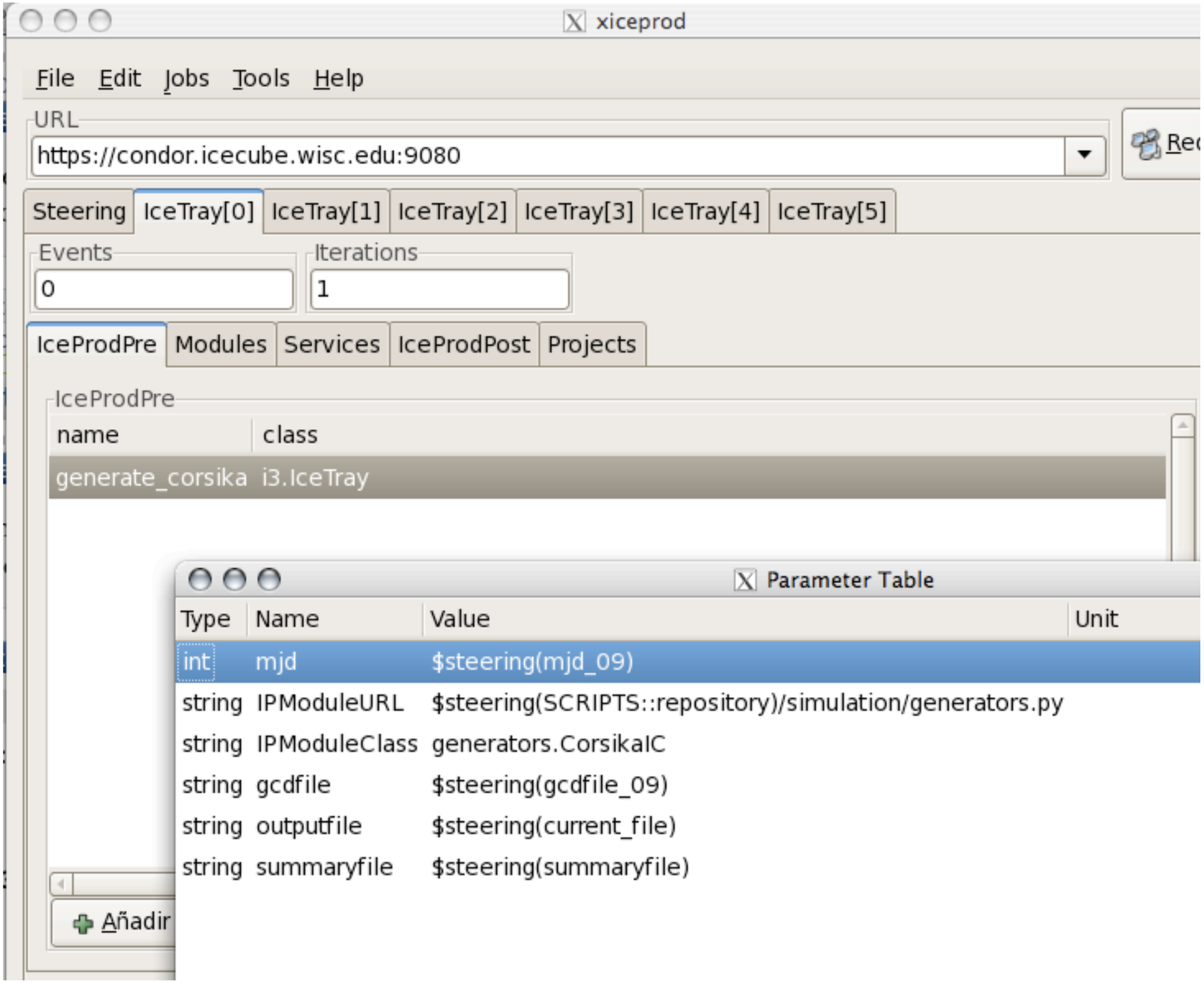
```
_______________________________________________
Simprod mailing list
Simprod@icecube.wisc.edu
http://www.icecube.wisc.edu/mailman/listinfo/simprod
```

Sin leer: 0 Total: 315

daily email usage report

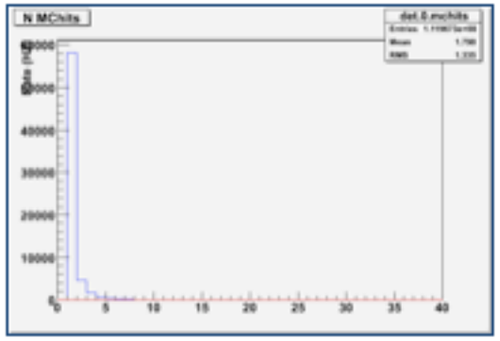
IceProd : community

IceProd : GUI

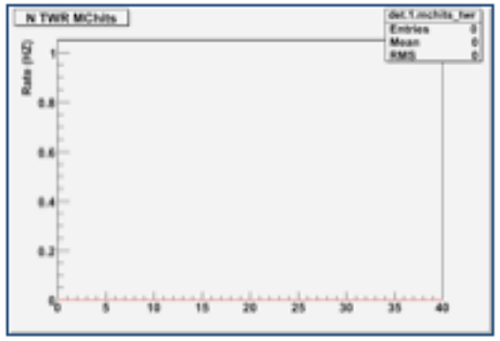

xiceprod
File Edit Jobs Tools Help
URL
https://condor.icecube.wisc.edu:9080
Steering IceTray[0] IceTray[1] IceTray[2] IceTray[3] IceTray[4] IceTray[5]
Events
0
Iterations
1
IceProdPre Modules Services IceProdPost Projects
IceProdPre
name class
generate_corsika i3.IceTray
Añadir
Parameter Table
Type Name Value Unit
int mjd $steering(mjd_09)
string IPModuleURL $steering(SCRIPTS::repository)/simulation/generators.py
string IPModuleClass generators.CorsikaIC
string gcdfile $steering(gcdfile_09)
string outputfile $steering(current_file)
string summaryfile $steering(summaryfile)

IceProd : production verification

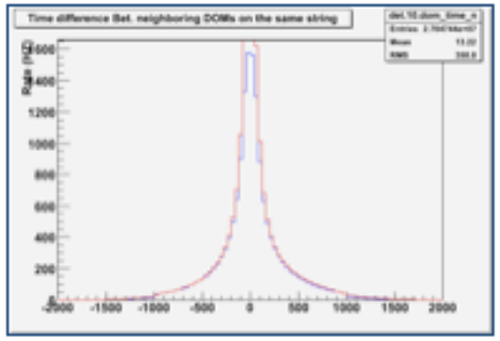
Detector Histograms



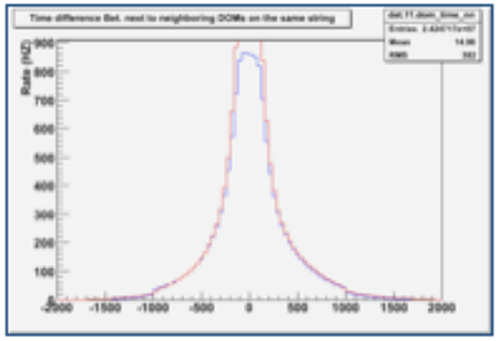
det.0.mchits



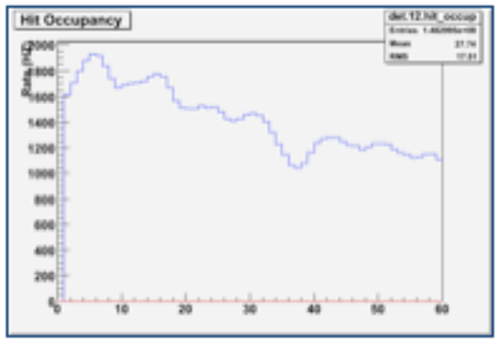
det.1.mchits_twr



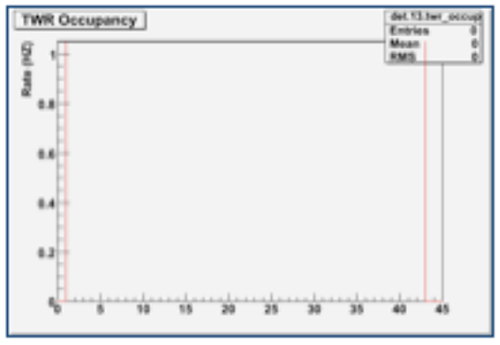
det.10.dom_time_n



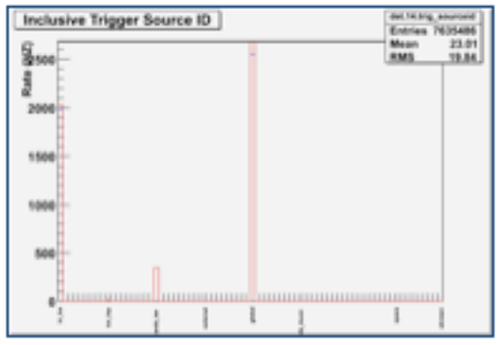
det.11.dom_time_nn



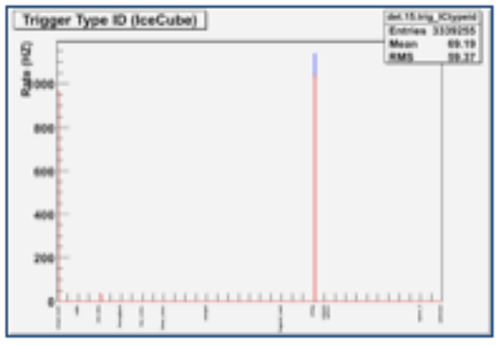
det.12.hit_occup



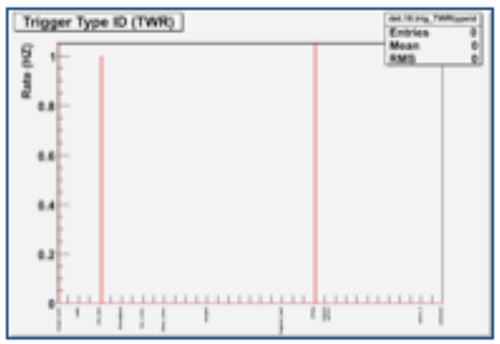
det.13.twr_occup



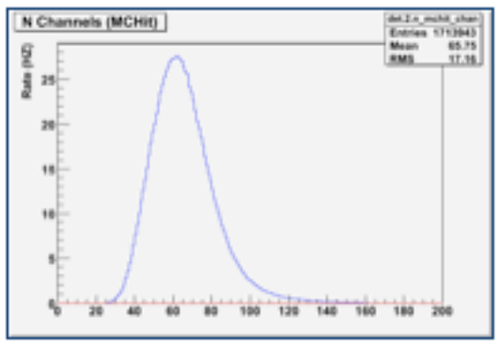
det.14.trig_sourceid



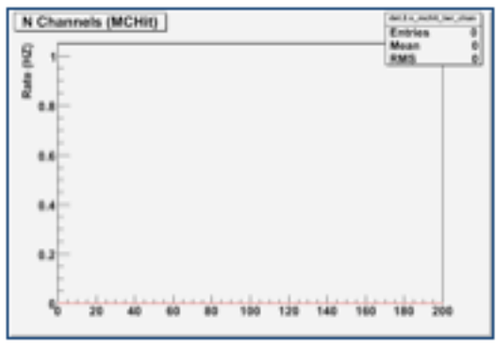
det.15.trig_ICtypeid



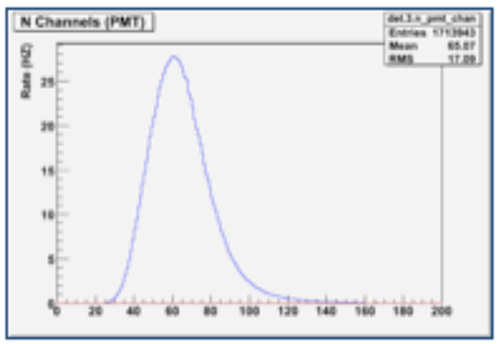
det.16.trig_TWRtypeid



det.2.n_mchit_chan



det.2.n_mchit_twr_chan



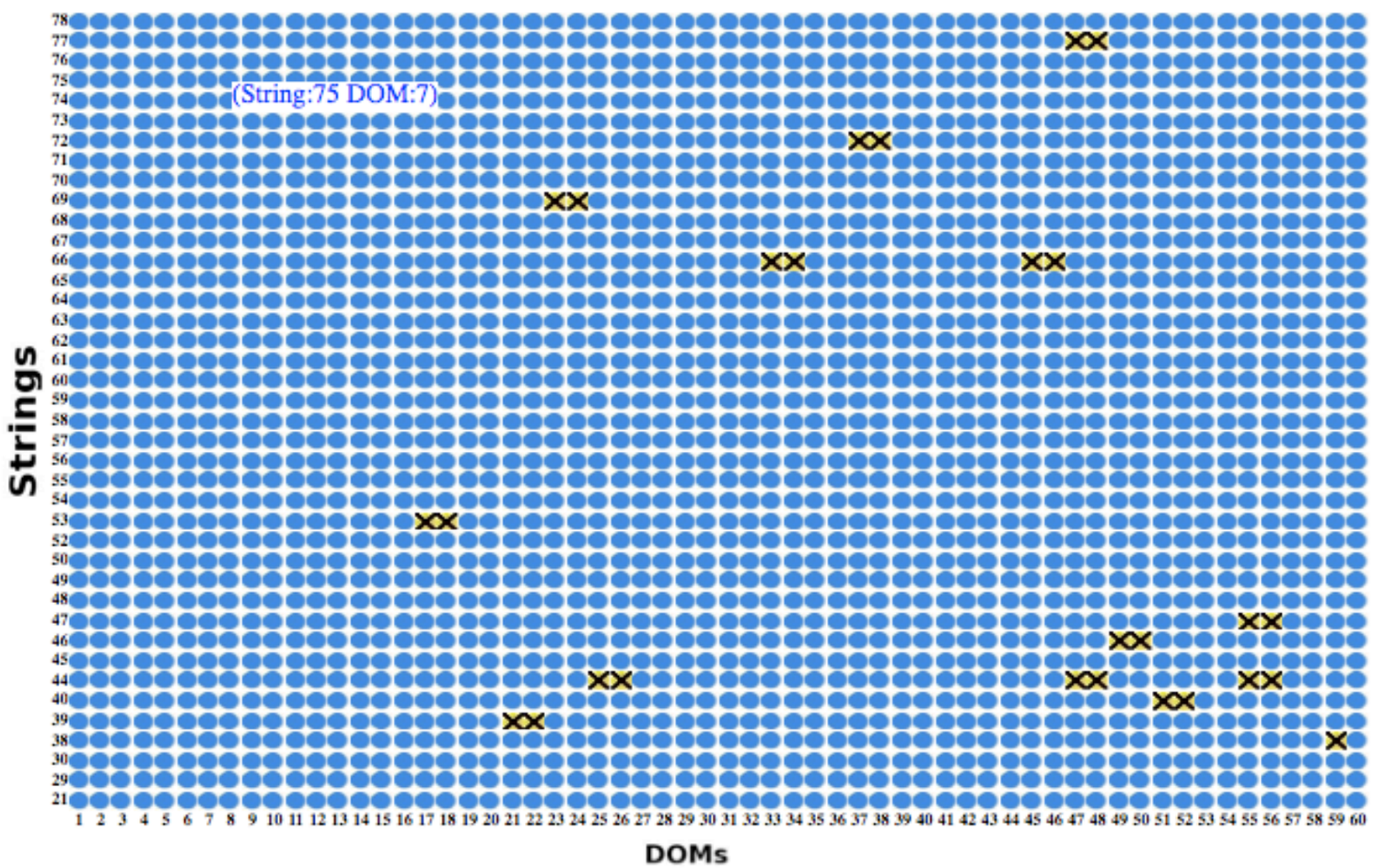
det.3.n_pmt_chan

simulation verification

Run #	Weight	Template	Analysis	Data Station
Threshold #	Original ○	Simulation ○	Occupancy ○	NPX2: ○
	Deweighted ○	Real Data ○	Charge ○	Glow: ○
		Previous release	TDP ○	Turtle: ○
			Start time ○	LONI: ○
			All ○	

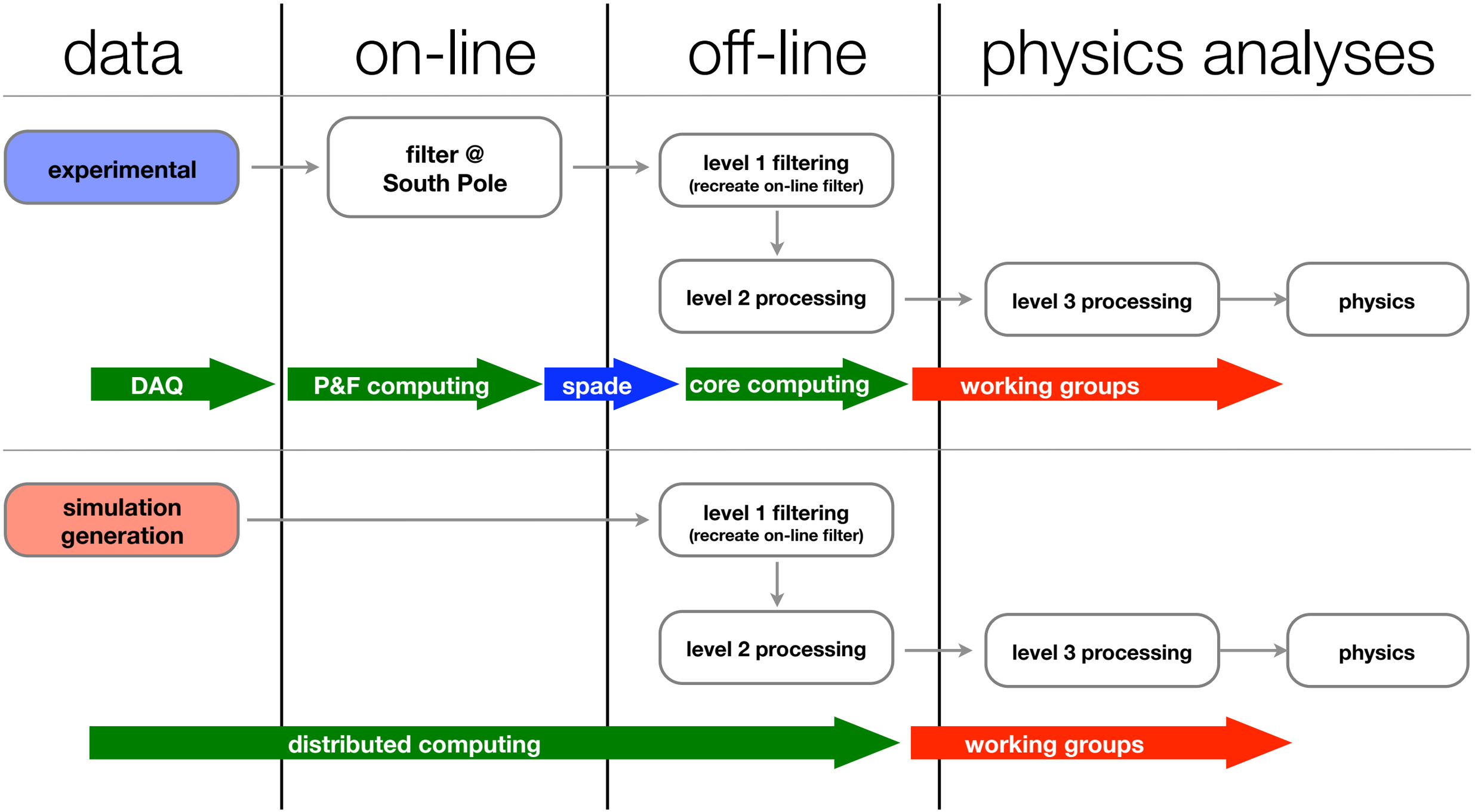
Submit Azzera

No comparison results for the Stations: Glow and RealData for the requested RunNo: 1540
Displaying results from the latest run RunNo: 2020 for these stations
DOMs marked by st analysis



extra

flow of experimental and simulation data

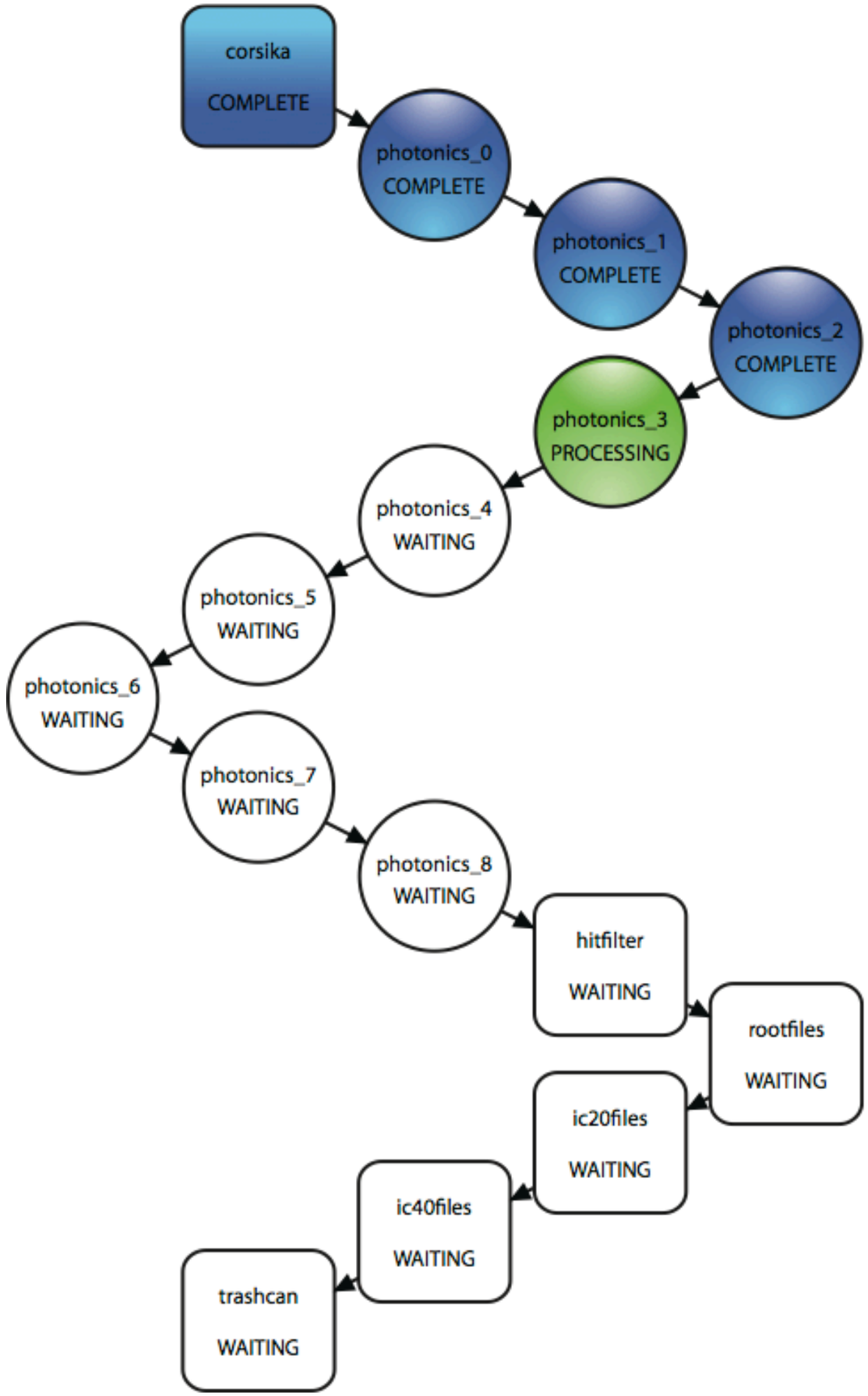


how to handle photon tables

- split jobs in pieces, each of which uses a subsample of photon tables (~700 MB)

- run jobs in sequence in the same node

➡ brake simulation chain in separate *trays*

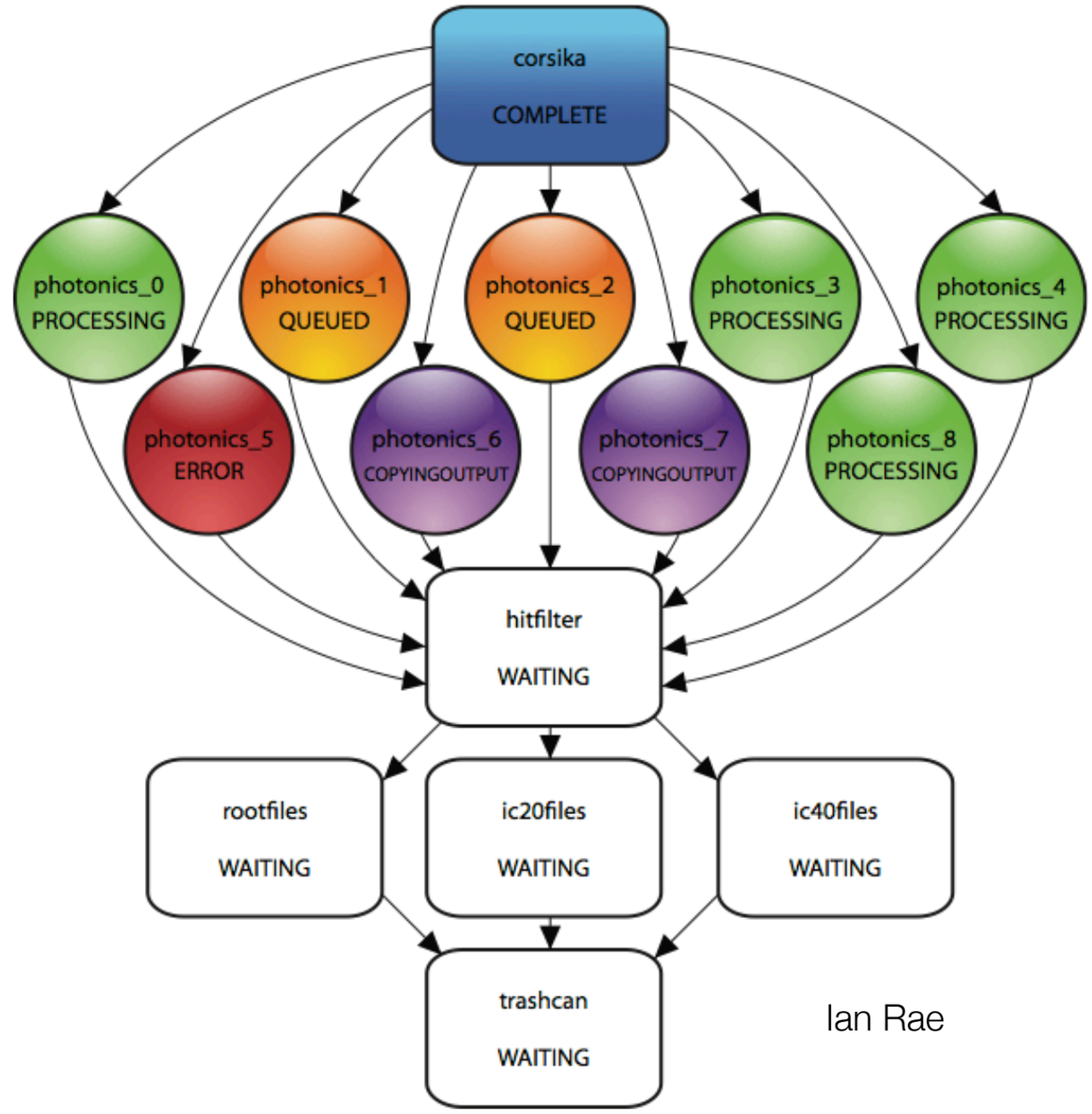


how to handle photon tables

Use Condor DAGMan to divide a simulation job into multiple Condor jobs

Each Condor job is called a “task” that runs part of a simulation job

Status updates are tracked for each task in the DB and displayed on the web



Ian Rae