
12 GeV CEBAF

Model Development

- Not just an interesting exercise:
- Must be able to explain observed machine behavior and predict new behavior
- Part of this involves designing “ad-hoc” solutions to optics problems as we encounter them (i.e extraction redesign)
- Also, focused on achieving certain beam parameters for the needs of the users (PQB team)

Overview

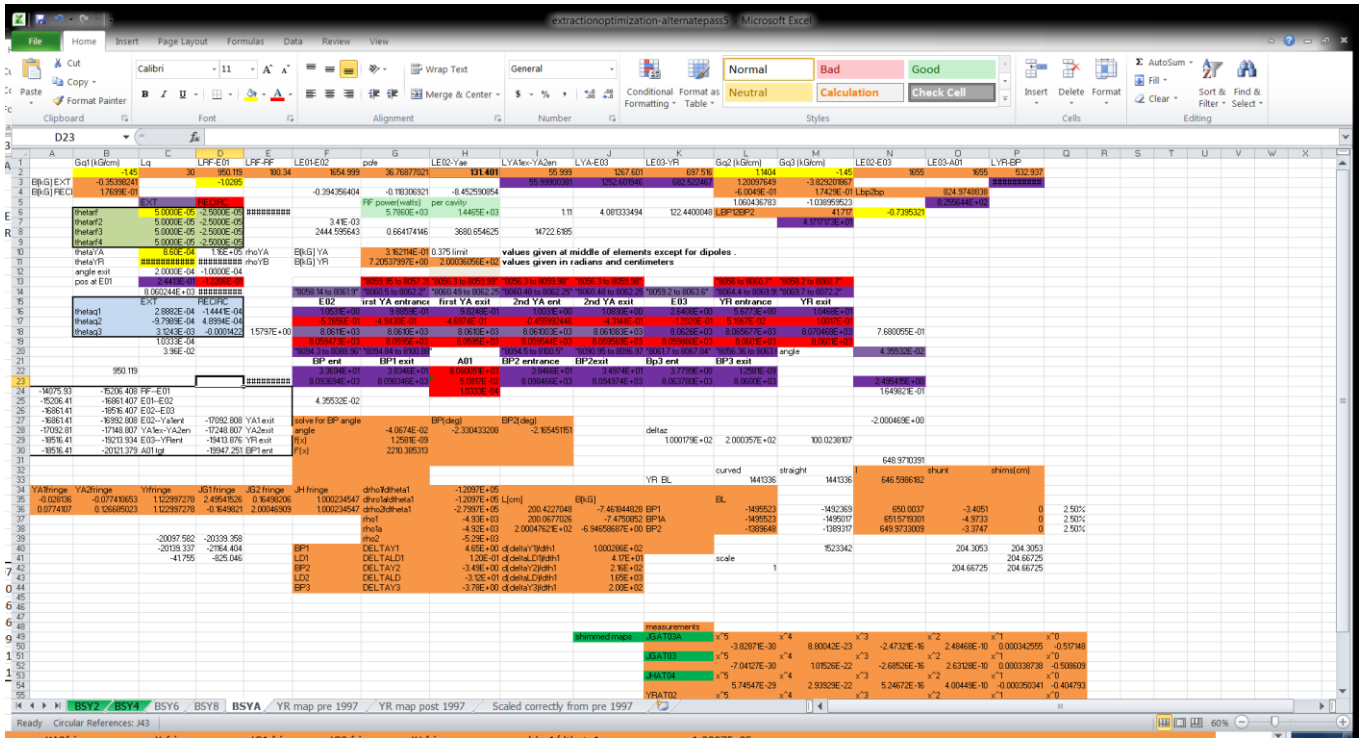
- Revisiting Extraction
- Magnet Field Quality
- Synchrotron radiation effects on upper pass steering
- Linac Focusing
- Longitudinal phase space tracking
- Spin tracking
- Hall A raster pattern
- Hall A 5T moller target
- Future Plans

Revisiting Extraction

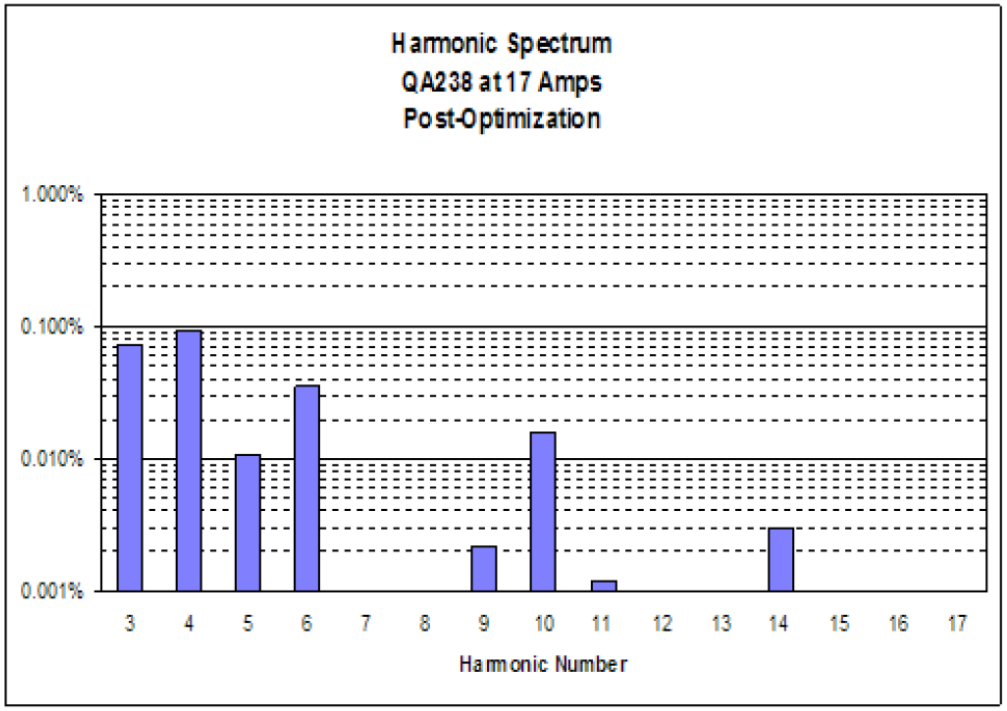
- Initial commissioning of separators showed they lacked the power to fully extract the beam
- Revisited the optics to use the E01,E02 and E03 quadrupoles to compensate for the lesser RF kick.
- Successfully tested and utilized to run the beam. The observed position was as predicted.

Revisiting Extraction(cont)

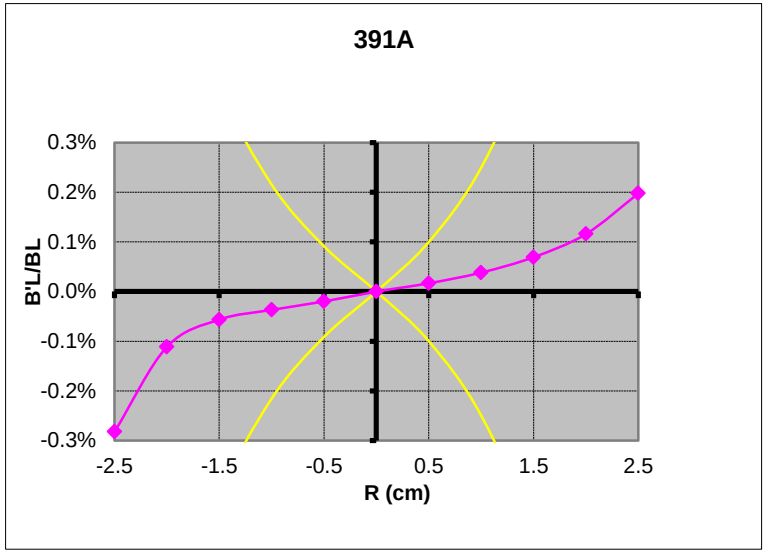
For the 12GeV project, developed an analytical model to calculate the extraction parameters,



Quadrupoles and dipoles Field quality



Dipoles were converted
From C to H style



	MBE1m(16) ARC1	MBR2m ARC2	MBE1m ARC3	MBB2m ARC4,5,6	MBA3m ARC7,8,9	MXP4m ARCA
$K_2L\ (m^{-2})$	0.35	0.22	0.24	0.12	0.11	0.07
$K_3L\ (m^{-3})$	2.22	3.51	8.31	4.21	2.20	2.26
$K_4L\ (m^{-4})$	543	1390	327	166	215	148
$\frac{B'L}{BL}\ (m^{-1})$	0.022	0.020	0.036	0.018	0.015	0.010

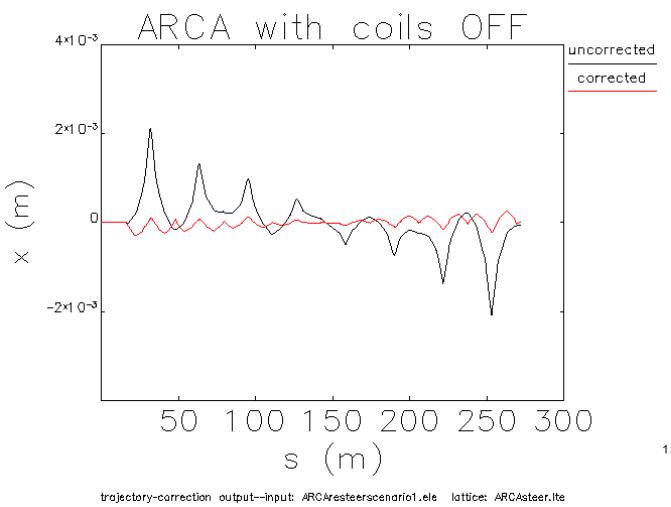
Magnet field quality (cont)

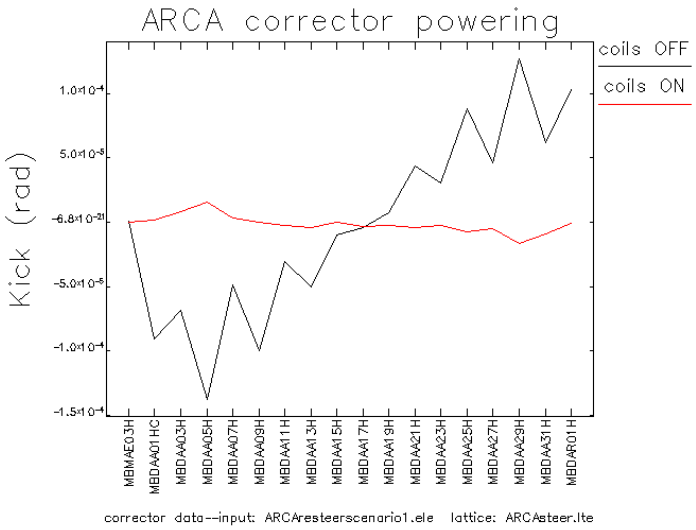
- We have the measured quadrupole terms for the dipoles in the model. Beam based measurements confirmed they are correct.
- It is possible to analyze the data for the sextupole term. Currently in progress.
- Comparison with TOSCA calculations (from J. Benesch) in progress.

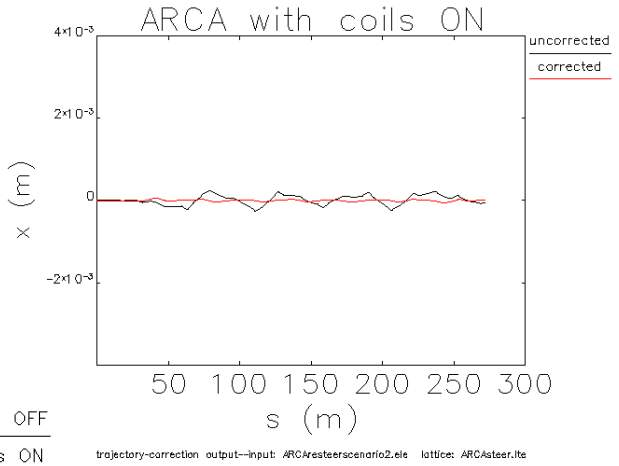
Linac Focusing

- Effect of gradient distribution in linac
  - Tool developped by D. Turner to load in grad. Distribution in ELEGANT.
  - Effects are small unless one is at low gain per linac
- Effect of cavity Focusing in linac
  - Just affects the first two quadrupoles in LINAC. Not adjusting them produces a beta beat of a few percents at most.
- Effect of gradient calibration in linac
  - Because of “fudging process”, its has a negligeable effect even with 5% uncertainty.

Effect of synchrotron radiation on upper pass steering



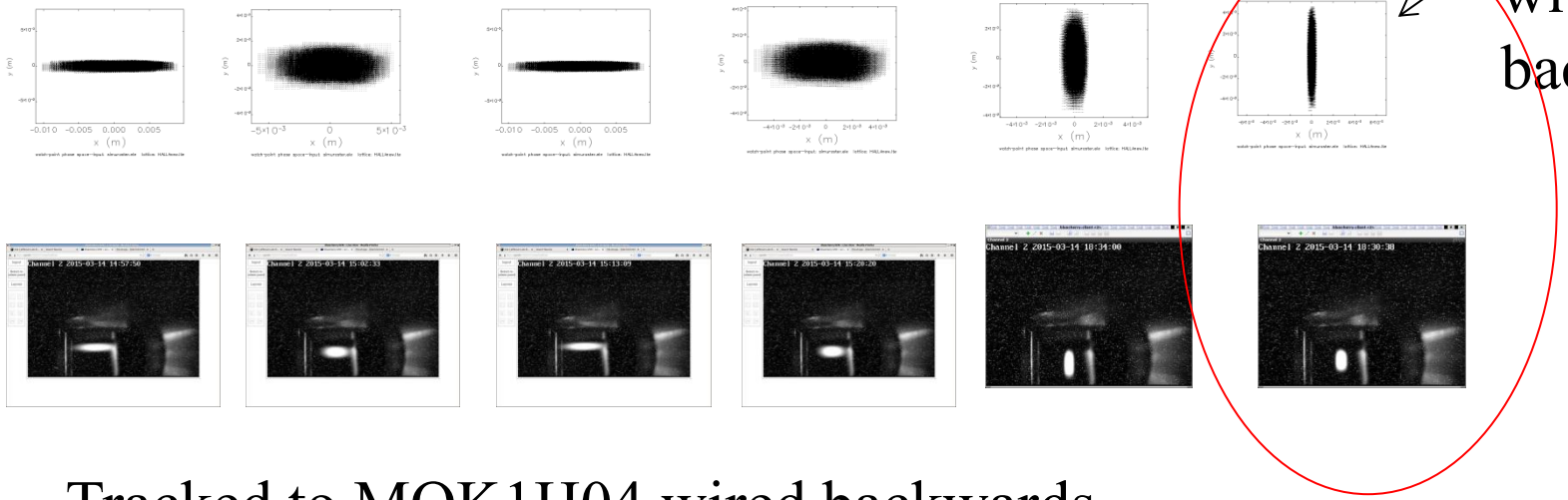




Longitudinal Optics

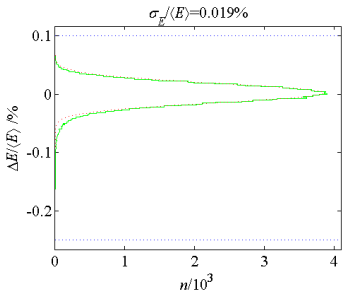
- Parity Experiments require tight beam quality.
- Longitudinal match of the machine now a concern.
- Optimized with LiTrack for fast turnaround
- Final tracking in ELEGANT confirms the results.
- Initial results suggest installing sextupoles in injector chicane and running off crest in linacs if we keep the non-zero M56 arcs.

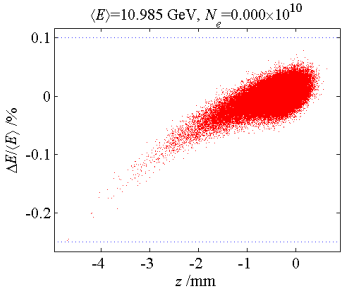
Hall A Raster pattern problem

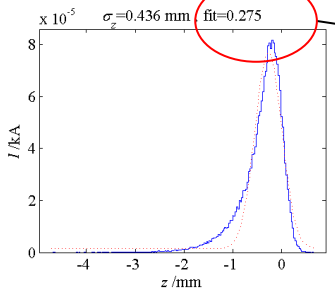


Tracked to MQK1H04 wired backwards.
After reversing the polarity we get the expected pattern:

DBA M56 in upper arcs with optimized longitudinal match

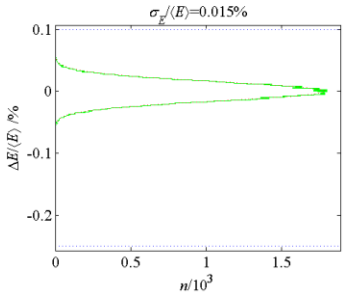


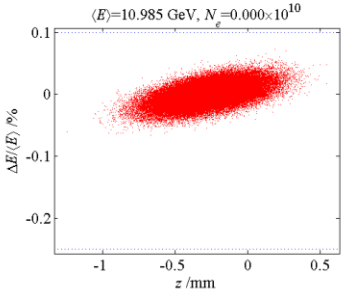


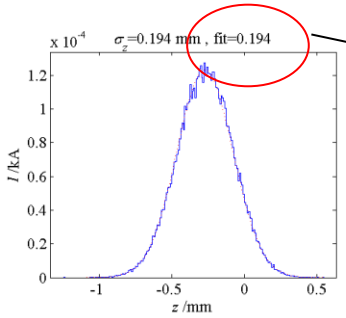


275 μm

chicane off.

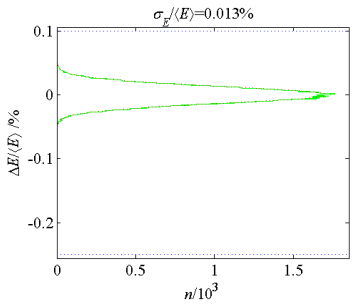


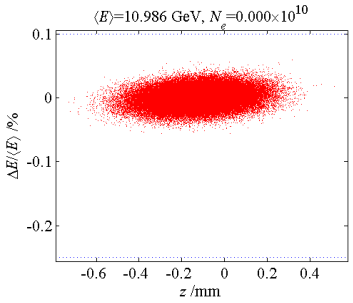


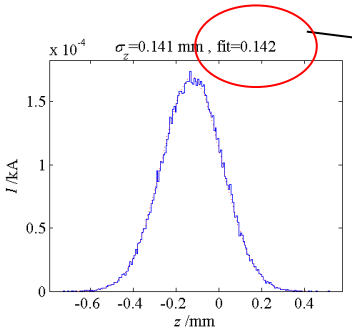


194 μm

chicane on..



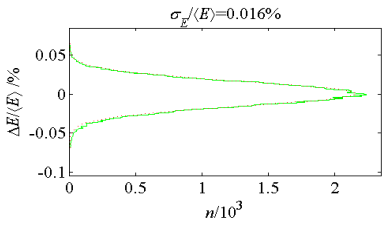


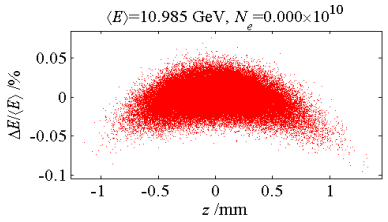


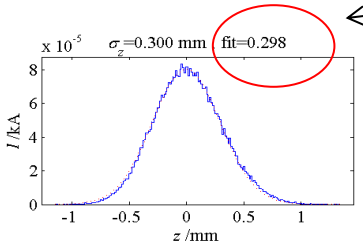
142 μm

Injection chicane on, linacs +4 off crest, Chicane Sextupoles on

Zero M56 in upper arcs

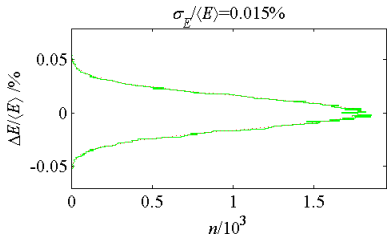


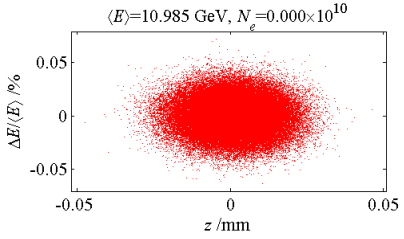


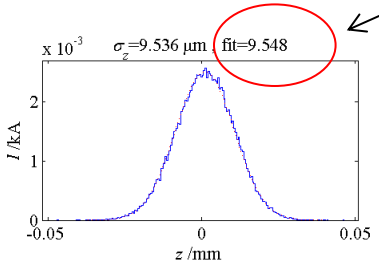


298 μm

Chicane OFF







9.5 μm

Chicane ON

No tails in both cases, just longer bunch if we run with the chicane off.

Spin Tracking

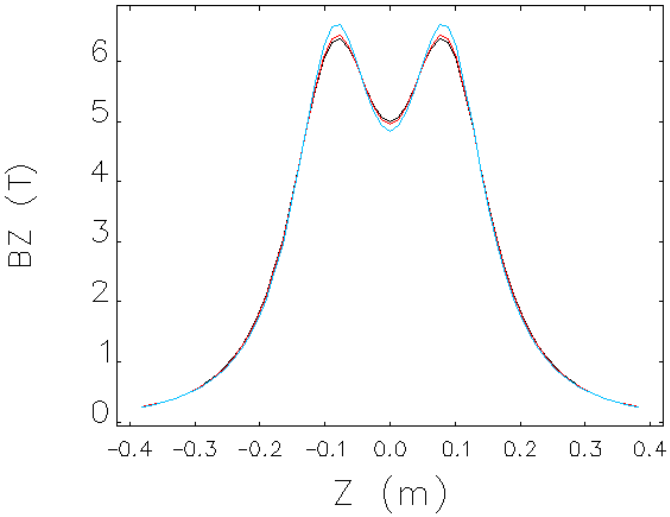
- Currently Collaborating with F. Meot (Brookaven) to perform 3D spin tracking through the machine

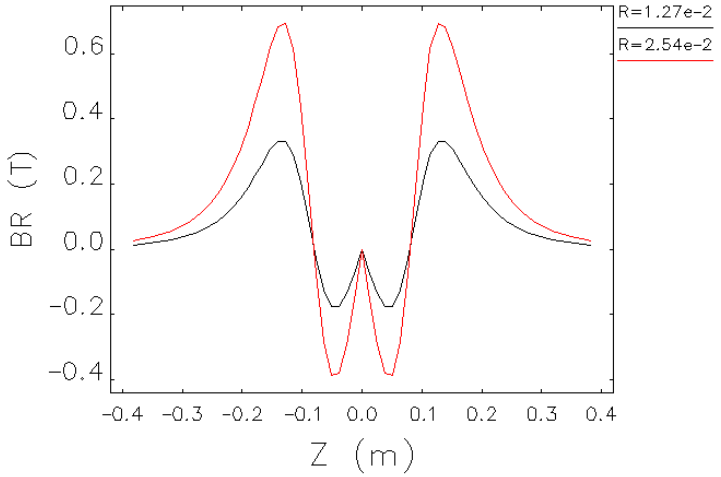
- Preliminary estimates of dilution (with ELEGANT) show that one will have to readjust Wien filters and that the optimal setups for multiple hall deliveries will be slightly different.

- Putting together a model to do that.

New Moller Target

- Hall A is installing a 5 Tesla solenoid.
- Manufacturer provided field $B(r, \theta, z)$
- Tracked 3D field in ELEGANT

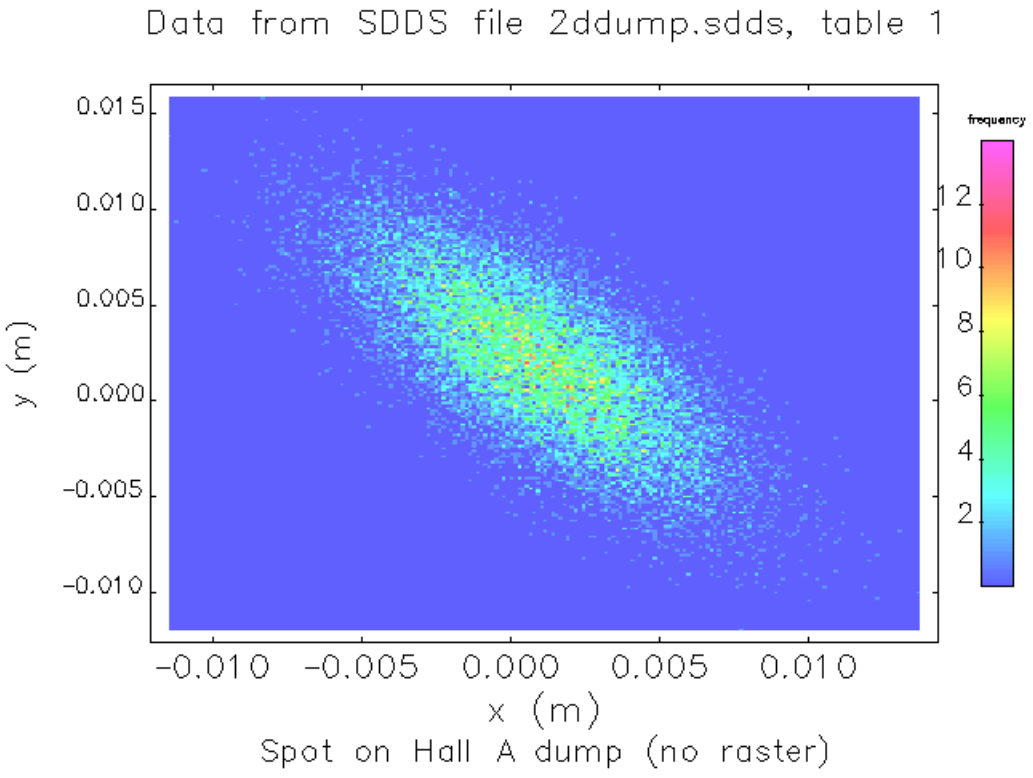




Sample distributions. The real field map is more fine grained.

Spot at DUMP

- Adjusting MCZ1H04V and MBD1H04H centers beam on dump. MCZ1H04V was added specifically for this purpose.



Plans

- Short term
  - Eliminate step Optim -> ELEGANT
  - Convert optics to zero M56 in upper arcs
  - Revert Extraction to nominal
- Medium term
  - Develop strategy for longitudinal matching aimed at minimizing Halo in Halls.
  - Study chromatic effects (sextupoles?)
  - Analyze magnet measurements for sextupole component, formulate new measurements, include in model