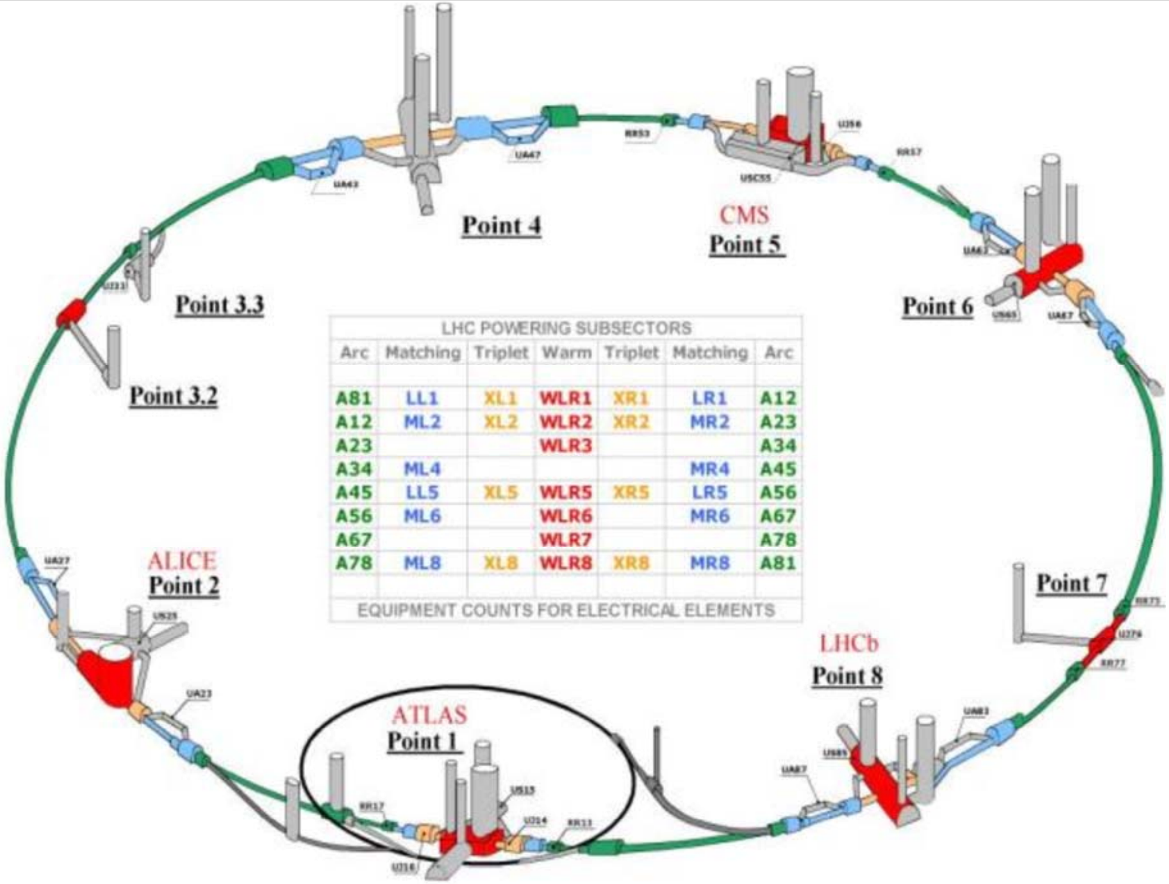
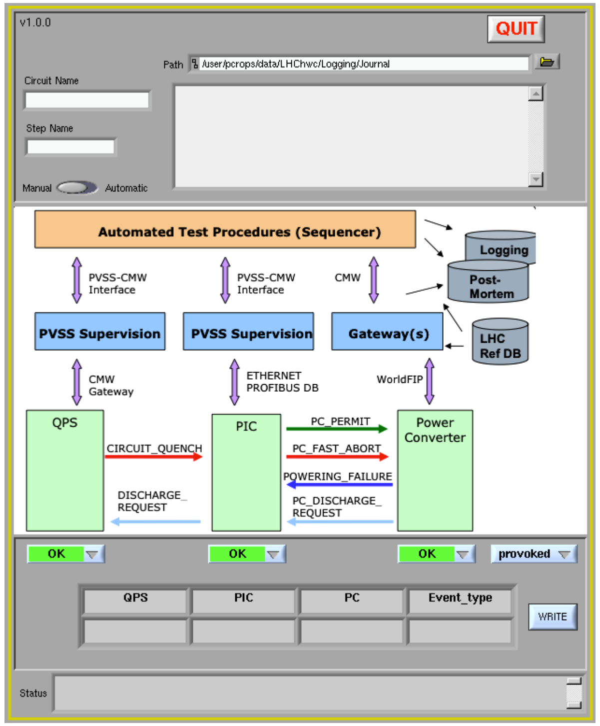
How do we tackle the extended requirements?

HWC and Beam Commissioning



Arc	Matching	Triplet	Warm	Triplet	Matching	Arc
A81	LL1	XL1	WLR1	XR1	LR1	A12
A12	ML2	XL2	WLR2	XR2	MR2	A23
A23			WLR3			A34
A34	ML4				MR4	A45
A45	LL5	XL5	WLR5	XR5	LR5	A56
A56	ML6		WLR6		MR6	A67
A67			WLR7			A78
A78	ML8	XL8	WLR8	XR8	MR8	A81

PIC1 PM Analysis



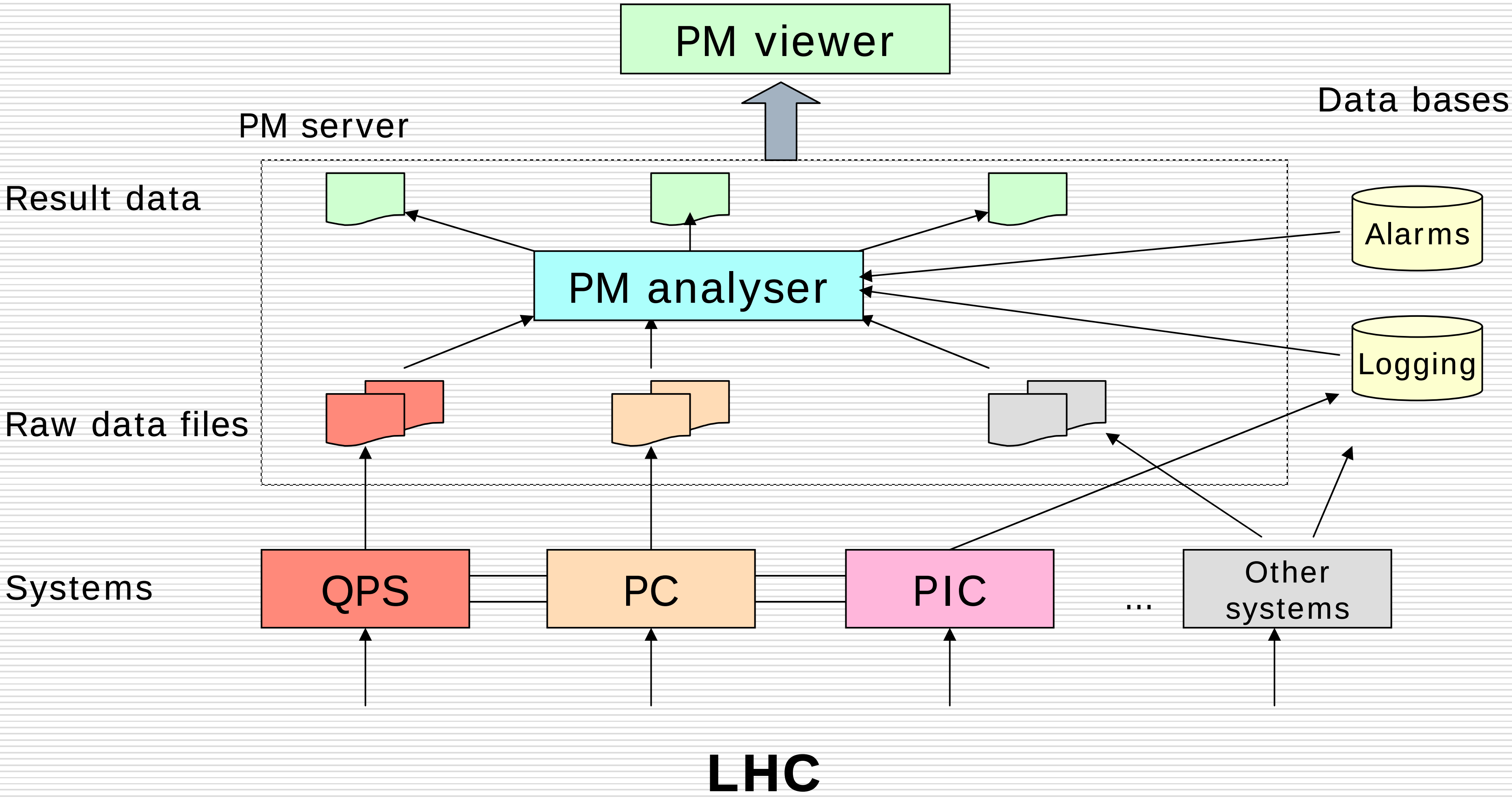
?

Outline

1. Simple PM system dataflow view
2. Known systems with PM requirements
3. Three step PM analysis
4. Software trigger
5. Linking requirements, source code and results
6. Implementation extensions
7. Recapitulation

PM system dataflow view, one-step analysis

Starting point in 2005



Summary of systems with PM requirements

Analyses well advanced → Machine Protection, Quench Protection, Power Converters

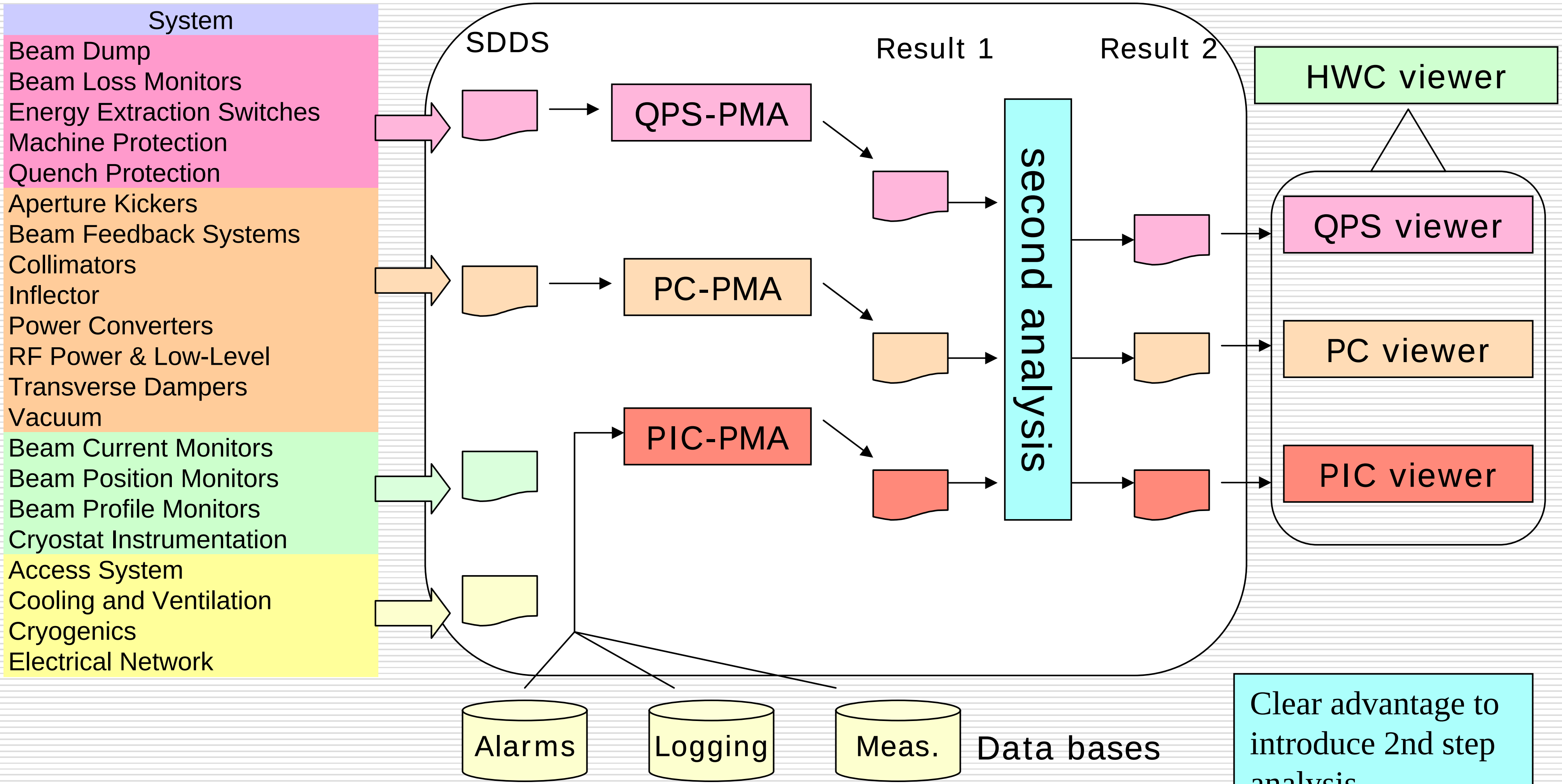
System	Transient Recorder	Logging	Alarms	
Beam Dump	y	n	y	
Beam Loss Monitors	y	y	y	
Energy Extraction Switches	y	y	y	Protection
Machine Protection	n	y	y	
Quench Protection	y	y	y	
Aperture Kickers	y	n	y	
Beam Feedback Systems	y	?	y	
Collimators	?	y	y	
Inflector	y	n	y	Act on Beam
Power Converters	y	y	y	
RF Power & Low-Level	y	y	y	
Transverse Dampers	y	n	y	
Vacuum	n	y	y	
Beam Current Monitors	y	y	y	
Beam Position Monitors	y	y	y	Monitors
Beam Profile Monitors	y	y	y	
Cryostat Instrumentation	?	y	y	
Access System	n	y	y	
Cooling and Ventilation	n	y	y	Services
Cryogenics	n	y	y	
Electrical Network	y	n	y	

Legend:
y - produces data
n - no data
? - not know yet

But all need PMA!

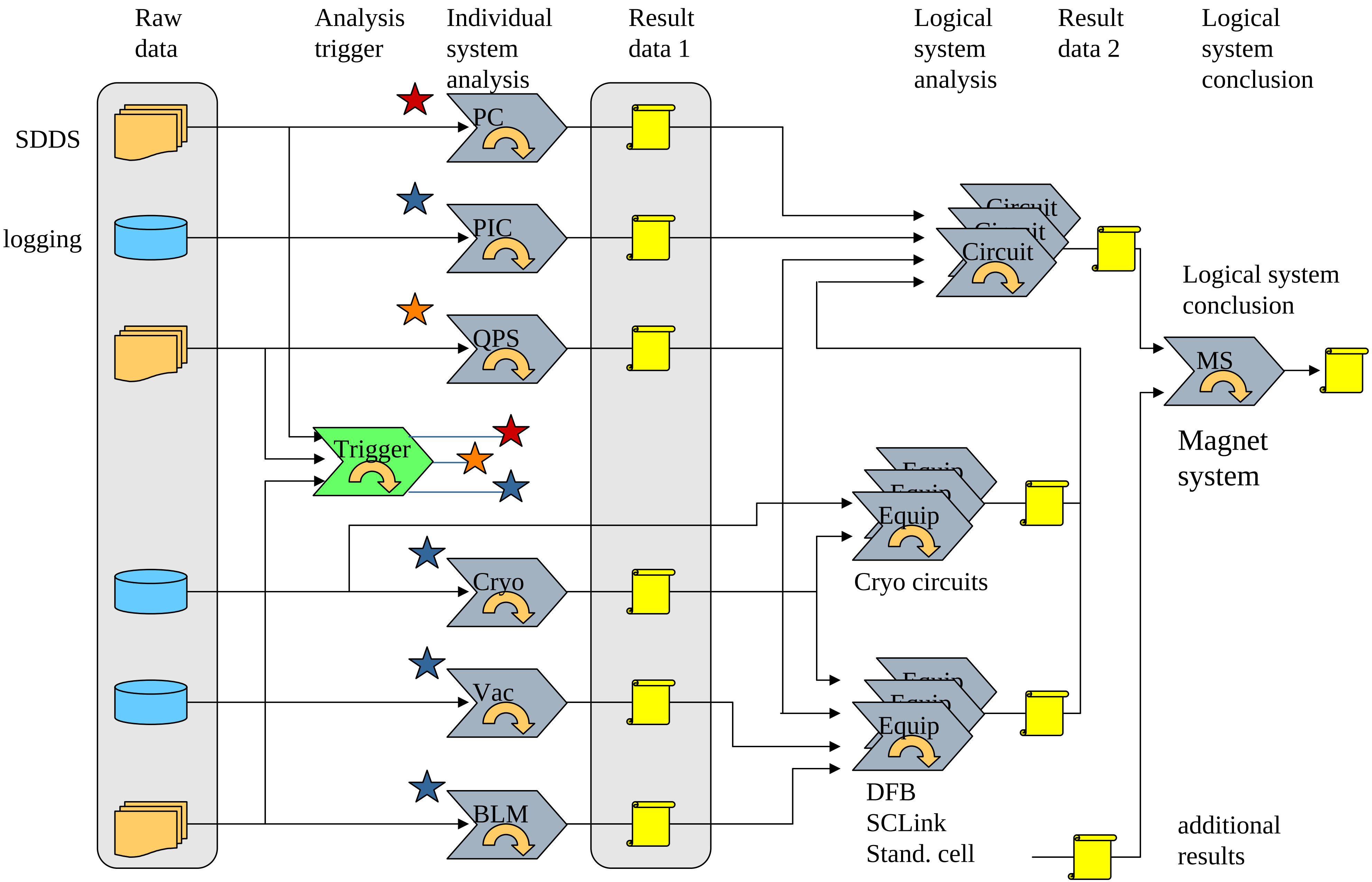
PM data flow, two-step analysis

PM system, evolution during 2006

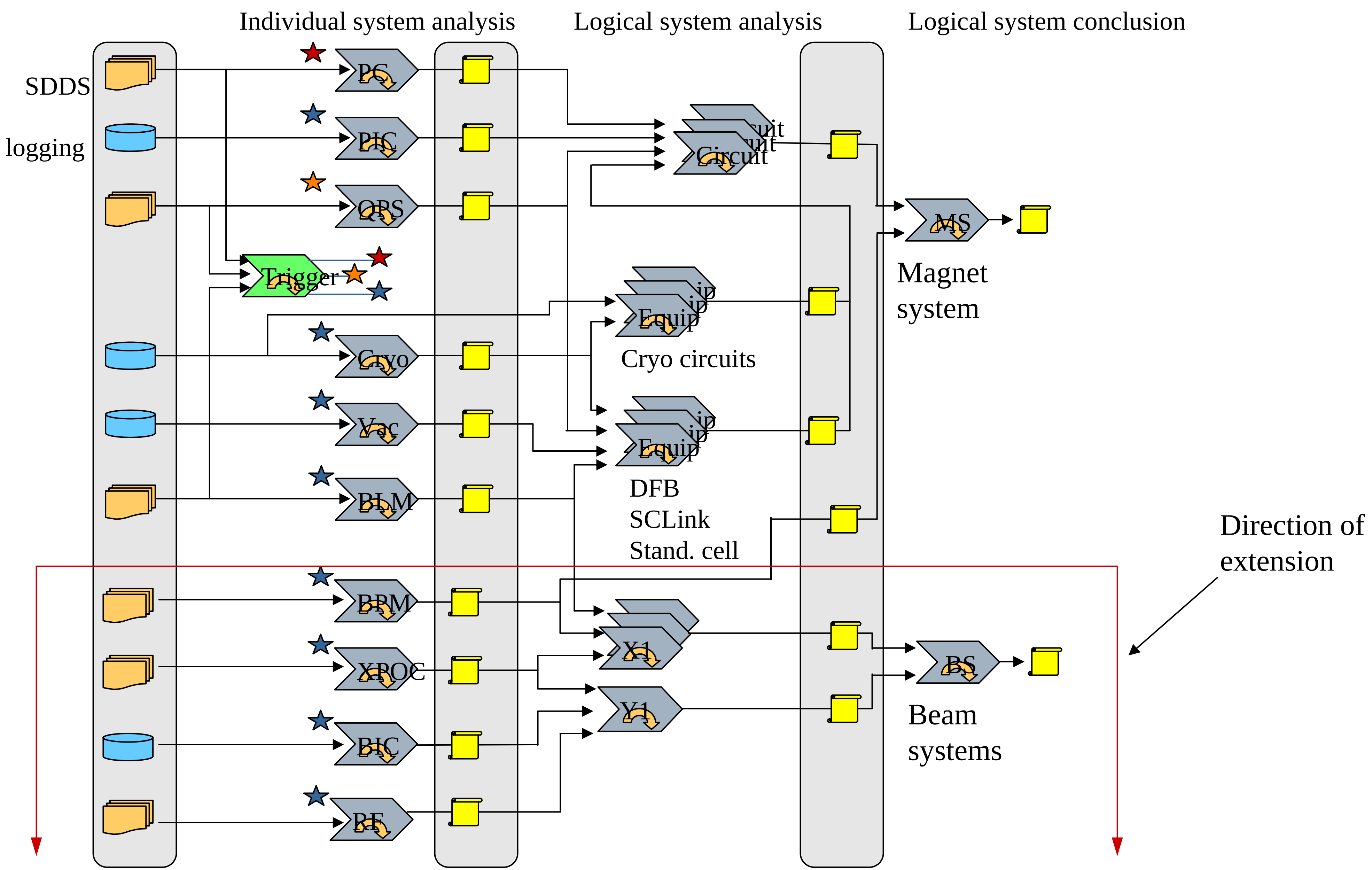


Clear advantage to introduce 2nd step analysis.

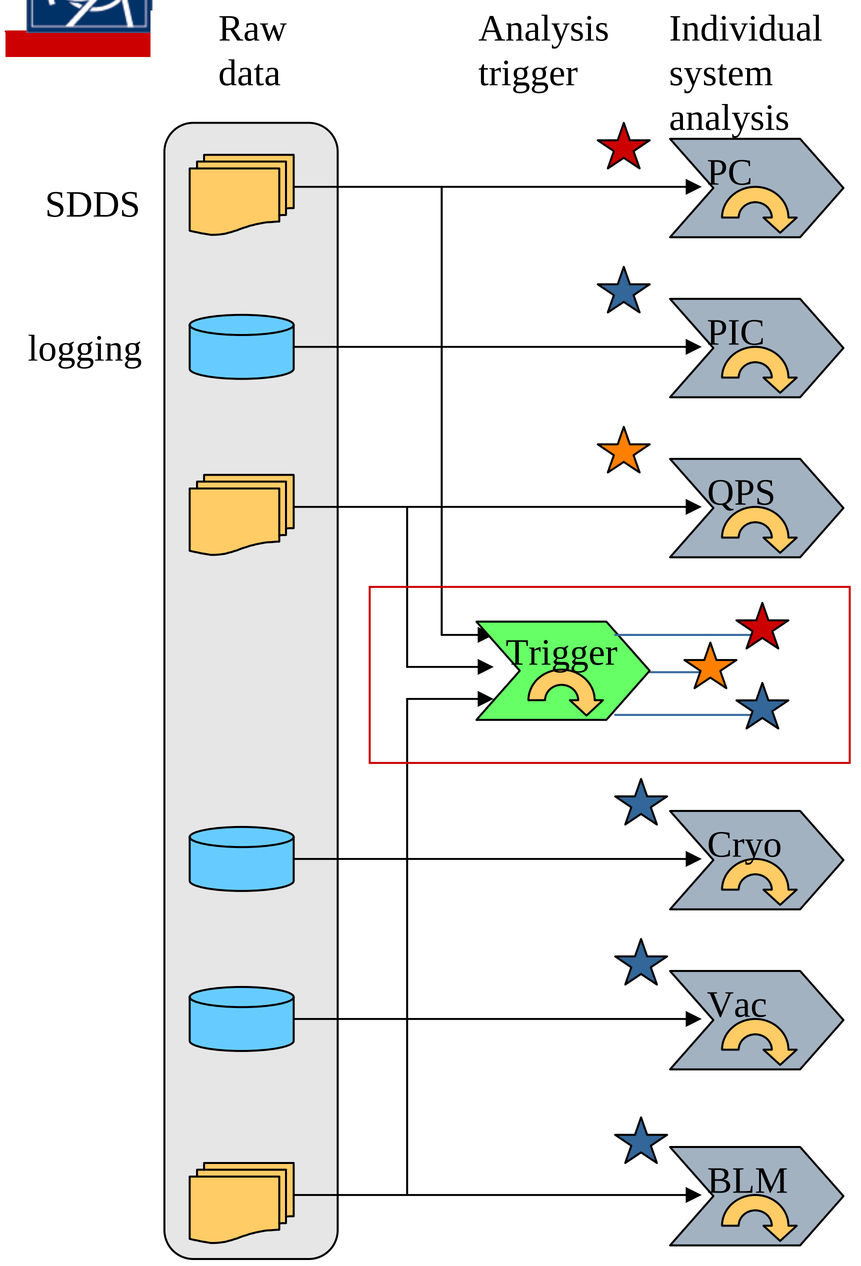
Architecture of PMA system, three-step including trigger



Architecture of PMA, extended to beam data analysis



Why a trigger module?



Reasons:

•Individual System analysis modules dealing with **logging data** need to know when to start

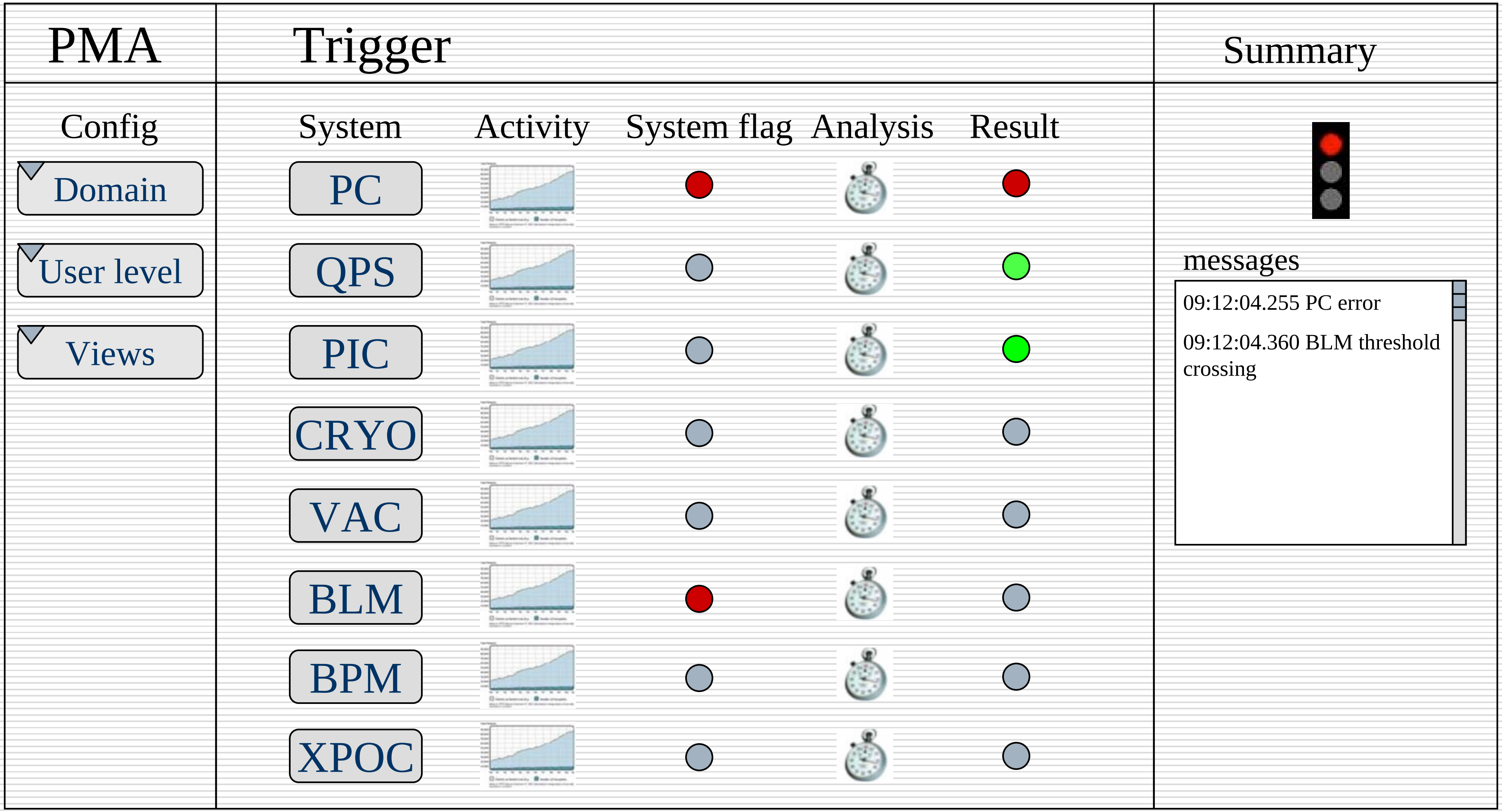
•Individual System analysis modules dealing with **SDDS data** could detect when to start by itself or rely on the trigger module

•Logical system analysis modules combining logging and SDDS data need trigger module or would need to communicate with Individual System modules

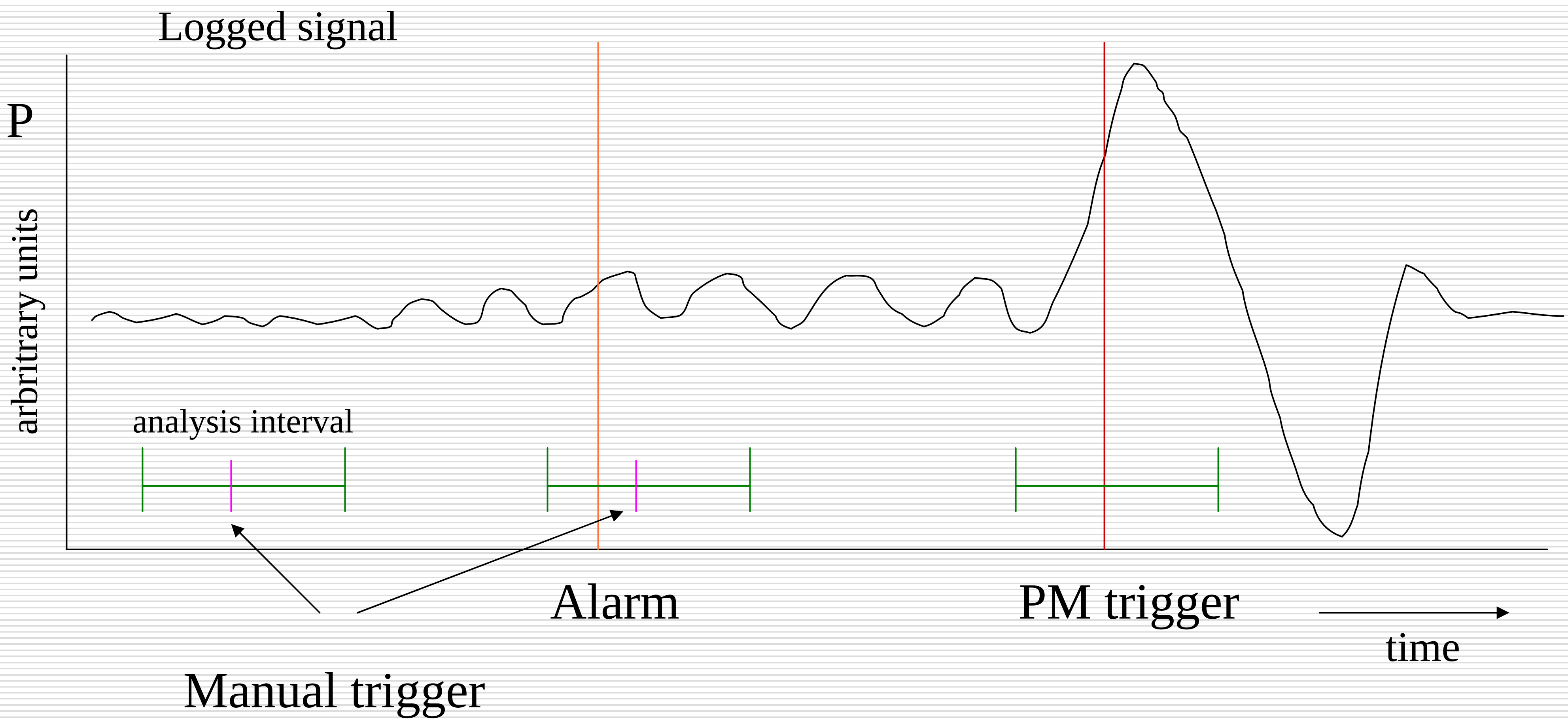
•Manual triggers could be given by an operator through the trigger module

•If all analysis modules rely on the trigger module this can also fulfill the task of **monitoring** the analysis process

PMA Software trigger



Manual trigger



Linking requirements, source code, docs and results

- PMA_home
  - QPS
    - QPS_req1.1 → Excel file; Word file
    - QPS_prog1.1 → LabVIEW source
    - QPS_doc1.1 → Program_description.doc
    - QPS_res1.1 → Text, XML or DB transfer
  - PC
    - PC_req1.1
    - PC_req1.2
    - PC_prog1.1
    - PC_prog1.2
    - PC_doc1.1
    - PC_doc1.2
    - PC_res1.1
    - PC_res1.2

Excel file

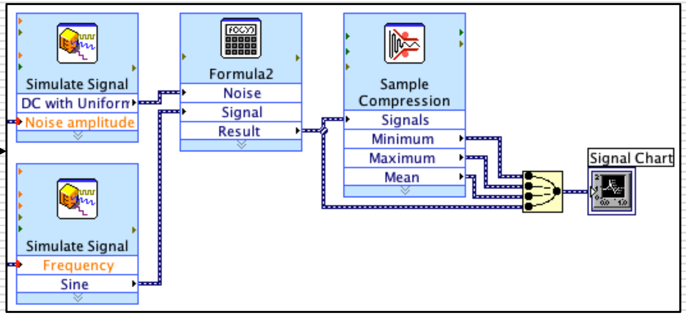
	A	B	C	D	E	F	G
1	Specification of analysis to be performed, aim is reference document, in computer readable format, tab spaced						
2	Text separate from numerical values						
3							
4							
5	System	Signal	Analysis	Nb.of pars	Par 1	Output (ref)	Output unit
6	PC	RPTE.UA83.RB.A78:I_MEAS	Average N	1	100	Iav1	[A]
7	CRYO	QSAA_8_PT350.POSST	Max last n min	1	15	Pmax1	[mbar]
8	QPS	DQAMCMB_B12R1:ST_PWR_PERM	Delay with	1	DQAMCMB_B12R1:ST_MAGNET_OK	t_diff1	[ms]
9	CRYO	XXX_TT821	t_max last n min	1	10	t_max1	[s]

Word file

HTS leads (600 A, 6000 A, 13000 A).

1. LHe level (cryo DFB signal)→given range.
2. Resistive part cooling: flow rate (% of valve, cryo DFB signal) and He gas temperature (cryo DFB signal)→given range.
3. Temperature at the top of HTS (cryo Current Lead signal)→given range.
4. Temperature of top part of the lead (cryo Current Lead signal)→given range.
5. Current (electrical signal).
6. Voltage drop across resistive part (electrical signal).
7. Voltage drop across HTS part (electrical signal).
8. Voltage drop of LTS circuit (electrical signal).

LabVIEW source



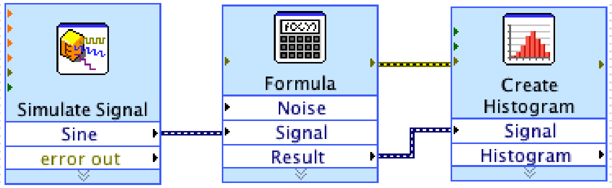
Program_description.doc

Text, XML or DB transfer

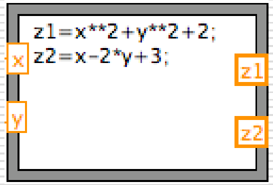
Different ways to implement mathematical analysis

There are at least 4 ways to implement mathematical analysis in LabVIEW

LabVIEW diagram



Formula node



MATLAB script

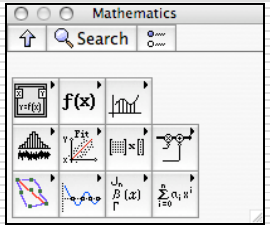
```
clear all

kr  = 1*1;
ki  = 1*1;
phi = 1*pi/4;

xmax = 15;
xmin = -4;
delx = 0.1;

x  = [   0:delx:xmax];
x2 = [xmin:delx:xmax];
```

C code in LabVIEW

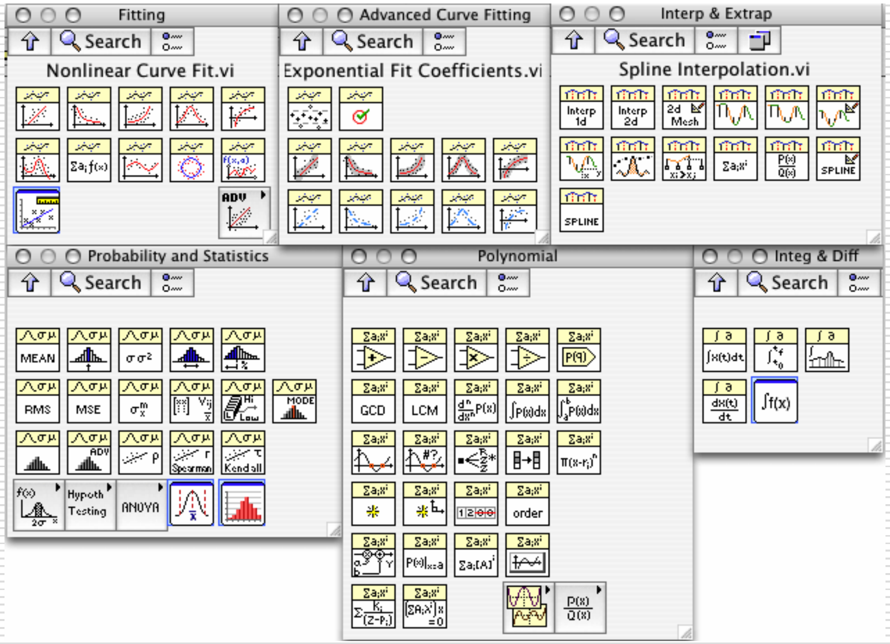
```
#include <gd.h>
#include <gdfontg.h>
#include <gdfontl.h>

static int red = 0;
static int green = 0;
static int blue = 0;

void setupcolor(char *str);

int main(int argc, char *argv[]) {
 FILE *pngout = {0};
 gdImagePtr img;
 int fgcol, bgcol;
 char *str = NULL;
```

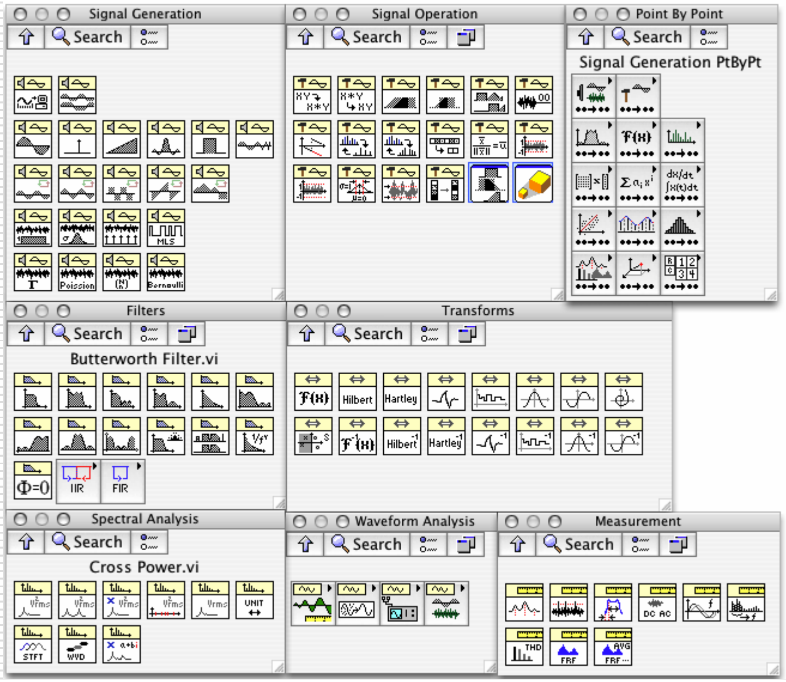
LabVIEW mathematical analysis libraries

Main palette



600 available functions





Does LabVIEW analysis scale?

- LabVIEW compiled code compares to C for memory use and speed
- However the Graphical User Interface (GUI) can slow down the execution, but sub program blocks don't need to show their GUI
- For tracing and debugging purposes all sub programs can show their GUI on user request
- LabVIEW code can run entirely without GUI using the technique of virtual display, for execution on a head-less linux server
- Tests should be done how many QPS or PIC modules we can run on one computer before a slowdown is noticed

Recap of «How do we tackle the extended requirements »

1. Three-step analysis gives best data reduction and processing for the problems to be solved
2. Software trigger module gives flexibility for automatic and manual triggering
3. Extension to beam related equipment has been shown
4. Linking documentation of requirements (xls, doc) to source code, to code description and to results using a reference system
5. Analysis implementation can integrate LabVIEW diagrams, formula nodes, MATLAB scripts and C code
6. A scaling test, running many analysis modules in parallel, needs to be done to determine what is the limit of one computer