Radiation studies on ADCs for EMC Forward Endcap

Modifies EMC Forward Endcap geometry: (PndGeom/emcFwCapG.xml)
expanded mother volume from z=11 to z=20.9 cm with z to PANDA world:
z=230,25cm (unmodified)

added Aluminum plate at z="19.25*cm with elliptical hole (dx="28*cm"
dy="18*cm") and dimensions: dz="1.5*cm" rMin="0*cm" rMax="110.*cm"

added 3 ADCs as Silicon Box with dimensions dx="1*cm" dy="1*cm"
dz="0.025*cm". Identified by their copyNumber

Positions	cpnr
x="0*cm" y="23*cm" z="20.875*cm"	6000001
x="0*cm" y="60*cm" z="20.875*cm"	6000002
x="0*cm" y="97*cm" z="20.875*cm"	6000003

Positions relative to EMC FwEndCap mother Volume
in theta:

cpnr	theta (degree)
6000001	5,233
6000002	13,4375
6000003	21,1196

overlap with solenoid -> removed it in PndGeom/PANDAConfStt.xml

Defined material „ADC_Silicon" in PndGeom/materials.xml and activated it in
BgsEmcSim/BgsEmcFull.cc

Redefined EmcGHit->exsX() (with X=[1,8]) in BgsEmcSim/BgsEmcFullSD.cc by the
energy-deposit of 7 different particles ("Photon" ,"e+/e-", "Muon", "Pion", "Kaon",
"Proton", "Neutron") and total deposit.

Defined root-Tuples in EmcReco/EmcTestQa.cc with output of EmcGHit->exsX() for
different particles. Other output: cpnr, pid, EmcGHit->edep() for Xtal, and
coordinates (x,y,z,theta,phi).

Generated 0.6M events at 15GeV with DPM based event-Generator with Monolisa.

ROOT-Script for event-analysis.
Script determined Crystals closest to theta of ADC with cpnr = 6120903,
6111410, 6020604.
Convert Energy-Deposit in GeV to Gray with weight of Crystal, weight of ADC and
run-time, based on time integrated Luminosity at total cross section/generated
events.

Volume of one Crystal:
((20./3.)*(2.4375*2.4376+2.6*2.6+sqrt(2.4375*2.4376*2.6*2.6) [cm³])
Weight: 8.28*volume/1000. [kg]
Weight of ADC: 2.33*2.*2.*0.05/1000. [kg]
Total cross section at 15 GeV: 55µb
Luminosity: 2e32 [1/cm²s]

integrated Luminosity: 1.1e7
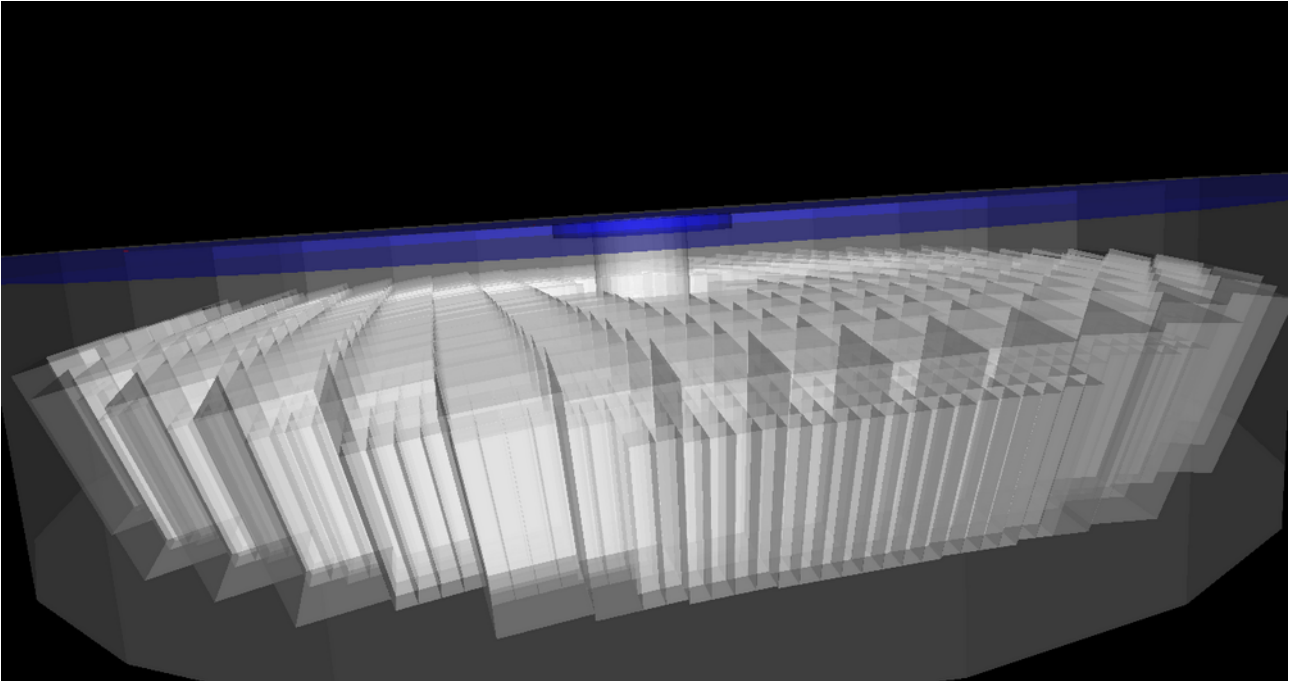with 1 GeV= 1.6021765e-10 J

Converted Gray to mGy/h.

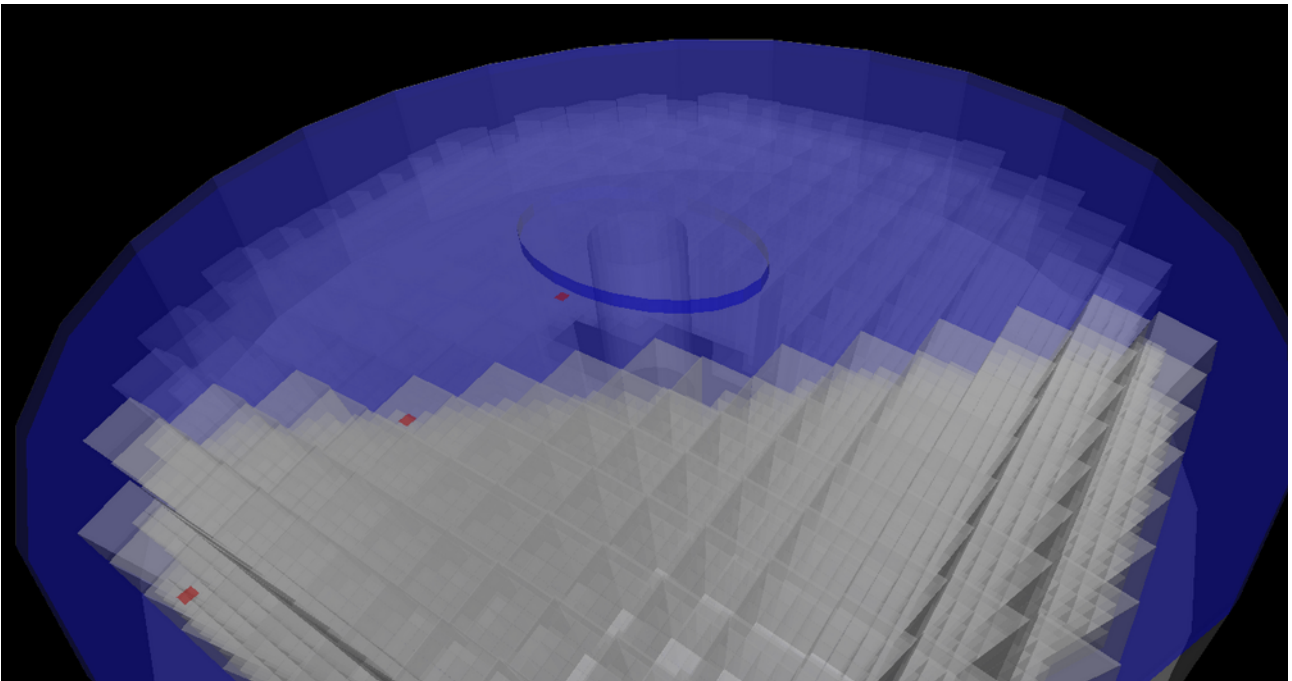*Figure 1: 3D view of ForwardEMCCap with Aluminum mountplate (blue)*

Figure 2: Rotated view with the three visible ADCs (red) on mountplate

Results:

Number of simulated events: 0.6M

Numbers are theta [degree]

Particle	ADC 5.2	ADC 13.4	ADC 21.1	Xtal 5.7	Xtal 13,0	Xtal 22.0
Photon	0.0703998	0.0054771	0.002814	3.72421	0.736226	0.095815
e+/e-	4.82379	0.330013	0.0702334	14.715	2.32144	0.292046
Muon	0.156604	0.0674322	0.0778604	0.178265	0.033865	0.005306
Pion	2.42224	0.271962	0.0669239	2.35668	0.482988	0.053408
Kaon	0.0456556	0	0	0.051295	0.0148955	0.000818
Proton	2.20732	0.175232	0.0675251	3.06563	0.469588	0.086044
Neutron	0	0	0	0.0002466	8.49e-05	2.28e-05
Other	0.25251	0.0580302	0.0003119	0.934874	0.0941124	0.010587
Total	10.0489	0.913624	0.288483	28.7504	4.88943	0.639861
# entries	1609	135	23	77930	27963	5873

in mGray/h
Xtal = PWO-Crystal

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Radiation Studies of VPTs for EMC Forward Endcap

Modified EMC Fw Cap geometrie (PndGeom/EmcFwCapD.xml), in which every single crystal is defined.

Defined vpt glass body as

<Tubs name="vpt" rMin="0*cm" rMax="1.2*cm" dz="1.*mm" startPhi="0*deg" deltaPhi="360*deg" />

with material: VPT_glass. Defined material in materials.xml as Si 2O with density of 2.2 g/cm³

Defined positions of 4 VPTs at

x="1.93622895495e-14*cm" y="-20.6803425634*cm" z="235.17781919*cm";
x="1.93622895495e-14*cm" y="-23.2695208078*cm" z="235.17194119*cm"
x="1.93622895495e-14*cm" y="-54.5003239962*cm" z="235.048807112*cm"
x="1.93622895495e-14*cm" y="-94.2685294894*cm" z="234.766285031*cm"

relativ to PANDAworld (absolute) which is in theta (with Copynumbers):

theta (degree)	cpnr
5.025	6000010,
5.651	6000011,
13.054	6000012,
21.794	6000013

activated material VPT_glass in BgsEmcSim/BgsEmcFull.cc

Redefined EmcGHit->exsX() (with X=[1,8]) in BgsEmcSim/BgsEmcFullSD.cc by the energy-deposit of 7 different particles ("Photon" ,"e+/e-", "Muon", "Pion", "Kaon", "Proton", "Neutron") and total deposit.

Defined root-Tuples in EmcReco/EmcTestQa.cc with output of EmcGHit->exsX() for different particles. Other output: cpnr, pid, EmcGHit->edep() for Xtal, and coordinates (x,y,z,theta,phi).

Generated 0.2M events at 15GeV with DPM based event-Generator.

ROOT-Script for event-analysis.
Dose of first Crystal in EmcFwCapD.xml with cpnr=100207 @ theta=5.25˚ for the purpose of comparison.
Convert Energy-Deposit in GeV to Gray with weight of Crystal, weight of VPT and run-time, based on time integrated Luminosity at total cross section/generated events.

Volume of one Crystal:
((20./3.)*(2.4375*2.4376+2.6*2.6+sqrt(2.4375*2.4376*2.6*2.6) [cm³])
Weight: 8.28*volume/1000. [kg]
Weight of VPT: 2.2 *0.2* 1.2*1.2* 3.14159 / 1000. [kg]
Total cross section at 15 GeV: 55µb
Luminosity: 2e32 [1/cm²s]

integrated Luminosity: 1.1e7
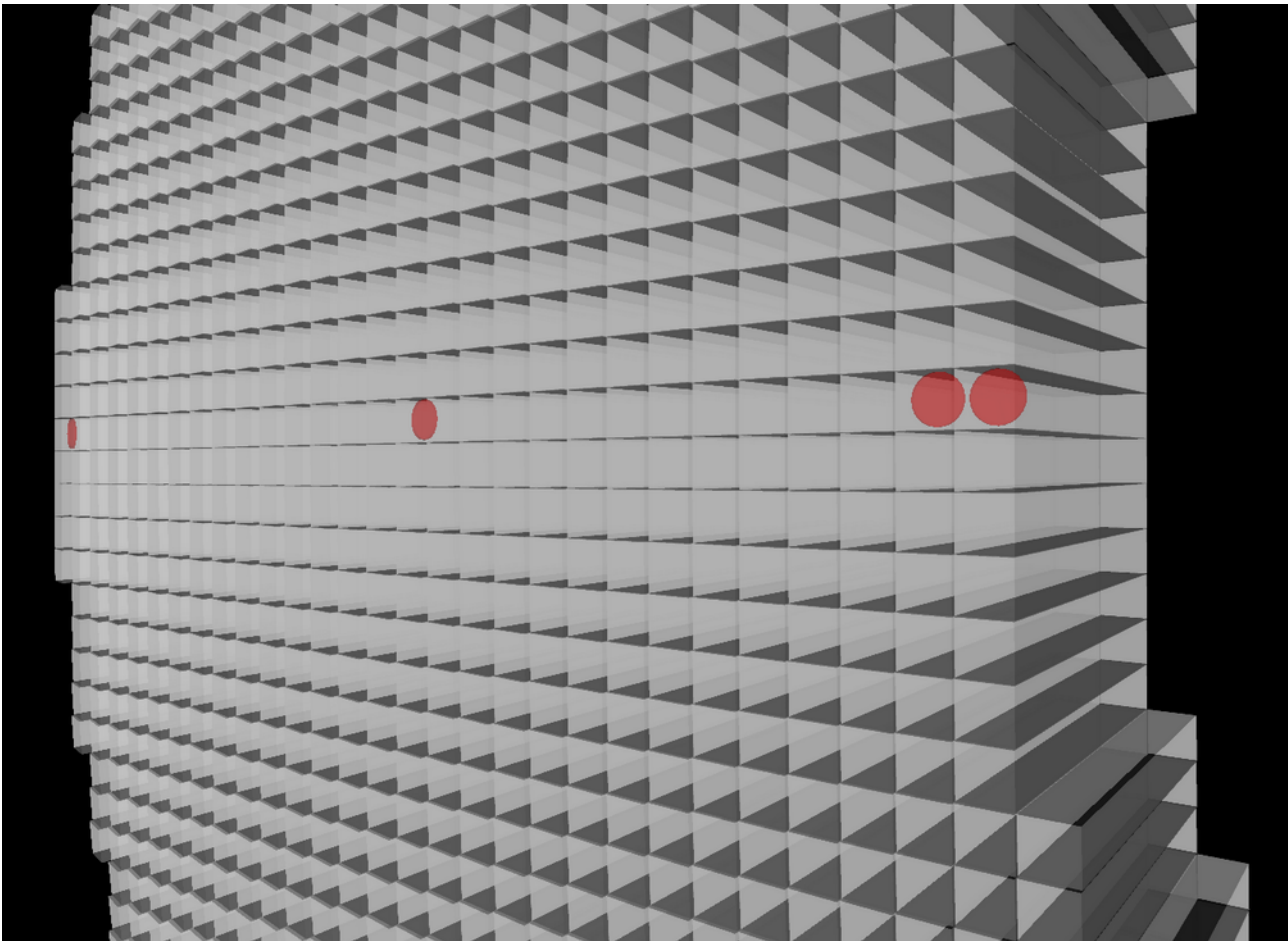with 1 GeV= 1.6021765e-10 J

Converted Gray to mGy/h.

Figure 1: 3D view of ForwardEMCCap (view from behind) with the four VPTs (red)

Results

Number of simulated events: 1M

Numbers are theta [degree]

Particle	VPT 5.025	VPT 5.651	VPT 13.054	VPT 21.794	Xtal 5.25
Photon	0.195458	0.191151	0.008009	0.00510614	4.0356
e+/e-	7.86603	4.69398	0.33363	0.0647453	15.8322
Muon	0.122478	0.202834	0.0319172	0.00380012	0.162491
Pion	2.85989	2.15471	0.378847	0.0541599	2.75511
Kaon	0.0718727	0.0193598	0.00807402	0.00175834	0.06973
Proton	3.71321	3.24389	0.488489	0.0420881	3.56548
Neutron	0	0	0	0	0.000291
Other	1.03277	0.320162	0.134826	0.006566	1.08303
Total	15.8617	10.8261	1.38379	0.178224	27.5039
# entries	4296	3029	372	71	131545

in mGray/h, except "# entries"
Xtal = PWO-Crystal

VPT with <Tubs name="vpt" rMin="0*cm" rMax="1.2*cm" dz="0.5*mm" startPhi="0*deg" deltaPhi="360*deg" />, therefor thinner glass of 1mm

Number of simulated events: 0.2M
Numbers are theta [degree]

Particle	VPT 5.025	VPT 5.651	VPT 13.054	VPT 21.794	Xtal 5.25
Photon	0.0966641	0.135109	0.00226935	0	3.97199
e+/e-	8.0189	4.86123	0.2294	0.098509	15.6322
Muon	0.0970761	0.0846691	0.0551144	0	0.156107
Pion	2.79696	1.99109	0.468667	0.0267113	2.89265
Kaon	0.0584967	0.0125795	0.00806742	0	0.0707774
Proton	3.96299	2.76553	0.650664	0.0423499	3.68287
Neutron	0	0	0	0	0.00029224
Other	2.24884	0.237658	0.00466117	0	1.16397
Total	17.2799	10.0879	1.41884	0.16757	27.5709
# entries	792	539	70	10	26208

in mGray/h, except "# entries"
Xtal = PWO-Crystal