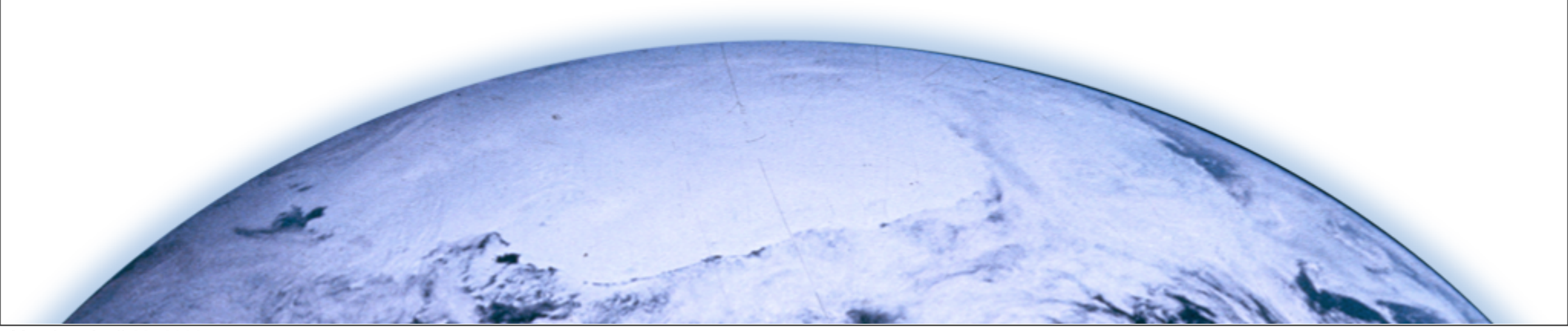
IceCube and Condor

Ian Rae
University of Wisconsin–Madison

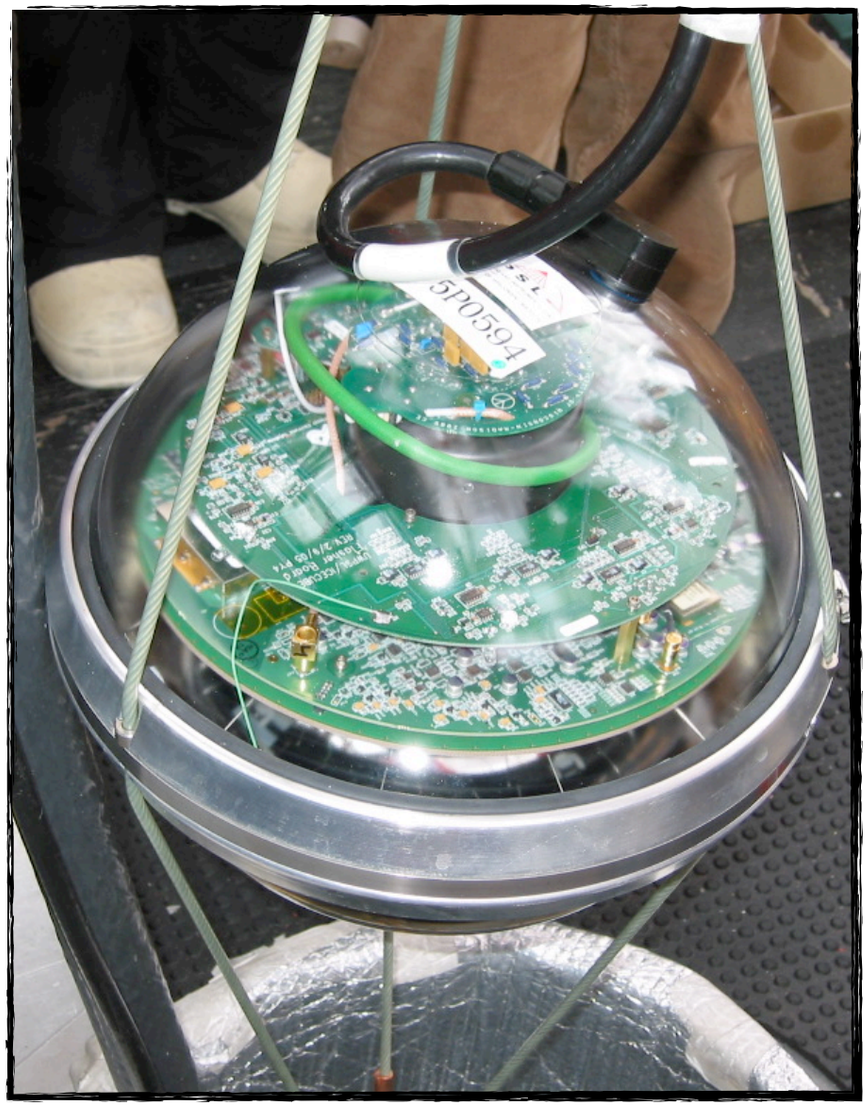
IceCube Collaboration

- 14 Universities in the US
- 15 Universities in Europe
- 2 Universities in Japan and New Zealand



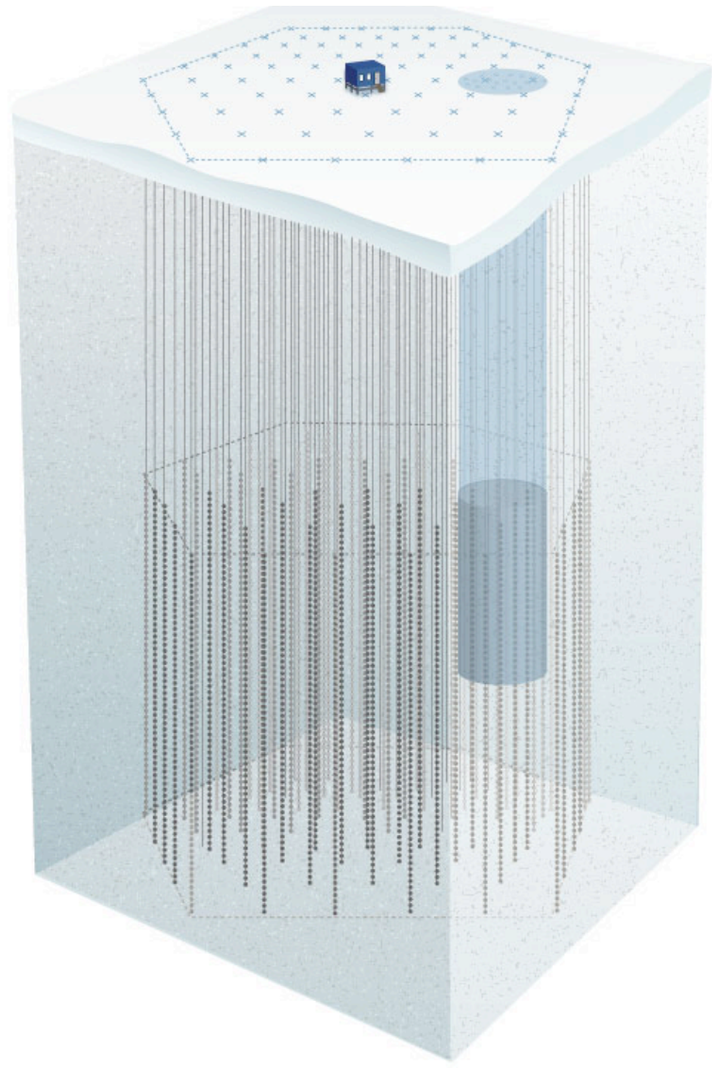
What is IceCube?

- Antarctic neutrino observatory
- Constructed in ice with a volume of 1 km^3
- Digital optical modules (DOMs) do the actual detection



In-Ice Arrangement

- DOMs arranged in 2450m long strings
- 60 DOMs per string
- Currently 59 strings deployed, final goal is 80+ strings
- Completion expected in 2011



Simulation Production

- Simulate detector in various states
  - 40 strings, 59 strings, 80 strings, etc.
- Monte Carlo method
- 1 neutrino per 1 million background particles

CPU Requirements

- One CPU hour needed to generate one detector second
- Three months livetime is 7,776,000 CPU hours
- Need Condor!

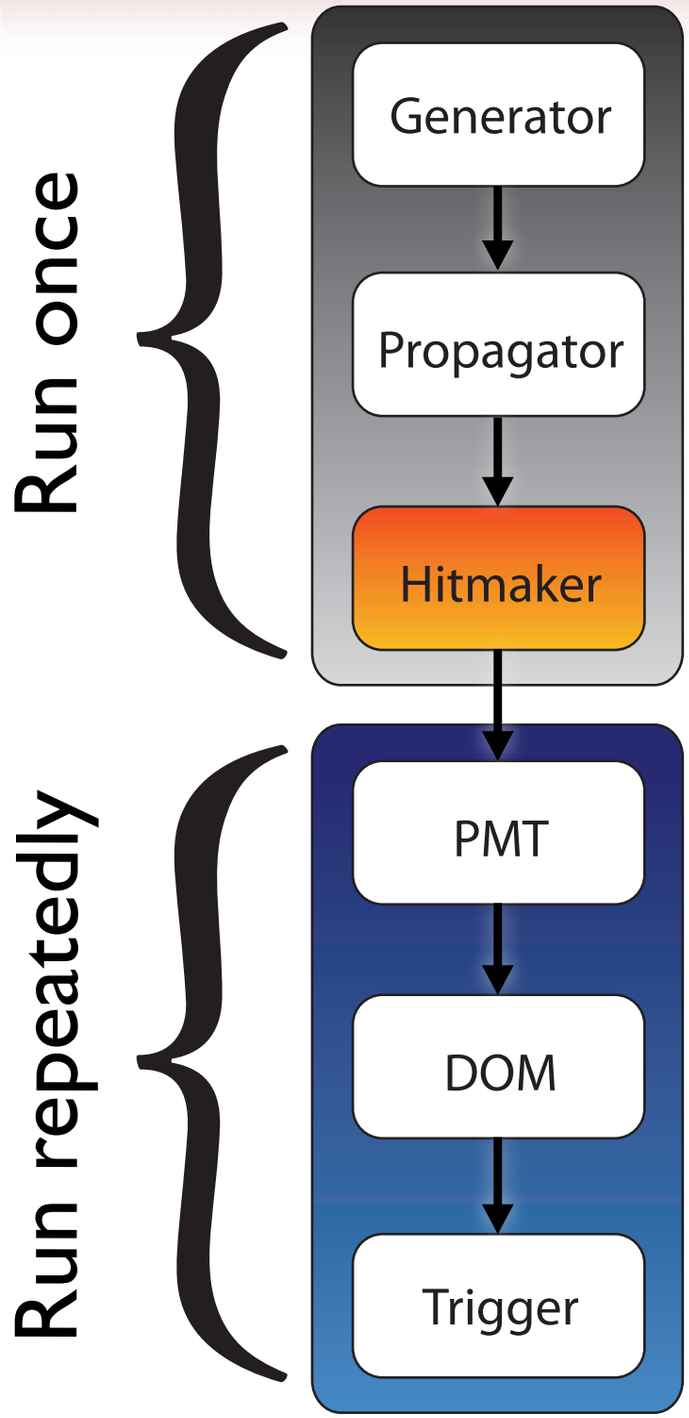
Dataset Workflow

- XML configuration files
  - Divided into sections called “trays”
    - Trays correspond to different parts of a simulation
    - Each tray executes in its own process
- Typical dataset has 10,000 simulation jobs

Photonics Tables

- Pre-computed data about the ice
- 14GB per set of tables
- Two sets
  - IceCube
  - AMANDA (IceCube's predecessor)

Job Workflow



Generate particles from various sources

Propagate particles through ice

Generate DOM hits for detected particles
Uses photonics tables, potentially lots of RAM

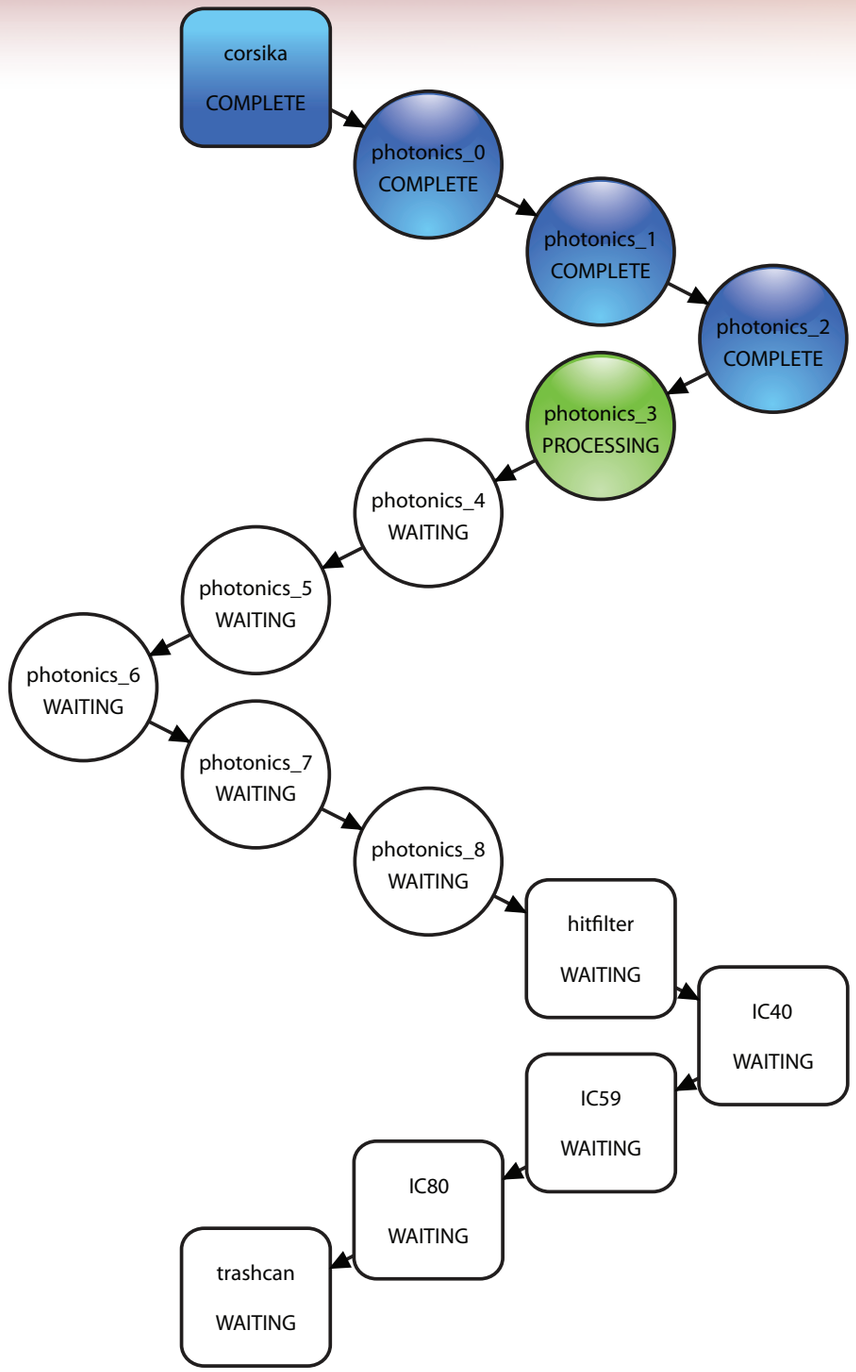
Simulate photomultiplier tubes

Simulate DOM mainboard

Simulate string trigger response

Old Implementation

- Daemons generate Condor submit files
- One simulation job is one Condor job
- Job execution is entirely linear (a “big snake”)

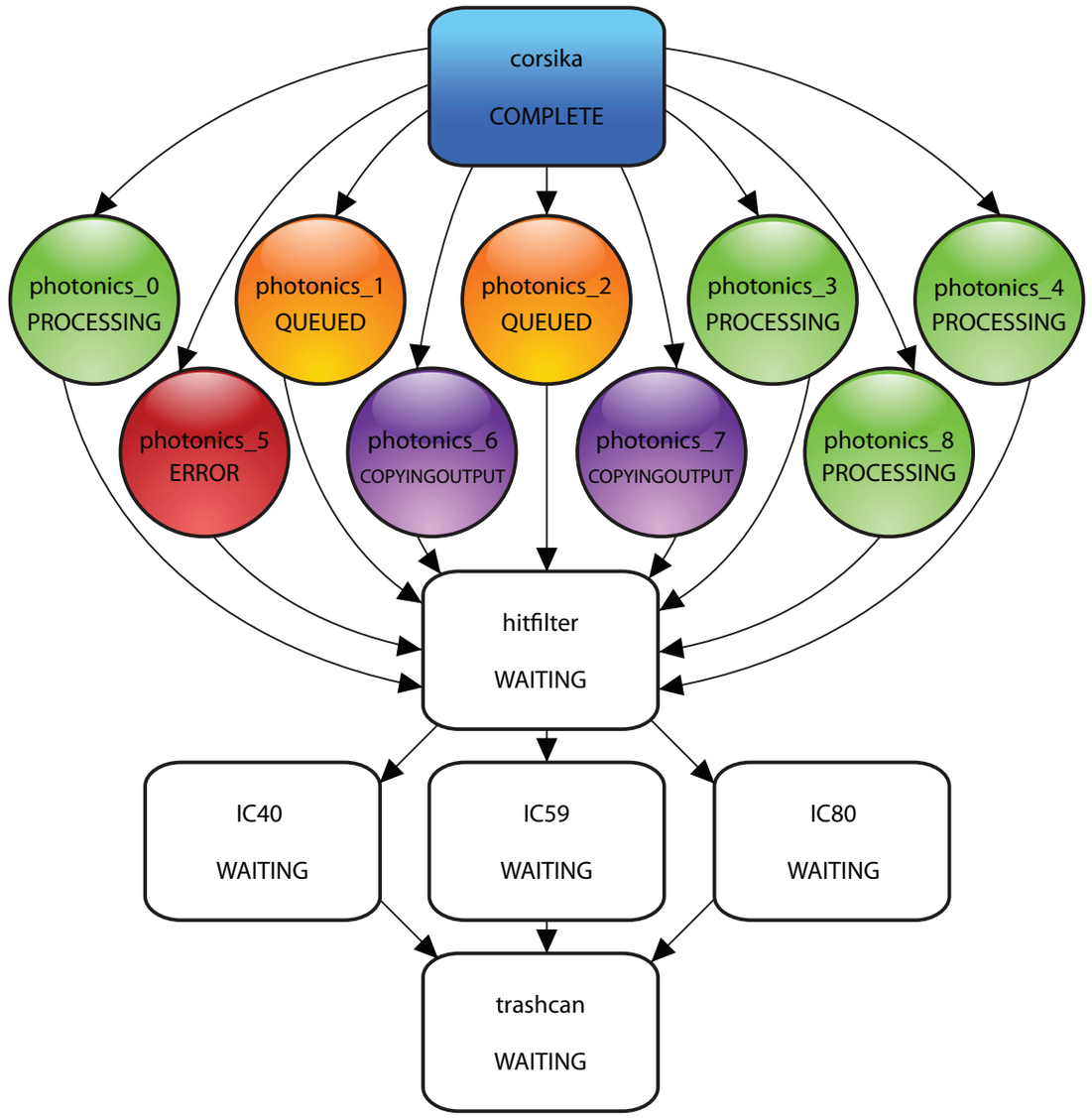


Disadvantages

- Photonics tables required for all trays
  - Assumed pre-installed on grid site
- Hardware requirements based on needs of greediest tray
- No checkpointing within jobs
- Not as parallel as it could be

New Implementation

- Break jobs into "tasks"
  - In general, each task executes a single tray
- Use DAGMan to manage dependencies
- One simulation job is 15-24 Condor jobs



Advantages

- Photonics tables can be binned
  - 1GB per bin
  - Small enough to stage on-demand
- Hardware requirements on per-task basis
- Checkpoints between every task
- Increased parallelism

Implementation Details

- Really simple
- Great fit for IceCube's existing code
- Daemons generate DAGs and submit files
- Intermediate files generated by tasks stored at IceCube and fetched using GridFTP

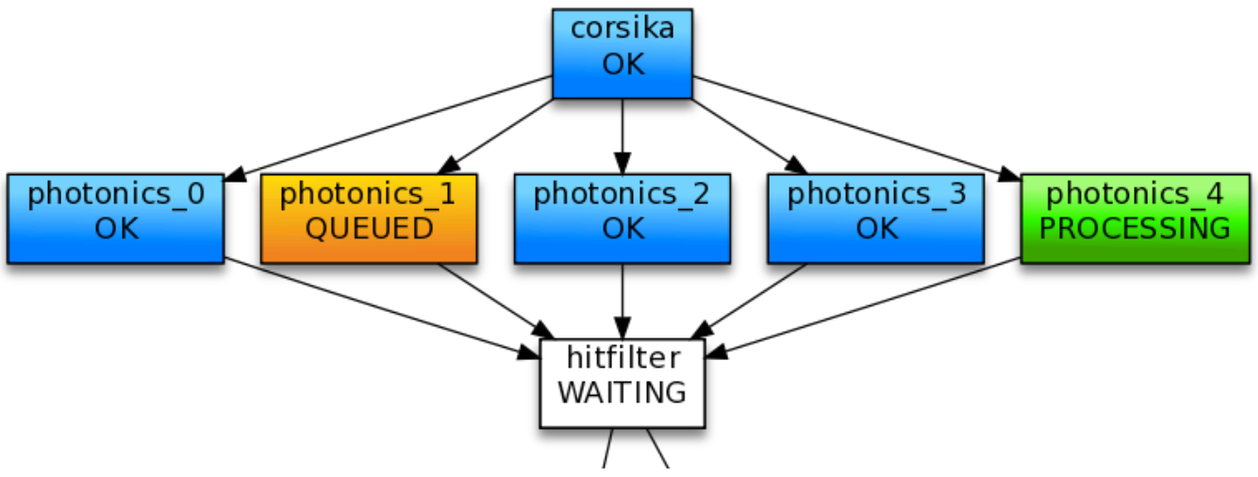
Job Performance

- Running only one simulation job, no gain from DAGs
  - Increased parallelism cancelled out by network overhead
- Running 1,000 simulation jobs, DAGs give 25-30% improvement in runtimes
  - Reuse data already transferred

Web Interface

Tabular display

NAME	TRAY	ITERATION	HOST	STATUS	START	FINISH
corsika	0	externs	glow-c003.icecube.wisc.edu	OK	2009-04-19 14:41:39	2009-04-19 16:20:21
corsika	0	0	glow-c003.icecube.wisc.edu	OK	2009-04-19 16:20:21	2009-04-19 16:44:26
photonics	1	0	glow-c003.icecube.wisc.edu	OK	2009-04-19 16:49:36	2009-04-19 16:58:16
photonics	1	1		QUEUED		
photonics	1	2	glow-c020.icecube.wisc.edu	OK	2009-04-19 16:49:08	2009-04-19 17:11:24
photonics	1	3	glow-c041.icecube.wisc.edu	OK	2009-04-19 16:48:40	2009-04-19 17:07:56
photonics	1	4	glow-c042.icecube.wisc.edu	PROCESSING	2009-04-19 16:49:21	
hitfilter	2	0		WAITING		



Graphical display

Future Work

- Task clustering
- Condor job router
- Glide-ins for photonics tables

Summary

- Large increase in flexibility
- Improvement in aggregate performance
- Access to more resources (e.g. OSG)
- Didn't require huge changes

Questions?

Presenter: Ian Rae
E-mail: ian@cs.wisc.edu
http://www.icecube.wisc.edu/