

ECAL for SPD

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Physics tasks for ECAL

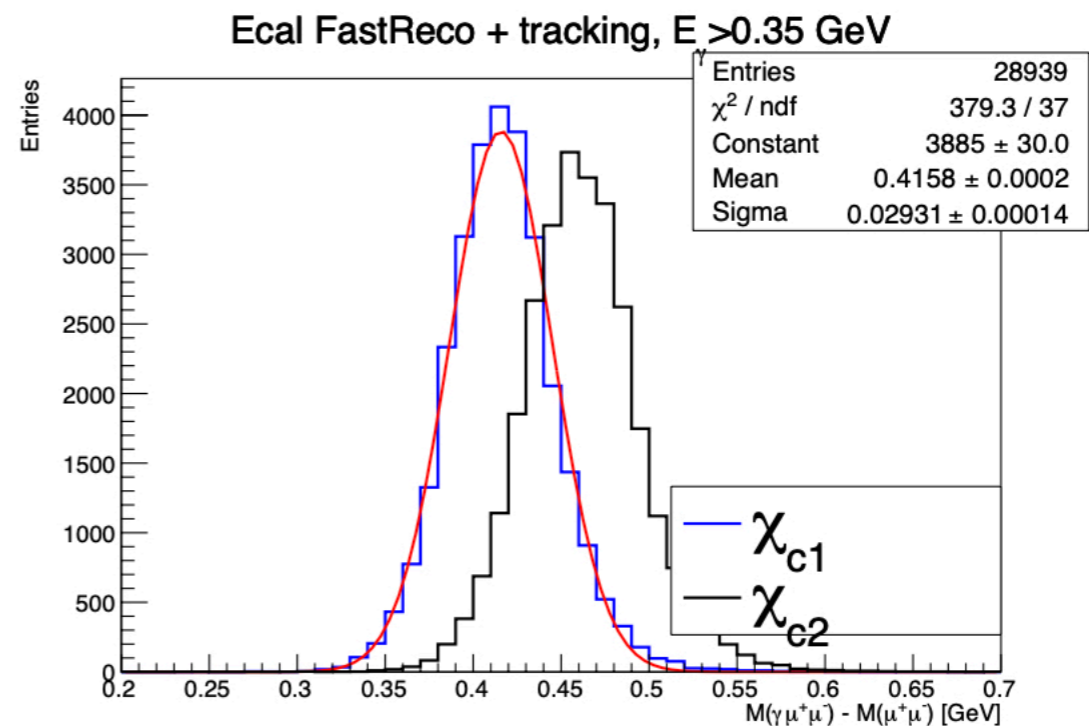
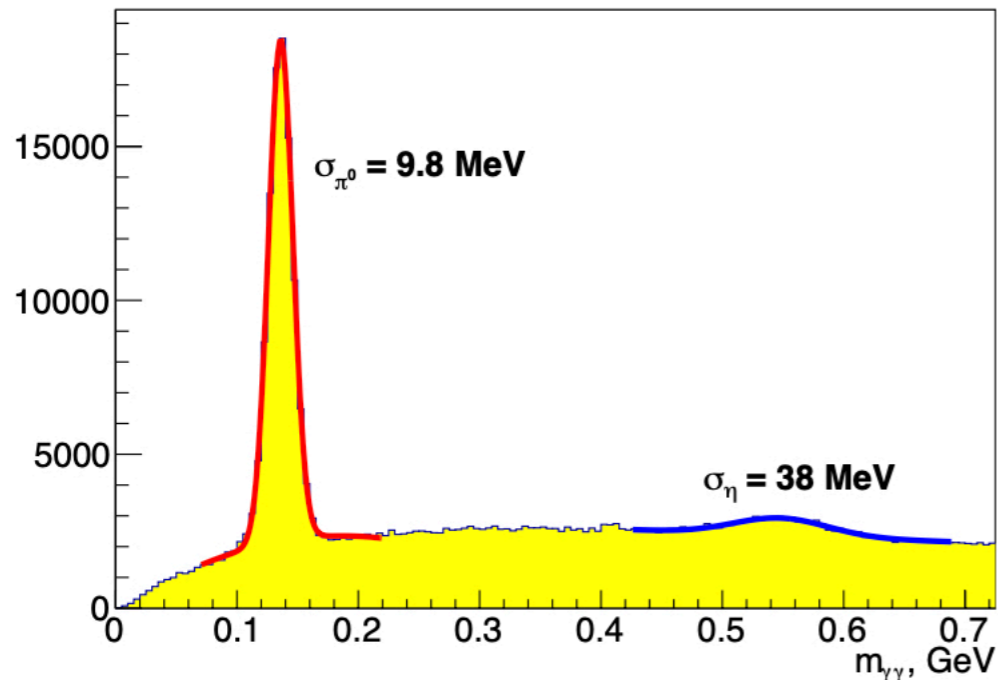
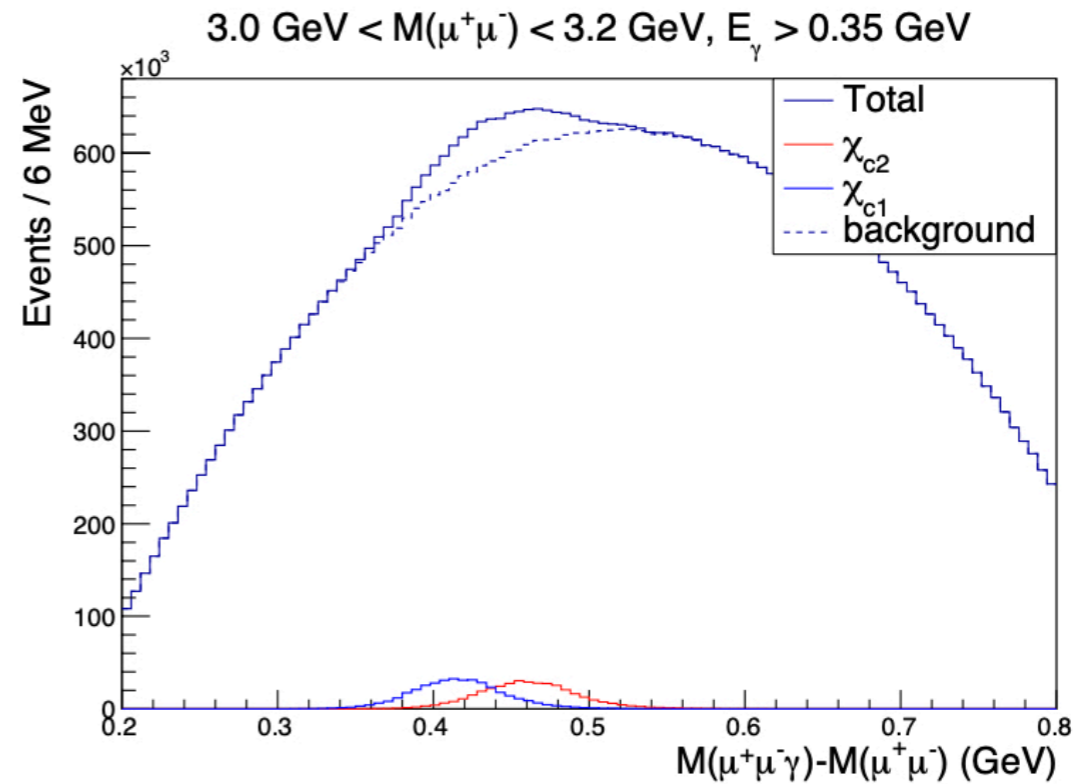
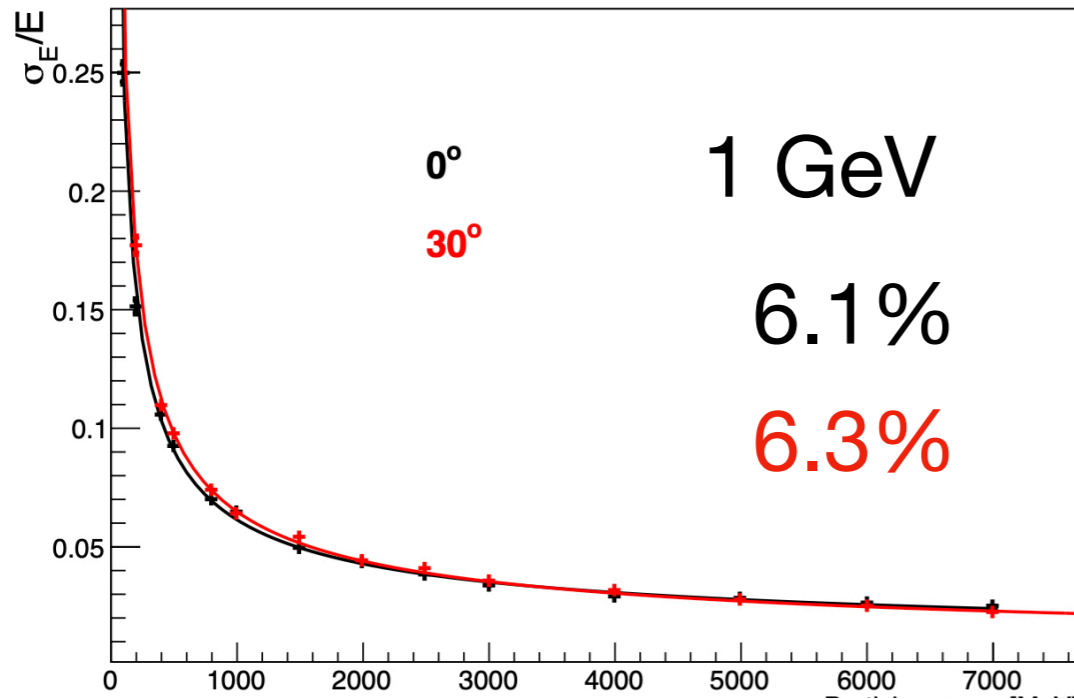
- Prompt photons ($p_T > \sim 2-4$ GeV/c)
- Radiative decays like χ_c decays into $J/\psi\gamma$ (soft photon ~ 0.7 GeV)
- Local polarimetry with π^0 (end-caps)

Requirements

- Good energy resolution for both low and high energies
- Fine granularity
- Time resolution ~ 1 ns

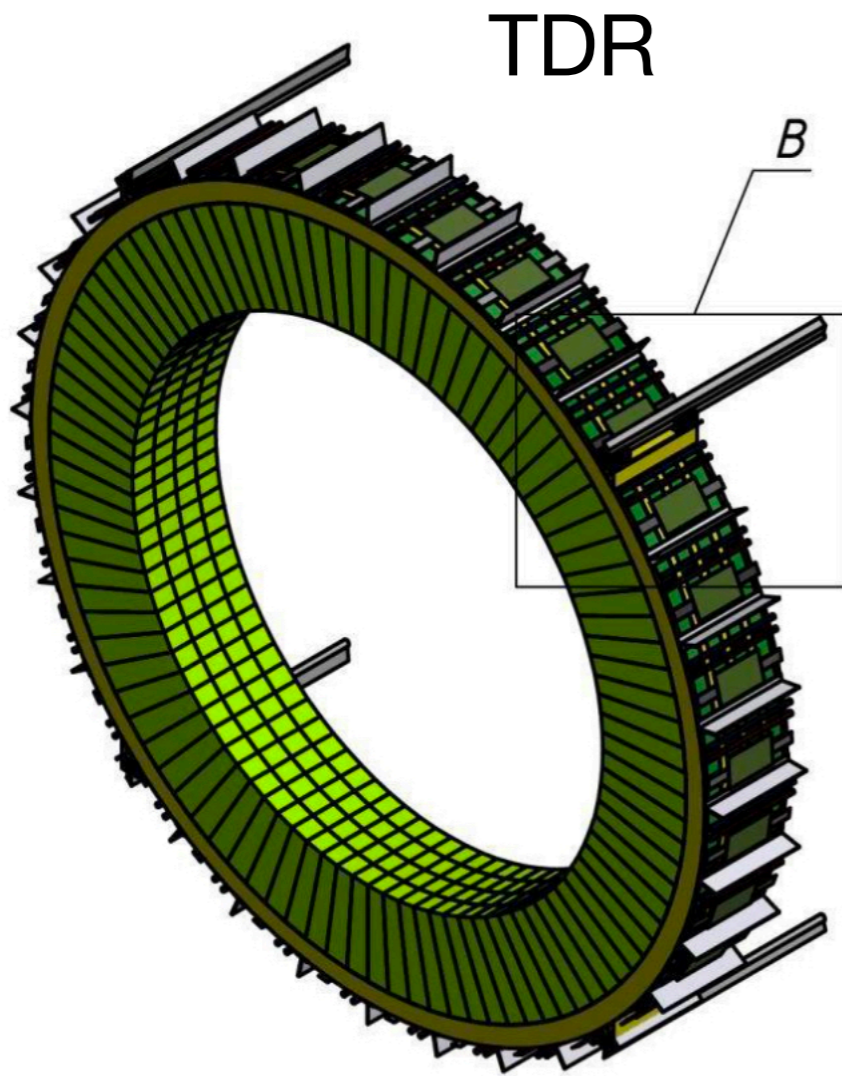
Expected ECAL resolution (CDR)

$$dE/E = 5\% / \sqrt{E}$$

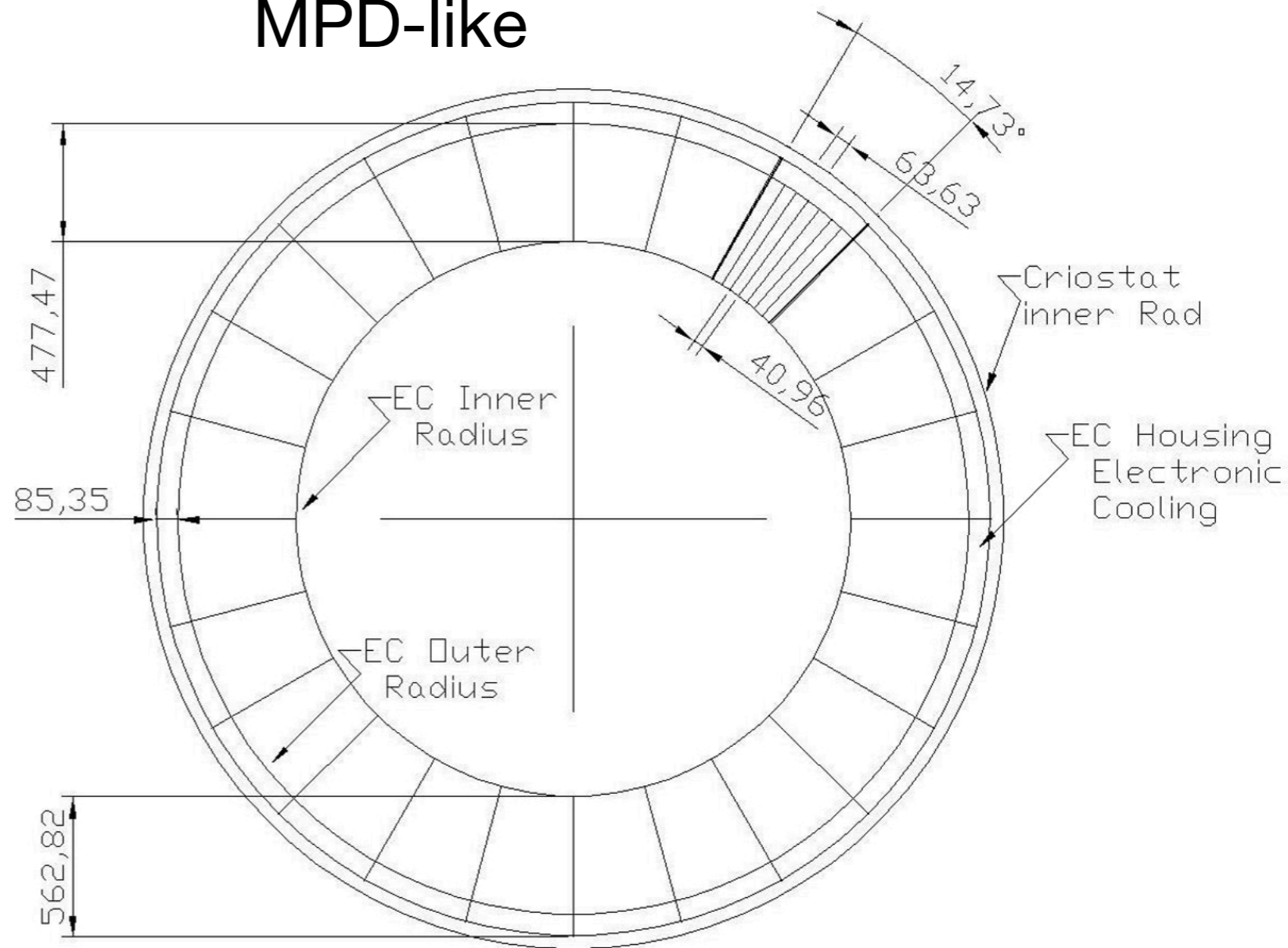


Azimuthal structure

MPD-like



TDR



Проблема сборки

Высокая азимутальная
однородность

Задел в проектировании
Азимутальная неоднородность
Съедаем 8 см по радиусу



8-cm problem

- -4 cm for ECAL (-2 cm for the sensitive part) , 18.3 X0 -> 17.4 X0
- -4 cm for Straw Tracker ($dP/P \sim L^2$, so -13% for the momentum resolution)
- Shorter flight base for TOR (-5%)
- Worse dE/dx resolution in Straw Tracker (-3.5%)

Is it the last “radial” problem?

Possible solutions

1. Leave things as they are and accept the permanent worsening of the setup
2. Skip a part of the physics program. Then see 1
3. Skip one of the detectors and a part of the physics program but keep other detectors untouched
4. Looking for other solutions for hanging and segmentation of the calorimeter
5. Re-discuss the barrel part of the calorimeter
6. Temporary cheap solution for hanging internal systems for phase one. Postpone a decision on the barrel portion of the calorimeter

Crystal barrel

Crystal	Nal(Tl)	Csl(Tl)	Csl	BaF ₂	BGO	LYSO(Ce)	PWO	PbF ₂
Density (g/cm ³)	3.67	4.51	4.51	4.89	7.13	7.40	8.3	7.77
Melting Point (°C)	651	621	621	1280	1050	2050	1123	824
Radiation Length (cm)	2.59	1.86	1.86	2.03	1.12	1.14	0.89	0.93
Molière Radius (cm)	4.13	3.57	3.57	3.10	2.23	2.07	2.00	2.21
Interaction Length (cm)	42.9	39.3	39.3	30.7	22.8	20.9	20.7	21.0
Refractive Index ^a	1.85	1.79	1.95	1.50	2.15	1.82	2.20	1.82
Hygroscopicity	Yes	Slight	Slight	No	No	No	No	No
Luminescence ^b (nm) (at peak)	410	550	310	300 220	480	402	425 420	?
Decay Time ^b (ns)	245	1220	26	650 0.	300	40	30 10	?
Light Yield ^{b,c} (%)	100	165	3.7	36 4.1	21	85	0.3 0.1	?
d(LY)/dT ^b (%/ °C)	-0.2	0.4	-1.4	-1.9 0.1	-0.9	-0.2	-2.5	?
Experiment	Crystal Ball	BaBar BELLE BES III	KTeV BELLE Mu2e	(GEM) TAPS Mu2e-II	L3 BELLE EIC?	Comet {Mu2e, SuperB} CMS MTD	CMS ALICE PANDA	A4 g-2 HHCAL?

Crystal barrel

Detector	Crystal type	Crystal number	Thickness X_0	Total mass, ton	σ_E/E , % %@E(GeV)	Start year	Lab.
Crystal Ball	NaI(Tl)	672	15,7	4,2	2,7 (1)	1977	BNL
CLEO-II	CsI(Tl)	7800	16,2	30	2 (1)	1990	Cornel
CMD-2	CsI(Na)-(Tl)	892	8,1	2,4	9 (0,5)	1992	BINP
SND	NaI(Tl)	1620	13,5	3,5	5 (0,5)	1995	BINP
KTeV	CsI, pure	3256	27	9	1 (1)	1995	FNAL
KEK-E246	CsI(Tl)	768	13,5	3	2,8 (0,2)	1996	KEK
PSI - $\pi\beta$	CsI, pure	240	13	1	2,5(0,07)	1996	PSI
WASA	CsI(Na)	1020	16,2	3,8	2 (1)	1998	Uppsala
KEDR	CsI(Na)	1312	16,2	3,2	2 (1)	1998	BINP
Belle	CsI(Tl)	8636	16,2	43	2 (1)	1999	KEK
BaBar	CsI(Tl)	6580	16,2	30	2 (1)	1999	SLAC
BES III	CsI(Tl)	6240	15.1	26	2.5(1)	2008	Beijing
CMD-3	CsI(Na)-(Tl)	1152	8.1 (15.3)	2.7	4 (1)	2010	BINP

Crystal barrel: CsI(Tl)

- $16 X_0$ - 30 cm, no fibers, shorter housing
- ~45 ton
- $dE/E = 2\%$ at 1 GeV
- ~ 50 M\$

Crystal barrel

Item	Size ($R_M \times R_M \times 25 X_0$)	1 m ³	10 m ³	100 m ³	Scaled to X_0
BGO	22.3×22.3×280 mm	\$8/cc	\$7/cc	\$6/cc	1.23
BaF ₂ :Y	31.0×31.0×507.5 cm	\$12/cc	\$11/cc	\$10/cc	2.28
LYSO:Ce	20.7x20.7x285 mm	\$36/cc	\$34/cc	\$32/cc	1.28
PWO	20x20x223 mm	\$9/cc	\$8/cc	\$7.5/cc	1.00
BSO	22x22x274 mm	\$8.5/cc	\$7.5/cc	\$7.0/cc	1.29
CsI	35.7x35.7x465 mm	\$4.6/cc	\$4.3/cc	\$4.0/cc	2.09

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