Update on the sweep magnet for the NPS experiments

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Kinematics of SI pion (E12-13-007)

#	θ_γ	θ_e	D_{mag}, m	Bdl, Tm	D_{mag}-Calo, m	angle range, degree
A **X**	10.57	10.27	1.57	0.3	3-1.57	
B **X**	16.20	11.70	1.57	0.3		
C	12.44	15.38	1.57	0.3		
D	7.93	24.15	1.57	0.3	1.43	4.7-11.1
E	16.57	15.65	1.57	0.3	1.43	
F	17.23	17.84	1.57	0.3	1.43	

X – SAM configuration is finalized. We checked 4(5) out of a total of 22 configurations.

Kinematics of DVCS (E12-13-10)

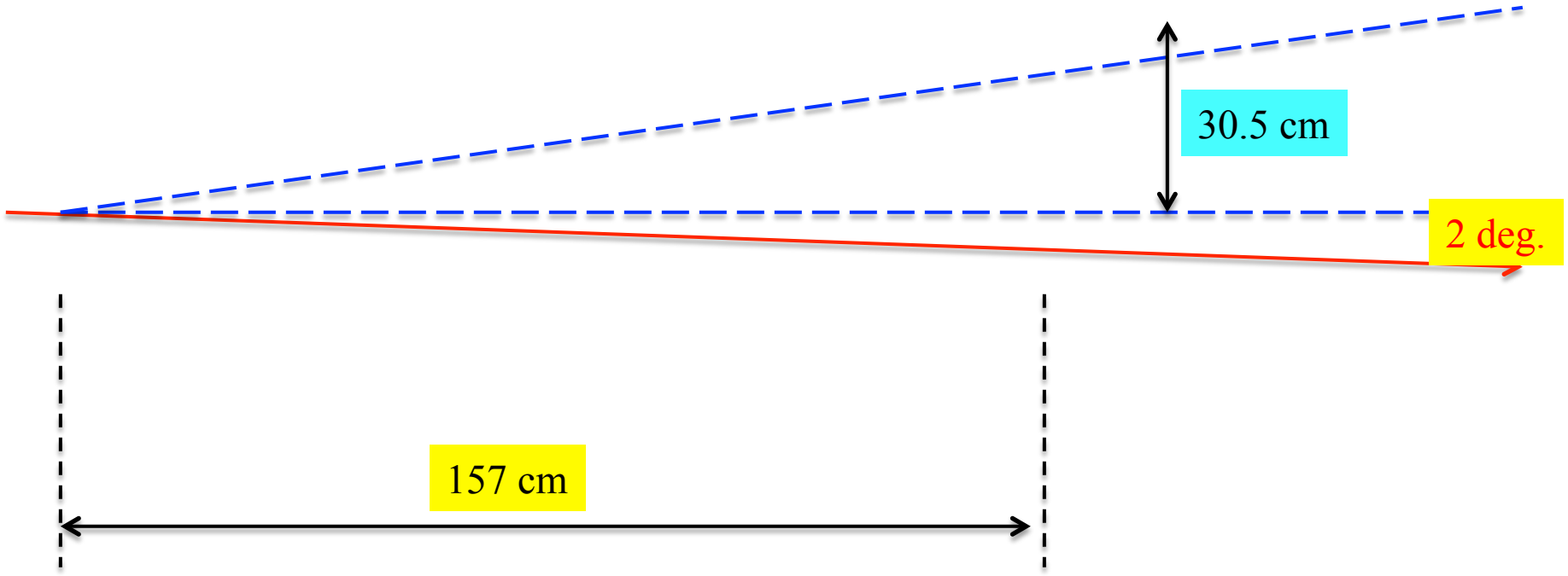
#	θ_γ	θ_e	D_{calo},m	Bdl, Tm	D_{mag}-Calo, m	angle range, degree
3 (=B)	16.2	11.7	3	0.3	1.43	
5 (~C)	12.4	15.3	3	0.3	1.43	
7	21.7	11.7	3	0.3	1.43	
8 X	16.6	15.6	3	0.3	1.43	
13	6.3	27.9	6	0.3	4.43	3.1 - 9.6
16 X	6.3	17.3	6	0.3	4.43	

range of angles: 68 cm / 300 => 12.8 degrees
range of angles: 68 cm / 600 => 6.5 degrees

Kinematics of WACS (E12-14-003) /Pion

#	θ_γ	θ_p	D_{mag} ,m	Bdl, Tm	D_{det}, m	D_{magr}-Calo, m	Bdl, Tm / D_{mag}-Calo, m
4A	14.2	40.1	2.45+0.2	0.3	9.0	6.15	0.3 / (9-1.57)
4B	17.9	33.7	1.65+0.2	0.4	7.0		
4C	22.5	27.8	1.65+0.2	0.5	5.0		
4D	26.9	23.7	1.10+0.2	0.6	3.5		
4E	34.0	18.9	1.10+0.2	0.6	3.0	1.7	0.61 Tm / 1.68
5A	11.0	41.7	2.45+0.2	0.25	11.0		9.3-12.7 deg
5B	13.8	35.3	2.45+0.2	0.35	9.0		
5C	16.9	30.0	1.65+0.2	0.4	7.5		
5D	19.7	26.3	1.65+0.2	0.5	6.0		
5E	29.9	17.8	1.10+0.2	0.6	3.25	1.95	0.70 Tm / 1.68

Horizontal field dipole



Parameters

1. Field integral from the target to NPS ~ 0.58 Tm, for the main coil: 1050A, 140 kW
   corrector coils ~ 500 A, 20 kW

1. Field integral along the beam line from the target to magnet middle
   Goal is a low transverse BdL, below 1 milli Tm -> OK (see Rolf's)
   after tuning of the corrector, there is some field at the target and before it.

3. Field integral along the HMS central trajectory from the target to Q1
   Goal is to have BdL below 1 milli Tm - > could be hard to do even with the cone on the snout (t=5 mm). May need Q1 in the model.

What are the requirements?

1. A low energy tail for the thin target case, $P_{loss} = P\_b \times 2t/3 \, (E_{cut}/E_b)^2$

   It would be enough to have $E_{cut} = 300$ MeV => 0.05% *t of the beam power
   The elastic scattering (11 GeV on 15 cm LH2), $\Theta_{min} = 0.75^o$ -> $P = 0.8 \times 10^{-5}$

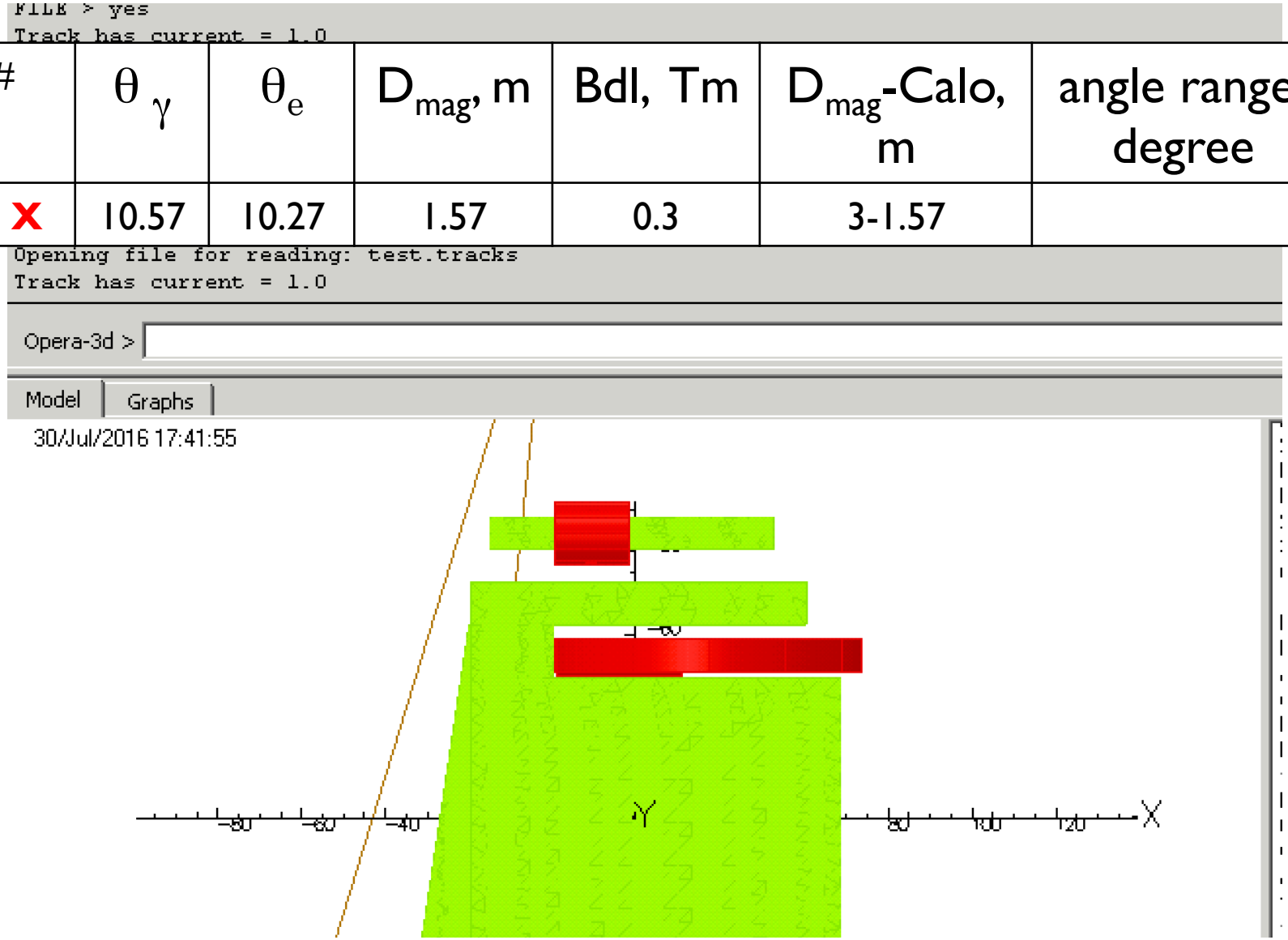
   $BdL = 3$ cm / 30 m * $[3 \times 10^8/300] = 10^3$ Gauss cm = 1 milli Tm (Rolf's)

2. HMS optics aberration for 3 GeV/c and $BdL = 1 \times 10^3$ Gauss cm (Rolf's)

   $\delta\theta \sim 300 \times BdL / 3 \times 10^9 = 0.1$ mrad
   vertex shift ~ < 0.5 mm?

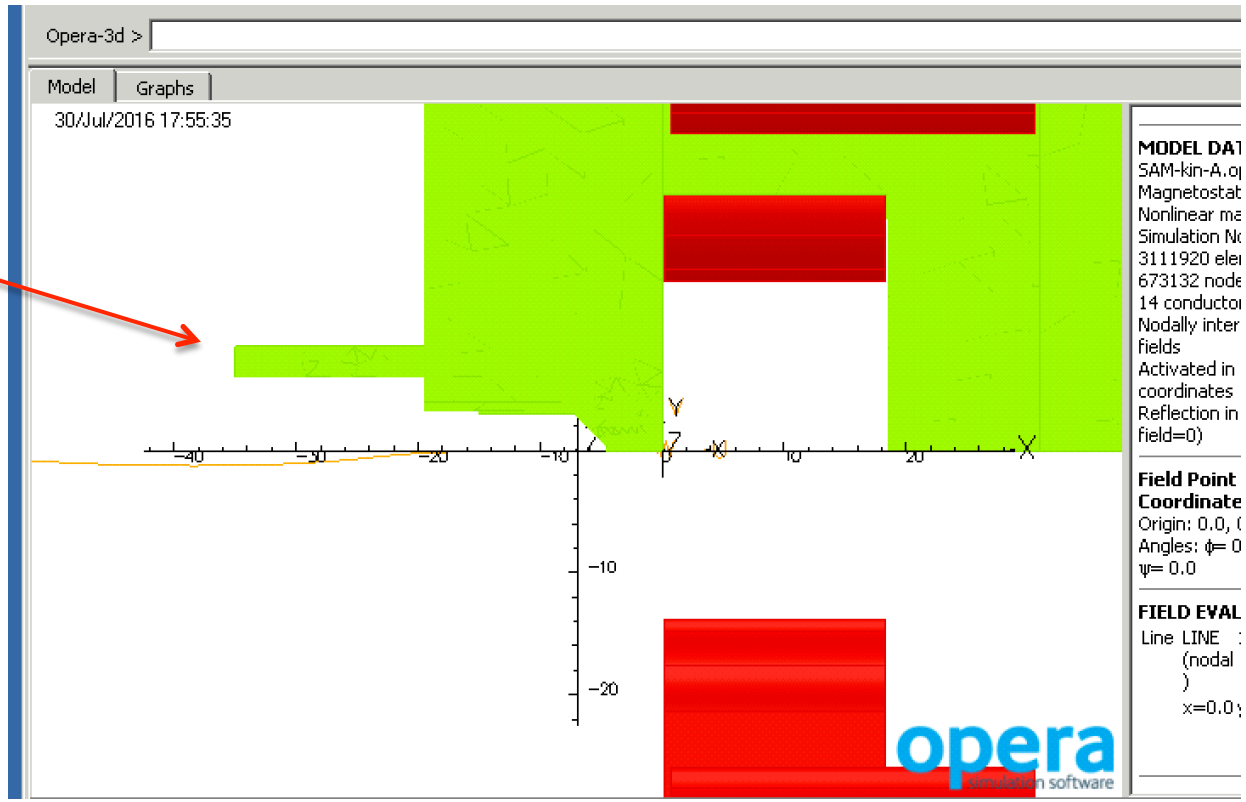
Kinematics “A” for pion

#	θ_γ	θ_e	D_{mag}, m	Bdl, Tm	D_{mag}-Calo, m	angle range, degree
A X	10.57	10.27	1.57	0.3	3-1.57	

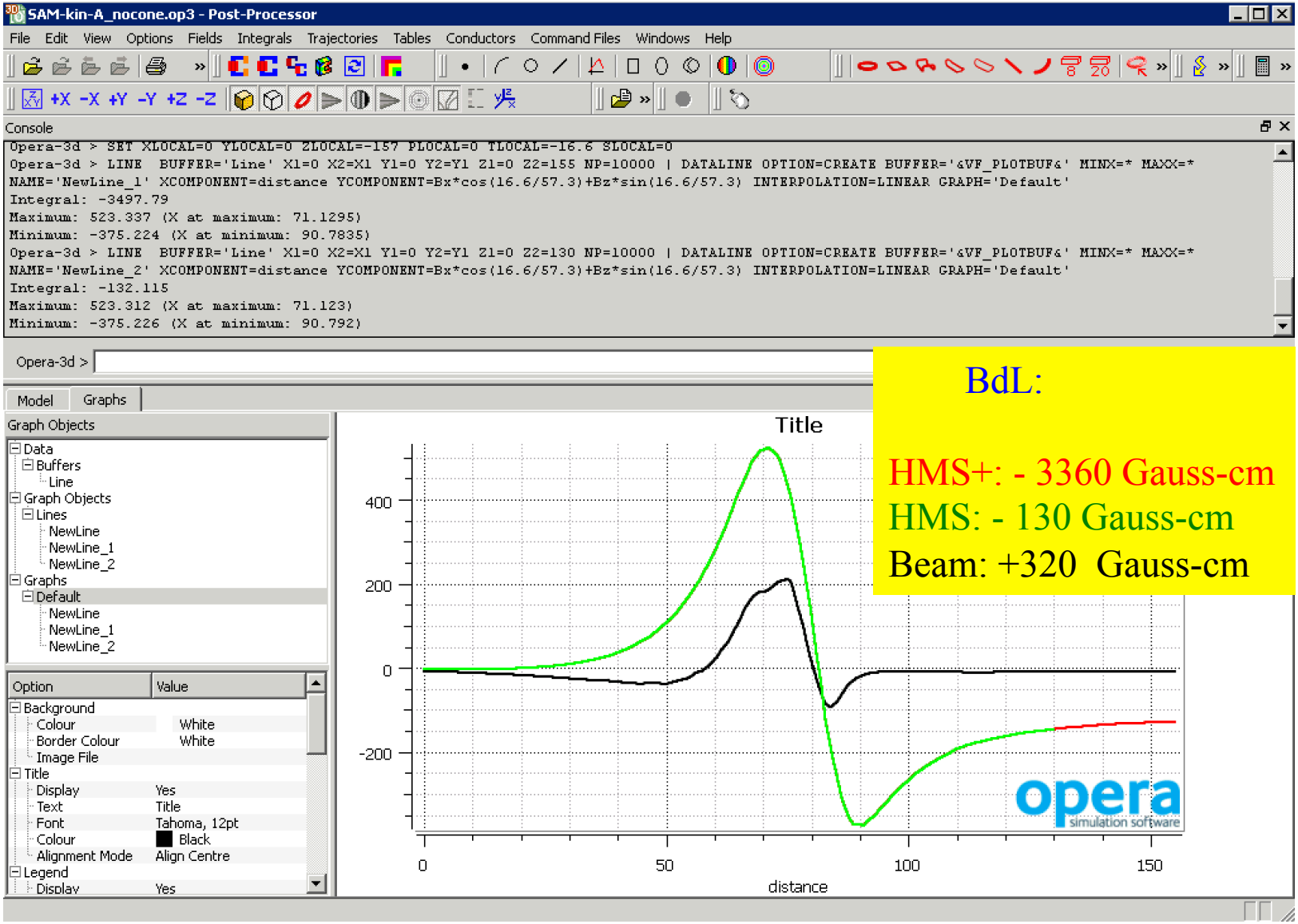


Kinematics “A” for pion

Beam line
is protected
by a 1” shelf



Kinematics “A” for pion



Kinematics “A” for pion

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Opera-3d > SET XLOCAL=0 YLOCAL=0 ZLOCAL=-157 PLOCAL=0 TLOCAL=-5.5 SLOCAL=0
Opera-3d > LINE  BUFFER='Line' X1=0 X2=X1 Y1=0 Y2=Y1 Z1=0 Z2=330 NP=10000 | DATALINE OPTION=CREATE
BUFFER='&VF_PLOTBUF&' MINX=* MAXX=* NAME='NewLine_9' XCOMPONENT=distance
YCOMPONENT=Bx*cos(5.5/57.3)+Bz*sin(5.5/57.3) INTERPOLATION=LINEAR GRAPH='Default'
Integral: 21456.1
Maximum: 358.148 (X at maximum: 229.482)
Minimum: -141.707 (X at minimum: 82.467)
```

Opera-3d >

Model | Graphs

Graph Objects

- NewLine_4
- NewLine_5
- NewLine_6
- NewLine_7
- NewLine_8
- NewLine_9
- Graphs
  - Default
    - NewLine
    - NewLine_1
    - NewLine_2
    - NewLine_3
    - NewLine_4
    - NewLine_5

Option	Value
Background	
Colour	W
Border Colour	W
Image File	
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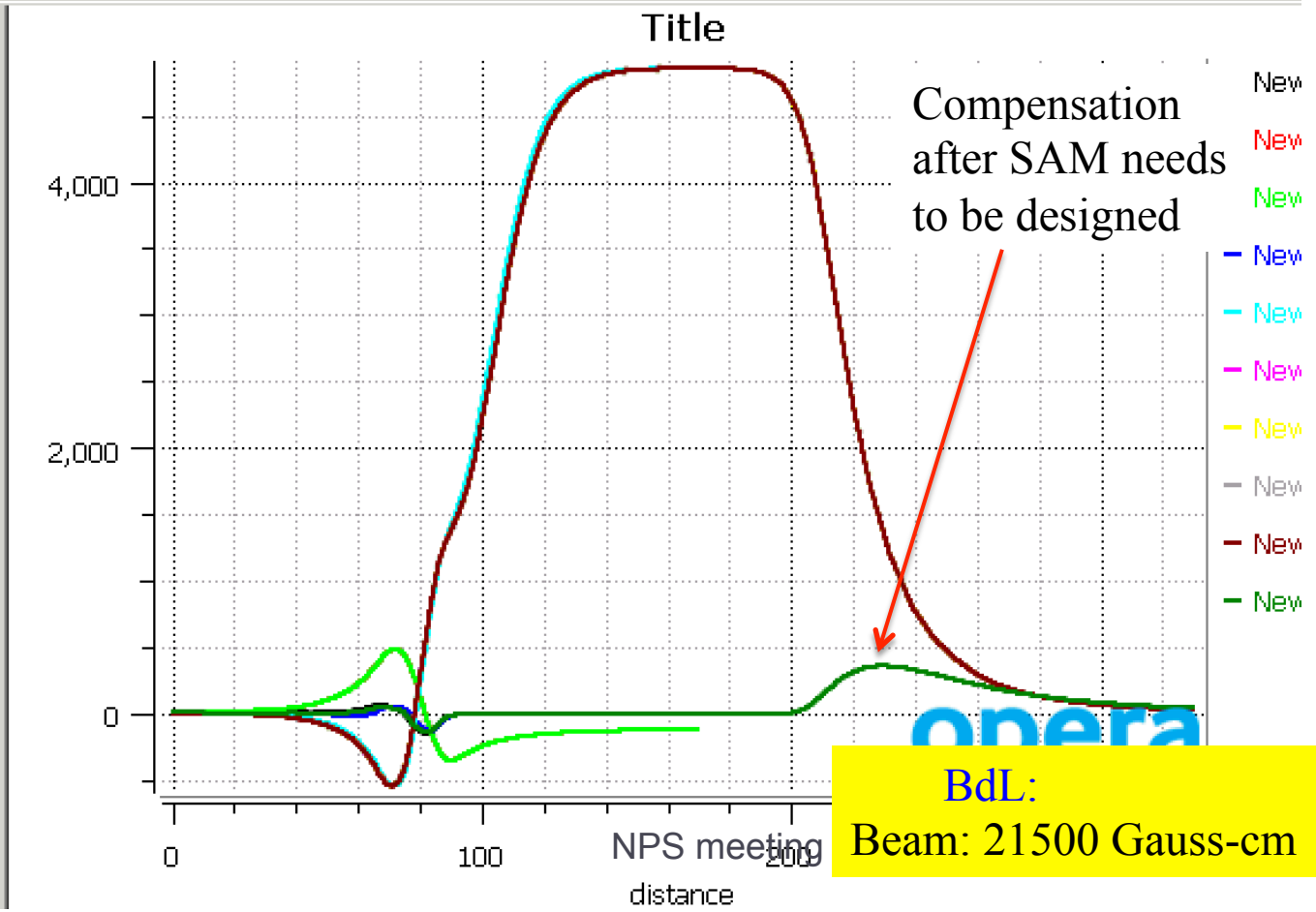
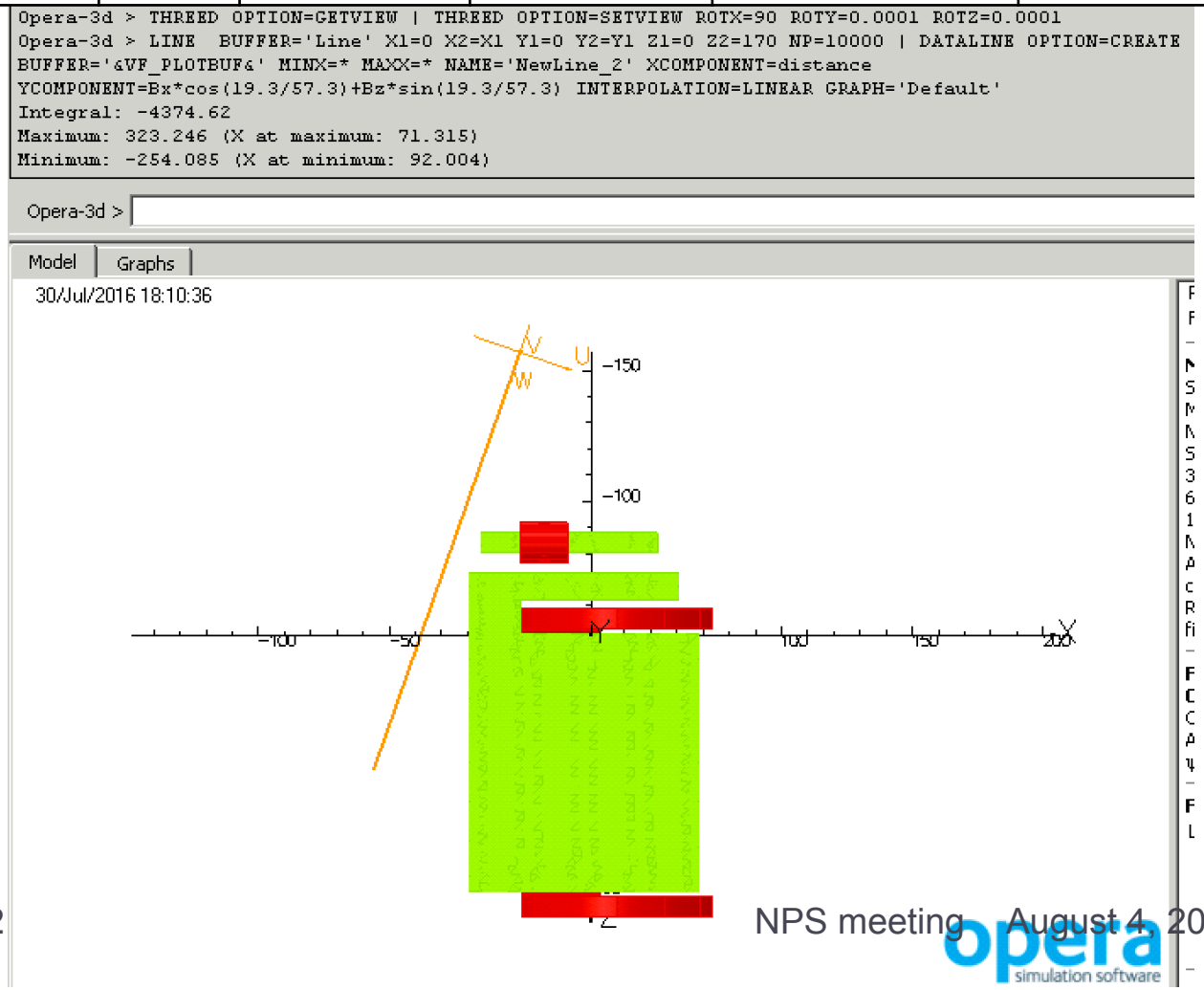
Font	Tahom
Colour	Bl
Alignment Mode	Align (
Legend	
Display	Yes



BdL:
Beam: 21500 Gauss-cm

Kinematics “16” for DVCS

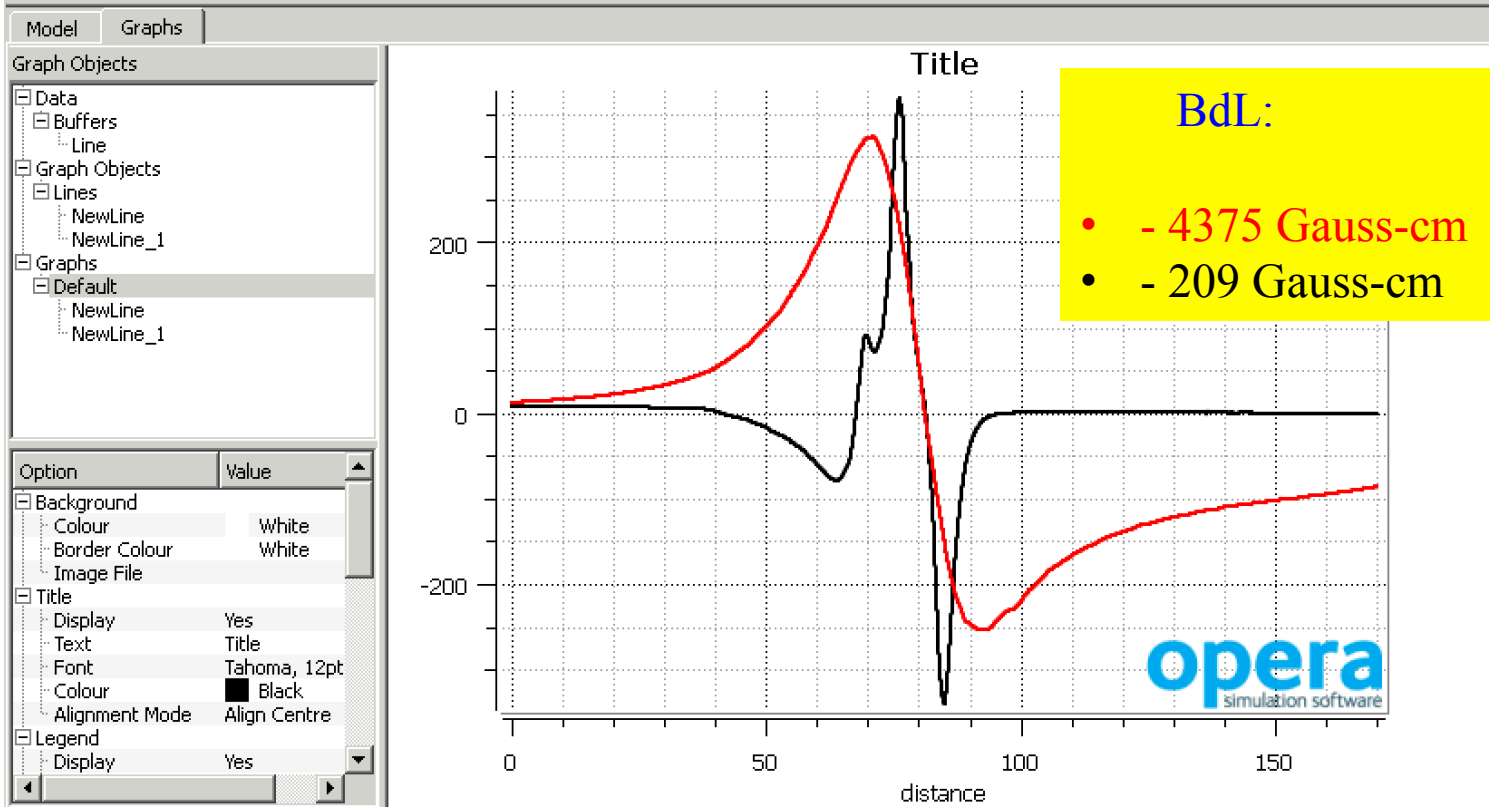
#	θ_γ	θ_e	D_{calo},m	Bdl, Tm	D_{mag}-Calo, m	angle range, degree
16 X	6.3	17.3	6	0.3	4.43	



Kinematics “16” for DVCS

```
INTERPOLATION=LINEAR GRAPH='Default'
Integral: -209.065
Maximum: 369.974 (X at maximum: 76.211)
Minimum: -341.417 (X at minimum: 85.034)
Opera-3d > SET XLOCAL=0 YLOCAL=0 ZLOCAL=-157 PLOCAL=0 TLOCAL=-19.3 SLOCAL=0
Opera-3d > LINE  BUFFER='Line' X1=0 X2=X1 Y1=0 Y2=Y1 Z1=0 Z2=170 NP=10000 | DATALINE OPTION=CREATE
BUFFER='&VF_PLOTBUF&' MINX=* MAXX=* NAME='NewLine_1' XCOMPONENT=distance
YCOMPONENT=Bx*cos(19.3/57.3)+Bz*sin(19.3/57.3) INTERPOLATION=LINEAR GRAPH='Default'
Integral: -4374.62
Maximum: 323.246 (X at maximum: 71.315)
Minimum: -254.085 (X at minimum: 92.004)
```

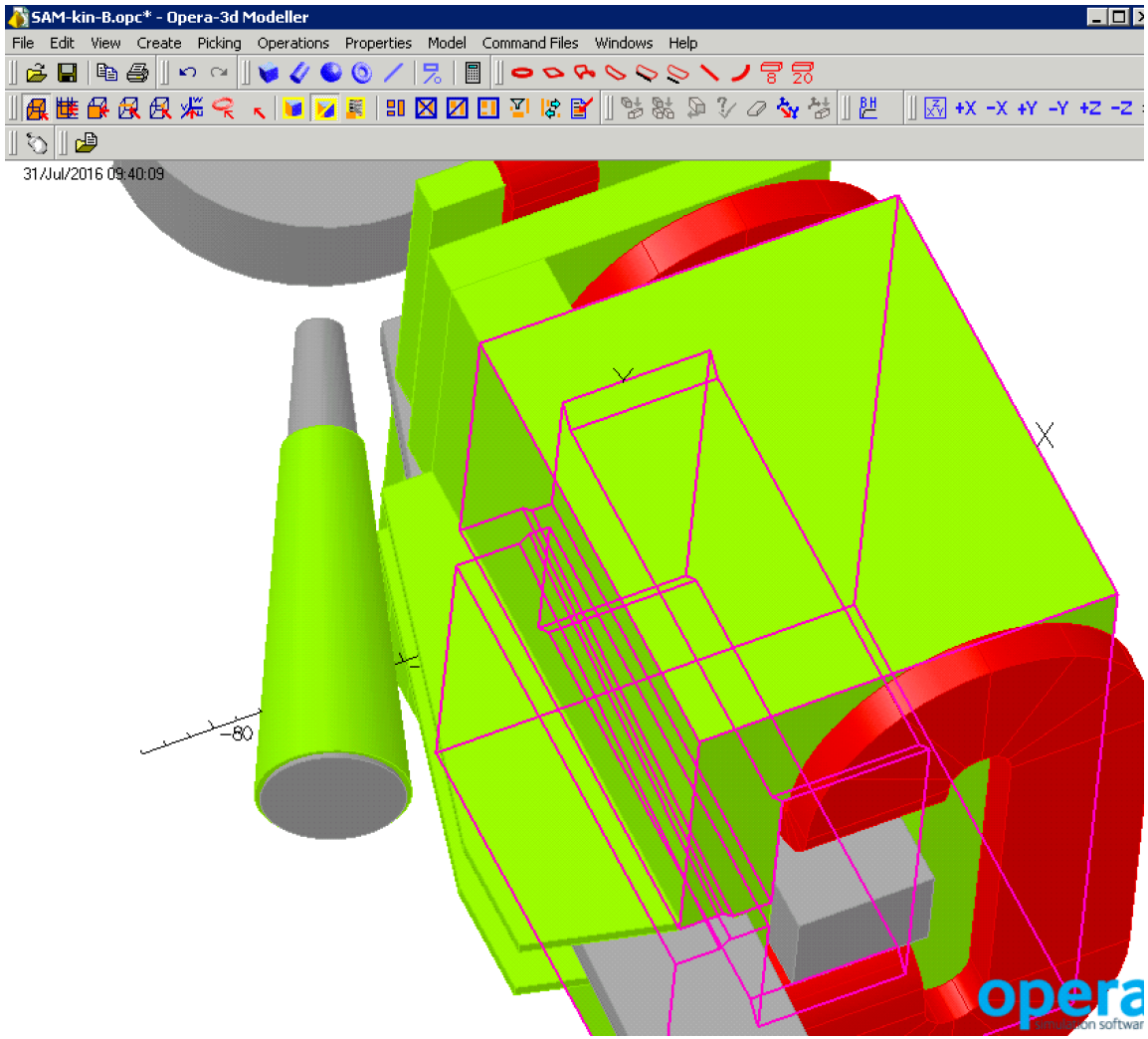
Opera-3d >



BdL:

- - 4375 Gauss-cm
- - 209 Gauss-cm

Kinematics “B” for pion



Kinematics “B” for pion

```
NAME='NewLine' XCOMPONENT=distance YCOMPONENT=Bx*cos(11.9/57.3)+Bz*sin(11.9/57.3) INTERPOLATION=LINEAR GRAPH='Default'
Integral: 691.459
Maximum: 131.026 (X at maximum: 44.733)
Minimum: -180.115 (X at minimum: 71.3465)
Opera-3d > SET XLOCAL=0 YLOCAL=0 ZLOCAL=-157 PLOCAL=0 TLOCAL=-23.6 SLOCAL=0
Opera-3d > LINE  BUFFER='Line' X1=0 X2=X1 Y1=0 Y2=Y1 Z1=0 Z2=155 NP=10000 | DATALINE OPTION=CREATE BUFFER='&VF_PLOTBUF&' MINX=* MAXX=*
NAME='NewLine_1' XCOMPONENT=distance YCOMPONENT=Bx*cos(23.6/57.3)+Bz*sin(23.6/57.3) INTERPOLATION=LINEAR GRAPH='Default'
Integral: 155.165
Maximum: 71.6425 (X at maximum: 24.3815)
Minimum: -124.908 (X at minimum: 71.362)
```

Opera-3d >

Model | Graphs

Graph Objects
- Data
  - Buffers
    - Line
- Graph Objects
  - Lines
    - NewLine
    - NewLine_1
- Graphs
  - Default
    - NewLine
    - NewLine_1

Option	Value
Background	
Colour	White
Border Colour	White
Image File	
Title	
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Legend	
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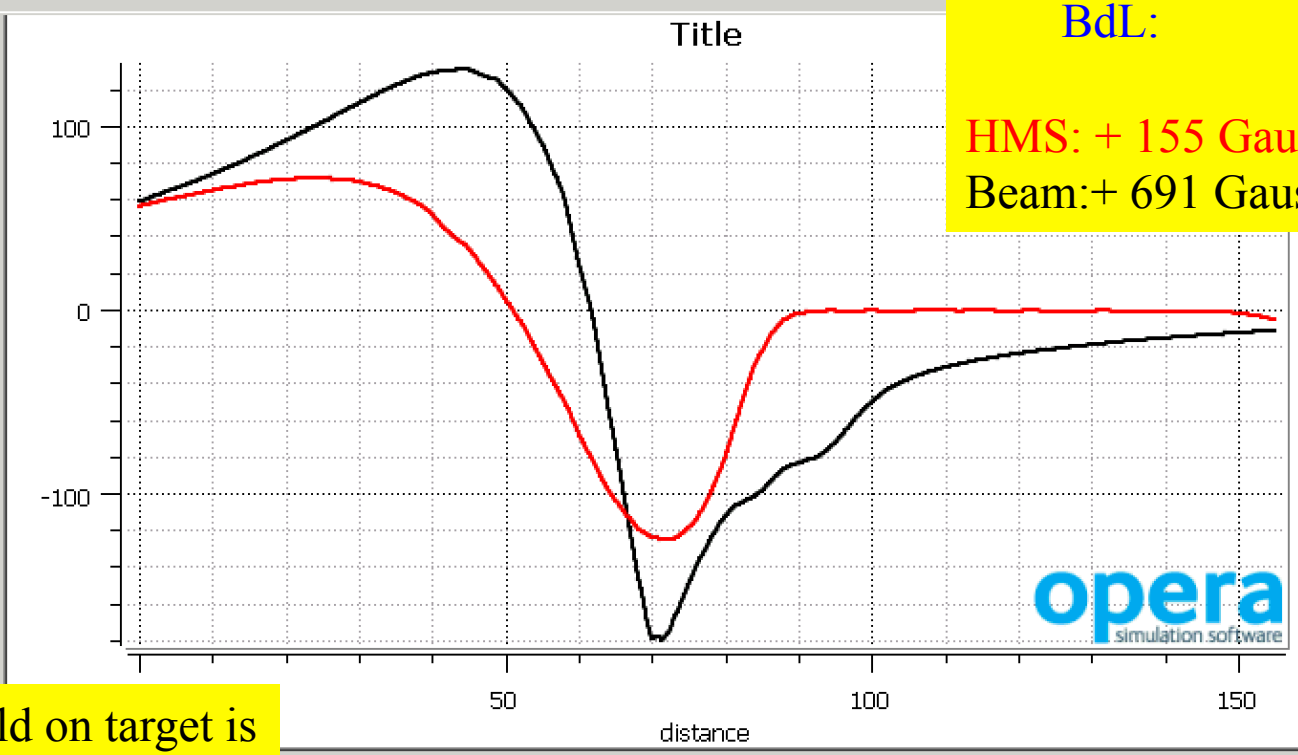


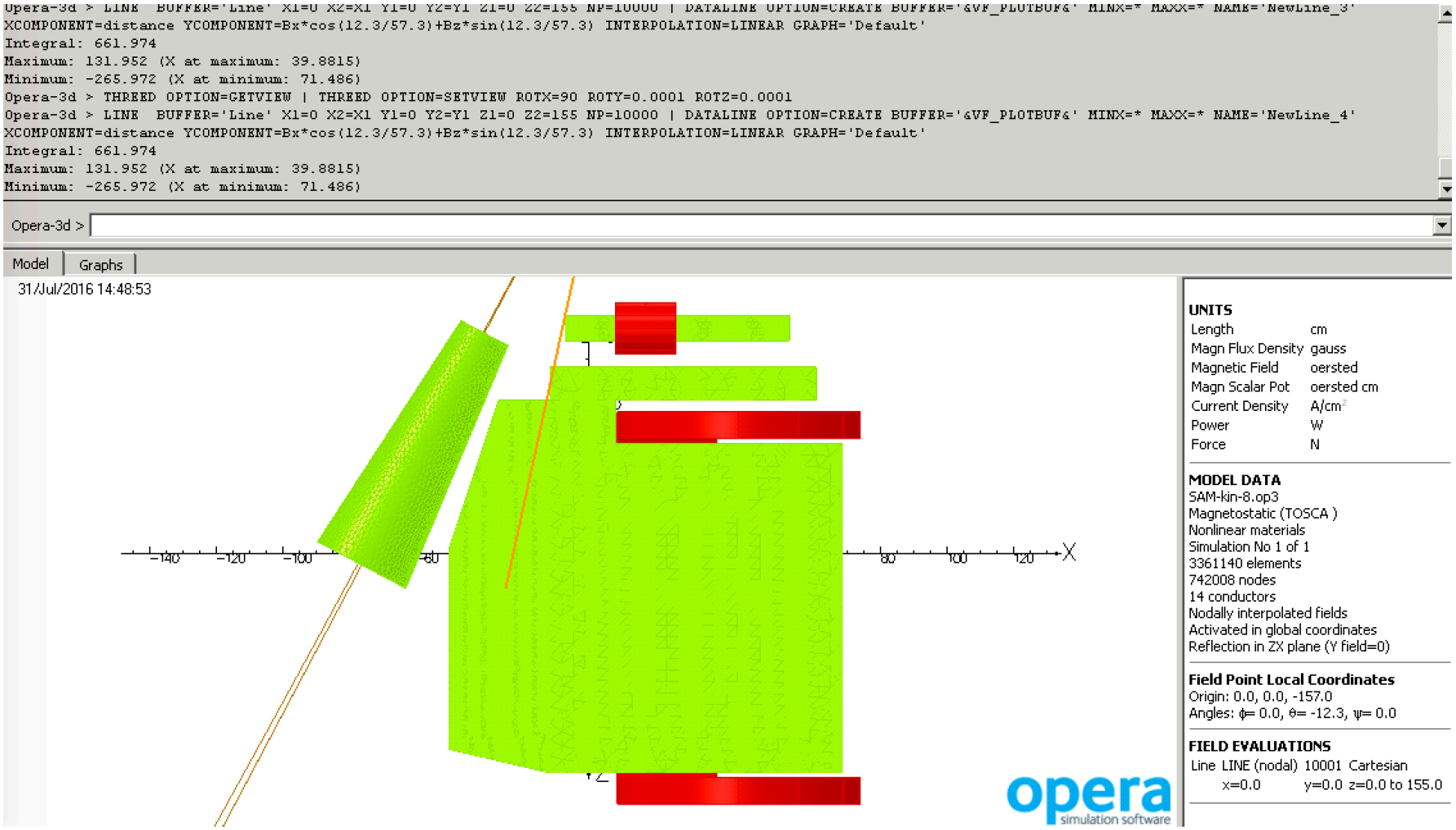
BdL:

HMS: + 155 Gauss-cm

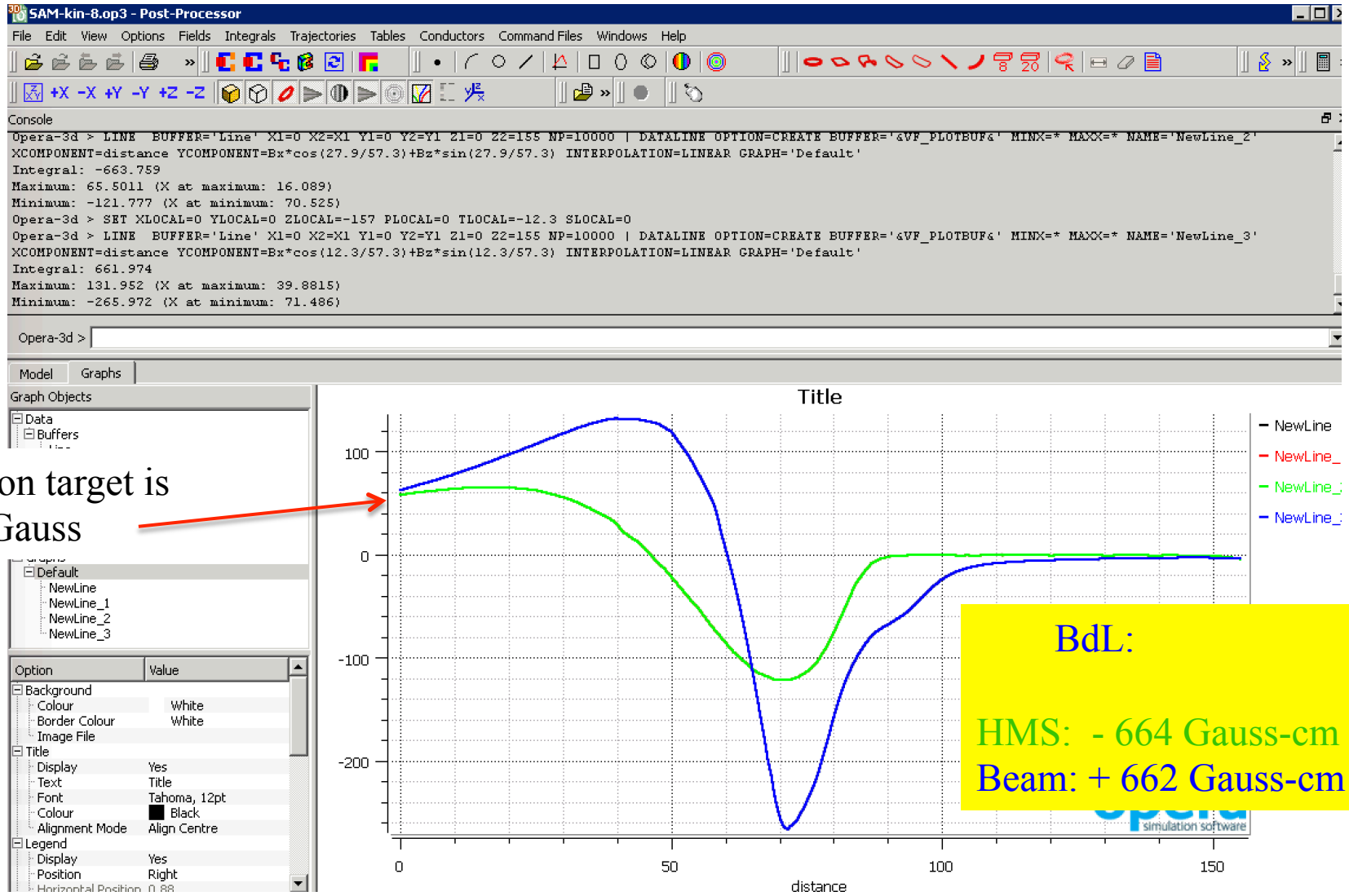
Beam:+ 691 Gauss-cm

Field on target is ~ 60 Gauss

Kinematics “8” for DVCS



Kinematics “8” for DVCS

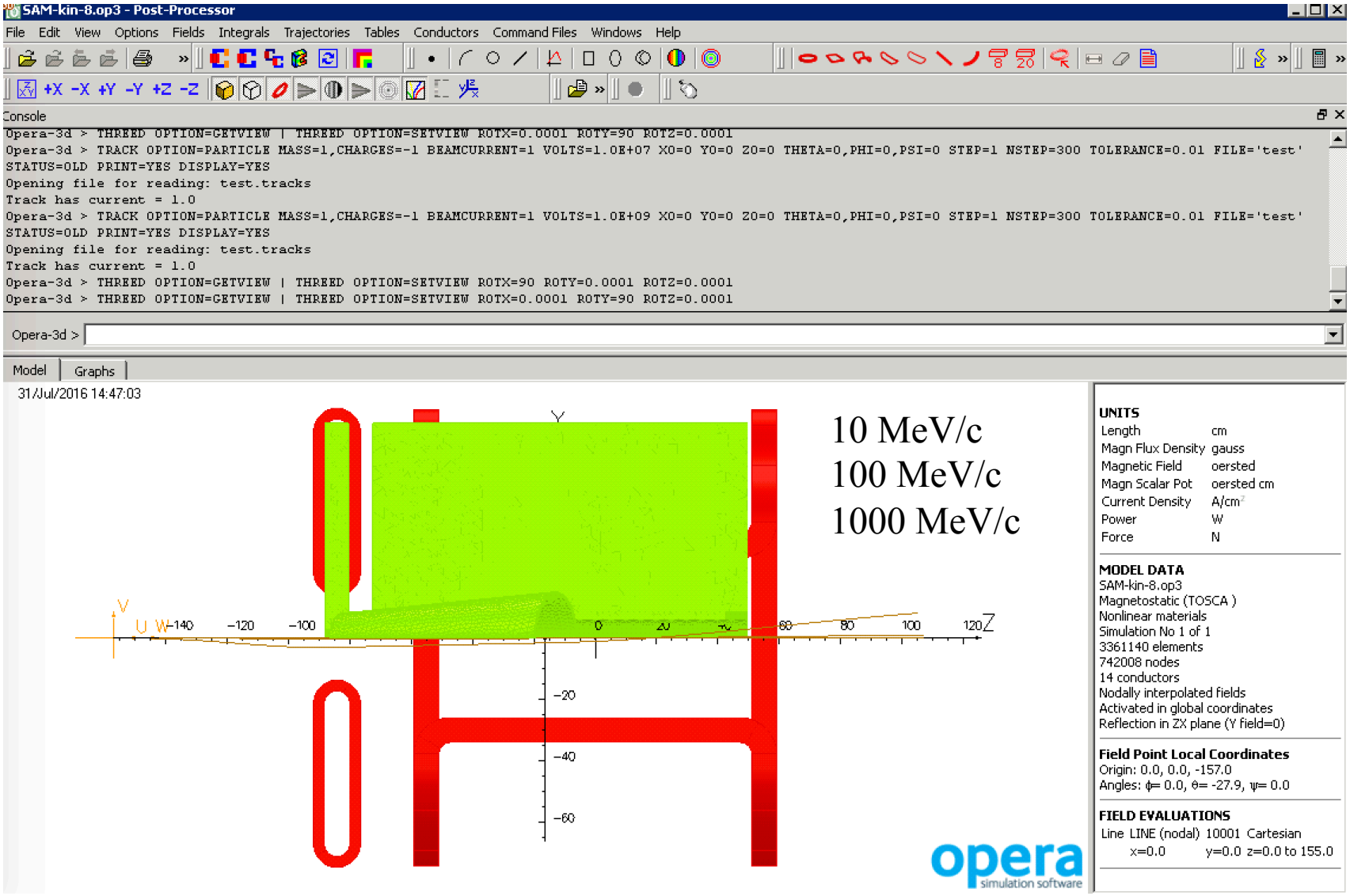


Field on target is
~ 60 Gauss

BdL:

HMS: - 664 Gauss-cm
Beam: + 662 Gauss-cm

Kinematics “8” for DVCS



Kinematics “8” for DVCS

BdL variation for 0.5 degree

```
XCOMPONENT=distance YCOMPONENT=Bx*cos(12.3/57.3)+Bz*sin(12.3/57.3) INTERPOLATION=LINEAR GRAPH='Default'
Integral: 661.974
Maximum: 131.952 (X at maximum: 39.8815)
Minimum: -265.972 (X at minimum: 71.486)
Opera-3d > SET XLOCAL=0 YLOCAL=0 ZLOCAL=-157 PLOCAL=0 TLOCAL=-12.8 SLOCAL=0
Opera-3d > LINE  BUFFER='Line' X1=0 X2=X1 Y1=0 Y2=Y1 Z1=0 Z2=155 NP=10000 | DATALINE OPTION=CREATE BUFFER='&VF_PLOTBUF&' MINX=* MAXX=* NAME='NewLine_5'
XCOMPONENT=distance YCOMPONENT=Bx*cos(12.8/57.3)+Bz*sin(12.8/57.3) INTERPOLATION=LINEAR GRAPH='Default'
Integral: -240.411
Maximum: 127.971 (X at maximum: 39.308)
Minimum: -293.343 (X at minimum: 72.23)
```

Opera-3d >

Model | Graphs

Graph Objects

- Graph Objects
  - Lines
    - NewLine
    - NewLine_1
    - NewLine_2
    - NewLine_3
    - NewLine_4
    - NewLine_5
  - Graphs
    - Default
      - NewLine
      - NewLine_1
      - NewLine_2
      - NewLine_3
      - NewLine_4

Option	Value
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Colour	White
Border Colour	White
Image File	
Title	
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Text	Title
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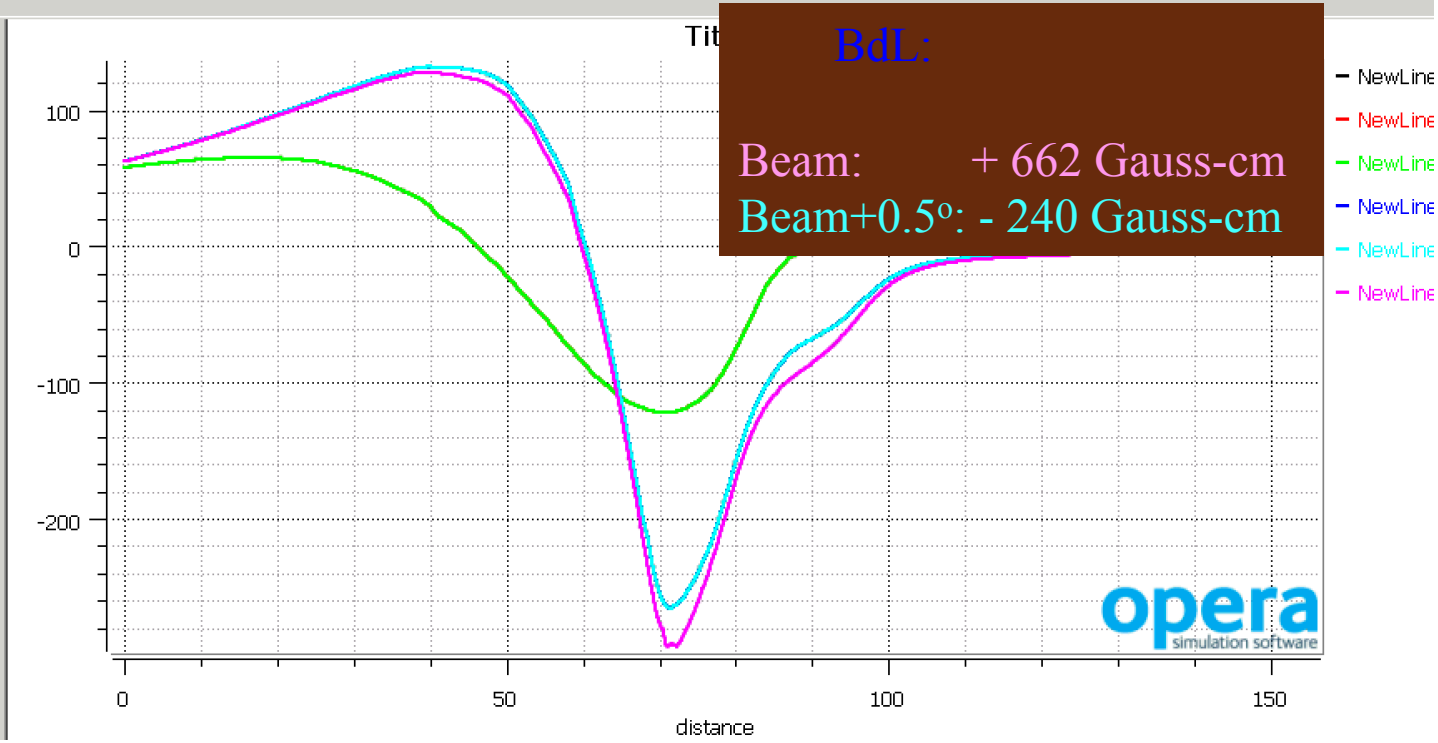
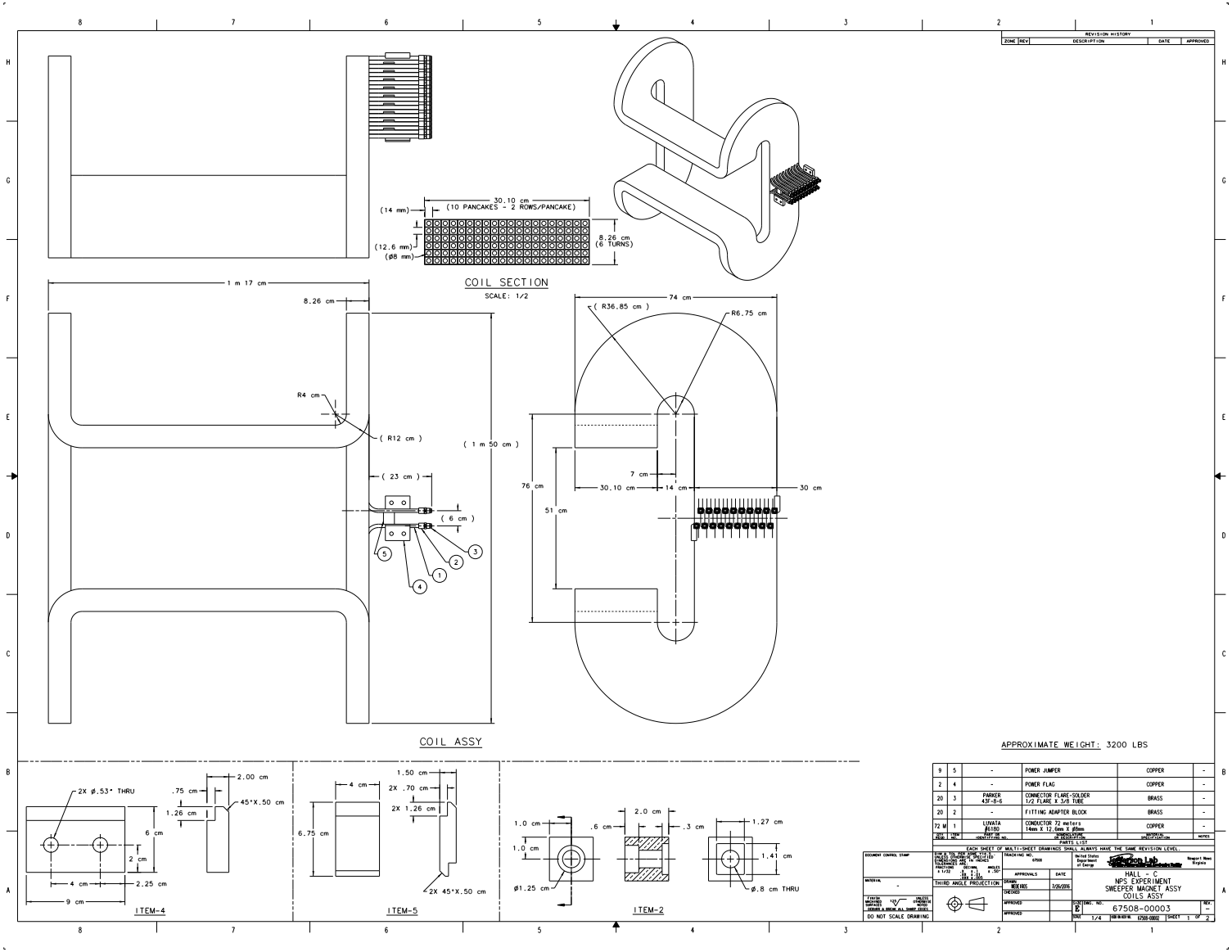
Horizontal Position	0.88

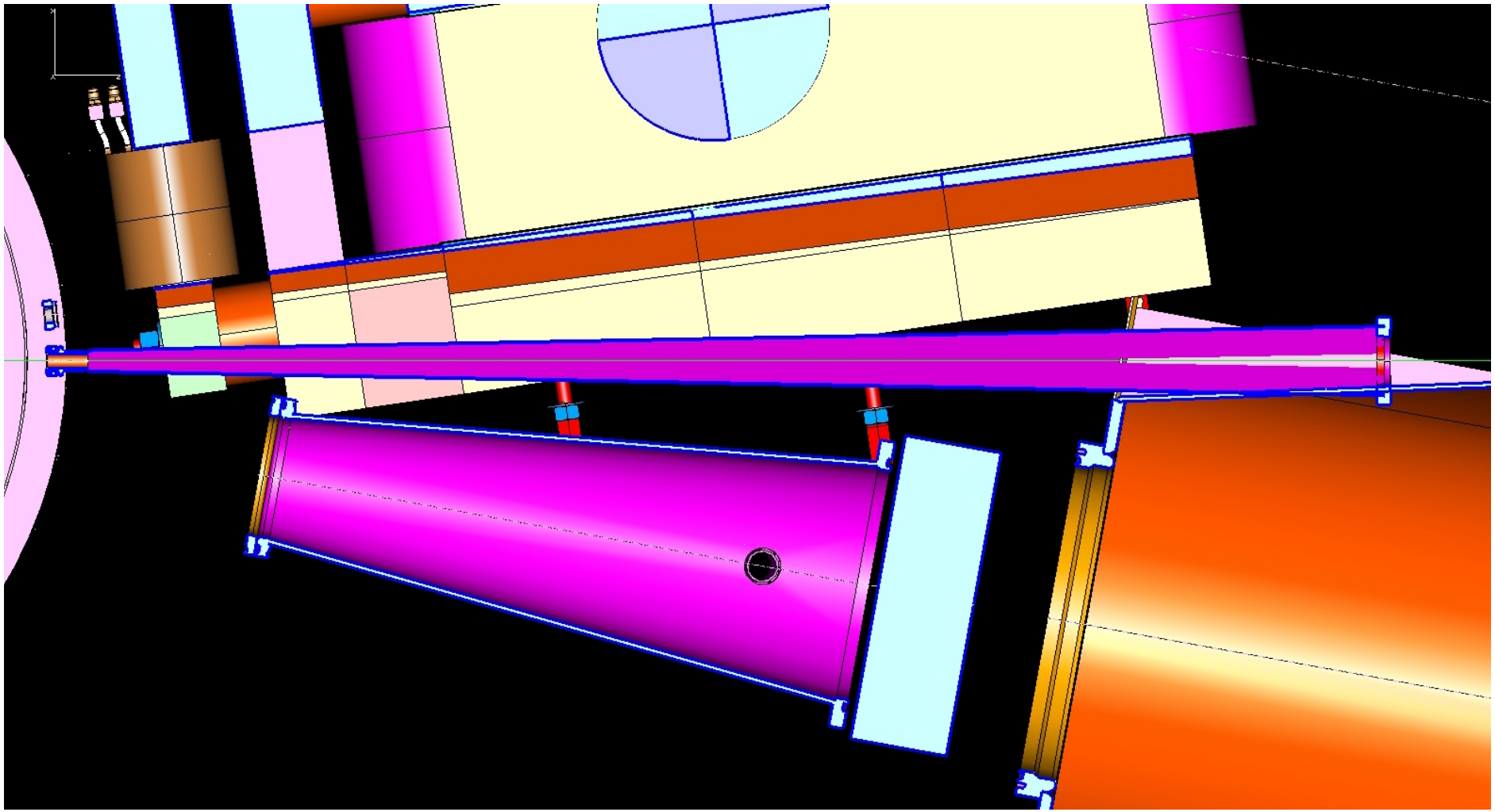


Magnet design/procurement



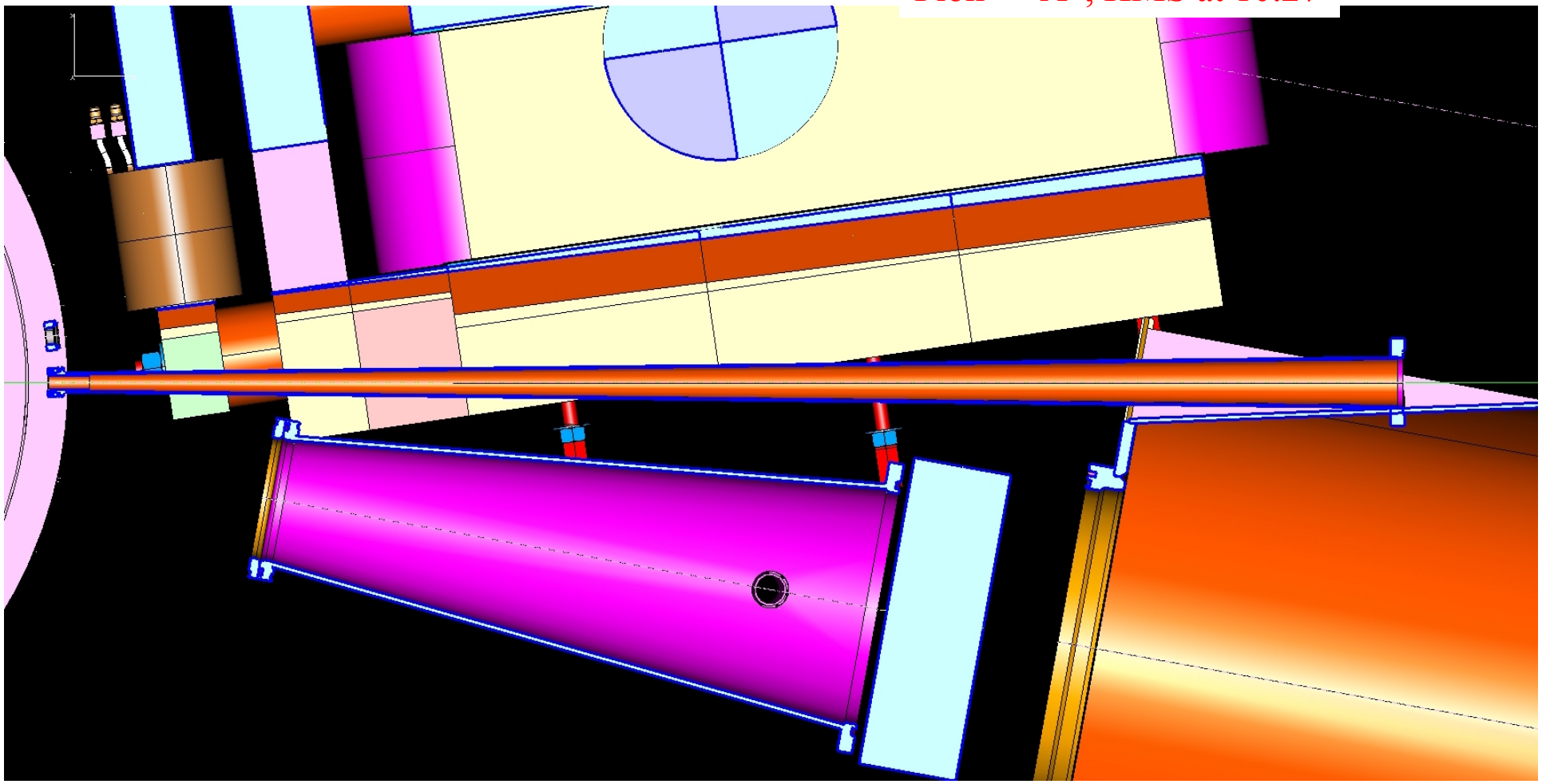
HMS-beam line

Pion – “A”, HMS at 10.27

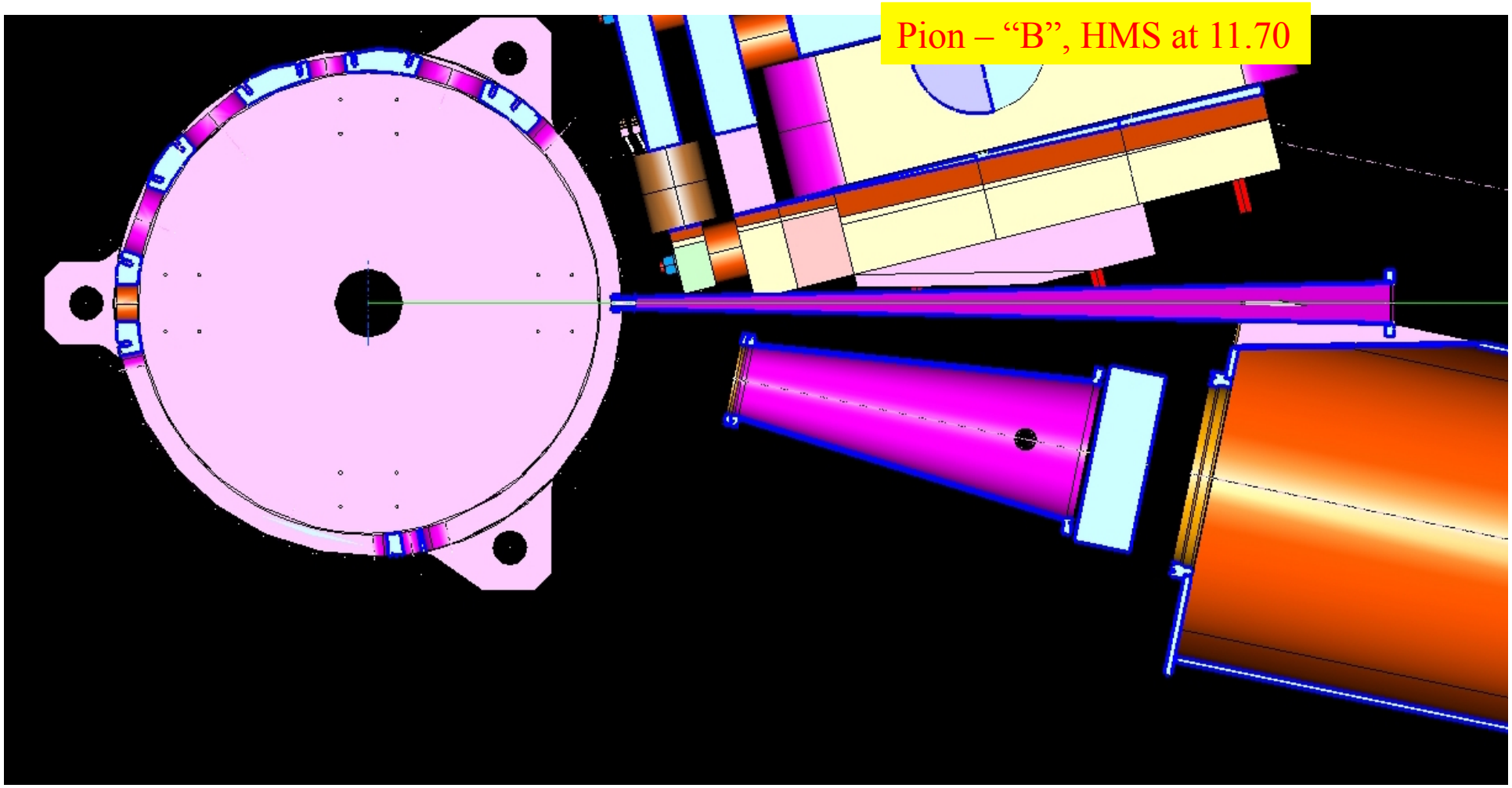


HMS-beam line

Pion – "A", HMS at 10.27



HMS-beam line



Magnet design plans

1. Large coil: a detailed drawing is competed (P. Medeiros)
2. The main yoke: magnetic design is finalized. Detailed design could start.

3. Option with an additional air-core corrector on the beam line could help reduction of the field on the target. Partial length cone in HMS?

4. A pipe problem at 10.27 angle of HMS – a low cost pipe is a bit too wide.

5. From Rolf: adjust cone length, keep field on the target as low as possible.

6. A post magnet beam line: a corrector + pipe requires some magnetic design.