University of Glasgow

Evaluation of Memory and CPU usage via Cgroups of ATLAS workloads running at a Tier-2

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Condor Cgroups

- Control Groups (Cgroups)
  - Linux kernel feature to limit/isolate resource usage among user-defined groups of tasks(processes).
  - Available Resource Controllers (or subsystems):
    - Block-I/O,cpu/cpuacct/cpuset/devices/freezer/memory/net_cls/net_prio/ns
- Condor Cgroups
  - Condor puts each job into a dedicated cgroup for a selected subsystem
  - Can be used to track the subsystem usage of all processes started by a job
  - control cpu usage at job level:
    - Jobs can use more cpu than allocated if there are still free cpu
  - control RSS (physical memory) usage at job level:
    - **soft**: jobs can access more memory than allocated if there is still free physical memory available in the system
    - **hard**: jobs can't access more physical memory than allocated

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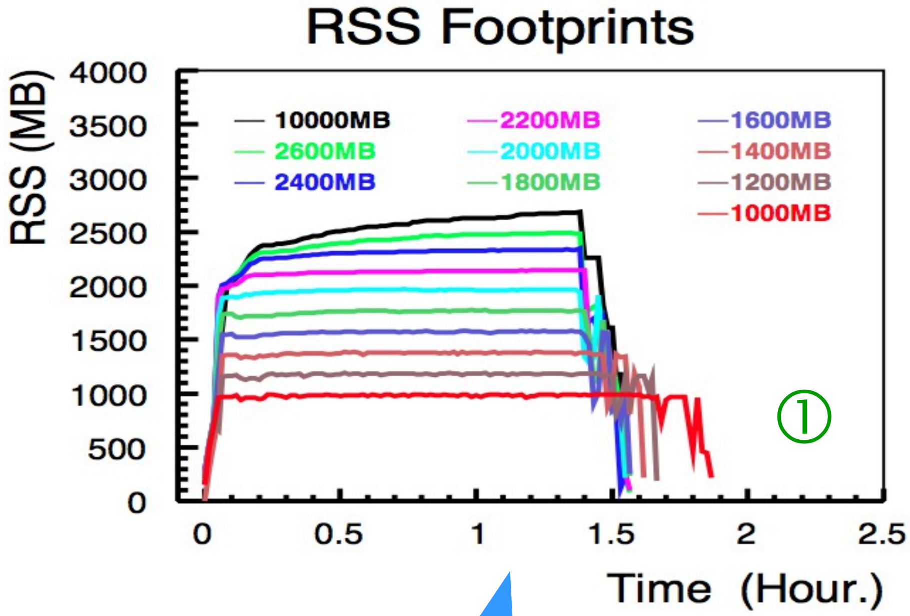
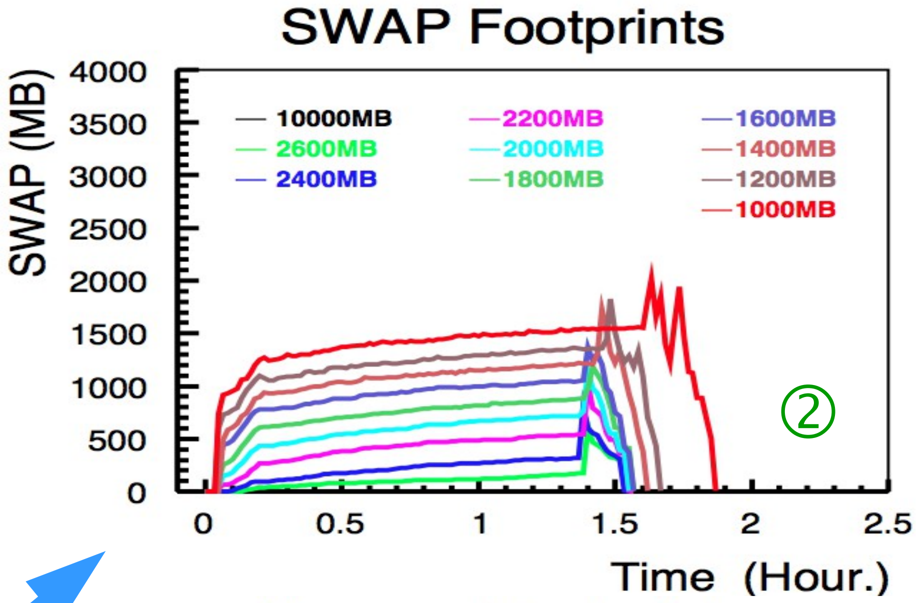
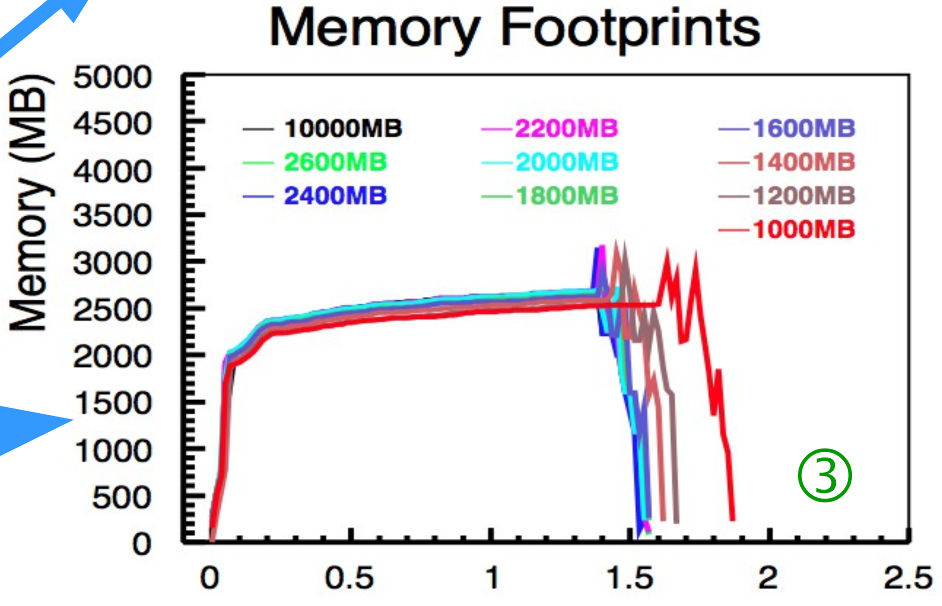
Condor Cgroups







- Can be used to track the subsyste
- control cpu usage at job level:
  - Jobs can use more cpu than a
- control RSS (physical memory) u
  - **soft**: jobs can access more m physical memory available i
  - **hard**: jobs can't access more

Glasgow Tier-2

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- Glasgow Condor Cluster
  - Production instance since Aug 2014, has received ~ 1.3 million jobs, comprises 2 ARC-CE(8/16 core), 1 condor central server (8core), 42 worker-nodes (1456 logical cores)
- MySQL Databases:
  - Condor: select/record historical info of condor jobs, incuding ClusterId/GlobalJobId/JobStatus/ExitCode/LastJobStatus/RequestCpus/RequestMemory/JobMemoryLimit/JobTimeLimit/Use/RemoteWallClockTime/RemoteSysCpu and etc..
  - Panda: PandaID of finished/failed jobs in GLASGOW panda queues
- Memory/Cpu info collection from cgroups:
  - Cgmemd collects the following every minute for each job (on each WN):
    - Cputime: total CPU time consumed by all tasks in the job (later converted into the regular CPU usage by comparing 2 neighbouring sampling points):
    - RSS: instantaneous physical memory usage of the job
    - SWAP: instantaneous swap usage of the job
  - Memory = RSS + SWAP

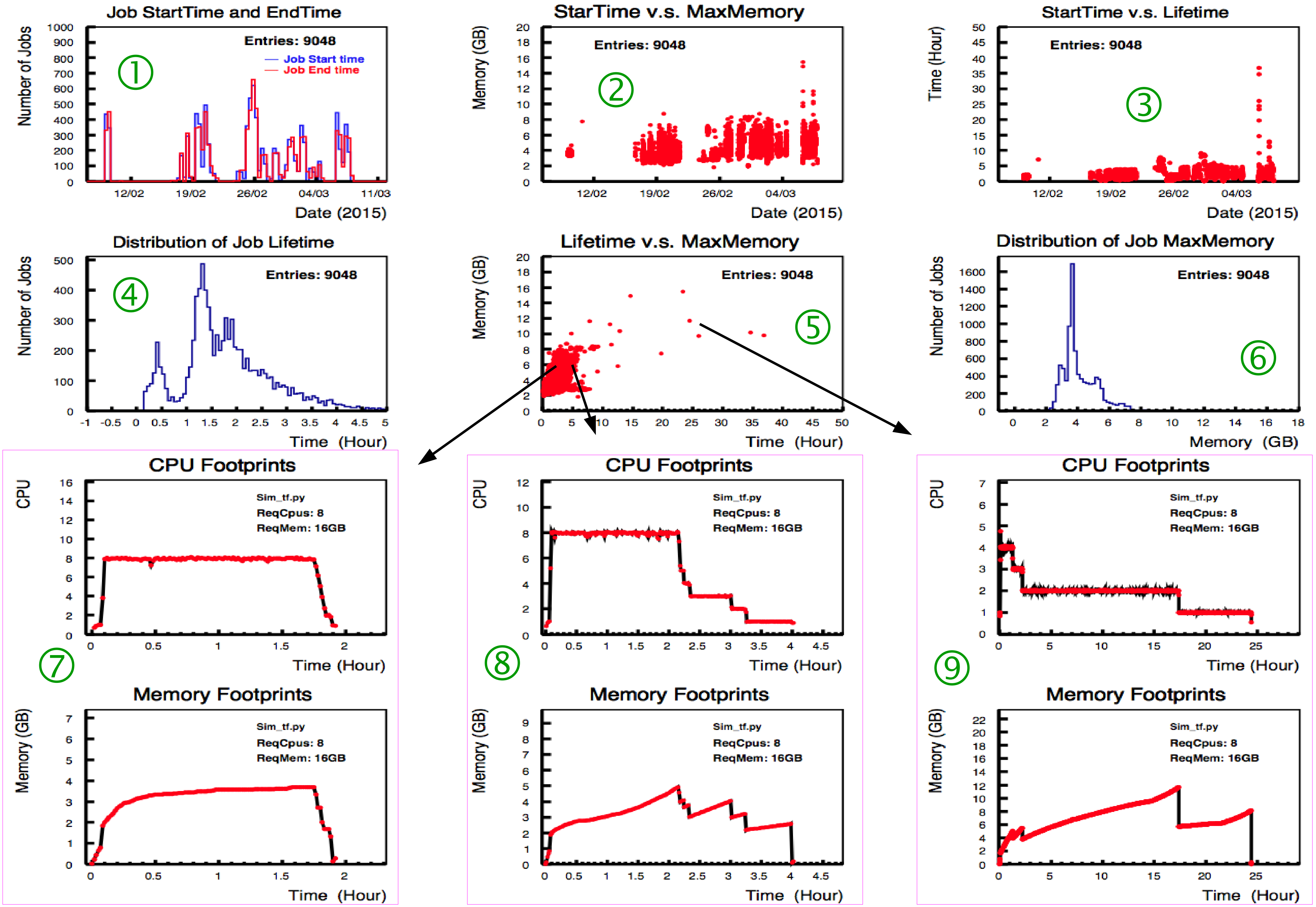
$$cpu\_usage_i = \frac{(cpu\_time_i - cpu\_time_{i-1})/10^9}{(Time_i - Time_{i-1})}$$

- ATLAS job Info tracking:
  - GlobalJobId, trfName(last one), PandaID (last one)
- Analysis
  - Currently focus on ATLAS good jobs

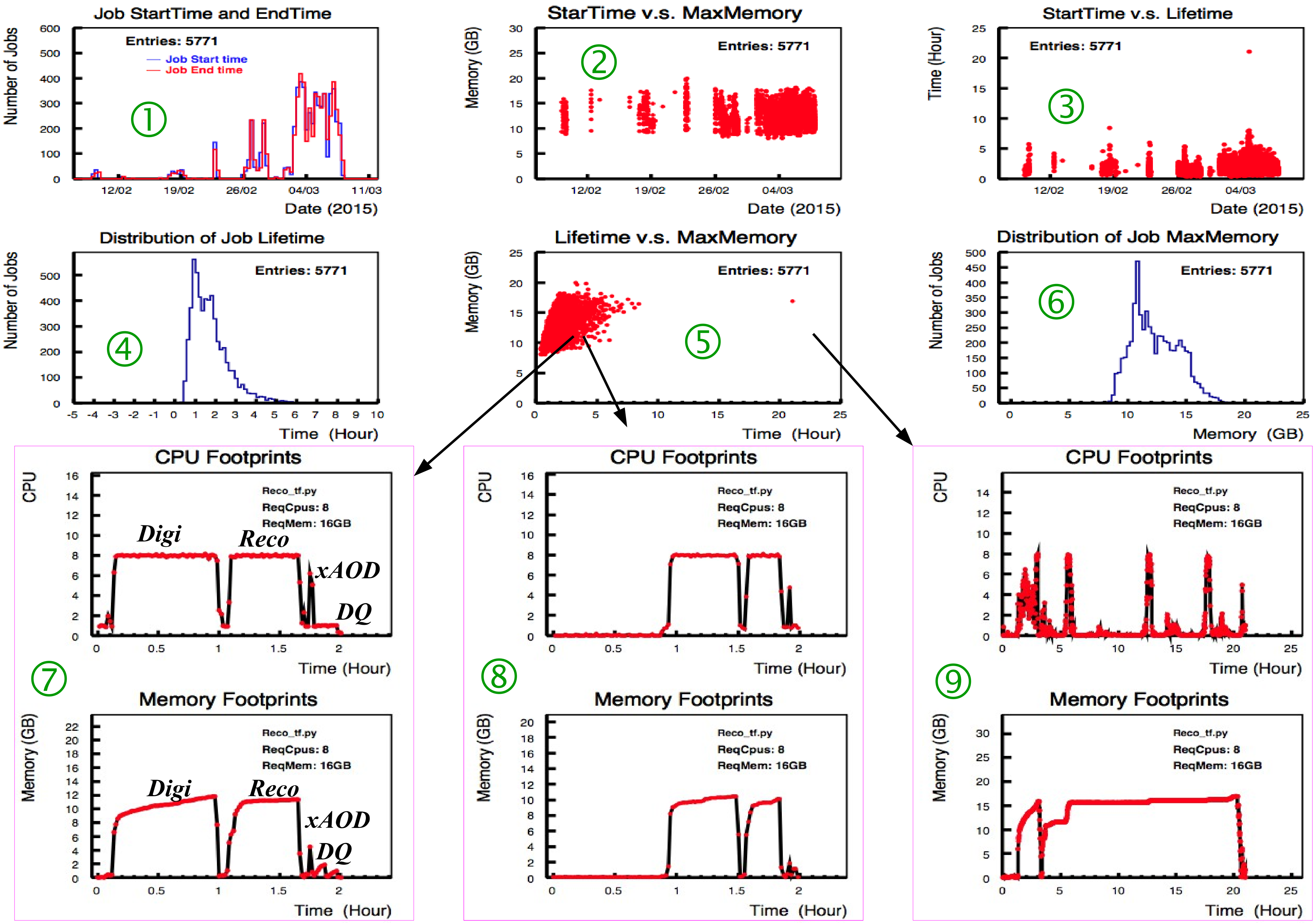
ATLAS jobs at Glasgow Tier-2 *(4)*

- Empty Pilots
  - runs 2 or 3 minutes, using ~25MB memory with CPU usage < 0.1
- Production jobs:
  - Multi-core:
    - panda_queue = UKI-SCOTGRID-GLASGOW_MCORE
    - Request_cpu = 8 & Req_memory = 16 GB
    - Site policy: RSS > 16GB not allowed, no restriction on SWAP
  - Single-core:
    - panda_queue = UKI-SCOTGRID-GLASGOW_SL6
    - Request_cpu = 1 & Request_memory = 3 GB
    - Site policy: RSS > 3GB not allowed, no restriction on SWAP
  - GlobalJobId – PandaID: one pilot picks <= 1 production job
- Analysis jobs:
  - panda_queue = ANALY_GLASGOW_SL6
  - Request_cpu = 1 & Request_memory = 4GB
  - Site restriction: RSS > 4 GB not allowed, no restriction on SWAP
  - GlobalJobId – PandaID : one pilot could pick >1 analysis jobs
- Selection of Good Jobs:
  - finished successfully both in condor and Panda

Multicore Simulation Jobs *(5)*



Multicore Reconstruction Jobs *(6)*



Job StartTime and EndTime

StarTime v.s. MaxMemory

StartTime v.s. Lifetime

Distribution of Job Lifetime

Lifetime v.s. MaxMemory

Distribution of Job MaxMemory

CPU Footprints

Memory Footprints

CPU Footprints

Memory Footprints

CPU Footprints

Memory Footprints

Lifetime of Singlecore Production Jobs

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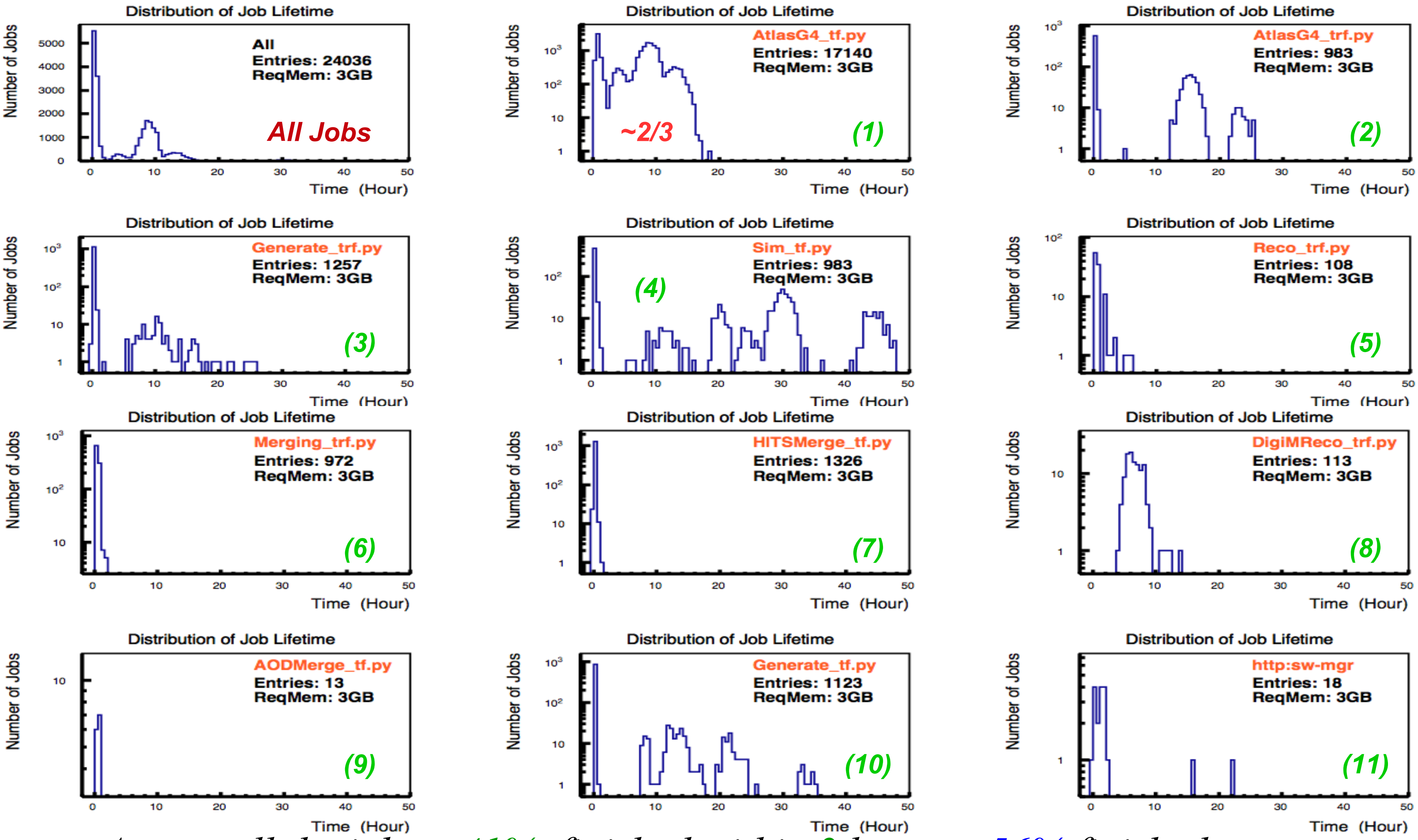

- *Among all the jobs, ~41% finished within 2 hours, ~56% finished between 2 and 20 hours, ~2.3% runs >20 hours.*

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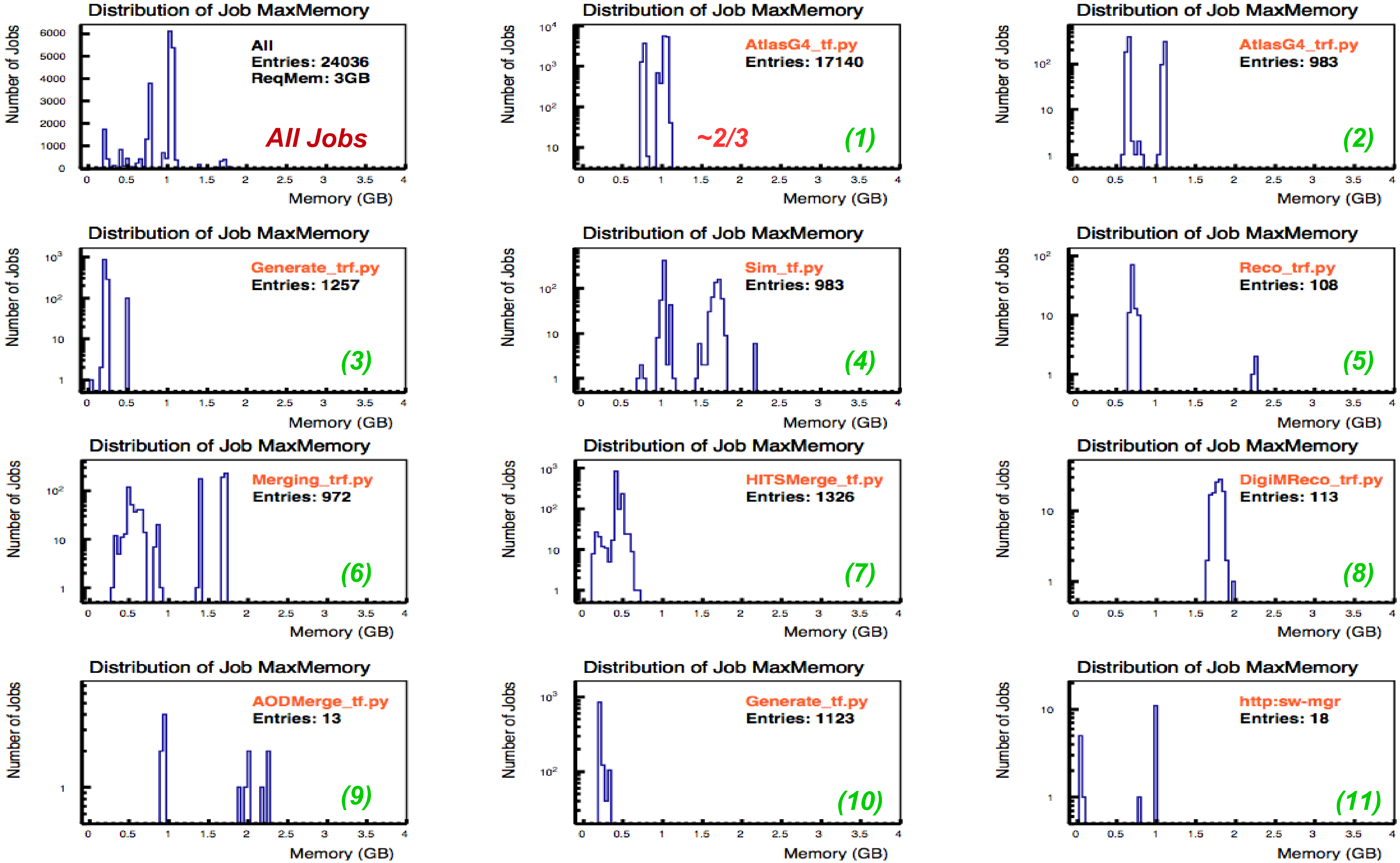
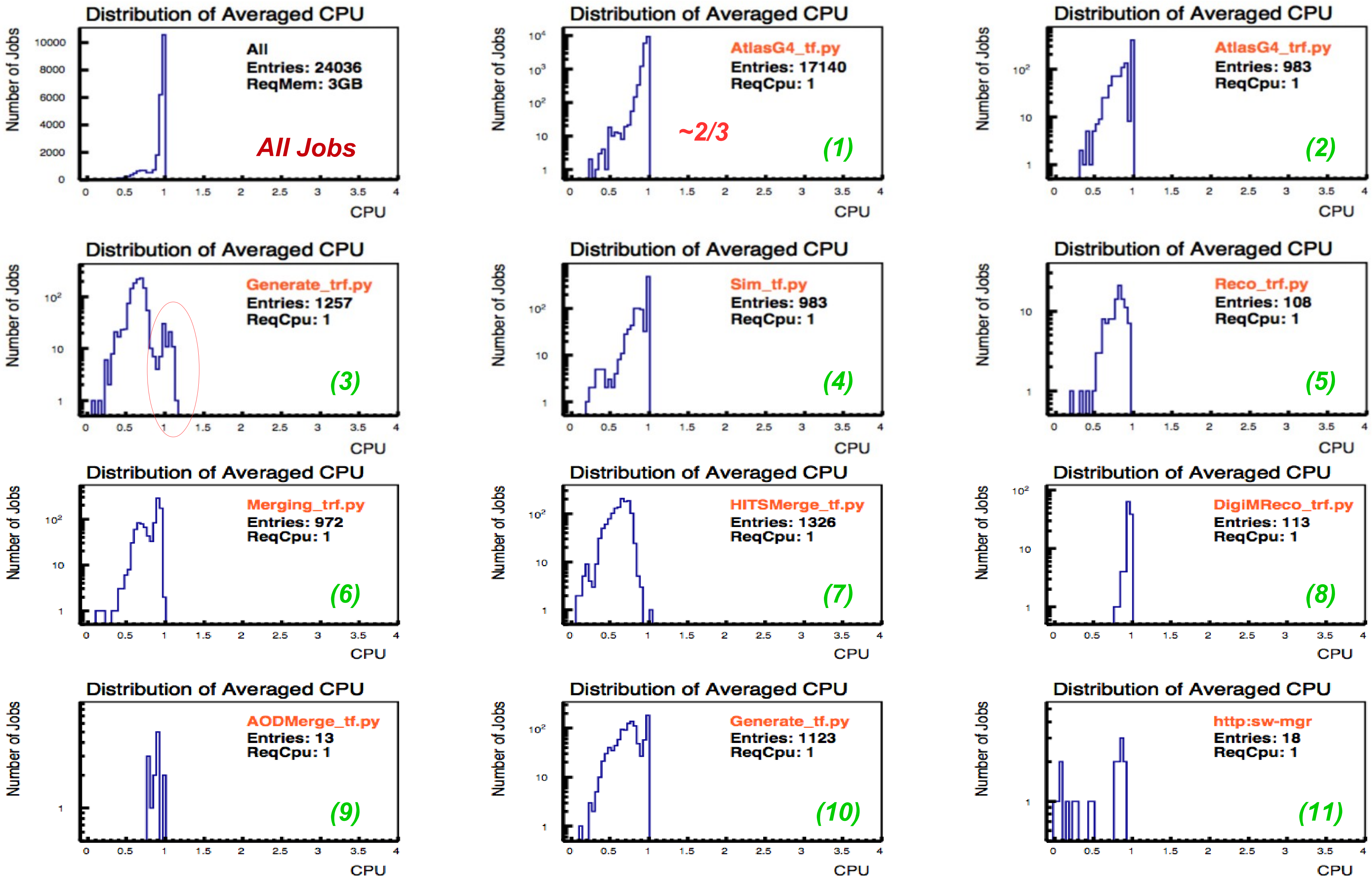
MaxMemory of Singlecore Production Jobs



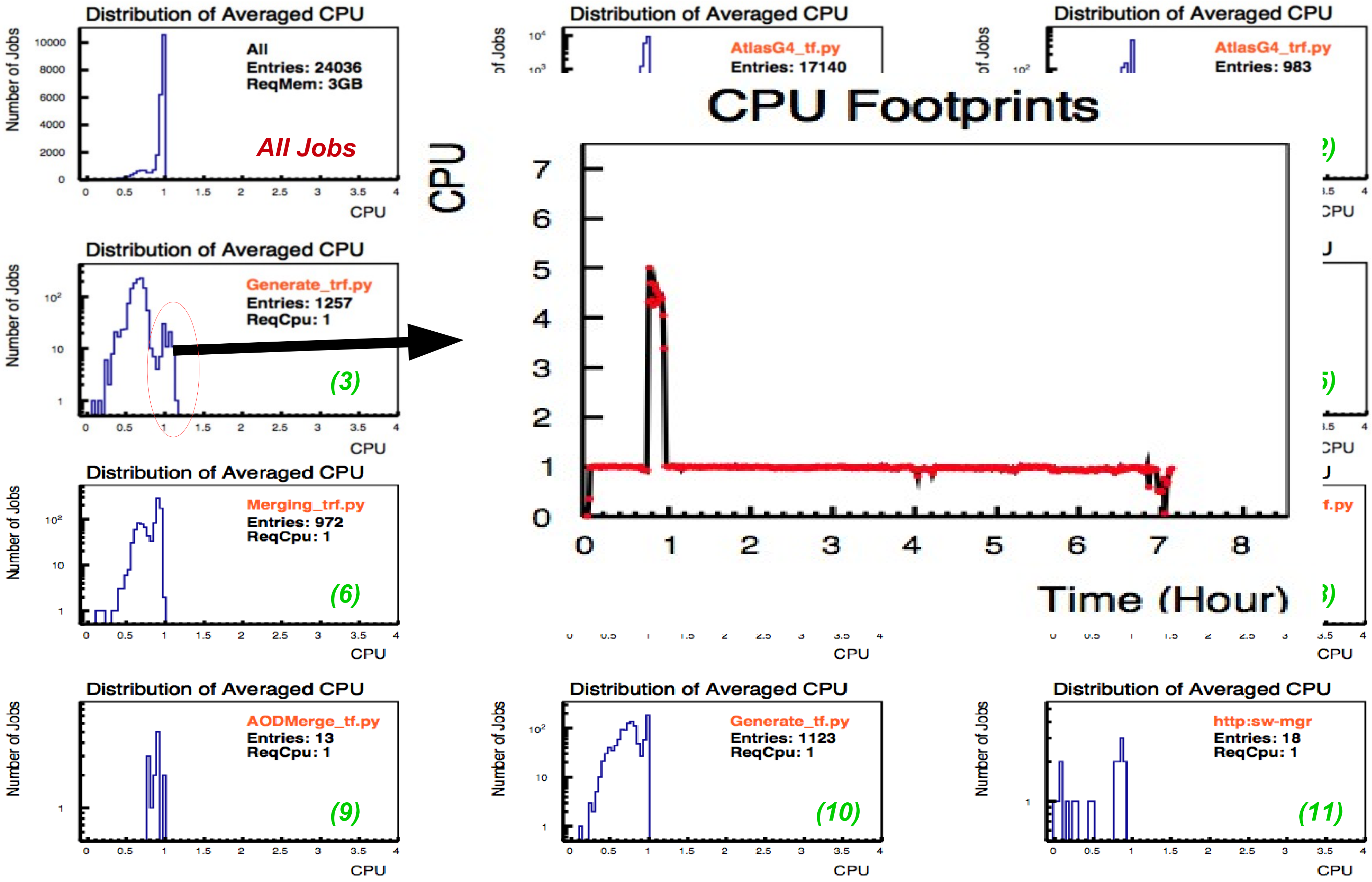
- *Among all the jobs, ~95% use < 1.2 GB, ~ 4.9% use within 1.2GB and 2GB range, <0.1% uses >2GB, none uses > 4GB*

Averaged Cpu of Singlecore Production Jobs



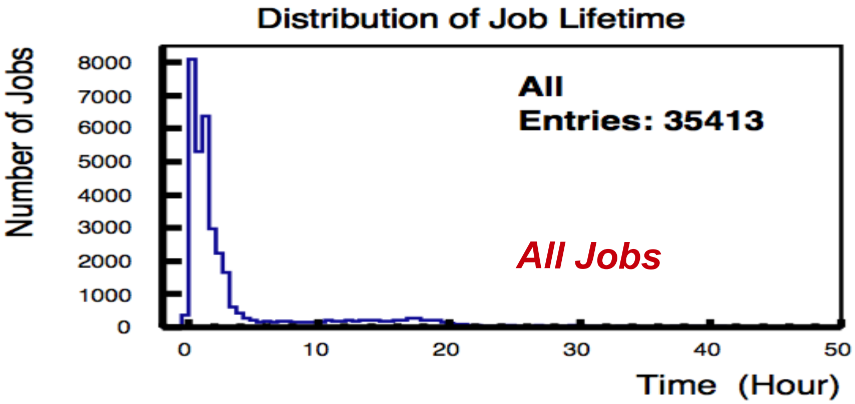
- *All < 1 except a few Generate_trf.py jobs*

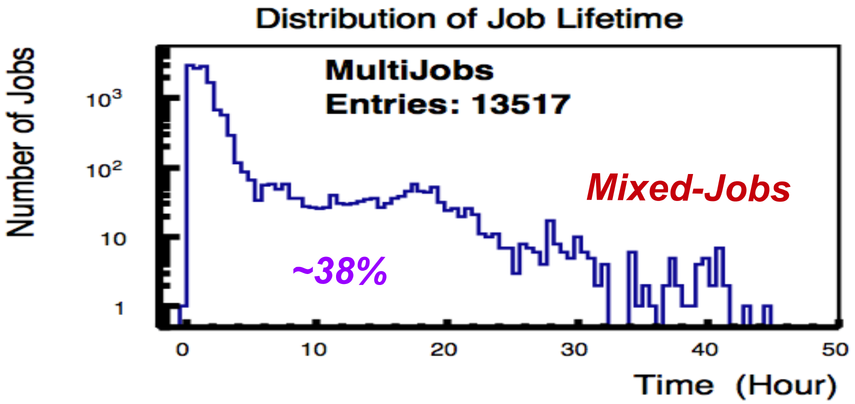
Averaged Cpu of Singlecore Production Jobs *(9)*

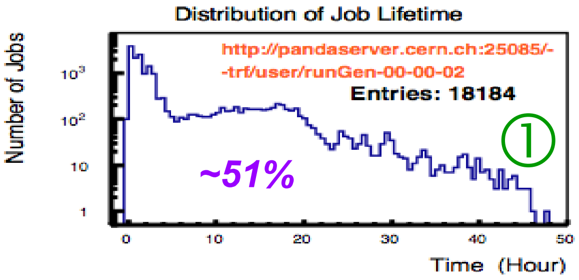


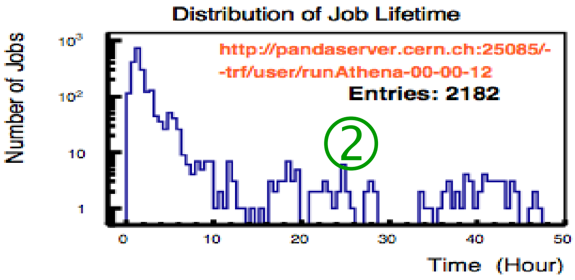
- *All < 1 except a few Generate_trf.py jobs*

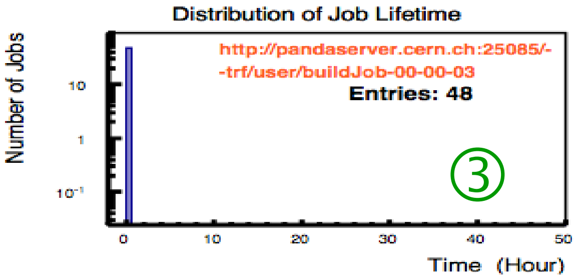
Lifetime Distribution of Analysis Jobs

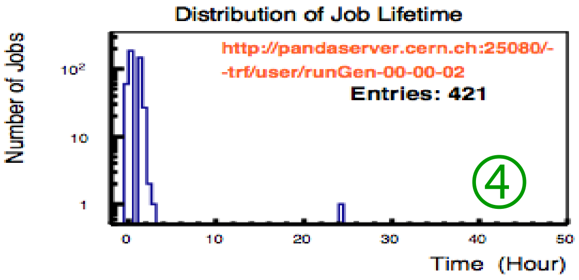


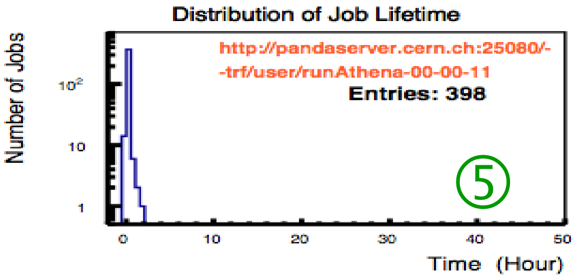


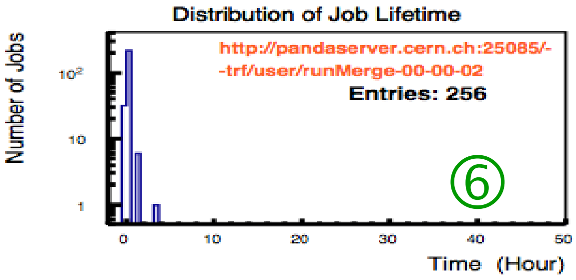


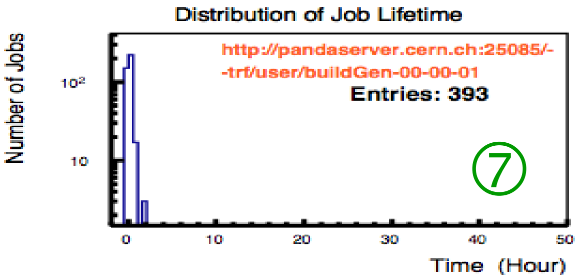


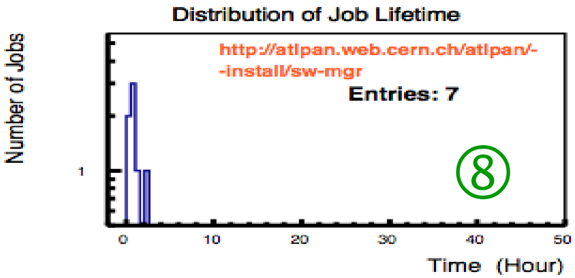


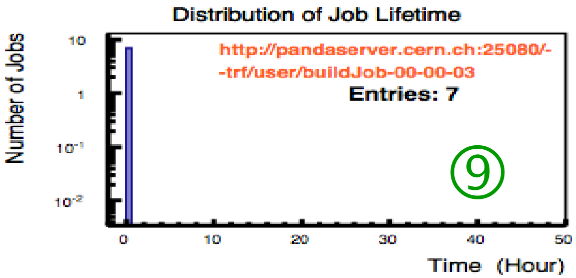












- *Among all the analysis jobs, ~63% finished within 2 hours, ~33% finished between 2 and 20 hours, 4% runs >20 hours.*

MaxMemory of Analysis Jobs

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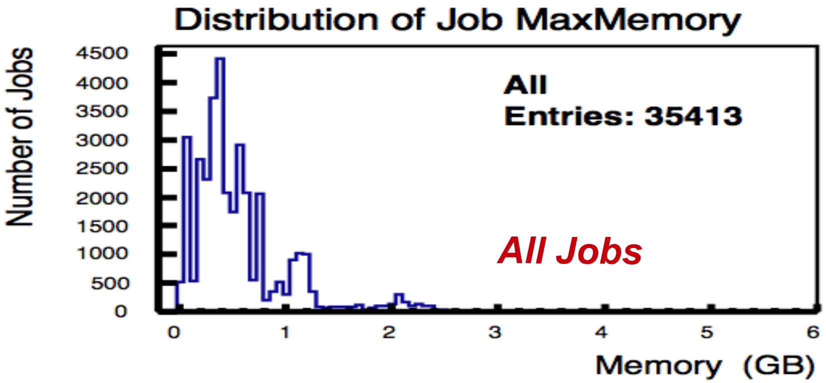

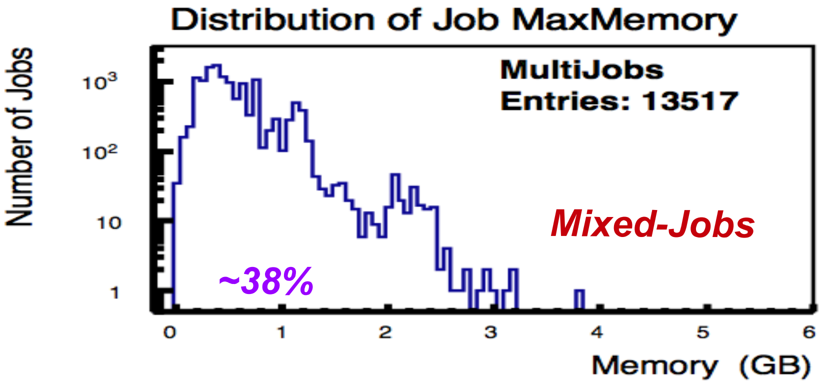

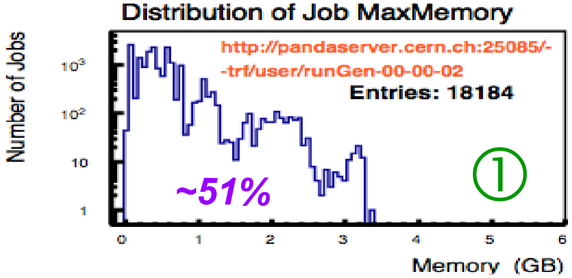

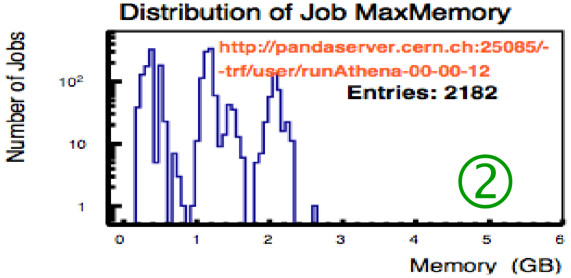

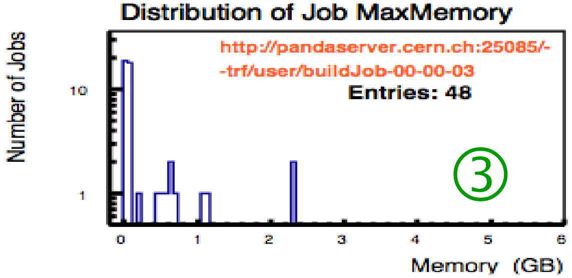

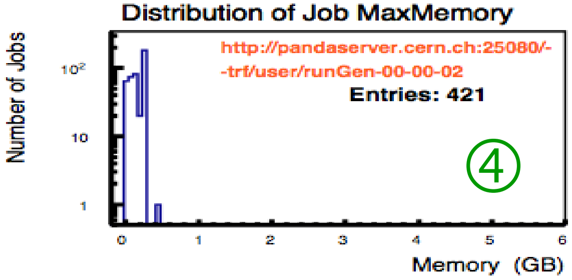

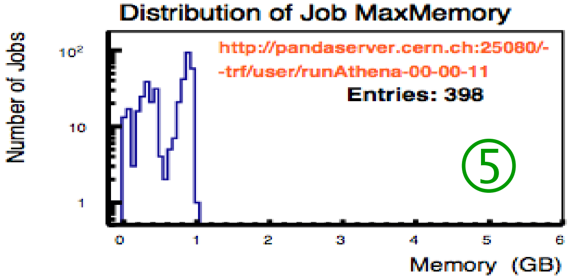

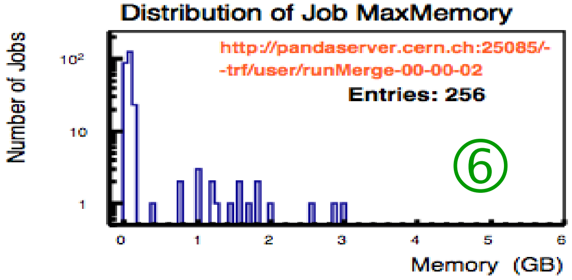

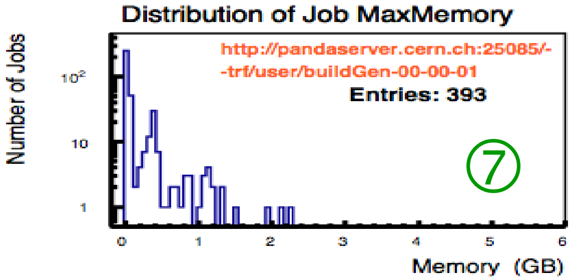

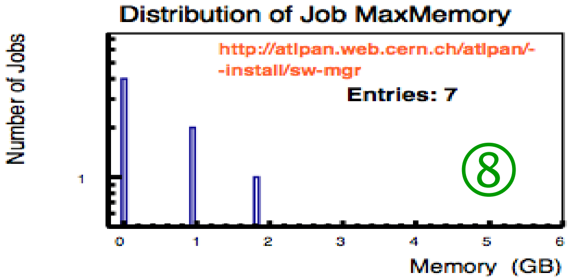

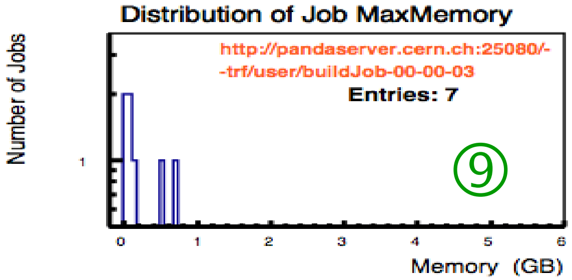

- *Among all the analysis jobs, ~94.5% use <1.5GB, ~5% uses 1.5-3GB, 0.2% uses >3GB.*

Averaged CPU of Analysis Jobs

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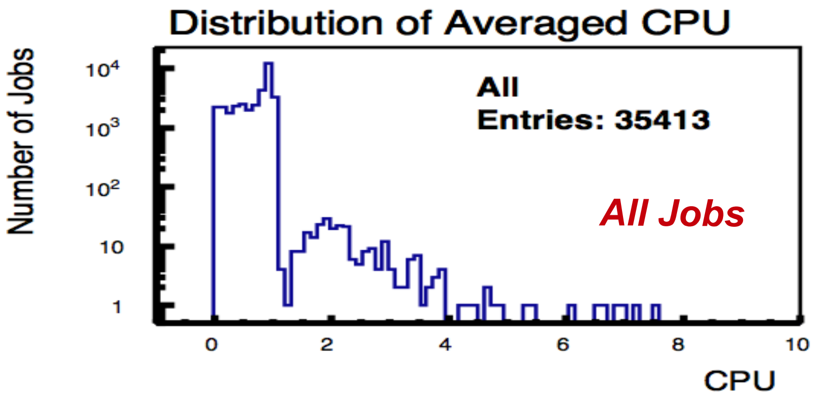
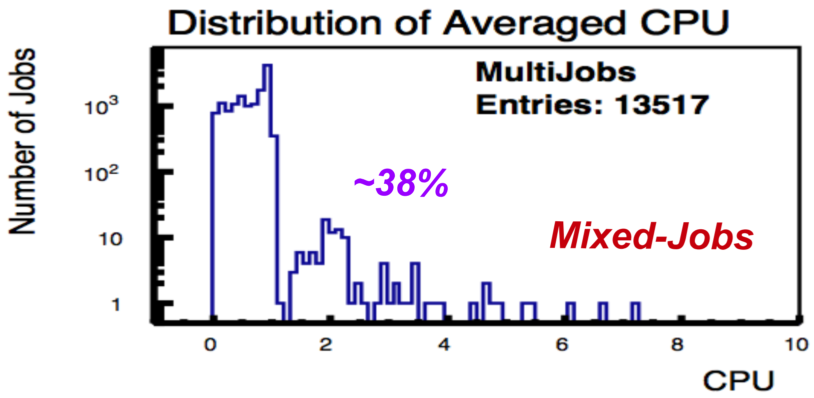
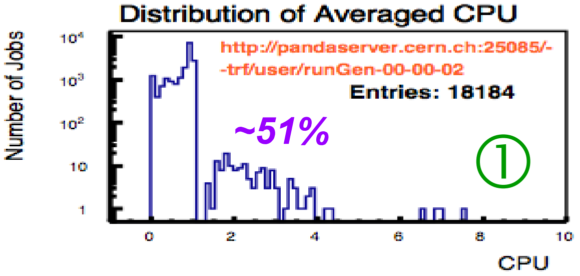
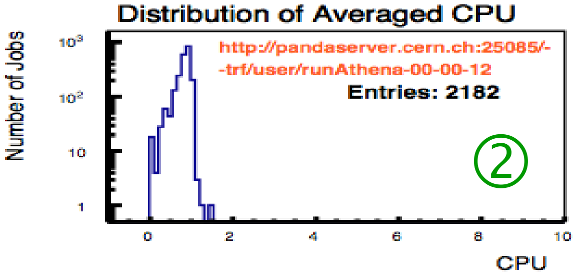
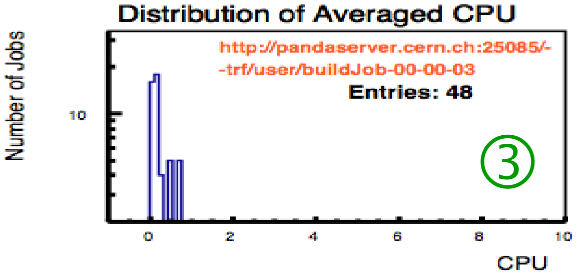
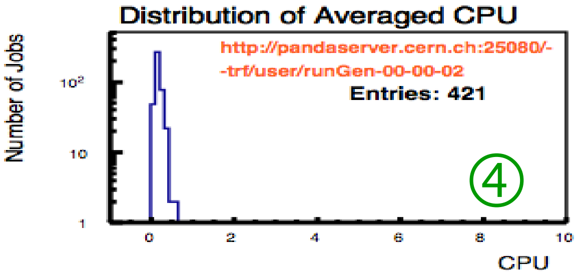


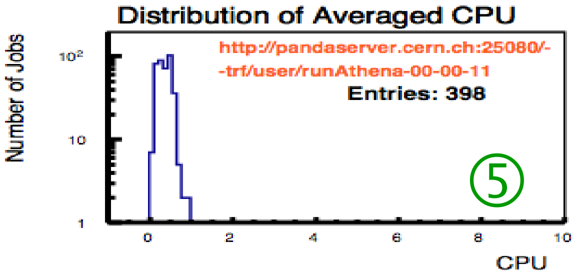


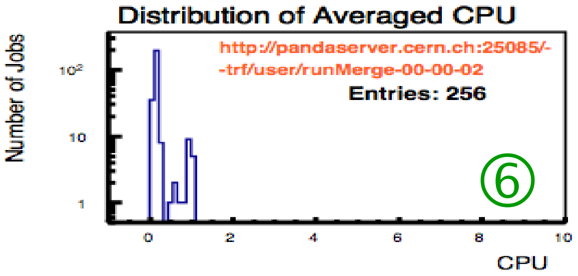


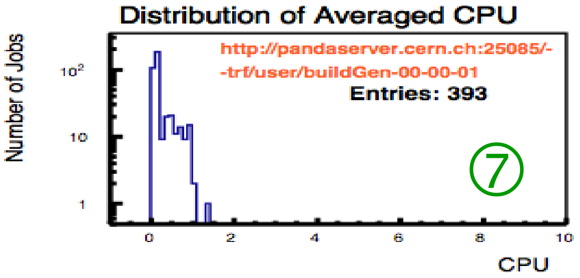


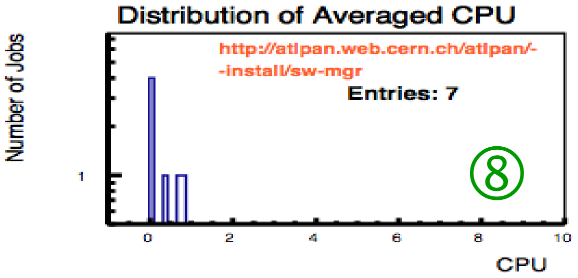


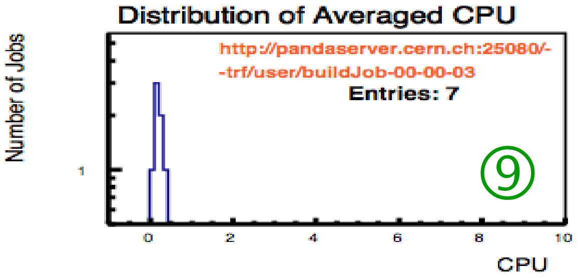






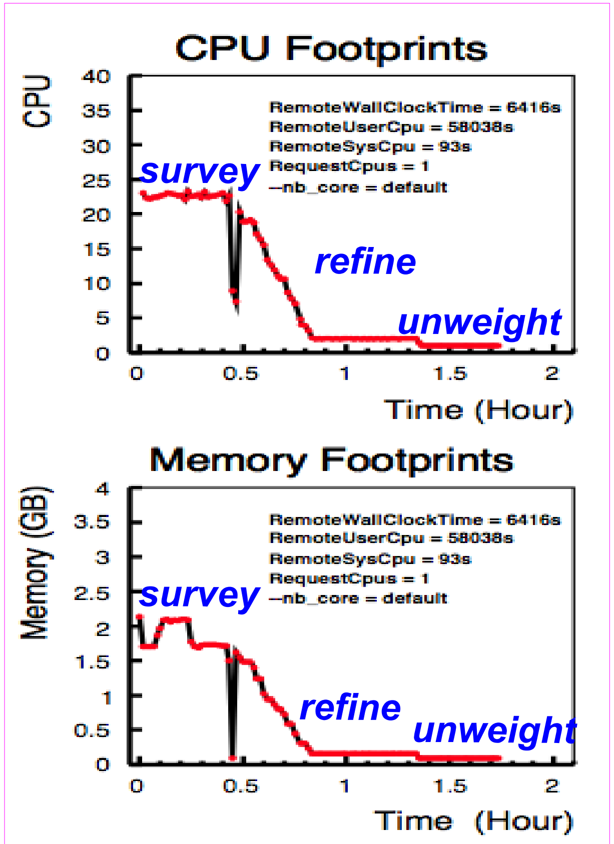




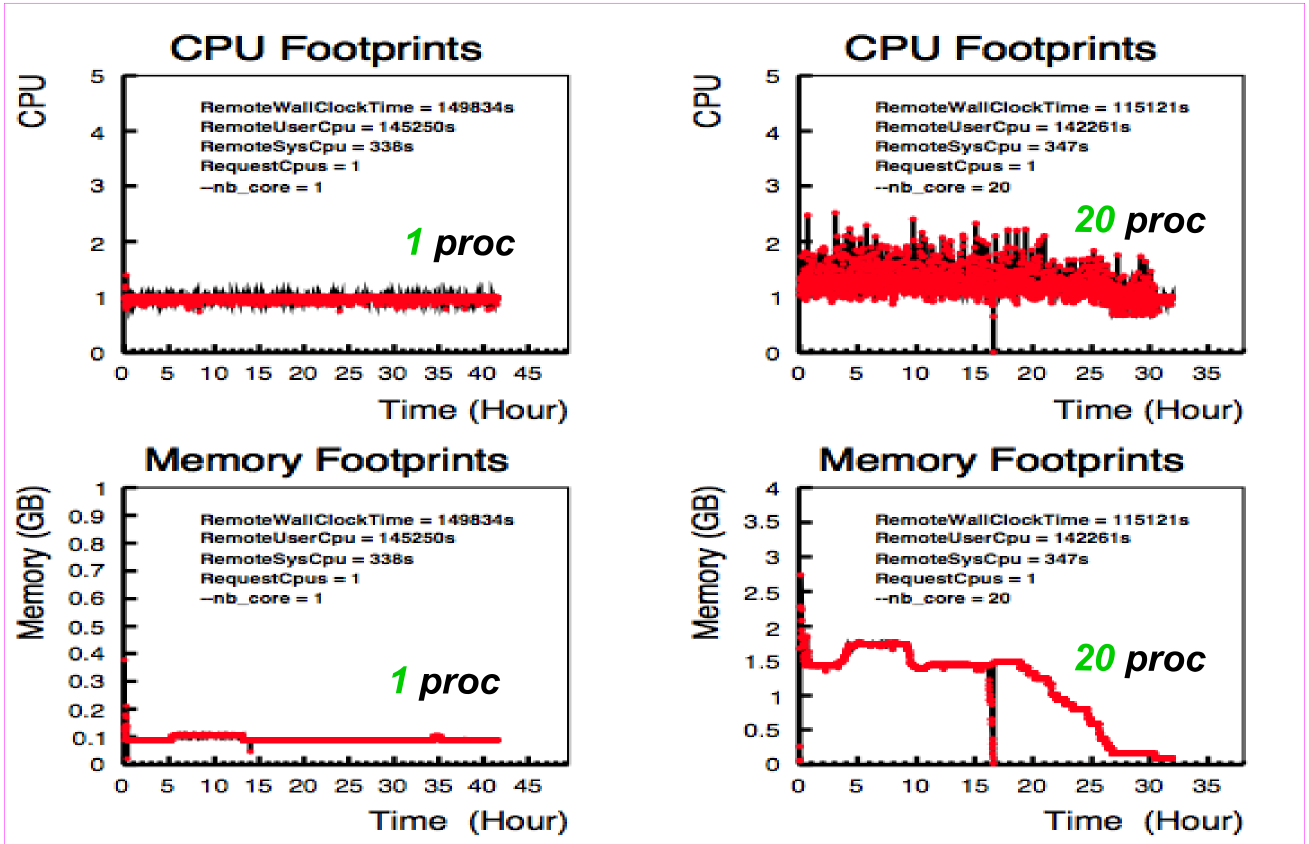


- *~1% jobs use > 1 cpu, known as Madevents jobs created by Madgraph*

Test of Madgraph jobs



Test 1



Test 2

- *Test node: node046, 24 core, 24GB physical memory, 24GB swap*
- *Test 1: run madgraph in default mode, e.g. without setting –nb_core*
- *Test 2: run madgraph with 1 and 20 processes separately, both in parallel with another condor job which stressed the other 23 cores all the time.*

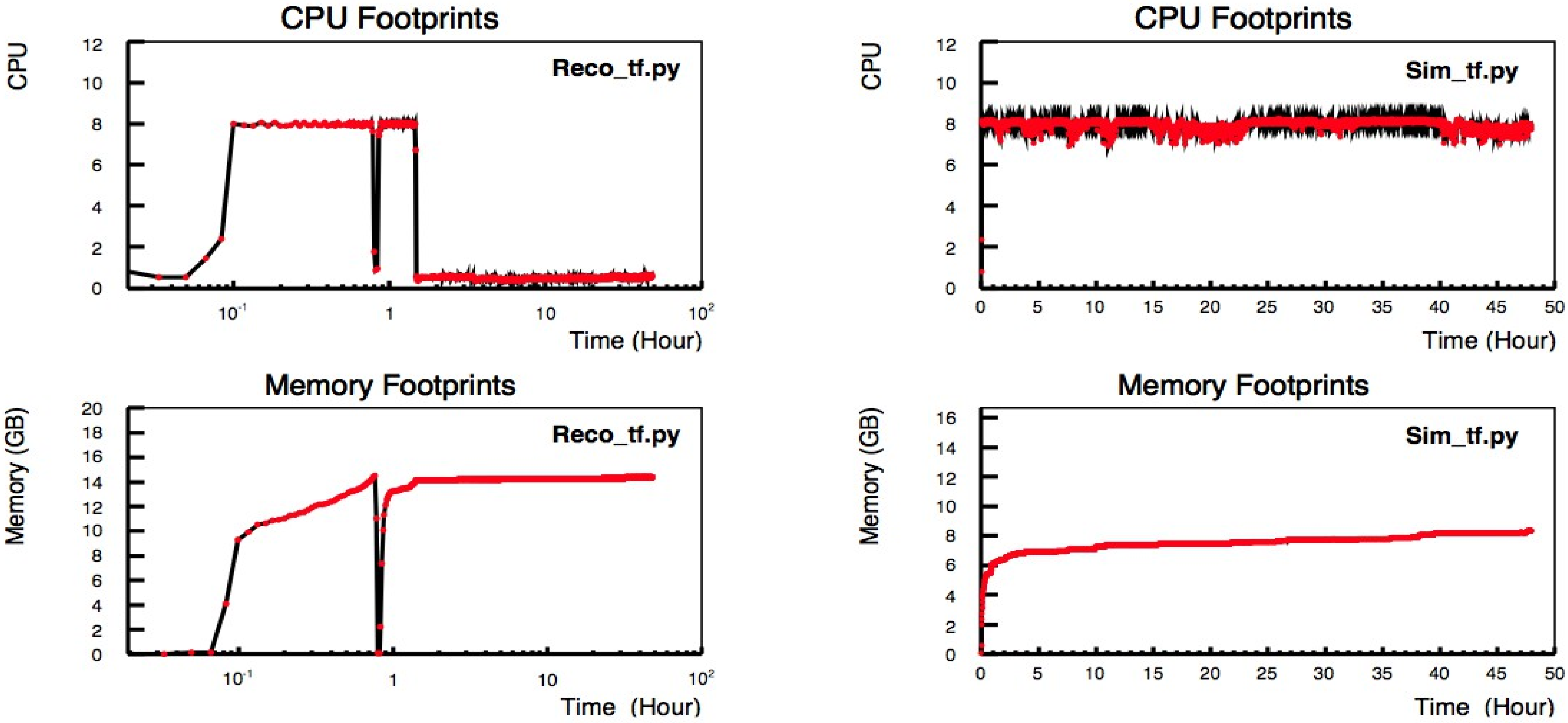
Memory Overcommit

- Balance between Job's memory over-requesting and high resource usage
  - Optimization is difficult due to job's complexity and WN variation
- ATLAS jobs:

	Request_CPU	Request_MEM	MAX_MEM_used	Request Mem/cpu	Ideal Mem/cpu
PRODUCTION	1	3GB	95% < 1.2GB	3 GB	1.2 GB
	8	16GB	[2-8],[8-16]	2 GB	2 GB
ANALYSIS	1	4GB	94.5% < 1.5GB	4 GB	1.5 GB

  - Multicore production jobs: request memory close to real usage
  - Single core jobs: request ~150% than real usage
  - ATLAS is planning to use RSS & SWAP to replace MEMORY in job description
- Site policy:
  - RSS > 2GB/CPU: overcommit_factor >= 2
  - RSS < 2GB/CPU: overcommit_factor < 2

Broken Multicore Jobs



- *Jobs could get broken at any step, and a broken job takes 48 hours (384 cpu-hours) while a normal multicore job only takes ~ 2 hours*
- *Suspicous job detecting system setup to track/kill suspicious multicore jobs*
  - *Reco_tf.py: cpu usage dropped to ~0.4 and memory usage unchanged*
  - *Sim_tf.py: running time > 10 hours (old Sim_tf.py jobs)*

Future Work

- Rerun the analysis on larger time scale
- Monthly calibation
  - To detect the change of Job properties
  - Update local resource policy correspondingly
- Integration into site monitoring/security tools
  - Online tracking of cpu/memory footprints of selected job
  - Online tracking of suspicous jobs
    - Enable the killing of broken multicore reconstruction jobs
- Expand the analysis to more VOs
  - CMS?
  - Small VOs?

Questions?