



# **LOI Planning**

## **The Very Forward Region**

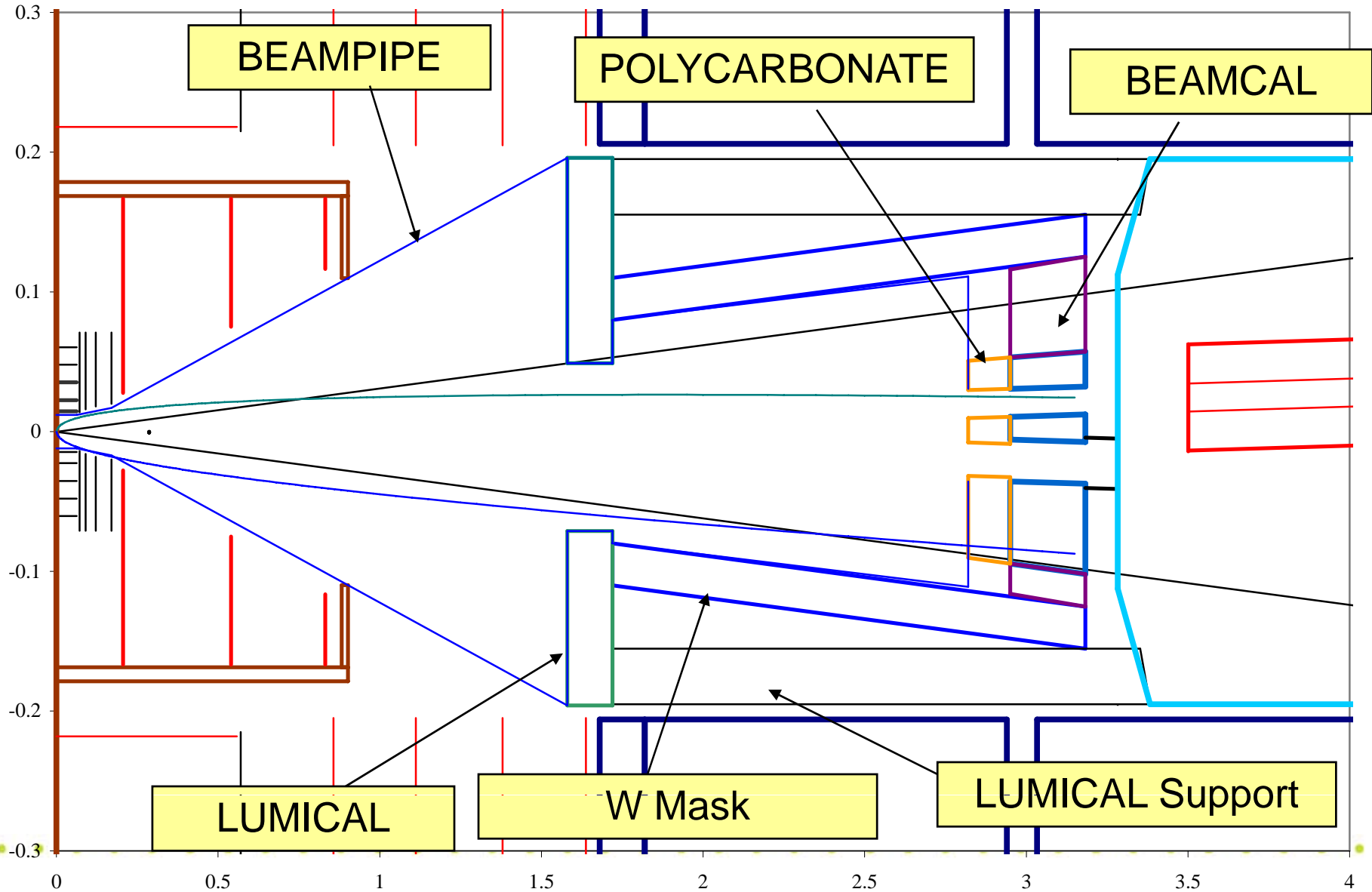
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SiD Collaboration Meeting,  
Boulder, CO

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# EXCEL pix of September 2008 Design





# LOI Outline of SiD FCAL Subsystem

## 1.1 System Definition

- **1.3.1 Lumical**
- **1.3.2 Beamcal**
- **1.3.3 Tungsten Mask**
- **1.3.4 Low Z Mask**
- **1.3.5 Cantilevered support**
- **1.3.6 Beampipe (with VXD group; description assumed to be elsewhere-Global issue?)**
- **NOT**
  - GammaCal (Posipol, Espec group)
  - Vacuum (if any) (MDI)
  - Not interface to QD0 nor fast feedback system

## 1.2 Contact authors

- **TWM & TVM**



# 1.3 Geometry

## 1.3.1 Lumical

- **Ecal structure: 1 + 20-2.5mm + 10-5mm**
- **OR=19.5cm on magnet axis**
- **IR = 6.0cm centered at 1.6m x 0.007 = 1.1cm below axis**
- **Z\_start=ECAL\_start-10cm=1.58m**

## 1.3.2 Beamcal

- **Z\_start=2.95m for historical reasons as all background calculations for pairs depend on this**
  - Consistent with  $L^*=3.5\text{m}$  and 10cm behind beamcal for flanges, bpm to QD0 cryostat
- **50 layers of 2.5mm W + tbd "Si" readout**
- **1.5cm radius exit hole, 1.0cm entrance hole at  $\pm 3\text{m} \times 0.007$**
- **OR= $\sim 12.5\text{cm}$  centered on detector axis, dependent on W mask and support structure details**

## 1.3.3 W Mask

- **3cm tungsten, conic at 31mrad, offset in radius from 6cm Lumical by 2cm = 8cm at Lumical back end**

## 1.3.4 Low Z mask

- **13cm Polycarbonate with 25cm OD and same apertures as Beamcal**



## 1.4 Function

### 1.4.1 Lumical

- **Luminosity**
- **Luminosity Spectrum**
- **Hermiticity**
- **Two Photon Veto**

### 1.4.2 Beamcal

- **Beam Parameters and Luminosity**
- **Two photon Veto**

### 1.4.3 Tungsten Mask

- **Protect TRK, HCAL from pair photon albedo**

### 1.4.4 Low Z Mask

- **Protect VXD, TRK, HCAL from pair charged albedo**

### 1.4.5 Cantilevered Support Tube

- **Stiff, accurate, vibration free support for FCAL, masks, beampipe and VXD**



## 1.5.1 Luminical Requirements & Specifications

- 1E-3 resolution on luminosity measurement
- MIP sensitivity:  $S/N > 10$
- Hardware
  - Radial segmentation
  - Angular resolution
  - Dynamic range
  - B/C time resolution or adequate buffer space
  - Alignment
  - Petal-to-Petal dead space
  - Support
  - Electronics cooling
- Physics Benchmarks
  - Bhabha scattering



## 1.5.2 Beamcal Requirements & Specifications

### Hardware

- Radial segmentation
- Angular resolution
- Dynamic range
- B/C time resolution
- Radiation Hardness
- Alignment
- Petal-to-Petal dead space
- Support
- Electronics cooling

### Physics Benchmarks

- E+e- pairs via QED processes
- Stau production
- Efficiency of two photon veto



## 2.0 Description of FCAL Subsystem

### 2.1 Concept

- Redundant, described in 1.3, 1.5

### 2.2 Baseline Design

- Redundant, described in 1.3, 1.5

### 2.3 Expected Performance

- Redundant, described in 2.5





## 2.4 FCAL System Illustrations

### Mechanics

- **Plan view such as slide 2, this ppt**



## 2.4.1 Lumical Performance & Specification Illustrations

- Energy resolution (TVM, slide 14)
- Luminosity resolution
  - **radial segmentation**
  - **Phi segmentation**
  - **Longitudinal segmentation & depth**
- Hermiticity (TVM, slide 6)
  - **Longitudinal position of Lumical**
- Mechanics
  - **Petal layout from 6" wafers**



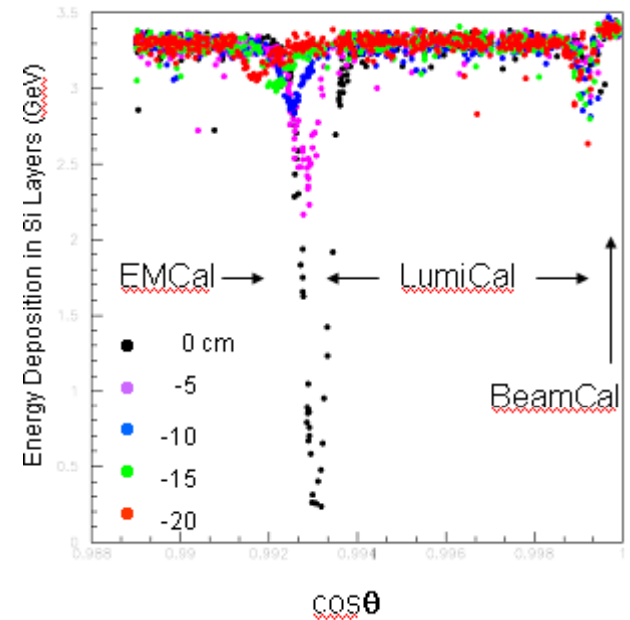
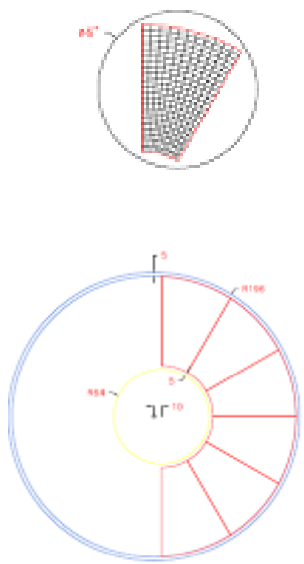
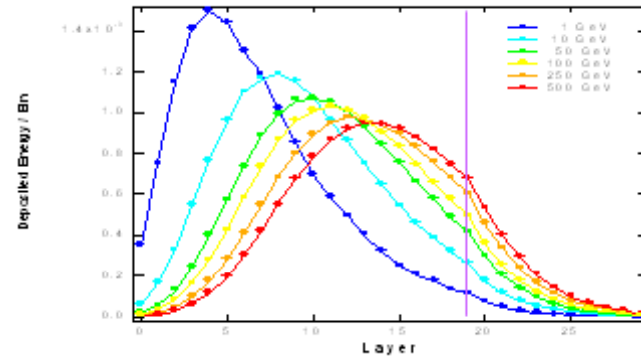
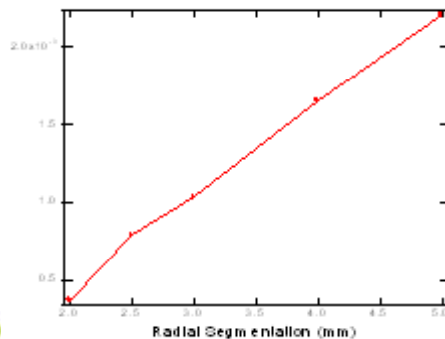
# Suggested LumiCal Tables & Figures

Radial segmentation  $N_\phi = 32$

$\Delta r$ (mm)	$\Delta\theta$ (mrad)	$\sigma(\theta)$ (mrad)	$\Delta L/L$
2.0	0.008	0.042	$3.3 \times 10^{-4}$
2.5	0.017	0.046	$7.9 \times 10^{-4}$
3.0	0.023	0.050	$1.0 \times 10^{-3}$
4.0	0.036	0.058	$1.7 \times 10^{-3}$
5.0	0.049	0.069	$2.2 \times 10^{-3}$

$\phi$  segmentation  $\Delta r = 2.5$  mm

$N_\phi$	$\Delta\theta$ (mrad)	$\sigma(\theta)$ (mrad)	$\Delta L/L$
16	0.017	0.046	$7.7 \times 10^{-4}$
32	0.017	0.046	$7.9 \times 10^{-4}$
48	0.017	0.045	$7.6 \times 10^{-4}$
64	0.014	0.045	$6.6 \times 10^{-4}$





## 2.4.2 Beamcal Performance & Specification Illustrations

- Energy resolution &/or electron identification efficiency as a function energy, radial distance from extraction line axis and phi for 2-photon events
- Stau pt distribution for signal/background w & w/o 2-photon veto
- Baseline:
  - **Lumi r-phi segmentation,**
  - **non-projective geometry**
    - Constant radius hole appropriately displaced from cylinder axis by the same amount for each of 50 layers



## 2.4.3 W Mask Performance & Specification Illustrations

- Tracker & HCAL Backgrounds as a function of
  - **Mask thickness**
  - **Lumical – Beamcal separation**
  - **Beamcal z loaction**



## 2.4.4 Low Z Performance & Specification Illustrations

- Tracker/HCAL backgrounds as function of mask thickness



## 2.4.5 Mechanical Support Performance & Specification Illustrations

- Mechanical 3D picture
- Deflection under load
  - **could be a one number quote or a diagram vs. annular thickness**
- Vibration modes (could be text)



## 2.5 Options and Unresolved Issues

### 2.5 Global FCAL

- **Installation & Servicing**

### 2.5.1 Lumical

- **Readout design**
- **Alignment verification/measurement**

### 2.5.2 Beamcal

- **Choice of sensor**
- **Readout design**
- **Beamcal OD & junction with support & W mask**

### 2.5.3 W Mask

- **Engineered design that dovetails with beamcal and lumical**

### 2.5.4 Low Z Mask

### 2.5.5 Support

- **Needs engineered, as opposed to conceptual, design**
- **Reproducible alignment of Lumical to ~30 um**
- **Adverse influence on QDO vibration spectrum**

### 2.5.6 BeamPipe

- **HOM heating, cooling & wakefields due to abrupt radial transitions**





## 3.0 R&D Roadmap (1)

### 3.1 R&D Issues

- Choice of Beamcal Sensor
- Development of appropriate front end electronics

### 3.2 R&D Milestones

- Prototype Lumical: 1 petal (360°/32)
- Prototype Lumical beam test
  - **Single electron response**
- Prototype BeamCal: 1 petal
- Prototype Beamcal beam tests
  - **Radiation Hardness Test**
  - **Single electron response**
  - **Response to showering electrons**



## 3.0 R&D Roadmap (2)

### 3.3 Resources Need

- Manpower not yet estimated
- M&S not yet estimated



## 4.0 Cost Estimate

- None: See MIB or some other chapter in LOI



## 5.0 Anticipated IDAG Questions & Answers

- None



## 6.0 Organization of the FCAL Group

### 6.1 Institutions Involved

- Beampipe: FNAL & SLAC
- Beamcal: FNAL, SLAC, UCB
- Lumical: SLAC
- Readout: SLAC
- Mechanics: SLAC