# Detector Performances on Warm / Cold Machine

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with

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# Introduction

- Some of the ITRP members want information on the detector issues at Warm/Cold Machine
- Someone says “The information might not be so important for the technology choice”, but he can say so because he knows that.
- It is our duty to give them the information, if they require it. Wise persons have sense of responsibility, and will not make decision without knowledge.
- We discussed on the cases of Vertex Detector, Central Tracker, and Calorimeter. Our conclusions was privately sent to a ITRP member in response to his request. It was also sent to SLAC via Toge-san.

# Vertex Detector

- Design Criteria:

$$\sigma_b = 5 \text{ Å } 10/(p\beta\sin^{3/2}\theta) \ \mu m$$

- Requirement for the detector
  - $\sigma_x < 3\mu m$
  - $t < 0.1\%\ X_0$ (Si:100μm)
  - Radiation tolerance for R=10~15mm
  - Readout Speed: 6.7ms for GLC / 50μs for TESLA
- Possible Technology for Cold Machine:
  - Column Parallel Readout
  - Digital CMOS
  - Analog buffered CMOS

# Vertex Detector (Cont.)

- Other Problem in Cold Machine
  - RF pickup noise
    - Happened at SLD
    - 100ns(?) loss to wait for the damp for every 330ns bunch interval
  - Signal diffusion in the epitaxial layer of CCD/CMOS
    - Key of excellent spatial resolution
    - Takes ~100ns

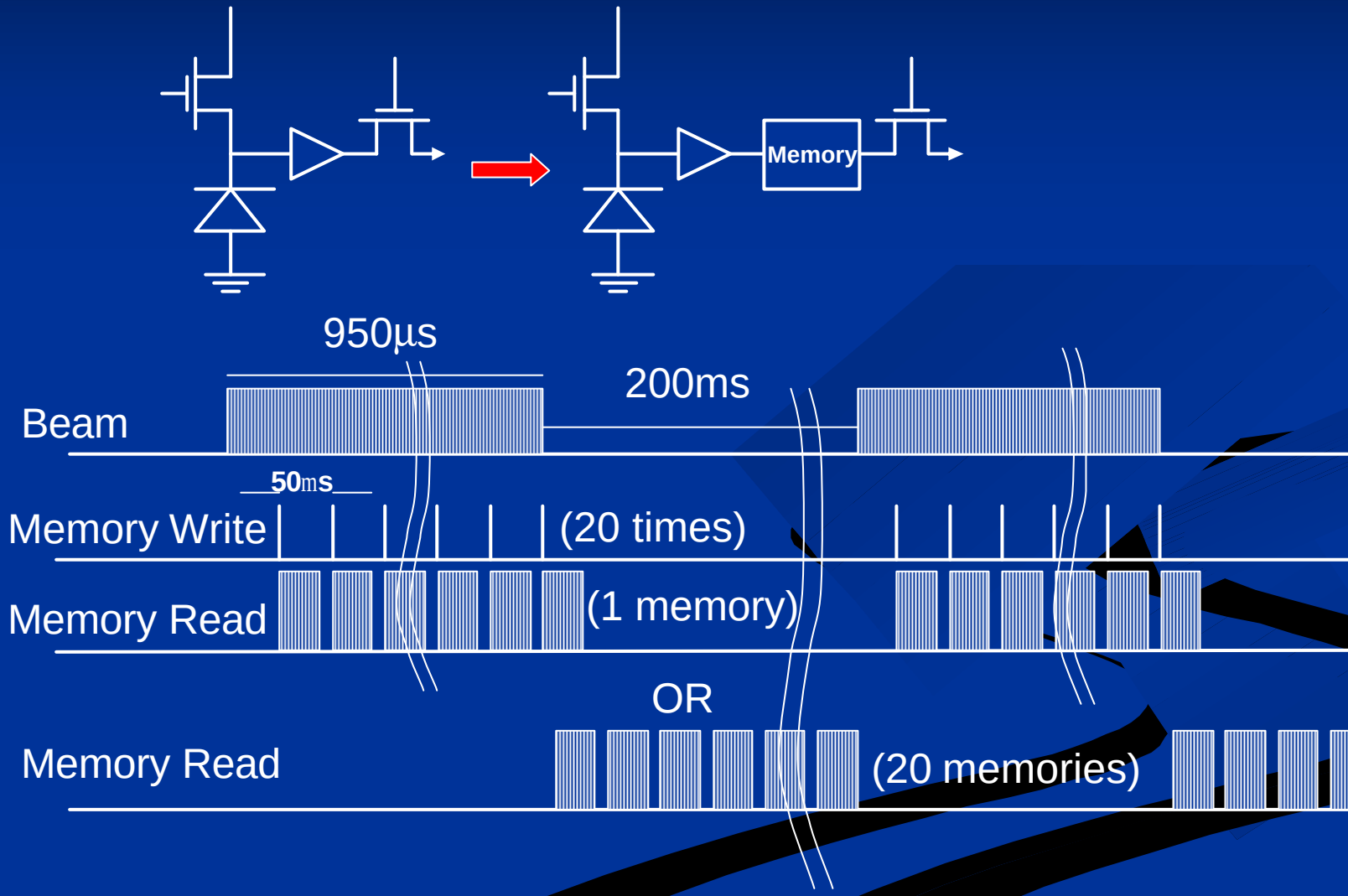
➔ Still more high speed readout necessary

# Vertex Detector (Cont.)

- Score:
  - 5: Demonstrated, 4: Will be demonstrated in 2~3 years, 3: Need large R&D effort, 2: Quite difficult, 1: Almost hopeless

| | σx (<3μm) | Thickness (<100μm) | Speed (Warm) (6ms) | Speed (Cold) (50μs) |
|---|---|---|---|---|
| CCD | 5 | 4 | 4 | 1 |
| CP-CCD | 5 | 4 | 4 | 3 |
| CP-CMOS | 5 | 4 | 4 | 3 |
| Digital CMOS | 5 | 4 | 4 | 3 |
| Analog-buffered CMOS | 4 | 4 | 4 | 3 |
| Hybrid Active Pixel | 3 | 2 | 5 | 5 |

# Analog-buffered CMOS



# Central Tracker

| | Time stamping capability | Bunch ID | | Space charge effect | |
|---|---|---|---|---|---|
| | | Warm | Cold | Warm | Cold |
| TPC | 2~3 ns (1) | ○(1) / ◎(2) | ◎ | ○ (4) | ○ (4) |
| CDC | 2 ns | ○ / ◎(3) | ◎ | ○ | × |

(1) With z-measurement external detector
(2) With z- and t-measurement external detector
(3) With t-measurement external detector
(4) Need gating grid

# Central Tracker (Cont.)

- External z-measurement (Si IT) is mandatory for TPC at Warm machine
- Effect of t-measurement device (Sci-Fi with Si-PM) needs simulation study

# Calorimeter

- Bunch ID in every fine-segmented cell is preferable --- Machine / Det-option dependent
  - Cold Machine: No problem
  - Warm Machine:
    - W-Si: Poor bunch ID capability. Combination with high speed device
    - Pb-Sci: Analog signal ➔ ADC and TAC / ADC

      Two successive hits in 100ns on the same cell cannot be separated
- Separation of event overlap is not studied well

  ➔ Simulation effort is necessary

# Conclusion

( Not sent to the ITRP member )

| | Warm | Cold |
|---|---|---|
| Vertex Detector | 10 | 7 |
| Central Tracker | 9 | 10 |
| Calorimeter | 9 | 10 |
| Others | ? | ? |
| Total | ? | ? |

More study (Simulation + Det. R&D) is necessary