How OSG Increases Goodput with Elasticsearch

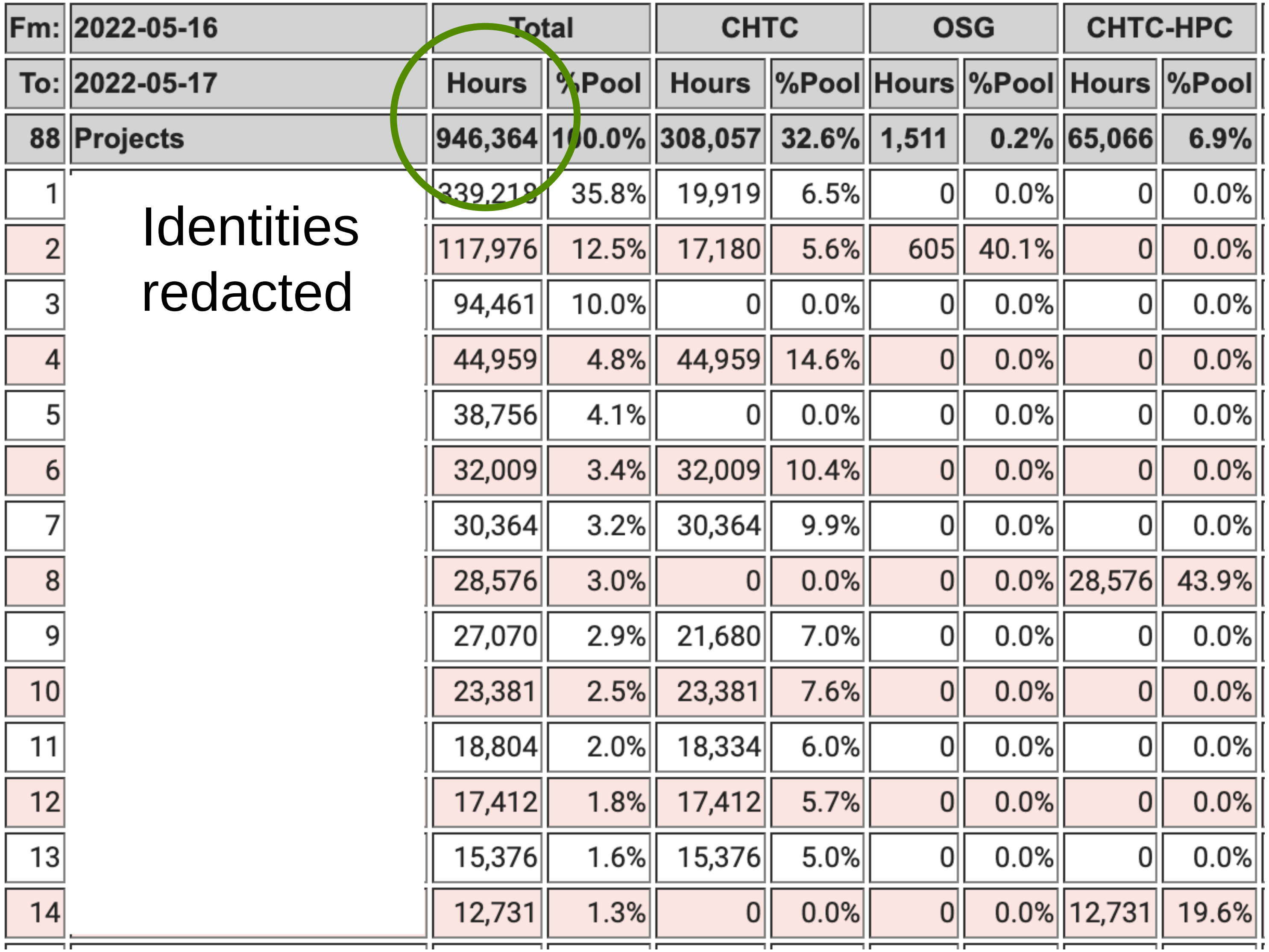
Todd Tannenbaum / Jason Patton
Center for High Throughput Computing

Usage reporting with Accounting ads

$ **condor_userprio** –usage

```
                        Wghted  Total Usage       Usage             Last
User Name               In Use  (wghted-hrs)    Start Time       Usage Time
----------------------- ------ ------------ ---------------- ----------------
todd@submit5.wisc.edu        0         0.04 10/10/2022 09:13 10/10/2022 09:22
fred@submit5.wisc.edu        0         1.02 10/10/2022 05:15 10/10/2022 09:29
----------------------- ------ ------------ ---------------- ----------------
Number of users: 2           0         1.06                  10/09/2022 09:29
```

Usage reporting with Accounting ads



Fm:	2022-05-16	Total		CHTC		OSG		CHTC-HPC	
To:	2022-05-17	Hours	%Pool	Hours	%Pool	Hours	%Pool	Hours	%Pool
88	Projects	946,364	100.0%	308,057	32.6%	1,511	0.2%	65,066	6.9%
1		339,219	35.8%	19,919	6.5%	0	0.0%	0	0.0%
2		117,976	12.5%	17,180	5.6%	605	40.1%	0	0.0%
3		94,461	10.0%	0	0.0%	0	0.0%	0	0.0%
4		44,959	4.8%	44,959	14.6%	0	0.0%	0	0.0%
5		38,756	4.1%	0	0.0%	0	0.0%	0	0.0%
6		32,009	3.4%	32,009	10.4%	0	0.0%	0	0.0%
7		30,364	3.2%	30,364	9.9%	0	0.0%	0	0.0%
8		28,576	3.0%	0	0.0%	0	0.0%	28,576	43.9%
9		27,070	2.9%	21,680	7.0%	0	0.0%	0	0.0%
10		23,381	2.5%	23,381	7.6%	0	0.0%	0	0.0%
11		18,804	2.0%	18,334	6.0%	0	0.0%	0	0.0%
12		17,412	1.8%	17,412	5.7%	0	0.0%	0	0.0%
13		15,376	1.6%	15,376	5.0%	0	0.0%	0	0.0%
14		12,731	1.3%	0	0.0%	0	0.0%	12,731	19.6%

Identities redacted

Usage reporting with Accounting ads

- So, we delivered almost a million CPU core hours that day.
  - …was any of it good?
- Any other usage?
  - GPU hours?
  - Memory usage?
  - Files transferred?
- How was the user experience?
  - How often were jobs interrupted or put on hold?

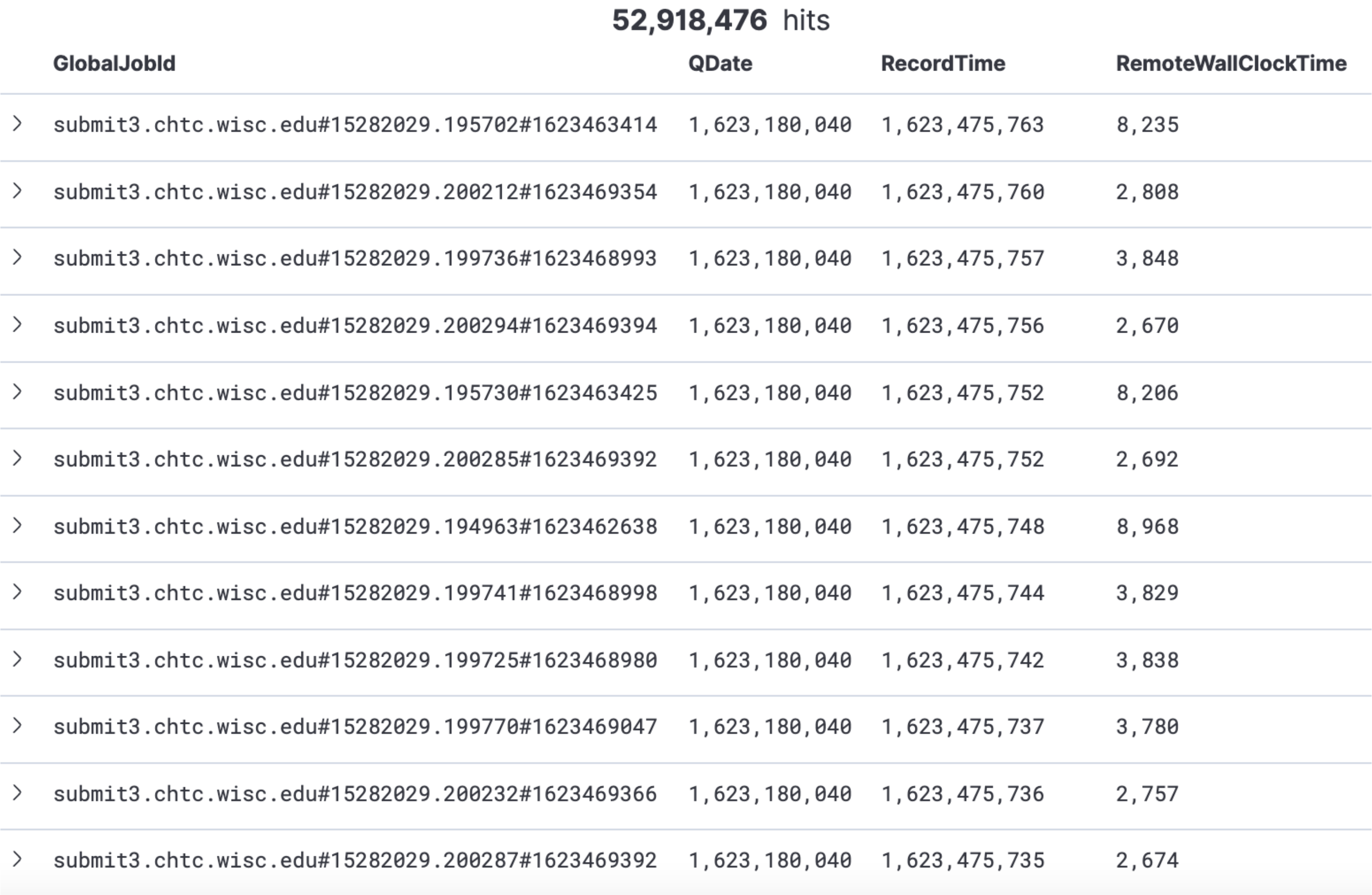
Storing job history in Elasticsearch

- We use the condor_adstash tool to periodically push job history ads from access points to Elasticsearch (ES).
- Wins:
  - Query-able history of all* job ads
  - New attributes do not have to be predefined before inserting ads
  - Libraries in popular languages for querying ES
  - Kibana web UI for simple queries and graphs

Storing job history in Elasticsearch

- Gotchas
  - Adstash does *remote* history queries, limited by knob setting HISTORY_HELPER_MAX_HISTORY (last 10,000 ads by default)
    - *may miss ads on busy APs, especially if outages occur
  - Unlike ClassAds (which may contain user-defined attrs), ES field names are case-sensitive and field values must have same type
    - By default, Adstash converts unknown attr names to lowercase and types unknown fields as text
  - (IMO) ES has a penchant for API breaking changes
    - Example: Adstash suddenly broken with elasticsearch-py v8.0+

Now what?



52,918,476 hits

	GlobalJobId	QDate	RecordTime	RemoteWallClockTime
>	submit3.chtc.wisc.edu#15282029.195702#1623463414	1,623,180,040	1,623,475,763	8,235
>	submit3.chtc.wisc.edu#15282029.200212#1623469354	1,623,180,040	1,623,475,760	2,808
>	submit3.chtc.wisc.edu#15282029.199736#1623468993	1,623,180,040	1,623,475,757	3,848
>	submit3.chtc.wisc.edu#15282029.200294#1623469394	1,623,180,040	1,623,475,756	2,670
>	submit3.chtc.wisc.edu#15282029.195730#1623463425	1,623,180,040	1,623,475,752	8,206
>	submit3.chtc.wisc.edu#15282029.200285#1623469392	1,623,180,040	1,623,475,752	2,692
>	submit3.chtc.wisc.edu#15282029.194963#1623462638	1,623,180,040	1,623,475,748	8,968
>	submit3.chtc.wisc.edu#15282029.199741#1623468998	1,623,180,040	1,623,475,744	3,829
>	submit3.chtc.wisc.edu#15282029.199725#1623468980	1,623,180,040	1,623,475,742	3,838
>	submit3.chtc.wisc.edu#15282029.199770#1623469047	1,623,180,040	1,623,475,737	3,780
>	submit3.chtc.wisc.edu#15282029.200232#1623469366	1,623,180,040	1,623,475,736	2,757
>	submit3.chtc.wisc.edu#15282029.200287#1623469392	1,623,180,040	1,623,475,735	2,674

Usage reporting with ~~Accounting ads~~ condor_adstash

- **Was any of our usage good?**
- Any other usage?
  - GPU hours?
  - Memory usage?
  - Files transferred?
- How was the user experience?
  - How often were jobs interrupted or put on hold?

Let’s use our job history for good(put)!

Goodput

noun

1. the opposite of badput.

Badput

noun

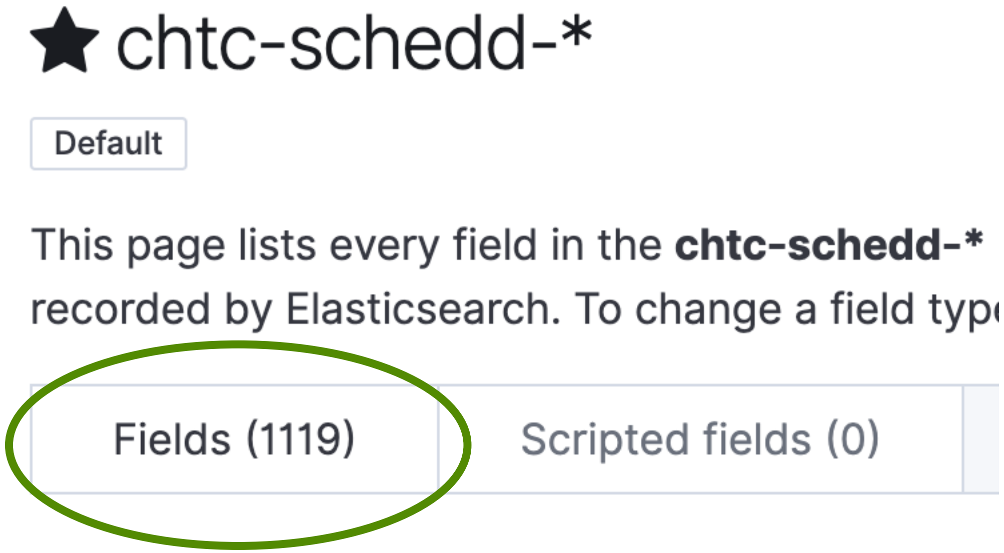
1. claimed computing resources that did not contribute meaningfully to a requested computing task (i.e. to science).

Let’s use our job history for good(put)!

- “good” CPU hours = total CPU hours – “bad” CPU hours
- What should count towards bad CPU hours?
  - The time spent by any job execution that doesn’t exit on its own accord or that doesn’t exit due to user action.
  - Evicted executions clearly lead to badput, what about held jobs and removed jobs?
  - Assumption: Good CPU hours are CPU hours used in the last execution attempt (i.e. “final run”) of a job.

Can we calculate goodput from a job ad?

Calculating goodput from a job ad



★ chtc-schedd-*

Default

This page lists every field in the **chtc-schedd-*** recorded by Elasticsearch. To change a field typ

Fields (1119) | Scripted fields (0)

```
$ condor_history -limit 1 -l | wc -l
167
```

Let’s check page 490 of the HTCondor manual…

Pop quiz!

Which pair of attributes provides the total runtime across all a job’s runs and the runtime of a job’s final run, respectively?

A. RemoteWallClockTime, CommittedTime

B. CommittedTime, RemoteWallClockTime

C. RemoteWallClockTime, LastRemoteWallClockTime

D. LastRemoteWallClockTime, RemoteWallClockTime

Pop quiz!

Which pair of attributes provides the total runtime across all a job’s runs and the runtime of a job’s final run, respectively?

A. **RemoteWallClockTime, CommittedTime**

B. CommittedTime, RemoteWallClockTime

Undefined if job was removed!

emoteWallClockTime

noteWallClockTime

Pop quiz!

Only exists since HTCondor 9.4.0

ides the total runtime across all a
f a job's final run, respectively?

A. RemoteWallClockTime, CommittedTime

B. CommittedTime, RemoteWallClockTime

C. RemoteWallClockTime, LastRemoteWallClockTime

D. LastRemoteWallClockTime, RemoteWallClockTime

Calculating goodput from a job ad

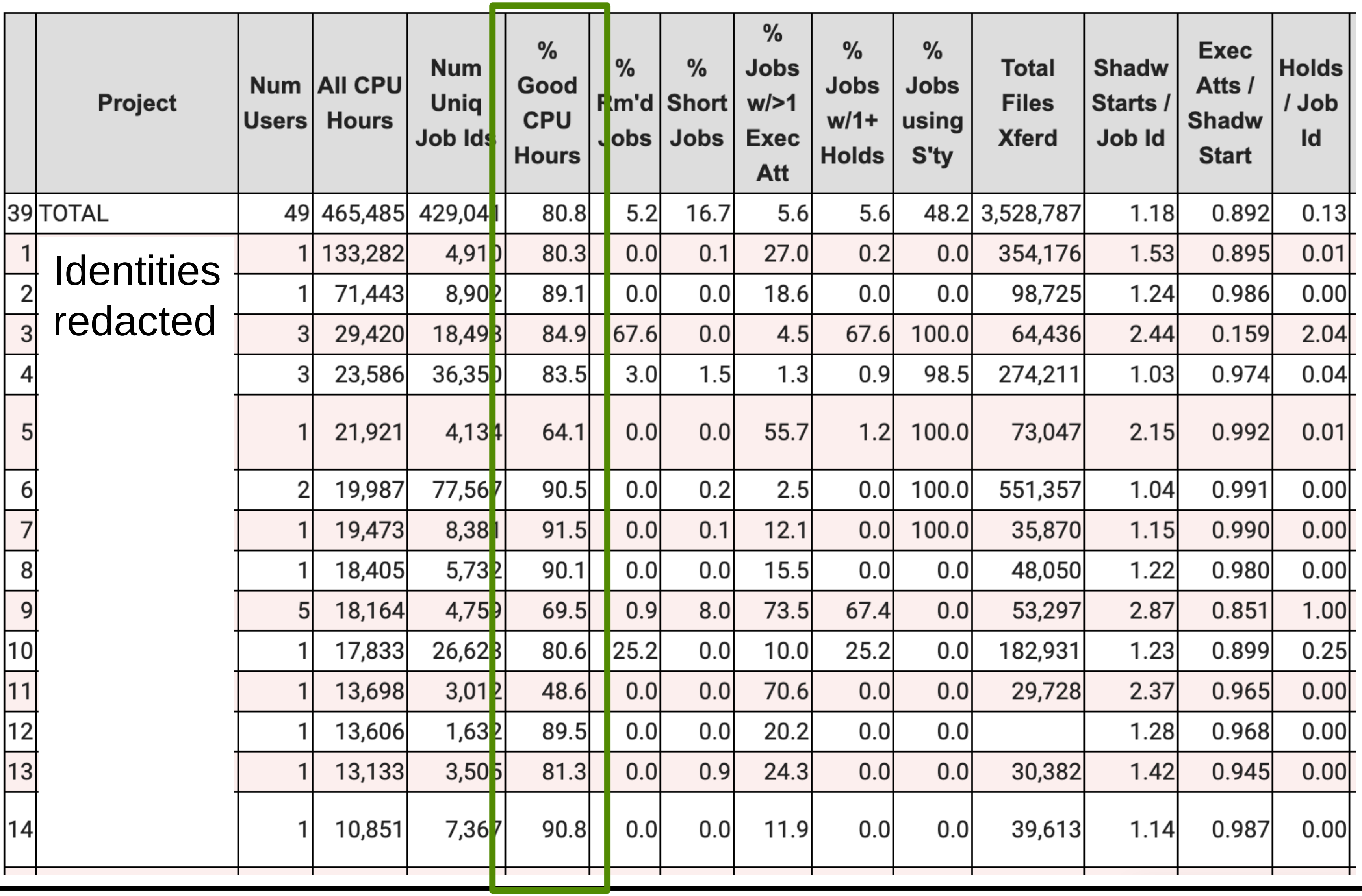
- Current approach:

```
Total CPU Hours ~= CpusProvisioned * RemoteWallClockTime / 3600
Good CPU Hours ~= CpusProvisioned * {
                    LastRemoteWallClockTime,
                    CommittedTime,
                    0
          } / 3600
```

- Finally, we can calculate goodput!

% Good CPU Hours = (Good CPU Hours/Total CPU Hours) * 100%

Calculating goodput from a job ad



	Project	Num Users	All CPU Hours	Num Uniq Job Ids	% Good CPU Hours	% Rm'd Jobs	% Short Jobs	% Jobs w/>1 Exec Att	% Jobs w/1+ Holds	% Jobs using S'ty	Total Files Xferd	Shadw Starts / Job Id	Exec Atts / Shadw Start	Holds / Job Id
39	TOTAL	49	465,485	429,041	80.8	5.2	16.7	5.6	5.6	48.2	3,528,787	1.18	0.892	0.13
1	Identities redacted	1	133,282	4,910	80.3	0.0	0.1	27.0	0.2	0.0	354,176	1.53	0.895	0.01
2		1	71,443	8,902	89.1	0.0	0.0	18.6	0.0	0.0	98,725	1.24	0.986	0.00
3		3	29,420	18,493	84.9	67.6	0.0	4.5	67.6	100.0	64,436	2.44	0.159	2.04
4		3	23,586	36,350	83.5	3.0	1.5	1.3	0.9	98.5	274,211	1.03	0.974	0.04
5		1	21,921	4,134	64.1	0.0	0.0	55.7	1.2	100.0	73,047	2.15	0.992	0.01
6		2	19,987	77,567	90.5	0.0	0.2	2.5	0.0	100.0	551,357	1.04	0.991	0.00
7		1	19,473	8,381	91.5	0.0	0.1	12.1	0.0	100.0	35,870	1.15	0.990	0.00
8		1	18,405	5,732	90.1	0.0	0.0	15.5	0.0	0.0	48,050	1.22	0.980	0.00
9		5	18,164	4,759	69.5	0.9	8.0	73.5	67.4	0.0	53,297	2.87	0.851	1.00
10		1	17,833	26,623	80.6	25.2	0.0	10.0	25.2	0.0	182,931	1.23	0.899	0.25
11		1	13,698	3,012	48.6	0.0	0.0	70.6	0.0	0.0	29,728	2.37	0.965	0.00
12		1	13,606	1,632	89.5	0.0	0.0	20.2	0.0	0.0		1.28	0.968	0.00
13		1	13,133	3,505	81.3	0.0	0.9	24.3	0.0	0.0	30,382	1.42	0.945	0.00
14		1	10,851	7,367	90.8	0.0	0.0	11.9	0.0	0.0	39,613	1.14	0.987	0.00

Usage reporting with ~~Accounting ads~~ condor_adstash

- **Was any of our usage good? ✓**
- Any other usage?
  - GPU hours?
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Usage reporting with ~~Accounting ads~~ condor_adstash

- Was any of our usage good? ✔
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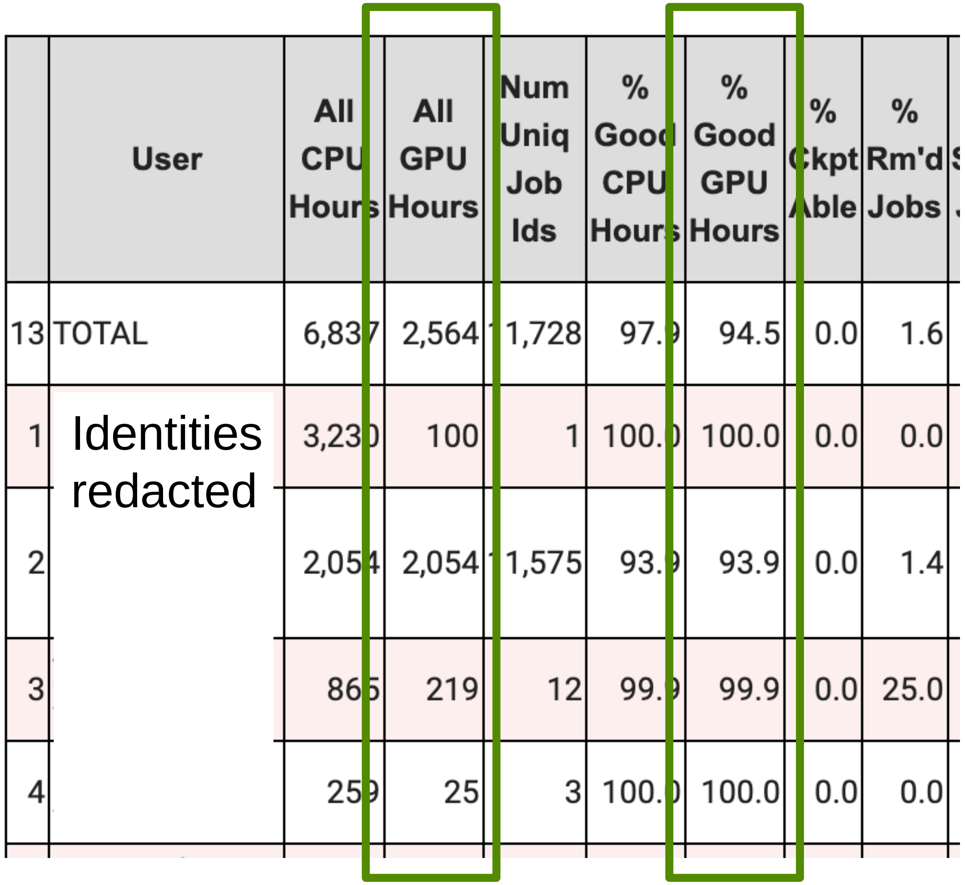
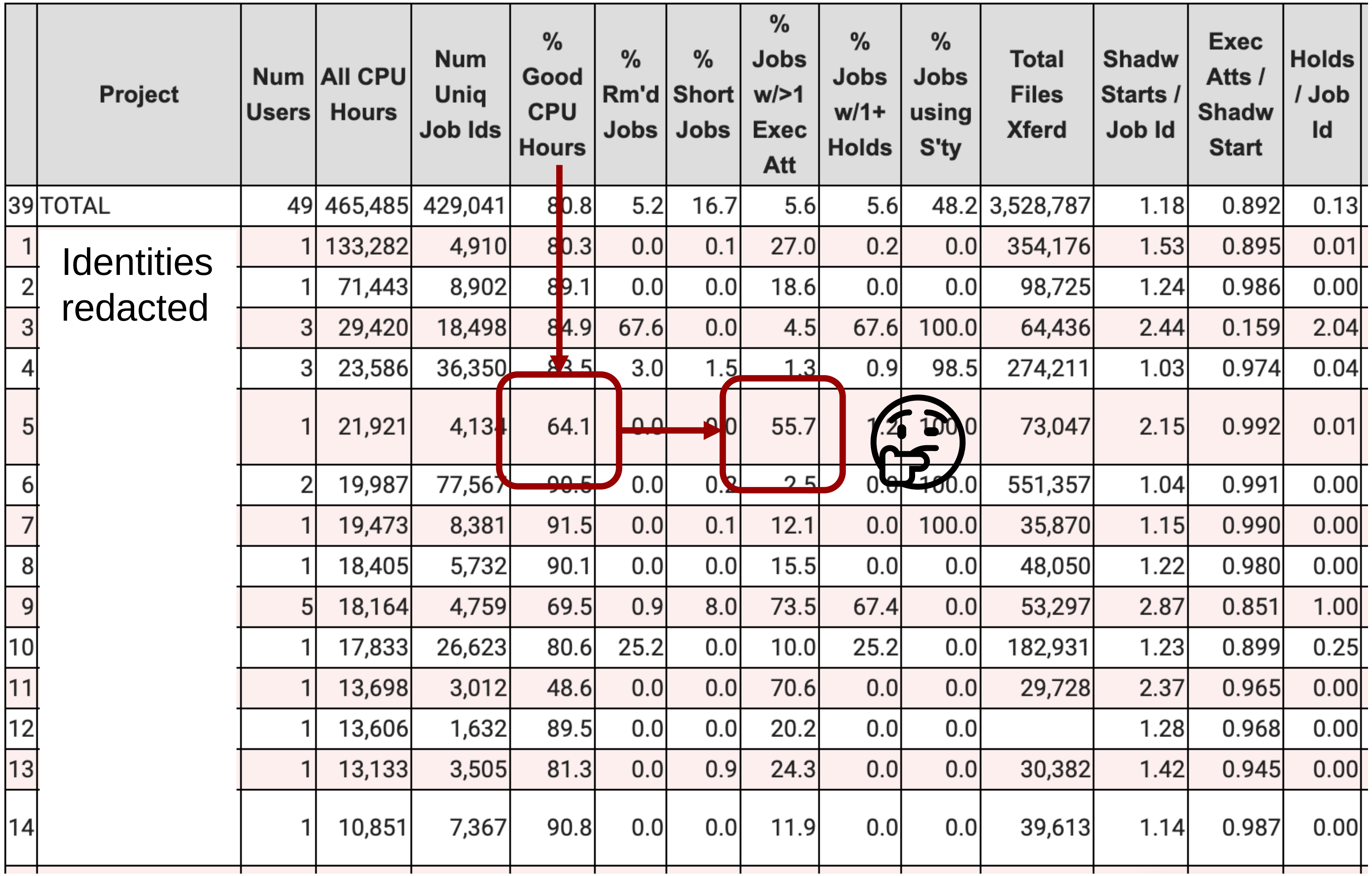


	User	All CPU Hours	All GPU Hours	Num Uniq Job Ids	% Good CPU Hours	% Good GPU Hours	% Ckpt Able	% Rm'd Jobs
13	TOTAL	6,837	2,564	11,728	97.9	94.5	0.0	1.6
1	Identities redacted	3,230	100	1	100.0	100.0	0.0	0.0
2		2,054	2,054	11,575	93.9	93.9	0.0	1.4
3		865	219	12	99.9	99.9	0.0	25.0
4		259	25	3	100.0	100.0	0.0	0.0

Usage reporting with ~~Accounting ads~~ condor_adstash

- Was any of it good? ✓
- Any other usage? ✓
  - GPU hours?
  - Memory usage?
  - Files transferred?
- **How was the user experience?**
  - How often were jobs interrupted or put on hold?

Finding users who are having a bad time



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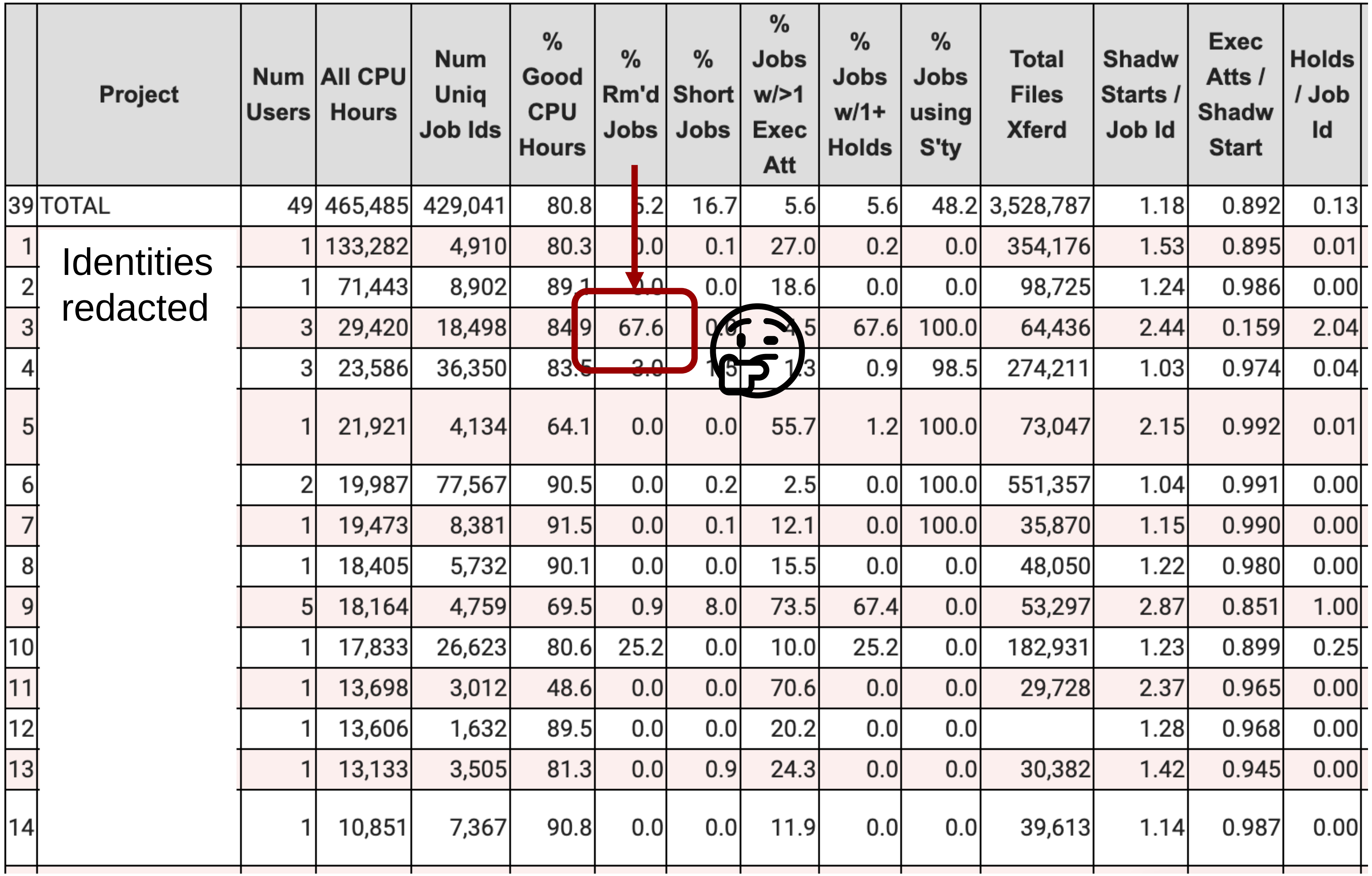

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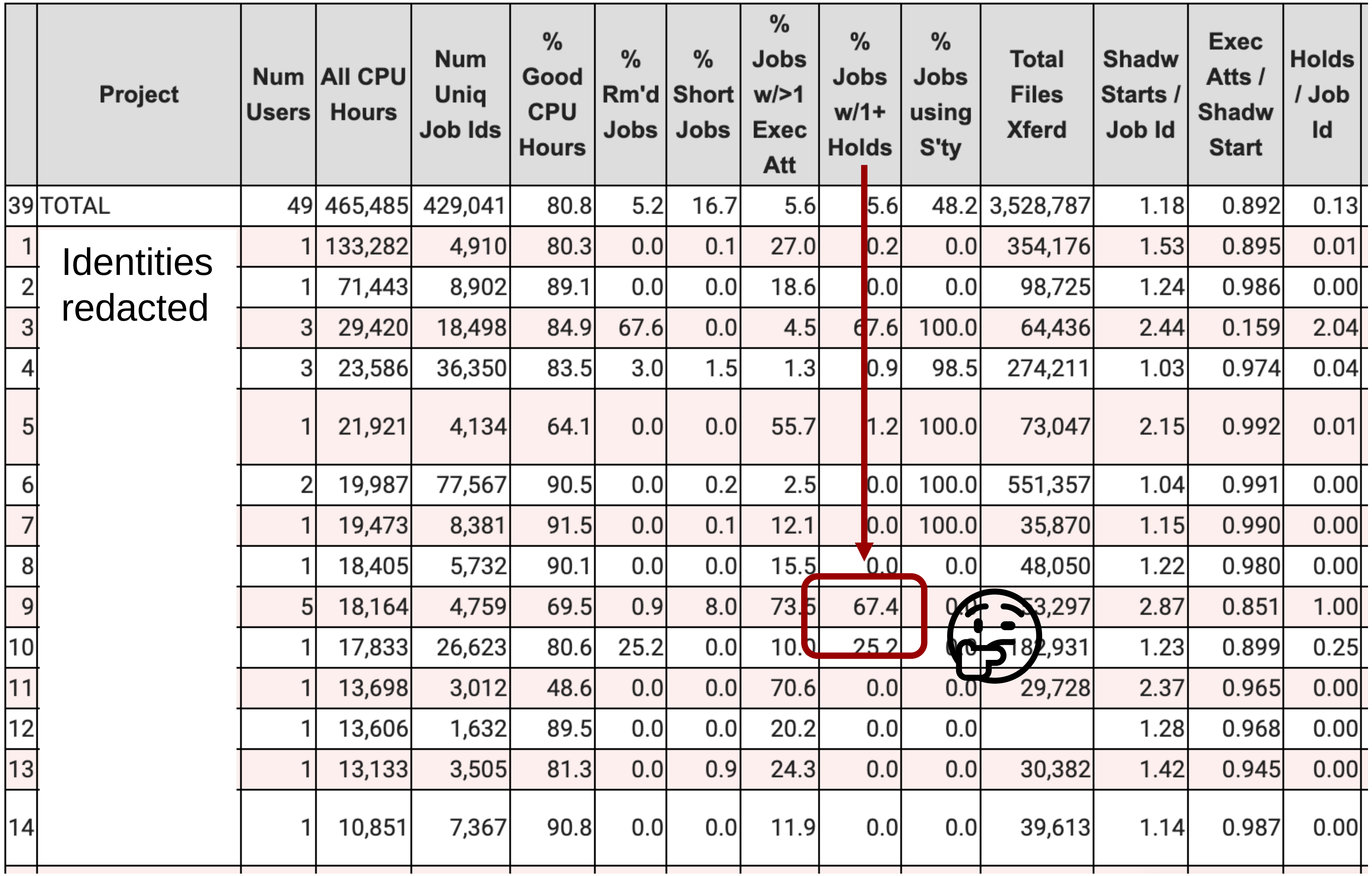

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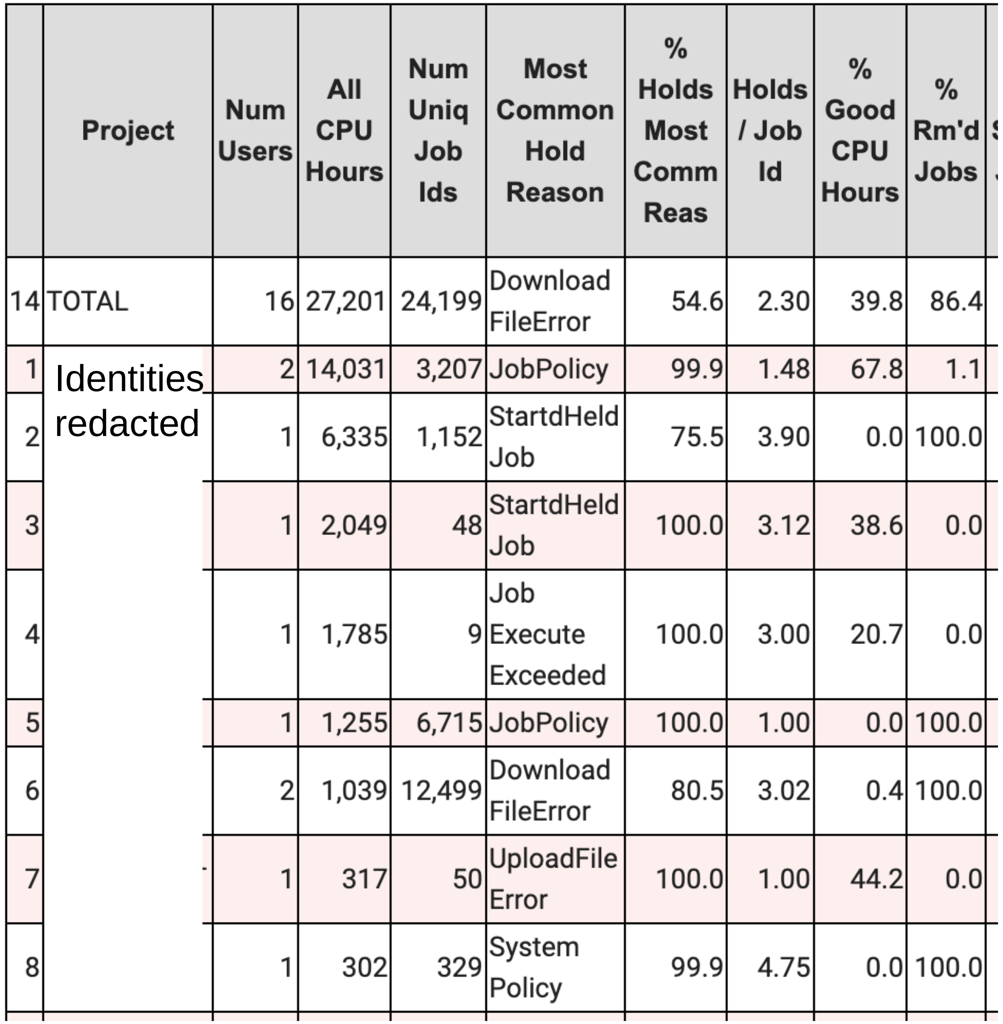
Finding users who are having a bad time

- Additional reports have shown to be helpful, such as reporting on all jobs that had at least one hold event.



	Project	Num Users	All CPU Hours	Num Uniq Job Ids	Most Common Hold Reason	% Holds Most Comm Reas	Holds / Job Id	% Good CPU Hours	% Rm'd Jobs
14	TOTAL	16	27,201	24,199	Download FileError	54.6	2.30	39.8	86.4
1	Identities redacted	2	14,031	3,207	JobPolicy	99.9	1.48	67.8	1.1
2		1	6,335	1,152	StartdHeld Job	75.5	3.90	0.0	100.0
3		1	2,049	48	StartdHeld Job	100.0	3.12	38.6	0.0
4		1	1,785	9	Job Execute Exceeded	100.0	3.00	20.7	0.0
5		1	1,255	6,715	JobPolicy	100.0	1.00	0.0	100.0
6		2	1,039	12,499	Download FileError	80.5	3.02	0.4	100.0
7		1	317	50	UploadFile Error	100.0	1.00	44.2	0.0
8		1	302	329	System Policy	99.9	4.75	0.0	100.0

Usage reporting with ~~Accounting ads~~ condor_adstash

- Was any of it good? ✓
- Any other usage? ✓
  - GPU hours?
  - Memory usage?
  - Files transferred?
- **How was the user experience? ✓**
  - How often were jobs interrupted or put on hold?

Improving HTCondor

- This project has prompted many additions to the job ad:

LastRemoteWallClockTime = 3764

NumHoldsByReason = [UserRequest = 2; JobPolicy = 10; UnableToOpenInput = 1]

TransferInputStats = [CedarFilesCountTotal = 5; CedarFilesCountLastRun = 5]

Remaining challenges

- How to find strangely behaved or broken “sites”?
  - Example: Job runs 3 times at Site A, failing to transfer output each time, before running and completing successfully at Site B.
  - Job ads lack information about intermediate job runs, must infer from cumulative and last run stats.
    - Startd History file on the EP
    - Upcoming: Instance History file on the AP
- How to determine if jobs are checkpointing *correctly*?
  - Are intermediate runs contributing to goodput or not?

Want to try it ?

- Setup Elasticsearch
  - Create an index named "`htcondor-000001`"
- Install HTCSS
  - Add to HTCSS config:

```
use feature: adstash
```

  - Details: See Manual / Admin Manual / Monitoring / Elasticsearch
- Checkout and/or customize our report generation scripts
  - https://github.com/CHTC/JobAccounting

Thank You!

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PATh PARTNERSHIP to ADVANCE THROUGHPUT COMPUTING

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