# STATISTICAL ANALYSIS PACKAGE FOR THE OPEARION MONITOR-ING AT THE TLS\*

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### Abstract

Machine operation parameters and interruptions to user beam at Taiwan Light Source (TLS) and Taiwan Photon Source (TPS) are recorded in databases. The data retrieve to TLS uses the File Transfer Protocol (FTP) with two separated databases 10 Hz and 0.1 Hz for quick or detail data analysis options. TPS data storage uses the open source database PostgreSQL.

A statistical analysis package HISTORY has been written in Microsoft Visual C to perform operation monitoring and data mining. Operation and failure statistics functions are produced for performance evaluation and User Administration & Promotion Office user time statistics.

## **INTRODUCTION**

The HISTORY layout is clear and easy to use. Quick function keys are on the top of window for database selection, parameters pickup and specific operation statistics [1]. More plot functions are also included in the top function keys (see Fig. 1).



Figure 1: Layout of HISTORY.

The TLS operation plot for specific day is generated by HISTORY (see Fig. 2). The plot shows several critical operation parameters including beam current, beamline photon deviation, beam size and fault time mark [2].



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## **OPERATION STATISTICS**

Periodic operation report is important for performance review and user time statistics. HISTORY includes two different function to generate operation report [3].

## MonthR3

MonthR3 function can generate a standard form of operation report including downtime period and percentage. The generation steps are:

- Use special function to select specific signals (see Fig. 3).
- Specify beam current threshold and user time period for each day (see Fig. 4).
- The monthly operation report is generated as text file for further process with Excel template (see Fig. 5).



Figure 3: Special function selection.



Figure 4: Specify setting values.



Figure 5: Generated operation report.

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## **MonthIO**

MonthIO is the simplified version of MonthR3 to generate quick operation report. The report displays the user time percentage for operator quick review (see Fig. 6).

DATE	usertime	<stab< th=""><th>percen<sup>*</sup></th></stab<>	percen <sup>*</sup>
2016/03/01	9:24	0.100	99.889
2016/03/02 2016/03/03 2016/03/04	0:1;9:24	0.100	98.955 98.656 98.830
2016/03/05	0:24	0.100	99.073
2016/03/06	0:24		99.375
2016/03/07 2016/03/08	0:9 9:24	0.100	98.054
2016/03/10 2016/03/11	0:1;9:24 0:24	0.100	98.796 99.444 97.986
2016/03/12	0:24	0.100	99.306
2016/03/13	0:24		99.722
2016/03/14	0:9	0.100	98.148
2016/03/15	9:24		98.814
2016/03/16	0:24		99.120
2016/03/17	0:1;9:24	0.100	99.667
2016/03/18	0:24		99.585
2016/03/19 2016/03/20	0:24	0.100	98.865 98.643
2016/03/22 2016/03/23	9:24 0:24	0.100	99.574 99.931
2016/03/24	0:1;9:24	0.100	98.076
2016/03/25	0:24		97.140
2016/03/26	0:24	0.100	98.194
2016/03/27	0:24		98.958
2016/03/28	0:9		98.889
2016/03/29	9:24	0.100	98.574
2016/03/30	0:24		99.523
2016/03/31	0:1;9:24	U.100	99.611

Total Average Percent 98.929

Figure 6: Quick operation report.

## **ORBIT TRACKING**

The beam trip event should be tracked for serious interruption of user time. Orbit change is important to clarify the event characteristics. The special function 'Difference' in HISTORY can track the beam orbit based on beam position monitor (BPM) signals (see Fig. 7).





It shows the graphical orbit difference through predefined golden orbit. The golden orbit should be solid reference in stable beam condition. Target means the orbit for event monitor (see Fig. 8). The special function 'Difference' shows the difference of golden and target orbit with graphical plot. 'Difference' provides an easy way to monitor the continuous orbit difference plots.

Solden 7 57	500
Farget 7 58	10
	1.01
KRange 0.002 YRange	0.002
🔲 add line	

Figure 8: Specify setting values.

The orbit change on specific time can be monitored with graphic mode. Figure 9 shows the orbit change of final moment before beam trip event. The 1st and 2nd figures shows the 2/10 and 1/10 second orbit difference before beam trip. The 3<sup>rd</sup> figure shows the orbit difference on beam trip time for tremendous BPM values.

'Difference' function can also be used to check beam stability or suspicious pattern. Storage ring parameters can be optimized with this orbit tracking tool.



Figure 9: Orbit tracking on beam trip.

#### **BEAM TRIPAUTO LOGGER**

Retrieving history data is important for beam trip debug. Because database capacity is limited by hard disk size, the operation data will be replaced by new data after period time. The task how to keep the beam trip data is critical for trip event debug.

HISTORY provides the auto logger function to save all 510 signals value on trip event. When HISTORY runs on Windows PC, the operation parameters are monitored. The logger function will start up if once beam trip event happens (see Fig. 10).

HISTORY includes the function to retrieve the logger saved data with graphical plot. Part of saved files are selected with function window and HISTORY generates the graphical plot (see Fig. 11).

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Bl10pbeamiy1	epu4dlenc	epu-tõdugkd	a fe09pbpma	fe23pbpmd	anwavdiff.	a kycoitti	r1bpm7y	a r3bpm0y	Hopm2x
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bl10pbpmi0	apu4dsgap	epu46dugkp	fe09pbpmc	fe23pbpml2y	aswbleadaf	Ikłycoil3i	l r1bpm8y	a r3bpm1y	4bpm3x
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bi22pbeami1	apu4phase	epu46ulpe	🔊 fe10pbpmb	gfbxon	anabt4	ampbeami1	2 rZbpm0y	r3bpm4ay	r4bpm5y
bl22pbeamidv	a epu4ulenc	epu46ulphase	a) fe10pbpmc	gfbxpause	a issubt14	mmpbeamidv	2 r2bpm1x	al r3bpm4x	Abpm6x
bl22pbeamie	a epu4urenc	epu46ulpkd	fe10pbpmd	gfbycrt.	aswbt15	mmpbeamiy	2 r2bpm1y	r3bpm4y	al stopmby
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bl22pbeamiy1	epu4usgdrvon	apu-tőulpkp	a fe10pbpmy	gfbypause	a issueghp	any must	2 r2bpm3x	ar3bpm5ay	Abpm7y

Figure 10: Auto logger saved data.

Directory	P.1110100	ιοεκιαατα
fx.bxt gfbxcnt.bxt gfbxon.bxt gfbypause gfbypa	==>	fx.bxt fy.bxt r3dccti.bxt

Figure 11: Retrieve auto logger data.

#### CONCLUSION

The application program HISTORY provides the instant examination of relevant parameters. It gets the benefit to acquire archive data from various servers, like VAX, UNIX, and Windows. Parameters correlation to specific event is the most important function for detail accelerator status check, including photon beam stability, life time, chamber vacuum and cavity temperature.

The HISTORY provides variety of functions for daily, weekly, monthly monitor on operation, beam stability, beam trip debug. Parameter fluctuation for long term can be analyzed by this tool. The new special function is under development for operation monitor. The main functions are linked to TLS database. However part of the main functions also implemented to TPS database for commission reference.

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