

Beam Trip Diagnostics for the TPS

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ABSTRACT

The Taiwan Photon Source (TPS) is available to users since March 2016. A beam trip diagnostic system is used as an important tool to analyze the cause of beam trip events since the beginning of 2017. The main function of the system is to record relevant signals when the stored beam is suddenly lost. In the past few months, some useful features have been added, such as capturing trigger signals for pulsers, power line voltage, and auto generated beam trip reports. A detailed system architecture, implementation and progress will be summarized in this report.

DATA STORAGE SERVER AND VIEWER

Data Storage Server

- The data storage server is used to automatically store post-mortem data, and provides FTP and web services for viewer GUI and web page access.
- The save program also performs a simple timing analysis of the recorded signals in order to give possible event identification.
- The report generator program Generates html file report for the web page access.

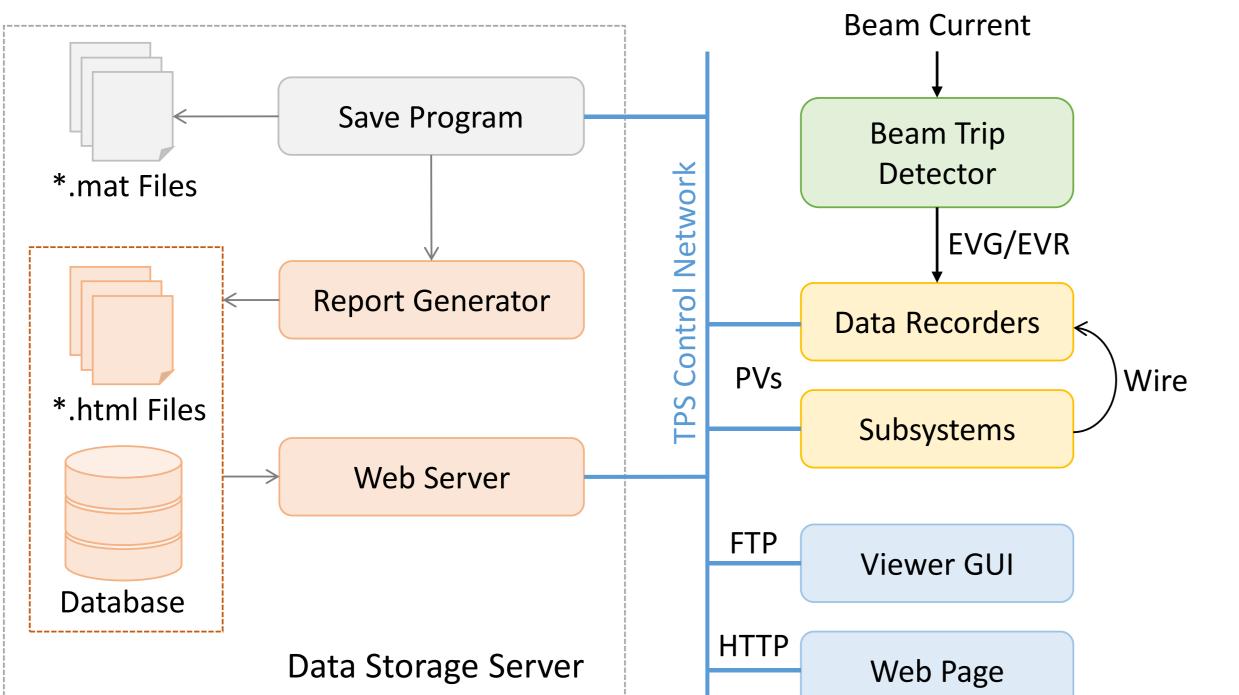
Viewer GUI

The viewer GUI is designed to list and plot beam trip events. The graphic user currently in interface is development with the Matlab guide tool as shown in Fig. 2.

TPS Post-mortem (Beam Trip) Viewer (V2.2)							
Filter	Select a Beam Trip Event		Note		Signals		
Date 🛛	20170725-072150.mat	-	[POS ILK Active]	^	00.Kickers WFs		
- 🖗 <mark>2017</mark>	20170725-043939.mat	255	[Kicker Dump Beam]	222	01.MPS:Ib		
01	20170725-001637.mat				02.MPS:PosILK		
···· 📦 02	20170724-223905.mat		[Kicker Dump Beam]		03.MPS:AngILK		
···· 🖗 03	20170724-151453.mat		[Kicker Dump Beam]		04.MPS:VacILK		
···· 📦 04	20170724-014750.mat		[SRF Trip]		05.MPS:FEILK		
05	20170723-165135.mat		[Kicker Dump Beam]		06.MPS:MPSTrip		
06	20170723-160315.mat		[Kicker Dump Beam]		▼ 07.MPS:BLILK		
07	20170723-111114.mat		[SRF Trip]		08.MPS:PMTrig_MPS		
• • • <i>i</i>	20170723-092847.mat		[SRF Trip]		09.SRF2:SRF2RC		
	20170723-085123.mat		[Kicker Dump Beam]		10.SRF2:No Used		
	20170722-153806.mat		[Kicker Dump Beam]		11.SRF2:SRF2Pf		
	20170722-131432.mat		[SRF Trip]				
Update Event Lis	st 20170722-105051.mat		[SRF Trip]		12.SRF2:SRF2Pr		
	20170722-102817.mat		[SRF Trip]		Cir 1 2 Plot		

SYSTEM DESCRIPTION

- A trigger signal is generated through the beam trip detector when the stored beam current suddenly drops.
- The data recorders will be updated on receiving a trigger, the server saves all data from the recorders and machine parameters from subsystem through a PV access.
- The probable cause of the event will be analyzed by the program.
- A beam trip report will be generated and saved as a web page. After that, operators can access and analyze the event data from viewer GUI or web browser at any time.



It can list the beam trip event with a simple note, and a signal list check box can be used to select the desired data for display (as shown in Fig. 3), which can be downloaded from the server using the FTP.

Website Interface

- The main page is developed with the Python/Django tool as shown in Fig. 4. It can list the beam trip event similar to the viewer GUI.
- The report, as shown in Fig. 5, is generated from report generator at the first moment or from the viewer GUI



Fig. 2: Main page of viewer graph user interface.

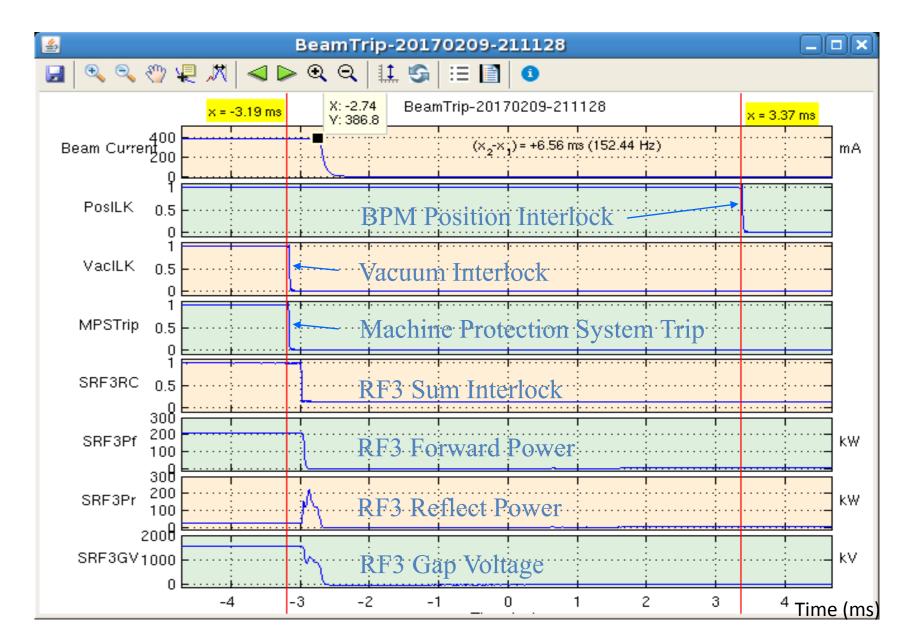


Fig. 3: Plot page of vacuum interlock event.

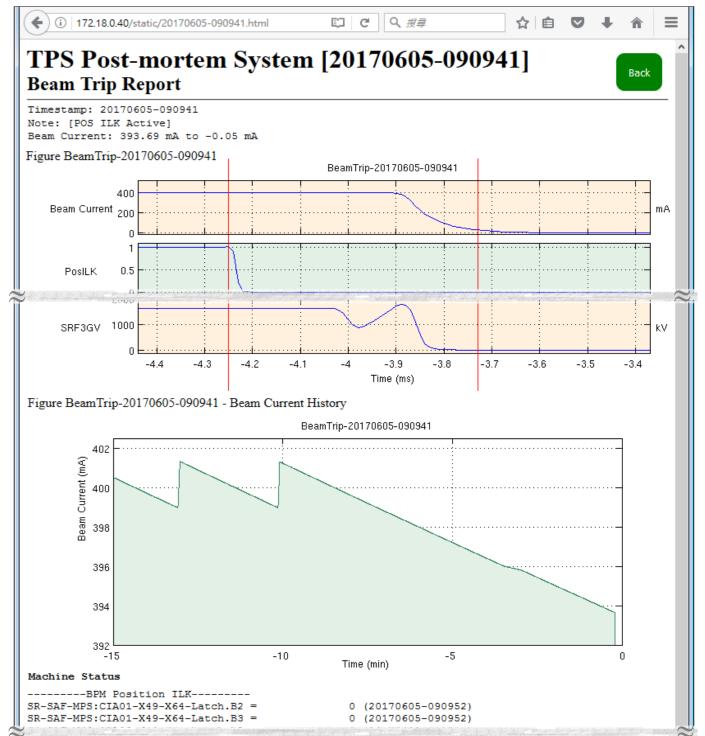


Fig. 1: Schematic layout of the TPS PM system.

PM TRIGGER GENERATION AND TRANSMISSION

- If the stored beam current drops abnormally fast (configurable, for example drop 25) mA within 0.1 ms), a trigger will be generated and transmitted via the timing system.
- Objects that accept this trigger signal include data recorders and beam position monitors (BPMs) which are distributed around the accelerator facility.
- Known possible causes for the stored beam current to drop abnormally include:
 - RF system trips
- Front end interlock
- BPM orbit interlock
- Beamline interlock
- Vacuum interlock
- Abnormal firing of pulsers

DATA RECORDER

- The quantity and parameters of the data recorders are shown in Table 1.
- The saved post-mortem data (waveform type post-mortem signals and subsystem parameter set value) are tabulated in Table 2.
- The TDS BDM system provides past

• The TPS BPIM s			•	Table 2: List of saved post-mortem data				
mortem data w		-		Group	Signals	Description		
role in recordi information	•	by-turn Ilyze	orbit beam	Beam signals	lb, Orbit	Stored beam current and turn-by- turn orbit data		
positions during Table 1: List of do			s used	RF signals	Pr, Pf, GV, RC	RF system forward power, reflect power, gap voltage, and ready-chain signal		
Device	BPM platform	Data recorder (8ch)		Interlock signals	BPM, Vacuum, Frontend, Beamline, Safety	Subsystem interlocks to shutdown the RF system		
Quantity	173	4	1	Pulser	Kickers	SR injection kicker waveform with trigger signal		
Sampling rate (kHz)	~578	100	50,000	Machine parameters	Set value	Subsystem parameters, alarm list		
Time span (ms)	~17.28	100	6	Power line	L1, L2, L3	3-phase voltage		
Data length (point)	10,000	10,000	300,000	Seismic	X, Y, Z	Up-down, north-south, and west- east acceleration (in planning)		

afterward	(regenerate)
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FPS Post-mortem (Beam Trip) Report List

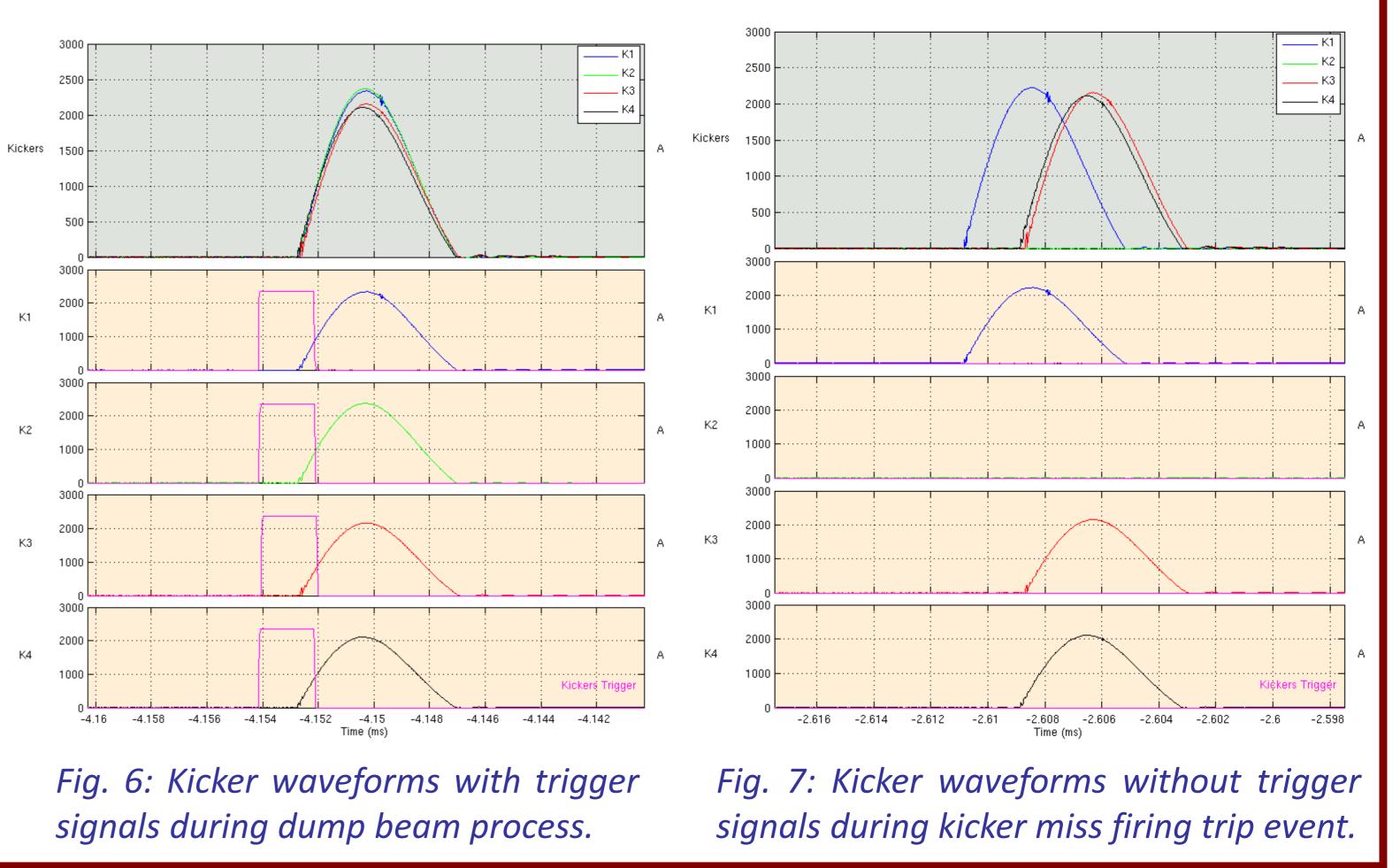
Timestamp 🧧	Note 🗠	Beam Current	Machine Status	Report Link 🗠	Created At
20170612-170000	Test Page Not Found	-	-	http://172.18.0.40/static/404.html	06/12/2017 5:25 p.m.
20170612-154946	-	-0.01 mA to -0.01 mA	-	http://172.18.0.40/static/20170612-154946.html	06/12/2017 3:50 p.m.
20170612-153339	-	-0.00 mA to 0.01 mA	-	http://172.18.0.40/static/20170612-153339.html	06/12/2017 3:34 p.m.
20170612-152920	-	0.01 mA to 0.02 mA	-	http://172.18.0.40/static/20170612-152920.html	06/12/2017 3:29 p.m.
20170612-152629	-	-0.00 mA to 0.01 mA	-	http://172.18.0.40/static/20170612-152629.html	06/12/2017 3:26 p.m.
20170607-081940	[Kicker Dump Beam]	19.59 mA to 7.73 mA	-	http://172.18.0.40/static/20170607-081940.html	06/07/2017 1:58 p.m.
20170605-090941	[POS ILK Active]	393.69 mA to -0.05 mA	-	http://172.18.0.40/static/20170605-090941.html	06/07/2017 1:59 p.m.
20170524-193527	[SRF Trip]	301.15 mA to -0.04 mA	User Beam	http://172.18.0.40/static/20170524-193527.html	06/07/2017 1:59 p.m.

Fig. 4: Web interface of beam trip report list.

Fig. 5: Web page of beam trip report.

PULSER MISS FIRING

- The current waveforms and the trigger signals of the four kickers should exist at the same time, as shown in Fig. 6.
- Some kickers were unexpectedly triggered without trigger signal, causing an instant loss of the electron beam, as shown in Fig. 7. The K1, K3, K4 spontaneously fires and no trigger signal was observed.
- In order to solve the possible noise interference, the improvement scheme proposed at present is to use the fiber link instead of the copper wire to transmit the trigger signal, hoping to reduce noise pickup.



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