ORNL/UT nn' meeting • July 12, 2022

Option of Venetian Blinds reflector for NNbar

HighNESS/NNbar meeting at ESS • Lund • 23 June 2022

For simulations here I used the file of neutron events from MCNPL LD_2 through the LBP provided by Richard Wagner on June 3

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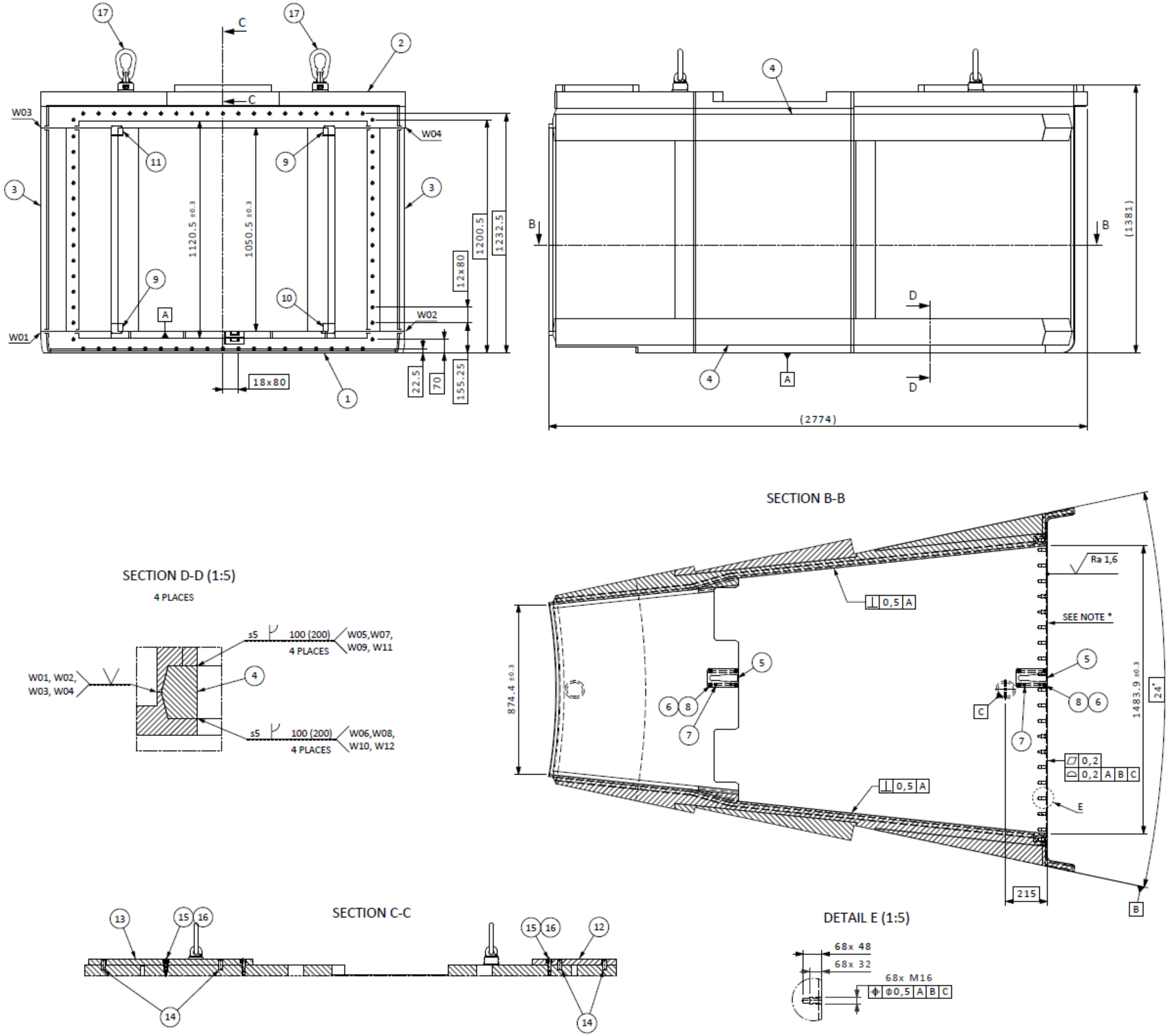
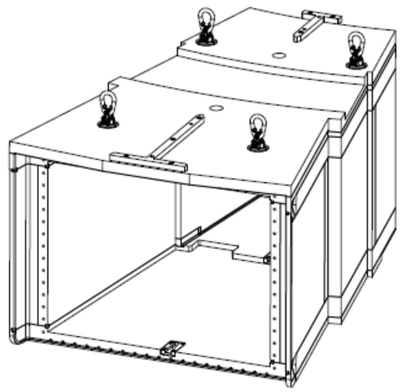
New LBP May 2022

Revision Notes

Revision 12 Changes:
Part/Assembly Revision Comment:
Side wall weld interface updated.





NOTE *:
THIS SURFACE TO BE MACHINED AND THREADED AFTER WELDING

WELD 01-04 TO BE PERFORMED ACCORDING TO WPS AND DOCUMENTED ON WELD LIST

COMPONENT 1-3 WELDED ACCORDING TO ISO 5817 CLASS B (HIGH) ALONG ALL 4 EDGES

NN-BAR PORT SHALL HAVE A SURFACE FINISH OF MAX Ra 1,6 ON ALL INTERIOR SURFACES

SHARP EDGES BROKEN

PARALLEL PINS SHOULD HAVE A SMALL GROOVE ALONG ITS LENGTH TO PREVENT TRAPPED AIR

PROTECT INTERNAL PORT FROM CONTAMINATION AND SCRATCHES

INTERNAL PORTS TO BE CHECKED AND CLEANED BEFORE ADDITIONAL ASSEMBLY

NNBAR TUBE TO BE LIFTED WITH SPREADER BARS SO THAT THE LIFTING POINTS IS LOADED VERTICALLY

INSPECTION PLAN FOR ASSEMBLY ESS-0338748
QUALITY CLASS MQC4A

DESIGN PRESSURE: 1 BAR(g) / VACUUM
TEST PRESSURE: 1,43 BAR(g)

MEDIA: VACUUM
TEST GROUP: 3B
PED KAT. IV, MODUL G

Item No.	Part Number	Qty	CAD Number	Title	Description	Material	Material std	Material cert.
17	ESS-0681166	4	ESS-0681166	LIFTING POINT M36X50	JDT TP10,0 M36X50	-	-	2.1
16	ESS-0311664	7	ESS-0311082	WASHER	NORD-LOCK NL16SS	1.4404	-	2.1
15	ESS-0195786	7	ESS-0070327	HEXAGON ALLEN HEAD	ISO 4762 M16x45	A4-80	ISO 3506-1	2.1
14	ESS-0223209	4	ESS-0221269	PIN	ISO 2338 20h8x50	-	-	2.1
13	ESS-1094823	1	ESS-1094822	GUIDE RAIL LOW	PLATE 850x500x35	1.0577	EN 10088-2	-
12	ESS-1094826	1	ESS-1094825	T-GUIDE LOW	PLATE 430x250x35	1.0577	EN 10088-2	-
11	ESS-0321320	1	ESS-0320792	FILLER WEDGE NO 3	PLATE 217x55x50	1.4404	EN 10088-2	3.1
10	ESS-0321318	1	ESS-0321250	FILLER WEDGE NO 2	PLATE 217x55x50	1.4404	EN 10088-2	3.1
9	ESS-0321317	2	ESS-0318728	FILLER WEDGE NO 1	PLATE 217x55x50	1.4404	EN 10088-2	3.1
8	ESS-0194335	8	ESS-0069394	HEXAGON ALLEN HEAD	ISO 4762 M10x30	A4-80	ISO 3506-1	2.1
7	ESS-0321315	4	ESS-0318717	PARALLEL PIN	ISO 8734-20x40-C1	-	-	2.1
6	ESS-0321312	8	ESS-0318714	WASHER	NORD-LOCK NL10SS	1.4404	-	2.1
5	ESS-0321314	2	ESS-0318696	GUIDE PLATE BACK	PLATE 160x100x30	1.4404	EN 10088-2	3.1
4	ESS-0321321	4	ESS-0318685	FILLER PLATE	PLATE 2645x262x135	1.4404	EN 10088-2	3.1
3	ESS-0321316	2	ESS-0321249	NN-BAR FRAME SIDE PLATE	PLATE 2800x1051x217	1.4404	EN 10028-7	3.1
2	ESS-0321322	1	ESS-0321248	NN-BAR FRAME TOP PLATE	PLATE 2781x1878x185	1.4404	EN 10028-7	3.1
1	ESS-0321324	1	ESS-0321247	NN-BAR FRAME BOTTOM PLATE	PLATE 2712x1878x110	1.4404	EN 10028-7	3.1

Title & Supplementary Title: NNBAR FRAME
SYSTEM 1098
Document Type:
Weight [kg]: 11 329,28
Sheet Type:
Standards: ISO 128, ISO 14405
EUROPEAN SPALLATION SOURCE
Drafted By: stigjorstad
Reviewed By: robertsvensson
Approved By: saraghatnekar
Level of Maturity: P
Integration Maturity:
Document Status: Release
Change Order: ESS-3479328
Drawing Number: ESS-0321251.3
Revision: 12.0
Date of Issue: 2021-06-11
Size: A1
Scale: 1:10
Sheet: 1/1

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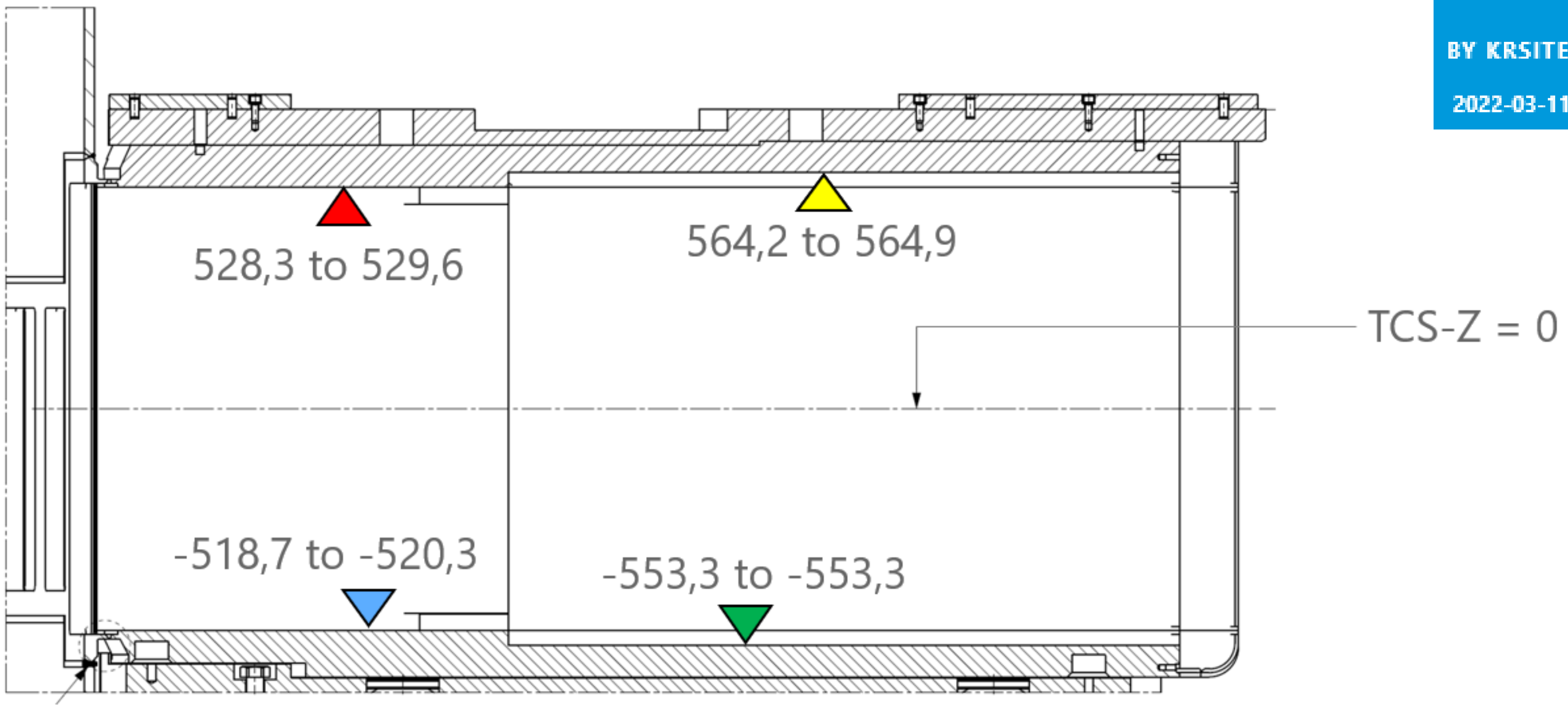
LBP side view. Picture from meeting May 18, 2022

ESS-4001838

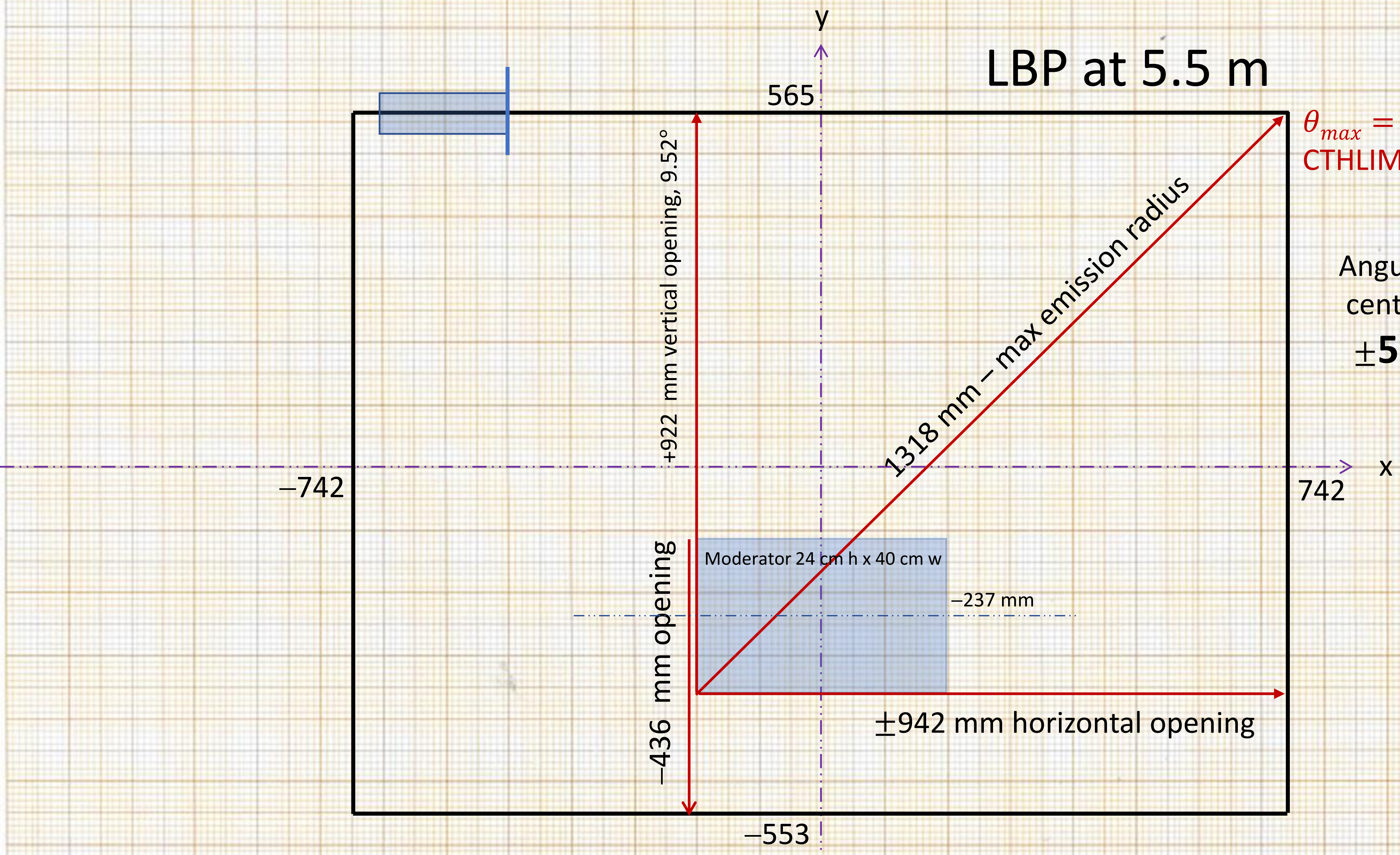
BY KRSITER BLOMBERG

2022-03-11



May 27, 2022

LBP at 5.5 m



$\theta_{max} = 13.477°$

CTHLIM=0.97246

Angular view from the center of coordinates

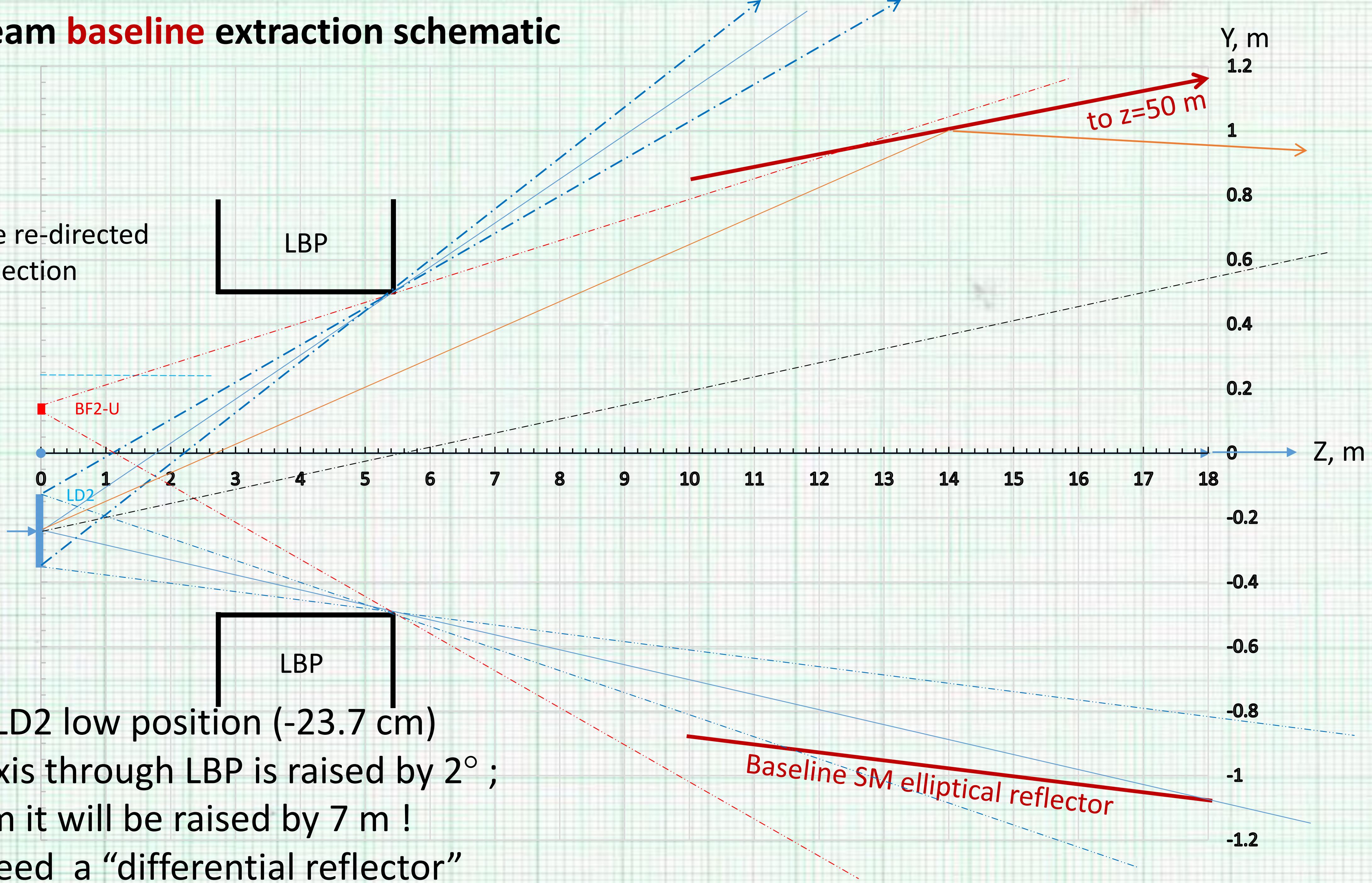
±5.8° × ±7.68°

5/28 Luca: I just checked the MCNP model, -23.7 is the center of the liquid deuterium moderator, in the present design. I think it is what is geometrically allowed, with a viewed surface of 24 cm height, and the need to have a pre-moderator of 2.5 cm between target and moderator.

NNbar beam baseline extraction schematic

Side View

Neutrons are re-directed by single reflection

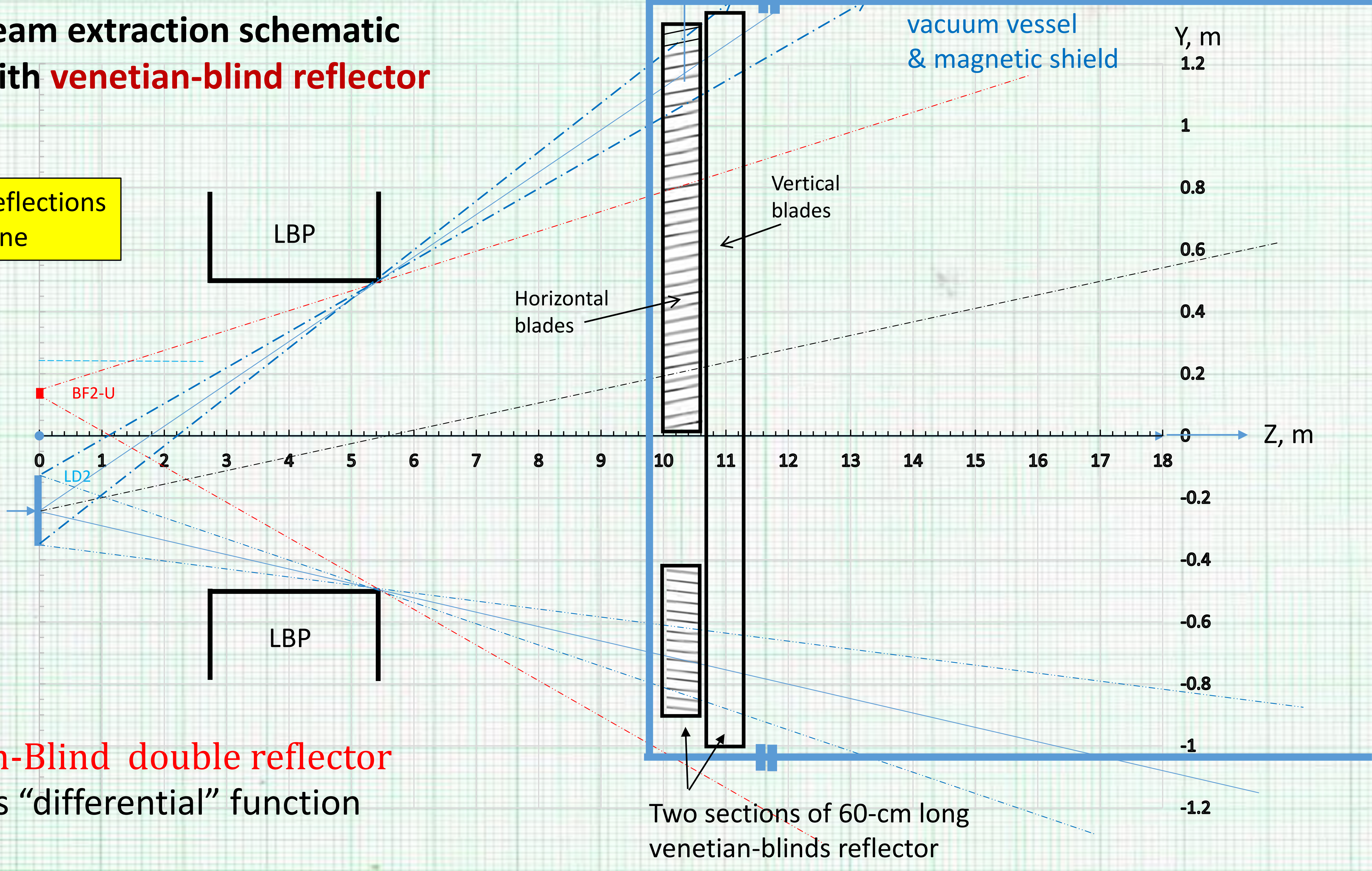


Due to LD2 low position (-23.7 cm)
beam axis through LBP is raised by 2° ;
at 200 m it will be raised by 7 m !
→ we need a "differential reflector"

NNbar beam extraction schematic option with venetian-blind reflector

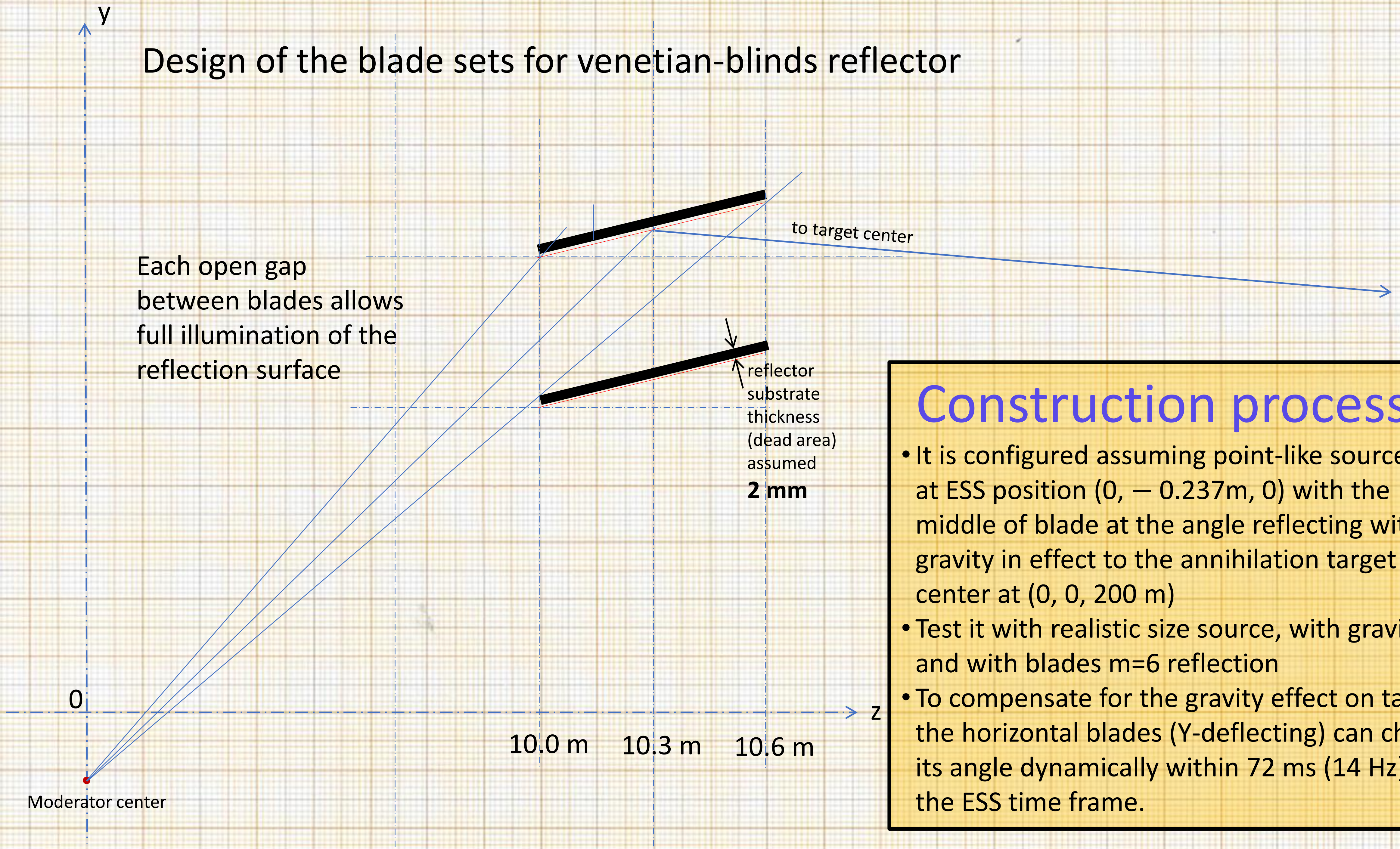
Side View

Two close reflections instead of one



Venetian-Blind double reflector
performs "differential" function

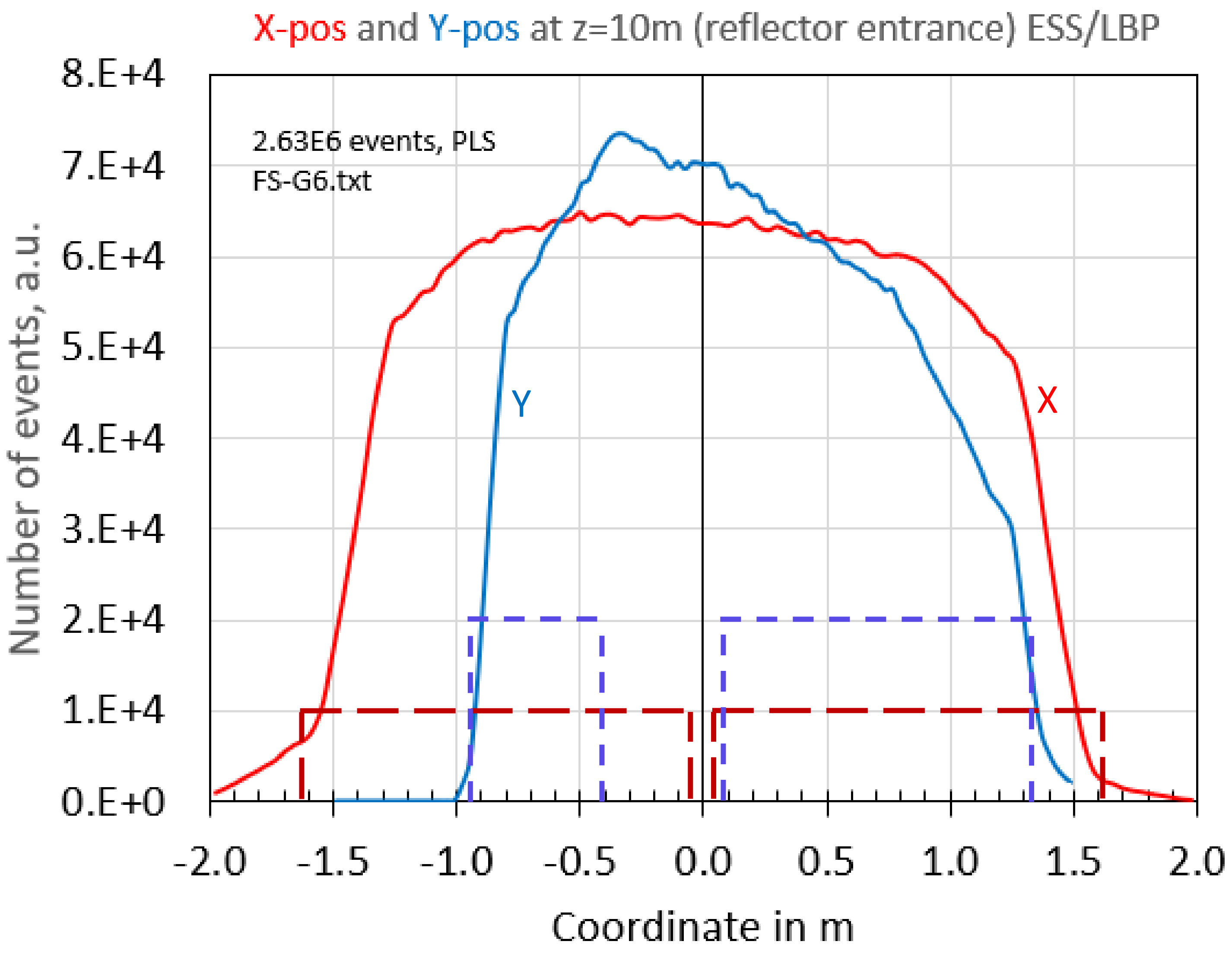
Design of the blade sets for venetian-blinds reflector



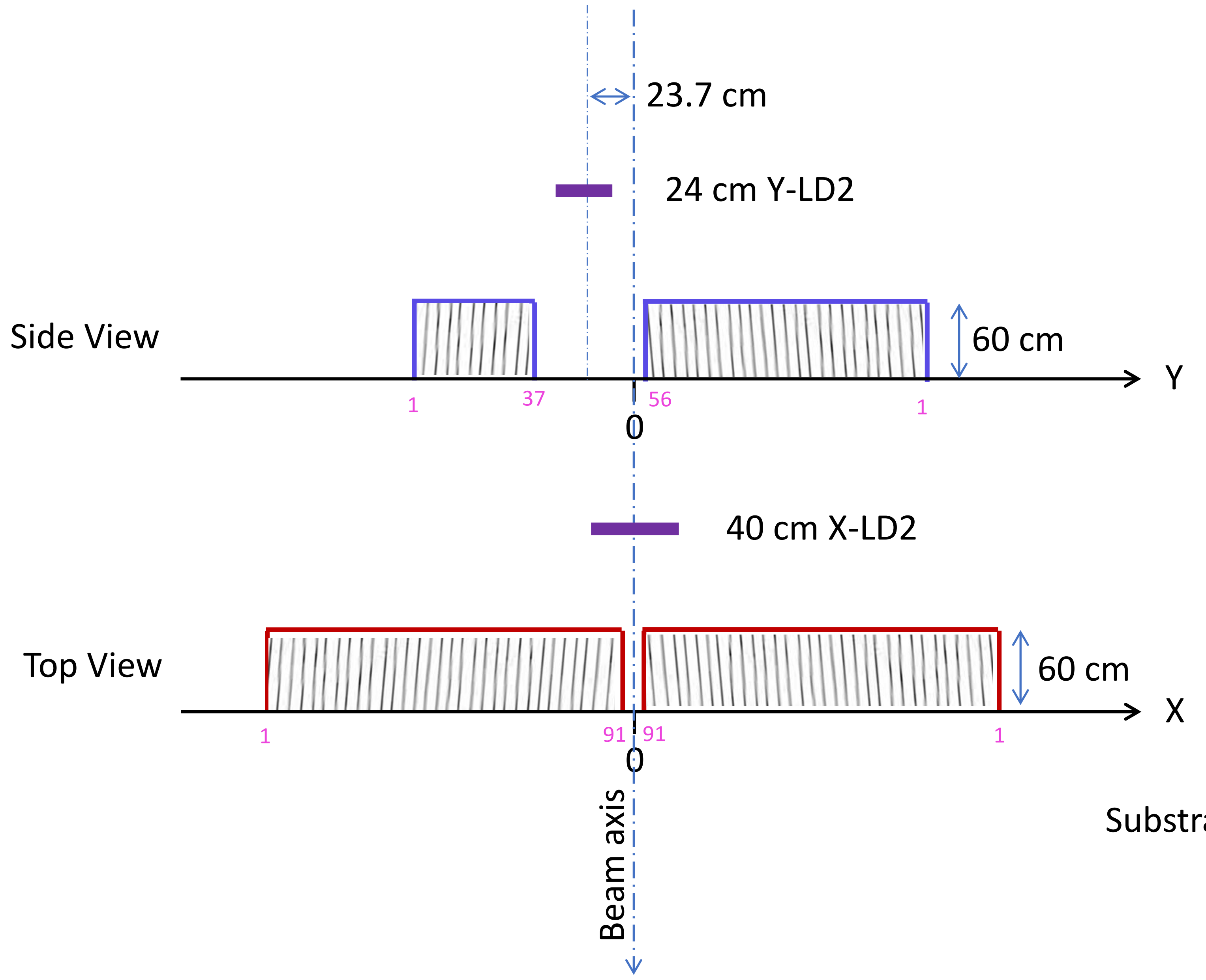
Construction process

- It is configured assuming point-like source at ESS position (0, – 0.237m, 0) with the middle of blade at the angle reflecting without gravity in effect to the annihilation target center at (0, 0, 200 m)
- Test it with realistic size source, with gravity, and with blades m=6 reflection
- To compensate for the gravity effect on target the horizontal blades (Y-deflecting) can change its angle dynamically within 72 ms (14 Hz) of the ESS time frame.

V-B reflector coverage at z=10 m through LBP



Two V-B reflector modules with m=6 (schematic)



Horizontal blades size
330 cm × 60 cm × 2 mm

Vertical blades size
230 cm × 60 cm × 2 mm

Substrate 2-mm thick is assumed

Upper horizontal blades (n=56)

# blade,	ystart,	center pos,	angle,	yend
1	1.319364	1.341147	0.072483	1.362930
2	1.270368	1.291479	0.070257	1.312591
3	1.222878	1.243339	0.068095	1.263799
4	1.176848	1.196676	0.065998	1.216504
5	1.132230	1.151445	0.063962	1.170660
6	1.088981	1.107600	0.061986	1.126220
7	1.047056	1.065099	0.060068	1.083140
8	1.006415	1.023897	0.058207	1.041379
9	0.967018	0.983956	0.056401	1.000895
10	0.928825	0.945236	0.054649	0.961647
11	0.891799	0.907698	0.052948	0.923598
12	0.855904	0.871307	0.051299	0.886710
13	0.821103	0.836025	0.049698	0.850947
14	0.787365	0.801820	0.048145	0.816274
15	0.754655	0.768656	0.046638	0.782658
16	0.722942	0.736504	0.045176	0.750066
17	0.692194	0.705330	0.043758	0.718466
18	0.662383	0.675105	0.042382	0.687827
19	0.633479	0.645800	0.041048	0.658121
20	0.605454	0.617386	0.039753	0.629318
21	0.578282	0.589836	0.038497	0.601391
22	0.551935	0.563124	0.037279	0.574313
23	0.526389	0.537223	0.036097	0.548057
24	0.501620	0.512109	0.034951	0.522599
25	0.477603	0.487758	0.033839	0.497914
26	0.454315	0.464147	0.032760	0.473978
27	0.431734	0.441252	0.031714	0.450769
28	0.409839	0.419052	0.030700	0.428264

~ 5 cm gap

# blade,	ystart,	center pos,	angle,	yend
29	0.388608	0.397525	0.029716	0.406443
30	0.368021	0.376652	0.028761	0.385283
31	0.348059	0.356412	0.027835	0.364764
32	0.328702	0.336785	0.026937	0.344869
33	0.309933	0.317754	0.026066	0.325576
34	0.291732	0.299300	0.025222	0.306868
35	0.274083	0.281405	0.024402	0.288727
36	0.256969	0.264053	0.023608	0.271137
37	0.240374	0.247227	0.022837	0.254079
38	0.224282	0.230910	0.022090	0.237538
39	0.208677	0.215088	0.021365	0.221498
40	0.193545	0.199745	0.020662	0.205944
41	0.178872	0.184867	0.019980	0.190862
42	0.164643	0.170440	0.019319	0.176236
43	0.150845	0.156449	0.018678	0.162053
44	0.137465	0.142883	0.018056	0.148300
45	0.124491	0.129727	0.017453	0.134963
46	0.111909	0.116970	0.016868	0.122031
47	0.099708	0.104599	0.016301	0.109489
48	0.087877	0.092602	0.015751	0.097328
49	0.076404	0.080969	0.015217	0.085535
50	0.065278	0.069688	0.014700	0.074098
51	0.054489	0.058749	0.014198	0.063008
52	0.044027	0.048140	0.013711	0.052254
53	0.033881	0.037853	0.013239	0.041825
54	0.024043	0.027877	0.012782	0.031712
55	0.014502	0.018204	0.012338	0.021905
56	0.005250	0.008823	0.011908	0.012395

~ 1 cm gap

Lower horizontal blades (n=37)

# blade,	ystart,	center pos,	angle,	yend
1	-0.909727	-0.918920	-0.030633	-0.928113
2	-0.886993	-0.895869	-0.029579	-0.904746
3	-0.864949	-0.873518	-0.028557	-0.882088
4	-0.843573	-0.851845	-0.027566	-0.860117
5	-0.822846	-0.830830	-0.026605	-0.838813
6	-0.802748	-0.810452	-0.025673	-0.818155
7	-0.783260	-0.790692	-0.024768	-0.798124
8	-0.764362	-0.771531	-0.023891	-0.778700
9	-0.746037	-0.752951	-0.023041	-0.759864
10	-0.728268	-0.734934	-0.022216	-0.741600
11	-0.711037	-0.717463	-0.021415	-0.723889
12	-0.694329	-0.700522	-0.020639	-0.706714
13	-0.678127	-0.684094	-0.019887	-0.690060
14	-0.662416	-0.668163	-0.019157	-0.673911
15	-0.647180	-0.652716	-0.018449	-0.658251
16	-0.632407	-0.637736	-0.017762	-0.643065
17	-0.618080	-0.623210	-0.017097	-0.628339
18	-0.604188	-0.609124	-0.016451	-0.614060
19	-0.590717	-0.595464	-0.015825	-0.600212
20	-0.577653	-0.582219	-0.015217	-0.586784

~ 2.2 cm gap

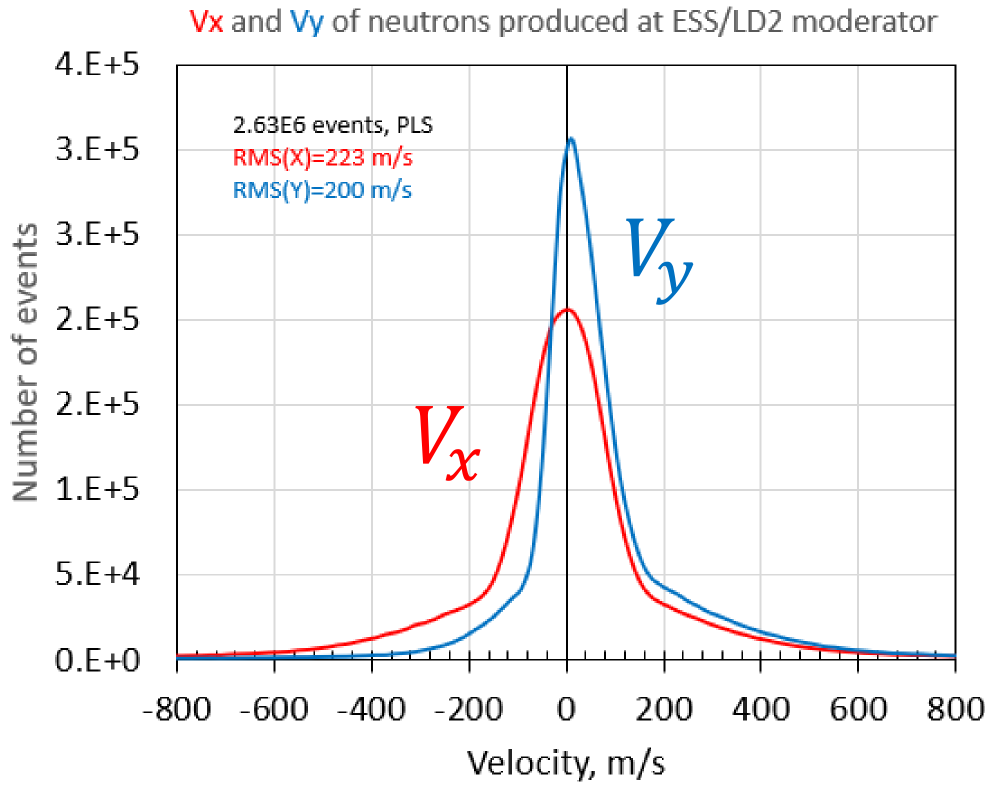
# blade,	ystart,	center pos,	angle,	yend
21	-0.564985	-0.569374	-0.014628	-0.573763
22	-0.552701	-0.556918	-0.014057	-0.561135
23	-0.540788	-0.544839	-0.013503	-0.548891
24	-0.529236	-0.533126	-0.012966	-0.537016
25	-0.518034	-0.521768	-0.012445	-0.525502
26	-0.507171	-0.510754	-0.011940	-0.514336
27	-0.496637	-0.500072	-0.011450	-0.503507
28	-0.486422	-0.489715	-0.010974	-0.493007
29	-0.476516	-0.479670	-0.010514	-0.482824
30	-0.466910	-0.469930	-0.010067	-0.472950
31	-0.457594	-0.460484	-0.009633	-0.463375
32	-0.448561	-0.451325	-0.009213	-0.454089
33	-0.439801	-0.442442	-0.008805	-0.445084
34	-0.431306	-0.433829	-0.008410	-0.436352
35	-0.423068	-0.425476	-0.008027	-0.427884
36	-0.415079	-0.417376	-0.007655	-0.419673
37	-0.407333	-0.409521	-0.007295	-0.411709

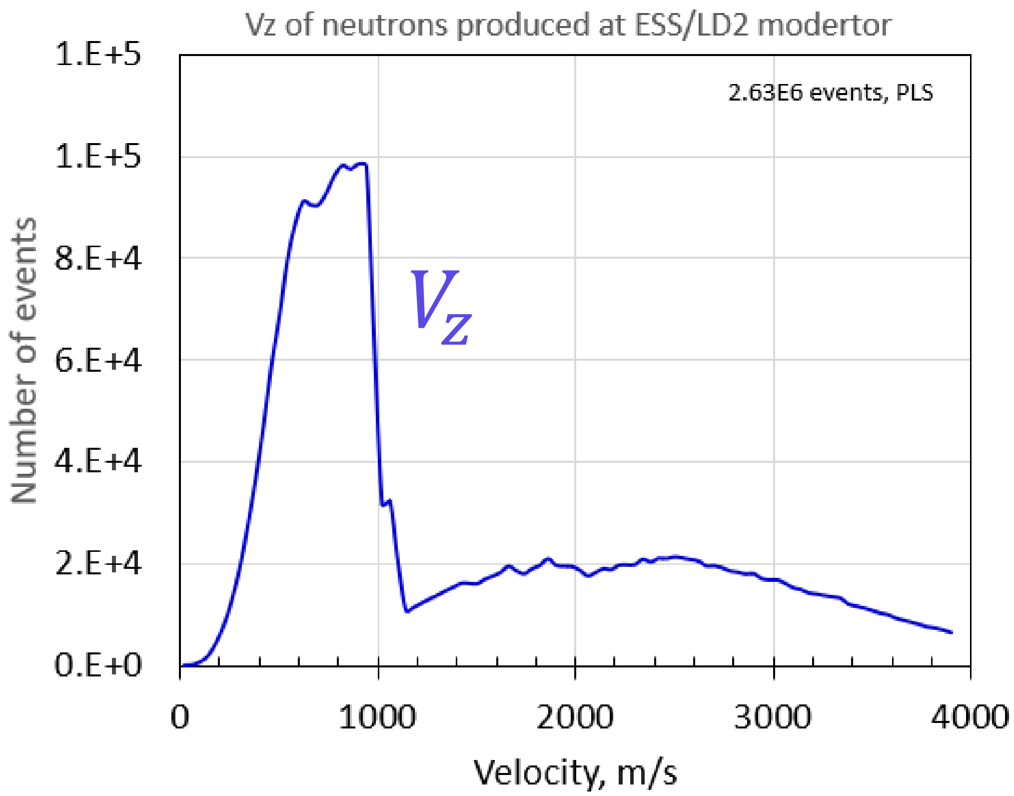
~ 0.78 cm gap

Vertical blades left and right [latter with opposite sign] (n=91) bending in X-direction

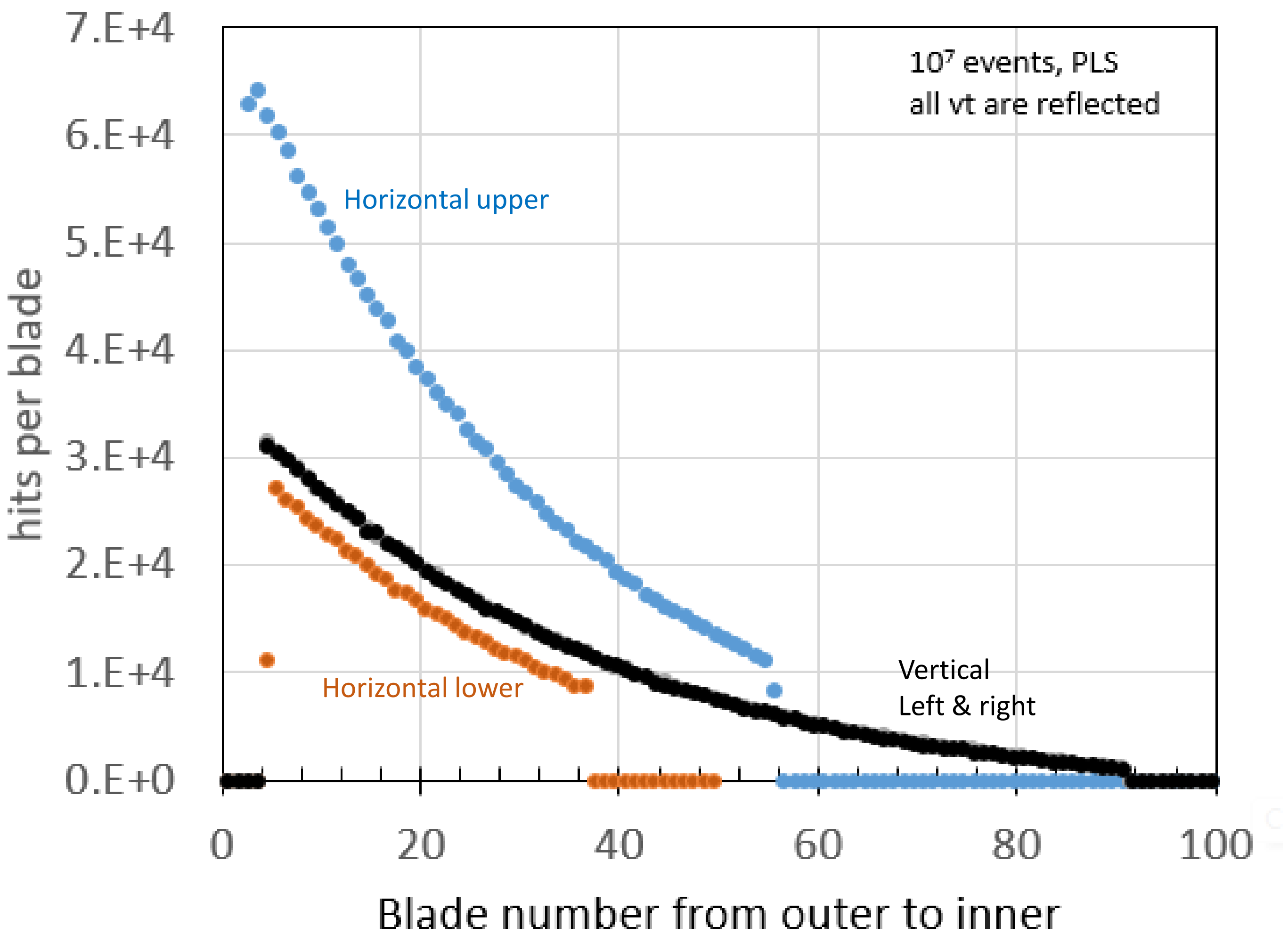
#	ystart,	center	pos,	angle,	yend
1	1.618916	1.64001	0.070198	0.601481	1.661105
2	1.570275	1.590743	0.068121	0.601395	1.611211
3	1.52305	1.54291	0.066101	0.601313	1.562769
4	1.477198	1.496466	0.064138	0.601236	1.515734
5	1.432679	1.451372	0.06223	0.601164	1.470065
6	1.389452	1.407586	0.060374	0.601095	1.425721
7	1.347479	1.36507	0.058571	0.601031	1.382662
8	1.306723	1.323786	0.056818	0.60097	1.34085
9	1.267147	1.283698	0.055114	0.600912	1.300249
10	1.228717	1.24477	0.053458	0.600858	1.260823
11	1.191399	1.206968	0.051849	0.600807	1.222536
12	1.15516	1.170258	0.050285	0.600759	1.185356
13	1.119968	1.134609	0.048765	0.600714	1.149251
14	1.085793	1.09999	0.047288	0.600672	1.114187
15	1.052605	1.06637	0.045852	0.600631	1.080136
16	1.020374	1.03372	0.044457	0.600593	1.047066
17	0.989074	1.002012	0.043102	0.600558	1.014951
18	0.958675	0.971218	0.041785	0.600524	0.983761
19	0.929153	0.941311	0.040505	0.600493	0.95347
20	0.900482	0.912266	0.039261	0.600463	0.924051
21	0.872636	0.884058	0.038053	0.600435	0.895479
22	0.845592	0.856661	0.036879	0.600408	0.86773
23	0.819327	0.830053	0.035738	0.600383	0.840779
24	0.793818	0.804211	0.03463	0.60036	0.814604
25	0.769042	0.779112	0.033553	0.600338	0.789182
26	0.744979	0.754735	0.032507	0.600317	0.76449
27	0.721609	0.731059	0.03149	0.600298	0.740509
28	0.69891	0.708063	0.030503	0.600279	0.717217
29	0.676863	0.685729	0.029543	0.600262	0.694594
30	0.65545	0.664036	0.028611	0.600246	0.672622
31	0.634653	0.642966	0.027706	0.60023	0.65128
32	0.614452	0.622502	0.026826	0.600216	0.630552
33	0.594832	0.602626	0.025971	0.600202	0.610419
34	0.575776	0.58332	0.025141	0.60019	0.590864
35	0.557267	0.564568	0.024334	0.600178	0.57187
36	0.539289	0.546355	0.023551	0.600166	0.553422
37	0.521827	0.528665	0.022789	0.600156	0.535503
38	0.504867	0.511483	0.02205	0.600146	0.518099
39	0.488393	0.494793	0.021331	0.600137	0.501194
40	0.472392	0.478583	0.020634	0.600128	0.484774
41	0.45685	0.462838	0.019956	0.600119	0.468825
42	0.441754	0.447544	0.019297	0.600112	0.453334
43	0.427091	0.432689	0.018657	0.600104	0.438287
44	0.412849	0.41826	0.018036	0.600098	0.423672
45	0.399015	0.404245	0.017432	0.600091	0.409476
46	0.385578	0.390633	0.016845	0.600085	0.395687
47	0.372527	0.37741	0.016276	0.600079	0.382293
48	0.35985	0.364567	0.015722	0.600074	0.369284
49	0.347536	0.352092	0.015185	0.600069	0.356648
50	0.335576	0.339975	0.014663	0.600065	0.344374
51	0.323958	0.328205	0.014155	0.60006	0.332452
52	0.312674	0.316773	0.013662	0.600056	0.320872
53	0.301713	0.305668	0.013184	0.600052	0.309623
54	0.291066	0.294882	0.012719	0.600049	0.298698
55	0.280725	0.284405	0.012267	0.600045	0.288085
56	0.27068	0.274228	0.011828	0.600042	0.277777
57	0.260923	0.264343	0.011402	0.600039	0.267764
58	0.251445	0.254742	0.010988	0.600036	0.258038
59	0.24224	0.245416	0.010586	0.600034	0.248591
60	0.233298	0.236357	0.010195	0.600031	0.239415
61	0.224612	0.227557	0.009816	0.600029	0.230502
62	0.216176	0.21901	0.009447	0.600027	0.221844
63	0.207981	0.210708	0.009089	0.600025	0.213435
64	0.200021	0.202644	0.008742	0.600023	0.205266
65	0.19229	0.194811	0.008404	0.600021	0.197332
66	0.184779	0.187202	0.008076	0.60002	0.189625
67	0.177484	0.179812	0.007757	0.600018	0.182139
68	0.170399	0.172633	0.007447	0.600017	0.174867
69	0.163516	0.16566	0.007146	0.600015	0.167804
70	0.15683	0.158887	0.006854	0.600014	0.160943
71	0.150336	0.152308	0.006571	0.600013	0.154279
72	0.144029	0.145917	0.006295	0.600012	0.147806
73	0.137902	0.13971	0.006027	0.600011	0.141518
74	0.13195	0.13368	0.005767	0.60001	0.13541
75	0.126169	0.127824	0.005514	0.600009	0.129478
76	0.120554	0.122135	0.005269	0.600008	0.123715
77	0.1151	0.116609	0.005031	0.600008	0.118118
78	0.109802	0.111241	0.004799	0.600007	0.112681
79	0.104655	0.106028	0.004574	0.600006	0.1074
80	0.099657	0.100963	0.004356	0.600006	0.10227
81	0.094801	0.096044	0.004144	0.600005	0.097287
82	0.090085	0.091266	0.003937	0.600005	0.092447
83	0.085503	0.086625	0.003737	0.600004	0.087746
84	0.081053	0.082116	0.003543	0.600004	0.083179
85	0.076731	0.077737	0.003354	0.600003	0.078743
86	0.072532	0.073483	0.00317	0.600003	0.074435
87	0.068454	0.069352	0.002992	0.600003	0.070249
88	0.064493	0.065338	0.002819	0.600002	0.066184
89	0.060645	0.06144	0.002651	0.600002	0.062235
90	0.056907	0.057653	0.002487	0.600002	0.058399
91	0.053277	0.053975	0.002329	0.600002	0.054674

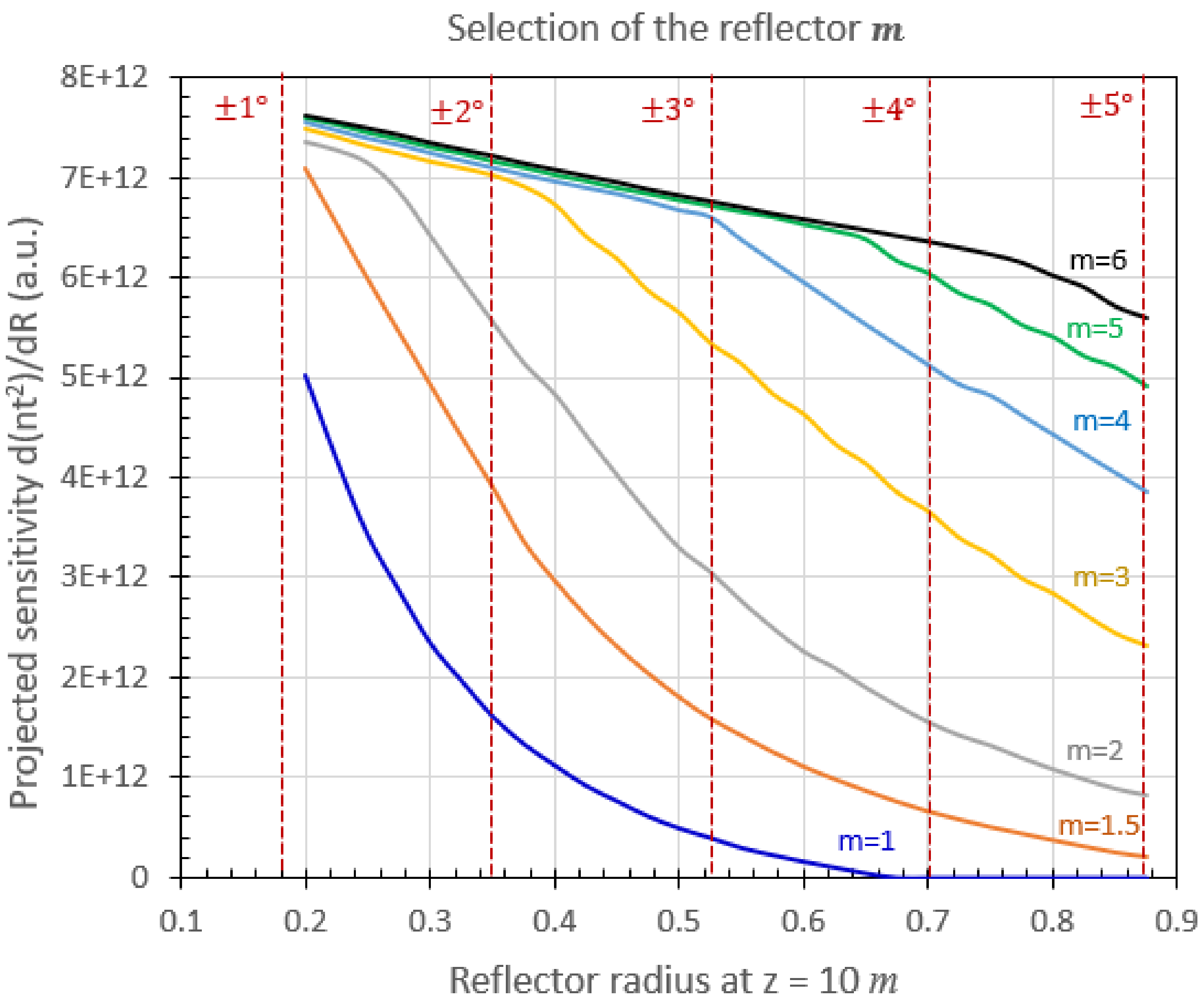
Velocity components at the source



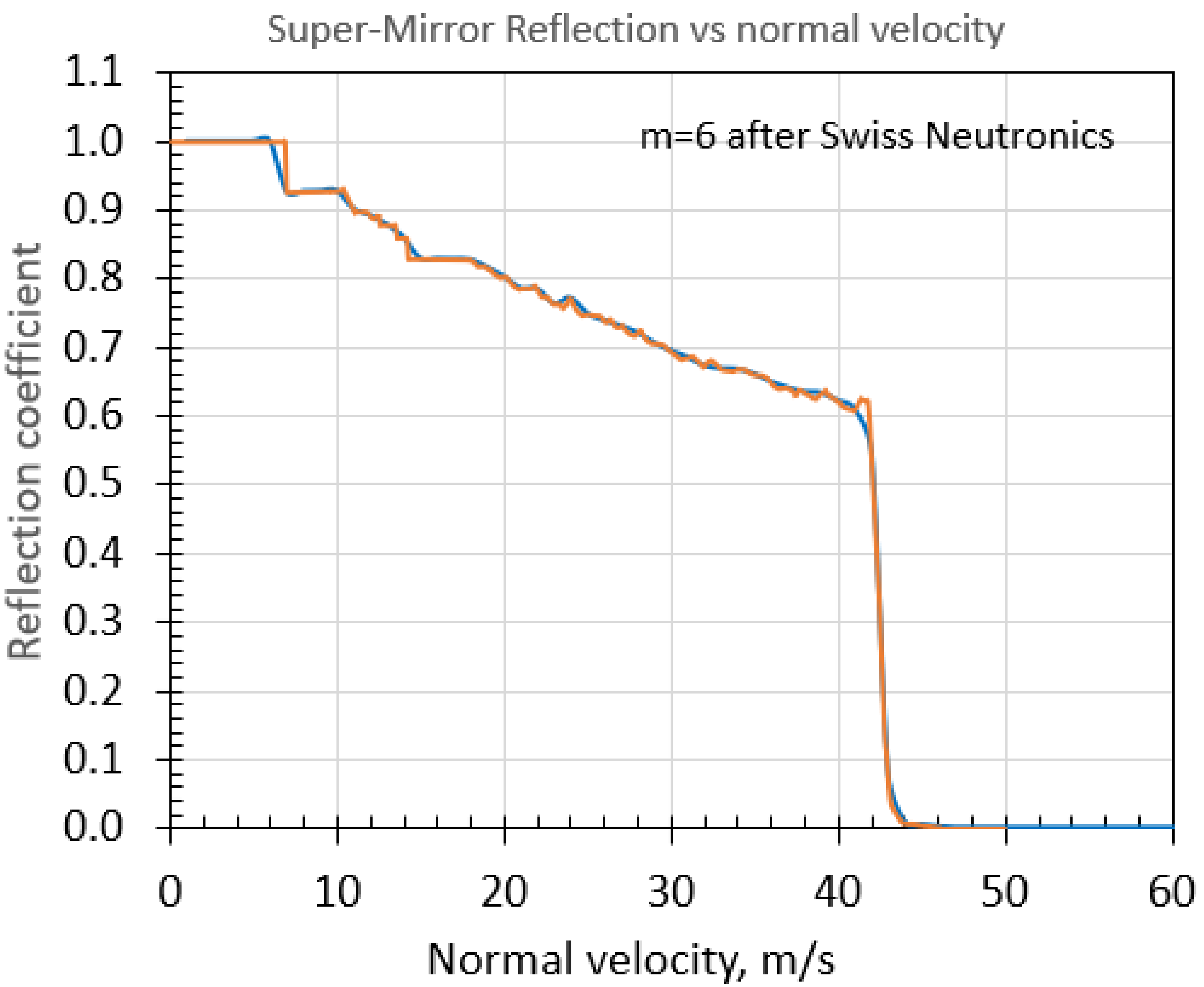


Blades hits vs blade number in stack, g=9.81 m/s^2

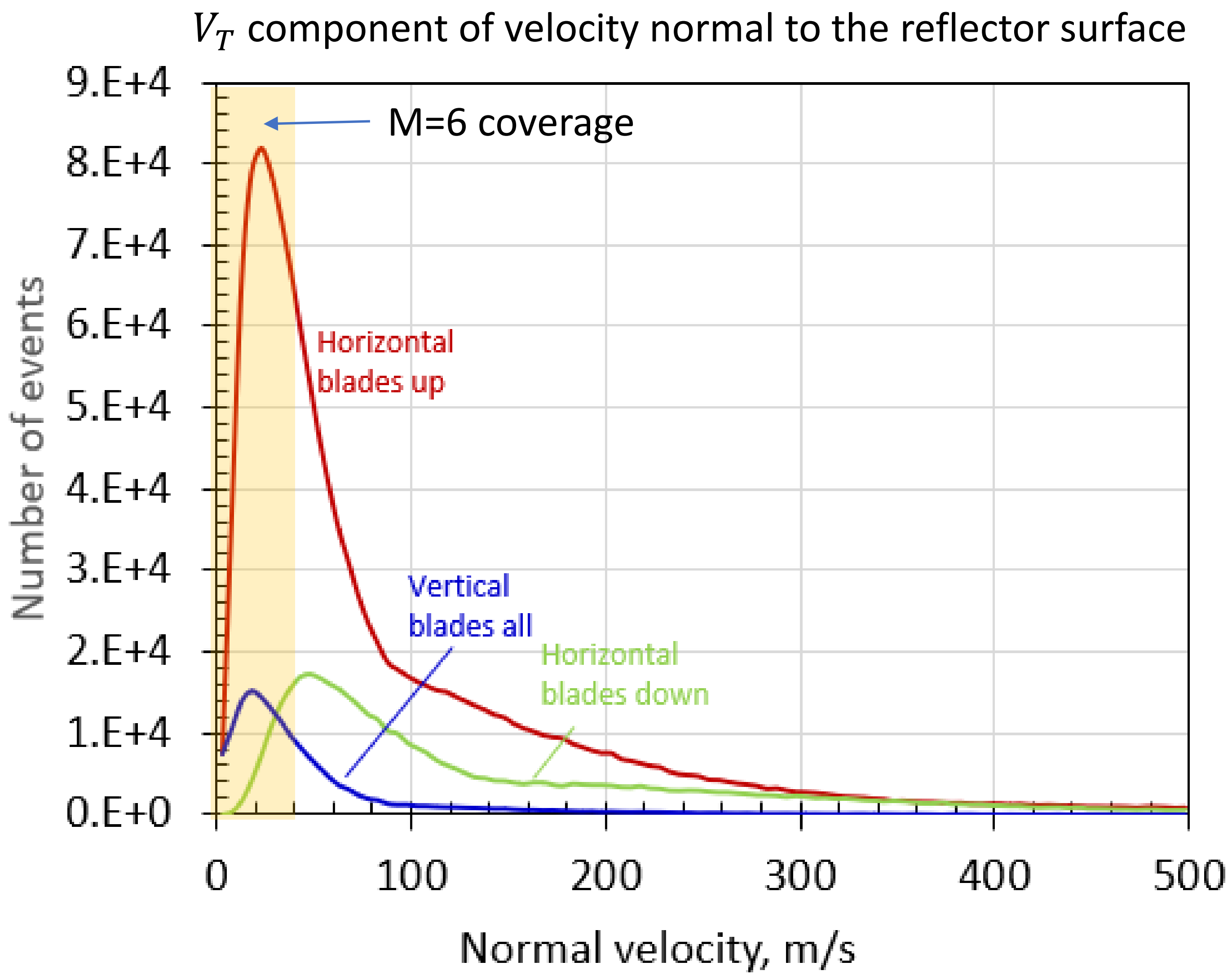




Selection of the reflector m
Projected sensitivity d(nt²)/dR (a.u.)
Reflector radius at z = 10 m
±1°
±2°
±3°
±4°
±5°
m=6
m=5
m=4
m=3
m=2
m=1.5
m=1
0
1E+12
2E+12
3E+12
4E+12
5E+12
6E+12
7E+12
8E+12
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9

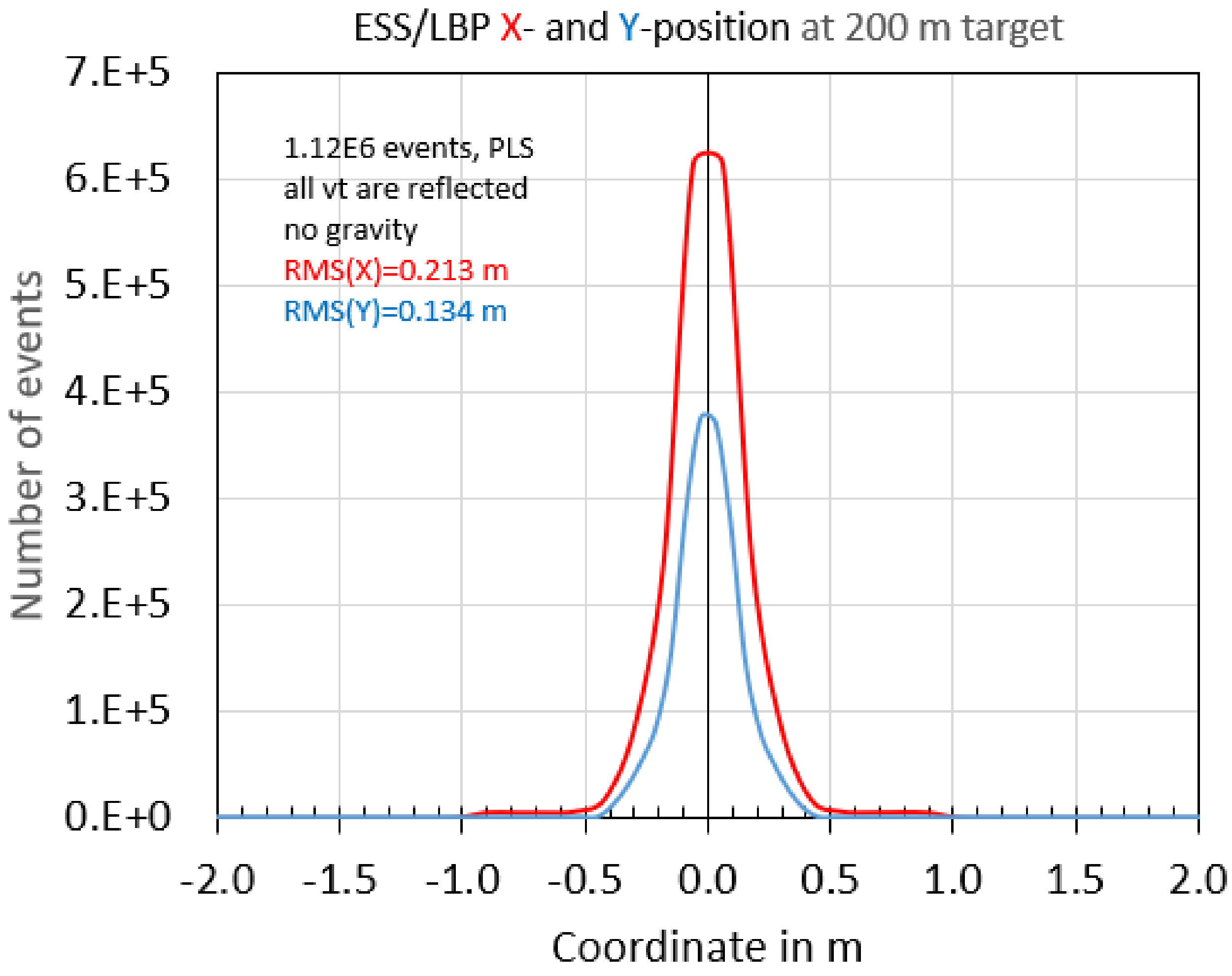


SwissNeutronics
Neutron Optical Components & Instruments



V_T component of velocity normal to the reflector surface
M=6 coverage
Horizontal blades up
Vertical blades all
Horizontal blades down
Number of events
9.E+4
8.E+4
7.E+4
6.E+4
5.E+4
4.E+4
3.E+4
2.E+4
1.E+4
0.E+0
0
100
200
300
400
500
Normal velocity, m/s

For point-like source and without gravity the beam size on the target is determined by the z-length of the flat blades (60 cm)



NNbar simulations summary for Venetian-Blinds Reflector with LBP geometry

YK, June 12-2022

Detector efficiency 100%   Target dia 2 m.

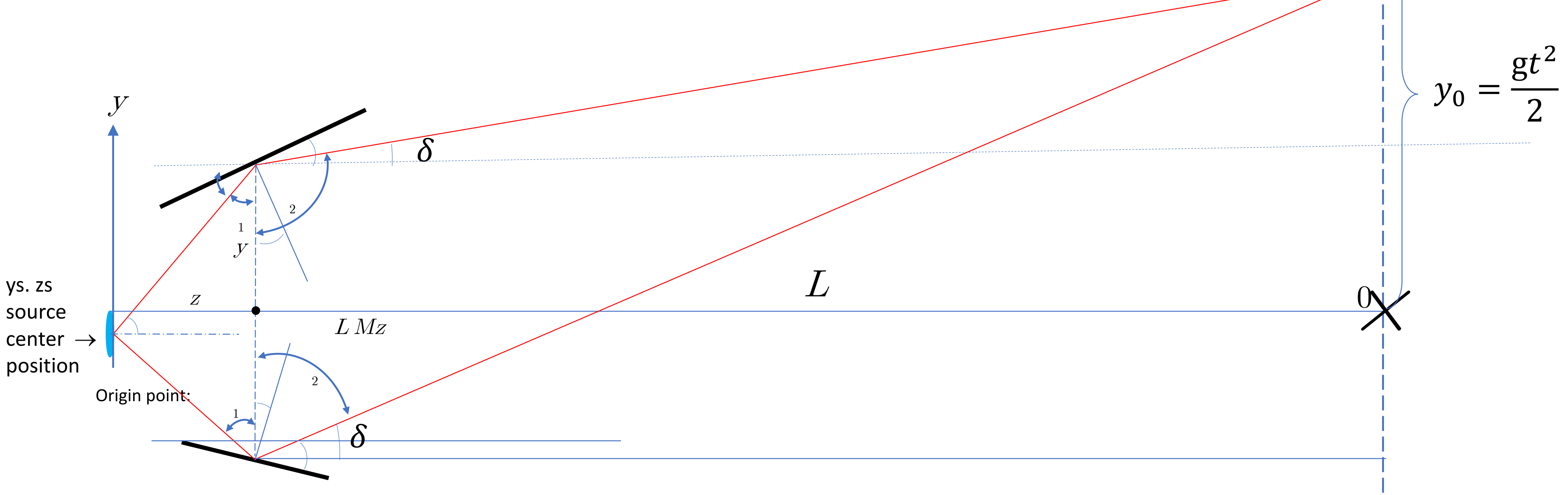
	File	Source	events in LBP	weight	g=	target offset	Reflector m	Nt^2 n·s	ILL units
Point-like source, all reflected, g=0	PLS-0.txt	Point-linke , low LD2 only, LBP	2.635E+06	w	0	0	∞	4.76E+12	2,642
Point-like source, all reflected, g=9.81	PLS-G.txt	Point-linke , low LD2 only, LBP	2.635E+06	w	9.81	-0.8	∞	3.90E+12	2,165
Full LD2 source, all reflected, g=0	FS-0.txt	Full source , low LD2 only, LBP	2.635E+06	w	0	0	∞	6.60E+11	367
Full LD2 source, all reflected, g=9.81	FS-G.txt	Full source , low LD2 only, LBP	2.635E+06	w	9.81	-1.2	∞	5.62E+11	312
Full LD2 source, M=6, g=0	FS-06.txt	Full source , low LD2 only, LBP	2.635E+06	w	0	0	6	4.05E+11	225
Full LD2 source, M=6, g=9.81	FS-G6.txt	Full source , low LD2 only, LBP	2.635E+06	w	9.81	-1.0	6	2.99E+11	166
Upper and lower moderator sources, M=6, g=9.81	ULS-G6.txt	UL full source, both, LBP	3.709E+06	w	9.81	-1.0	6	3.03E+11	168

1 ILL unit is 1.8×10^9 n·s
The detector efficiency is 100%

Moving Blades (only horizontal)

Reflector geometry for moving blades

only vertical plane, no gravity



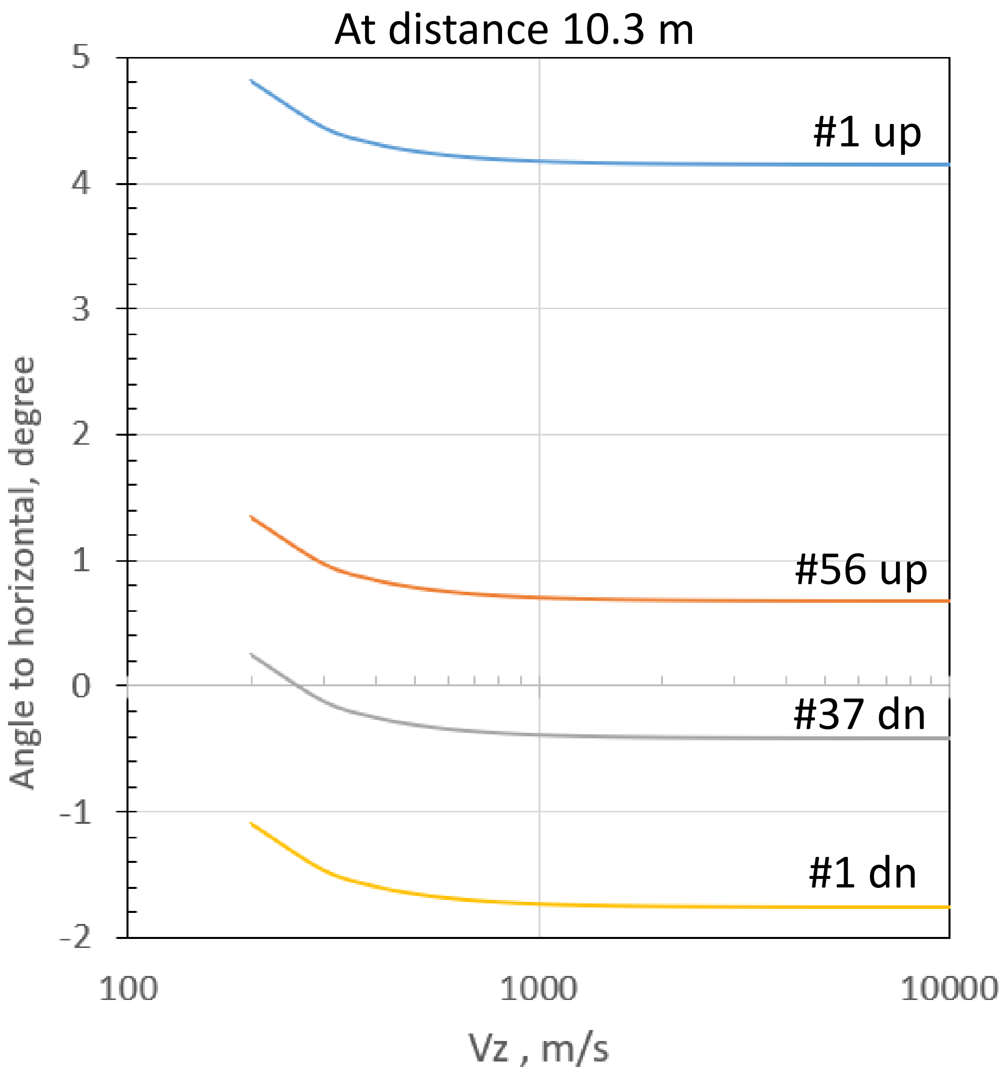
For reflection point at (y , z):

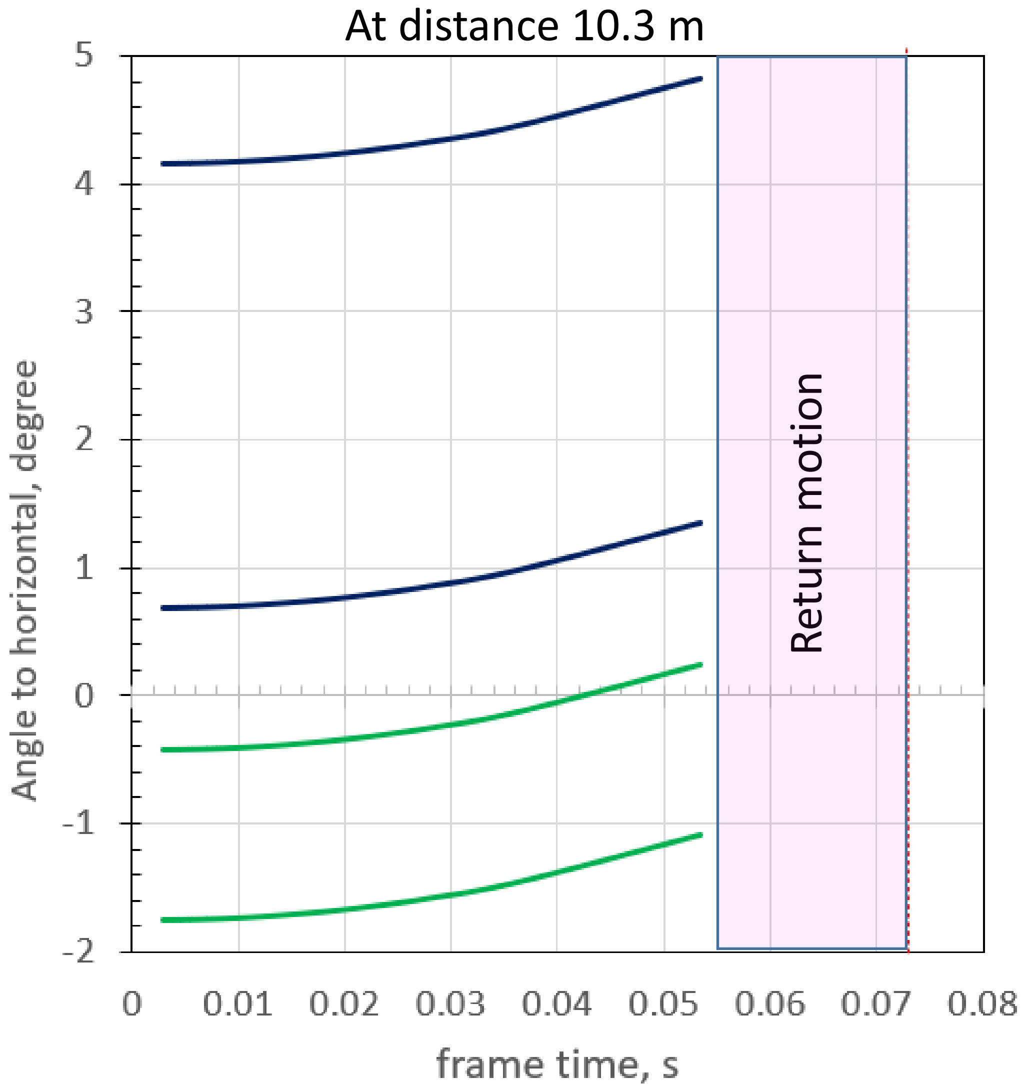
$$\tan\alpha_1 = \frac{z - zs}{y - ys}$$

$$\tan\delta = (y_0 - y)/(\mathrm{L} - \mathrm{z})$$
$$\delta = \mathrm{atan}(tan\delta)$$
$$\alpha_2 = 90° + \delta$$

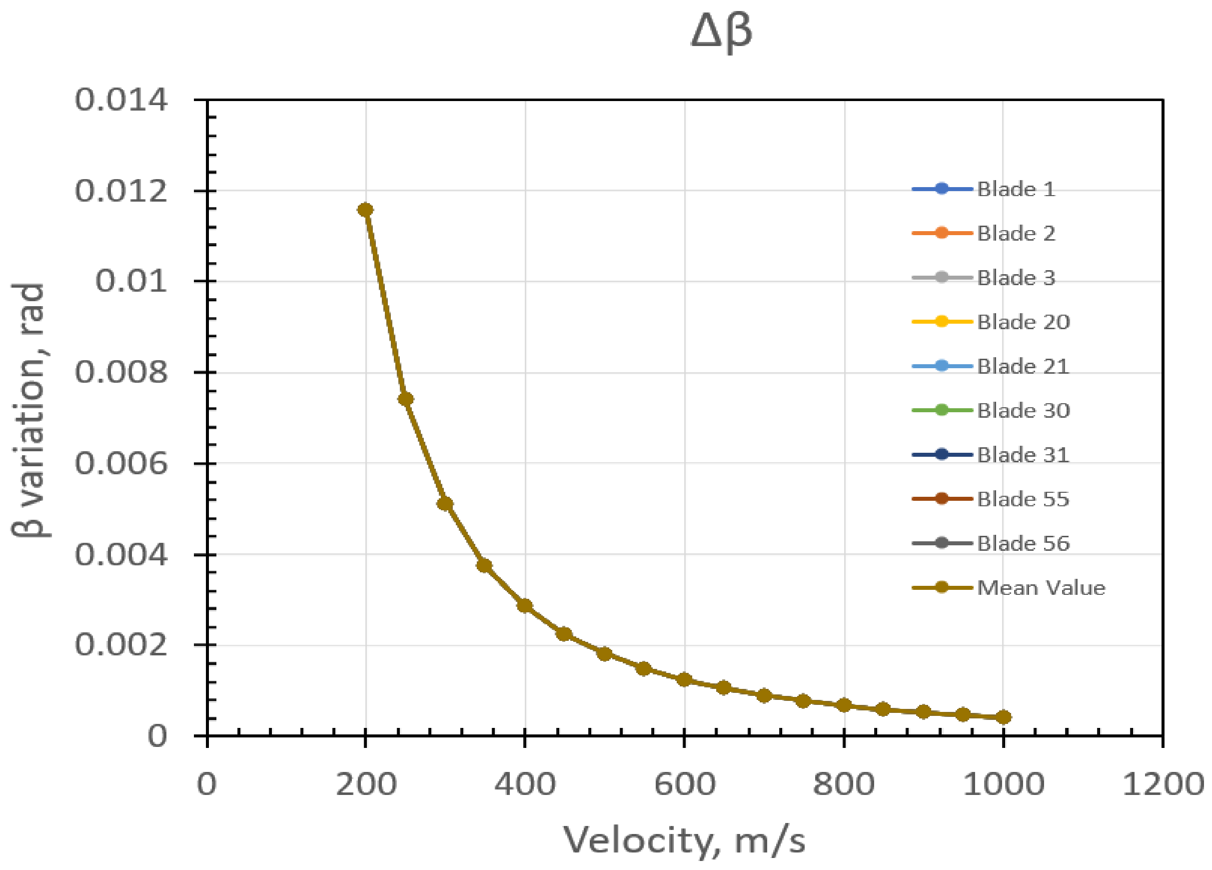
$$\alpha_1 + \beta = \alpha_2 - \beta; \quad \beta = \frac{\alpha_2 - \alpha_1}{2}$$

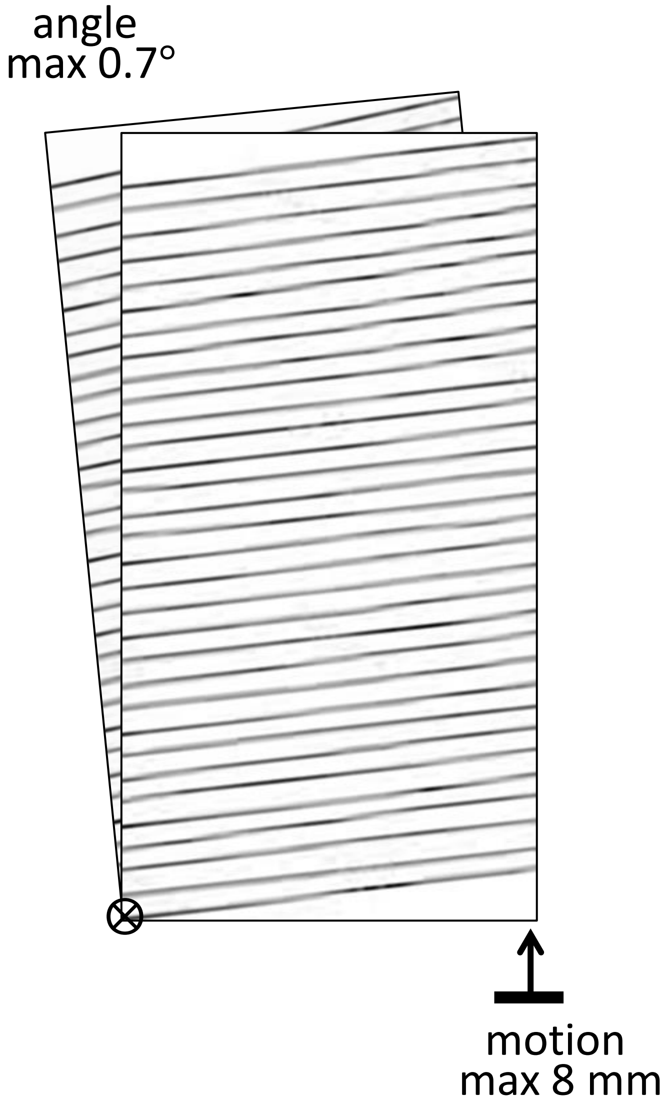
Small motion of horizontal blades of V-B reflector within 72 msec time frame (14 Hz) of ESS dynamic angle that focuses n to the target center at (0,0,200) depending on reflection time.



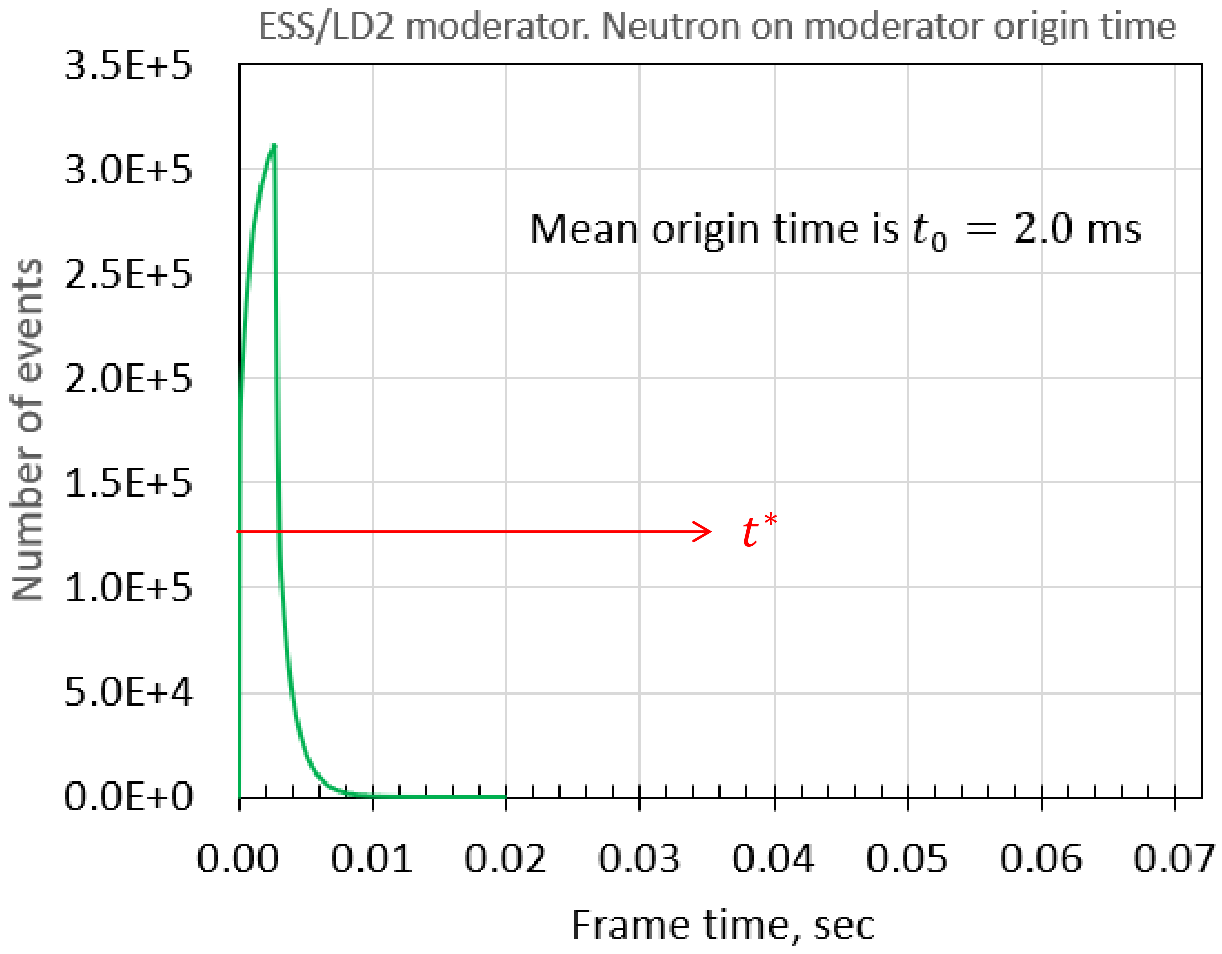


Since the variation of angle with velocity for each blade (1-56) is the same one can think of the rigid structure of the stack of blades in a single module that will be pivoted around one axis (at the beginning of blade #56)

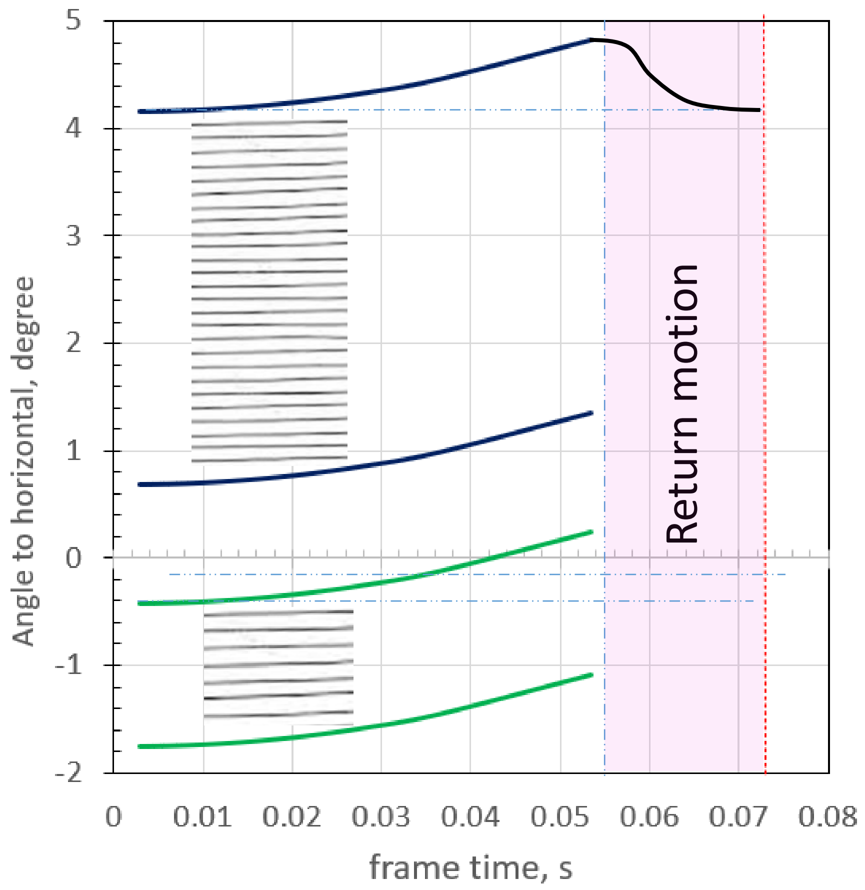




Angle – time correction $\beta = \beta(t^* - t_0)$ for distance 10.3 m



Required common angle motion is ~ 0.7° or the motion of one side of the 60-cm blade package by 7.3 mm. It can be made with piezo – actuators.



10 m / 200 m/s =50 ms

NNbar simulations summary for Venetian-Blinds Reflector with LBP geometry

YK, June 12-2022

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FS-0.txt	Full source , low LD2 only, LBP	2.635E+06	w	0	0	∞	6.60E+11	367
FS-G.txt	Full source , low LD2 only, LBP	2.635E+06	w	9.81	-1.2	∞	5.62E+11	312
FS-06.txt	Full source , low LD2 only, LBP	2.635E+06	w	0	0	6	4.05E+11	225
FS-G6.txt	Full source , low LD2 only, LBP	2.635E+06	w	9.81	-1.0	6	2.99E+11	166
ULS-G6.txt	UL full source, both, LBP	3.709E+06	w	9.81	-1.0	6	3.03E+11	168
FS-G6M.txt	UL full source, both, LBP	2.635E+06	w	9.81	-1.0	6	3.65E+11	203

Moving blades

Effect of the moving blades will be larger for colder spectrum of neutrons.

Comparison

At 5 MW

Richard Wagner on April 12, 2022

Using MCNPL from April 2022.

Same optics as with Esben spectra (baseline)

- Ratio FOM: 310 / 468 = 0.66
- Ratio Area: (15x15)cm^2 / (24x40)cm^2 = 0.23
- FOM for LD2_ESS (Esben's model): 290 (@5MW)

- Is Esben's model calculated with LD2 position at $-23.7\ cm$?
- Detector efficiency assumed 50 %
- "ILL unit" is 1.8×10^9 n·s

At 2 MW "Esben's model" FOM=116

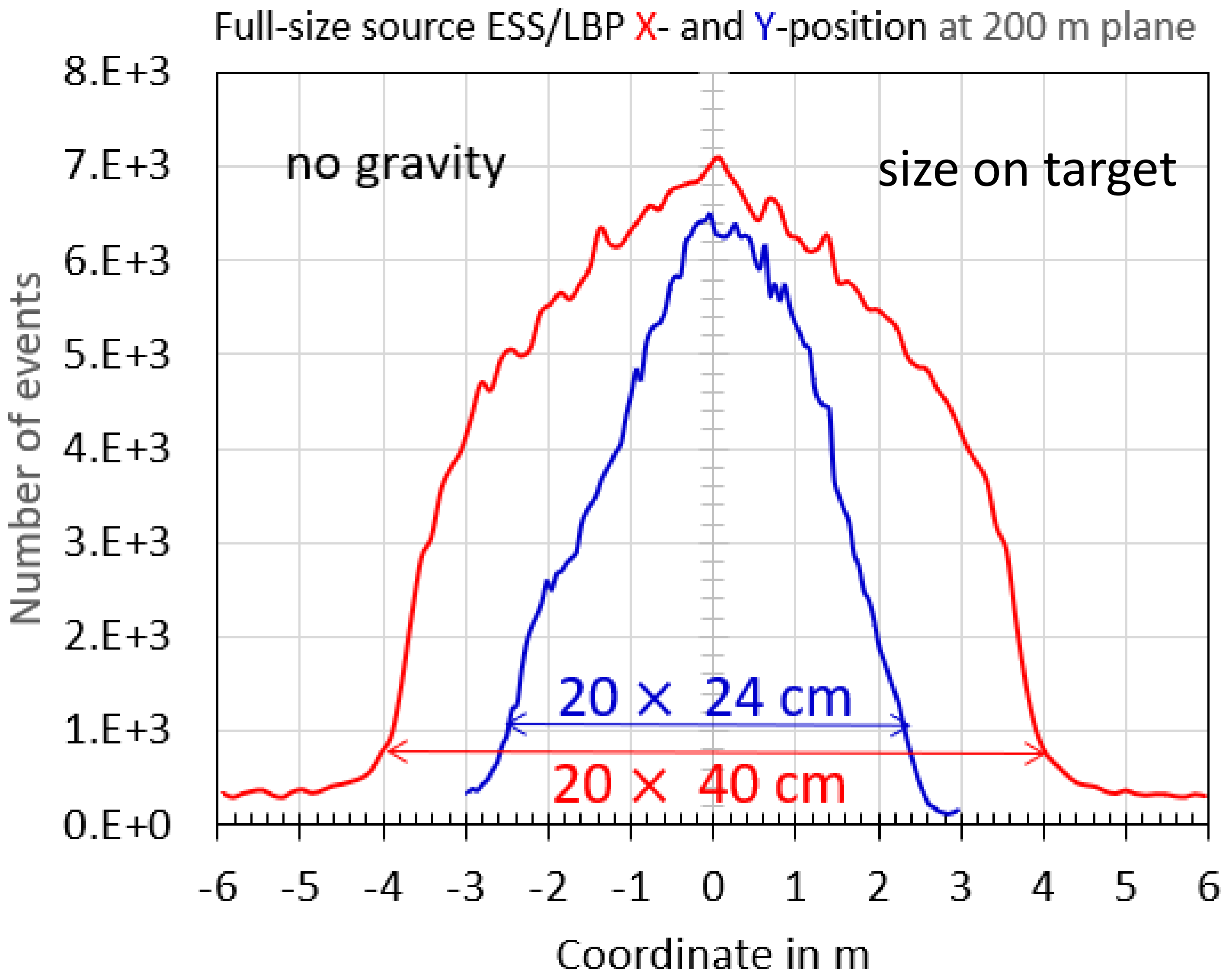
24x40 LD2 FOM=187

current FOM=101

Taken at 50% of detector efficiency VB reflector shows

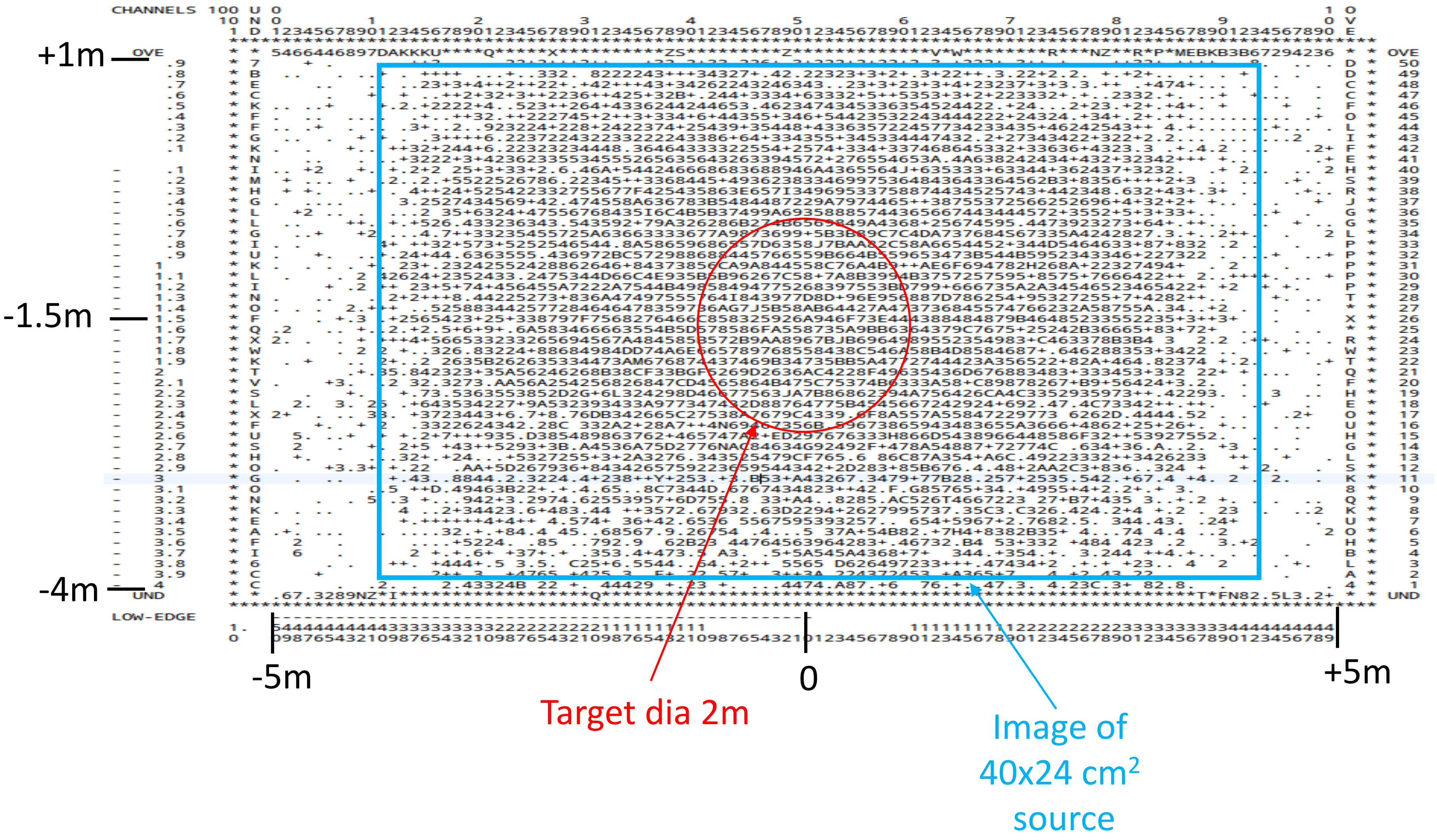
This result should be confirmed by independent simulations

If reflector is at z=10 m the image at z=200 m reproduces the source with magnification of × 20



X-Y on the target plane weighted by Nt^2

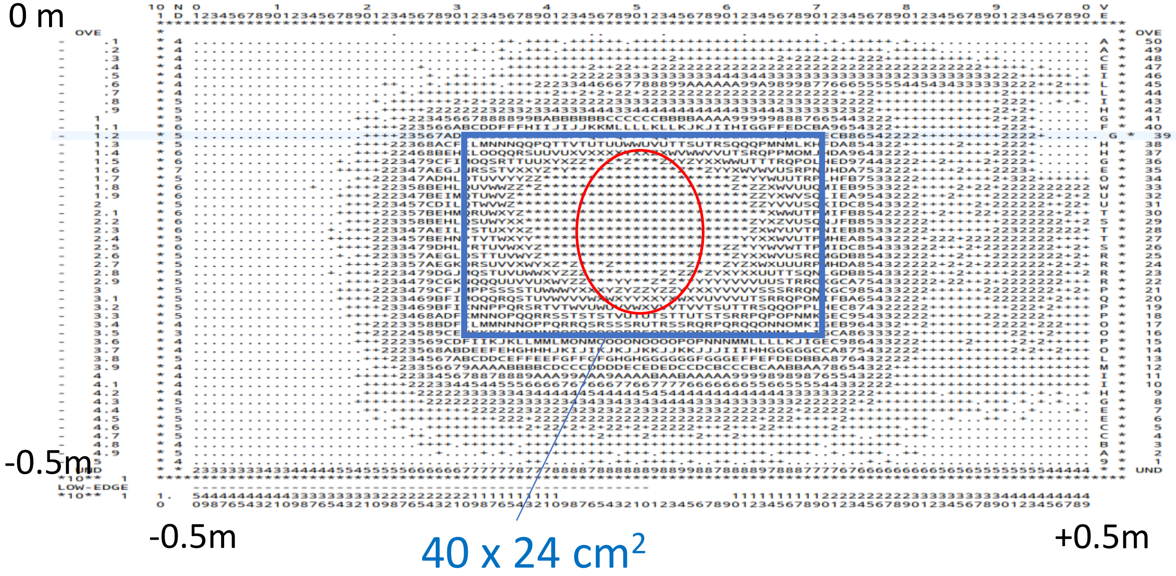
LBP LD2 source,
gravity ON,
m=6 reflector,
target displacement -1.5 m
NO moving blades

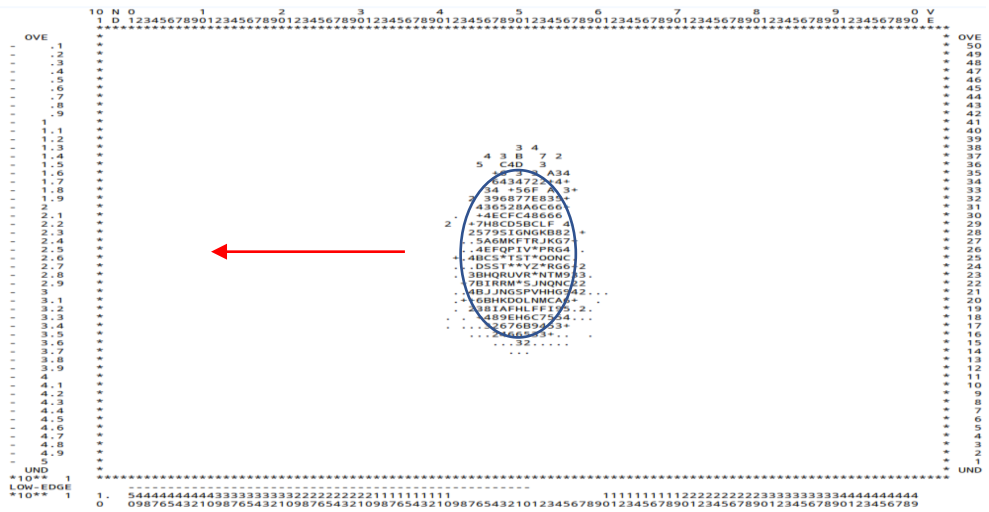


Target hits select only small area of the source.
Not all the area of the source is efficient for creating Nt^2

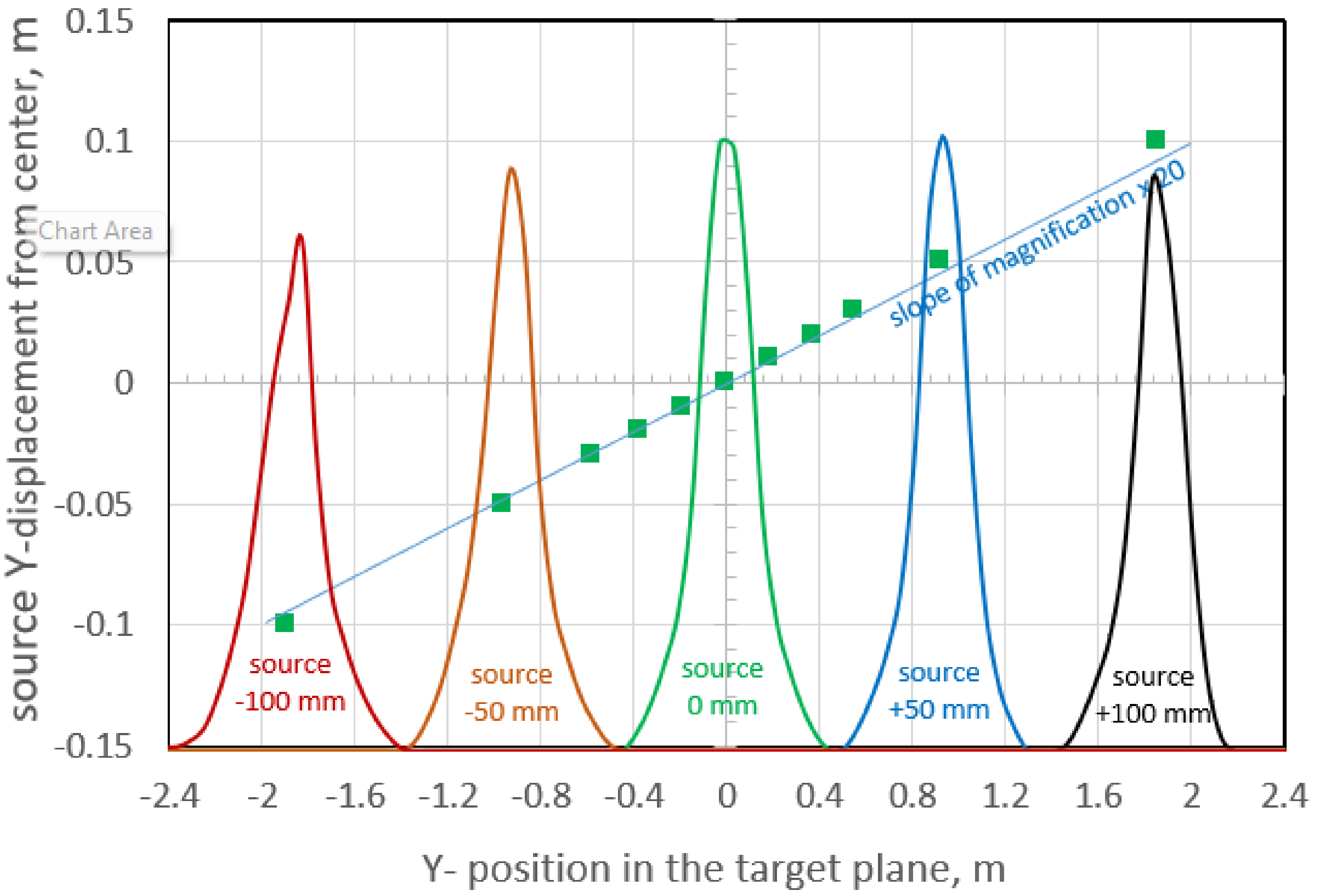
Neutrons that reached the target plane z = 200 m were originated in the source plane as ↓

Back image of the target with dia 2 m in the source plane through the V-B reflector

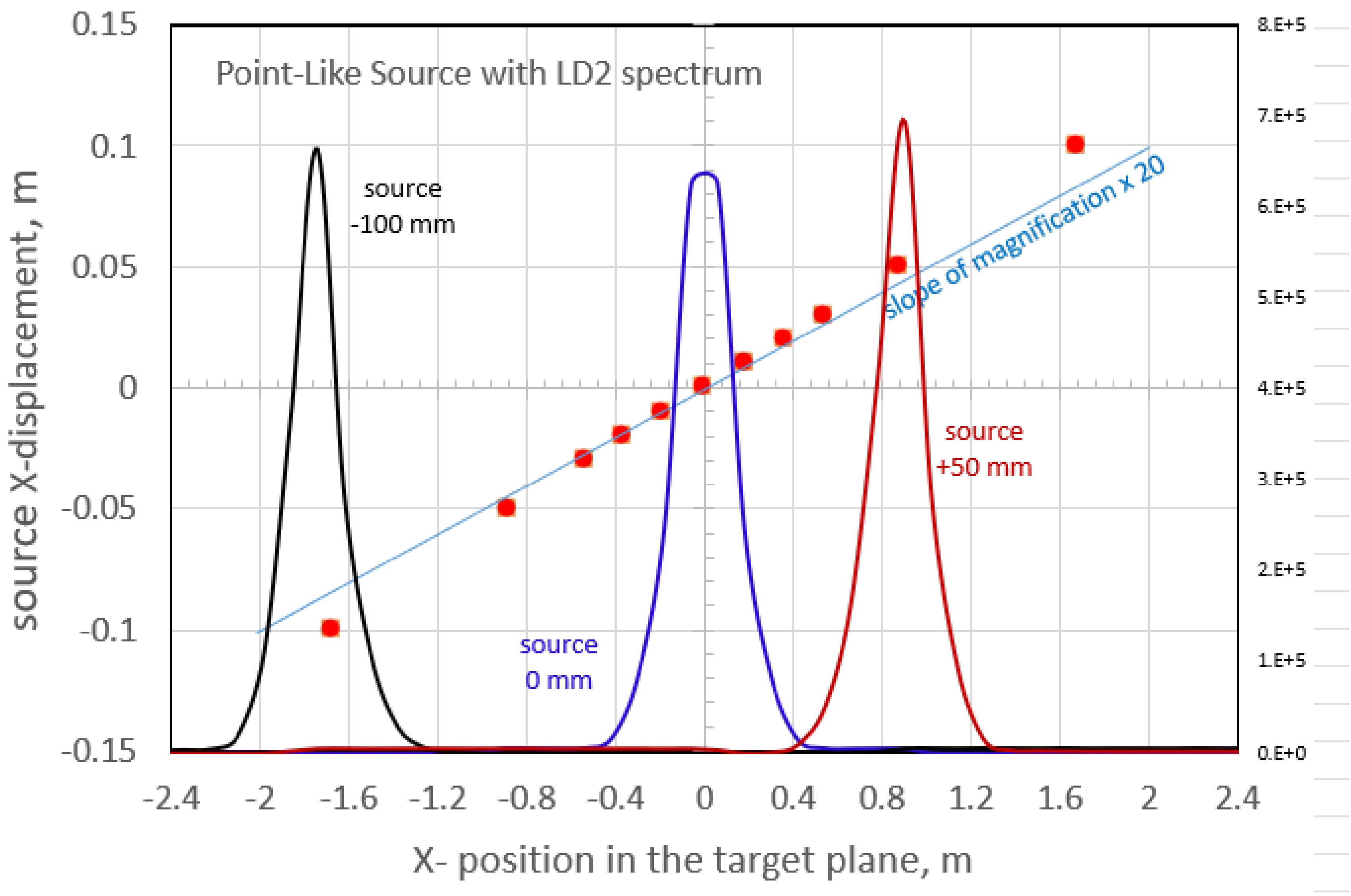




Y-positioning of point-like source from -100 mm to + 100 mm from the center position at Y=-0.237m, X=0

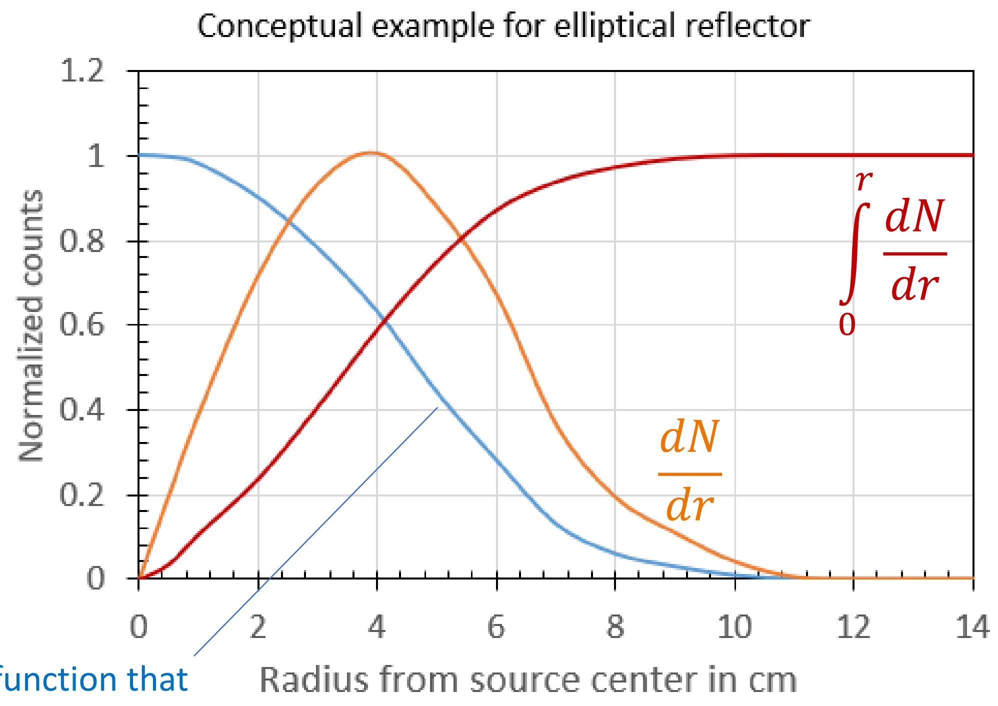


X-positioning of point-like source from -100 mm to + 100 mm (Y=-0.237m)



Elliptical reflector à la NNbar baseline

- For the elliptical reflector the focusing efficiency reduces with the radius.
- With magnification $\sim\ \times 20$ the target with diameter 2m corresponds to the source area with diameter 10 cm.
- Area of the source integrate the effective radial efficiency function defined by the elliptical reflector

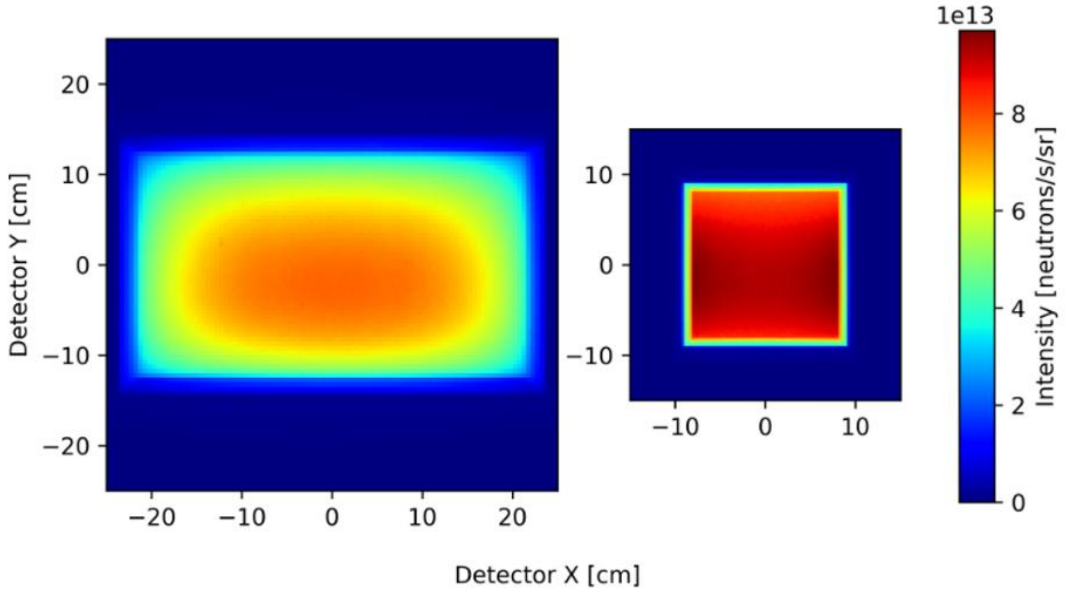


Radial function that can be obtained with point-like source scan

- For Venetian-blinds reflector every point of the source is almost equally efficient for building image in the target plane at z=200 m. But brighter source might give better Nt^2

- V-B reflector should be tried at the back of LD_2 source (15 x 15 cm^2)→ its image on the target x 20 will fit into 2-m target diameter

- Optimization of LD_2 source is the function of the reflector type. With V-B reflector the concept of neutron optics for NNbar might be changed.



Advantages of the V-B reflector

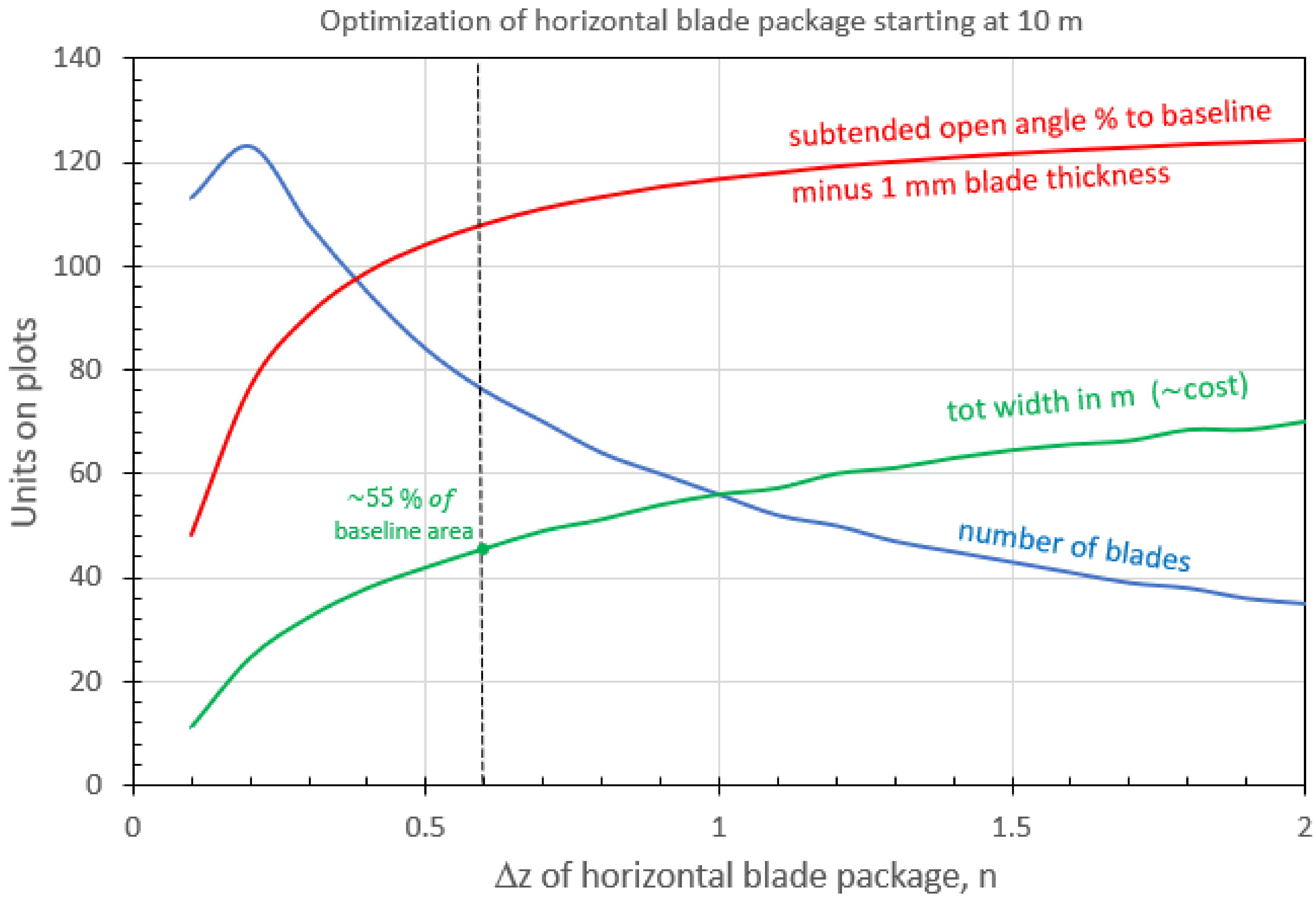
1. Can be optimized for larger Nt^2
2. Compatible with large vacuum tube of smaller diameter ($\sim$ 3.5 m)
3. Large ballistic path (larger t^2)
4. Installation doesn't require assembly inside the big tube
5. Blade to blade alignment can be done separately
6. Flat super-mirror surfaces (not elliptical)
7. Vertical "focus" is re-adjustable to target position
8. Vertical source is re-adjustable (can be tuned to UPPER moderator)

Challenges in the V-B reflector

1. Keep blades flat (particularly horizontal)
2. Keep blades thin (to increase aperture) 2 mm $\rightarrow$ 0.2 mm ?
3. Needs high accuracy of installation and alignment
4. Moving blades need to be in vacuum (14 Hz noise)
5. Larger front flange (at least) 3.3×2.3 m

Further V-B reflector design steps

- Optimization of VB reflector scheme:
  - Optimization of LD_2 moderator to higher brightness
  - starting z-position (10 m)
  - length of blades (60 cm)
  - Larger distance to target (200 → 300 m)
  - aperture coverage (angles currently not covered by blades)
  - control of Y-motion of horizontal blades (t_0)
- development of thin metal-substrate flat super mirrors m$\geq$ 6 (H. Shimizu?)
- Mechanical construction: stretching super-mirror blades on a heavy frame or using spacers
- Mechanical installation and alignment, blade moving mechanism
- Front vacuum flange design



Optimization of horizontal blade package starting at 10 m
140
120
100
80
60
40
20
0
Units on plots
0
0.5
1
1.5
2
Δz of horizontal blade package, n
subtended open angle % to baseline
minus 1 mm blade thickness
tot width in m (~cost)
~55 % of
baseline area
number of blades

END