Recent work on 750 x 750 GeV Collider

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Current Design Overview

- 750 GeV
  - Arc module ~5.3T dipole fields:
    - Fits ~circumference, surrounds present Tevatron tunnel
      - Direct piping of existing electrical, water, cryo services
    - Negative momentum compaction
      - Can be isochronous up to 3rd order in α
    - Peak beta functions are half of equivalent FODO cell
      - 40% smaller beam size in arcs
    - Lower fields allow potential for increased collider energy
      - Potentially up to 1 x 1 TeV
  - IR straight design: currently β^*=1cm
    - IR quads ~10T
    - 6m IP to first quad spacing for detector
    - Zero dispersion derivative at IP (D=0 @IP)

Site Considerations

- Depth
  - Water tables
  - Geological constraints for tunnel construction
  - Civil engineering for tunnels “hundreds of meters” deep

General limitations

- Site depth and civil engineering:
  - Fermilab and BNL have depth constraints, for example; the larger of the two, restricted to <200m down.
    - Municipal water supply + substrate will not support tunnel.
  - The NUMI project at Fermilab entailed considerable civil engineering for an ~1 km long tunnel only 100 m deep – (won the 2005 civil engineering award)
  - Maintenance, water leaks are a problem even with the NUMI depth (muons are much nicer, however, from an activation standpoint)

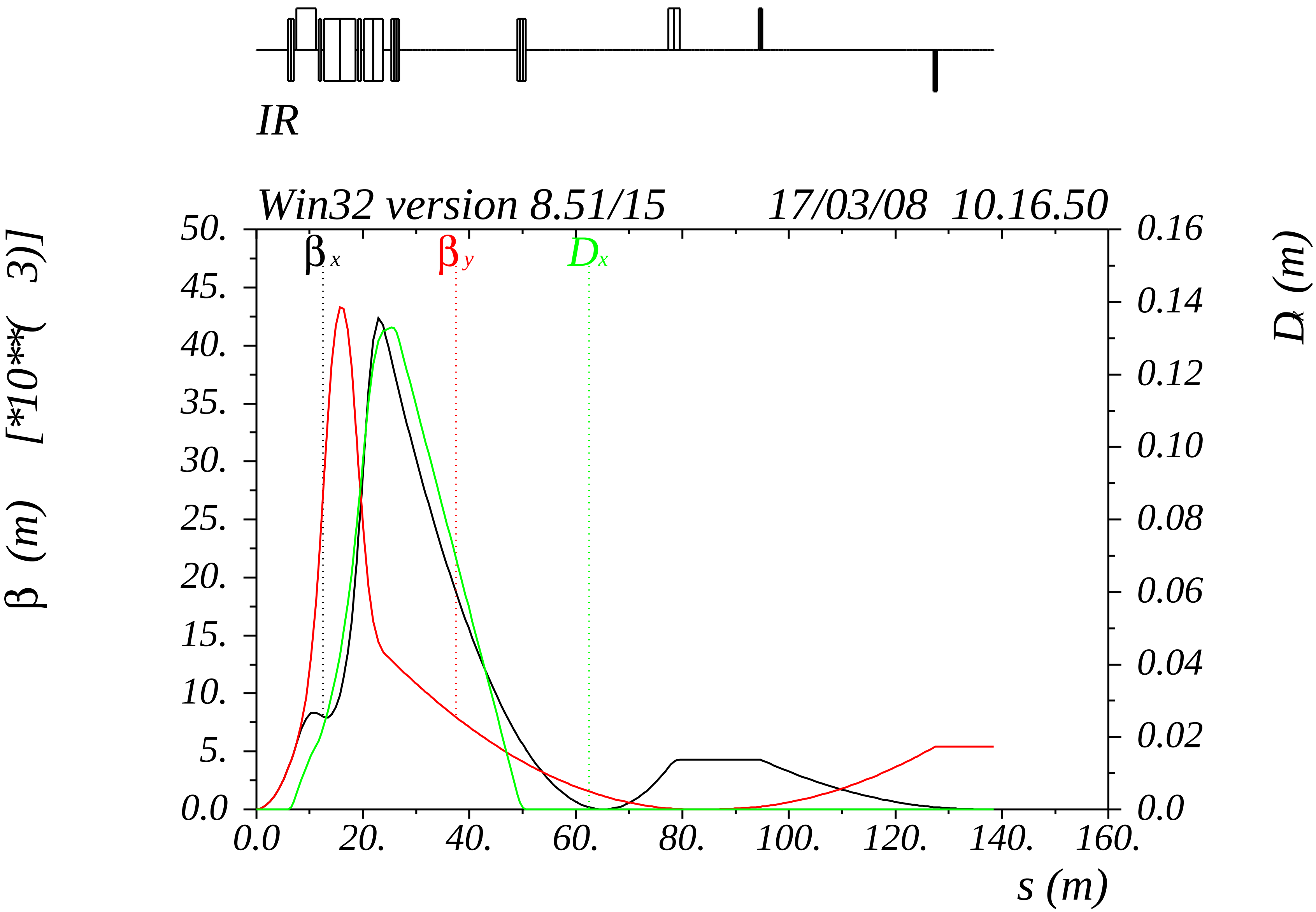
Ring Structures: General Information

- IR: final focus + aberration correction section:
  - Relatively compact: ~425 m
  - Peak Beta function ~43 km
  - Linear chromaticity ~-500 to -700

- Arcs
  - Flexible Momentum compaction, ~70 m long
  - Momentum compaction corrected up to 3rd order
  - Peak beta function, ~110 m

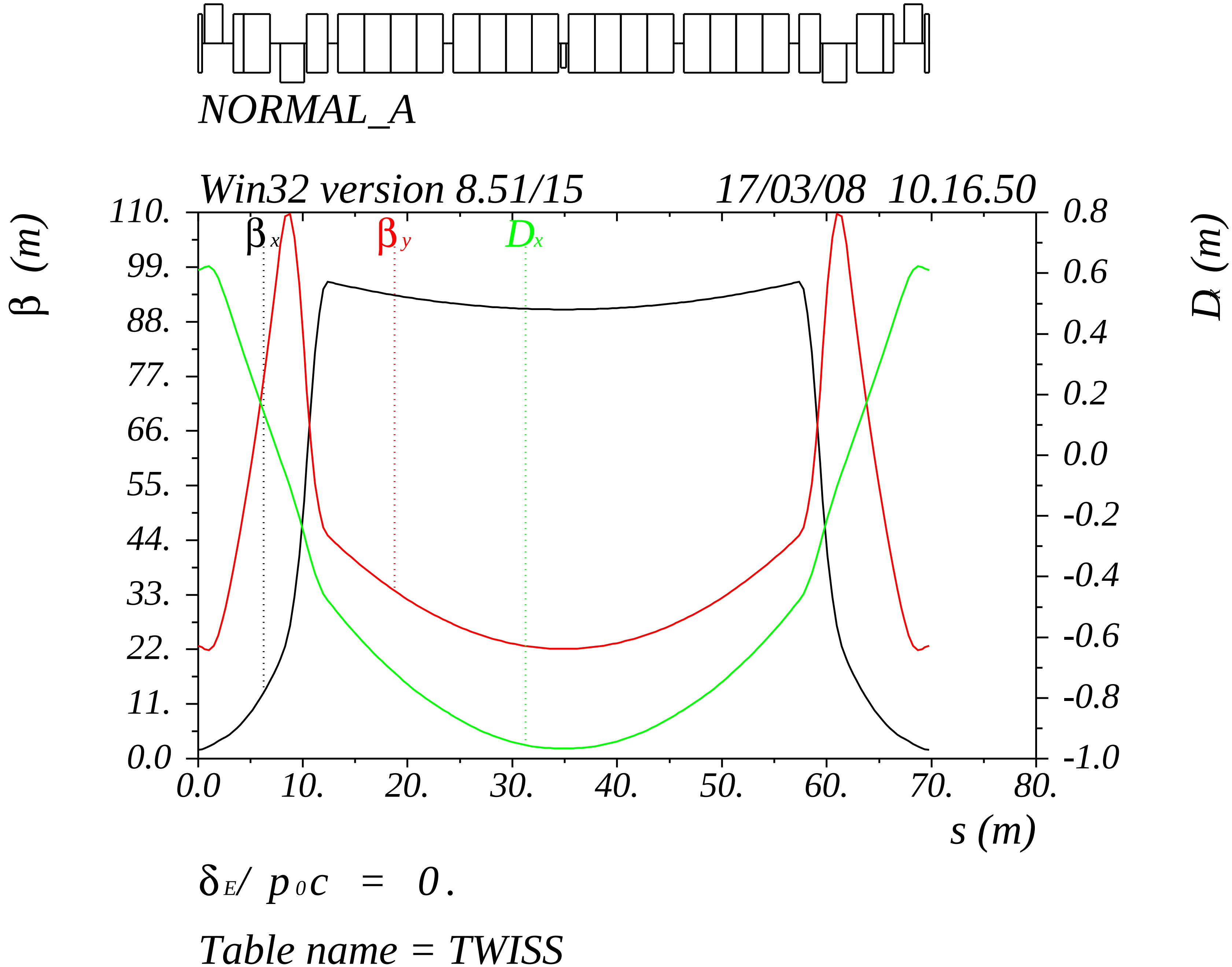
- Scraping and utility section
  - Presently a simple representative R matrix

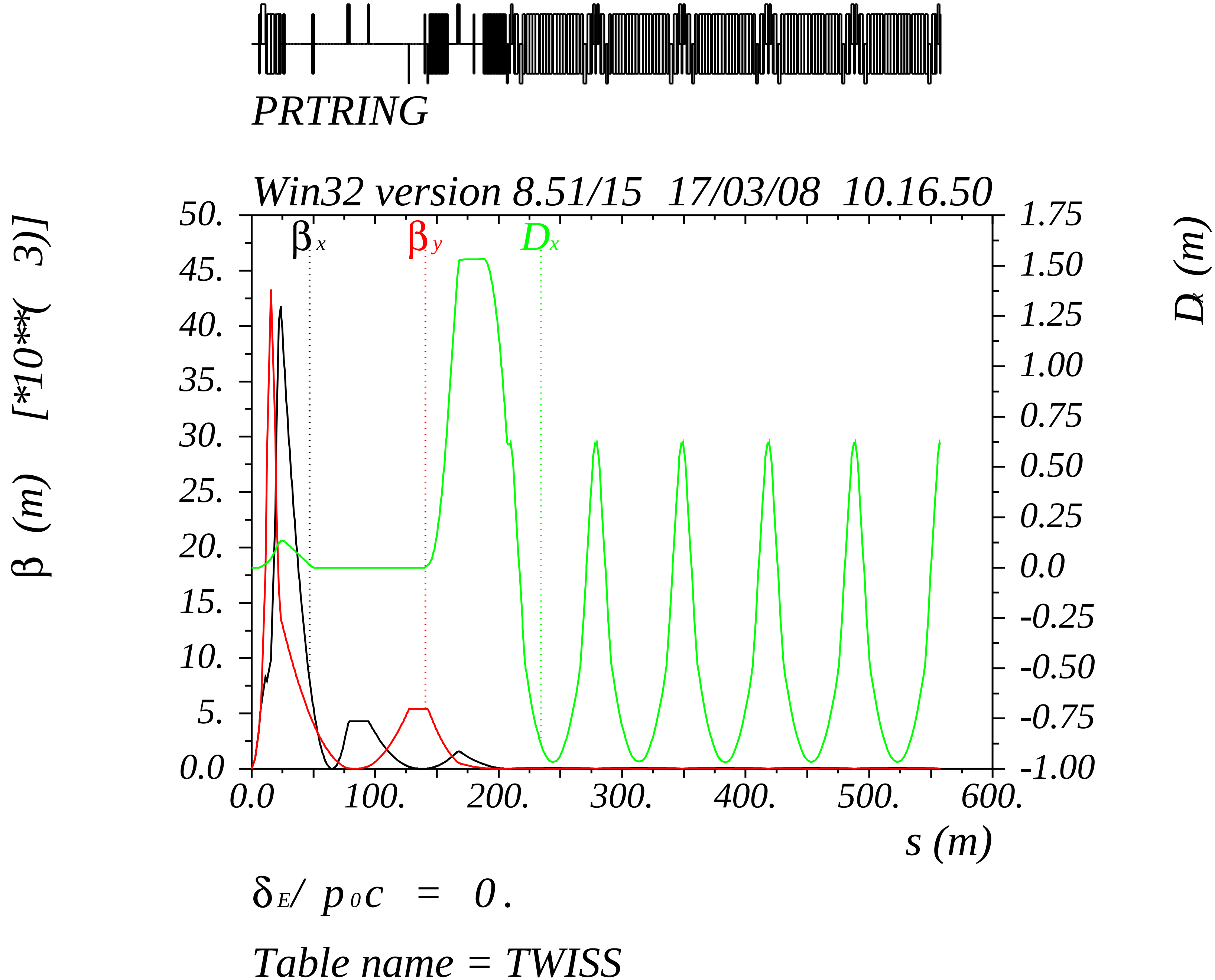
- Ring
  - ~ 1 km radius for 750 x 750 GeV
  - 2-fold symmetric
  - 64 arc modules



$\delta_E / p_0 c = 0.$

Table name = TWISS


NORMAL_A
Win32 version 8.51/15
17/03/08 10.16.50
β (m)
D (m)
βx
βy
Dx
110.
99.
88.
77.
66.
55.
44.
33.
22.
11.
0.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0.0
10.
20.
30.
40.
50.
60.
70.
80.
s (m)
δE/ p0c = 0.
Table name = TWISS


PRTRING
Win32 version 8.51/15 17/03/08 10.16.50
β x
β y
D x
β (m) [*10**(3)]
D x (m)
50.
45.
40.
35.
30.
25.
20.
15.
10.
5.
0.0
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.0
-0.25
-0.50
-0.75
-1.00
0.0
100.
200.
300.
400.
500.
600.
s (m)
δE/ p0c = 0.
Table name = TWISS

Present and Future Work

- Implementation in COSY for high-order studies and correction
  - Kinematical corrections are important!
    - Cannot be done in MAD
    - Field-map codes such as ZGOUBI have limited optimization tools
- Tune optimiztion
  - Tune sweep is automatically performed in COSY using a simple R matrix to jump fractional tune (preserves match to all optical functions)
- High-order correction
    - Ocutpole families: DA was doubled using COSY to fit DA in 50 x 50 GeV collider
    - Decapole – duo-decapole
- High-order chromatic correction
  - 2nd order chromatic correction appears essential
- Final momentum compaction adjustment
  - This is easy in FMC module – beta functions essentially do not change, dispersion change is small so re-matching is not a problem.
- Tracking with fringe fields – will be bad news

Example: DA optimization in COSY using octupole families for 50 x 50 GeV collider

(x-x′): (y-y′):

Before:

After: