

Extraction line simulation using BDSIM

20mrad & 2mrad

Ilya Agapov, RHUL



Rob Appleby, Univ. of Manchester & Cockcroft Institute

John Carter, RHUL



Olivier Dadoun, LAL Orsay dadoun@lal.in2p3.fr



Overview

1. What we are looking for ?
2. Brief introduction to BDSIM
3. Main difference, from the BDSIM point of view, between large and small crossing angle (the 20mrad and 2mrad case)
4. Power losses along the extraction
5. Conclusion and future for BDSIM

What we are looking for ...

See the plenary session on MDI (Graham & Philip)

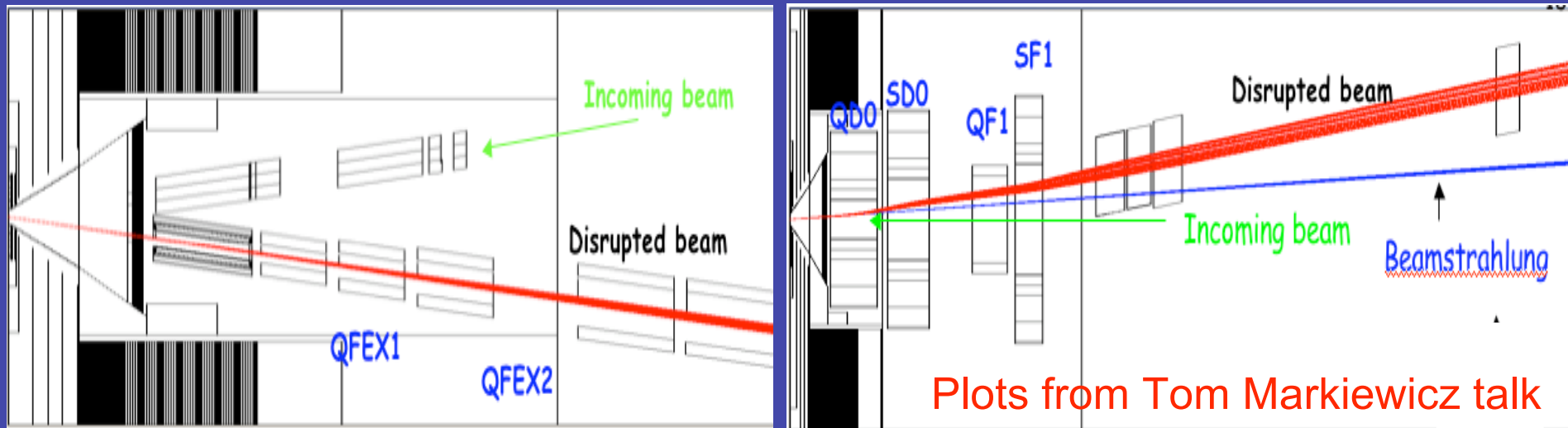
Need to extract the beam after collisions and transport it with minimal losses to the dump

Our primary goal:

→ evaluate the background this generates in the detector

1. Isolate the elements where the losses occur
(possible damage on beam magnets:
SC elements for example)
2. What are and how many particles are
backscattered into the detector region

Large and small crossing angle 20 & 2 mrad design

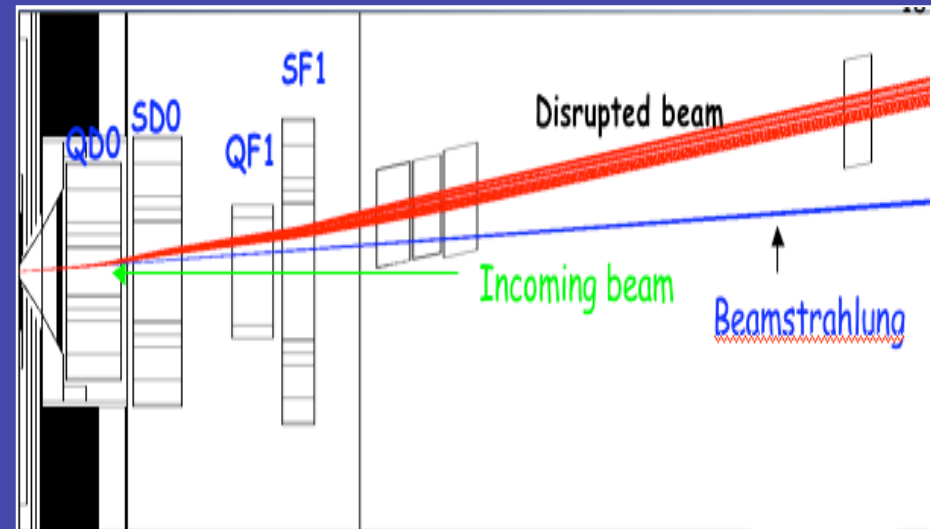
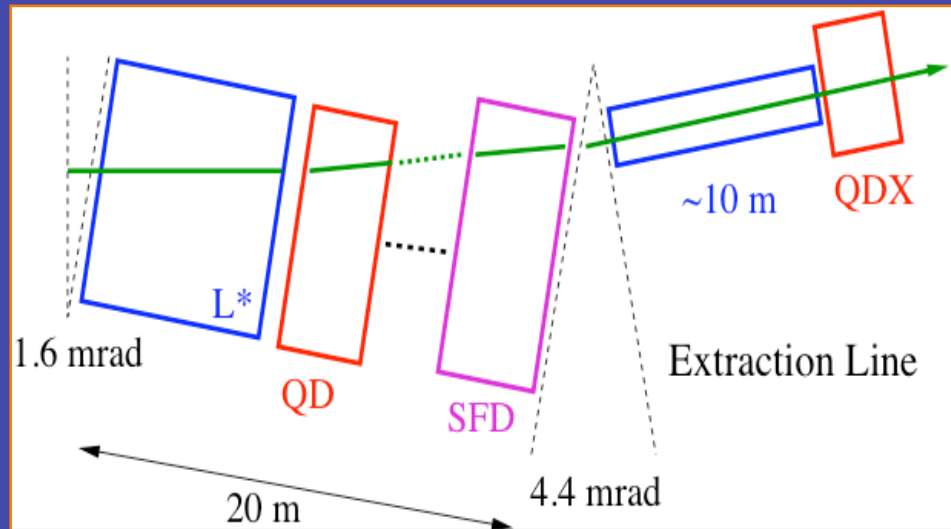


Separate magnets for incoming and outgoing beams in
20mrad extraction

Length of the extraction line between IP and dump

- ~ 350 m for 2mrad
- ~ 680 m for 20mrad

Large and small crossing angle 20 & 2 mrad design



Common Elements between incoming and outgoing for the first 20 m
After, separate structure

Special coordinate transformation for the 2mrad

Brief Introduction to BDSIM

Track particles through the BDS of a generic in LC including particle interactions and production of secondary in materials

BDSIM simulation based on Geant4

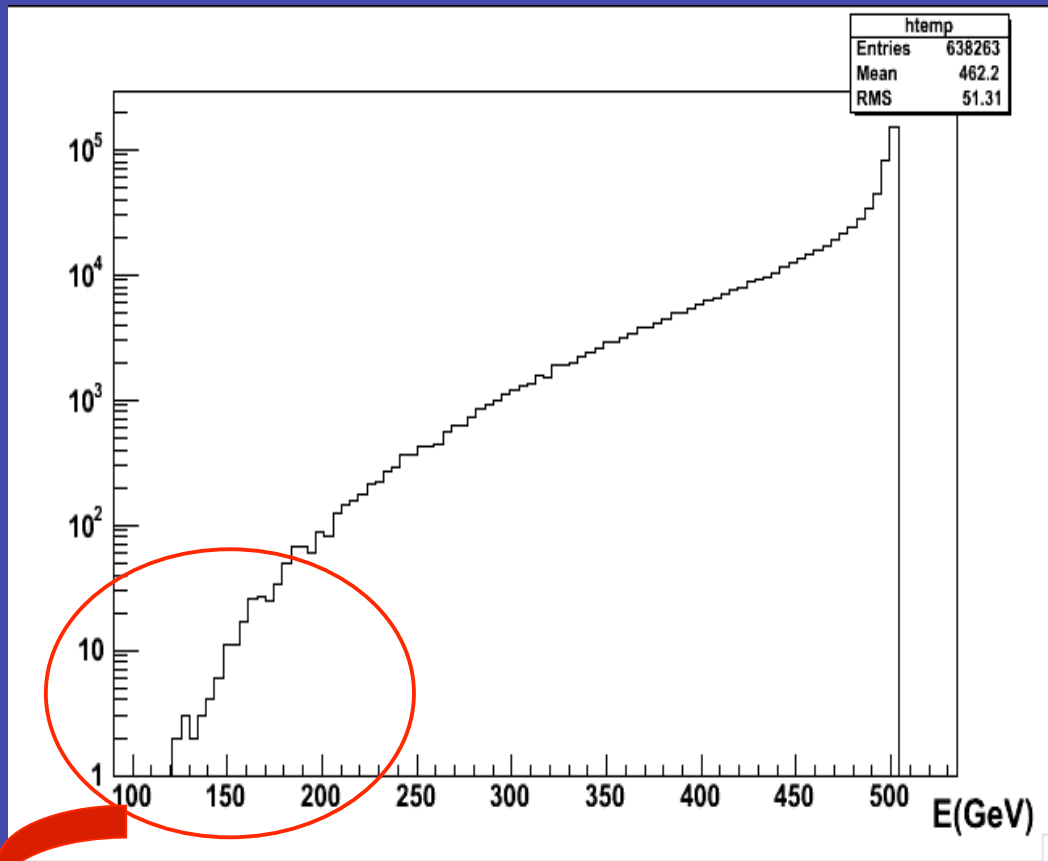
Up to now we have only taken care of the disrupted beam itself without emission of secondary

Since October 2005 new BDSIM version

- New input format very close to MAD format
- Histogram of the power losses by default
- All the optical elements being implemented
- Special coordinate transformation (for 2mrad)
- MAD style visualization (via ROOT dictionaries)

Disrupted beam

1TeV Nominal 100 nm y offset



Huge Statistic 640k particles
100nm maximize the energy losses

Beam parameters:

$$\sigma_x = 554nm$$

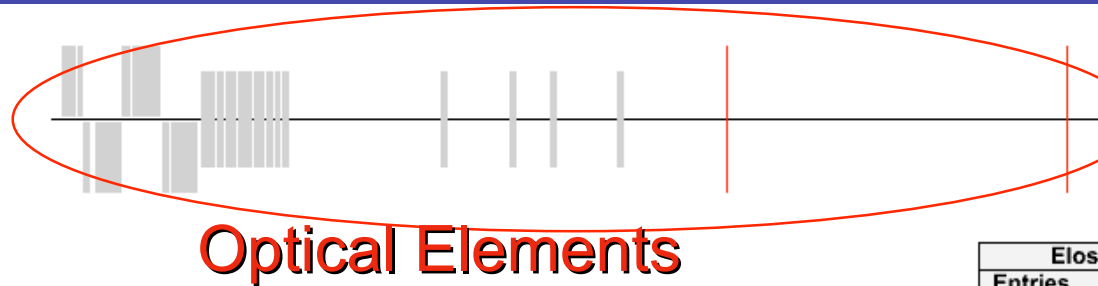
$$\sigma_y = 3.5nm$$

$$\delta = 7.6\%$$

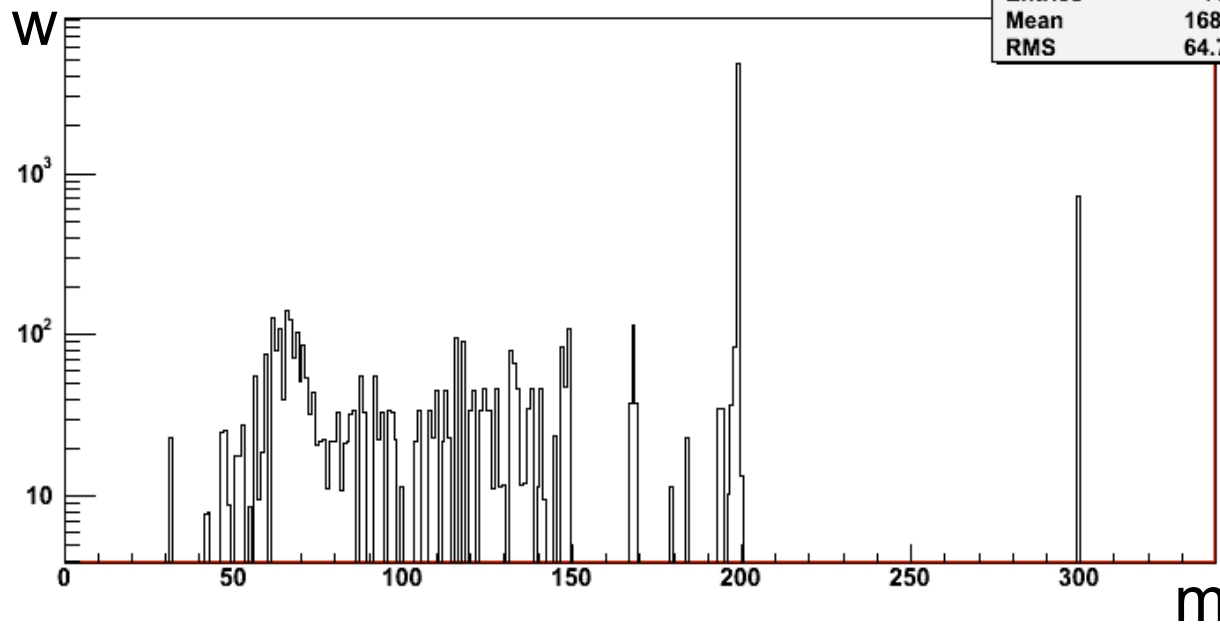
$$P=18.1 MW$$

Need to increase the statistics in the low energy tail

Power Losses along the 20mrad



800 particles out of 640k are losses : 22 kW



ElossHisto	
Entries	796
Mean	168.9
RMS	64.72

Ecol1:
BDSIM 5.48 kW
Dimad 5.15 kW

→ Ecol2:
BDSIM 0.84 kW
Dimad 0.12 kW

ZOOM on the 20mrad histogram

The screenshot shows a ROOT framework window titled "BDSIM ROOT Framework" with a menu bar (File, Edit, View, Options, Inspect, Classes, Help) and a toolbar. The main plot area displays a histogram of energy loss, with a red bar at approximately 32.6 m. A table titled "ElossHisto" provides summary statistics:

ElossHisto	
Entries	796
Mean	63.9
RMS	8.008

Below the histogram, a terminal window shows the following output:

```

dadoun, Mon Nov 14 11:45:51 CET 2005
BDSIM input file : 20mrad.gmad
dadoun:~/Volumes/DATA/Desktop/BDSIM/Utils: cd power/
dadoun:~/Volumes/DATA/Desktop/BDSIM/Utils/power: ls
20mrad.gmad          Makefile~
20mrad.root         ROB_JC20mrad_0.root
20mrad.root         ROB_20mrad.root
20mrad.root         ROB_20mrad.root
20mrad.root         ROB_20mrad.root
Makefile            ROB_JC20mrad_0.root
Makefile            UINS
dadoun:~/Volumes/DATA/Desktop/BDSIM/Utils/power: vim power.C
dadoun:~/Volumes/DATA/Desktop/BDSIM/Utils/power:

```

On the right, an "Optics Specs." window displays the following information:

Opticals Elements specs.
Name: qdex3d Type :Quadrupole
@ 32.576565 m with a length of 2.625449 m
k1=0.000000, k2=-0.009993
k3=0.000000, k4=-1.849137

Below the optics specs, a "display" window shows the output of a ROOT command:

```

http://root.cern.ch
FreeType Engine v2.1.3 used to render True Type fonts.
Compiled for macosx with thread support.
CINT/ROOT C/C++ Interpreter version 5.15.1
38, May 23 2004
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0]
Processing histoPOWER.C("20mrad.gmad","ROB_JC20mrad_0.root")...
0
total length 339.999
Axis max: 339.999 m
(int)0
root [1]

```

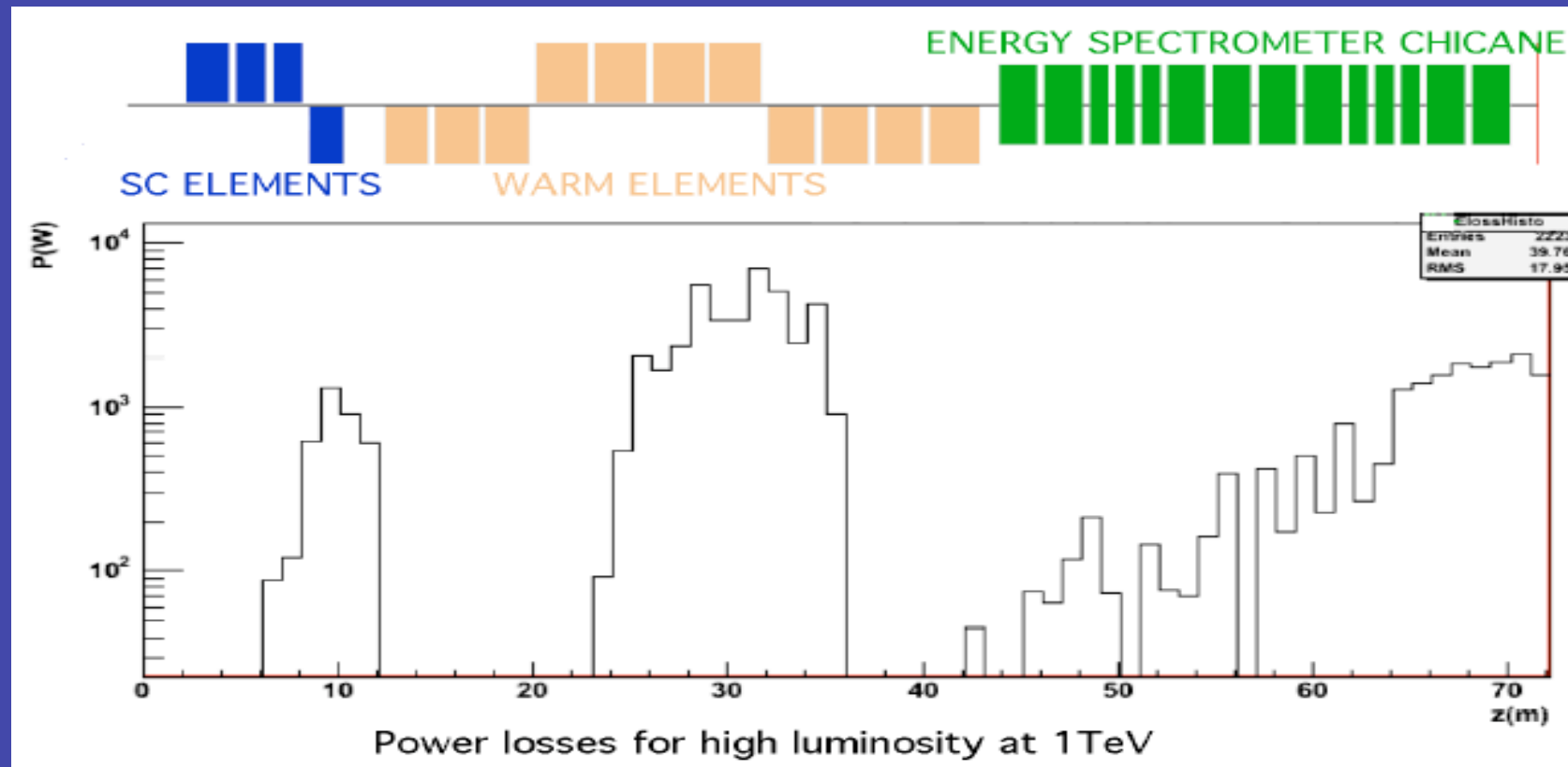
MAD display event

Papers

No loss until 30m

Power Losses along the 20mrad

High luminosity beam parameters



Power losses even in the beginning of the extraction

Table of the power losses

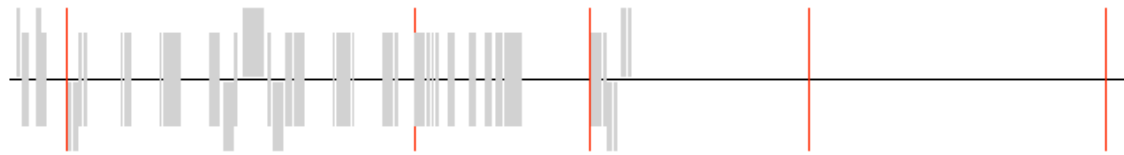
20mrad Extraction Line

Disrupted beam loss on collimators and max loss density in the magnets.
Both collimators using round aperture: $R_{COL1} = 88\text{mm}$, $R_{COL2} = 132\text{mm}$.

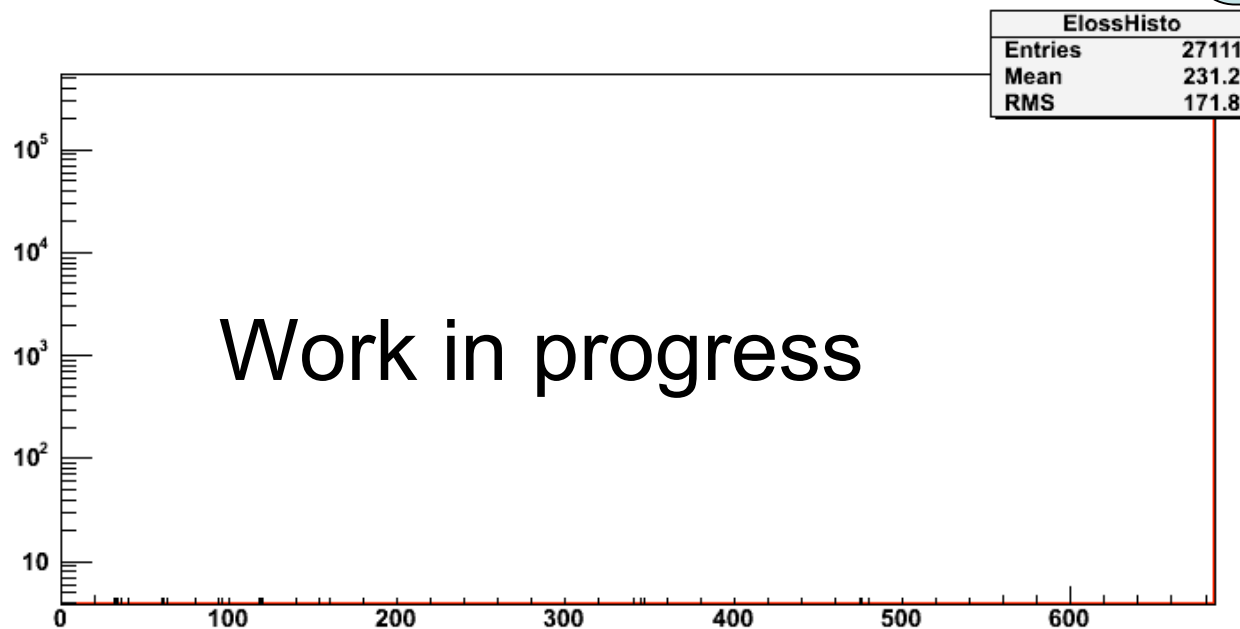
Tracked in BDSIM using $7e4$ particles (except **1TeV Nom. Dy100 - 640K** particles)

E_{cm} [TeV]	Vertical Offset [nm]	E-Loss [kW]		Max E-Loss density in Magnets [W/m]		
		Col1	Col2	SC Quads	Warm Quads	Bends
0.5 Nominal	0	0	0	0	0	0
	200	0	0	0	0	0
0.5 High Lumi	0	46.4	75.5	0	58	52
	120	174.1	179.7	0	95	265
1.0 Nominal	0	0.86	0	0	0	0
	100	5.48	0.84	0	10	139
1.0 High Lumi	0	49.7	56.7	1284	6205	2162
	80	122.3	67.7	1125	7250	5725

Power Losses along the 2mrad



? particles out of 640k
are losse : ? kW



Recently (yesterday)

Found a disagreement
Between Dimad/BDSIM

→ But we are
able to fix it ...

Summary and prospects

- Good understanding of DIMAD and BDSIM comparison on power losses is essential before estimating backgrounds
- Increase the statistics in the low energy tail
- Power losses due to the radiative Bhabha
- More systematic studies needed for all beam parameters
- Track the behavior of the secondary particles
- Customize the existing neutron propagation in GeantIV (CPU time !)
- Run BDSIM onto DATA GRID