Prescale tools for L1T

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Outline

- What are the “PS tools” and why do we need them?
- Features of the tools (incl. usage examples)
- Ideas for future implementations and use cases

➜ List of relevant links & resources at the end of the talk!

Prescales reminder...

- Each L1 seed comes with a set of prescale (PS) values that are used to keep the trigger rates within manageable limits:
  - PS = 1: unprescaled seed
  - PS = n > 1: prescaled seed; only every *n*th triggered event is accepted
  - PS = 0: seed disabled
- To increase data taking efficiency in light of the constantly decreasing beam luminosity in a given LHC fill, prescale “columns” are switched routinely at P5 (going from larger PS values to smaller ones) to keep the overall data taking rate roughly constant.
- The matrix of PS values for the different seeds and their prescale columns is called a **“prescale table”**.

What are the “PS tools”?

- PS (prescale) tools is a new collection of scripts for…
  - …**creating new PS tables** from the combined information of (a) an existing PS table and (b) a L1 menu
  - …**comparing two PS tables** and displaying their diff in various output formats
- These tools have been developed only recently and have not been used during Run 2.

Why do we need them?

- Up to now, PS table generation has been done “by hand”, which…
  - …has a slower turnaround.
  - …is more error prone - especially when the seed ordering (i.e., the algorithm bit mapping) between two menus changed significantly.
- In the spirit of advancing automation, we aim to provide **tools for easy, fast and reliable means of processing PS tables**.

Available tools

with PS tools v0.2.0

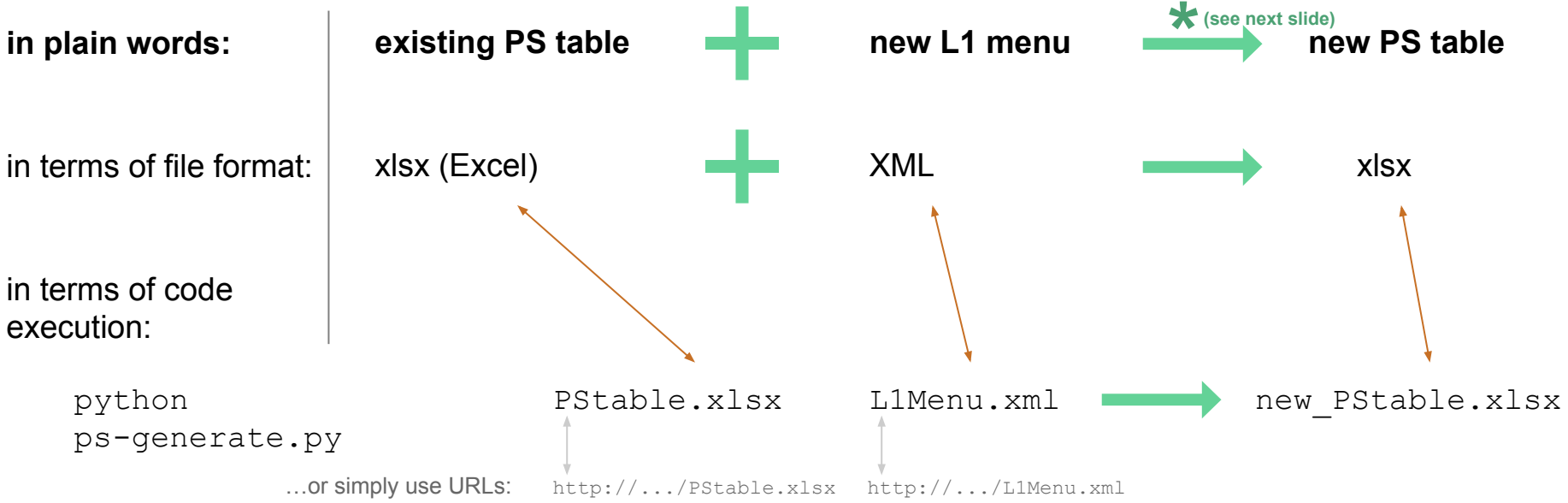
ps-generate (PS table creation tool)

ps-diff (PS table comparison tool)

→ L1 Trigger Menu Tools twiki

ps-generate

PS table creation tool: Basic working principle



(from slide before)

New PS table generation logic

- seed ordering according to the new menu
- PS values are copied if existing in the old PS table, otherwise left empty
- output format: Excel sheet (xlsx)

Example:

PS table generated according to Collisions2018_v2_1_0 menu, using prescales from Collisions2018_v2_0_0

	A	B	C	D	E	F	G	H	I	J	K
1	**n**	**Name**	**Emergency**	**2.2E+034**	**2E+034**	**1.6E+034**	**1.4E+034**	**1.2E+034**	**1E+034**	**8E+033**	**5E+033**
2	0	L1_SingleMuCosmics	0	0	0	0	0	0	0	0	0
3	1	L1_SingleMuCosmics_BMTF	0	0	0	0	0	0	0	0	0
4	2	L1_SingleMuCosmics_OMTF	0	0	0	0	0	0	0	0	0
5	3	L1_SingleMuCosmics_EMTF	0	0	0	0	0	0	0	0	0
6	4	L1_SingleMuOpen	0	63000	63000	63000	63000	63000	63000	63000	63000
7	5	L1_SingleMu0_DQ	0	0	0	0	0	0	0	0	0
8	6	L1_SingleMu0_BMTF	0	0	0	0	0	0	0	0	0
9	7	L1_SingleMu0_OMTF	0	0	0	0	0	0	0	0	0
10	8	L1_SingleMu0_EMTF	0	0	0	0	0	0	0	0	0
11	9	L1_SingleMu3	0	22000	22000	22000	22000	22000	22000	22000	22000
12	10	L1_SingleMu5	0	1700	1700	1700	1700	1700	1700	1700	1700
13	11	L1_SingleMu7_DQ	0	0	0	0	0	0	0	0	0
14	12	L1_SingleMu7	0	220	200	160	140	140	140	140	140

ps-diff

Basic usage examples (in ascending order of usefulness)

PS table comparison: usage example (1)

“left” PS table is compared to “right” PS table

default format (no further options given): line-by-line comparison

```
$ python ps-diff.py PStable_left.xslx PStable_right.xslx
```

Output snippet:

```
< 282 L1_Mu18er2p1_Tau26er2p1 0 1 1 1 1 1 1 1 1
< 283 nan 1 1 1 1 1 1 1 1 1
---
> 264 L1_SingleTau120er2p1 0 1 1 1 1 1 1 1 1
> 265 L1_SingleTau130er2p1 0 1 1 1 1 1 1 1 1
> 267 L1_DoubleTau70er2p1 0 1 1 1 1 1 1 1 1
> 269 L1_DoubleIsoTau28er2p1 0 0 0 0 0 0 0 0 0
> 270 L1_DoubleIsoTau30er2p1 0 0 0 1 1 1 1 1 1
> 271 L1_DoubleIsoTau32er2p1 0 0 1 1 1 1 1 1 1
> 272 L1_DoubleIsoTau34er2p1 0 1 1 1 1 1 1 1 1
> 273 L1_DoubleIsoTau36er2p1 0 1 1 1 1 1 1 1 1
> 274 L1_DoubleIsoTau28er2p1_Mass_Max90 0 0 0 0 0 0 0 0 0
> 275 L1_DoubleIsoTau28er2p1_Mass_Max80 0 0 0 1 1 1 1 1 1
> 276 L1_DoubleIsoTau30er2p1_Mass_Max90 0 0 0 0 0 0 0 0 0
> 277 L1_DoubleIsoTau30er2p1_Mass_Max80 0 0 0 1 1 1 1 1 1
> 279 L1_Mu18er2p1_Tau24er2p1 0 1 1 1 1 1 1 1 1
> 280 L1_Mu18er2p1_Tau26er2p1 0 1 1 1 1 1 1 1 1
> 282 L1_Mu22er2p1_IsoTau28er2p1 0 0 0 1 1 1 1 1 1
> 283 L1_Mu22er2p1_IsoTau30er2p1 0 0 0 1 1 1 1 1 1
303d223
< 288 nan 1 1 1 1 1 1 1 1 1
```

Here and in the following slides: diff between Collisions2018_v2_0_0 menu prescales (“left” PS table) & Collisions2018_v2_1_0 menu prescales (“right” PS table)

PS table comparison: usage example (2)

“left” PS table is compared to “right” PS table

output in two columns

no further options given: line-by-line comparison

```
$ python ps-diff.py PStable_left.xslx PStable_right.xslx side-by-side
```

Output snippet:

PS table comparison: usage example (3)

“left” PS table is compared to “right” PS table

output in two columns

invoke name-by-name (i.e., seed-by-seed) comparison

```
$ python ps-diff.py PStable_left.xslx PStable_right.xslx side-by-side --by-name
```

Output snippet:

PS table comparison: usage example (4)

“left” PS table — is compared to — “right” PS table — output in two columns — do not show lines that are the same in both PS tables

```
$ python ps-diff.py PStable_left.xslx PStable_right.xslx y suppress-common-lines --by-name
```

Output snippet:

```
                                                         > 273 L1_DoubleIsoTau36er2p1 0 1 1 1 1 1 1 1 1
57 L1_DoubleMu0er1p5_SQ_dR_Max1p4 0 0 0 0 0 0 0 0 0      | 57 L1_DoubleMu0er1p5_SQ_dR_Max1p4 0 0 2 1 1 1 1 1 1
273 L1_DoubleTau70er2p1 0 1 1 1 1 1 1 1 1                | 267 L1_DoubleTau70er2p1 0 1 1 1 1 1 1 1 1
428 L1_ETMHF90_HTT60er 0 0 1 1 1 1 1 1 1                 | 428 L1_ETMHF90_HTT60er 0 0 0 0 0 0 0 0 0
281 L1_Mu18er2p1_Tau24er2p1 0 1 1 1 1 1 1 1 1            | 279 L1_Mu18er2p1_Tau24er2p1 0 1 1 1 1 1 1 1 1
282 L1_Mu18er2p1_Tau26er2p1 0 1 1 1 1 1 1 1 1            | 280 L1_Mu18er2p1_Tau26er2p1 0 1 1 1 1 1 1 1 1
                                                         > 282 L1_Mu22er2p1_IsoTau28er2p1 0 0 0 1 1 1 1 1 1
                                                         > 283 L1_Mu22er2p1_IsoTau30er2p1 0 0 0 1 1 1 1 1 1
176 L1_SingleLooseIsoEG26er1p5 0 0 1 1 1 1 1 1 1         | 176 L1_SingleLooseIsoEG26er1p5 0 0 0 0 0 0 0 0 0
270 L1_SingleTau120er2p1 0 1 1 1 1 1 1 1 1               | 264 L1_SingleTau120er2p1 0 1 1 1 1 1 1 1 1
271 L1_SingleTau130er2p1 0 1 1 1 1 1 1 1 1               | 265 L1_SingleTau130er2p1 0 1 1 1 1 1 1 1 1
24 nan 1 1 1 1 1 1 1 1 1                                 <
34 nan 1 1 1 1 1 1 1 1 1                                 <
```

PS table comparison: getting help

```
$ python ps-diff.py --help
```

required arguments: PS tables (local paths or URLs)

any valid arguments for the unix `diff` command (run `man diff` to see them all) **[do not prepend dashes for these args!]**

```
usage: ps-diff.py [-h] [--by-line] [--by-name] [--no-color]
                  PSTABLE_LEFT PSTABLE_RIGHT [DIFF_OPTIONS [DIFF_OPTIONS ...]]

positional arguments:
  PSTABLE_LEFT          Left PS table
  PSTABLE_RIGHT         Right PS table
  DIFF_OPTIONS          Any number of valid options for the unix diff command,
                        without dash prefixes (i.e., don't use "-" or "--")

optional arguments:
  -h, --help            show this help message and exit
  --by-line             Do a line-by-line comparison
  --by-name, --by-seed  Do a name-by-name comparison
  --no-color, --nocolor
                        Do not colorize the terminal output
```

Possible improvements for the near future

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- Option to (internally or explicitly) tag seeds as signal/background seeds
  - enables generation of special PS tables for rate estimation (pure rate, signal vs. backup, unprescaled,...)
  - *See also “L1T menu rate prediction and verification” talk by Hui Wang*
- Bridging the gap between offline L1 menu development cycles and online menu operations:
  - Prescales are routinely changed during CMS running operation, but the divergence between the PS table released with a given L1 menu and the latest online PS table versions has not been monitored so far.
  - *Idea*: provide means to extract the latest set of online prescales from L1CE/OMS/WBM during the development of a new L1 menu and update existing PS values accordingly
- Incorporate prescales into the Trigger Menu Editor (TME) to have better sync with the menu XML?
- Match the PS table format (currently .xlsx) with the format used at HLT, towards an improved combined L1T+HLT prescale deployment and tracking?
- ...

Links & Resources

- PS-tools on GitHub: https://github.com/tempse/PS-tools
- L1 Trigger Menu Tools Twiki: https://twiki.cern.ch/twiki/bin/view/CMS/SWGuideL1TriggerMenuTools
- L1 Trigger Menu Twiki: https://twiki.cern.ch/twiki/bin/viewauth/CMS/SWGuideL1TriggerMenu

Conclusions

- In the spirit of ongoing automation and optimization of the L1 Menu workflows, a set of **tools for prescale table processing** has been introduced:
  - “ps-generate”: creation of new PS tables
  - “ps-diff”: comparison of PS tables
- Several **exemplary use cases** of the tools have been presented throughout this talk & their **ease of use** has been demonstrated.
- Ideas for future improvements of the PS tools and of the overall PS deployment and tracking strategy have been offered, including…
  - extraction of online information from L1CE/WBM/OMS,
  - combination of PS tools with TME, …