

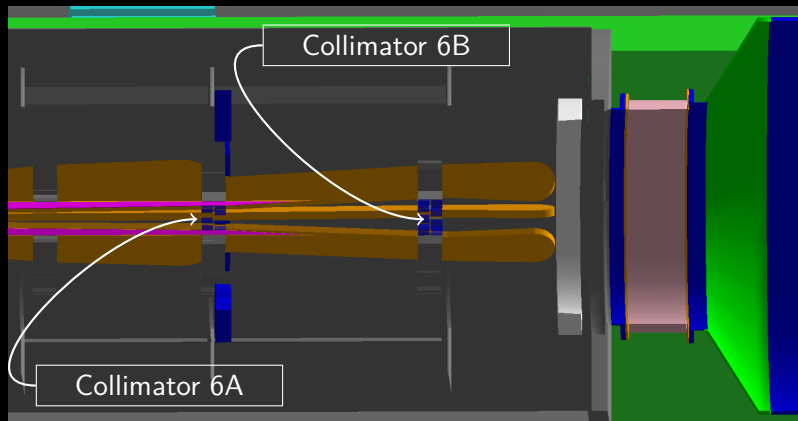
Collimator 6A/6B Redesign Status

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Collaboration Meeting
2023-05-05



Introduction

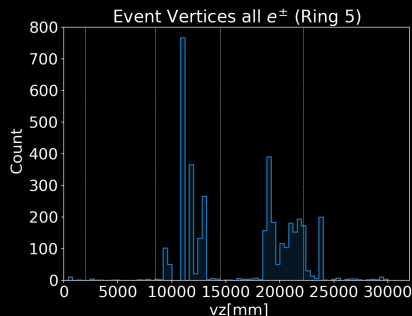


- Collimator 6A: IR 55.31mm. and 6B: IR 59.91mm
- Collimator 6A: ~ 9555 mm and 6B: ~ 10927 mm, z location.

Current Design

- Simulation with Collimator 6A/6B design from develop branch.
- 100M beam events.

vzmin	vzmax	Components
$-\infty$	< -3700	Target Region.
-3700	2000	Collimator 1, 2 etc.
2000	8500	Collimator 4, 5 etc.
8500	14500	Collimator 6A/B, Lintel.
14500	22200	Detector Beampipe Region.
>35000	∞	Downstream of Moller Detector.



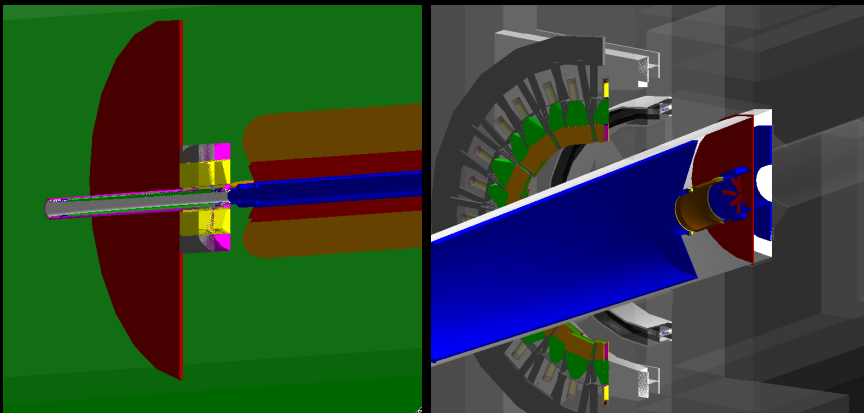
Simulation data from Ryan

Introduction

(vzmin - vzmax]	Ring0 (moller%)	Ring1 (moller%)	Ring2 (moller%)	Ring3 (moller%)	Ring4 (moller%)	Ring5 (moller%)	Ring6 (moller%)
-100000 - -3700	53919 (177.933)%	36 (0.119)%	5177 (17.084)%	4073 (13.441)%	3813 (12.583)%	32061(105.801)%	8759 (28.905)%
-3700 - 2000	97 (0.320)%	1 (0.003)%	4 (0.013)%	6 (0.020)%	10 (0.033)%	28 (0.092)%	48 (0.158)%
2000 - 8500	70 (0.231)%	5 (0.017)%	9 (0.030)%	6 (0.020)%	20 (0.066)%	14 (0.046)%	16 (0.053)%
8500 - 14500	5220 (17.226)%	143 (0.472)%	350 (1.155)%	486 (1.604)%	1264 (4.171)%	1721 (5.679)%	1256 (4.145)%
14500 - 22200	5572 (18.388)%	250 (0.825)%	569 (1.878)%	609 (2.010)%	1311 (4.326)%	1713 (5.653)%	1120 (3.696)%
22200 - 35000	1080 (3.564)%	38 (0.125)%	104 (0.343)%	104 (0.343)%	247 (0.815)%	336 (1.109)%	251 (0.828)%
35000 - 1000000	61 (0.201)%	1 (0.003)%	6 (0.020)%	10 (0.033)%	13 (0.043)%	19 (0.063)%	12 (0.040)%
-100000 - 1000000	66019 (217.863)%	474 (1.564)%	6219 (20.523)%	5294 (17.470)%	6678 (22.037)%	35892 (118.444)%	11462 (37.825)%

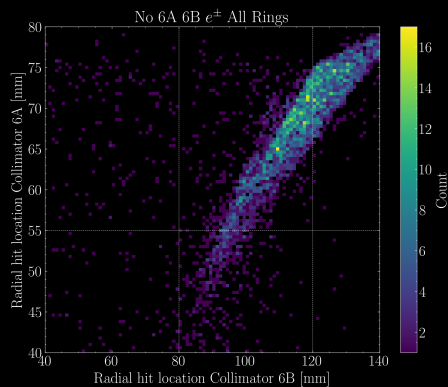
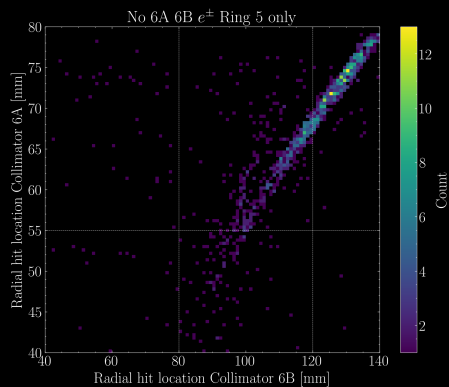
- High background rates from Collimator 6A/B Region.
- For moller rate calculation, 1 Moller per 3300 beam events used.

New simulation without 6A 6B with Kryptonite shields



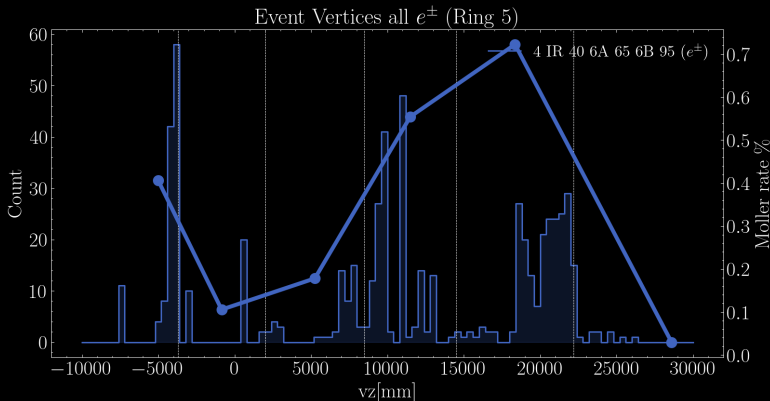
- Kryptonite shield used right in front of Collimator 2 and after SAM to block the everything else other than the beam line .
 - Allows us to focus on beamline background.
 - Saves computation cost: faster simulation time.
- "Real asymmetric" field map used.
- 100M events simulated with "beam" generator.

New Simulation without 6A 6B

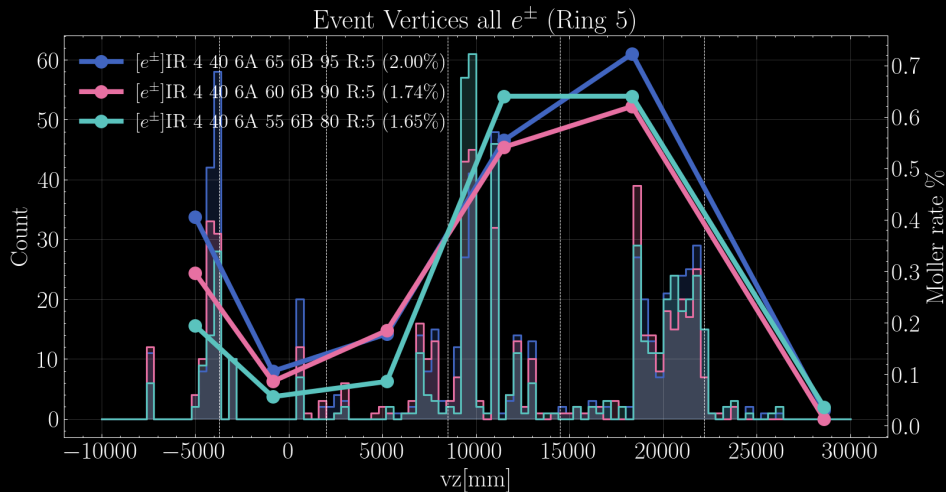


- What gets to Moller Detector(MD) from 6A 6B Region?
- Plot shows those tracks that hit both 6A, 6B virtual plane and go on to hit MD.

Background Summary Example Plot

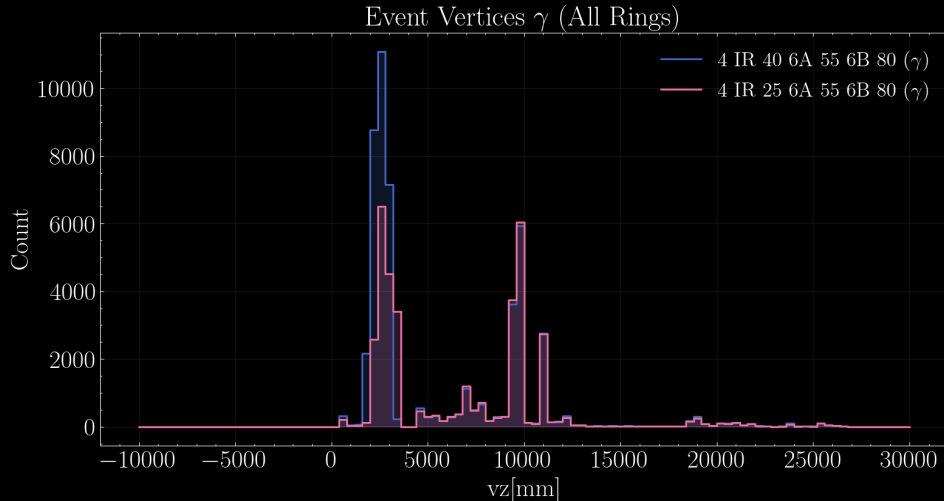


(vzmin - vzmax]	Ring0 (moller%)	Ring1 (moller%)	Ring2 (moller%)	Ring3 (moller%)	Ring4 (moller%)	Ring5 (moller%)	Ring6 (moller%)
-100000 - -3700	530 (1.749)%	8 (0.026)%	57 (0.188)%	106 (0.350)%	161 (0.531)%	123 (0.406)%	75 (0.247)%
-3700 - 2000	163 (0.538)%	4 (0.013)%	22 (0.073)%	29 (0.096)%	56 (0.185)%	32 (0.106)%	20 (0.066)%
2000 - 8500	186 (0.614)%	2 (0.007)%	11 (0.036)%	28 (0.092)%	61 (0.201)%	54 (0.178)%	30 (0.099)%
8500 - 14500	540 (1.782)%	12 (0.040)%	41 (0.135)%	61 (0.201)%	159 (0.525)%	168 (0.554)%	99 (0.327)%
14500 - 22200	728 (2.402)%	36 (0.119)%	72 (0.238)%	88 (0.290)%	174 (0.574)%	219 (0.723)%	139 (0.459)%
22200 - 35000	34 (0.112)%	2 (0.007)%	3 (0.010)%	4 (0.013)%	5 (0.017)%	9 (0.030)%	11 (0.036)%
35000 - 1000000	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%
-100000 - 1000000	2181 (7.197)%	64 (0.211)%	206 (0.680)%	316 (1.043)%	616 (2.033)%	605 (1.996)%	374 (1.234)%



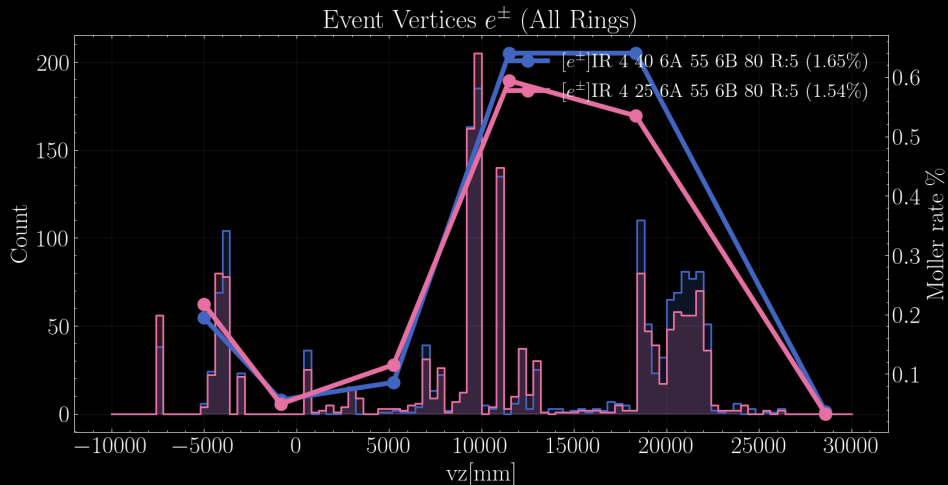
- 6A 55mm decreases background from upstream, but increases from 6A/6B.
- Minimum at 6A 55mm and 6B 80mm in Ring 5. (Similarly for Rings 3,4 etc).

Collimator 4 IR Change.



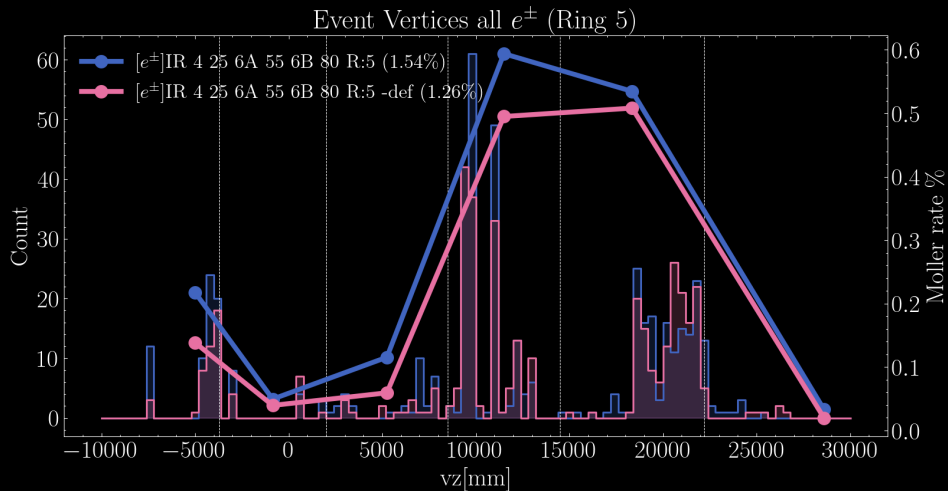
- Current collimator 4 design has IR 40mm.
- Reducing IR of collimator 4 from 40mm to 25mm reduces γ background; these are "two bounce shield" photon background.

Collimator 4 IR Change.



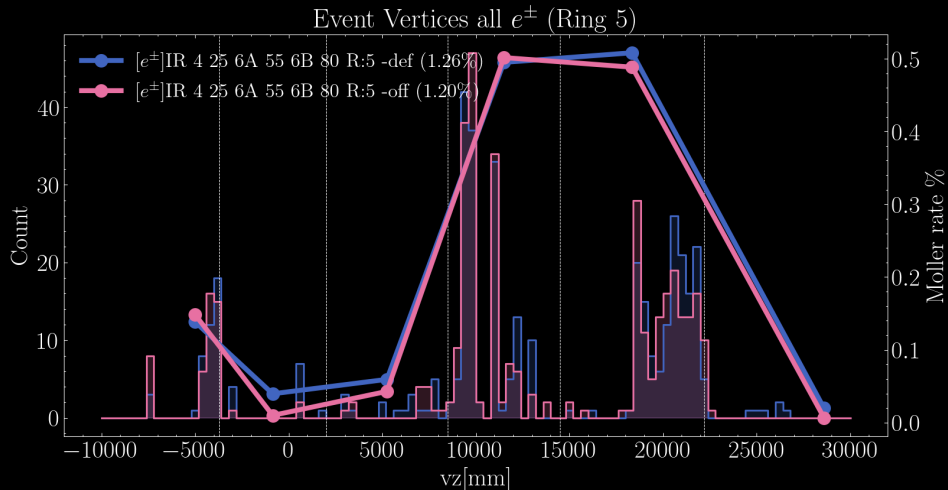
- This change reduces background from the detector beampipe region.
- Thus the overall background in Ring 5 further improves.
- IR 4: 25mm, 6A: 55mm and 6B: 80mm is the optimal combination.

Comparison of field maps for optimal combination



- Blue: "Real asymmetric" field map.
- Pink: Default field map.

With offset of 1mm on beam origin.



- Default field map used in both.
- Blue: `/remoll/evgen/beam/origin 0 0 -7.5 m`
- Pink: `/remoll/evgen/beam/origin 1 0 -7500 mm`

- Large background coming from 6A/6B in the existing design.
- 6A IR: 55mm and 6B IR: 80mm is optimal.
- Tested with different fields("Real asymmetric" and default) and beam offset of 1mm.
- At request of Engineering, will evaluate shrinking the Collimator 6A outer radius by 6mm.
- Further studies are being done.

Backup

Rates in all rings with default field map.

- 4 IR: 25mm, 6A 55mm and 6B: 80mm.

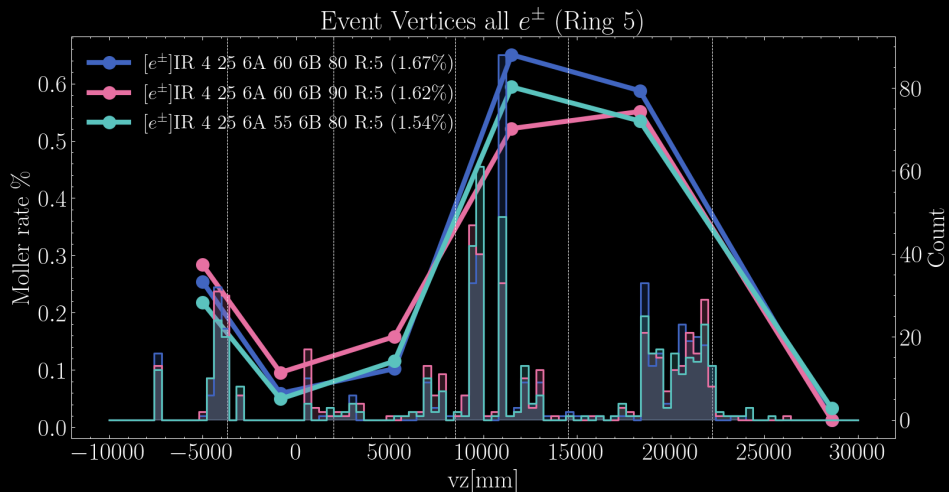
/remoll/evgen/beam/origin 0 0 -7.5m

(vzmin - vzmax]	Ring0 (moller%)	Ring1 (moller%)	Ring2 (moller%)	Ring3 (moller%)	Ring4 (moller%)	Ring5 (moller%)	Ring6 (moller%)
-100000.0 - -3700.0	194 (0.640)%	3 (0.010)%	17 (0.056)%	29 (0.096)%	73 (0.241)%	42 (0.139)%	30 (0.099)%
-3700.0 - 2000.0	40 (0.132)%	2 (0.007)%	3 (0.010)%	5 (0.017)%	15 (0.050)%	12 (0.040)%	3 (0.010)%
2000.0 - 8500.0	59 (0.195)%	1 (0.003)%	4 (0.013)%	7 (0.023)%	18 (0.059)%	18 (0.059)%	11 (0.036)%
8500.0 - 14500.0	492 (1.624)%	10 (0.033)%	40 (0.132)%	68 (0.224)%	143 (0.472)%	150 (0.495)%	81 (0.267)%
14500.0 - 22200.0	491 (1.620)%	16 (0.053)%	54 (0.178)%	48 (0.158)%	121 (0.399)%	154 (0.508)%	98 (0.323)%
22200.0 - 35000.0	18 (0.059)%	3 (0.010)%	1 (0.003)%	3 (0.010)%	2 (0.007)%	6 (0.020)%	3 (0.010)%
35000.0 -1000000.0	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%
-100000.0 -1000000.0	1294 (4.270)%	35 (0.116)%	119 (0.393)%	160 (0.528)%	372 (1.228)%	382 (1.261)%	226 (0.746)%

/remoll/evgen/beam/origin 1 0 -7500mm

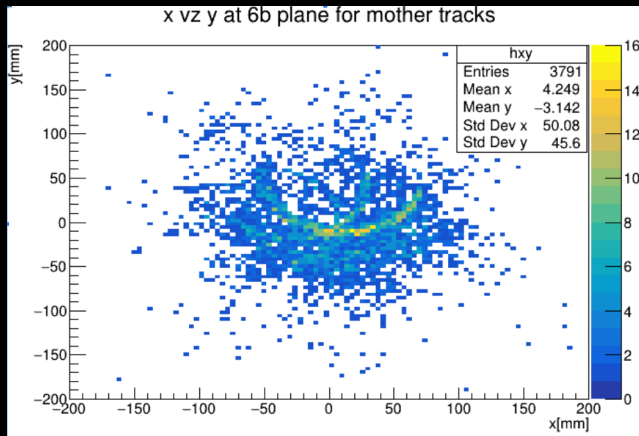
(vzmin - vzmax]	Ring0 (moller%)	Ring1 (moller%)	Ring2 (moller%)	Ring3 (moller%)	Ring4 (moller%)	Ring5 (moller%)	Ring6 (moller%)
-100000.0 - -3700.0	191 (0.630)%	4 (0.013)%	15 (0.050)%	35 (0.116)%	66 (0.218)%	45 (0.148)%	26 (0.086)%
-3700.0 - 2000.0	27 (0.089)%	1 (0.003)%	2 (0.007)%	3 (0.010)%	12 (0.040)%	3 (0.010)%	6 (0.020)%
2000.0 - 8500.0	58 (0.191)%	1 (0.003)%	3 (0.010)%	9 (0.030)%	22 (0.073)%	13 (0.043)%	10 (0.033)%
8500.0 - 14500.0	510 (1.683)%	11 (0.036)%	30 (0.099)%	59 (0.195)%	168 (0.554)%	152 (0.502)%	90 (0.297)%
14500.0 - 22200.0	504 (1.663)%	22 (0.073)%	49 (0.162)%	61 (0.201)%	120 (0.396)%	148 (0.488)%	104 (0.343)%
22200.0 - 35000.0	22 (0.073)%	4 (0.013)%	3 (0.010)%	5 (0.017)%	2 (0.007)%	2 (0.007)%	6 (0.020)%
35000.0 -1000000.0	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%	0 (0.000)%
-100000.0 -1000000.0	1312 (4.330)%	43 (0.142)%	102 (0.337)%	172 (0.568)%	390 (1.287)%	363 (1.198)%	242 (0.799)%

Other combinations comparisons combination



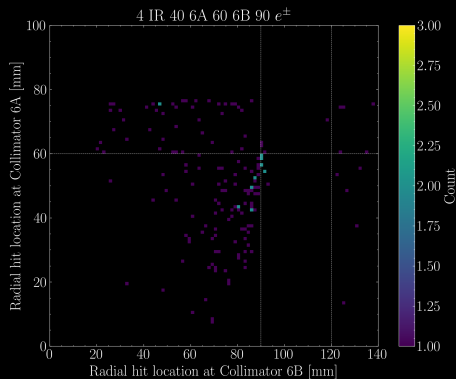
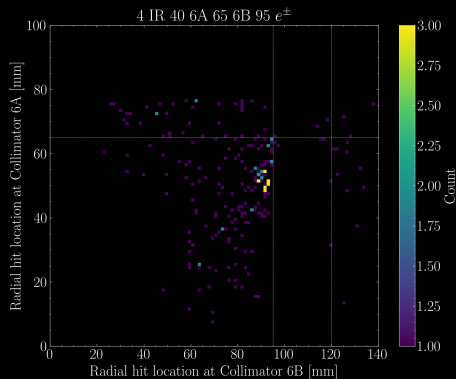
- Has 6A: 60 and 6B: 80.

What produces background at beampipe?



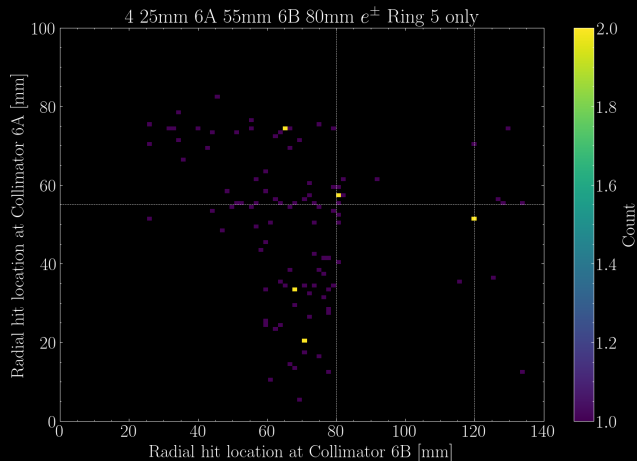
- The intersection plane at Collimator 6B for those mother tracks of those events that originate at the beampipe and hit the MD Ring 5.
- These are through the bore.

Other combinations comparisons combination



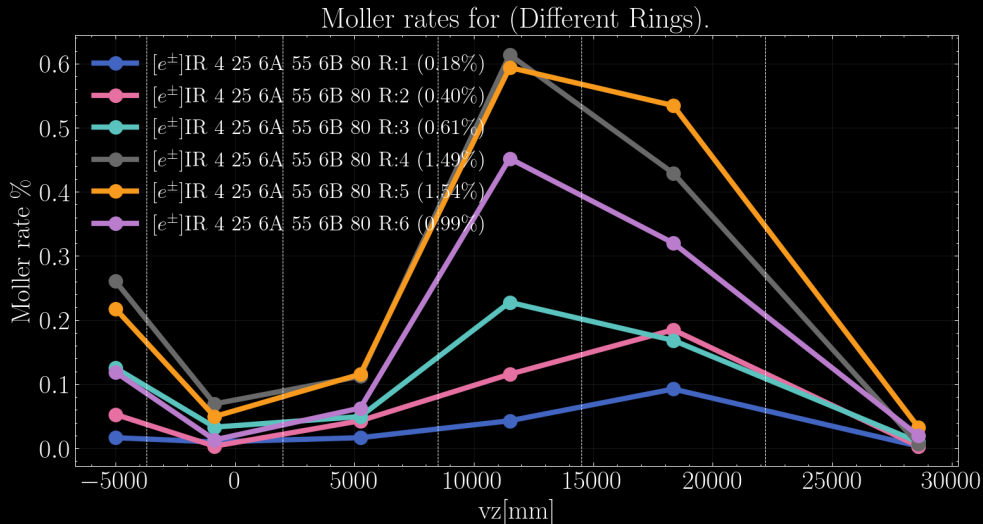
- What passes with different combination? Rationale for 6A 6B IR change.

What passes from 6A/6B with optimal combination?



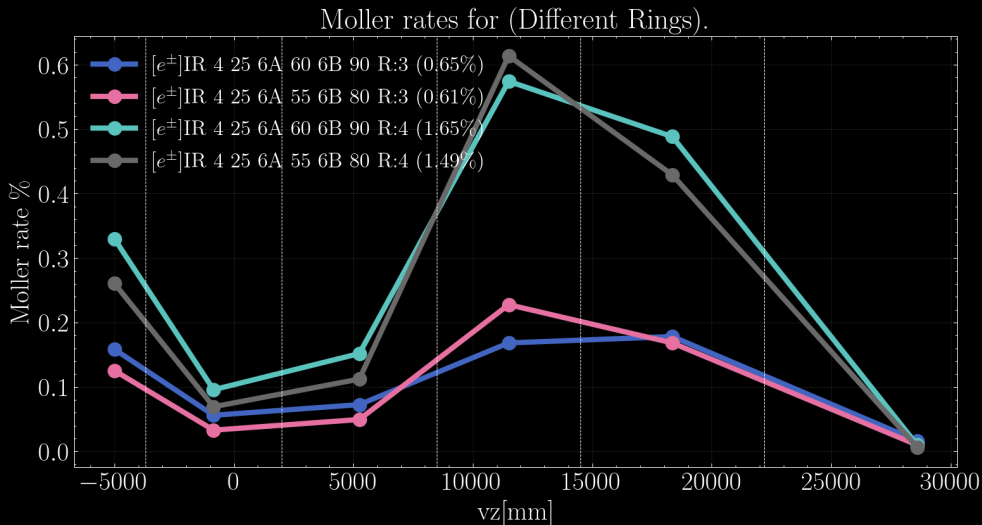
- What still passes through with optimal 6A and 6B?

Different Rings for 4 IR: 25mm, 6A IR: 55mm and 6B IR: 80mm.



- Background at different Rings for 4 IR: 25mm, 6A IR: 55mm and 6B IR: 80mm.

Rings 3 and 4 IR: 25mm, 6A IR: 55mm,60mm and 6B IR: 80mm,90mm.



- Background at Rings 3 and 4 IR: 25mm, 6A IR: {55mm,60mm} and 6B IR: {80mm,90mm}.