

EIC detector simulations: aer-fi

E. Cisbani, C. Fanelli

Simulation of Aerogel with block of Fibers

In the animation:

- High P electron shot from 5 cm (left)
- Aerogel with two planes of fibers
- Sensor plane (observed ring)



Notice:

- No quantum efficiency
- Need to turn off reflection from sensor plane
- No absorption/diffusion in aerogel

Detector Part	Parameter	Value	Notes
aerogel	thickness	4 cm	
aerogel	width	10 cm	
aerogel	refraction index		now embedded in the code, can be controlled externally
fiber	diameter	0.5 mm	
fiber	pitch	10 mm	
fiber	gap	20 mm	# planes of fibers resulting from aerogel width and fiber gap
sensor plane	distance	5 cm	
sensor plane	size	20 cm	

Old Results

Fiber diameter = (0.05, 0.14) [mm] ~x Fiber pitch = (5, 15) [mm] ~ \checkmark Fiber gap = (5, 25) [mm] ~ \checkmark Aerogel thickness = (3, 6) [cm] ~ \checkmark Aerogel width = (8, 12) [cm] ~x



Increasing the thickness of the aerogel from 4 to 6 cm, effect of absorption negligible? d-RICH optimization suggested n=1.03 and thickness of 6 cm.

Two optimization steps:

Sensor @ 5 cm Electrons @0 deg from point

- Aerogel thickness (ranked 1 in importance)

 Increased to 6 cm
- Optimization of 2nd block of parameters
 - Need further tuning



Old Results

Optimal coordinates d(fib) = 0.15 mm, p(fib)=8.99 mm, g(fib)=24.82 mm, w(aer)=8.06 cm t(aer)=6.00 cm

Optimal minimum (so far...): f(x^*)=0.148 mm (from starting 0.235 mm)

~40% improved ring radius RMS



Main focus on fiber "randomization"

Variable	Description	# pars	Range	Optimal/Result
Rigid rotation of tiles f_rotx, f_roty	all fibers rotating by same angle along x, y (z along aerogel thickness)	2	(-5,5), (-5,5) deg	2.35; -5.0 deg
Single fibers rotation f_sthx, f_sthy	used to estimate tolerances on single fiber angles x, y	2	(0.1,1.0) deg	0.1; 1.0 deg
Single fibers shifts f_x, f_y, f_z	to estimate tolerances on single fiber positioning x, y, z	3	(0.5, 3.0) mm	0.61; 2.25; 0.53 mm
Fiber diameter	Fixed to 50um	0		50 um
Fiber pitch f_pitch	distance between fibers	1	(5,15) mm	5 mm
Fiber gap	distance between planes of fibers fixed to 25 mm	0		25 mm
Aerogel thickness	Fixed to 6 cm	0		6 cm
Aerogel width a_width	Side of a square, orthogonal to thickness	1	(8,12) cm	11.52 cm
Aerogel refractive index a_n	Allowed to vary	1	(1.01,1.05)	1.026

Modifications in Simulation aerfib v7 [for records]

- Suppressed photons in the sensor plane
- Macro aerana estimate of input parameters for analysis
- Correct units wavelength -> rind
- Increased area of sensor
- world 210 210 210 cm
- Sensor distance 200 cm
- Sensor size 200 cm
- Gun position -5 cm
- Gun xWidth, xWidth 3. cm
- Gun deltaTheta 10. deg

The "exact" optimal solution is: "f_pitch [mm]", "a_width [cm]", "a_n", "f_rotx [deg]", "f_roty [deg]", "f_sthx [deg]", "f_sthy [deg]", "f_x [mm]", "f_y [mm]", "f_z [mm]" '5.0000000000', '11.5182355753', '1.0259815697', '2.3542939063', '-5.0000000000', '0.1000000000', '1.000000000', '0.6048817172', '2.2460465399', '0.5277117819'



- The dominant contribution comes from the aerogel refractive index
- With a thickness of 6 cm, the optimal index and width of the aerogel tile is 1.026 and 11.5 cm
- The single fibers parameters indicate tolerances of up to 1 deg in (θx, θy) and 3 mm in (x,y,z) from the flat partial dependence
- The fiber pitch has not been determined yet in the range (5,15) mm: no significant difference
- Next: fix the aerogel parameters and sub-optimize all fiber parameters







from optimization...

Need to do some noise study and test reproducibility with same seed





fiber "randomization"

- With a model based on 1000 observations the conclusion is that the aerfib resolution does not depend critically on the fibers
- We have tolerances of at least a few mm on single fibers
- We have tolerances of at least 1 deg on single fibers
- Some dependence of the resolution on (rigid) θy, probably not relevant within the noise
- We did not test rigid spatial offsets







f_pitch, f_rotx, f_roty, f_sthx, f_sthy, f_x, f_y, f_z '8.8412050476', '-3.8831780239', '2.2352240682', '0.3427530923', '0.4146470353', '1.5294975414', '2.5060267110', '2.7588276007'

Variable	Description	# pars	Range	Optimal/Result
Rigid rotation of tiles f_rotx, f_roty	all fibers rotating by same angle along x, y (z along aerogel thickness)	2	(-5,5), (-5,5) deg	0; 2.0(?) deg
Single fibers rotation f_sthx, f_sthy	used to estimate tolerances on single fiber angles x, y	2	(0.1,1.0) deg	(>=) 1.0 deg
Single fibers shifts f_x, f_y, f_z	to estimate tolerances on single fiber positioning x, y, z	3	(0.5, 3.0) mm	(>=) 1-3 mm
Fiber diameter	Fixed to 50um	0		50 um
Fiber pitch f_pitch	distance between fibers	1	(5,15) mm	~5-8 mm
Fiber gap	distance between planes of fibers fixed to 25 mm	0		25 mm
Aerogel thickness	Fixed to 6 cm	0		6 cm
Aerogel width a_width	Side of a square, orthogonal to thickness	1	(8,12) cm	11.52 cm
Aerogel refractive index a_n	Allowed to vary	1	(1.01,1.05)	1.026