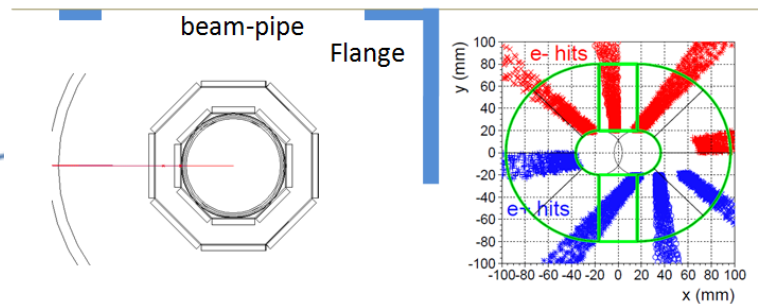
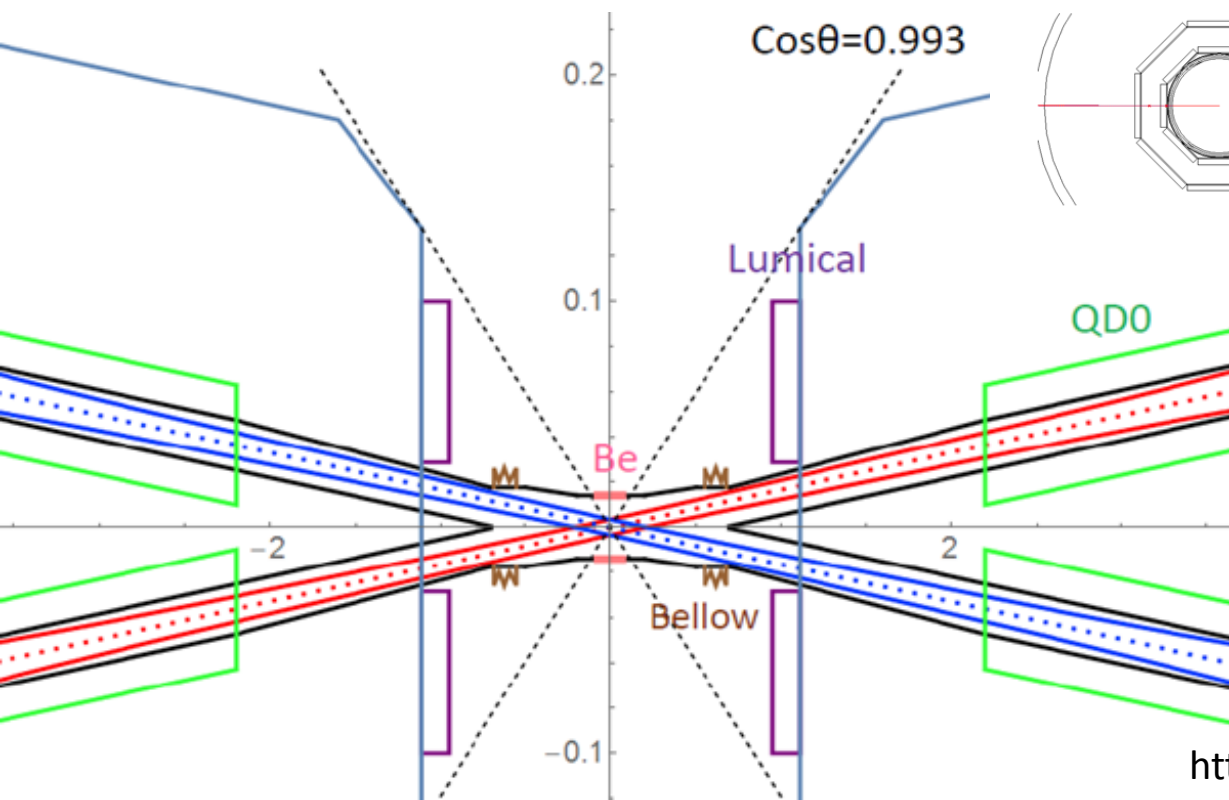
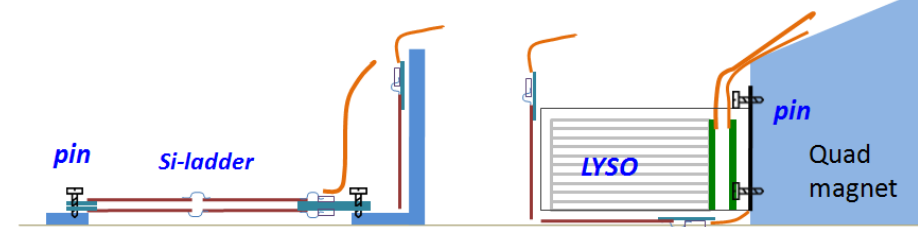


# TDAQ for LumiCal

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IPAS, 2020.10.28



# LumiCal physics

- **Bhabha  $e^+e^- \rightarrow e^+e^- (\gamma)$**

elastics  $e^+e^-$  scattering, luminosity measurement

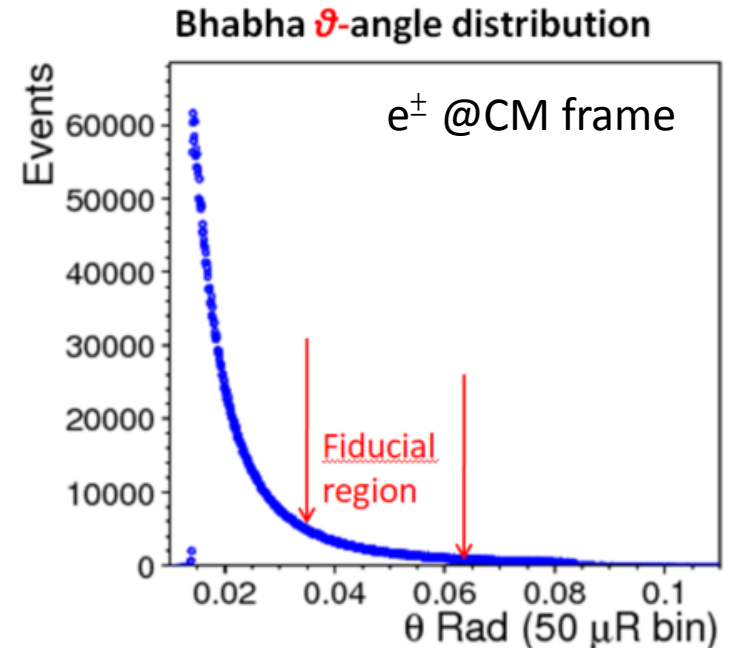
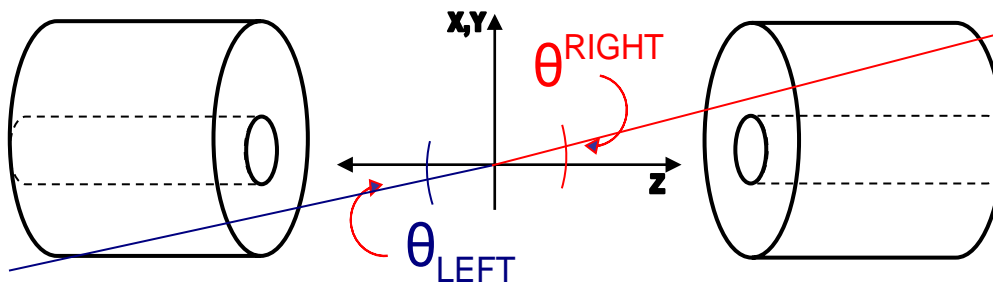
1.  $E(e^\pm) = E_{\text{beam}}$
2.  $e^+, e^-$  Back-to-Back
3. radiative Bhabha, correlated with  $e^+e^-$ ,  $\Sigma p=0$

- **Two-photon interaction  $e^+e^- \rightarrow e^+e^- \chi$ ,**

1. single tagged, one  $e^\pm$  enter LumiCal
2.  $\gamma\gamma$  final state enter central det.

- **Forward physics**

NLO SM, energetic gamma, searches



# LumiCal event rate

- **Event rate, Bhabha dominant**, @  $L = 10^{34} / \text{cm}^2 \text{ s}$

$$260 \text{ nb} \times 10^{34} / \text{cm}^2 \text{ s} = \mathbf{2.6 \text{ kHz}}$$

- **Data volume per side**

$$80\text{k channels, 8-bit words} = 2.6\text{k} \times 80 \text{ kB/sec} = \mathbf{210 \text{ MB/sec}}$$

**Scale factor x10** →

$$\text{event rate} = \mathbf{26 \text{ kHz}}$$

$$\text{data volume each Z sides} = \mathbf{2.1 \text{ GB/sec}}$$

**Zero suppression x 0.01**

$$\text{Data flow} = \mathbf{21 \text{ MB/sec}}$$

**Bhabha Xsection, Lab frame,  $r = 30 \text{ mRad}$**

**Full phi coverage**

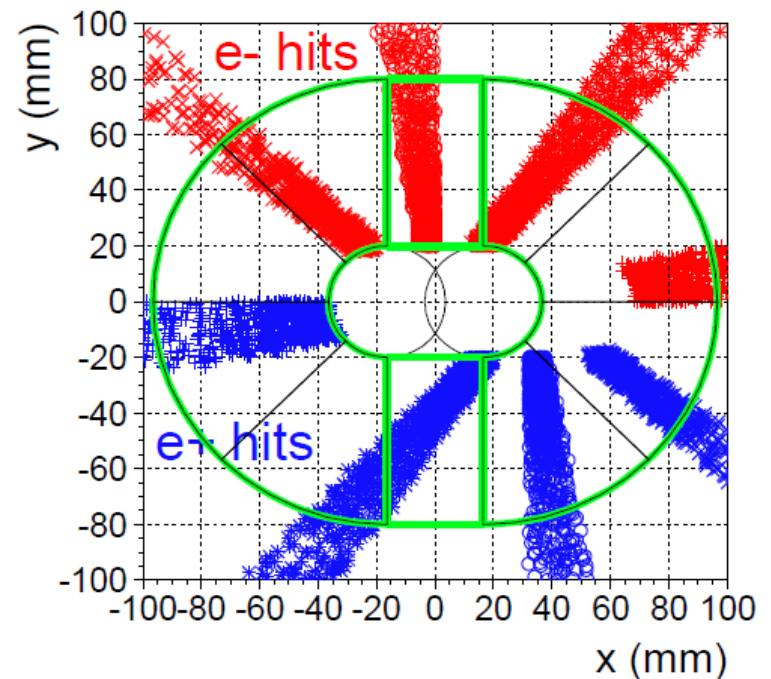
detect **ONE** electron

detect **both** electrons

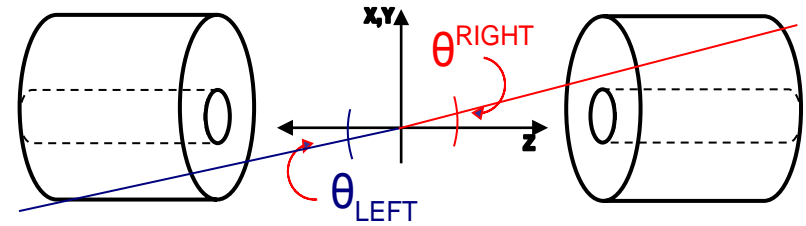
**262.0 nb**

**74.6 nb**

**$e^\pm$  hit distribution @  $Z = \pm 1 \text{ m}$**



# LumiCal triggers



- **Bhabha Lumi Trigger**

**Level 1:** (?? 100 kHz @  $L=10^{34}$ )

1. Calo  $E_{cluster} > 1/2 E_{beam}$
2. Si-strip sum-Q

**Level 2:** (?? 10 kHz @  $L=10^{34}$ )

1. **Phi back-to-back coincidence of Left/Right Calo-E**  
→ Bhabha both  $e^+e^-$  detected
2. **Phi same-side coincidence of Calo-E, Si-strip**  
→ Bhabha one  $e^\pm$  detected

- **Physics trigger:** (?? <1 kHz @  $L=10^{34}$ )

1. **Two-photon, Radiative Z**

Coincidence w. central tracker/E cal

**Single tagged two-photon, one electron trigger**

2. **Searches**

Calo-E, coincidence w. MissET

**Single-photon** e.g.  $ee \rightarrow \nu\nu\gamma$

# LumiCal data stream **80k chs/Z-side**

Coverage 30 ~ 100 mRad

## 8-fold Silicon-Strip surrounding beam-pipe $Z = 340 - 700$ mm:

- 28 chips on z-strip, 100  $\mu$ m pitch,  $128 \times 28 \times 0.1 = 360$  mm
- 2 chips on  $\phi$ -strips
- Total  $8 \times 30 \times 128 = \mathbf{31k}$  channels

## 8-fold Silicon-Strip disks on flange $r=20 - 70$ mm :

- 8 chips on r-strip, 50  $\mu$ m pitch,  $128 \times 8 \times 0.05 = 51$  mm
- 2 chips on  $\phi$ -strips
- Total  $8 \times 10 \times 128 = \mathbf{10k}$  channels

## Calo inner Silicon-Strip surrounding beam-pipe $Z = 1100 - 1300$ mm:

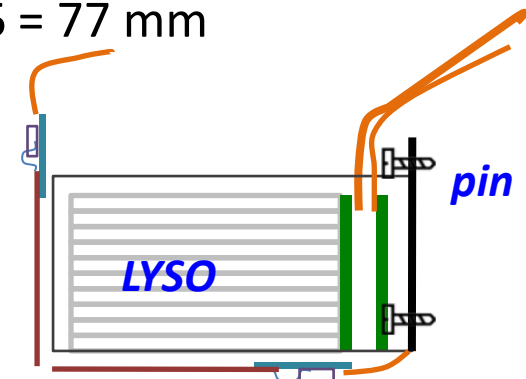
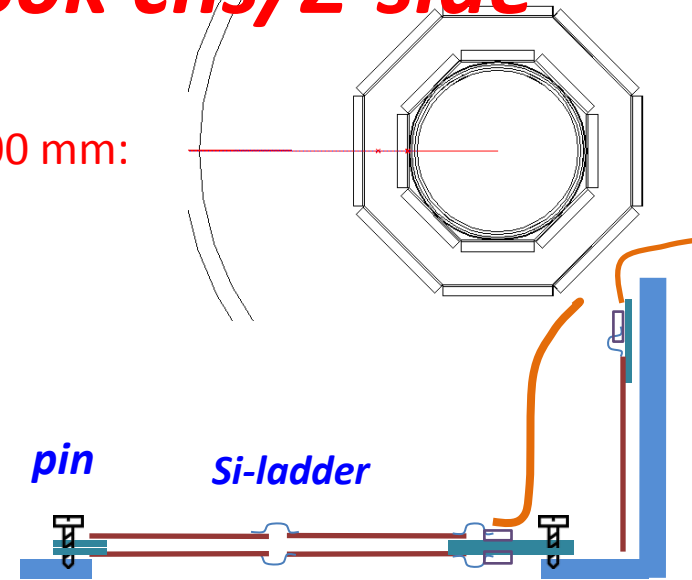
- 8 fold round+2-rectangulars: 16 chips on z-strips, 100  $\mu$ m pitch  
 $128 \times 16 \times 0.1 = 200$  mm
- Total  $10 \times 16 \times 128 = \mathbf{20k}$  channels

## Silicon-Strip disk on Calo surface $r=20 - 100$ mm @ $z=1100$ :

- 8-fold slice: 12 chips on r-strip, 50  $\mu$ m pitch,  $128 \times 12 \times 0.05 = 77$  mm
- 2 rectangular: 12 chip on r-strip,
- 2 chips on  $\phi$ -strips each slice/rectagular
- Total  $10 \times 14 \times 128 = \mathbf{18k}$  channels

## Calo SiPM, $2 \times 2 \text{ mm}^2$ over $x=\pm 100 \text{ mm}, y=\pm 80 \text{ mm}$

- Total  $100 \times 80 = \mathbf{8k}$  channels



# LumiCal TDAQ summary

- **Bhabha event rate : 2.6 kHz @ $L=10^{34}/\text{cm}^2\text{s}$**   
Trigger: back-to-back Calo-E || , single sided Calo-E || Si-Strip
- **Physics event, two-photon, NLO SM, searches**  
event rate  $\sim 1\%$  to Bhabha; trigger : Calo-E || tracker/Ecal
- **LumiCal data volume: 80k Ch., 2.6 kHz x 80 kB raw data**  
*Trigger scale x10*  
*Occupancy, Zero suppression x0.01*  
➔ **data flow = 21 MB/sec**