Beam-beam tune footprint viewer

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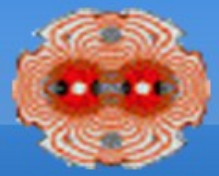
- Make a footprint as automatically as possible based on data extracted from the control system
- Usage :
  - Working point optimisation
  - Understanding of measurements/observations

Outline

- What is a tune footprint ?

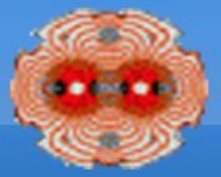
  Why do we care ?
- How to make one with the footprint viewer ?
- Future work

Beam-beam effects



- Amplitude detuning
- Emittance effect
- Orbit effect
- Dynamic aperture reduction
- Dynamic beta
- Coherent motion
- ...

Beam-beam footprint



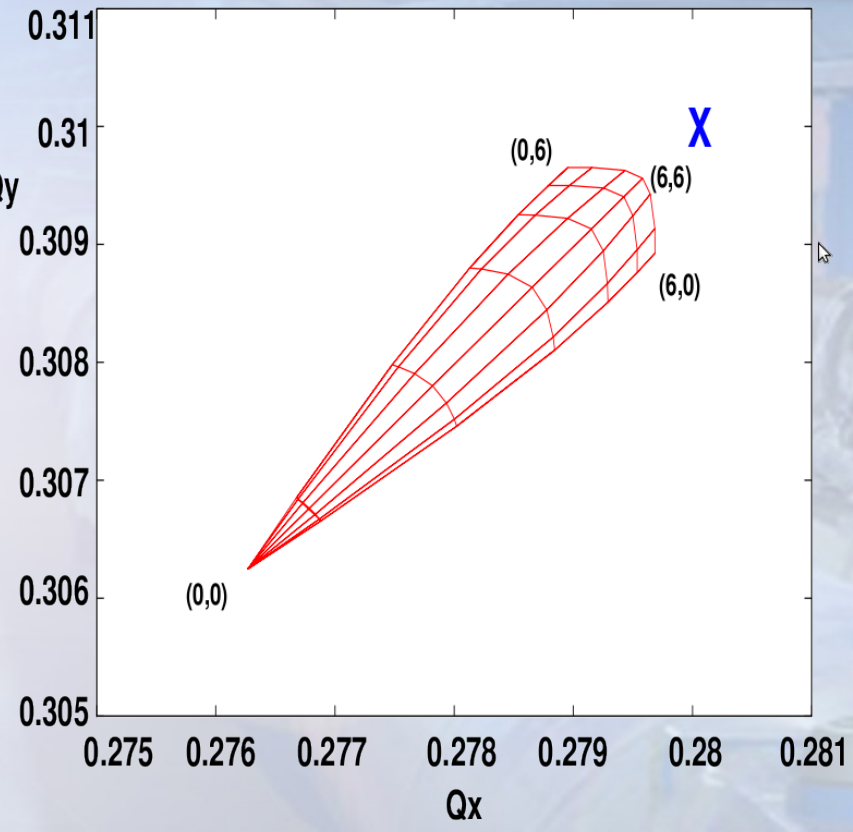
Non linear force

amplitude detuning

- Depends on
  - Xing (value and plane !)
  - Separation (value and plane !)
  - Intensity
  - Emittance
  - Optics

Footprint

- Representation of amplitude detuning in 2D
- Can be obtained via tracking and FFT
- Some relevant properties
  - Sensitive to resonances
  - Scales NON linearly with emittance
  - Scales linearly with intensity
  - Shifts with initial tune



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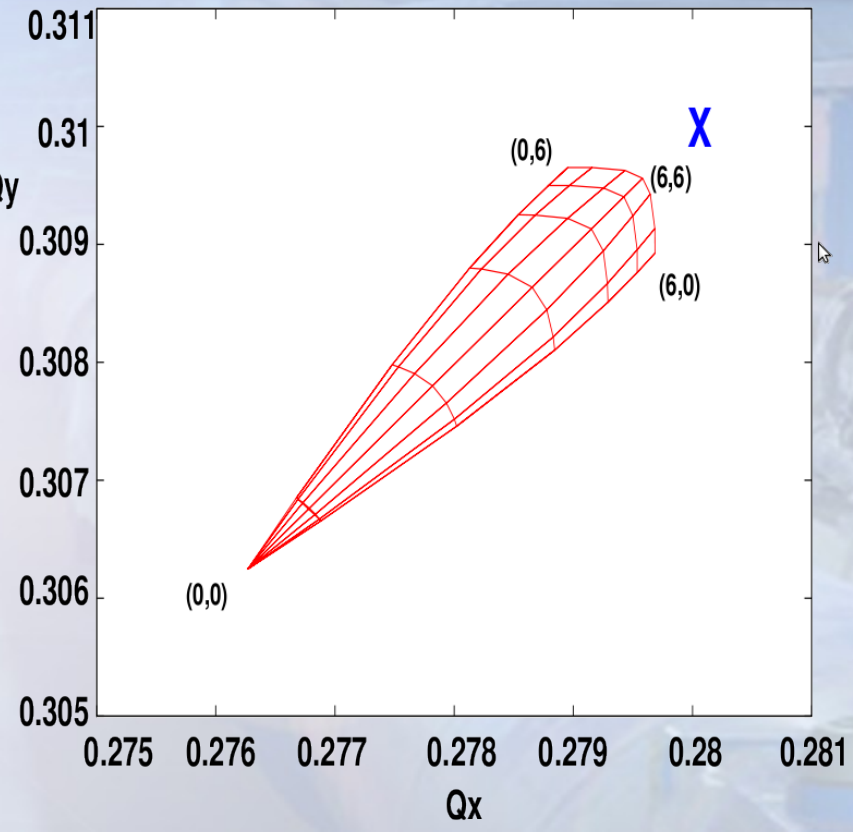
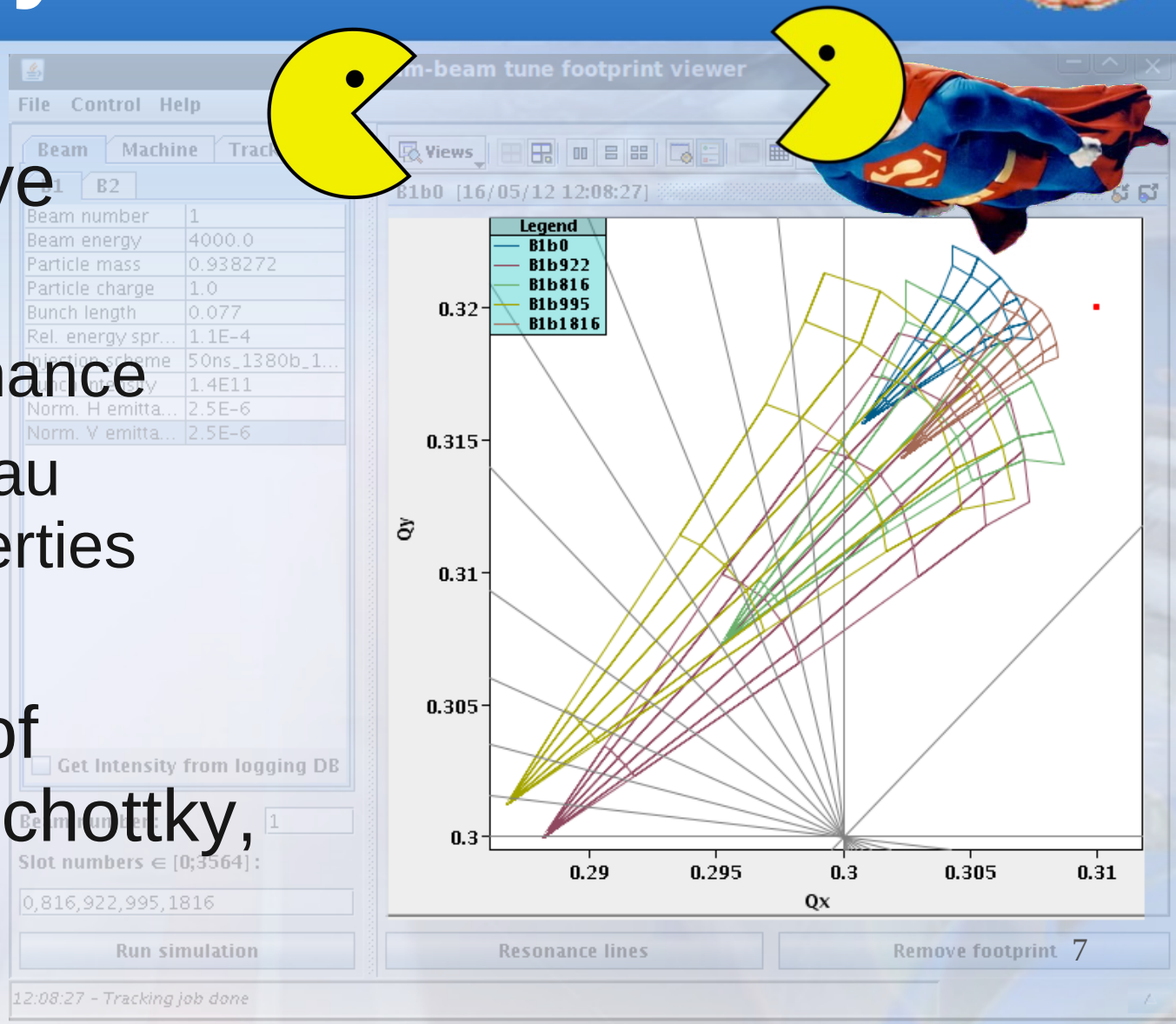


WARNING : this is an approximation (ignoring resonances and dynamic beta)

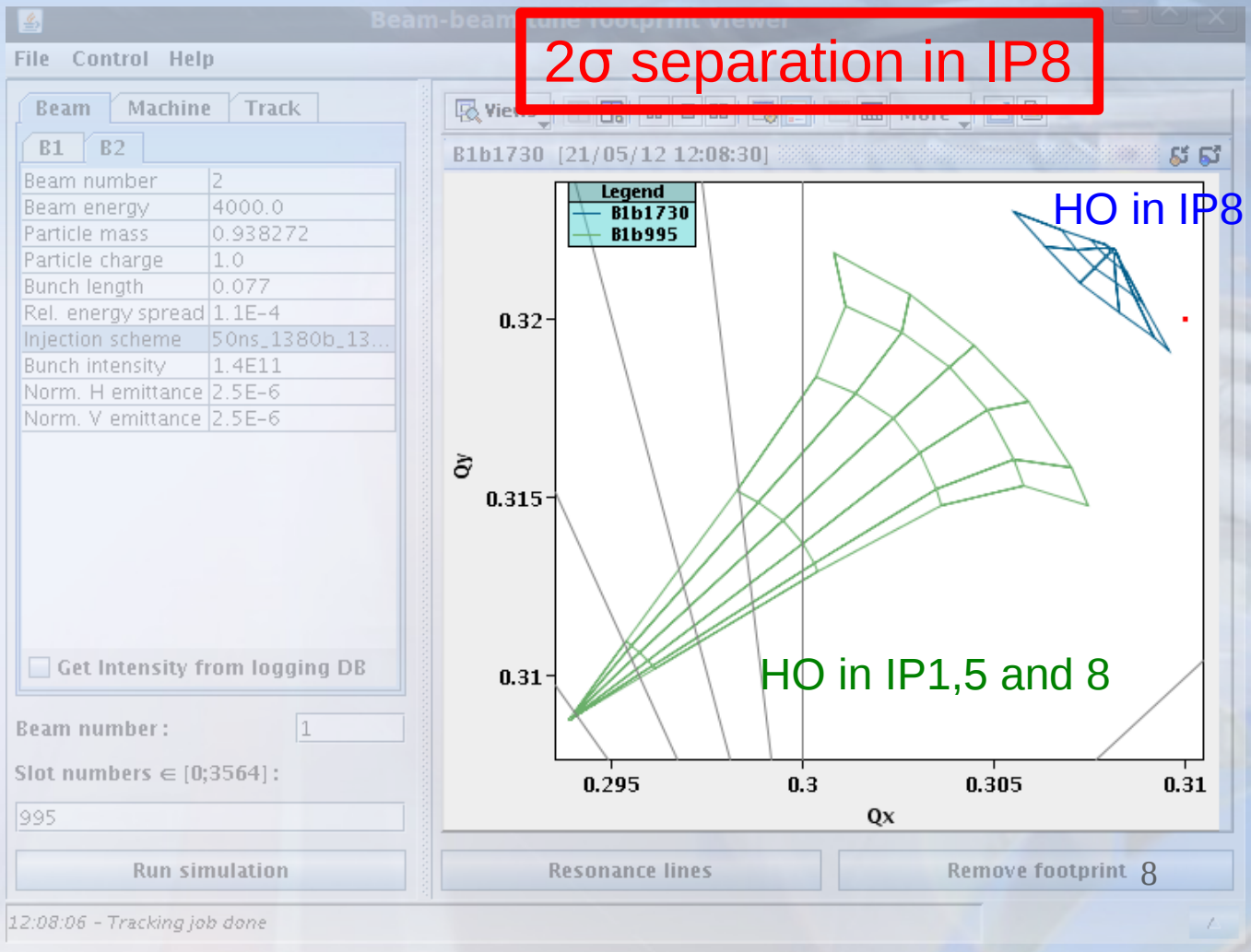
Why do we care ?

- Bunches behave differently
  - Different resonance
  - Different Landau damping properties
- We have no measurement of detuning yet (Schottky, gated BBQ)



Real example
IP8 private bunches

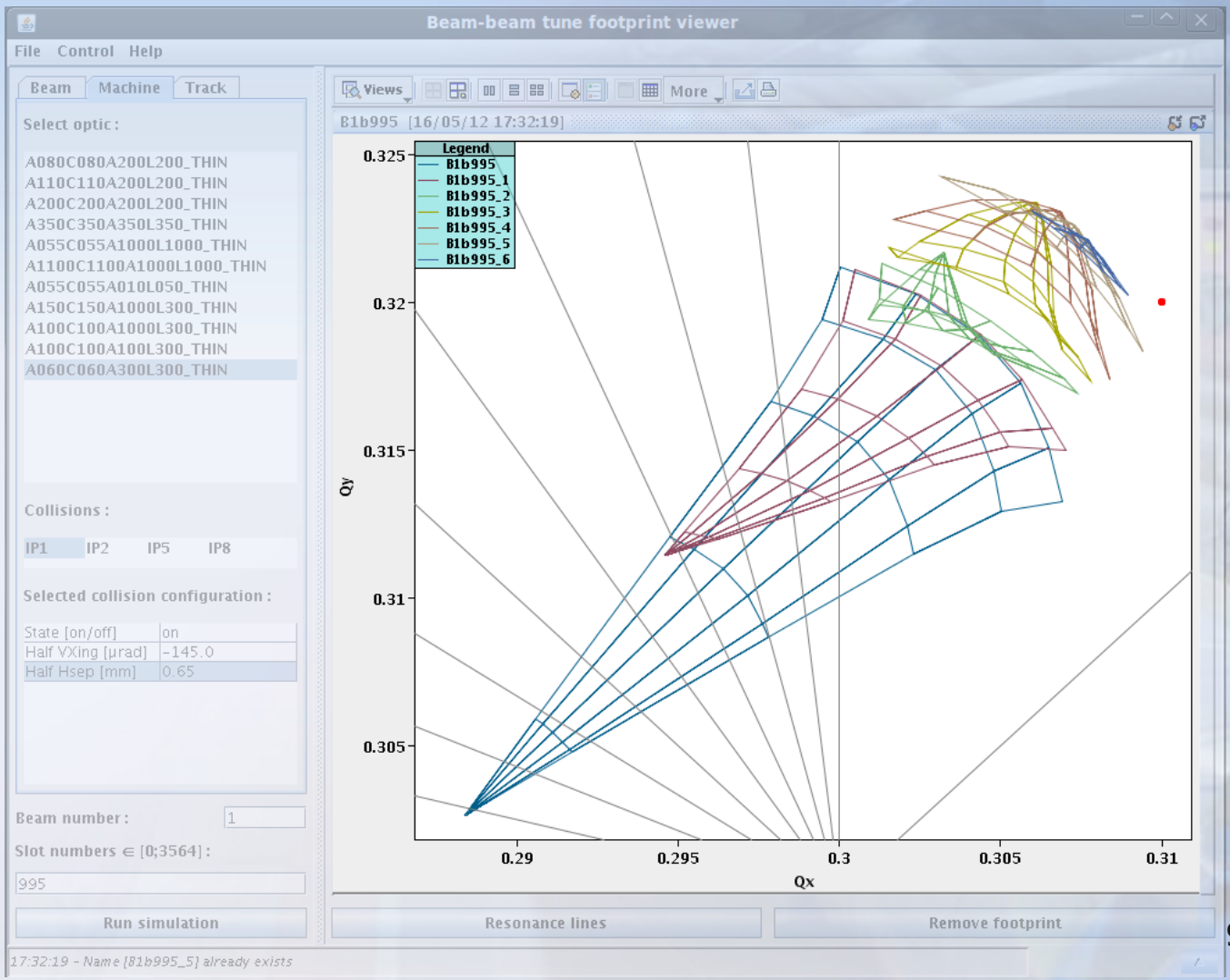
- Selected bunches lose more
- Selected bunches go unstable



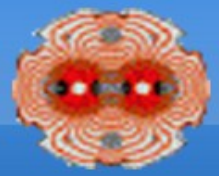
Real example separation scan

0.65 mm // sep

0.0 mm // sep



Application workflow



- Input
  - injection scheme from LSA (AK D. Jacquet, G. Papotti)
  - thin lens optics from Online Model Definitions (AK G. Müller)
  - Machine and beam parameters from user
- Run MAD-X simulation via JMAD (AK K. Fuchsberger)
- Plot footprint
- Allow basic manipulation of the footprint.

HOWTO start

CCM – lhcop

↓

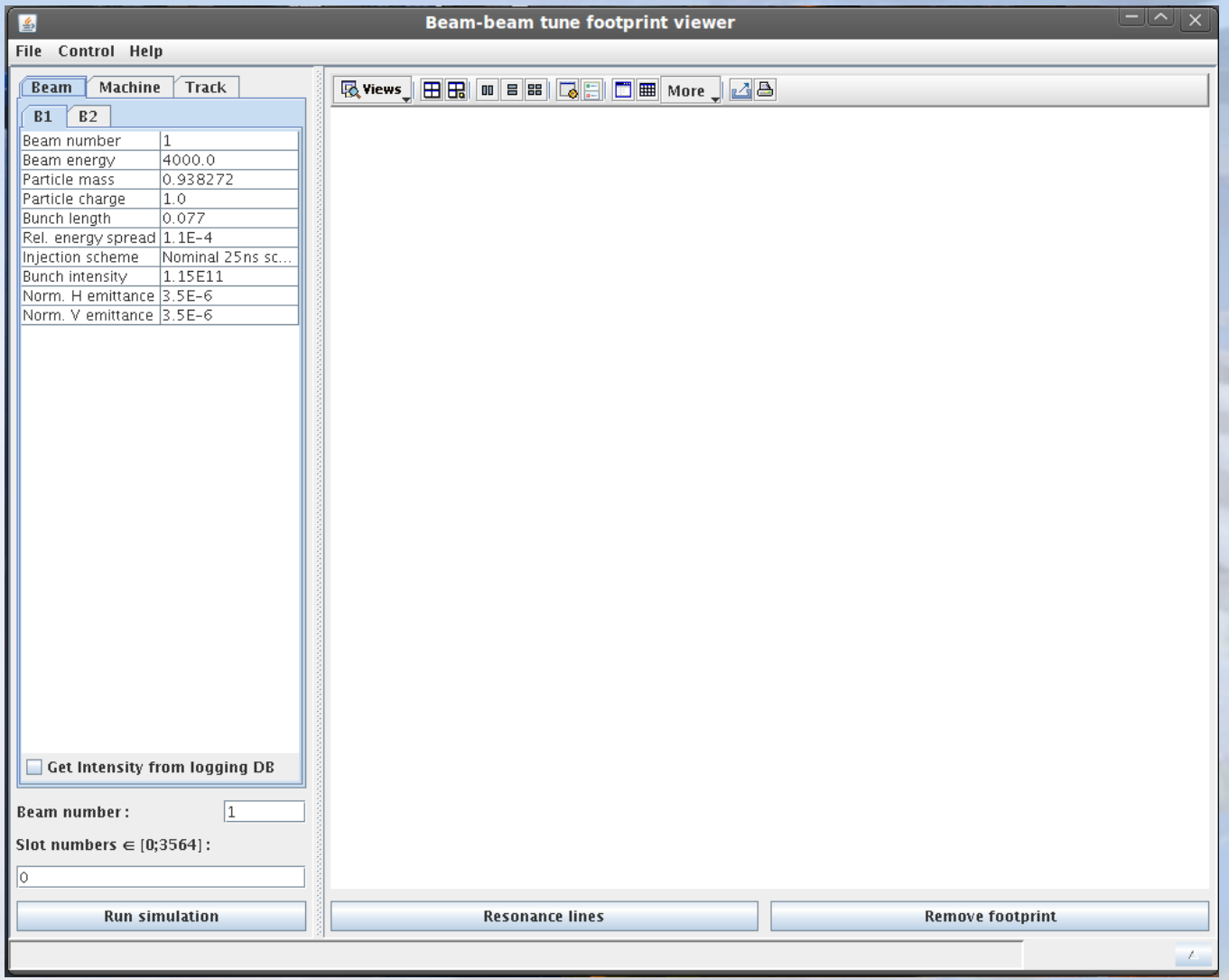
LHC control

↓

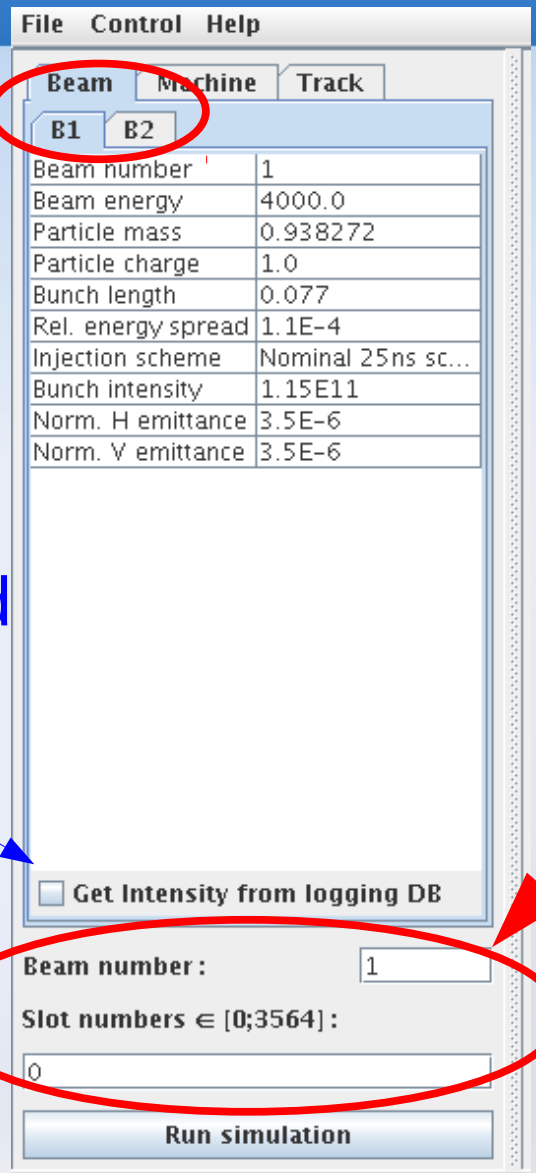
Beam control

↓

Beam-beam footprint viewer



HOWTO setup beams

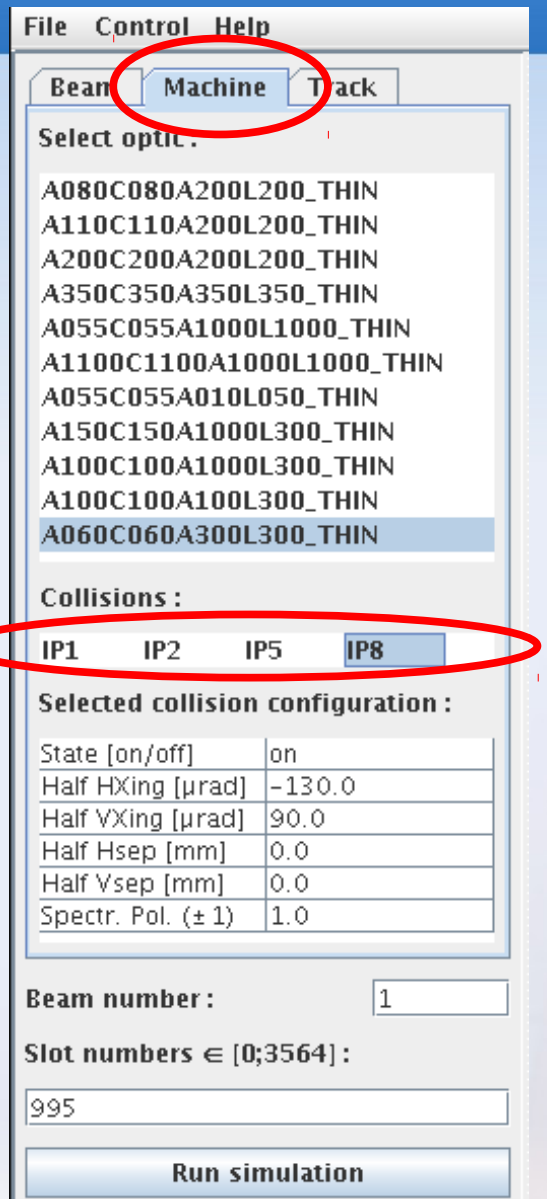


- Intensity bbb can be loaded from logging DB

- Set up parameters for both beams
  - Specifiy the observed beam and bunch

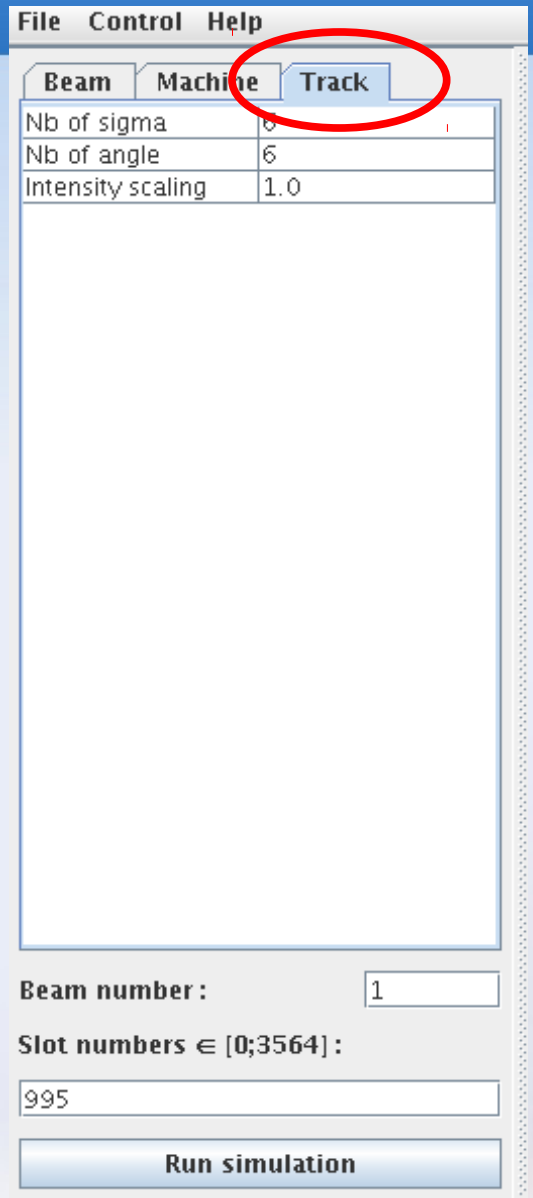
bunch = (RFBucket-1)/10

HOWTO setup machine



- Setup machine parameters
  - Optics (Thin lens required!)
  - Xing
  - separation

HOWTO setup simulation

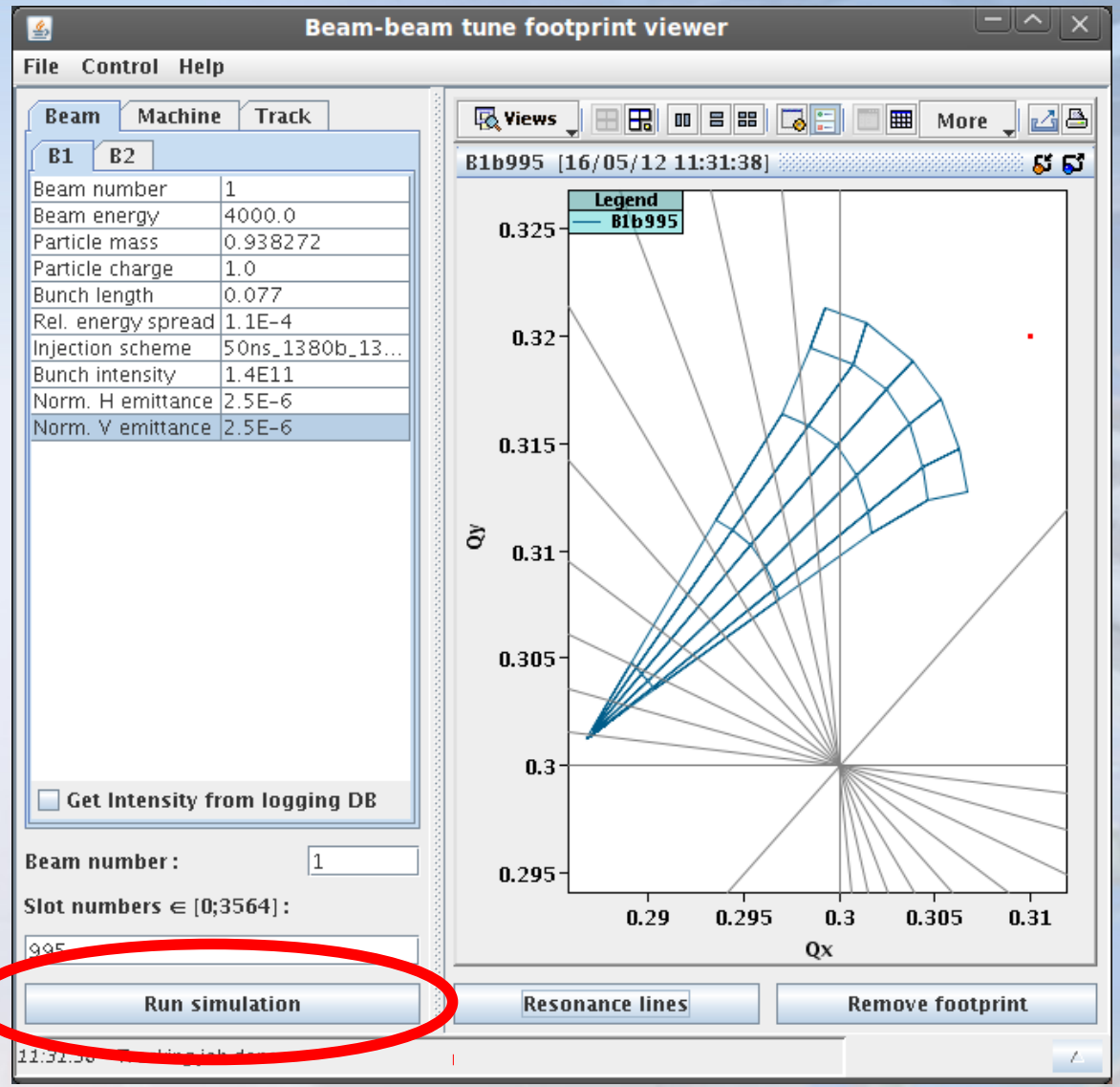


- Setup simulation parameter
  - Test particle distribution for the footpint
  - Small intensity scaling factor to avoid deformation from resonance

HOWTO run

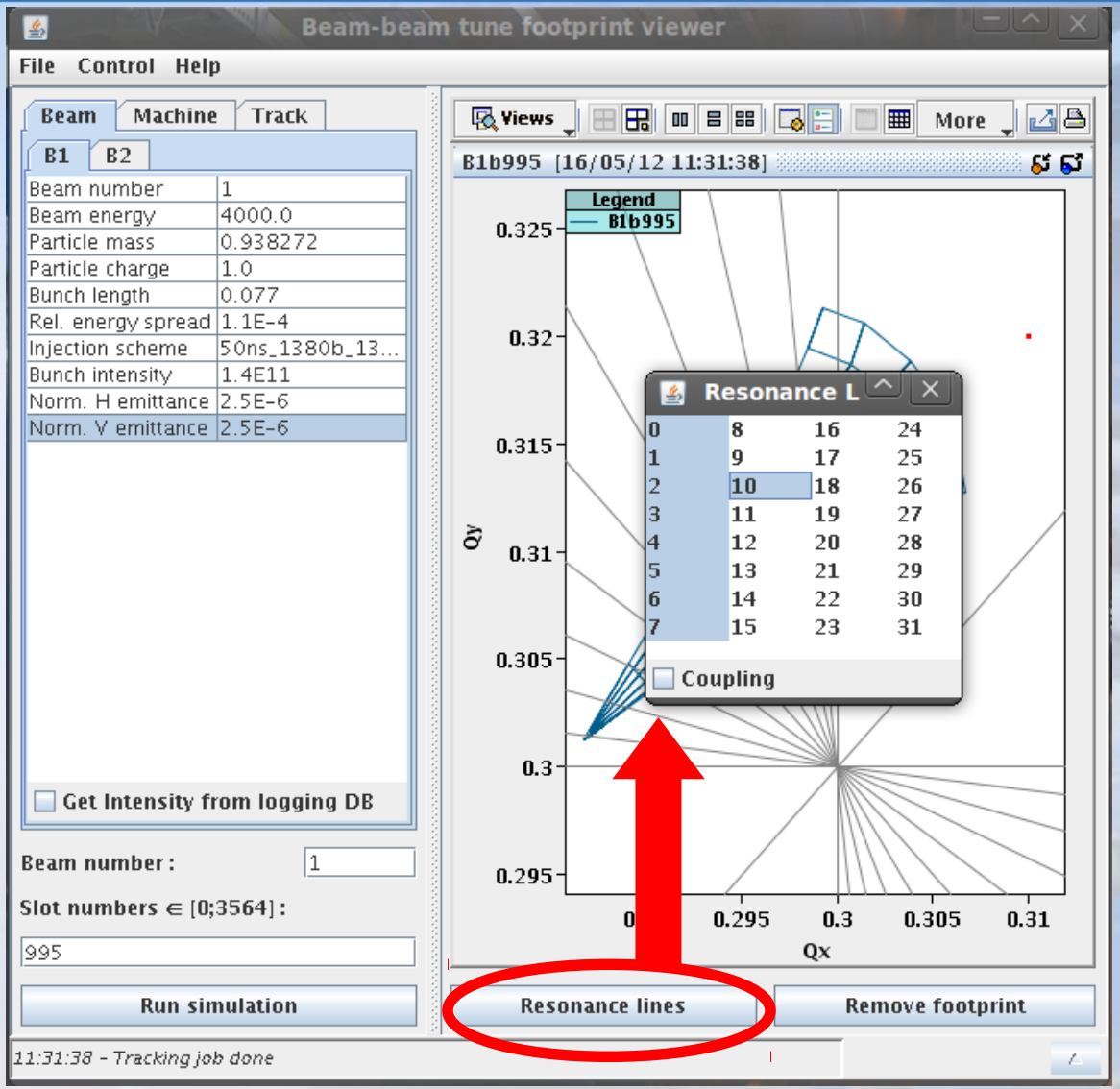
- Run simulation
- Wait for the footprint to appear
  - Multiple footprint can be drawn on the same plot
- ~ 1 min per bunch !

→ ~ 1 day for the whole beam



HOWTO check resonances

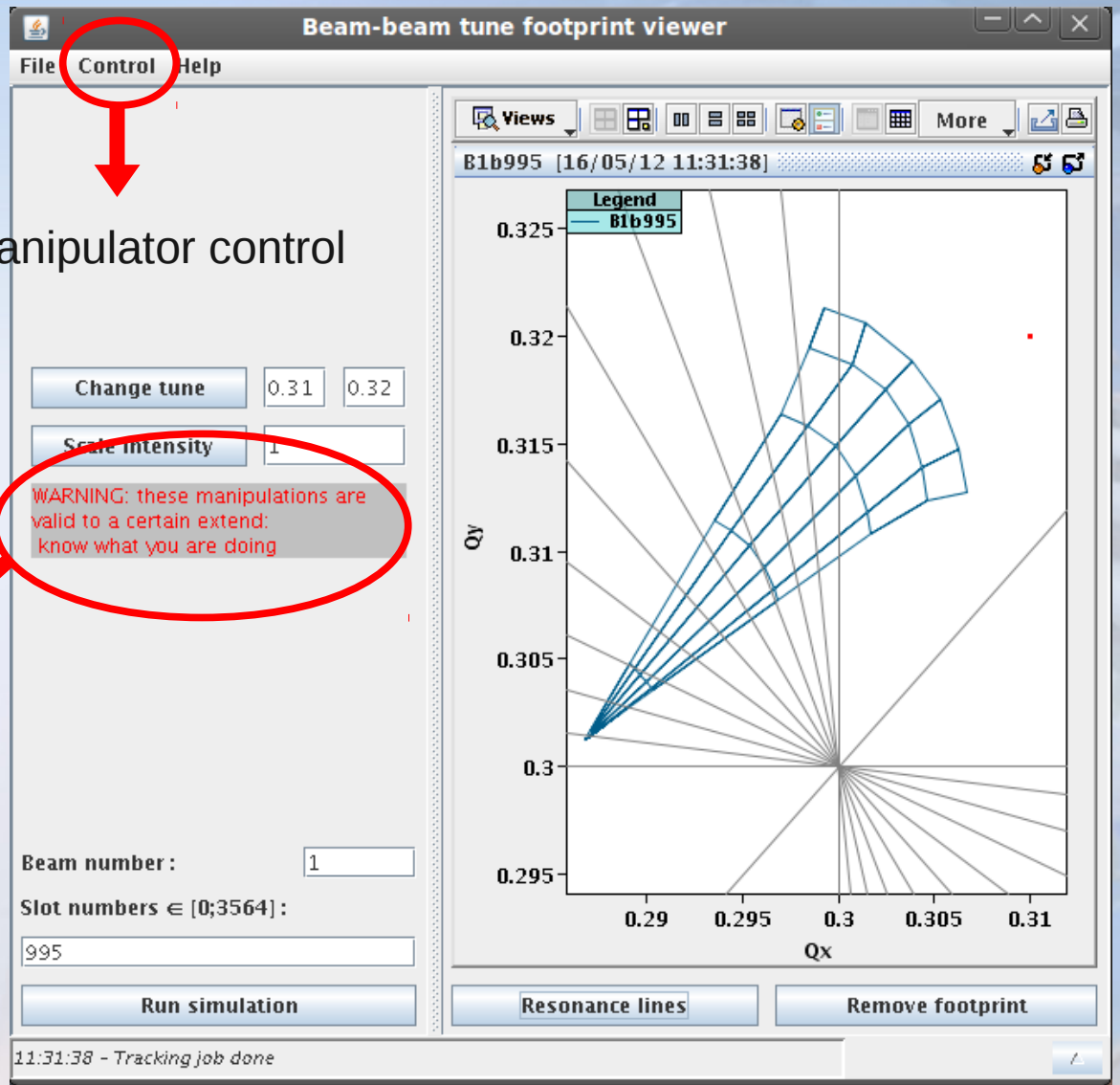
- Select visible resonance lines



HOWTO manipulate

- Scale, shift

Show manipulator control



No dynamic beta,
Discard the effect
of resonance

Future work

- What can be done if found to be useful during operation/MD
  - Import measurement of beam parameters from Logging database
  - Import machine parameters from LSA database
  - Improve manipulation of footprints
  - Have an online mode (based on online tune, intensity and emittance measurement and simple scaling laws)
- Tune scan would enable us to find good/bad spots
- Any other proposal or feedback are welcome