BaBar Trigger Upgrade

Nikolai Sinev

U of Oregon

Talk at DOE review

01.29.2001

Plan

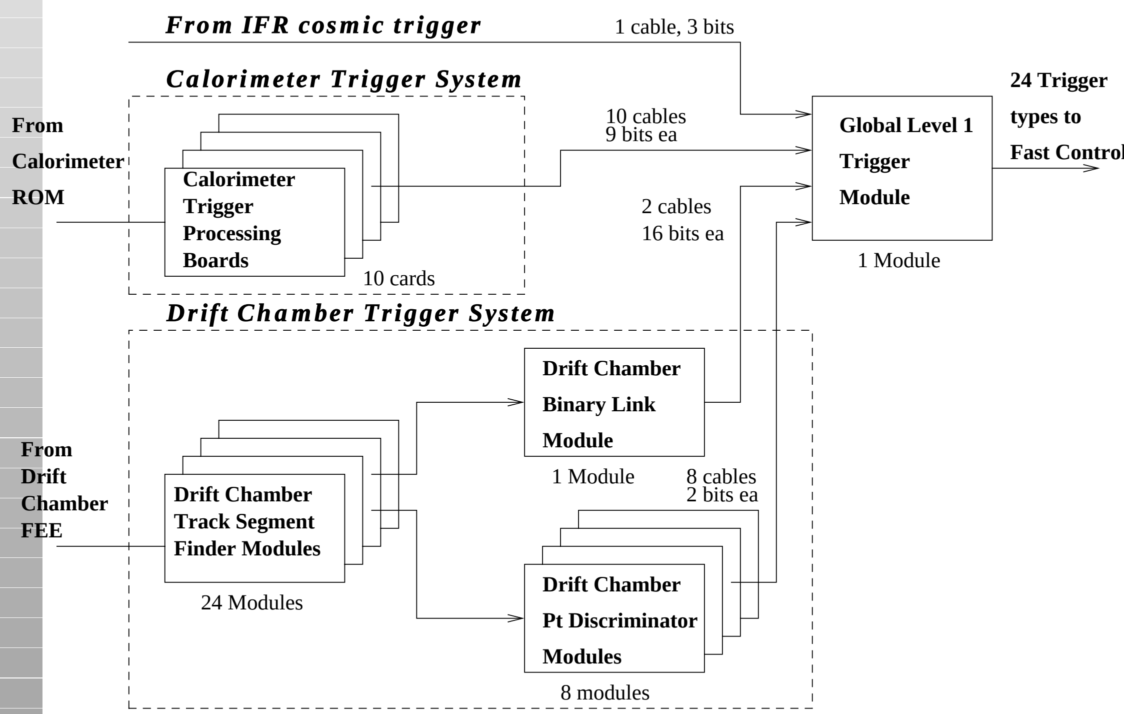
- BaBar trigger
  - requirements
  - implementation
    - overview
    - DCH trigger
- Need for upgrade
- DCH upgrade - Z cut
- Possible hardware option
- Simulation results
- Conclusion

BaBar trigger requirements

- High efficiency (~100%) for physics of interest
  - tracks with Pt as low as 120 MeV
  - E deposit in EMC as low as 100 MeV (min. ionizing muon)
- Level 1 rate not exceed 2 kHz
- Level 1 latency less than 12 μS

Trigger implementation

- **Two levels: hardware trigger (Level 1) and software trigger (Level 3)**
  - **we will discuss only Level 1**



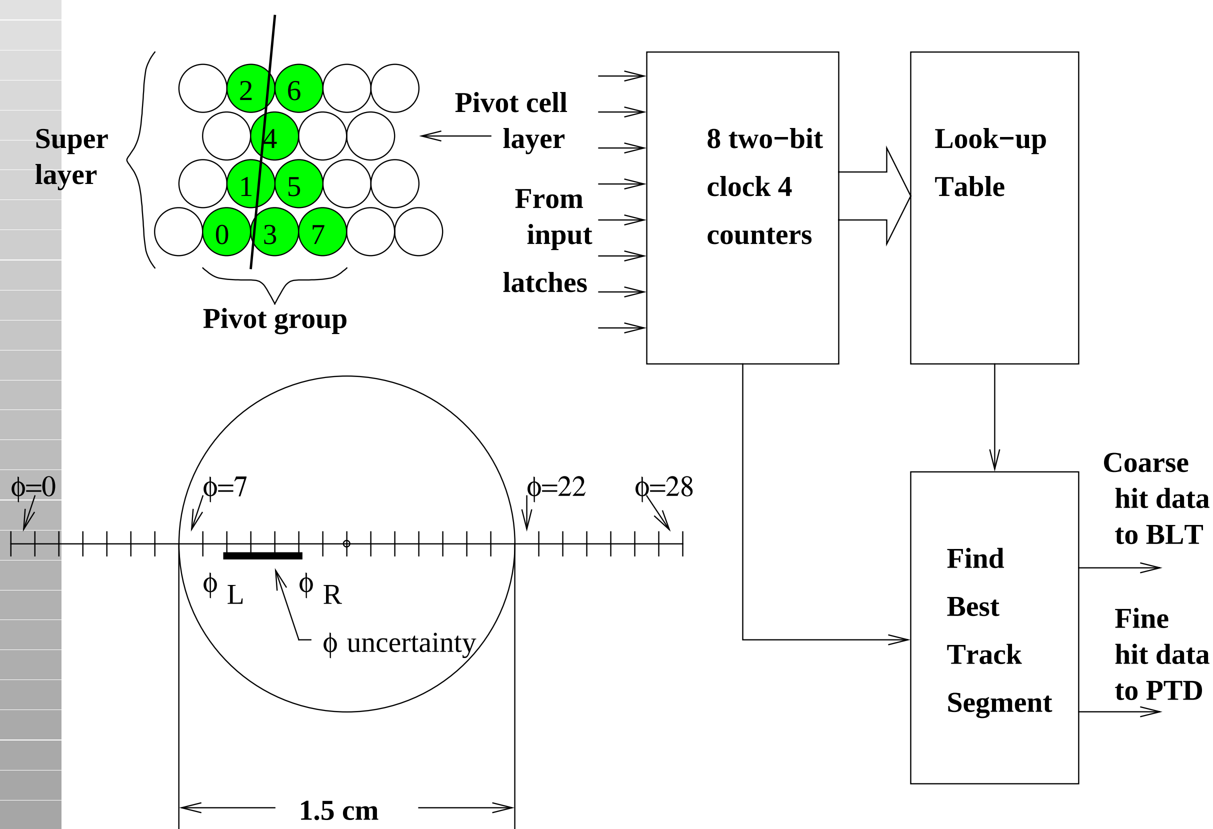
Principal Components of Level 1 Trigger System

DCH Trigger

- BaBar Drift Chamber
  - 40 cylindrical layers of signal wires
  - Grouped in 10 Super Layers
  - SL 1,4,7 and 10 - axial (wires parallel to Z axis
  - SL 2,5,8 stereo (U) 0.05 rad. to Z
  - SL 3,6,9 stereo (V) -0.05 rad. to Z
  - Length 286 cm (-101 to +175 in Z)
  - SL1 inner radius 23.6 cm
  - SL10 outer radius 80.9 cm
  - Signal wires spacing ~1.5 cm

DCH Trigger

- **Track Segment Finder (TSF)**



Global Level 1 Trigger

- **Trigger objects - primitives**
  - **DCT objects**
    - **B - short tracks (Pt>120 MeV)**
    - **A - long tracks (Pt>150 MeV)**
    - **A' - High Pt trks (Pt>800 MeV)**
  - **EMC objects**
    - **M - min.ionizing (E>100 MeV)**
    - **G - intermediate (E>300 MeV)**
    - **E - high energy (E>700Mev)**
    - **X - MIP in forward EC**
    - **Y - electron in backward barrel**
  - **IFT**
    - **U - one of IFR trigger object**

Global Level 1 Trigger

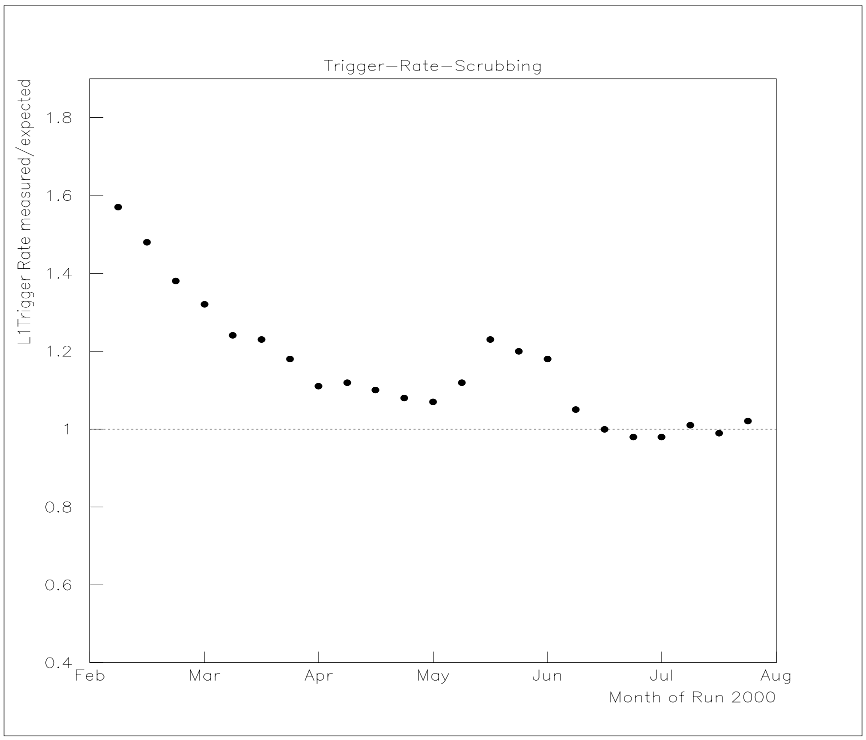
- Trigger objects
  - Back-to-back
    - B*,A*
    - M*,G*
    - E- M
  - DCT+EMT match
    - BM
    - AM
    - A’M
    - BMX
  - Compound objects
    - A+ = 1A&1A’
    - D2 = 2B&1A
    - D2* = B*&1A
    - D2*+ = B*&1A+
    - Z* - any two back-to-back primitive objects

Need for upgrade

Rate extrapolation (by Sybille Petrak)

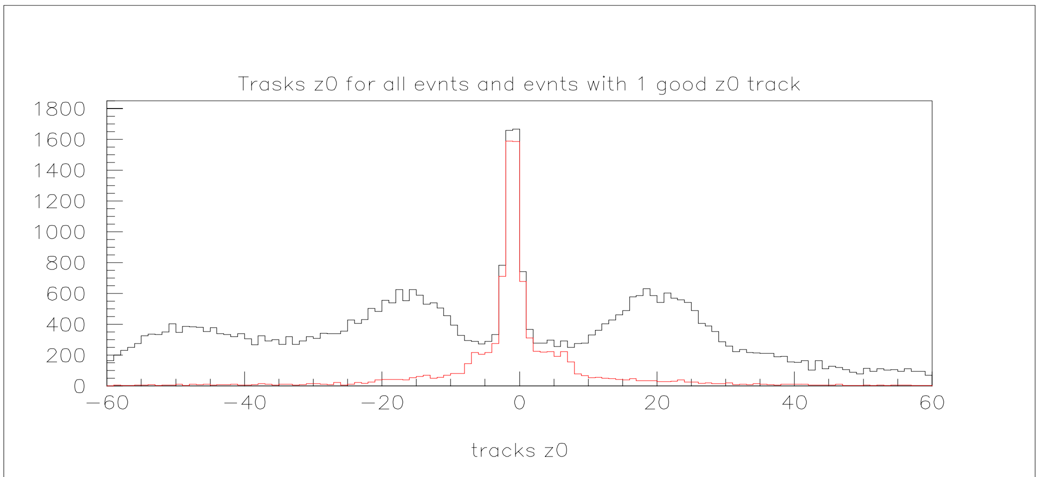
YEAR		2000	2001	2002	2003	2004
PEP II	HER(A)	0.8	1.0	1.1	1.2	1.3
	LER(A)	1.1	2.0	2.6	3.1	3.6
	Lumi (10 33)	2.5	5.7	7.7	10.5	13.3
L1 Rates	HER (Hz)	290	360	380	430	470
	LER (Hz)	140	260	340	400	470
	Lumi (Hz)	180	400	540	740	930
	Total (kHz)	0.7	1.1	1.4	1.7	2.0
Ratios	HER/ LER	2.1	1.4	1.1	1.1	1.0
	Lumi/ Rest	0.4	0.6	0.8	0.9	1.0

Effect of scrubbing

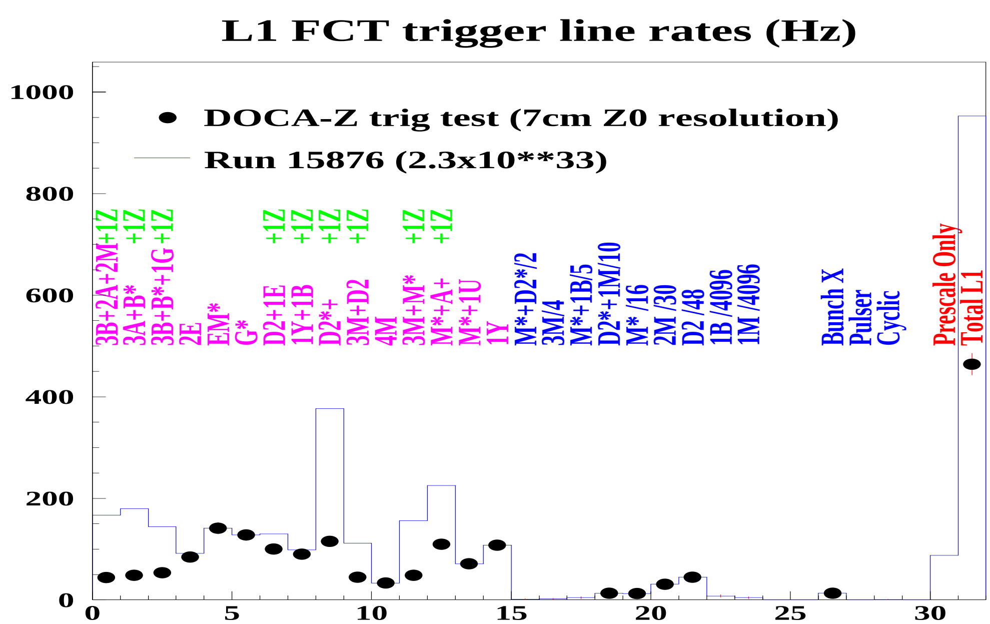


- **As you can see from this plot, background conditions at the beginning of the PEPII run are much worse than after few months of running. And this leads to much higher L1 trigger rates.**

Effect of Z-trigger



Background and good event tracks



Simulated effect of Z0 cut on trigger rates

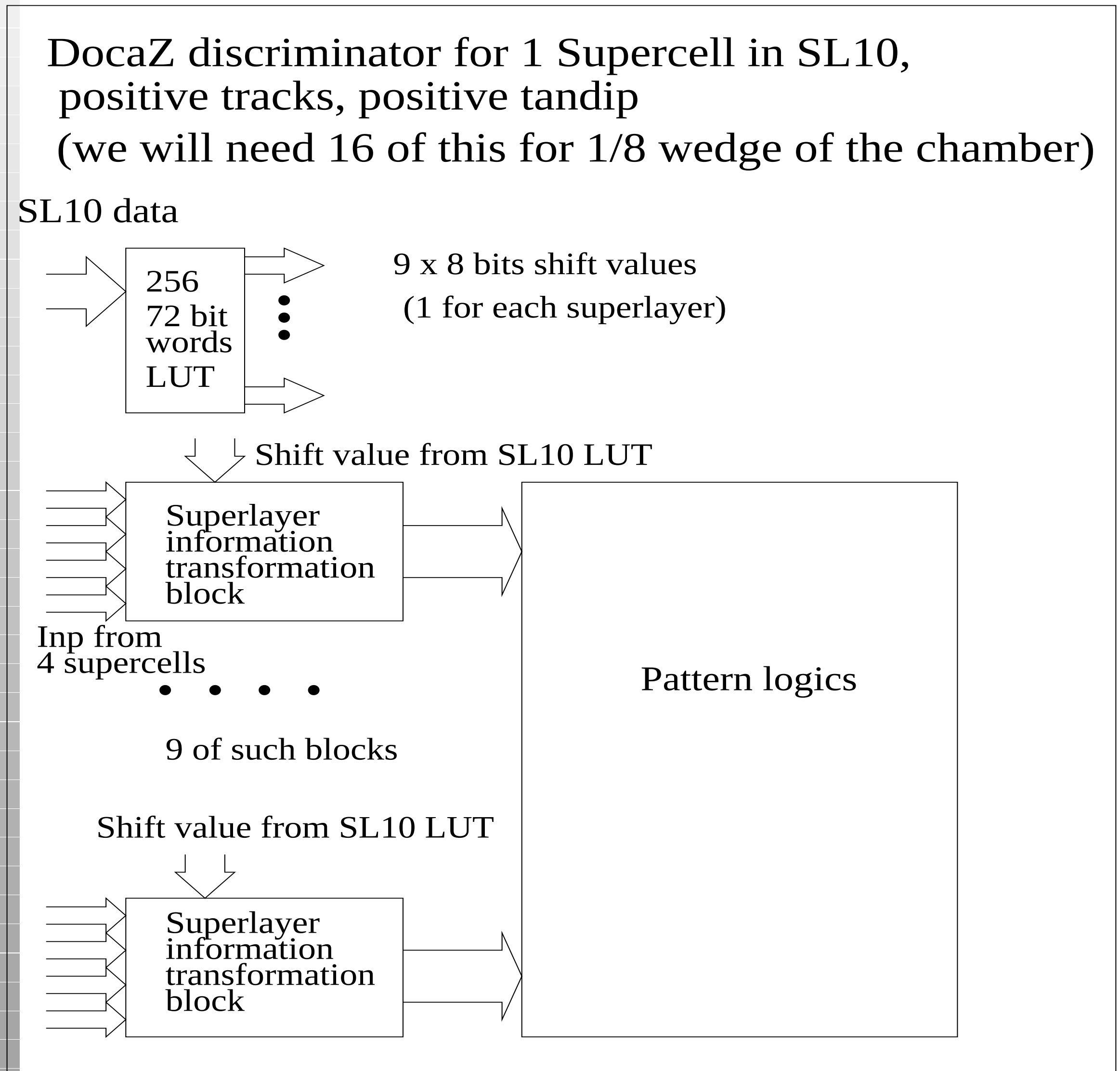
Benefit of Z-trigger

YEAR		2000	2001	2002	2003	2004
PEP II	HER(A)	0.8	1.0	1.1	1.2	1.3
	LER(A)	1.1	2.0	2.6	3.1	3.6
	Lumi (10 33)	2.5	5.7	7.7	10.5	13.3
L1 Rates	HER (Hz)	290	360	380	430	470
	LER (Hz)	140	260	340	400	470
	Lumi (Hz)	180	400	540	740	930
	Total(kHz)	**0.7**	**1.1**	**1.4**	**1.7**	**2.0**
	Begin run (kHz)	**1.1**	**1.6**	**2.0**	**2.4**	**2.8**
DOCAZ	Total(kHz)	**0.4**	**0.67**	**0.9**	**1.1**	**1.34**
	Begin run (kHz)	**0.54**	**0.82**	**1.1**	**1.3**	**1.6**

Possible implementation

- **If track originates in the IP, and phi0 dependence of TSF data is removed by subtracting phi value of TSF segment in SL10 (or SL7) from phi values of other segments, then pair of axial SL defines Pt, and, thus, phi of 2 remaining axial segments. One pair of axial-stereo segments together with Pt defines dip angle. So, 3 out of 10 segments are enough to define track. If the rest confirms found track parameters, good track is found**
- **Set of logical elements (OR and AND gates) can be used to implement such method.**

Pattern recognition method.



General diagram of 1 of 16 chips on one of 8 ZD boards

Pattern recognition method.

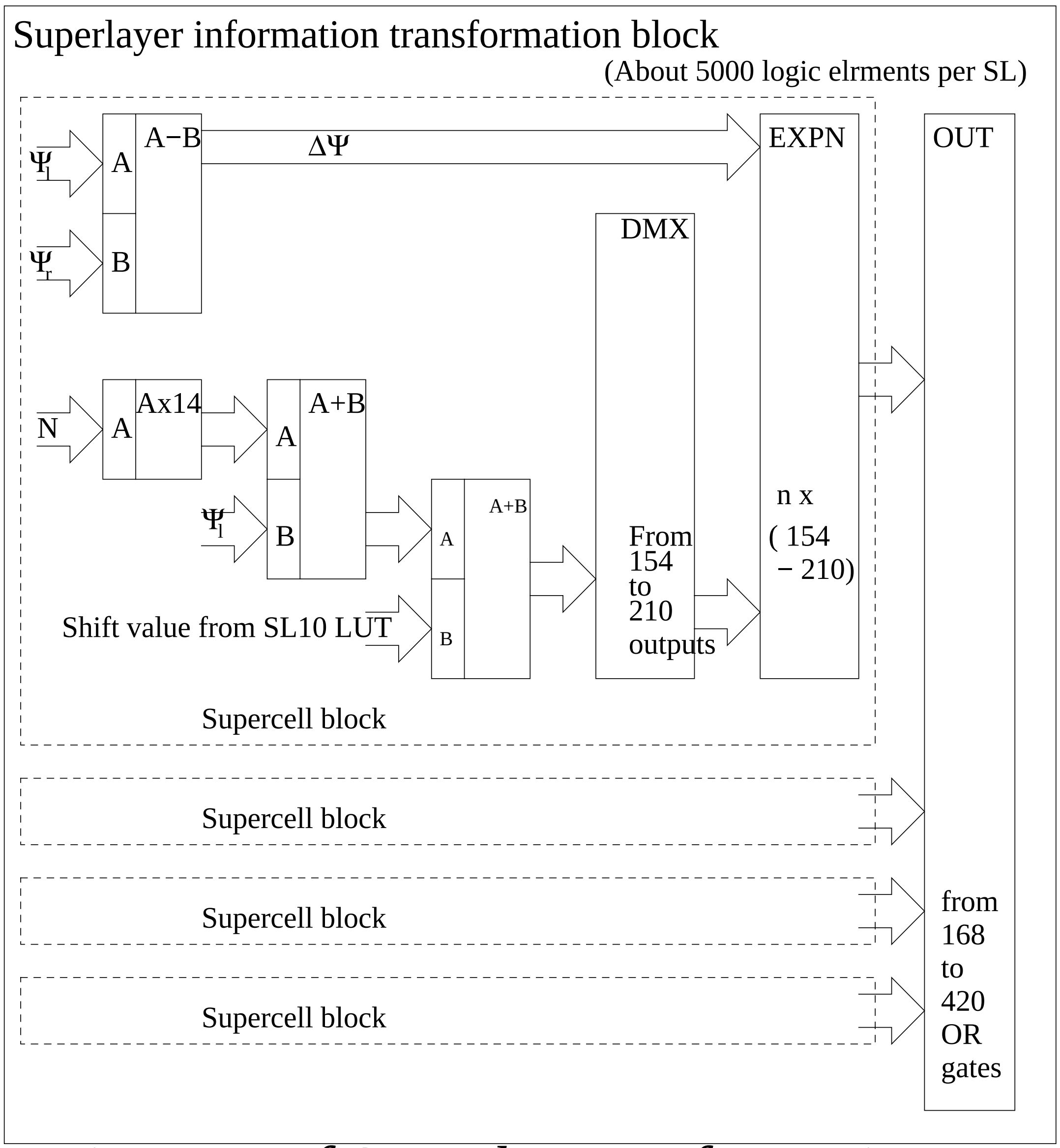


Diagram of Superlayer Information Transformation block

Pattern recognition method .

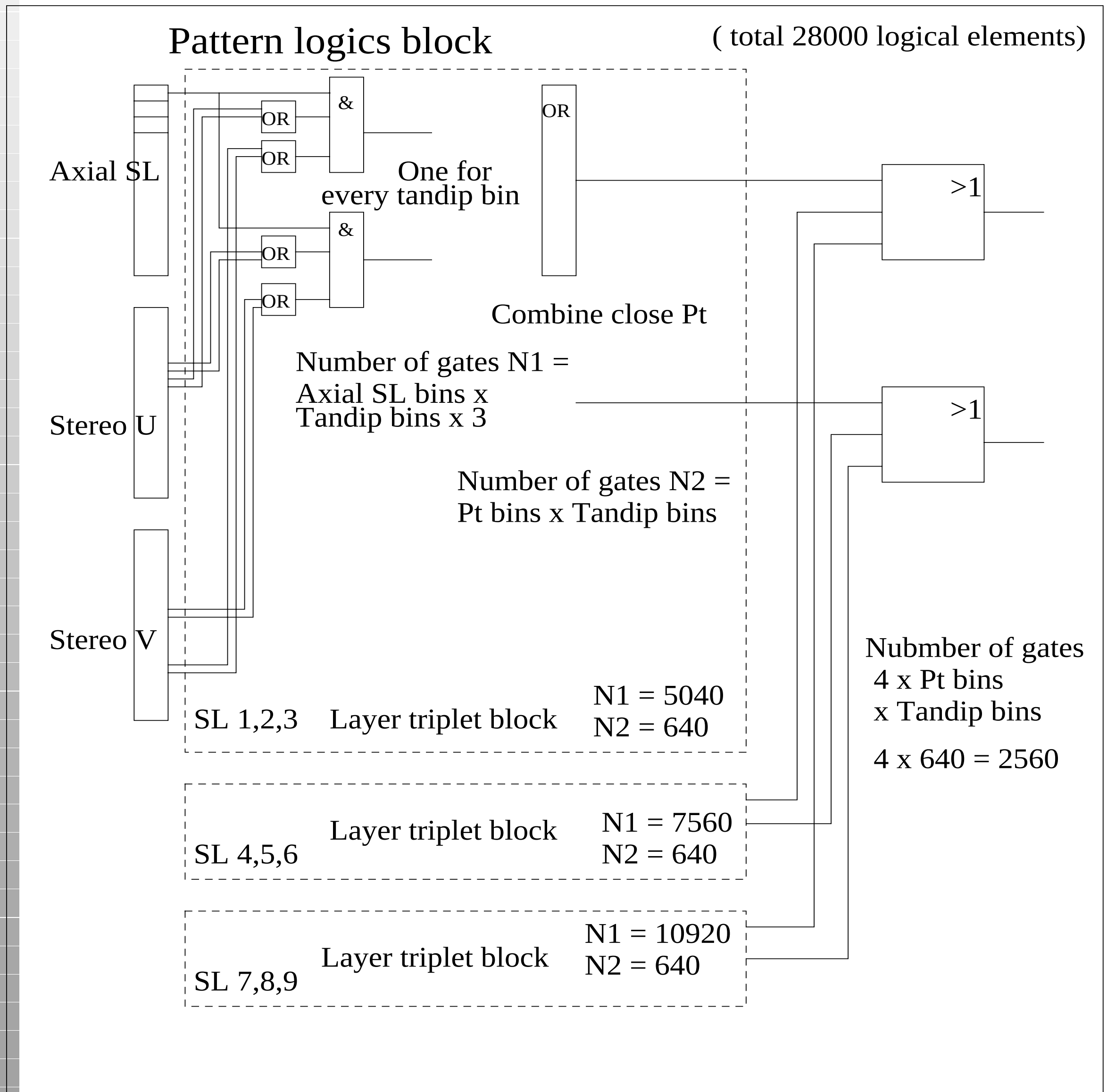
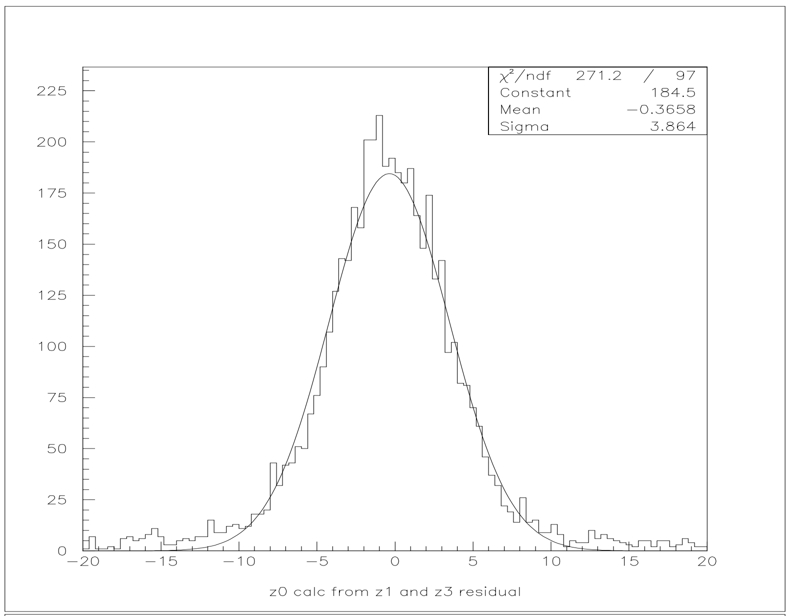
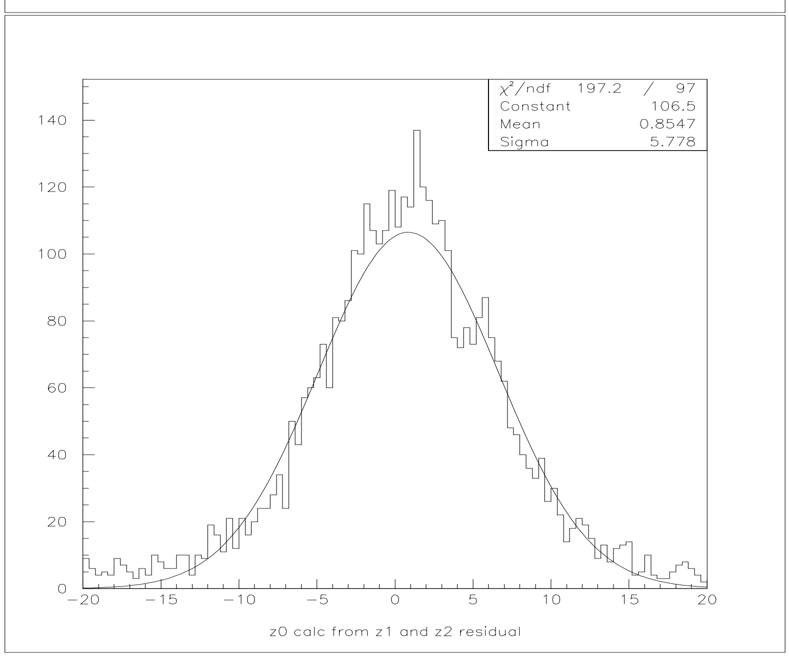


Diagram of Pattern Recognition block

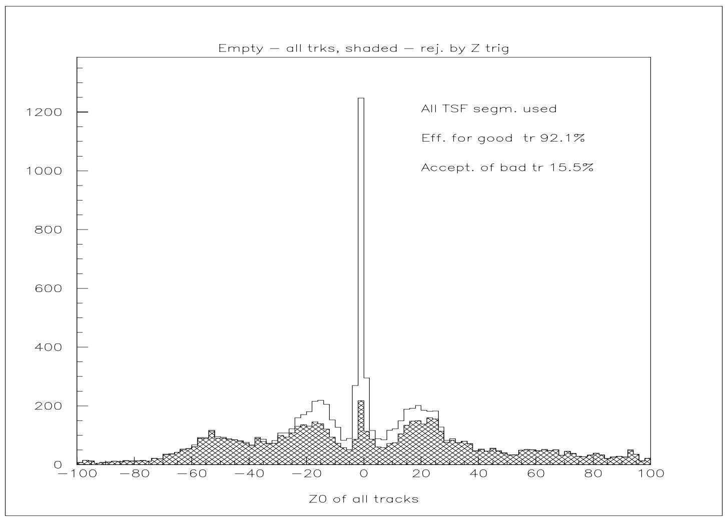
Simulation results

- **Is there enough resolution in TSF data?**

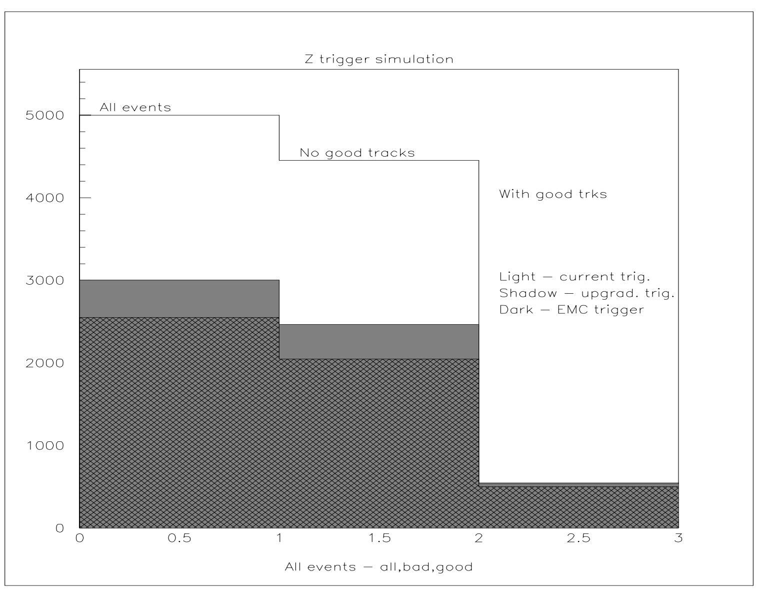




Simulation results



Bad track rejection



Effect on trigger rate

Problems and plans

- To understand proposed trigger efficiency for physics new simulation software urgently needed
- Existing TSF modules are not suitable for proposed upgrade. Redesign is needed.
- Proposed hardware implementation of Z discriminators requires very large number of logical elements. Optimization is needed. New ideas would be useful.
- Conceptual design deadline is approaching fast - in March we need it if we want to be ready for planned BaBar upgrade brake.

Conclusion

- **Proposed upgrade of DCT can help in keeping level 1 rate within set limit (2 kHz)**
- **Hardware implementation scenario is not finalized yet. But it looks feasible.**
- **Much more work is needed**

.