SDA Time Intervals

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What is SDA?

- **Sequenced Data Acquisition**
- Backed up with **Hierarchical** Data Logging System.

SDA Viewer version 4

File Data View Edit Help

get data | reload tree | open view | edit view | clear view | show Over (old)

```
sda
  ColliderShot
    4135   05/09/2005 17:31:14        shot index 25743
    4134   05/08/2005 15:37:52        shot index 25720
    4132   05/07/2005 12:15:52        shot index 25703
      Proton Injection porch          05/07/2005 12:16:09   case 1    set 0    collection 0
      Proton Injection tune up        05/07/2005 12:25:43   case 2
      Eject Protons                   05/07/2005 12:36:43   case 3
      Inject Protons                  05/07/2005 13:25:12   case 4
      Pbar Injection porch            05/07/2005 13:54:27   case 5    set 0    collection 587
      Inject Pbars                    05/07/2005 13:56:33   case 6
      Before Ramp                     05/07/2005 14:18:56   case 8    set 0    collection 608
      Acceleration                    05/07/2005 14:20:19   case 9    set 0    collection 609
      Flattop                         05/07/2005 14:21:52   case 10   set 0    collection 612
      Squeeze                         05/07/2005 14:22:56   case 11   set 0    collection 613
      Initiate Collisions             05/07/2005 14:25:39   case 12   set 0    collection 616
      Remove Halo                     05/07/2005 14:26:29   case 13   set 1    collection 618
      HEP                             05/07/2005 14:44:49   case 14
      Pause HEP                       05/08/2005 12:02:28   case 15   set 0    collection 749
      Inject Protons: Booster to MI   05/07/2005 13:25:12   case 26
      Accelerate Protons in MI        05/07/2005 13:25:12   case 27
      Coalesce Protons                05/07/2005 13:25:12   case 28
      Abort                           05/08/2005 12:03:17   case 29   set 1    collection 751
      Conditions                      05/07/2005 13:33:07   case 30   set 0    collection 266
      Set up                          05/07/2005 12:22:56   case 1    set 1    collection 0   shot 2667   shot index 25704   owne
      Unstack pbars                   05/07/2005 13:57:59   case 2    shot 2667   shot index 25704   owner PbarTransferShot
      Transfer pbars from Accum to MI 05/07/2005 13:59:13   case 3    shot 2667   shot index 25704   owner PbarTransferShot
      Accelerate pbars in the MI      05/07/2005 13:59:30   case 4    shot 2667   shot index 25704   owner PbarTransferShot
      Coalesce Pbars in the MI        05/07/2005 13:59:30   case 5    shot 2667   shot index 25704   owner PbarTransferShot
      Pbar Transfer Shot from RR to MI05/07/2005 14:03:02   case 7    shot 403   shot index 25706   owner RecyclerShot
      RR Accelerate Pbars in the MI   05/07/2005 14:03:02   case 8    shot 403   shot index 25706   owner RecyclerShot
      RR Coalesce Pbars in the MI     05/07/2005 14:03:12   case 9    shot 403   shot index 25706   owner RecyclerShot
      Set up                          05/07/2005 12:56:41   case 10   set 0    collection 0   shot 403   shot index 25706   owner
    4131   05/06/2005 06:28:08        shot index 25682
    4126   05/04/2005 06:17:37        shot index 25666
    4125   05/03/2005 03:07:21        shot index 25641
```

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ACNET Events

- 256 **Tclk** events + delay
- Absolute and Relative Time events, delays.
- State variable changes.
- **Changes of ACNET special device readings (category of devices).**

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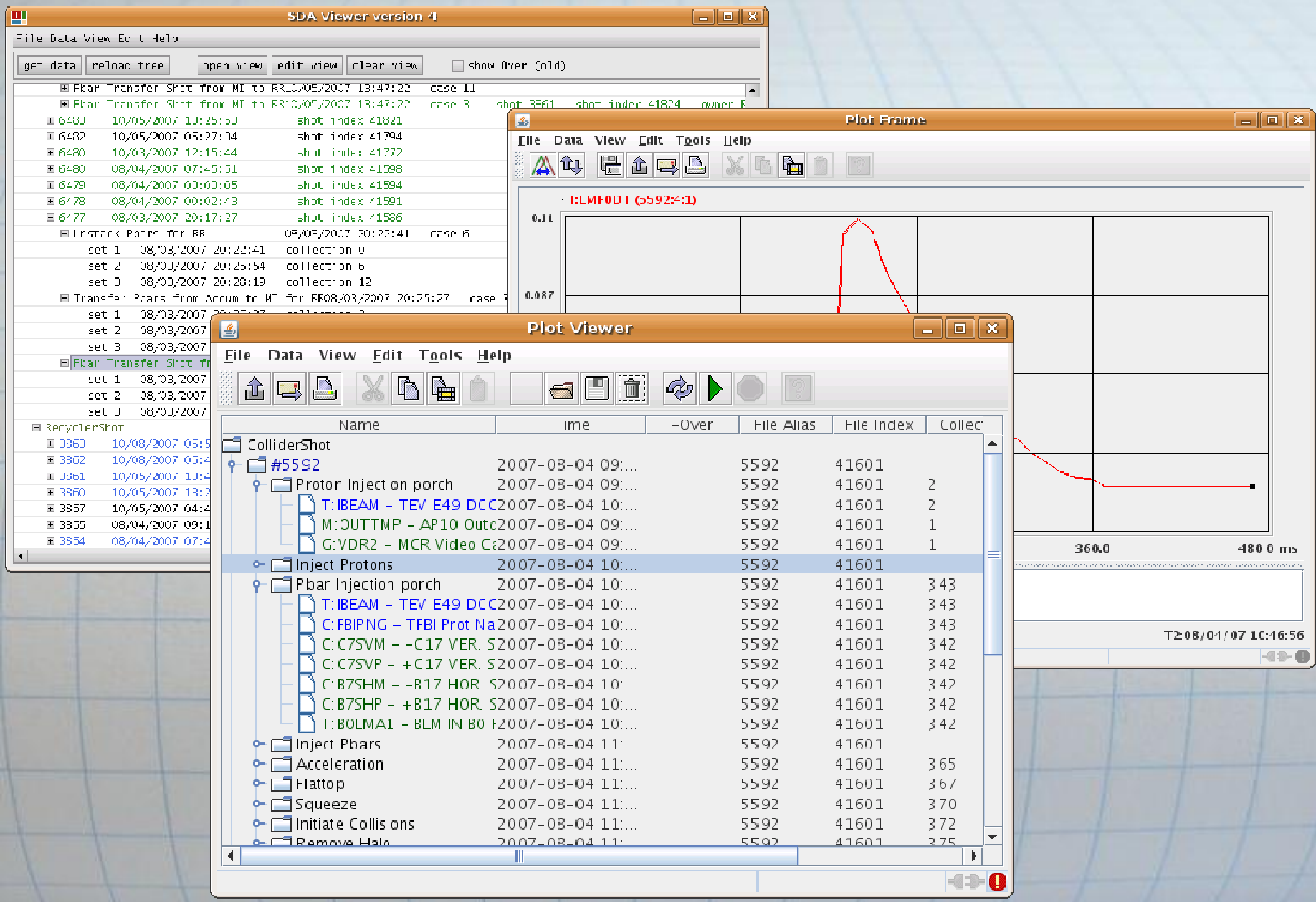
- Numerous tools, tables, applications..


SDA Viewer version 4
File Data View Edit Help
get data
reload tree
open view
edit view
clear view
show Over (old)
Pbar Transfer Shot from MI to RR10/05/2007 13:47:22 case 11
Pbar Transfer Shot from MI to RR10/05/2007 13:47:22 case 3 shot 3861 shot index 41824
6483 10/05/2007 13:25:53 shot index 41821
6482 10/05/2007 05:27:34 shot index 41794
6480 10/03/2007 12:15:44 shot index 41772
6480 08/04/2007 07:45:51 shot index 41598
6479 08/04/2007 03:03:05 shot index 41594
6478 08/04/2007 00:02:43 shot index 41591
6477 08/03/2007 20:17:27 shot index 41586
Unstack Pbars for RR 08/03/2007 20:22:41 case 6
set 1 08/03/2007 20:22:41 collection 0
set 2 08/03/2007 20:25:54 collection 6
set 3 08/03/2007 20:28:19 collection 12
Transfer Pbars from Accum to MI for RR08/03/2007 20:25:27
RecyclerShot
Plot Frame
File Data View Edit Tools Help
T:LMF0DT (5592:4:1)
0.11
0.087
360.0
480.0 ms
T:08/04/07 10:46:56
Plot Viewer
File Data View Edit Tools Help
Name
Time
-Over
File Alias
File Index
Collec
ColliderShot
#5592 2007-08-04 09:... 5592 41601
Proton Injection porch 2007-08-04 09:... 5592 41601 2
T:IBEAM - TEV E49 DCC 2007-08-04 10:... 5592 41601 2
M:OUTTMP - AP10 Outc 2007-08-04 09:... 5592 41601 1
G:VDR2 - MCR Video C 2007-08-04 09:... 5592 41601 1
Inject Protons 2007-08-04 10:... 5592 41601
Pbar Injection porch 2007-08-04 10:... 5592 41601 343
T:IBEAM - TEV E49 DCC 2007-08-04 10:... 5592 41601 343
C:FBIPNG - TFBI Prot Na 2007-08-04 10:... 5592 41601 343
C:C7SVM - -C17 VER. S 2007-08-04 10:... 5592 41601 342
C:C7SVP - +C17 VER. S 2007-08-04 10:... 5592 41601 342
C:B7SHM - -B17 HOR. S 2007-08-04 10:... 5592 41601 342
C:B7SHP - +B17 HOR. S 2007-08-04 10:... 5592 41601 342
T:BOLMA1 - BLM IN B0 F 2007-08-04 10:... 5592 41601 342
Inject Pbars 2007-08-04 11:... 5592 41601
Acceleration 2007-08-04 11:... 5592 41601 365
Flattop 2007-08-04 11:... 5592 41601 367
Squeeze 2007-08-04 11:... 5592 41601 370
Initiate Collisions 2007-08-04 11:... 5592 41601 372

Summary tables

- **Intensities and Emittances**, averages and bunch by bunch for both Collider Shot and Pbar Transfers from Accumulator to Recycler.
- ñ**Supertables**ò for both Collider Shot and Pbar Transfers from Accumulator to Recycler.
- Performance plots**.**
- Luminosity plots.
- OSDA ï API for reading SDA data.
- Physicists named SDA Shot Data Analisys.

Mozilla Firefox <2>

File Edit View Go Bookmarks Tools Help

http://www-bd.fnal.gov/javaapplications/html_write/ShotSummary

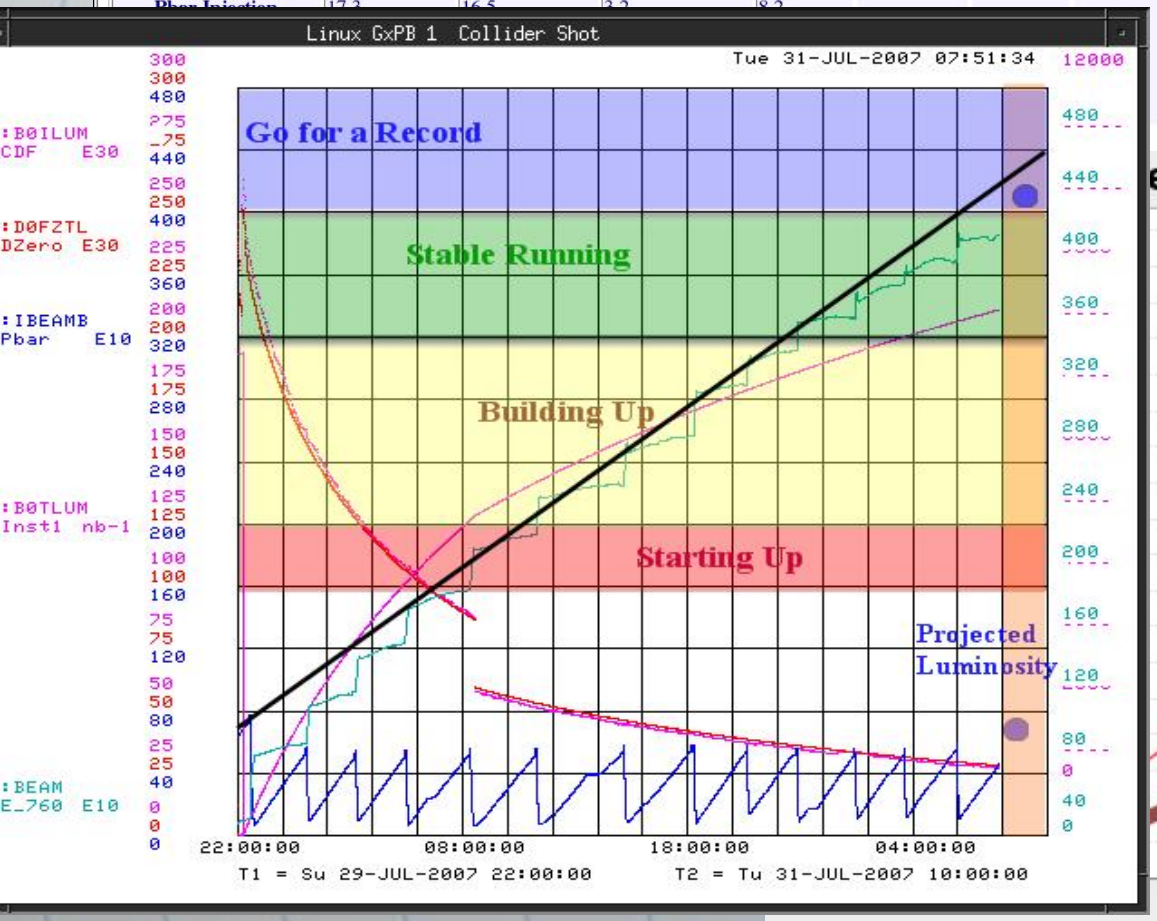
Getting Started Latest Headlines

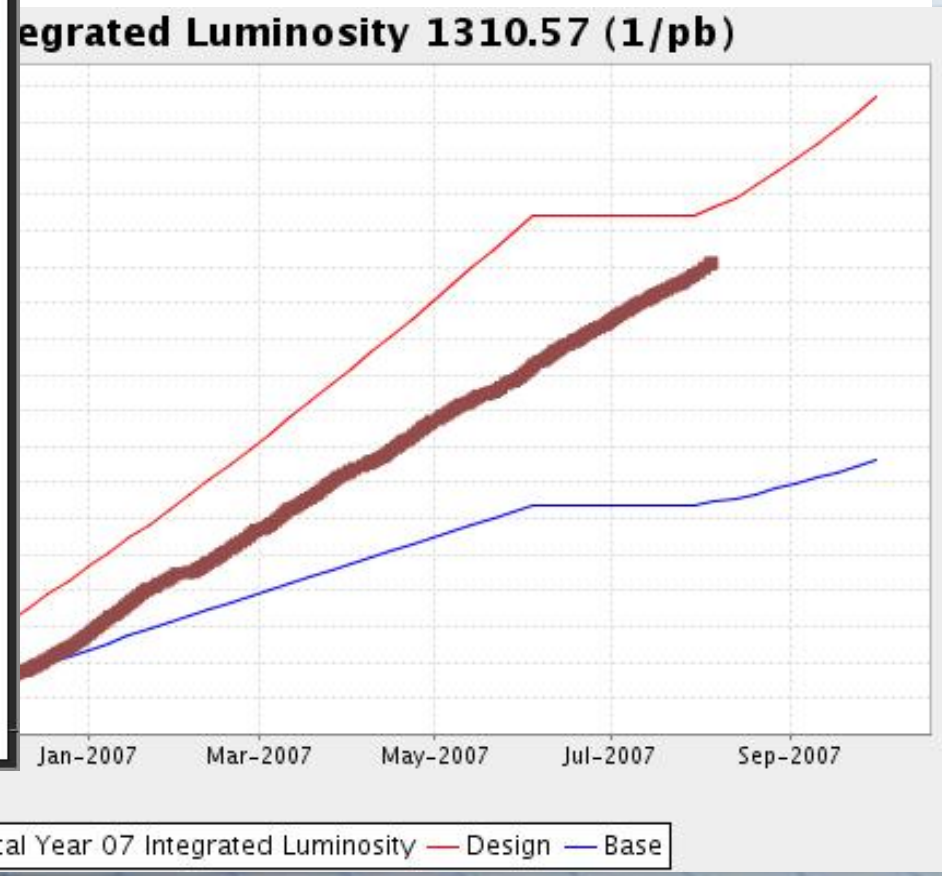
Recomputed Emittances Table

Shot Summary 4100 04/17/2005 01:50:29 Initial Stack size: 138.9 E10 Initial Stash size: No

Store # 4100	Proton Vertical pi-mm-mr	Proton Horizontal pi-mm-mr	Proton Longitudinal eV-sec	Pbar Vert pi-mm-n
Accumulator	.	.	.	2.0
Recycler	.	.	.	ï¿½
MI 8 GeV	12.7	13.9	.	5.3
MI 150 GeV	12.2	13.3	.	4.9
Proton Injection	16.7	14.2	3.3	.
Pbar Injection Porch	16.8	15.3	3.2	.

# 138 Tev p bunch length at 150, before helix opened (ns)	# 139 Tev p bunch length before ramp (ns)	# 140 Tev p bunch length at Remove Halo (ns)	# 141 p bunch growth (hours)	# 142 pbar bunch growth (hours)	# 143 time on helix (minutes)	# 144 p lifetime on helix (hours)	# 145 pbar lifetime at 150 (hours)	# 146 p lifetime, 1st 2 hours into store (hours)	# 147 pbar lifetime, 1st 2 hours into store (hours)
2.58	2.72	1.65	-22.39	-66.46	45.12	36.95	21.67	151.46	21.49
			-24.01	-54.68	24.48	32.43	11.95	73.99	22.51





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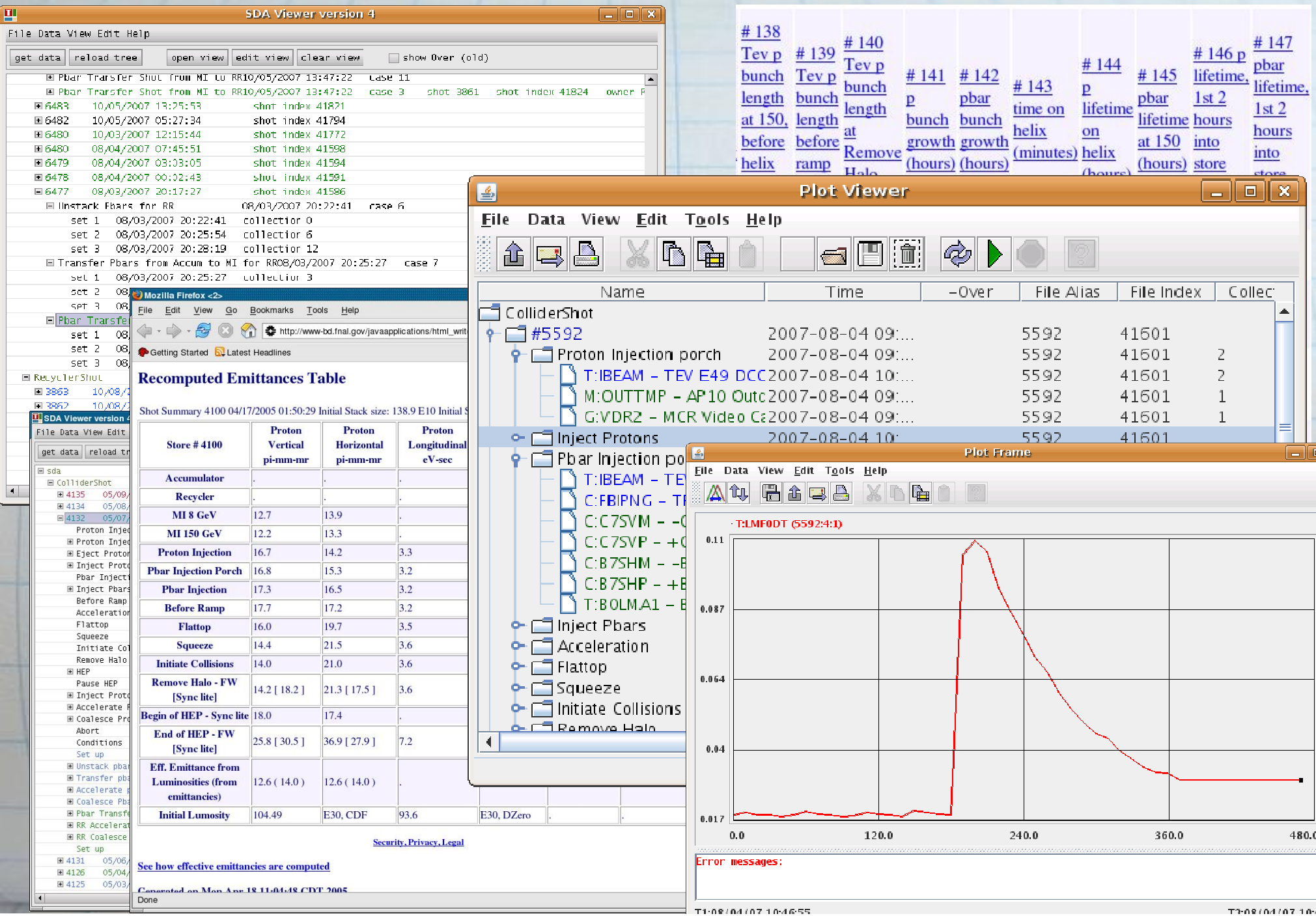
- Terms: **Event, Device, Collection, Shot, Case, Set.**
- Numerous tools, tables, applications.
- Defines common language for different workgroups.
- Used during Fermilab Collider Run II for **fine tuning** of accelerator complex.

SDA tools and tables screenshots.



What is SDA?

SDA was vital for fine tuning
of Fermilab Accelerator complex
during Collider Run II.

How Fermilab SDA is organized?

There are several types of Shots. Each has a rule for starting a shot (an event) and a rule for stopping a shot (another event).

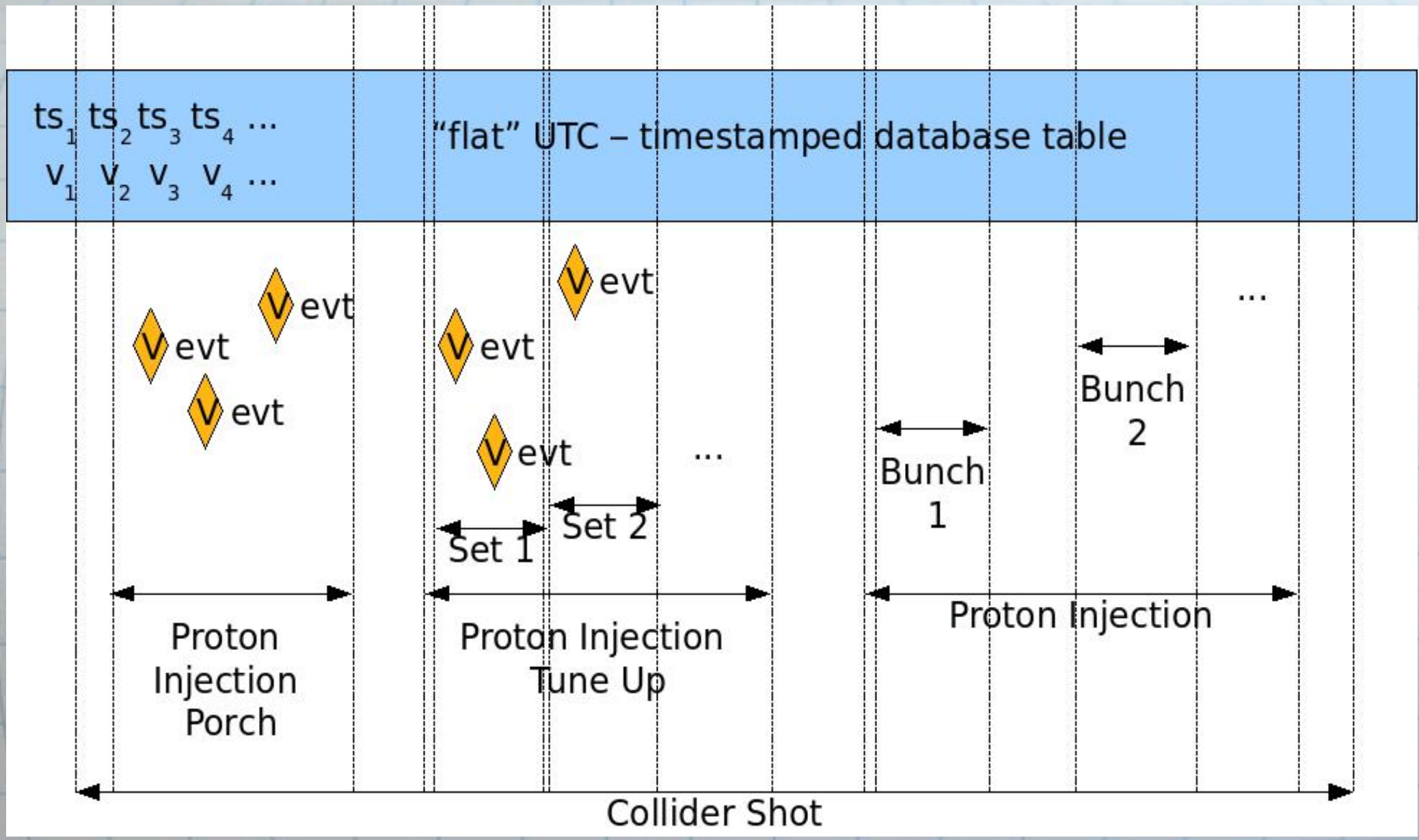
Shot has collections. Each type of collection has rules with starting and stopping events too.

Inside collection there are event-based rules for devices.

Type of collection defines a Case. Different devices are collected during "Inject Pbars" and "Remove Halo" cases.

Flat Datalogger is considered as database table with fields: device_name, timestamp, device_value.

Example of Time Intervals / Collections.



SDA on Collections.

ColliderShot # 5592

Proton Injection Porch

Collection #1

Proton Injection Tune Up

Collection #2 - Set 1

...

...

Inject Pbars

Collection # 120 - Set 1

Collection # 121 - Set 2

Collection # 122 - Set 3

...

Before Ramp

Recycler Shot # 3855

Setup

Pbar Transfer Shot From RR to MI

Collection # 1 - Set 1

Collection # 4 - Set 2

...

Accelerate Pbars In MI

Collection # 2 - Set 1

...

Coalesce Pbars in the MI

Collection # 3 - Set 1

...

Why redesign ?

LAFS (LHC At Fermilab Software) group was formed in Fermilab in Autumn 2006.

LAFS Goal - share experience & software with CERN and learn from new CERN control system.

SDA was one of the initial project.

"Proof of design" SDA version based on **XML DB** was implemented.

Our collaborators did not like it :

- **XML DB is not common (boosts support cost).**
- **Huge initial time investment (device rules).**
- **No integration with time - based datalogger.**

Initial time investment.

To define Fermilab-like SDA one needs to define shot start/stop rules, collection rules and device reading rules.

Some collections have up to 350 devices reading rules.

It may be unclear which devices to include.

The set of collection types is rather clear from the beginning.

Collections → Time Intervals.

SDA Time Intervals (TI) provides a solution of these problems and enriches Fermilab SDA with Temporal Logic.

The idea is to get rid of individual device-related rules, but leave all the Collection-related rules. Collections become "empty", so they are renamed to Time Intervals.

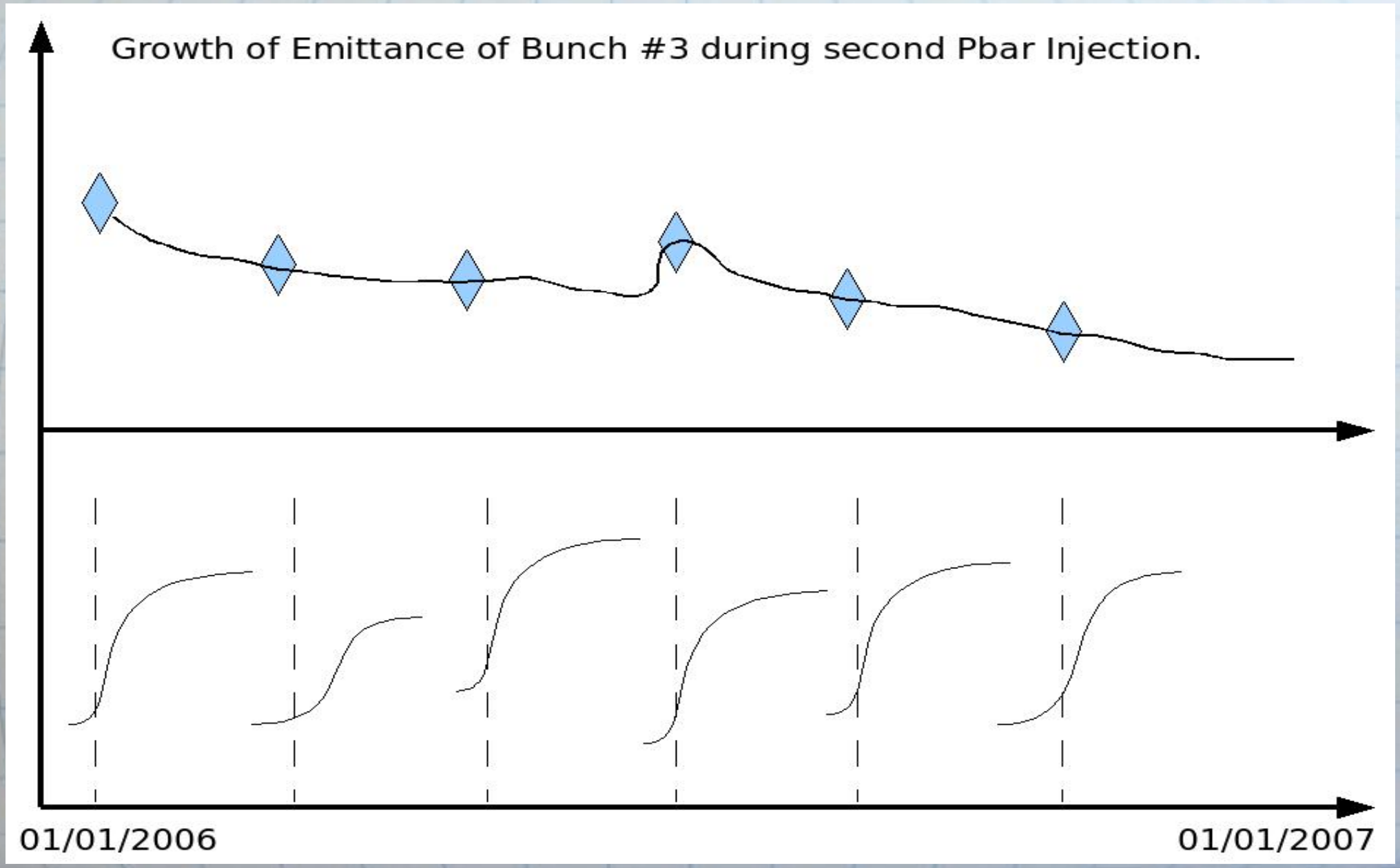
Time Intervals are stored in a relational database. The TI table can be used in SQL queries to "flat" time-based datalogger table, providing "filtering" and "tagging".

Implementation - SQL Tables.

```
CREATE TABLE ti(
    owner          INT not null,
    shot           INT not null,
    theCase        INT not null,
    theSet         INT not null,
    file_idx       INT not null,
    coll_idx       INT not null,
    success        TINYINT DEFAULT 1,
    tStart         Timestamp not null,
    tStop          Timestamp not null
)
create unique index ti1 on ti(  owner, file_idx, coll_idx )
create index ti2      on ti( owner, shot, theCase, theSet )
create index ti_tstart on ti(  tStart )
create index ti_tstop  on ti(  tStop )
```

Implementation - Filtering

Read values of Device during Pbar Injection #2

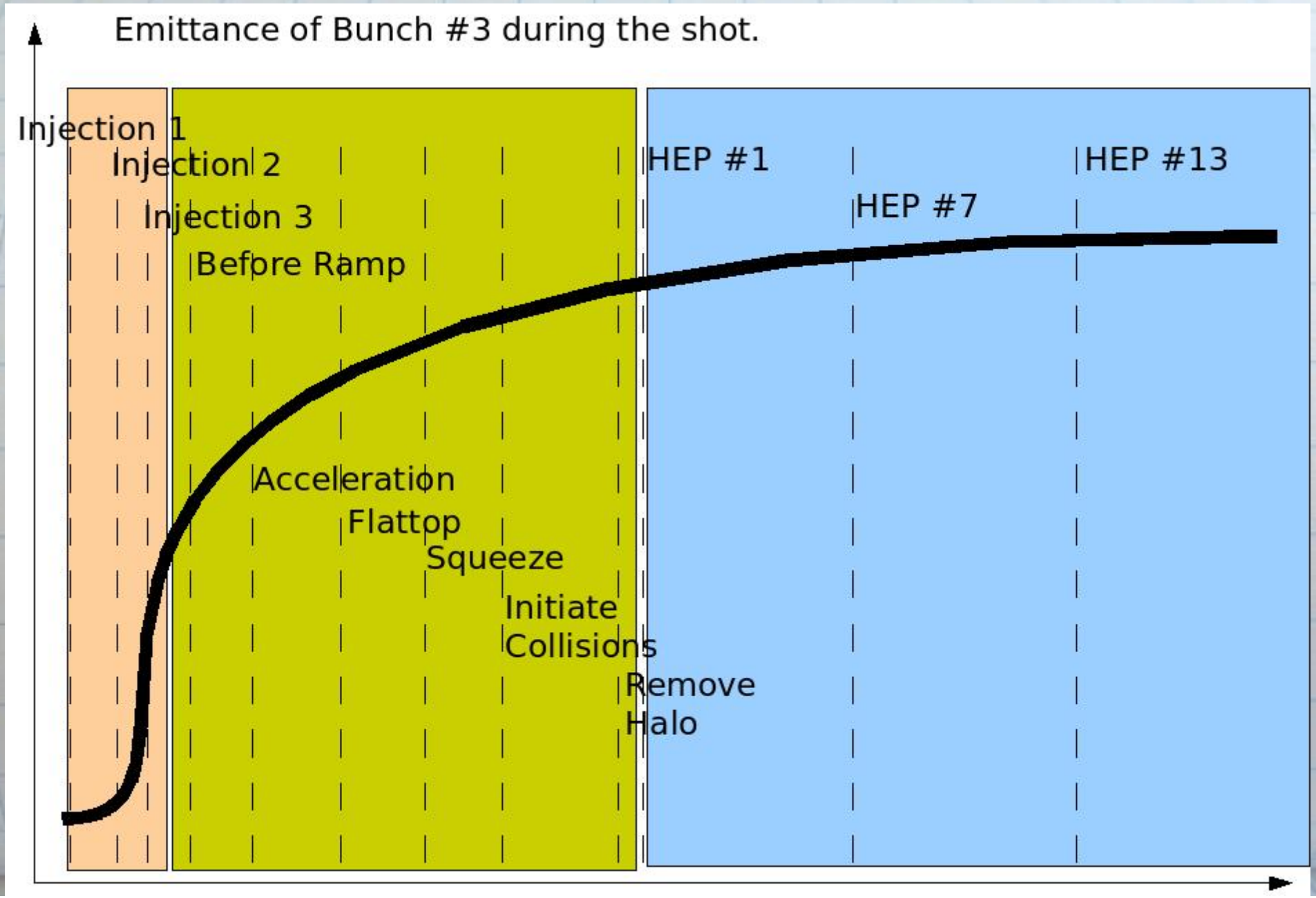


Implementation - Filtering

```
SELECT A.ts, A.value
   FROM flat_dl A,  ti B
   WHERE
      A.ts >= '01/01/2006' AND A.ts <= '01/01/2007'
AND
      A.device     = "Device"          AND
      B.owner      = ColliderShot      AND
      B.theCase  = InjectPbars         AND
      B.theSet     = 2                 AND
      B.success    = 1                 AND
      A.ts >= B.tStart AND A.ts <= B.tStop
   ORDER BY
      A.ts
```

Implementation - Data Tagging

How reading of Device changed throughout shot?



Implementation ï Data Tagging

```
SELECT A.ts, A.value, B.theCase, B.theSet
   FROM flat_dl A,  ti B
   WHERE
      A.device     = "Device"          AND
      B.owner     = ColliderShot     AND
      B.shot        = 5592
      B.success   = 1                      AND
      A.ts >= B.tStart AND A.ts <= B.tStop
   ORDER BY
      A.ts
```

Implementation - Temporal Logic

How much time was spent between shots throughout the year (average)? And between HEP (Collisions mode)?

How many transfers from Accumulator to Recycler was done during ColliderShot #5592?

How much time was spent in shot setup is comparing to total HEP time?

List all the time intervals of Pbar Injection? And Proton Injection? And throughout last 3 year? Does it grow?

Implementation - Temporal Logic

```
public class SdaTimeInterval{
    private long start, stop;
    private List <SdaTimeInterval> children;
    private SdaTimeInterval parent;

    private int[]  logicCoords;      // owner/shot/case/set
    private int[] uniqueCoords;   //  unique keys
    private String[]      names;     // owner and case names
    private boolean valid = true;

    public boolean includes( SdaTimeInterval interval );
    public boolean overlaps( SdaTimeInterval interval );
    public boolean before( SdaTimeInterval interval );
    public boolean after (SdaTimeInterval interval );
    public boolean insideOf( SdaTimeInterval interval );
```

Implementation

SDA TI was implemented in Fermilab in Spring 2007.

It is actively used since.

What is not covered by TI?

Fermilab SDA allows for saving bunch of high frequency data collected at necessary time, TI cannot provide it.

Fermilab SDA collections provides all the information about a given stage - physicist can look at all the relevant devices.

Data, collected on event are always more precise then data read on time.