UMER Research in support of IOTA

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4/28/15

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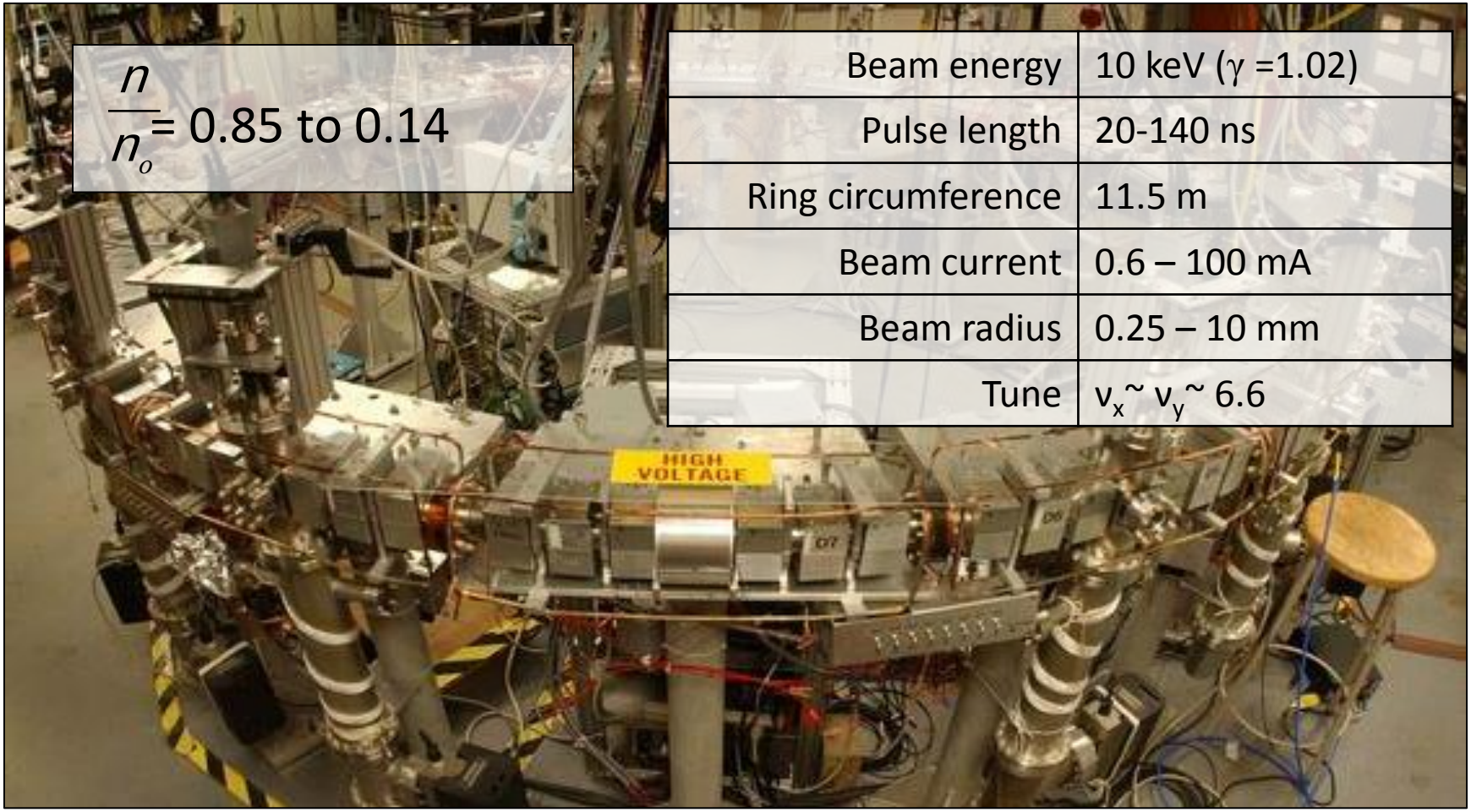
UMER Specs



$$\frac{n}{n_o} = 0.85 \text{ to } 0.14$$

Beam energy	10 keV (γ =1.02)
Pulse length	20-140 ns
Ring circumference	11.5 m
Beam current	0.6 – 100 mA
Beam radius	0.25 – 10 mm
Tune	$\nu_x \sim \nu_y \sim 6.6$

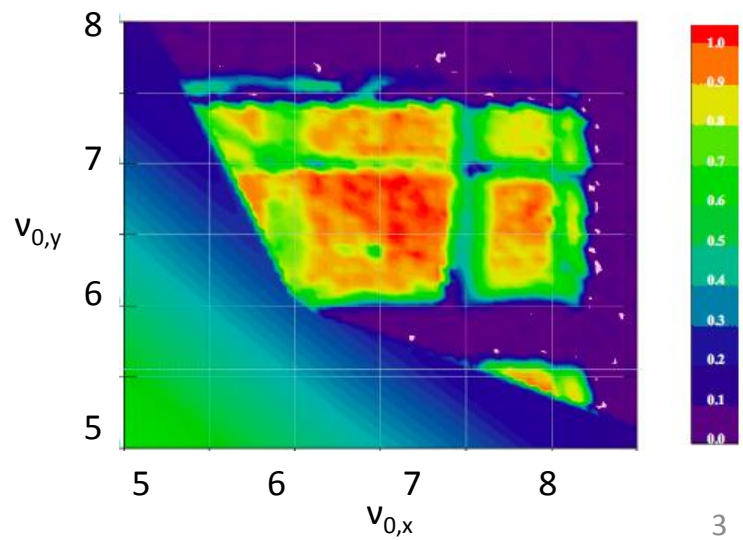
UMER as nonlinear optics testbed

- Nonlinear integrable optics theory is compelling for single particle dynamics (Danilov and Nagaitsev, Phys. Rev. ST Accel. Beams, 2010)
- Ideal testing ground for nonlinear optics with space charge
  - Well bench-marked simulations
  - Inexpensive printed circuit magnets
  - UMER flexibility
    - Multiple lattice solutions
    - Variable space charge

GOALS:

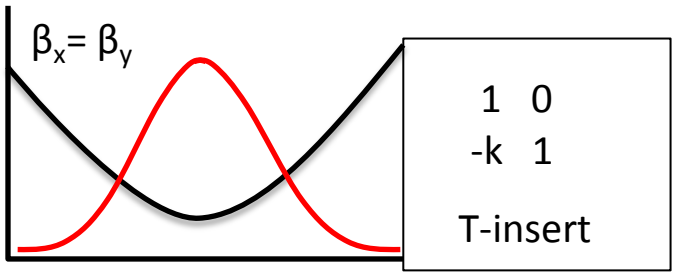
- Design and implement a nonlinear lattice in the UMER framework
- Experimentally verify lattice properties (stability, halo suppression)
- Investigate consequences of space charge through experiment and simulation

Beam Lifetime Plot, 6.0 mA



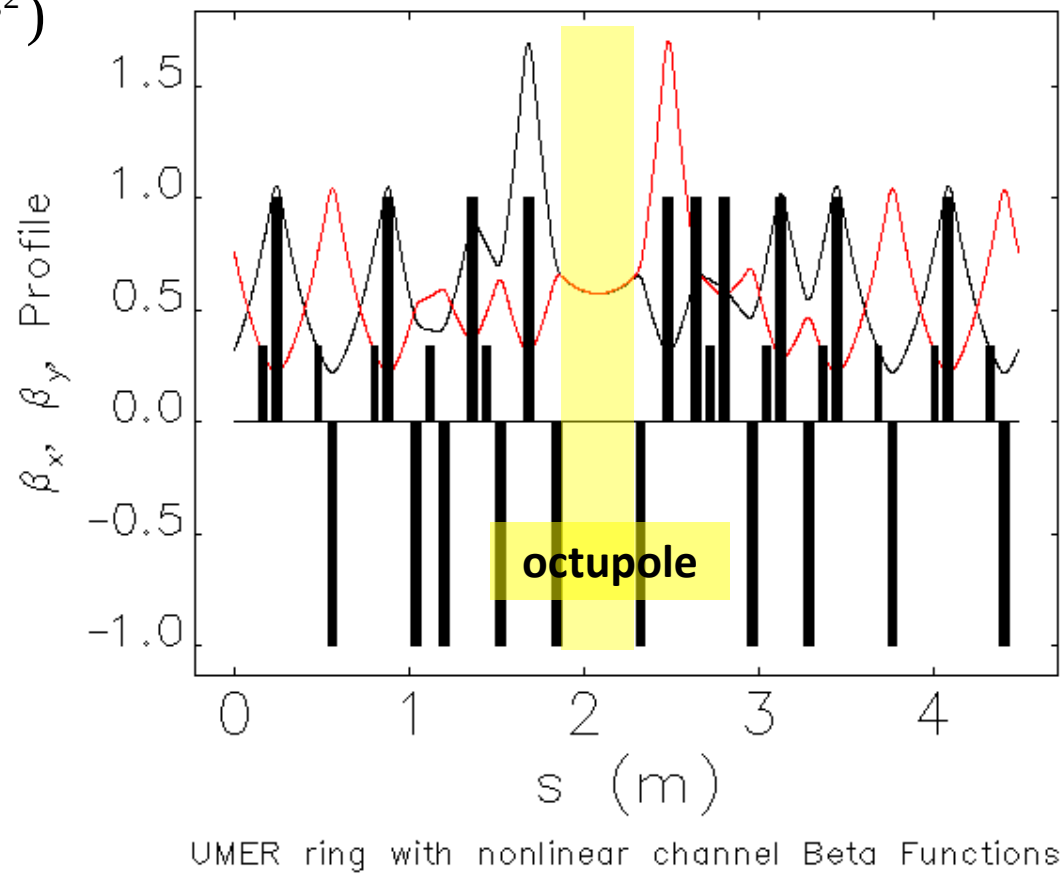
Quasi-integrable octupole lattice

$$V(x,y,s) = \frac{K}{4b(s)^3}(x^4 + y^4 - 6x^2y^2)$$



Octupole strength

"0-current" Lattice Functions with **Elegant**

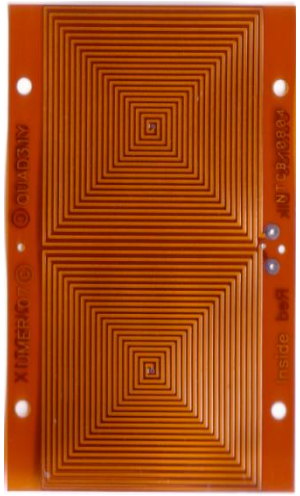


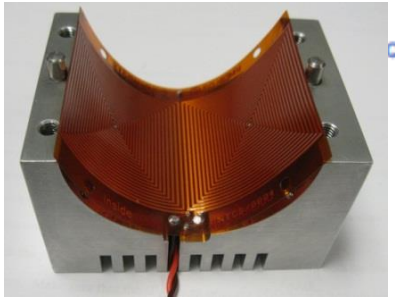
What will an experiment look like?

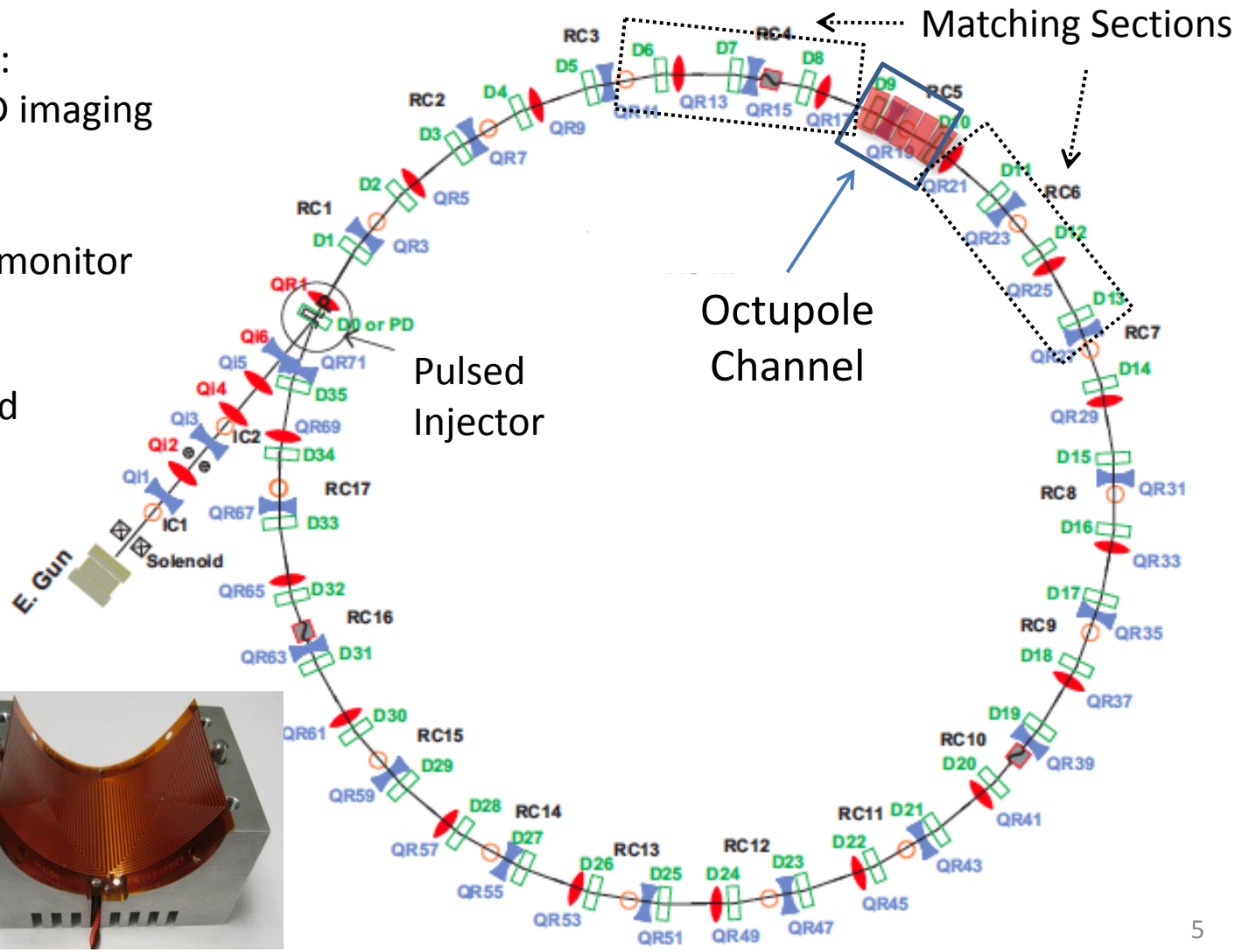
Ring Diagnostics:

- Multi-turn 3D imaging "knock-out"
- 14 BPM's
- Wall current monitor

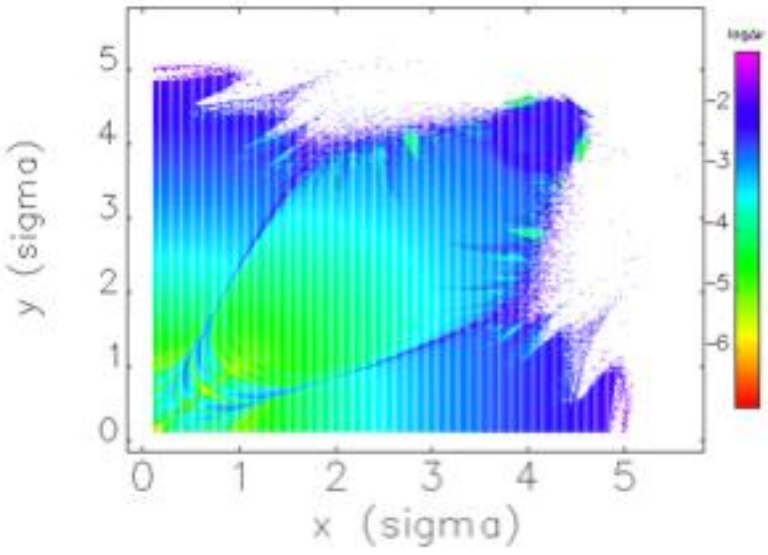
Printed circuit board magnets



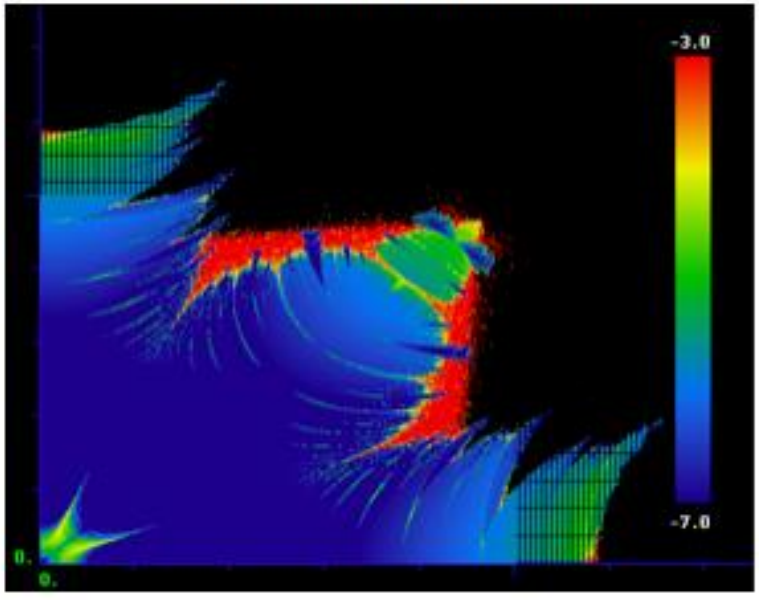




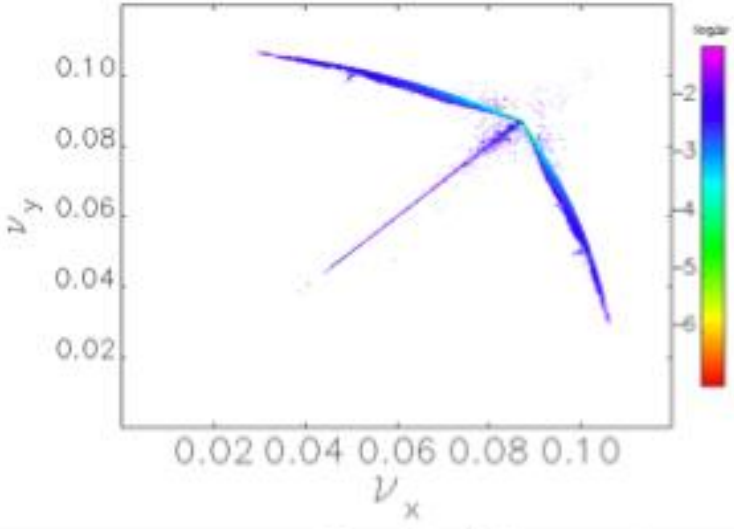
a) Elegant amplitude plot



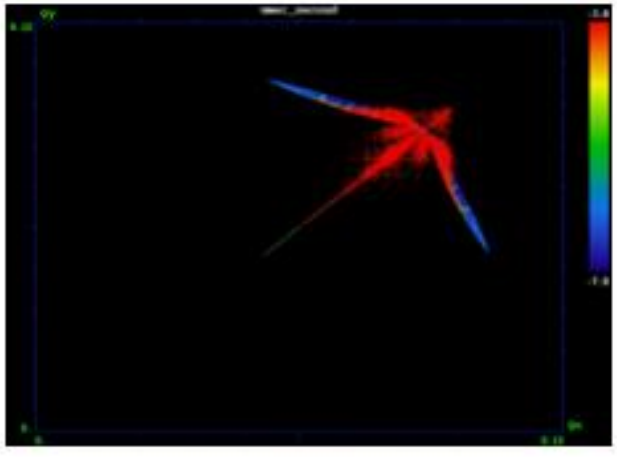
b) Lifetrac amplitude plot



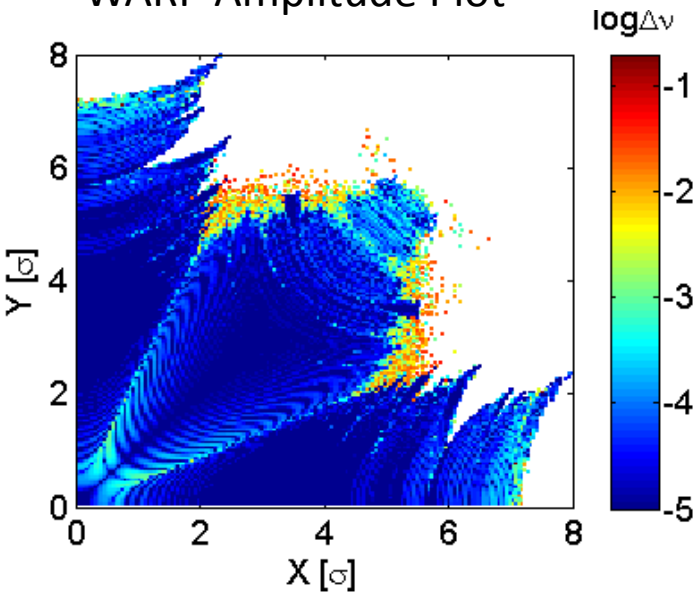
c) Elegant tune space



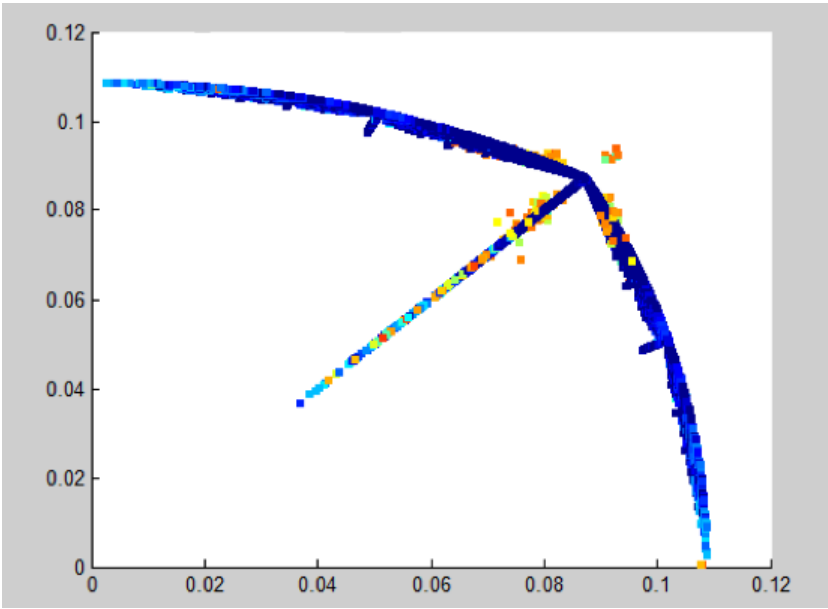
d) Lifetrac tune space



WARP Amplitude Plot



WARP tune space



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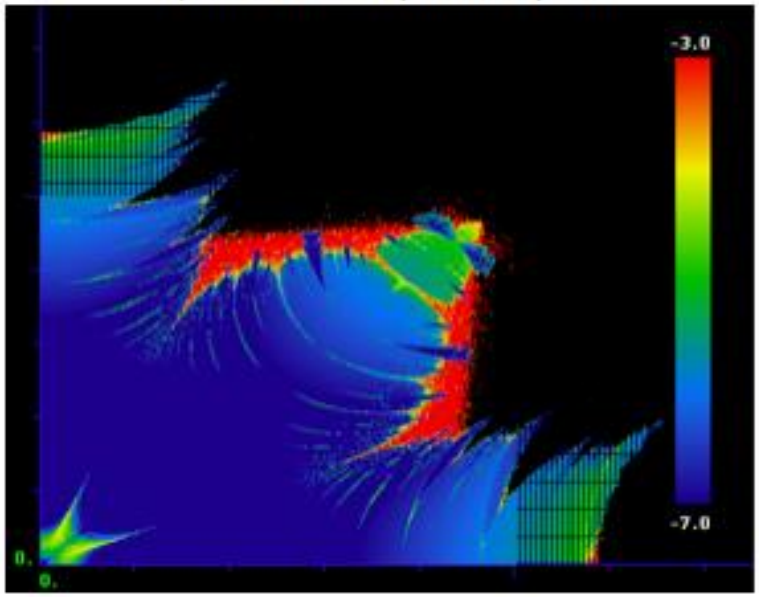

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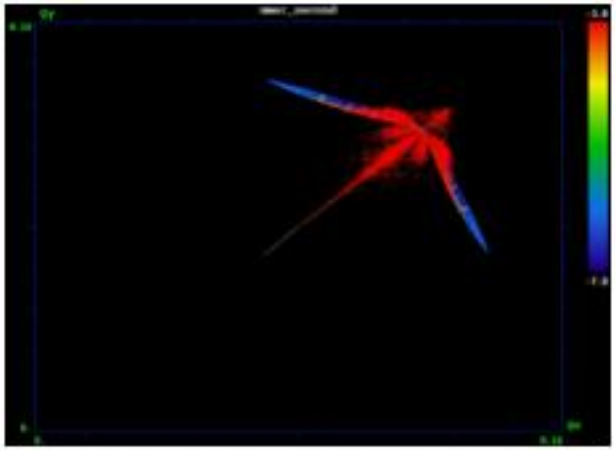

Research priorities for UMER

- Maximizing octupole-induced tune spread
- Lattice solution for UMER
- Detection sensitivity to tune spread
- Negligible space charge beam: generation and detection
  - BPM signal to noise ratio
- Understanding space charge, external nonlinearity interaction

Some research priorities for IOTA

- Commissioning, studying octupole lattice
- Planning for proton beam, varying space charge concentration
- Designing halo experiments/ halo diagnostics