

# How to use the Timing System as a Client

April 6, 2012

Controls Software

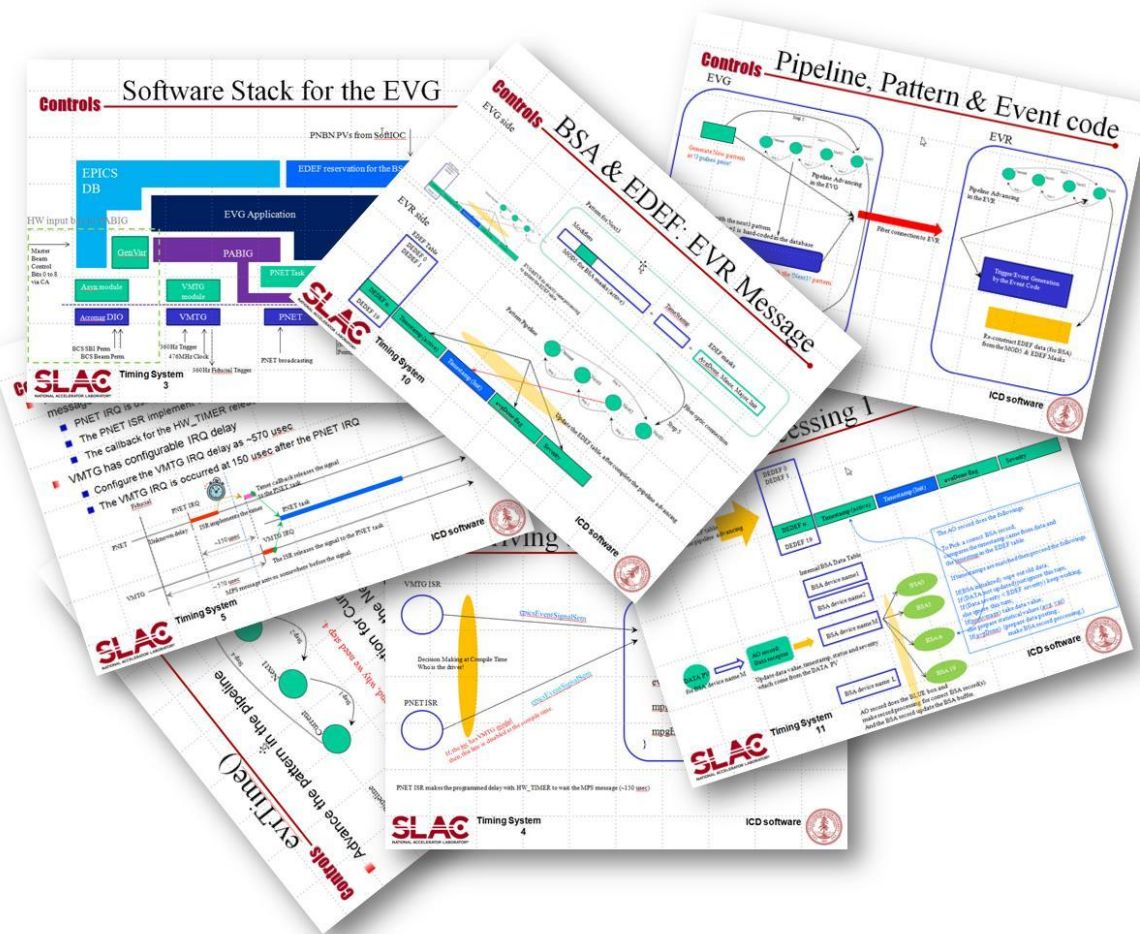
# Controls Contents

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- EVR Low Level Screens
- How to make triggers with the Low Level Screens
- What is the relationship between Low Level Screen and High Level Screen
- How to set up the EVR in your application
- Form factor & OS dependency on the EVR : go to first place with photo
- What is BSA
- How does BSA work
- How to Setup BSA

# Controls

# Complicated...



# Controls EVR Diag. Screen

## Controls

**IN20 EVR RF01 Diagnostics**  
 Changes on this display are NOT restored on IOC reboot! **EXIT**

Module Description: PMC Card 0 @2/4/0, IRQ 0x50      FPGA Version: 0xf305

**Triggers**

**Events**

Board Enable: **NO** / **YES**

Rx Link: **ON**

Rx Link Error Count since Reset: 0

Reset

Last Reset Time: 04/02/12 11:12:09

Rx Link Errors in Last 2 Sec: 0

VME IRQ: **Disabled**

**Front Panel Signal**

Trigger Selection	Trigger Selection Key
0 TTL 0	0 = Ext Delay Trigger 0
1 TTL 1	1 = Ext Delay Trigger 1
2 TTL 2	2 = Ext Delay Trigger 2
3 TTL* 3	3 = Ext Delay Trigger 3
4 TTL* 0	11 = Trigger Output 0
5 LVPECL* 0	12 = Trigger Output 1
6 LVPECL* 0	13 = Trigger Output 2
	14 = Trigger Output 3
	15 = Trigger Output 4
	16 = Trigger Output 5
	17 = Trigger Output 6
	18 = Trigger Output 7
	19 = Trigger Output 8
	20 = Trigger Output 9
	21 = Trigger Output 10
	22 = Trigger Output 11
	23 = Trigger Output 12
	24 = Trigger Output 13

\* N/A for PMC

**Trigger Output**

State	Polarity	Width**	Delay*
0 Enabled Normal 12 109980			
1 Enabled Normal 12 110000			
2 Enabled Normal 12 110000			
3 Enabled Normal 12 110000			
4 Enabled Normal 12 110000			
5 Enabled Normal 12 110000			
6 Enabled Normal 12 110000			
7 Enabled Normal 12 107156			
8 Enabled Normal 12 110648			
9 Enabled Normal 12 110590			
10 Enabled Normal 12 110013			
11 Enabled Normal 12 110074			
12 Enabled Normal 12 110000			
13 Enabled Normal 12 111124			

**Extended Delay Trigger Output**

State	Polarity	Width***	Delay*	Clock Prescaler
0 Enabled Normal 12 109990 1				
1 Enabled Normal 12 110000 1				
2 Enabled Normal 12 110000 1				
3 Enabled Normal 12 110000 1				

\*\*\* Max pulse width is 4.3E9 ticks.      \*\* Max pulse width is 65535 ticks. Values greater than 65535 will wraparound to a lower number.

**Annotations:**

- (D1) Board information
- (D2) Board Control and Monitoring
- (D3) Trigger Selection Key for Front Panel
- (D4) Extended Delay Front Panel Trigger
- (D5) Regular Trigger Control
- (D6) VME IRQ delay configuration Don't Use It!

\* All delays and pulse widths on this panel are in periods of the 119MHz event rate. Max delay is 4.3E9 ticks. All delays start from the time of receipt of the event code assigned to the channel (the "Events" display has detail). The actual delay is the entered value plus the intrinsic system delay which is different per channel, measured at ~300nsec for VME EVRs and ~415nsec for PMC EVRs, not including cable delays.

Go to IOC-specific trigger panels to enter delays in nsec from TREF and to change trigger output states. Changes made on those displays will be permanent and restored on IOC reboot. Changes to settings on this panel that need to be permanent must be sent to controls-software so that the bootup databases are changed.

# Controls Cont'd: EVR Diags

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- EVR Board
  - Board Type/Instance/IRQLevel/FPGA version (see D1)
  - Board Enable/Disable (see D2)
  - RX link Status (D2)
  - Error Counter and Reset (D2)
- Extended Trigger/Front Panel Trigger (D3/D4)
- Rear Panel Trigger (D5)
- VME delayed IRQ (Not Use) (D6)

# Ext. Delay Trigger?/Front Panel Trigger?

## Controls

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### ■ Front Panel Trigger

- Physically located on the front panel (D4)
  - VME: 4 Channels
  - PMC: 3 Channels
- Select the Real Trigger Channel and route to Front Panel
  - Configure with the trigger selection key from 11 to 24 (please, see the trigger selection key list in the D3 session)
  - Uses same delay and width as the rear trigger which is selected by the trigger selection key

### ■ Extended Delay Trigger

- Physically using same output channel with the front panel trigger
- Shares same event code with the rear transition
- Configure with the trigger selection key from 0 to 3 (please, see the trigger selection key list in the session D3)
- Has its own delay, width and prescaler

# Controls Extended Delay and Prescaler

- Max Width: 64k (16 bits)
- Max Delay: 4.3E+9 (32 bits)
- Need more longer delay? Then the Extended Delay
  - Extended Delay = Delay x Prescaler (32 bits)
  - Thus, we have 64 bits wide delay counter for the extended delay
- PMC EVR has only 2 prescalers for the first 2 channels
- Thus, the third channel on the front panel
  - is **NOT** available as the Extended Trigger
  - is available as the Front Panel Trigger

# Controls

# Trigger Panel

IN20 EVR RF01 Event Diags

IN20 EVR RF01 Trigger Diags

Changes on this display are NOT restored on IOC reboot! **EXIT**

Event Code		Trigger Selection														IRQ**	
		0*	1*	2*	3*	4	5	6	7	8	9	10	11	12	13		
32	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
41	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
42	Enabled	Disabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled	Disabled	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled	
43	Enabled	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	
140	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	Disabled	Disabled	
9	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled	Disabled	
11	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	
143	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	
151	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	
152	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	
153	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	
154	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	
155	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	
149	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	

\* Either regular or extended delay trigger. Extended delay triggers are available from front panel only.  
 \*\* IRQ must be enabled for event record processing and the update of event rate shown on the "Events" display. It must also be enabled for records with the TSE field set to the event code.

Devices Triggered by Channels:

0* RF Dist PAD	4 RF SPAC (CLK)	8 RF Gun 1 PAD	12 Spare Trig 8
1* RF SPAC (MDL)	5 Spare Trig 5	9 RF Gun 2 PAD	13 Spare Trig 9
2* RF SPAC (RF Ref)	6 Laser SPAC	10 Spare Trig 6	
3* RF SPAC (LOR)	7 Laser PAD	11 Spare Trig 7	
FP0* Spare Trig 1			
FP1* Spare Trig 2			
FP2* Spare Trig 3			
FP3* Spare Trig 4			

(T3) matrix switches for mapping the events to the trigger channel

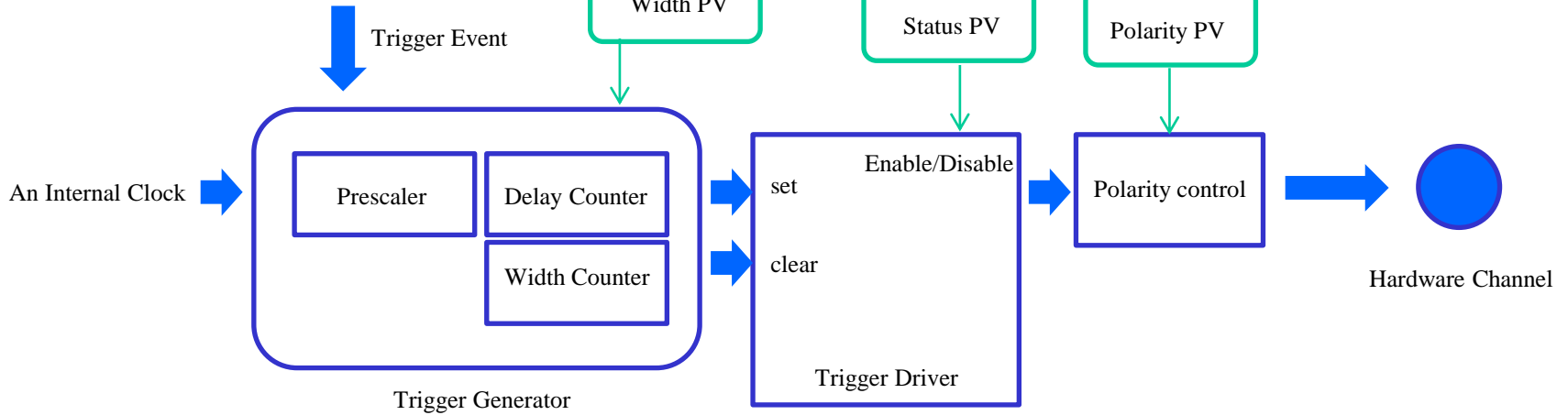
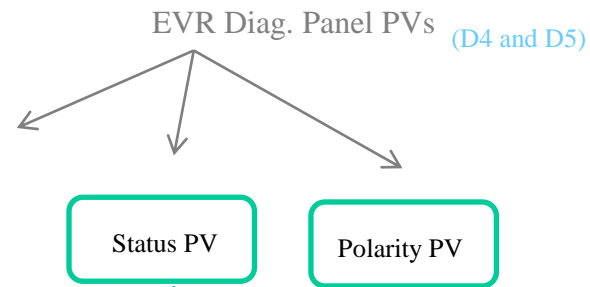
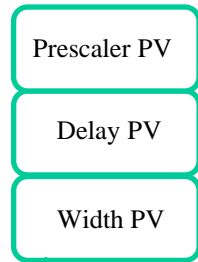
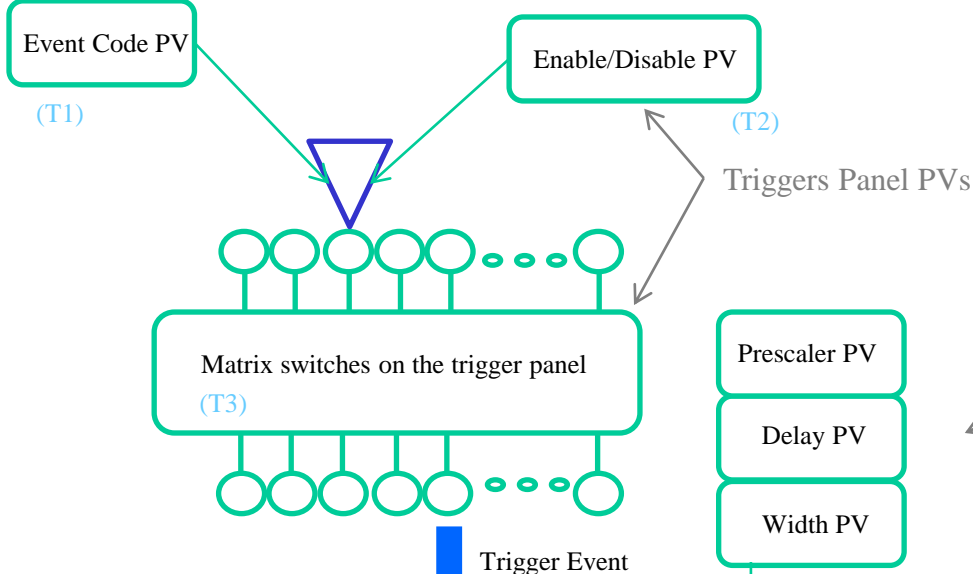
(T1) event code for trigger generator

(T2) enable/disable the event code (only for the trigger generator)



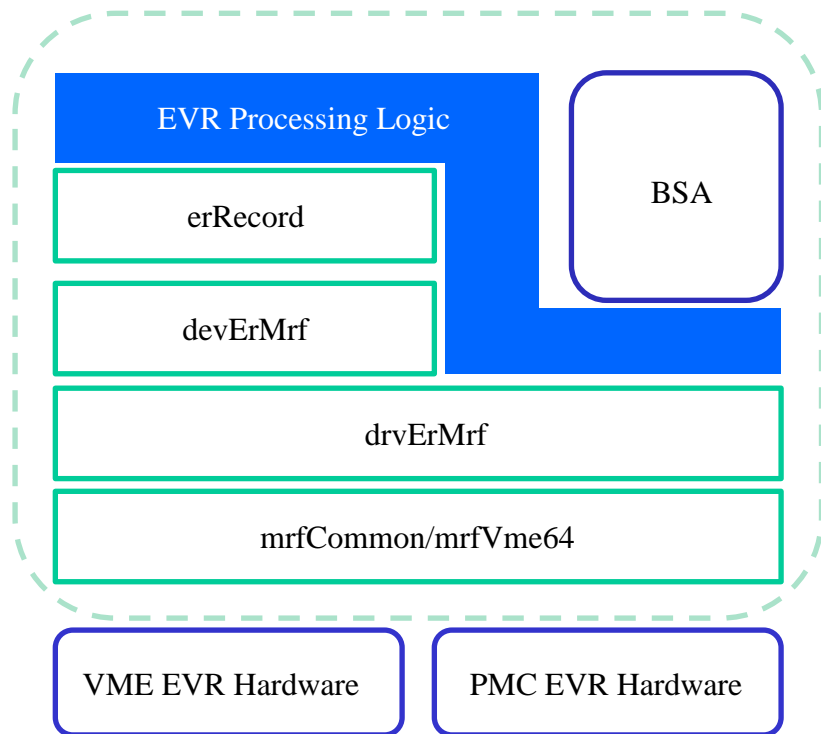
## How to control the trigger

Triggers Panel PVs



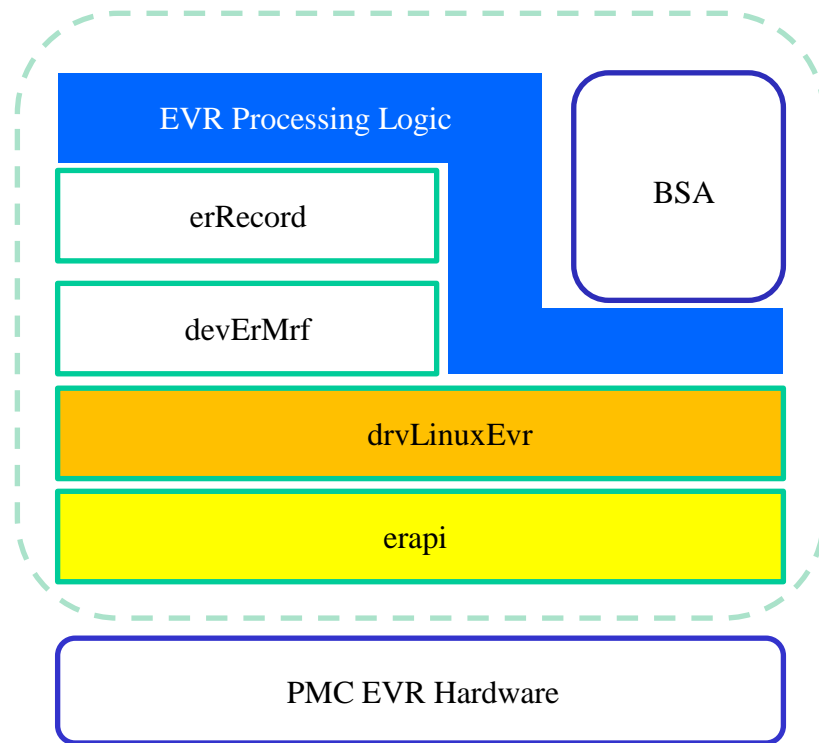
# Controls Form Factor/OS dependency

## Event Module for RTEMS/vxWorks



Works with old register map

## Event Module for Linux



Works with modular register map (new)

# High Level Screen

IN20 - Events - LLRF RF01

IN20 Events / Triggers - Low level RF RF01 Exit

Expert

EVR:IN20:RF01... RF01 Triggers... Events... *This file is generated with a script. Do not edit.*

LLRF - EVR:IN20:RF01 \* w.r. to TREF

Description	Diag	Polarity	Width(ns)	TDES(ns)*	TCTL	Evt Unit Screen	Trig	Ch
RF Dist PAD	<input type="checkbox"/> ...	Normal	100	3816	Enabled	<input type="checkbox"/> TTB/FP 0 Trig...	TTB	0
RF SPAC (MDL)	<input type="checkbox"/> ...	Normal	100	3824	Enabled	<input type="checkbox"/> TTB/FP 1 Trig...	TTB	1
RF SPAC (RF Ref)	<input type="checkbox"/> ...	Normal	100	3816	Enabled	<input type="checkbox"/> TTB/FP 2 Trig...	TTB	2
RF SPAC (LOR)	<input type="checkbox"/> ...	Normal	100	3816	Enabled	<input type="checkbox"/> TTB/FP 3 Trig...	TTB	3
RF SPAC (CLK)	<input type="checkbox"/> ...	Normal	100	3816	Enabled	<input type="checkbox"/> TTB 4 Trig...	TTB	4
Spare Trig 5	<input type="checkbox"/> ...	Normal	100	3816	Enabled	<input type="checkbox"/> TTB 5 Trig...	TTB	5
Laser SPAC	<input type="checkbox"/> ...	Normal	100	3816	Enabled	<input type="checkbox"/> TTB 6 Trig...	TTB	6
Laser PAD	<input type="checkbox"/> ...	Normal	100	2102	Enabled	<input type="checkbox"/> TTB 7 Trig...	TTB	7
RF Gun 1 PAD	<input type="checkbox"/> ...	Normal	100	-117	Enabled	<input type="checkbox"/> TTB 8 Trig...	TTB	8
RF Gun 2 PAD	<input type="checkbox"/> ...	Normal	100	-554	Enabled	<input type="checkbox"/> TTB 9 Trig...	TTB	9
Spare Trig 1	<input type="checkbox"/> ...	Normal	100	3820	Enabled	<input type="checkbox"/> TTB/FP 0 Trig...	FP	0
Spare Trig 2	<input type="checkbox"/> ...	Normal	100	3820	Enabled	<input type="checkbox"/> TTB/FP 1 Trig...	FP	1
Spare Trig 3	<input type="checkbox"/> ...	Normal	100	3820	Enabled	<input type="checkbox"/> TTB/FP 2 Trig...	FP	2
Spare Trig 4	<input type="checkbox"/> ...	Normal	100	3820	Enabled	<input type="checkbox"/> TTB/FP 3 Trig...	FP	3
Spare Trig 6	<input type="checkbox"/> ...	Normal	10000	-109	Enabled	<input type="checkbox"/> TTB 10 Trig...	TTB	10
Spare Trig 7	<input type="checkbox"/> ...	Normal	50000	-921176	Enabled	<input type="checkbox"/> TTB 11 Trig...	TTB	11
Spare Trig 8	<input type="checkbox"/> ...	Normal	100	3816	Enabled	<input type="checkbox"/> TTB 12 Trig...	TTB	12
Spare Trig 9	<input type="checkbox"/> ...	Normal	100	3816	Enabled	<input type="checkbox"/> TTB 13 Trig...	TTB	13

LLRF Triggers IN20:RF02 ... LLRF Triggers IN20:RF03 ... LLRF Triggers IN20:RF04 ...

PRODUCTION 04/03/2012 16:05:22

# Issue 1: FWD/BWD Propagation

## Controls

Low Level PVs  
on Diagnostics Screen

High level PVs  
on Events Screen

Event  
Number<sup>(3\*)</sup>

Event Number  
on Trigger Screen

Changes on this display are NOT restored on IOC reboot! **EXIT**

Vector 0x60) FPGA Version 0xd308

Trigger Output	State	Polarity	Width**	Delay*
0	Enabled	Normal	12	109990
1	Enabled	Normal	12	110001
2	Enabled	Normal	12	110000
3	Enabled	Normal	12	110000
4	Enabled	Normal	12	110000
5	Enabled	Normal	12	110000
6	Enabled	Normal	12	110000
7	Enabled	Normal	12	109796
8	Enabled	Normal	12	110645
9	Enabled	Normal	12	110590
10	Enabled	Normal	1190	109546
11	Enabled	Normal	5950	0
12	Enabled	Normal	12	110000
13	Enabled	Normal	12	111000

Clock Prescaler

4.3E9 ticks.

119MHz event rate. Max delay is 4.3E9 ticks assigned to the channel (the "Events" display has a system delay which is different per channel, EVRs, not including cable delays).

119MHz event rate. Max delay is 4.3E9 ticks assigned to the channel (the "Events" display has a system delay which is different per channel, EVRs, not including cable delays).

119MHz event rate. Max delay is 4.3E9 ticks assigned to the channel (the "Events" display has a system delay which is different per channel, EVRs, not including cable delays).

Forward/Backward  
Propagations (\*)

1

Polarity	Width(ns)	TDES(ns)	TCTL	EVR Diags	Trig	Ch
Normal	100	3735	Enabled	EVR.IN20.RF01...	TTB	0
Normal	100	3821	Enabled	EVR.IN20.RF01...	TTB	1
Normal	100	3820	Enabled	EVR.IN20.RF01...	TTB	2
Normal	100	3820	Enabled	EVR.IN20.RF01...	TTB	3
Normal	100	3820	Enabled	EVR.IN20.RF01...	TTB	4
Normal	100	3820	Enabled	EVR.IN20.RF01...	TTB	5
Normal	100	3820	Enabled	EVR.IN20.RF01...	TTB	6
Normal	100	2100	Enabled	EVR.IN20.RF01...	TTB	7
Normal	100	-94	Enabled	EVR.IN20.RF01...	TTB	8
Normal	100	-554	Enabled	EVR.IN20.RF01...	TTB	9
Normal	100	3820	Enabled	EVR.IN20.RF01...	FP	0
Normal	100	3820	Enabled	EVR.IN20.RF01...	FP	1
Normal	100	3820	Enabled	EVR.IN20.RF01...	FP	2
Normal	100	3820	Enabled	EVR.IN20.RF01...	FP	3
Normal	10000	0	Enabled	EVR.IN20.RF01...	TTB	10
Normal	50000	-999000	Enabled	EVR.IN20.RF01...	TTB	11
Normal	100	3820	Enabled	EVR.IN20.RF01...	TTB	12
Normal	100	3820	Enabled	EVR.IN20.RF01...	TTB	13

LLRF Triggers Page 3...

07/18/2011 16:11:09

Save/Restore for High Level PVs (\*)

IN20 EVR RF01 Event Diags

IN20 EVR RF01 Trigg

Event Code	0*	1*
32	Disabled	Disabled
41	Disabled	Disabled
42	Disabled	Enabled
43	Enabled	Disabled
140	Disabled	Disabled
9	Disabled	Disabled
11	Disabled	Disabled
143	Disabled	Disabled
151	Disabled	Disabled
152	Disabled	Disabled
153	Disabled	Disabled
154	Disabled	Disabled
155	Disabled	Disabled
149	Disabled	Disabled

\* Either regular  
\*\* IRQ must be e  
It must also be e

Hard-coded Event number  
and Trigger Configuration<sup>(2\*)</sup>

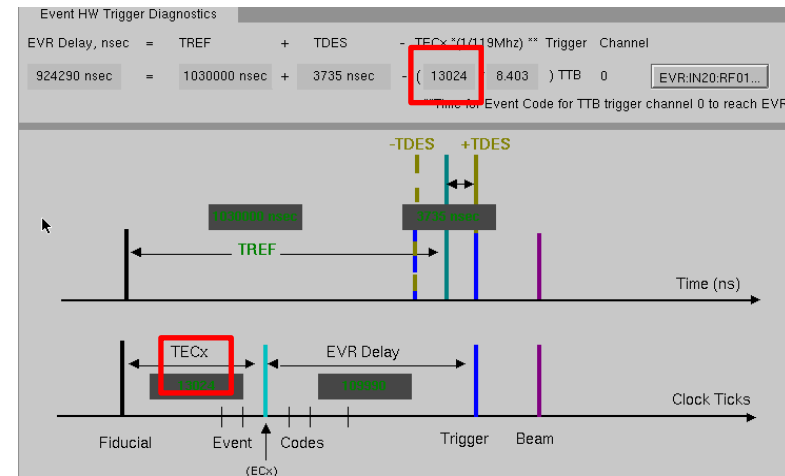
# Controls

## Issue 2: Event Code Invariant Delay

- Each Event Code has its own offset
  - Each event code has to have different offset
  - The delay has been hard-coded in the EVG
  - EVG assumes there is no duplicated offset
  
- These offsets are involved in the hardware trigger calculations for trigger delay on EVR side
  - But, the offset PV is hard-coded for each trigger channel
  - Thus, the changing event code (or, changing trigger selection) makes different delay

Name	Event Code	Delay* (Clock Kicks)	Delay* (nsec)	On/Off	Beam Code	Mask Setup	Rate (Hz)
Beam Full	140	11900	99882	1	1	Masks	10.0
Beam&60Hz	141	11901	99891	1	1	Masks	10.0
Beam&30Hz	142	11902	99899	1	1	Masks	10.0
Beam&10Hz	143	11903	99908	1	1	Masks	10.0
Beam & 5Hz	144	11904	99916	1	1	Masks	5.0
Beam & 1Hz	145	11905	99924	1	1	Masks	1.0
Beam&0.5Hz	146	11906	99933	1	1	Masks	0.5
Full N-1	147	11907	99941	1	1	Masks	10.0
Full N-2	148	11908	99950	1	1	Masks	10.0
TCAVo	149	11909	99958	1	1	Masks	0.0
Burst	150	11910	99966	1	1	Masks	0.0
Klys Accel	151	11911	99975	1	1	Masks	10.0

Event information in EVG



Trigger Delay Calculation in the EVR

# Controls Event Code and Delay

## ■ Delay Calculation

$$T_{delay} = T_{ref} + T_{des} - \left\{ T_{ec} \cdot (1/119MHz) \right\}$$

Fiducial to Beam: Constant

Desired Delay

Event Code Offset by EVG

Clock Rate

- To make “event code invariant delay”, need to fix the hard-coded part
  - Require to detect changing event code (or, changing trigger selection)
  - Re-calculate the forward propagation
  - Actually, the offset of event code is a function of event code and trigger configuration

# Event Module

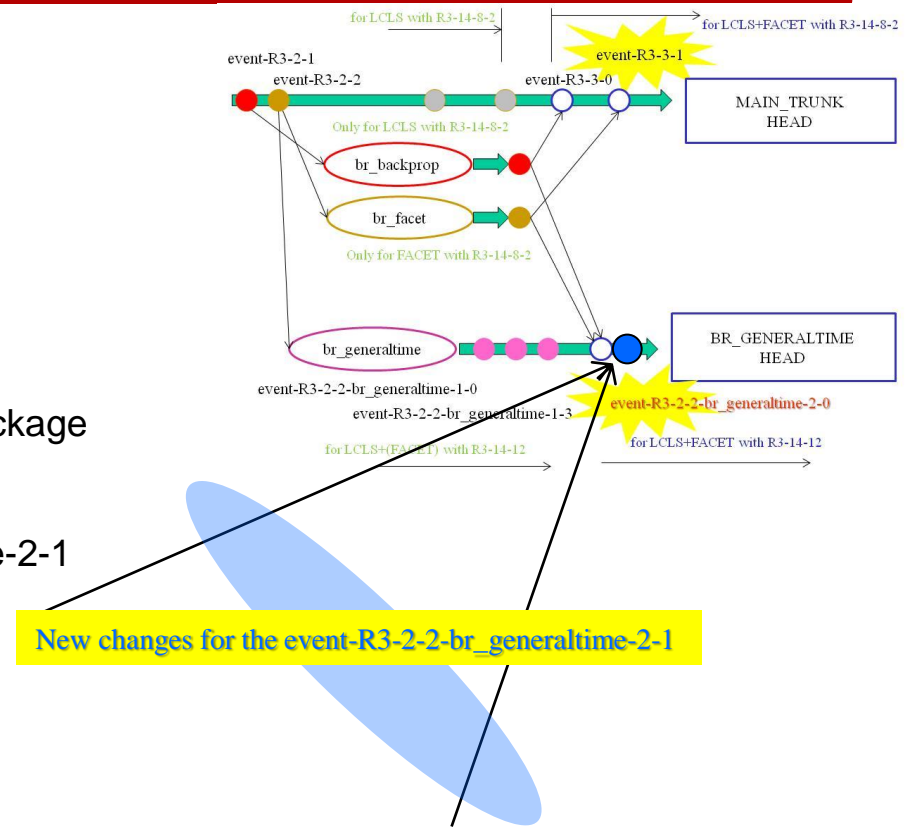
## ■ Pick a correct event module

### ■ R3-14-8-2

- Please, use event-R3-3-1
- for LCLS, FACET
- back-propagation, event invariant delay
- requires the standalone generalltime package

### ■ R3-14-12

- Please use event-R3-2-2-br\_generalltime-2-1
- for LCLS, FACET and XTA
- bundled generalltime in EPICS base
- back-propagation, event invariant delay
- mrfApi for linux platform
- Info(autosaveFields\_pass0, "VAL") + PINI=YES in evrDevTrig.db
- Additional macros to bsaTOROEdef.substitutions, egu, hopr, lopr, prec, adel



**Notice)** The latest update (to fix bugs for the Linux PMC EVR) is still stuck in the HEAD of the branch for the R3-14-12. Thus, there will be another release very soon!

# Controls \*evr.substitutions

- EVR record instance + EVR event instances
  - EVR record instance / need to choose one of the followings
    - evr.db
      - Simplest one
      - DEV, CARD, DELAY, WIDTH
    - evrWithDelays.db
      - More degree of freedom for delays
      - DEV, CARD, DELAY[0\_9, A\_D], WIDTH
    - evrWithExtDelays.db
      - evr.db + more degree of freedom for front panel trigger channels
      - State, Width, Delay, Prescaler, Polarity for each front panel channels
    - evrWithFrontPanel.db
      - Similar with evrWithFronPanel
      - Disable Rear panel trigger
      - Less degree of freedom: DEV, CARD, WIDTH DELAY



## Cont'd : EVR Instance

IN20 EVR RF01 Diags

### IN20 EVR RF01 Diagnostics

Changes on this display are NOT restored on IOC reboot! **EXIT**

Module Description: PMC Card 0 @2/4/0, IRQ 0x50      FPGA Version: 0xf305

**Triggers**

**Events**

Board Enable

Rx Link

Rx Link Error Count since Reset

Last Reset Time  
 04/02/12 11:12:09

Rx Link Errors in Last 2 Sec

VME IRQ

**Front Panel Signal**

Trigger Selection	Trigger Selection Key
0 TTL <input type="text" value="0"/>	0 = Ext Delay Trigger 0
1 TTL <input type="text" value="1"/>	1 = Ext Delay Trigger 1
2 TTL <input type="text" value="2"/>	2 = Ext Delay Trigger 2
3 TTL* <input type="text" value="3"/>	3 = Ext Delay Trigger 3
4 TTL* <input type="text" value="0"/>	11 = Trigger Output 0
5 LVPECL* <input type="text" value="0"/>	12 = Trigger Output 1
6 LVPECL* <input type="text" value="0"/>	13 = Trigger Output 2
	14 = Trigger Output 3
	15 = Trigger Output 4
	16 = Trigger Output 5
	17 = Trigger Output 6
	18 = Trigger Output 7
	19 = Trigger Output 8
	20 = Trigger Output 9
	21 = Trigger Output 10
	22 = Trigger Output 11
	23 = Trigger Output 12
	24 = Trigger Output 13

\* N/A for PMC

**Extended Delay Trigger Output**

State	Polarity	Width***	Delay*	Prescaler	
0	Enabled	Normal	12	109990	1
1	Enabled	Normal	12	110000	1
2	Enabled	Normal	12	110000	1
3	Enabled	Normal	12	110000	1

\*\*\* Max pulse width is 4.3E9 ticks.

**Trigger Output**

State	Polarity	Width**	Delay*	
0	Enabled	Normal	12	109980
1	Enabled	Normal	12	110000
2	Enabled	Normal	12	110000
3	Enabled	Normal	12	110000
4	Enabled	Normal	12	110000
5	Enabled	Normal	12	110000
6	Enabled	Normal	12	110000
7	Enabled	Normal	12	107156
8	Enabled	Normal	12	110648
9	Enabled	Normal	12	110590
10	Enabled	Normal	12	110013
11	Enabled	Normal	12	110074
12	Enabled	Normal	12	110000
13	Enabled	Normal	12	111124

\*\* Max pulse width is 65535 ticks. Values greater than 65535 will wraparound to a lower number.

\* All delays and pulse widths on this panel are in periods of the 119MHz event rate. Max delay is 4.3E9 ticks. All delays start from the time of receipt of the event code assigned to the channel (the "Events" display has detail). The actual delay is the entered value plus the intrinsic system delay which is different per channel, measured at ~300nsec for VME EVRs and ~415nsec for PMC EVRs, not including cable delays.

Go to IOC-specific trigger panels to enter delays in nsec from TREF and to change trigger output states. Changes made on those displays will be permanent and restored on IOC reboot. Changes to settings on this panel that need to be permanent must be sent to controls-software so that the bootstrap databases are changed.

EVR record instance and the EVR Diag Screen

# Controls

## Cont'd

### ■ EVR event instances

- controls the mapping between event code and trigger channel
- Use evrEventCtrl.db
- DEV, CARD, NAME, ID, P0-P13, VME
  - NAME: EVENT1 to EVENT14
  - ID: Event code
  - Pn: 0 to 1 for the matrix switch
  - VME: Enable the softevent

ID: Event code

Hard-coded

Changes on this display are NOT restored on IOC reboot! **EXIT**

P0 to P13

VME

Event Code		0*	1*	2*	3*	4	5	6	7	8	9	10	11	12	13	IRG**
32	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
41	Enabled	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled
42	Enabled	Disabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled
43	Enabled	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
140	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled
9	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled
11	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled	Disabled
143	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
151	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
152	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
153	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
154	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
155	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
148	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled

\* Either regular or extended delay trigger. Extended delay triggers are available from front panel only.  
 \*\* IRG must be enabled for event record processing and the update of event rate shown on the "Events" display. It must also be enabled for records with the TSE field set to the event code.

Devices Triggered by Channels:

0* RF Dist PAD	4 RF SPAC (CLK)	8 RF Gun 1 PAD	12 Spare Trig 8
1* RF SPAC (MDL)	5 Spare Trig 5	9 RF Gun 2 PAD	13 Spare Trig 9
2* RF SPAC (RF Ref)	6 Laser SPAC	10 Spare Trig 6	
3* RF SPAC (LOR)	7 Laser PAD	11 Spare Trig 7	
FP0* Spare Trig 1			
FP1* Spare Trig 2			
FP2* Spare Trig 3			
FP3* Spare Trig 4			

## Example of \*evr.substitutions

```

file evrLithDelays.db
{
#
#      Device      Card  Pulse
#      Device      Card  Width  Channel Delays (clock ticks)
pattern { DEV      , CARD , WIDTH , DELAY0, DELAY1, DELAY2, DELAY3, DELAY4, DELAY5, DELAY6, DELAY7, DELAY8, DELAY9, DELAYA, DELAYB, DELAYC, DELAYD }
        { EVR:LI24:RF01, 0 , 12 , 110000, 110000, 110000, 110000, 110000, 110000, 110000, 110000, 110700, 110000, 110000, 110000, 110000 }
}
file evrEventCtrl.db
{
#      Device      Card  <----- Event ----->
pattern { DEV      , CARD , NAME      , ID , P0,P1,P2,P3,P4,P5,P6,P7,P8,P9,P10,P11,P12,P13,VME}
        { EVR:LI24:RF01, 0 , EVENT1   , 40 , 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT2   , 41 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT3   , 42 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT4   , 43 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT5   ,140 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT6   ,141 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT7   ,142 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT8   ,143 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT9   ,151 , 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT10  ,152 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT11  ,154 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT12  ,155 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT13  ,156 , 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
        { EVR:LI24:RF01, 0 , EVENT14  ,157 , 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0 }
}

```

# Controls \*pattern.substitutions

- First Session for evrPattern.db
  - Records for the pipeline related PVs
  - Just use evrPatternAll.db
  - Need to specify ACTIVE TIMESLOT
    - LCLS: 1 and 4
    - FACET: 2 and 5
    - XTA: 3 and 6
  
- Second Session for Events
  - for the Event records
  - Each beam program has different event sets
  - Need to use a proper template
    - LCLS: evrEventAll.db
    - FACET: evrEventFACET.db
    - XTA: evrEventXTA.db

# Controls Example of \*pattern.substitutions

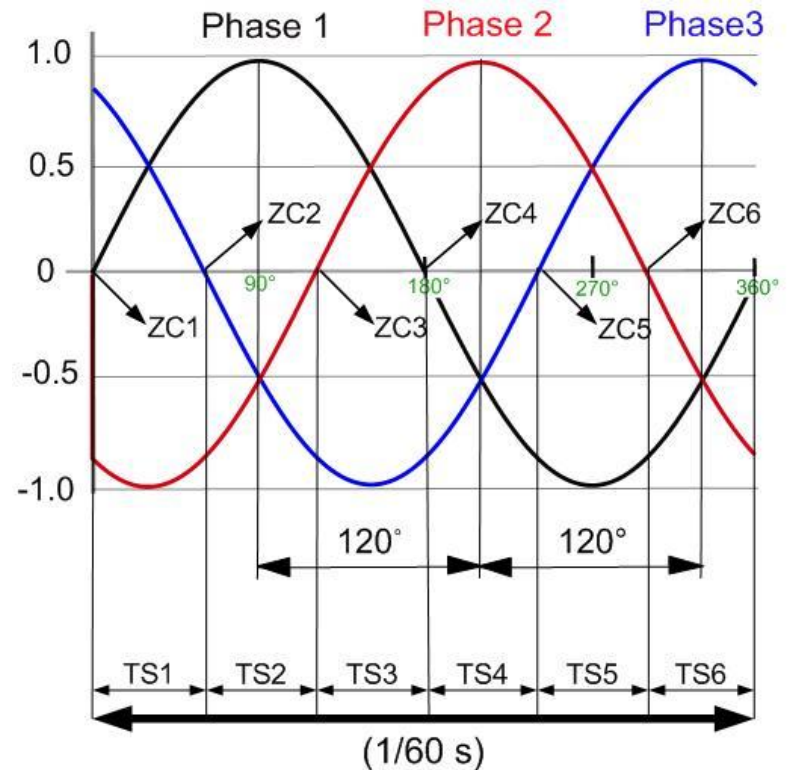
Specify proper ACTIVE TIMESLOT for each beam program

```
file evrPatternAll.db
{
#           Device           , SLC Pattern, EVR/Trigger
#                               Links
pattern { DEVICE           , LINK4           , LINK5           , LINK6           , TREF           , TS1ST , TS2ND }
# 7/3/8; TS1ST=0 for 16.6 ms valid flag: 1 for 8.3 ms
      { IOC:IN20:RF01 , ""           , ""           , ""           , 1.03E06 , 1 , 4 }
}
file evrEventAll.db
{
pattern { DEVICE           }
      { IOC:IN20:RF01 }
}
}
```

Choose a proper template for the each beam program

# Controls **What is the Timeslot**

- Zero Crossings at AC 3 phases lead out the 6 time slots
- Same Timeslot in different period shows exactly same AC phase configuration.
- Active Timeslot
  - LCLS: TS1 and TS4
  - FACET: TS2 and TS5
  - XTA: TS3 and TS6
- Primary Timeslot



ZC = Zero Crossing  
TS = Time Slot

# Controls \*trig.substitutions

---

- Make PV for the High Level Screen
- Use, evrDevTrig.db
- Add 2 new macros for new features
  - Backward Propagation
  - Event Code Invariant Delay
  - TOUT
    - Make mapping between logic and output channel
    - OUT0 to OUT9 and OUTA to OUTD
    - For the front panel re-use OUT0 to OUT3
  - ACTV
    - Enable/Disable the event code invariant delay
- Timing Usability project to auto-generate trigger EDM screens

# Controls

# Example of \*trig.substitutions

For trigger screen autogeneration:

1) Add comment tags & 2) modify Makefile (next slide)

New macros

Optional tags for LCLS; necessary for other facilities

```
file evrDevTrig.db
#
# Device , Description ,polarity,width,delay,event , EVR , EVR, IOC
# code ,location,unit
# , LOCA , UNIT, IOC , DRVL , DRVH , TCTL , TPOL, TWID, TDES, CTL, TOUT, ACTV}
pattern { DEV , DESC , POL, UID, DES , TEC
#EVR EVR:LI24:RF01 #CONTROLPV1 SIOC:SYS0:AL00:MODE
#FILE evt_li24_llrf #CONTROLPV2 SIOC:SYS0:AL00:TOD
{ ACCL:LI24:100:KLY_C_1 , "24-1 PAC Acc" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTP0 , OT0P, OT0W, OT0D, 1, OUT0, 1 }
{ ACCL:LI24:100:KLY_C_2 , "24-1 PAC SB" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTP1 , OT1P, OT1W, OT1D, 1, OUT1, 1 }
{ ACCL:LI24:200:KLY_C_1 , "24-2 PAC Acc" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTP2 , OT2P, OT2W, OT2D, 1, OUT2, 1 }
{ ACCL:LI24:200:KLY_C_2 , "24-2 PAC SB" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTP3 , OT3P, OT3W, OT3D, 1, OUT3, 1 }
{ ACCL:LI24:300:KLY_C_1 , "24-3 PAC Acc" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTP4 , OT4P, OT4W, OT4D, 1, OUT4, 1 }
{ ACCL:LI24:300:KLY_C_2 , "24-3 PAC SB" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTP5 , OT5P, OT5W, OT5D, 1, OUT5, 1 }
{ TCAV:LI24:800:TC3_C_1 , "L3TcavPAC(24-8)Acc" , 0 , 100, -31605, LCLSTCAV , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTP6 , OT6P, OT6W, OT6D, 1, OUT6, 1 }
{ TCAV:LI24:800:TC3_C_2 , "L3TcavPAC(24-8)SB" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTP7 , OT7P, OT7W, OT7D, 1, OUT7, 1 }
{ TCAV:LI24:800:TC3_D , "L3TcavPAD(24-8)" , 0 , 100, 3820 , LCRFONLY , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTP8 , OT8P, OT8W, OT8D, 1, OUT8, 1 }
{ LLRF:LI24:0:REF_C , "24-8KlyPAD/L3Pcav" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTP9 , OT9P, OT9W, OT9D, 1, OUT9, 1 }
# spare triggers 5-8 TTb 11-13
{ TRIG:LI24:RF05: , "Spare Trig 5" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTPA , OTAP, OTAW, OTAD, 1, OUTA, 1 }
{ TRIG:LI24:RF06: , "Spare Trig 6" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTPB , OTBP, OTBW, OTBD, 1, OUTB, 1 }
{ TRIG:LI24:RF07: , "Spare Trig 7" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTPC , OTCP, OTCW, OTCD, 1, OUTC, 1 }
{ TRIG:LI24:RF08: , "Spare Trig 8" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTPD , OTDP, OTDW, OTDD, 1, OUTD, 1 }
#{ ACCL:LI24:800:KLY_D , "24-8 Kly PAD" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , OTPE , OTEP, OTEW, OTED, 1, NONE, 0 }
# spare triggers 1- 4 FP (VME)
{ TRIG:LI24:RF01: , "Spare Trig 1" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , DG0E , DG0P, DG0W, DG0D, 1, OUT0, 1 }
{ TRIG:LI24:RF02: , "Spare Trig 2" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , DG1E , DG1P, DG1W, DG1D, 1, OUT1, 1 }
{ TRIG:LI24:RF03: , "Spare Trig 3" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , DG2E , DG2P, DG2W, DG2D, 1, OUT2, 1 }
{ TRIG:LI24:RF04: , "Spare Trig 4" , 0 , 100, 3820 , TS4_30_ , LI24 , RF01, IOC:LI24:RF01, -2.8E06, 2.8E06 , DG3E , DG3P, DG3W, DG3D, 1, OUT3, 1 }
```





## Example of xApp/Db Makefile

```
TOP=../../..
```

```
include $(TOP)/configure/CONFIG
```

```
<snip>
```

```
# Create and install (or just install) into <top>/db # databases, templates, substitutions like this
```

```
DB += IOC-XT01-IM01-adc.db
```

```
DB += IOC-XT01-IM01evr.db
```

```
DB += IOC-XT01-IM01pattern.db
```

```
DB += IOC-XT01-IM01bsa.db
```

```
DB += IOC-XT01-IM01trig.db
```

New target

- Pass in \*trig.substitutions file
  - For multiple EVRs, one file contains substitutions for every EVR, separated with appropriate #EVR, #FILE tags
  - edl trigger files specified by #FILE are output to \$EDM/install directory

```
gen_trig_edl:
```

```
    create_edm_event_msi.py IOC-XT01-IM01trig.substitutions
```

- Infrastructure will be ready for engineers to build after next week PAMM (4/10)

```
include $(TOP)/configure/RULES
```

```
#-----
```

```
# ADD RULES AFTER THIS LINE
```

```
*****
```

# Controls **Beam Synchronous Acquisition (BSA)**

- Acquire beam dependent scalar values across multiple IOCs to analyze the correlations among the values which are acquired at the same pulse
- Maintain the buffer up to 2800 points
- The buffered values can be averaged up to 1000 samples
- Up to 20 different BSA requests are available
- Each BSA requests can specify:
  - Beam Code
  - Inclusion/Exclusion Masks for the Event Pattern
  - Measurement Count (number of data points)
  - Average per Measurement
  - Severity Level

# How to Setup the BSA request

## Controls EVG side

---

- Bring up the Event Global
- Choose Event Definition
- Make EDEF reservation with your own name
- Bring up your EDEF slot
- Set up Masks / Beam Code / Measurements/  
Average/Severity
- Turn ON to start BSA
- Finally release your EDEF slot

# Bring up the EDEF screen

The screenshot shows the 'LCLS Subsystems and Areas: Global Event / Timing System' interface. The title bar reads 'LCLS Subsystems and Areas: evtnt all'. The main window title is 'LCLS Subsystems and Areas: Global Event / Timing System'. The interface is divided into several sections:

- Global Tab:** Includes buttons for 'Diagnostics...', 'Events...', and 'Event Definitions...' (circled in red).
- Event Generator (EVG) IOC:** Shows 'EVG IOC Status' with 'Pattern/PNET', 'NTP', and 'MPS Interface' all set to 'OK'.
- LCLS Rates (Hz):** A table of rates for various components like Beam Full Rate, Pockels Cell, Klystron Standby, etc.
- Base Rate Triggers:** A table of triggers for different frequencies like TS4 and TS1.
- Trigger Control:** A section with a blue dashed border containing controls for 'Pockels Cell Burst', 'Pockels Cell Disable', 'LI25 Burst', 'LTU Burst', and 'Kick on TCAV3'. It includes buttons for 'SingShot', 'Burst', and 'Rate' (Full).
- Profile Monitor:** Shows 'Dark Current Diags' set to 'On'.
- MPS Rates:** Shows rates for 'Pockels Cell', 'Mech Shutter', 'BYKIK', and 'Laser Htr Shutter'.
- MPS Control:** Includes 'Mitigation Control...' and 'Burst Control...' buttons.
- BYKIK Abort:** Includes 'Disable' and 'Enable' buttons, and a text field for 'Abort beam at BYKIK every 5000 beam shots'.
- CAMAC Timing:** Includes a 'PDU Global Rules...' button.
- Master Beam Control:** Includes a 'Master Beam Control...' button.

At the bottom of the window, it says 'PRODUCTION', 'evnt\_all\_main.edi', and '04/03/2012 17:07:55'.

Event Global Screen

# Make EDEF Reservation

SYS0 Event Definitions (EDEFs) Development		# of Available EDEFs	EDEF Reserve	EXIT
1		14	KHKIM	
App Name	User	Last Active Time	Last Reserved Time	
2	zelazny	Client	OFF 04/03/12 10:22:57	03/21/12 16:42:12
3		OFF	03/22/12 11:12:20	03/22/12 11:08:34
4		OFF	04/03/12 10:45:57	
5		OFF		
6		OFF		
7		OFF		
8		OFF		
9		OFF		
10		OFF		
11		OFF		
12		OFF		
13		OFF		
14		OFF		
15		OFF		
TH	1HZ	SYS	ON	03/21/12 16:42:12
TH	10HZ	SYS	ON	03/21/12 16:42:12
BR	FULL	SYS	ON	03/21/12 16:42:12
F1	FBCK1	SYS	OFF	03/21/12 16:42:12
F2	FBCK2	SYS	ON	03/21/12 16:42:12

SYS0 Event Definitions (EDEFs) Development		# of Available EDEFs	EDEF Reserve	EXIT
1		13	KHKIM	
App Name	User	Last Active Time	Last Reserved Time	
2	zelazny	Client	OFF 04/03/12 10:22:57	03/21/12 16:42:12
3		OFF	03/22/12 11:12:20	03/22/12 11:08:34
4	KHKIM	Client	OFF 04/03/12 10:45:57	04/03/12 10:23:32
5		OFF		04/03/12 17:12:43
6		OFF		
7		OFF		
8		OFF		
9		OFF		
10		OFF		
11		OFF		
12		OFF		
13		OFF		
14		OFF		
15		OFF		
TH	1HZ	SYS	ON	03/21/12 16:42:12
TH	10HZ	SYS	ON	03/21/12 16:42:12
BR	FULL	SYS	ON	03/21/12 16:42:12
F1	FBCK1	SYS	OFF	03/21/12 16:42:12
F2	FBCK2	SYS	ON	03/21/12 16:42:12

# Play with your EDEF slot

EDEF:SYS0:4 Event Definition

### SYS0 Event Definition 4 Development

**Name** KHKIM **Last Active Time** OFF  
**User** **Last Reserved Time** ON 04/03/12 17:12:43  
**Client**

**Timing Pattern Masks**  
 EDEF Inclusion Mask **Mask Setup**  
 pockcel\_perm

EDEF Exclusion Mask  
 TS2 TS3 TS5 TS6

**Beam Code**  
 1

**Measurement Parameters**  
 # to Average per Measurement 1 # Measurements 1  
 Severity Level for Invalid Data 0 = Abort. -1 = Forever  
 NONE MINOR MAJOR **INVALID**

Total to Acquire 1 **Reset DATA**  
 Total Acquired so far 0 **Release EDEF**

EDEF Slot

EDEF:SYS0:4 Exclusion and Inclusion Mask Setup

### SYS0 Event Definition 4 Exclusion and Inclusion Mask Setup Development

Name	KHKIM	User	Client
<input type="checkbox"/> ASSET	<input type="checkbox"/> EXTB_LER0	<input type="checkbox"/> GUNB_LER1	<input type="checkbox"/> RATE_01HZ
<input type="checkbox"/> Asset_inj	<input type="checkbox"/> EXTB_LER1	<input type="checkbox"/> HERINJNDR	<input type="checkbox"/> RATE_05HZ
<input type="checkbox"/> BCSFAULT	<input type="checkbox"/> FBCK_FB3PHAS	<input type="checkbox"/> HER_BEAMABRT	<input type="checkbox"/> RATE_10HZ
<input type="checkbox"/> BPMX1INJECT	<input type="checkbox"/> FBCK_HER	<input type="checkbox"/> INJT_HER	<input type="checkbox"/> RATE_30HZ
<input type="checkbox"/> BPMX1LINAC	<input type="checkbox"/> FBFASTLIN	<input type="checkbox"/> INJT_LER	<input type="checkbox"/> RATE_HALFHZ
<input type="checkbox"/> BYP_K_HER	<input type="checkbox"/> FBSCAVINJNDR	<input type="checkbox"/> KICKER_LI25	<input type="checkbox"/> SBDARCN
<input type="checkbox"/> BYP_K_LER	<input type="checkbox"/> FBSLOWINJ	<input type="checkbox"/> KICKER_LTU	<input type="checkbox"/> SBDARCN_AUX
<input type="checkbox"/> Calibration	<input type="checkbox"/> FBSLOWINJ2	<input type="checkbox"/> LCLS_BEAM	<input type="checkbox"/> SBDARCS
<input type="checkbox"/> DUMP_2_9	<input type="checkbox"/> FBSLOWLIN	<input type="checkbox"/> LER_BEAMABRT	<input type="checkbox"/> SBDARCS_AUX
<input type="checkbox"/> DUMP_2_9_AUX	<input type="checkbox"/> FB_HERINJNDR	<input type="checkbox"/> MAKE_EP_LER	<input type="checkbox"/> SCAVINJ
<input type="checkbox"/> DUMP_BAS1	<input type="checkbox"/> FB_PEPPOSI	<input type="checkbox"/> MPS_BYKIK	<input type="checkbox"/> SCREEN30
<input type="checkbox"/> DUMP_BYP_HER	<input type="checkbox"/> FB_SCAV	<input type="checkbox"/> MPS_LHTRSHUT	<input type="checkbox"/> SDRSTORE
<input type="checkbox"/> DUMP_BYP_LER	<input type="checkbox"/> FFTB_ext	<input type="checkbox"/> MPS_MECHSHUT	<input type="checkbox"/> SDRSTOR_LER
<input type="checkbox"/> DUMP_Ko2	<input type="checkbox"/> FFTB_inj	<input type="checkbox"/> MPS_POCKCELL	<input type="checkbox"/> SIXTY_HERTZ
<input type="checkbox"/> DUMP_Ko2_AUX	<input type="checkbox"/> FIDSH_HLR0	<input type="checkbox"/> NO_EXT_ELEC	<input type="checkbox"/> SLC_MTG_DISA
<input type="checkbox"/> E144_LC	<input type="checkbox"/> FIDSH_HLR1	<input type="checkbox"/> NO_EXT_E_AUX	<input type="checkbox"/> TCAV
<input type="checkbox"/> E154witness	<input type="checkbox"/> FIDSH_HLR2	<input type="checkbox"/> NO_EXT_POSI	<input type="checkbox"/> TCAV3
<input type="checkbox"/> ESA_PED	<input type="checkbox"/> FIDSH_HLR3	<input type="checkbox"/> NO_EXT_P_AUX	<input type="checkbox"/> TEN_HERTZ
<input type="checkbox"/> EVG_BURST	<input type="checkbox"/> FIVE_HERTZ	<input type="checkbox"/> NO_GUN_PERM	<input type="checkbox"/> THIRTY_HERTZ
<input type="checkbox"/> EVG_SPARE2	<input type="checkbox"/> FLIP	<input type="checkbox"/> NO_SCAV_PERM	<input type="checkbox"/> TS1
<input type="checkbox"/> EVG_SPARE5	<input type="checkbox"/> GUNA_HER	<input type="checkbox"/> ONE_HERTZ	<input type="checkbox"/> TS2
<input type="checkbox"/> EXTA_HER	<input type="checkbox"/> GUNA_HER0	<input type="checkbox"/> PHAS_DITHR	<input type="checkbox"/> TS3
<input type="checkbox"/> EXTA_HER0	<input type="checkbox"/> GUNA_HER1	<input type="checkbox"/> PNET_SEQCHK	<input type="checkbox"/> TS4
<input type="checkbox"/> EXTA_HER1	<input type="checkbox"/> GUNB_LER	<input type="checkbox"/> PROF_DIAG	<input type="checkbox"/> TS5
<input type="checkbox"/> EXTB_LER	<input type="checkbox"/> GUNB_LER0	<input type="checkbox"/> PULSID_ZERO	<input type="checkbox"/> TS6

Inclusion Mask pockcel\_perm

Exclusion Mask TS2 TS3 TS5 TS6

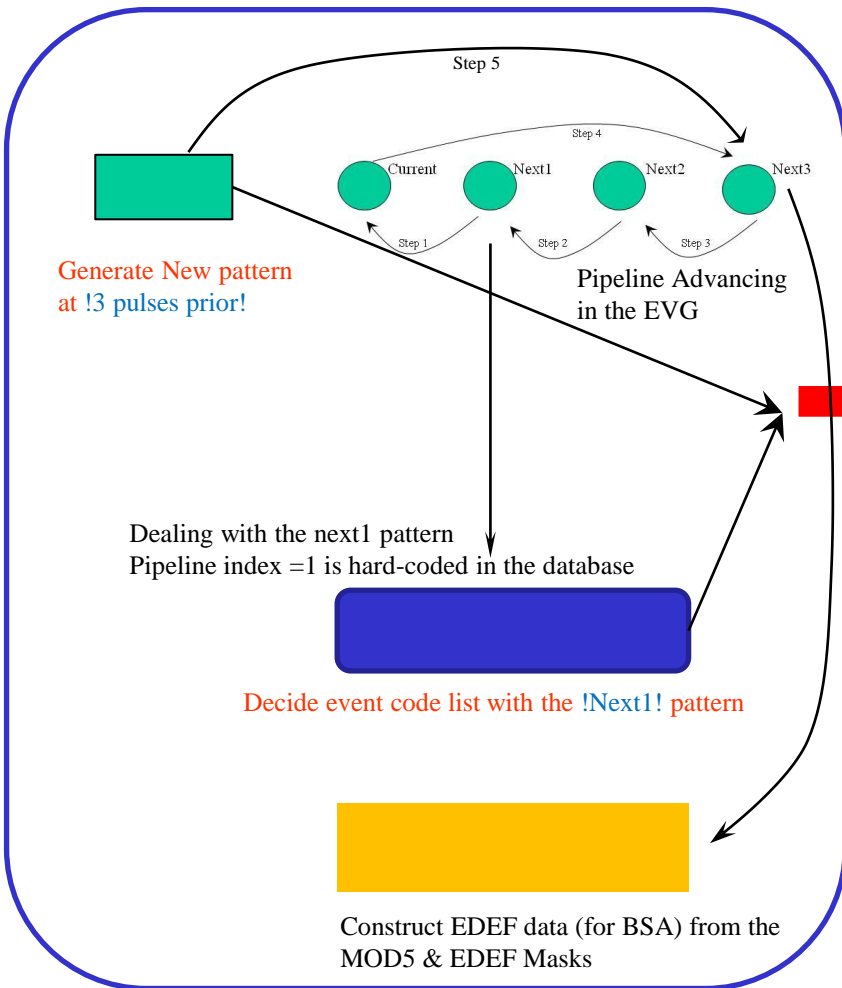
	Modifier 6	Modifier 5	Modifier 4	Modifier 3	Modifier 2
Inclusion Mask	0x0	0x0	0x0	0x80000	0x0
Exclusion Mask	0x0	0x0	0x0	0x0	0x36

Mask Setup

# Controls Pipeline, Pattern & Event code

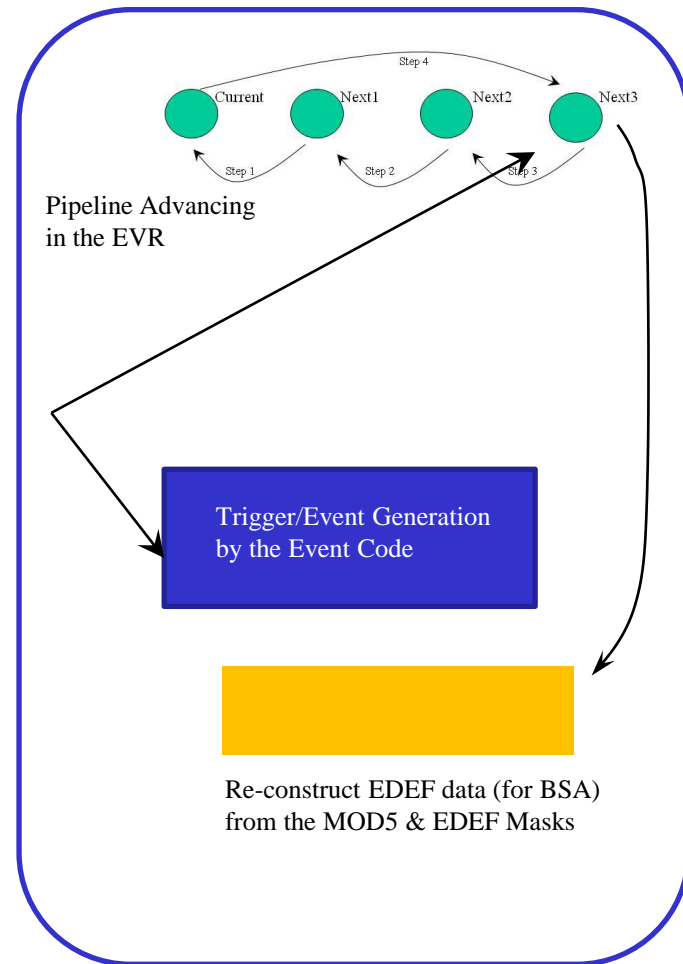
## Controls

### EVG



Fiber connection to EVR

### EVR

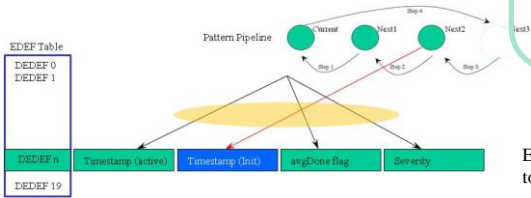
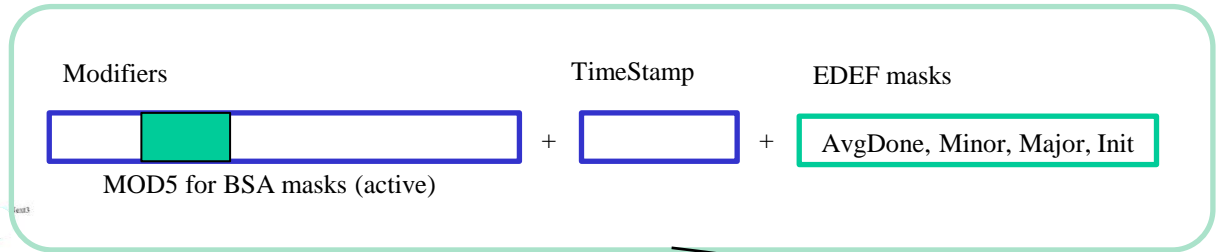


# Controls

# BSA & EDEF: EVR Message

EVG side

Pattern for Next3



EVG&EVR do exactly same processing to update the EDEF table

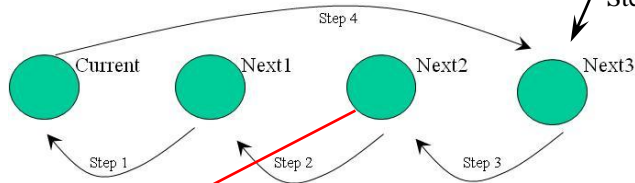
Fiber optic connection

EVR side

EDEF Table

DEDEF 0
DEDEF 1
DEDEF n
DEDEF 19

Pattern Pipeline



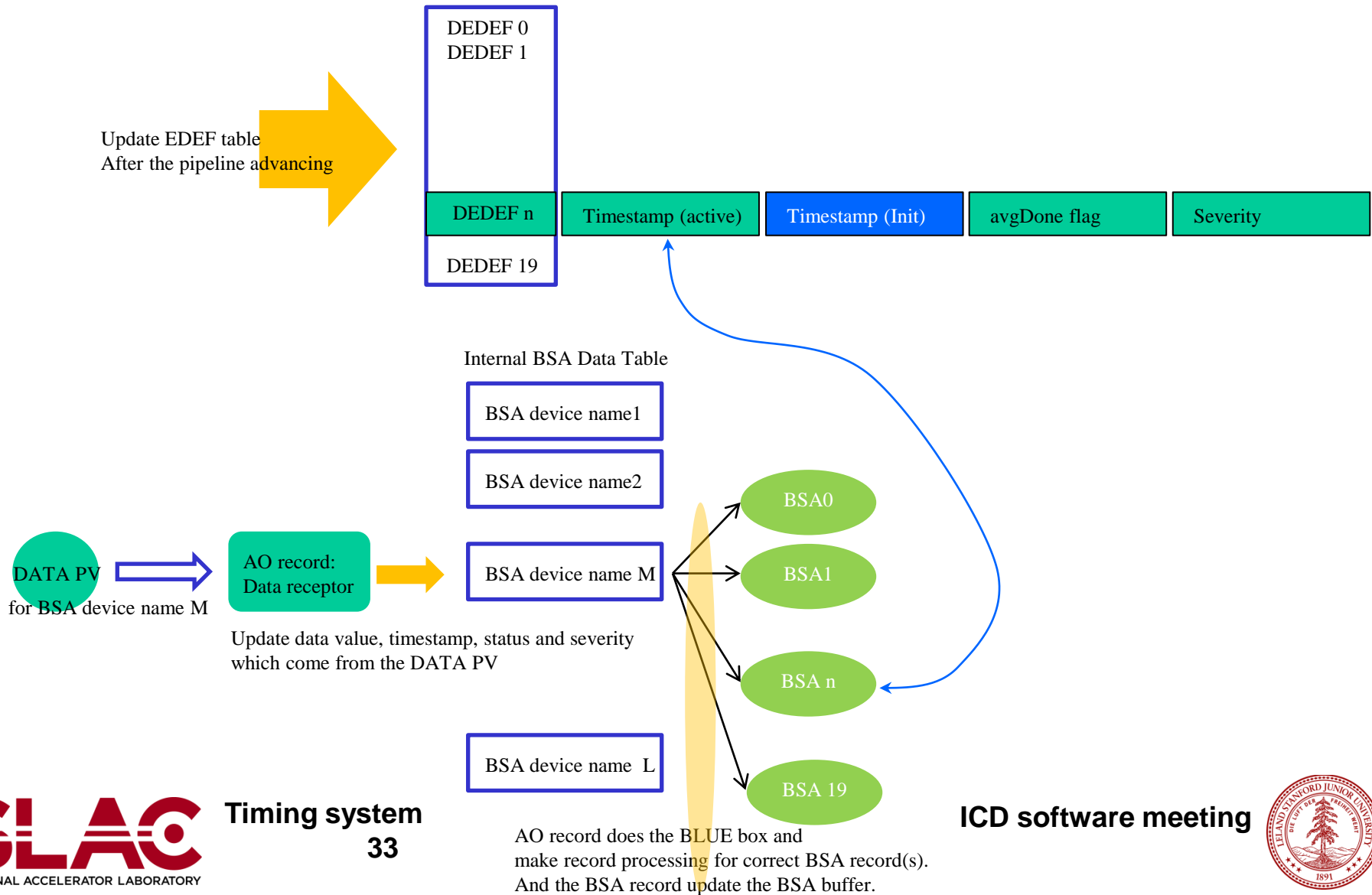
Update the EDEF table, after complete the pipeline advancing





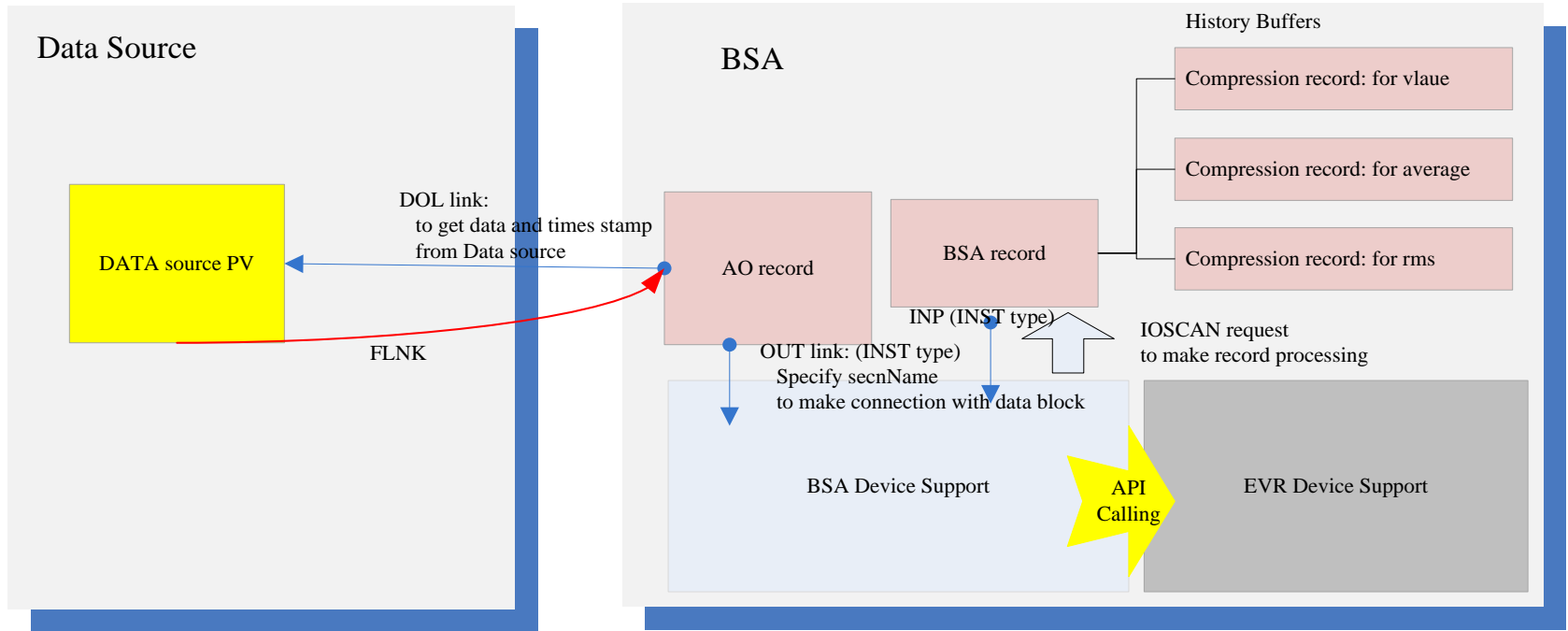
# BSA processing

## Controls



# How to setup the BSA in your

## Controls application



Your Application

BSA Package in Event Module

# Controls <system>bsa.substitutions

- Pick a proper template: <...>Edef.db
- Example

```

file bsaPHASEdef.db
{
#      Device           ,loc'n , IOC , Attribute
pattern {DEVICE       , LOC , UN , ATRB , IN , SLCLNK}
        { TCAV:LI24:800 , LI24 , RF01 , P , TCAV:LI24:800:TC3_PAVG, "" }
# Future. To standardize for SCORE
#      { TCAV:LI24:800 , LI24 , RF01 , P , TCAV:LI24:800:P , "" }
        { PCAV:LI25:300 , LI24 , RF01 , P , PCAV:LI25:300:PH3_3_PACT, "" }
# Future. To standardize for SCORE
#      { PCAV:LI25:300 , LI24 , RF01 , P , PCAV:LI25:300:P , "" }
        { PCAV:LI29:100 , LI24 , RF01 , P , PCAV:LI29:100:PH4_3_PACT, "" }
# Future. To standardize for SCORE
#      { PCAV:LI29:100 , LI24 , RF01 , P , PCAV:LI29:100:P , "" }
}
file bsaAMPLEdef.db
{
#      Device           ,loc'n , IOC , Attribute
pattern {DEVICE       , LOC , UN , ATRB , IN , SLCLNK}
        { TCAV:LI24:800 , LI24 , RF01 , A , TCAV:LI24:800:TC3_AAVG, "" }
# Future. To standardize for SCORE
#      { TCAV:LI24:800 , LI24 , RF01 , A , TCAV:LI24:800:A , "" }
        { PCAV:LI25:300 , LI24 , RF01 , A , PCAV:LI25:300:PH3_3_AACT, "" }
# Future. To standardize for SCORE
#      { PCAV:LI25:300 , LI24 , RF01 , A , PCAV:LI25:300:A , "" }
# Future. To standardize for SCORE
#      { PCAV:LI29:100 , LI24 , RF01 , A , PCAV:LI29:100:A , "" }
        { PCAV:LI29:100 , LI24 , RF01 , A , PCAV:LI29:100:PH4_3_AACT, "" }
}
    
```

Session for LLRF Phase

Session for LLRF Amplitude

BSA device name

Location

Unit

Attribute

Data PV name

# BSA templates

Template	Description	BSA properties
bsaAMPLEdef.db	RF Amplitude	Amplitude
bsaPHASEdef.db	RF Phase	Phase
bsaBLENEdef.db	Bunch Length	RAW, IMAX
bsaBLENTTest.db	Fake for Test	
bsaBPMSCavityEdef.db	Cavity BPMs	Re(Hor), Im(Hor), Re(Ver), Im(Ver), RAW ref
bsaBPMSEdef.db	BPMs (stripline?)	X, Y, TMIT
bsaBPMSTest.db	Fake for Test	
bsaEnergyEdef.db	Beam Energy	Single Attribute
bsaFARCEdef.db	Faraday Cup/Bunch Charge	Charge
bsaFARCTest.db	Fake for Test	
bsaPMTdef.db	PMT	QADC Raw
bsaPMTTest.db	Fake for Test	
bsaPWREdef.db	Beam Power	Power
bsaTOROEdef.db	Toroids/Beam current	TIMIT
bsaTOROTest.db	Fake for Test	
bsaWIREEdef.db	Wire Scanner	Position, Mask
bsaWIRETest.db	Fake for Test	

# Controls BSA Check Point

---

- DOL field in data receptor
  - AO record in BSA facility
  - The data receptor gets data, timestamp, and severity from the DOL LINK.
  - DOL should be pointed your data source
- Data Source PV
  - Timestamp (BSA aware)
  - FLNK to the data receptor

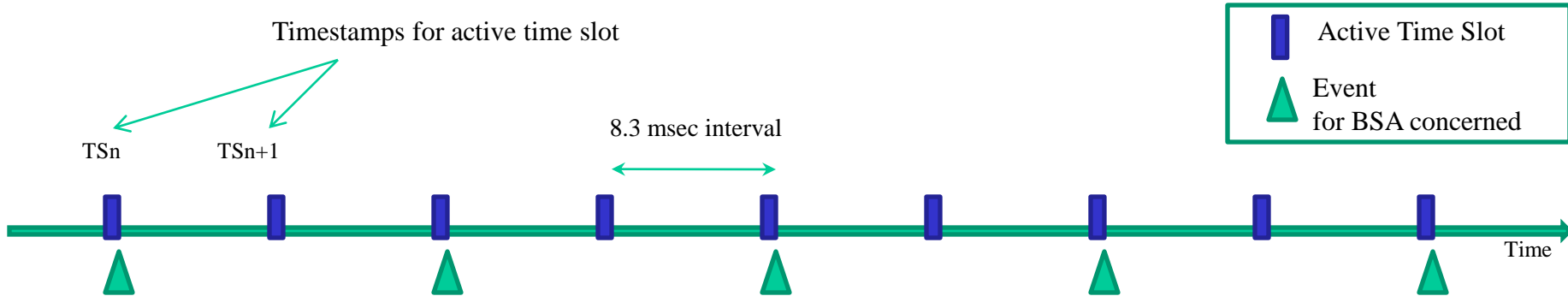
# Controls BSA aware Timestamp

- Basically, BSA facility compares the timestamp from data source and BSA event definition
- Assume, the timestamp from data source reflects ACTIVE\_TIMESLOT and Pulse ID
  - ACTIVE\_TIMESLOT: TS1 and TS4, event#0 in LCLS Event system
  - Pulse ID: lower 17 bits in nano-sec in timestamp
- **TSE=-2** for your data source PV
  - if, our device support for data source PV, takes care the timestamp
  - Somewhere in device support should call the following function  
`evrTimeGet(&pMyRec->timestamp, 0)`
- **TSE=0, -1** for your data source PV
  - If we can guarantee that record processing must be finished within 8.33 msec (time interval between active timeslot 1/120).
- **TSE>1** for your data source PV
  - If we can not guarantee, the record processing can be finished within 8.33 msec (time interval between active time slot 1/120)
  - Or, data getting is not synchronized with beam or event system.

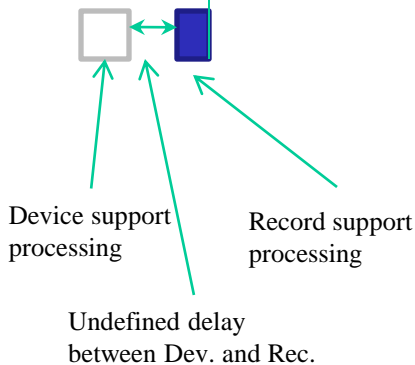
# BSA aware timestamp

## Controls

# and BSA Success/Fail scenario (1)



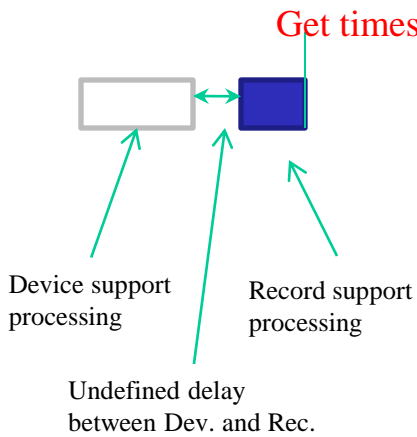
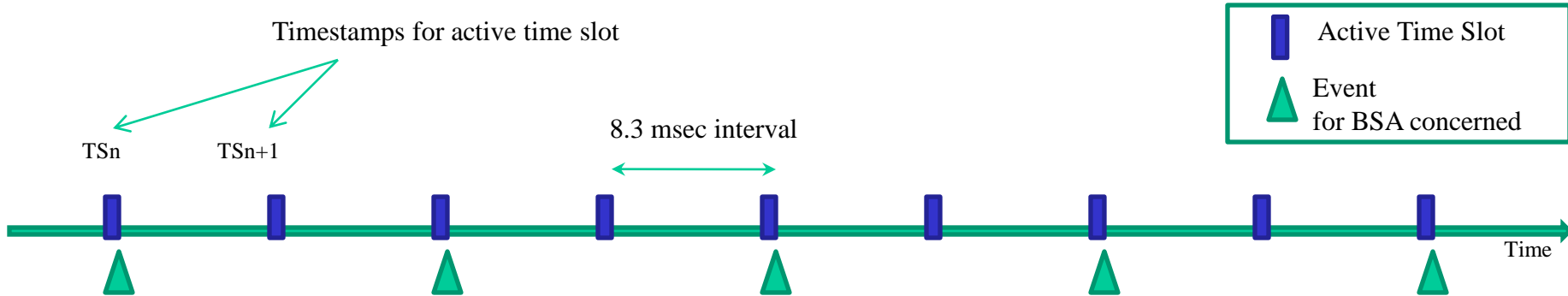
Get timestamp at this point



- Success Scenario: if  $TSE=(0,-1)$  and Guaranteed everything can be finished before next active time slot (within 8.3 msec)
  - Device support gets data for  $TS_n$
  - When the record instance gets timestamp, it should be still  $TS_n$

# BSA aware timestamp

## Controls and BSA fail/success scenario (2)

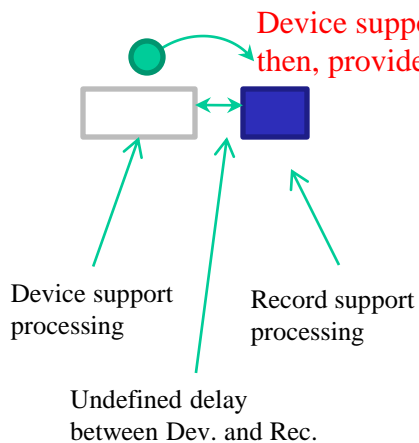
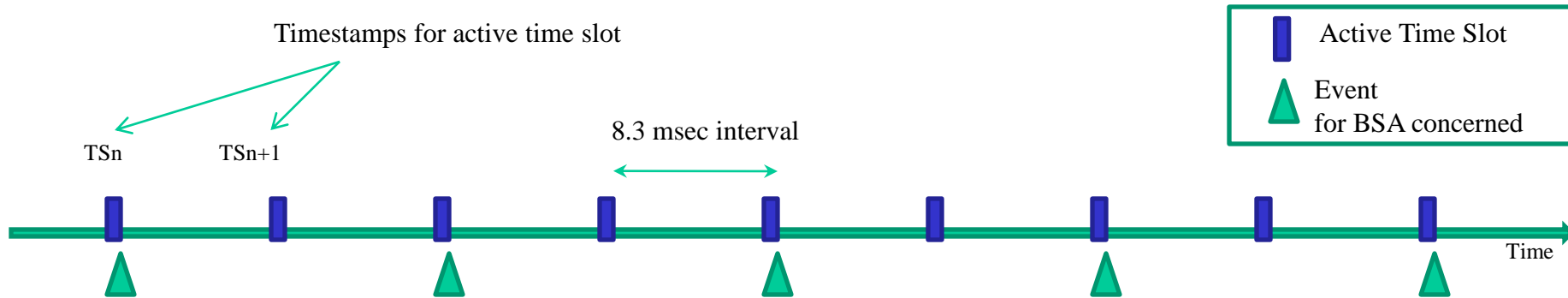


- Fail Scenario: if TSE=0, -1
  - Device support successfully get data for TS<sub>n</sub>
  - But, need to assume, there should be undefined delay before start record processing
  - And, record processing might be not finished until next active timeslot
  - The record (the data source PV) time stamp gets **TS<sub>n+1</sub>**
  - Then, BSA could be failed.  
BSA assumed TS<sub>n</sub> timestamp for the data source PV



# BSA aware timestamp and BSA fail/success scenario (3)

## Controls

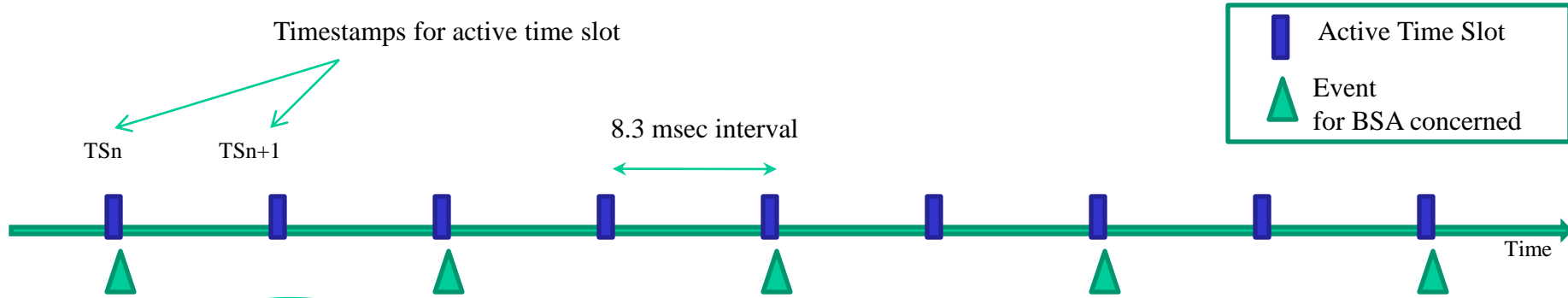


### Success Scenario: if $TSE = -2$

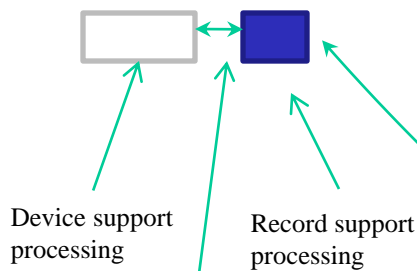
- Device support provides timestamp  $TS_n$  to the record instance
- Even, record processing is finished after  $TS_{n+1}$ , the timestamp should be  $TS_n$ .
- BSA is succeeded

# BSA aware timestamp and BSA fail/success scenario (4)

## Controls




(1) Event system update internal timestamp tables with the given event number



Undefined delay between Dev. and Rec.

Event #	Description	Timestamp
0	Active timeslot	03/23/2011 14:30:11.1343234234
1	360Hz Fiducial	03/23/2011 14:30:11.12343443343
m		TS <sub>n</sub>

(2) Record gets timestamp from the Event System Internal Table with the given event number

■ Success Scenario: if TSE=m (event for )

- Need to Enable VME IRQ for event m
- Event System maintain internal timestamp table for the events (including event m)
- Record gets latest timestamp from table for event number m

## Example for Scenario (1)

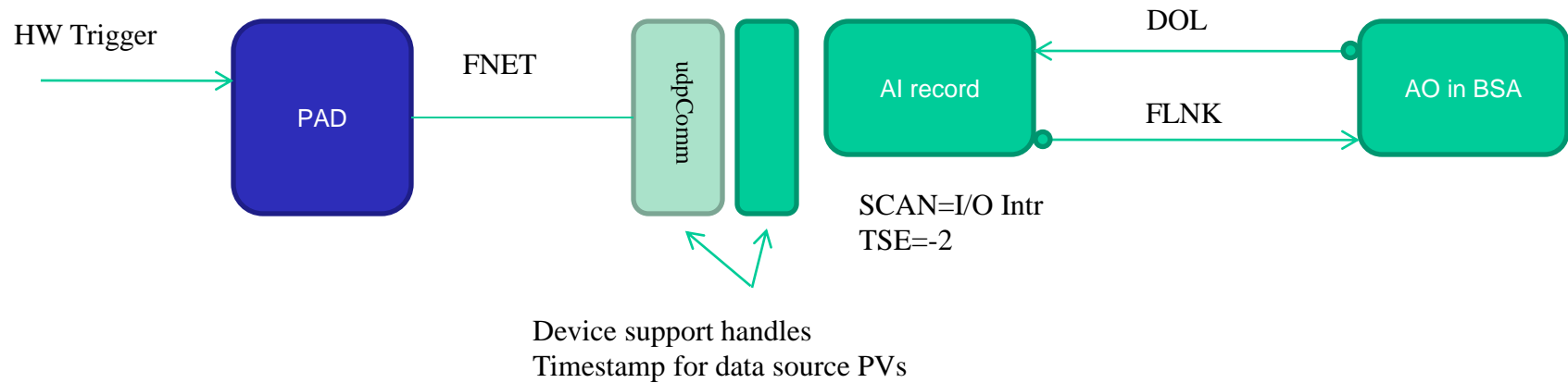
Guarantee that everything can be finished within 8.3 msec

### LLRF PAD reading



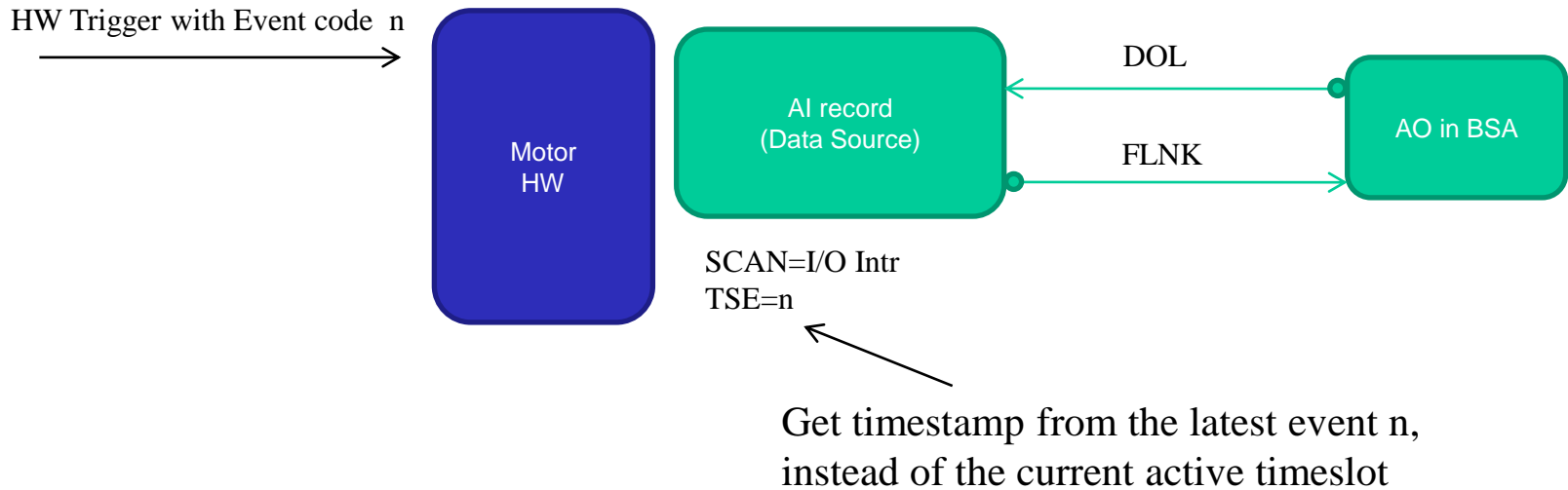
# Controls Example for Scenario (3)

## BPM PAD reading



## Example of Scenario (4): Long Processing Time

Record processing is spilled out to the next active time slot, but is not violated the dead-line for the next event.

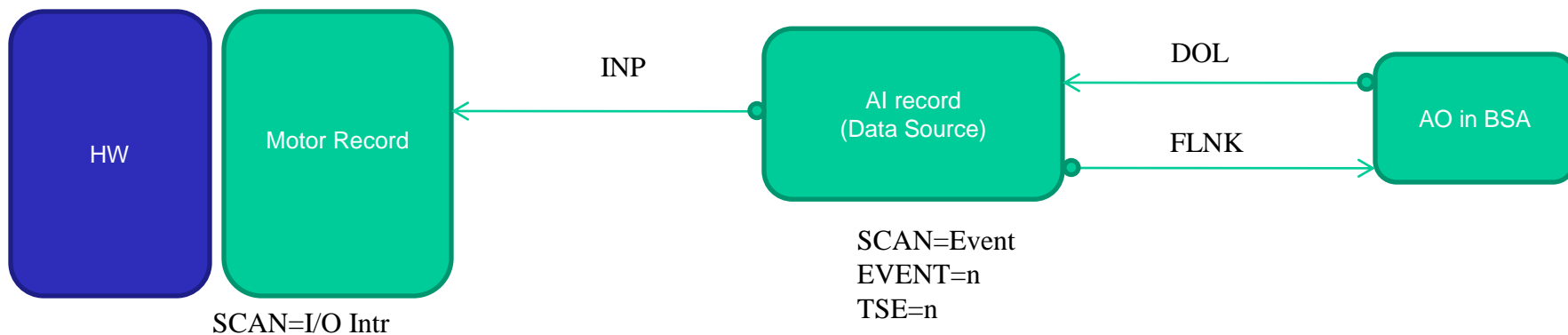


# Example of Scenario (4)

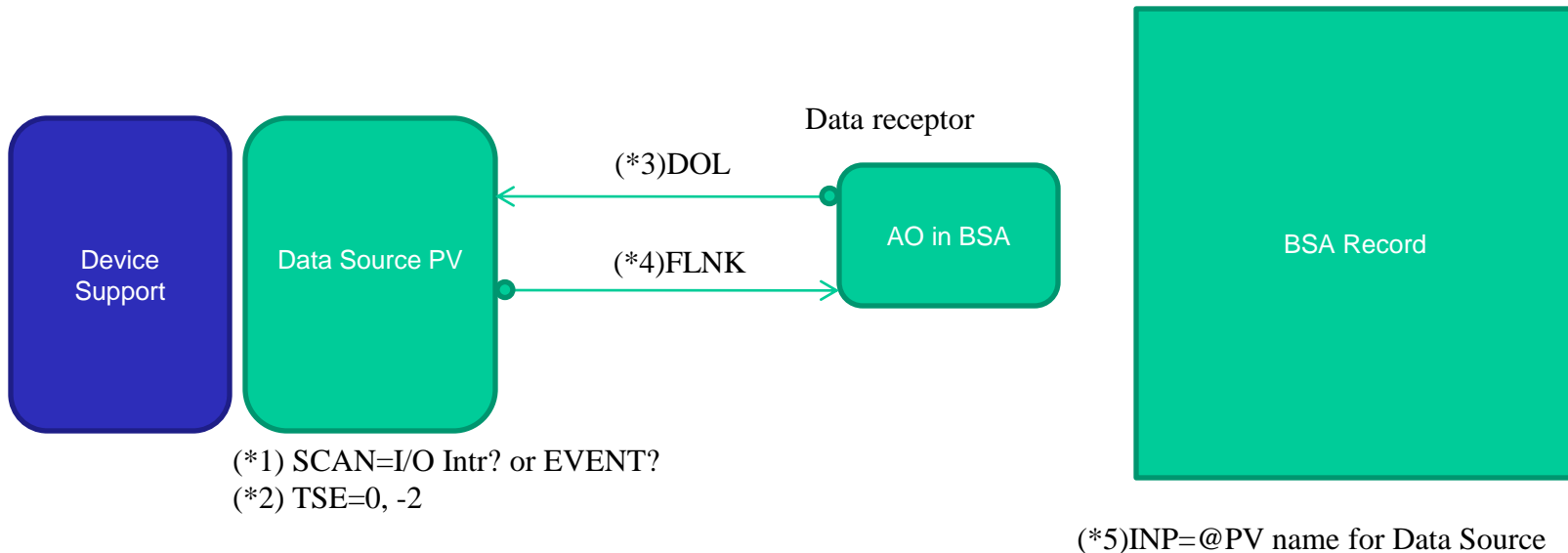
## Asynchronous BSA?

**Controls**

No Sync with BSA



# BSA Check Point AGAIN!



- (\*1) check up your data source driving mechanism
- (\*2) check up TSE in your data source, Please remind the success/fail scenario
- (\*3) (\*5) check up if the PV name matched, DOL in data receptor and INP in BSA
- (\*4) check up the FLNK, your data source should drive the data receptor