Consolidating Computational Resources at IceCube

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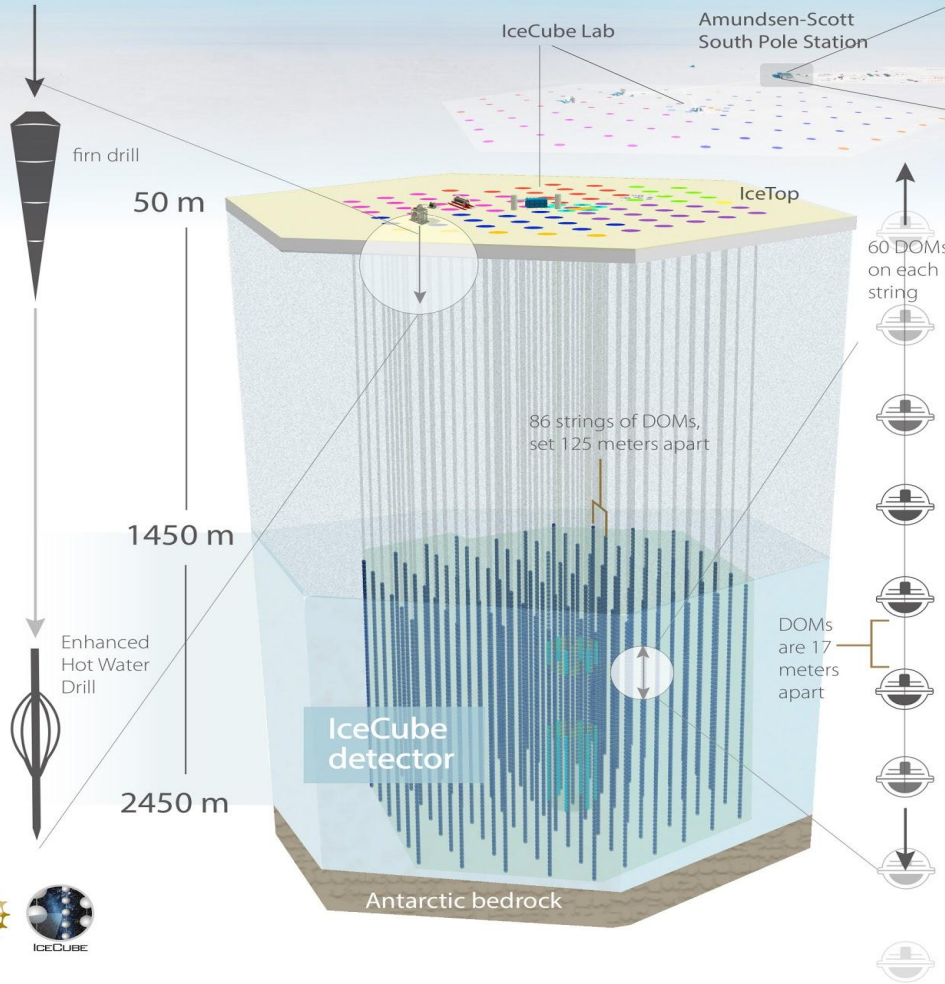
IceCube
South Pole Neutrino Observatory

icecube.wisc.edu

The IceCube Neutrino Observatory

Design and construction

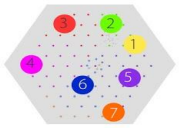


Detector Design

- 1 gigaton of instrumented ice
- 5,160 light sensors, or digital optical modules (DOMs), digitize and time-stamp signals
- 1 square kilometer surface array, IceTop, with 324 DOMs
- 2 nanosecond time resolution
- IceCube Lab (ICL) houses data processing and storage and sends 100 GB of data north by satellite daily

Detector Construction

7 seasons of construction, 2004-2011



- 28,000 person-days to complete construction, or 77 years of continuous work
- 4.7 million pounds of cargo shipped, 1.2 million of which was the drill
- 48 hours to drill and 11 hours to deploy sensors per hole
- 4.7 megawatts of drill thermal power with 200 gallons of water per minute delivered at 88 °C and1,000 psi

IceCube's Computing Ecosystem

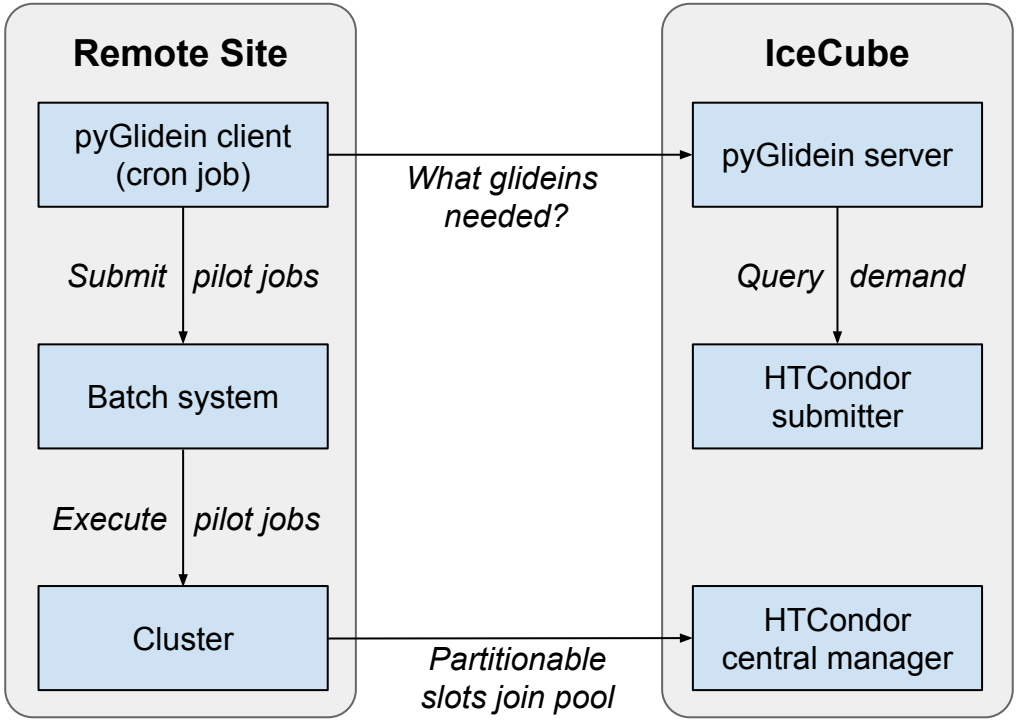
1. IceCube's HTCondor cluster at UW-Madison
   - Main analysis facility; 7300 CPU cores, 320 GPUs; *direct access to Lustre storage*
2. Flocking access to OSG, and various HTCondor pools at UW-Madison
   - Good source of CPUs, but not a lot of GPUs available
3. Clusters owned by institutions that are part of IceCube collaboration
   - Many CPUs and GPUs across about 20 heterogeneous sites
4. XSEDE allocations on Comet, Bridges, XStream supercomputers
   - Mostly interested in GPUs; can have special constraints

Goal: consolidate all available resources into a single global HTCondor pool (eventually)

IceCube's pyGlidein software

- https://github.com/WIPACrepo/pyglidein
  - Uses glideins to make many sites' resources accessible via a single HTCondor pool
  - In production since 2015, making difficult-to-access resources easy to use
  - People like it: simple, easy to set up by a non-expert, low maintenance
  - "Client" is a cron job that submits pilots to the local cluster
  - Can submit to HTCondor, PBS, SLURM, UGE, LSF
  - For technical details see David Schultz's Condor Week 2016 presentation: http://research.cs.wisc.edu/htcondor/HTCondorWeek2016/presentations/ThuSchultz_IceCubeGlideins.pdf

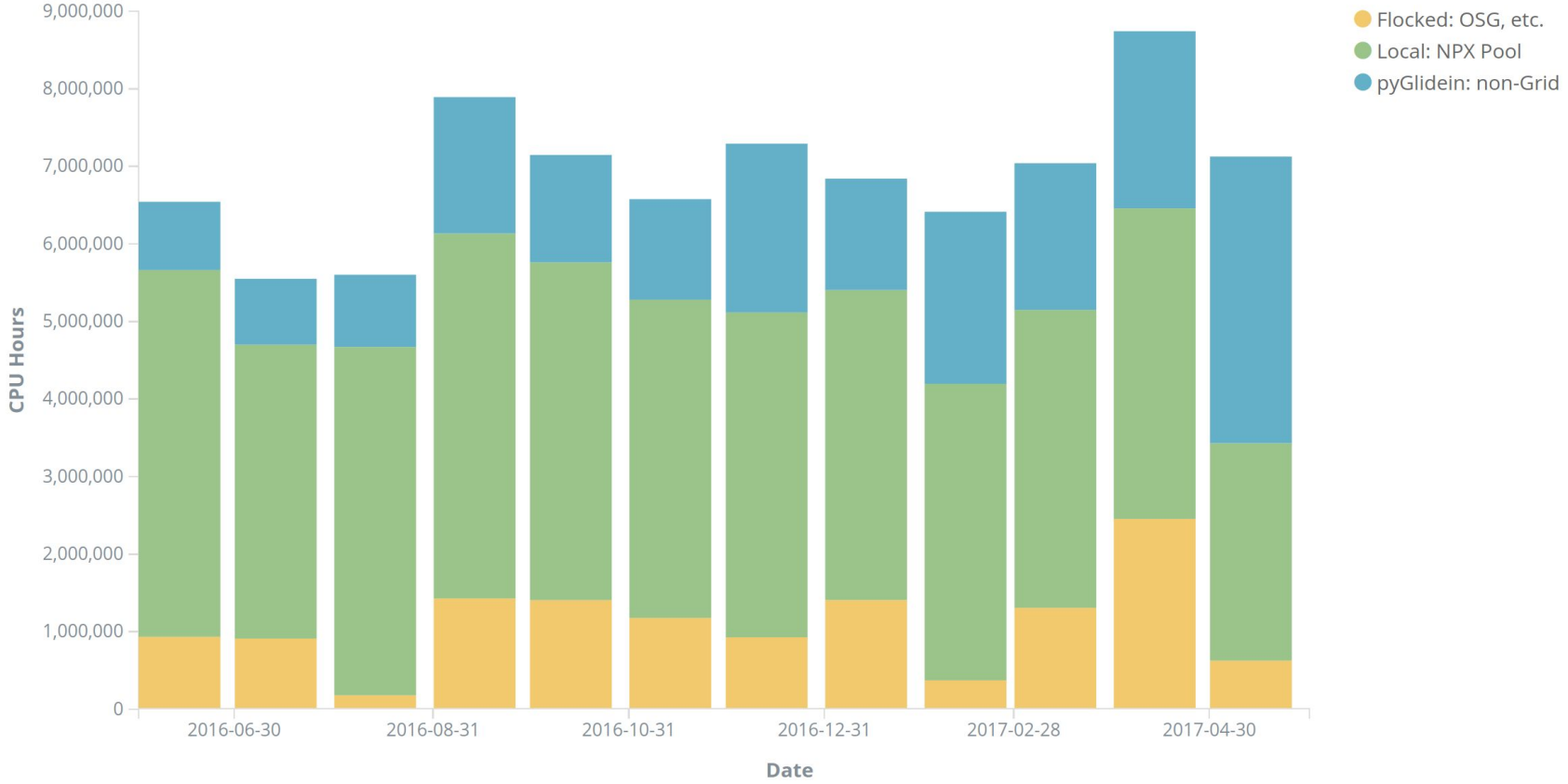
IceCube's pyGlidein software



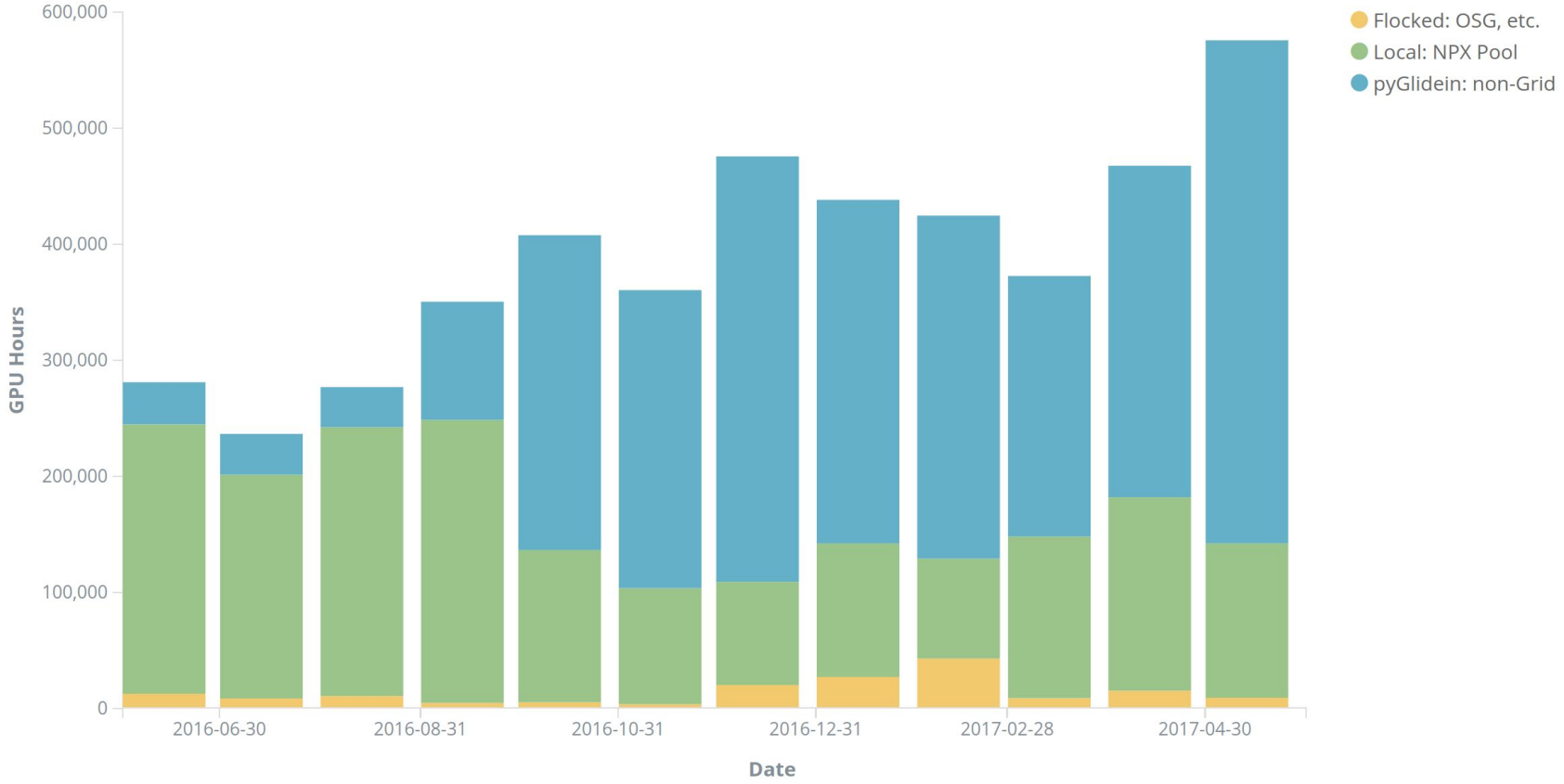
IceCube’s pyGlidein software

- Designed to make incorporation of new sites easier
  - Simplicity makes people more willing to get on-board
  - Support for site admins provided via a Slack channel
  - Local admins can specify policies at their sites
- Combines heterogeneous resources into a single HTCondor pool
  - Centralized management of priorities, accounting, monitoring
  - Up to 6000 CPUs, 600 GPUs seen in pool so far
  - Sub-collectors used to improve scalability

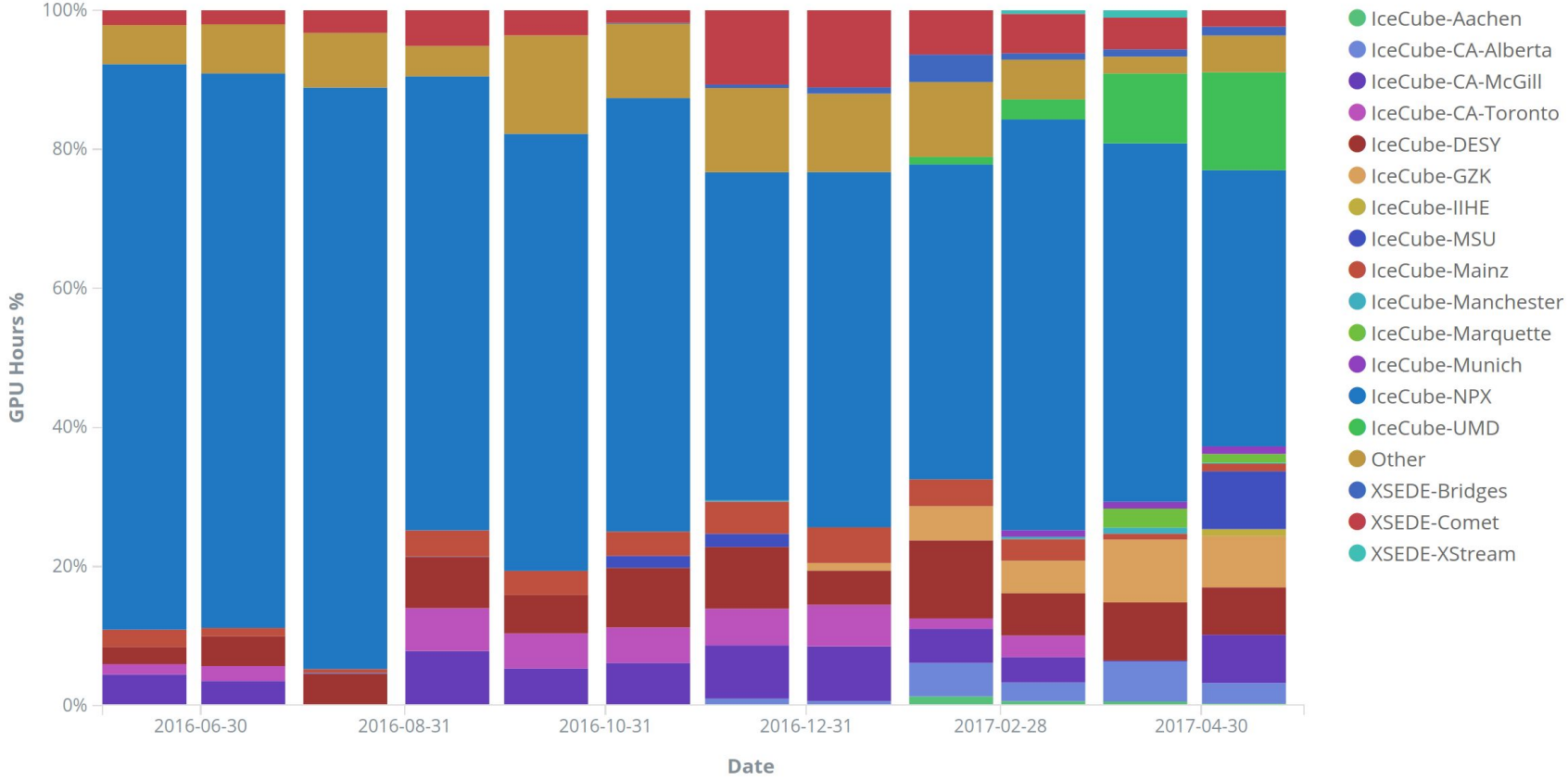
CPU hours by job type



GPU hours by job type



Relative GPU hours by site



Use case: CHTC resource allocation

- Before glideins: IceCube flocked to UW CHTC pool
  - Couldn't prioritize important workflows or UW users from our side
- Now: all CHTC resources are glideins
  - Can implement resource allocation policies on per-site basis using RANK expressions
  - IceCube submitters tag jobs based on owner's LDAP groups

```
include command : /usr/local/libexec/condor/set_affiliation.sh
SUBMIT_EXPRS = $(SUBMIT_EXPRS) Affiliation
```

  - At start-up glideins probabilistically pick a RANK to satisfy resource allocation policy

```
if [ "$rand" -lt 45 ]; then export _condor_RANK=...
elif [ "$rand" -lt 70 ]; then export _condor_RANK=...
...
```

Future work

- Auto-update pyGlidein software
  - Update process is trivial, but tracking down all admins is not
- Collect more monitoring and accounting data
  - Really want data on efficiency GPU jobs
  - Provide easy-to-use centralized monitoring for dispersed operators
- Collect glideins' HTCondor logs for debugging
  - Debugging pilot failures can be a challenge