Grid computing for the SNO+ experiment

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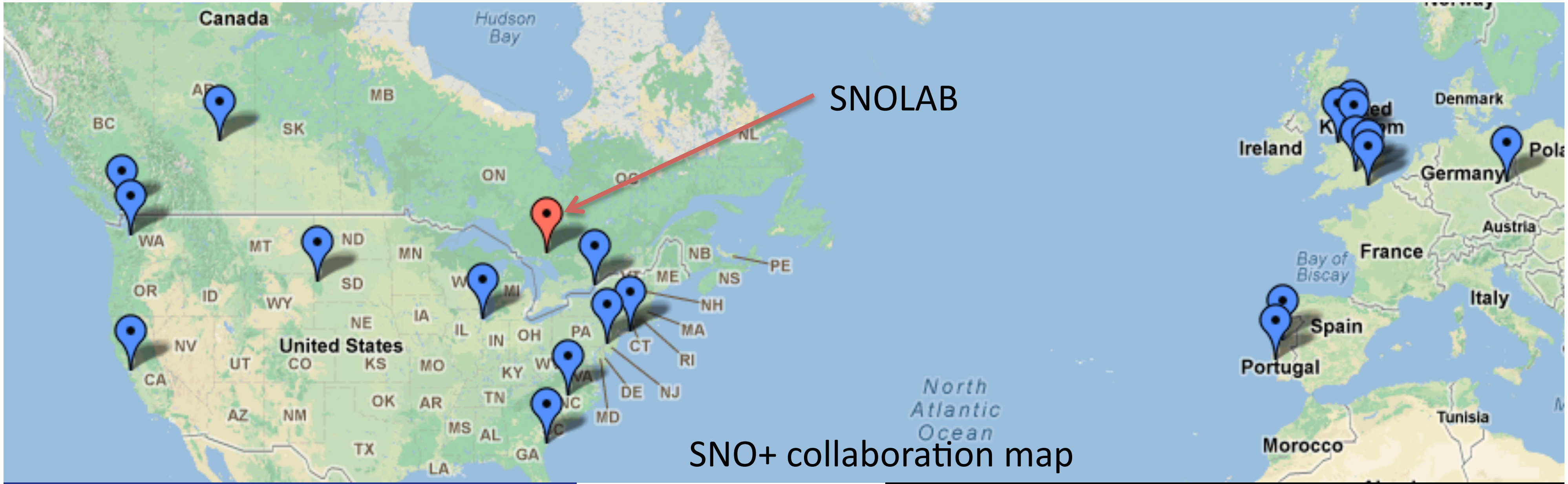
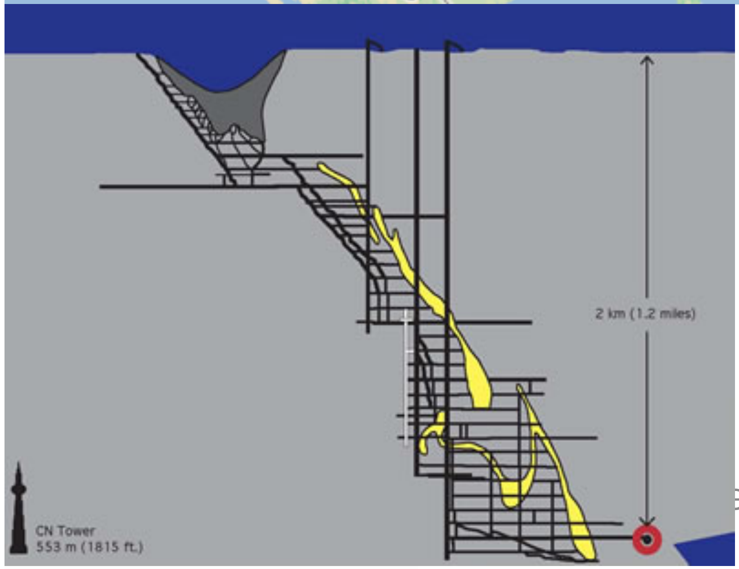
Introduction to SNO+ & SNOLAB

Multi-purpose physics (neutrino) experiment at SNOLAB



SNOLAB

SNO+ collaboration map



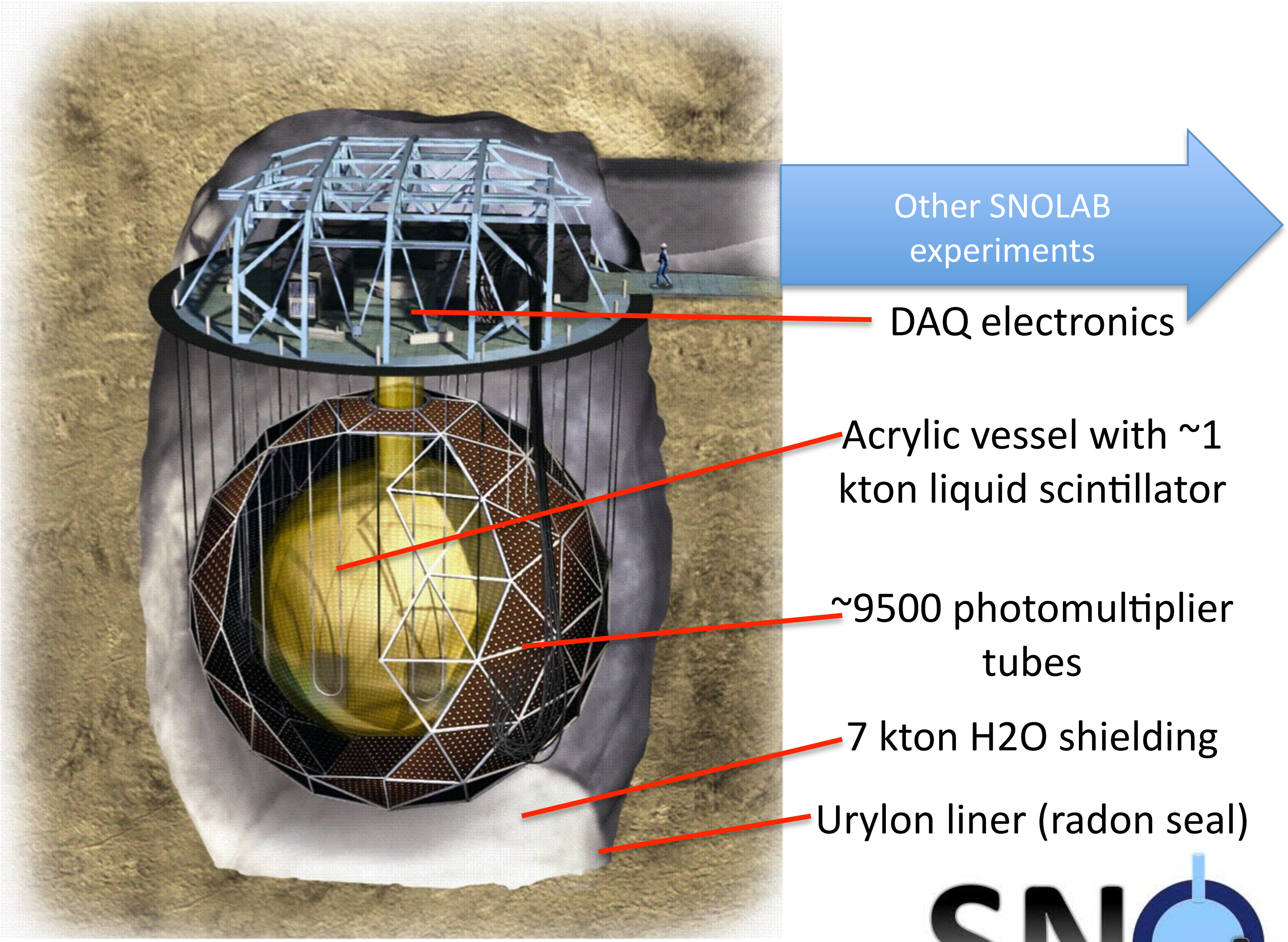
6800 feet (2 km) underground

Class-2000 cleanroom (in a working mine)

The SNO+ experiment

- Physics goals:
- **Double beta-decay**
- Solar, geo, reactor, supernova neutrinos
- Forbidden nucleon decay

2km underground (!!!)



Other SNOLAB experiments

DAQ electronics

Acrylic vessel with ~1 kton liquid scintillator

~9500 photomultiplier tubes

7 kton H2O shielding

Urylon liner (radon seal)

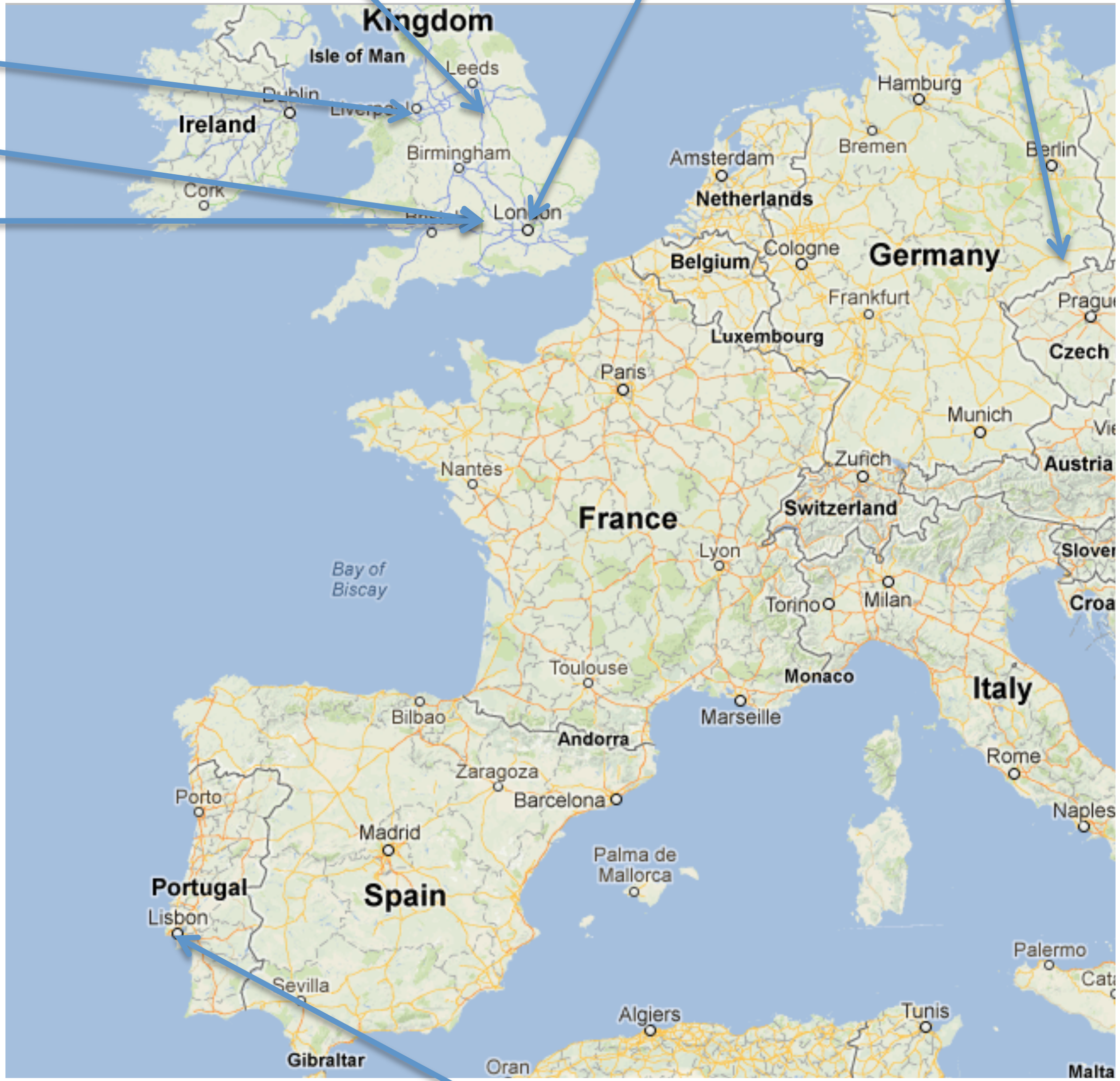
Data transfer & storage requirements

- Max data taking rate of 450Mbit/s (!)
  - Expect 10s TB of real data a year
  - Require 10x simulated data
    - Larger data-structure size compare to real data
    - But not all real data requires simulating
    - -> 10s-100 TB a year
- Very limited computing resources at SNOLAB:
  - Buffer data underground and on surface
  - Ship all real data off-site
  - All simulations processed off-site
- **Expect** (guess) **we need 10s of cores continuous use and 10s-100s of TB of storage a year to process/simulate required datasets.**

Resource layout

- SNO+ will store and process/simulate data at two locations:
- WestGrid (ComputeCanada):
  - Canadian Grid Tier 1 storage resource
  - One single batch farm (qsub submission)
  - 100 nodes, priority access
- LHC Computing Grid (LCG):
  - UK Grid Tier 1 storage at RAL
  - Processing at distributed Tier 2 sites
  - 1000s of nodes, but low priority
  - Use glite software and workload management services (WMS)
    - Do not submit jobs directly to specific site
    - Place requirements on data, software etc, WMS does the rest

LCG data-processing



Tier 2: Queen Mary, London

Tier 2: Sheffield

Tier 2: TU-Dresden

Tier 2: Liverpool

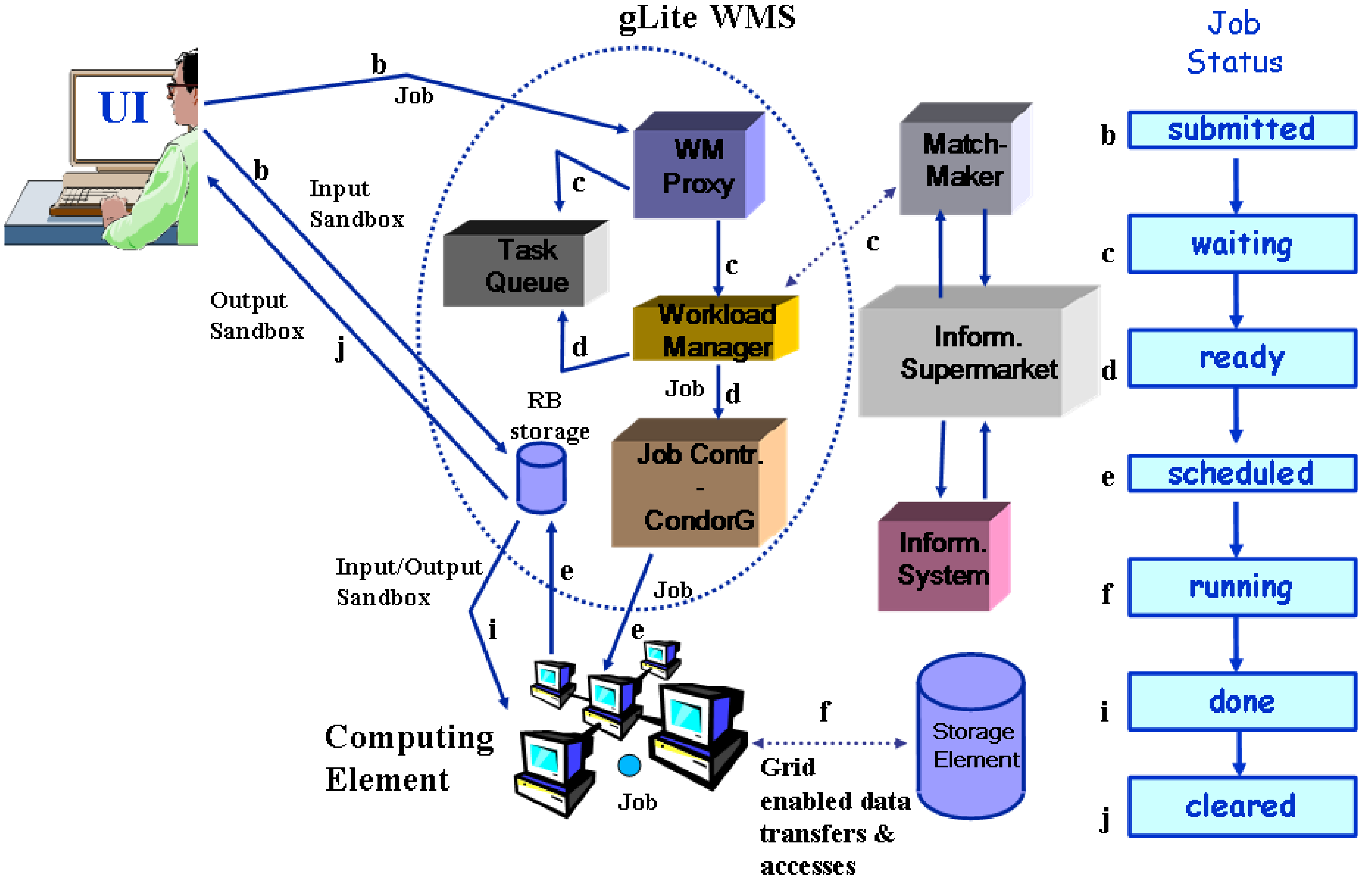
Tier 2: Oxford

Tier 1: RAL

Tier 2: PT national Grid

- Access to 7 sites
- Process/produce data at Tier-2 sites
- Archive data at Tier-1 storage
- Ship data out to Tier-2 sites ready for (re)-processing

Grid job lifecycle



From glite-3.2 user guide

Grid jobs/data – current SNO+ method

- Submit job to Workload Management System (WMS)
  - WMS matches job requirements to available computing elements (CE) - software, memory etc
  - Submits job to specific queue
  - SNO+ rely entirely on the WMS for job management (so we use three)
- Jobs output data to their local storage element (SE)
  - All data logged in LCG File Catalogue (LFC)
  - SNO+ jobs *would* rely entirely on the LFC
    - But access only to one of these, at RAL
    - Official Monte Carlo and processed/raw real data are logged in a SNO+ database

Processing & Production

- Two very different production environments
  - Plus possibility of introduction of more farms/grids
  - Plus smaller analysis groups may want to reprocess data at local institution
- -> Need for backend agnostic production system
- Ganga: “configure once, run everywhere”
  - Python job management software
  - Setup to run SNO+ software on range (batch, grid etc) of submission backends, low user expertise required

Ganga vs no Ganga

Ganga

ganga_script.py

```
j=Job()
j.application='RATUser'
j.application.ratMacro=‘mymacro.mac’
j.application.ratBaseVersion='4.1'
j.application.outputDir=‘myDirectory'
j.backend='LCG'
j.submit()
```

job_description_file.jdl

```
Executable=“job_script.scr”,
Arguments={“-l”,”rat.log”},
StdOutput = “job.out”,
StdError = “job.err”,
InputSandbox = {“job_script.scr”},
OutputSandbox = {“rat.log”,”job.out”,”job.err”},
VirtualOrganisation = “snoplus.snolab.ca”
```

job_script.scr

```
source $VO_SNOPLUS_SNOLAB_CA_SW_DIR/snoing-
install/env_rat-4.1.sh
rat mymacro.rat
lcg-cr –vo snoplus.snolab.ca –d
$VO_SNOPLUS_SNOLAB_CA_DEFAULT_SE –P myDirectory/
myoutput.root –l lfn:/grid/snoplus.snolab.ca/
myDirectory/myoutput.root myoutput.root
```

No Ganga

Ganga vs no Ganga (2)

Job submission and monitoring

```
j.submit()
j.status()
```

Job submission and monitoring

```
glite-wms-job-submit –c config.conf –a –o myjob.jid
job_description_file.jdl
glite-wms-job-status –i myjob.jid
glite-wms-job-output –i mujob.jid
```

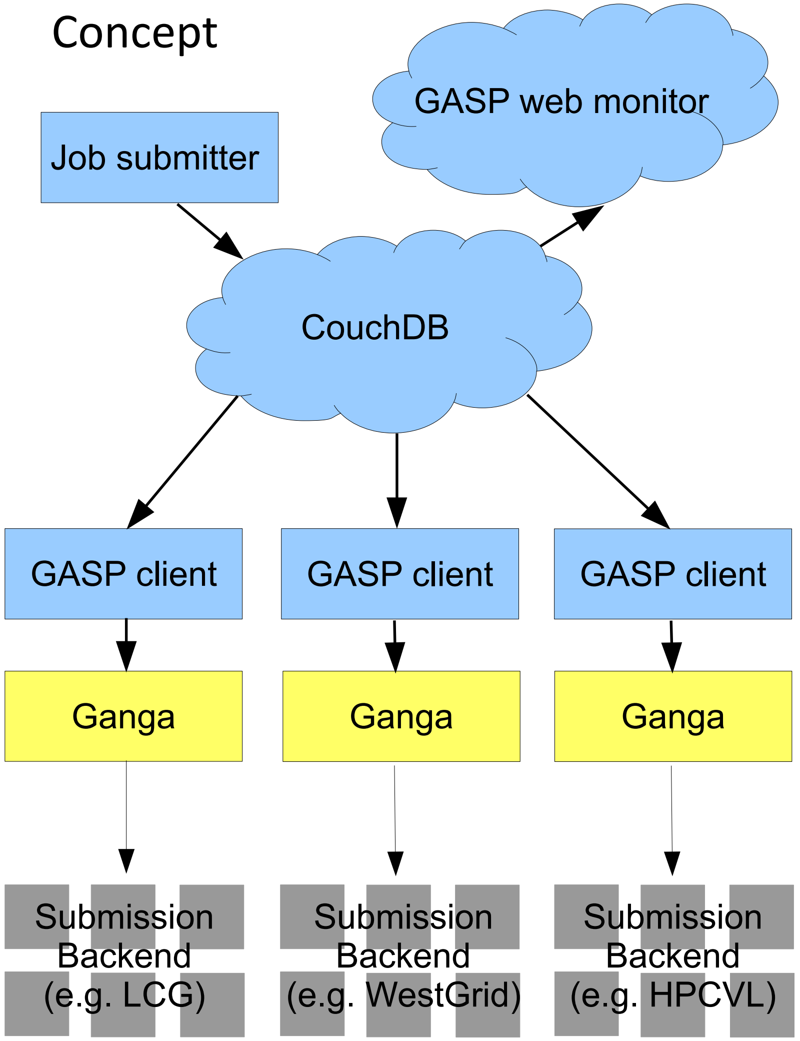
- GangaSNO plugin created:
  - Jobs on batch/grid/local node will automatically setup the correct environment to run SNO+ software
  - User just provides a job (Geant4) macro
  - Very little configuration required by user, but ability to configure is there if desired.

Production systems

- SNO+ will automate processing and simulation of "official" SNO+ data:
  - Production systems with a big bookkeeping task:
    - O(10k) data runs per year (real data)
    - Number of processing modules (~10) per run
    - One job per module
    - + 10x Monte Carlo with 10s of modules per physics run
  - Use CouchDB database:
    - Schema free
    - Documents, not tables
    - Documents stored as JSON objects
    - Pre-processed ("design") views – fast querying

Production systems

Concept


GASP web monitor
Job submitter
CouchDB
GASP client
GASP client
GASP client
Ganga
Ganga
Ganga
Submission Backend (e.g. LCG)
Submission Backend (e.g. WestGrid)
Submission Backend (e.g. HPCVL)

Database (CouchDB) document

```
{
 "_id": "19bfec64083952f4f6c2bd37df00110f",
 "_rev": "1-7b833b61ceccc06acedf9be72eabcb51",
 "status": "waiting”,
 “run”: 13,
 “module”: “Dummy”,
 “locked”: null,
 “type”: “job”,
 "passes": [
         { "status": "waiting",
           "ratv": "3_00",
           "subRun": [
                 { "status": "waiting",
                   "failCount": 0,
                   "output":
                         { "cksum": null,
                           "loc": null,
                           "name": null,
                           "se": null,
                           "size": null },
                   "subRun": 0 },
         "pass": 0 }
         ]
}
```

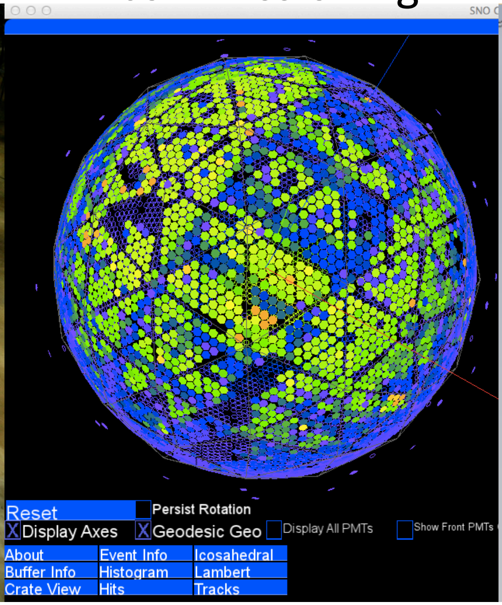
SNO+ roadmap

- Preparing for data-taking:
  - Spring 2013: fill with water, first physics data
  - Autumn/Winter 2013: fill with liquid scintillator
  - 2014: deploy double-beta-decay isotope
- In the meantime (a small selection of recent/ongoing work):

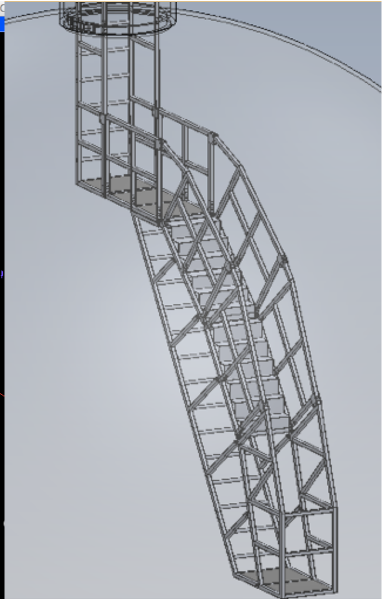
Hold down rope net (AV buoyant)

Installation of in-situ calibration systems

Empty detector (air filled) commissioning



AV acrylic cleaning



Thanks for listening!