SNS Ring Lattice and Survey

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SNS Ring Lattice and Survey

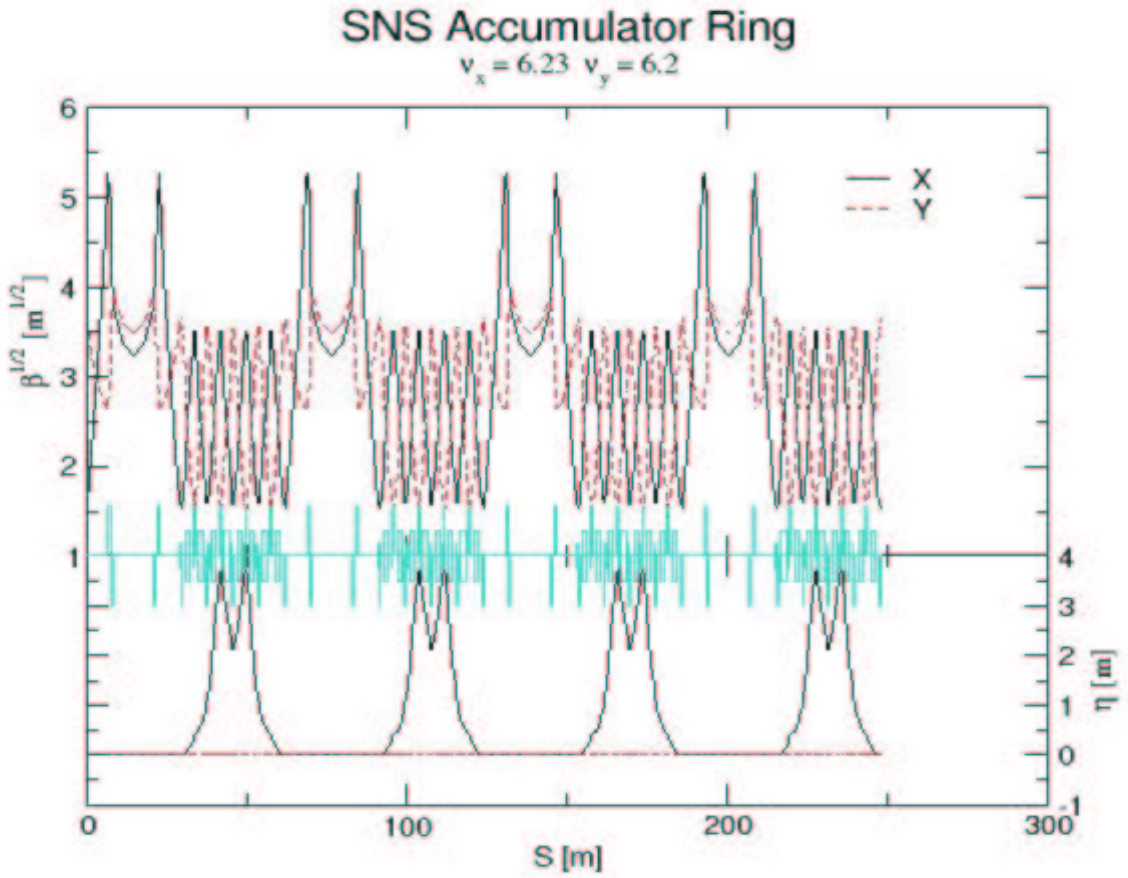
- **Parameters for the Ring**
- **Apertures for injection**
- **Freezing the geometry of the Ring**
  - ***Matching the ring to the existing designs of the HEBT and RTBT lines***
  - ***Choosing the dipole length, based on measurements***
- **Sorting the Ring Dipoles**
- **Multipole Polarity Definitions**
- **Single source for the Optics design**
- **The Lambda tools**

Summary of Parameters

Ion type	proton	
Energy	1	GeV
Circumference*	248.00612	m
Dipole length*	1.4407	m
Dipole angle	11.25	°
Ring Center North, X	10110.611218	m
Ring Center Height, Y	2000.000000	m
Ring Center East, Z	20000.000000	m
Superperiods	4	
Horizontal Betatron tune	6.23	
Vertical Betatron tune	6.20	
Transition Gamma	5.224	

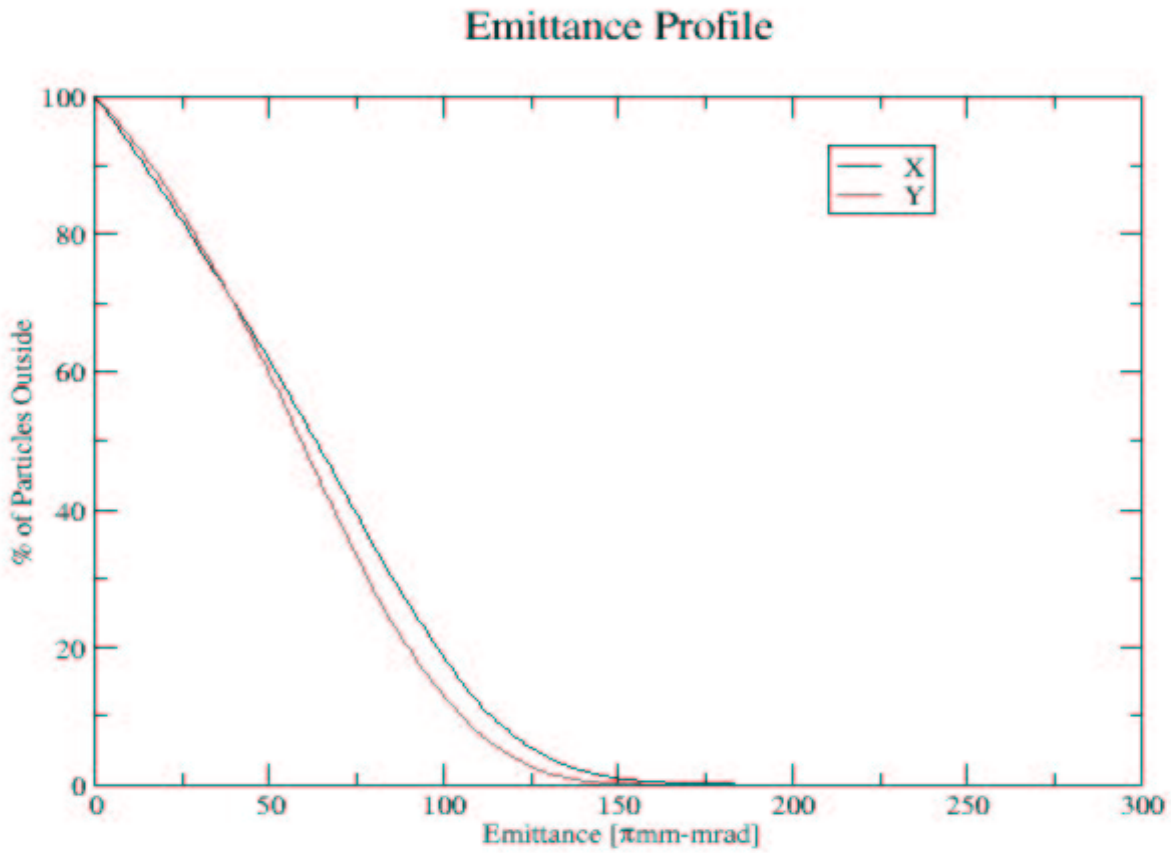
* The change in dipole length leads to a change in circumference, by keeping the geometry fixed.

Twiss Functions



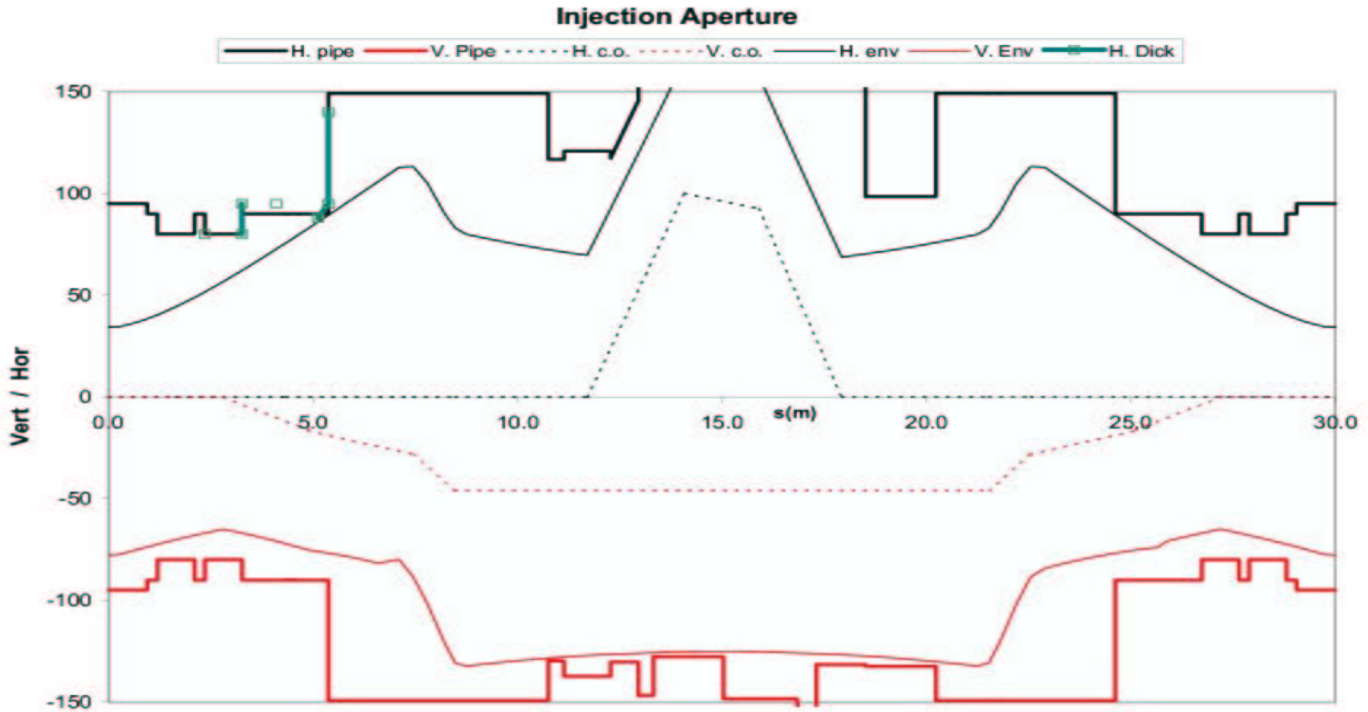
Emittance Profile

(A. Fedotov)



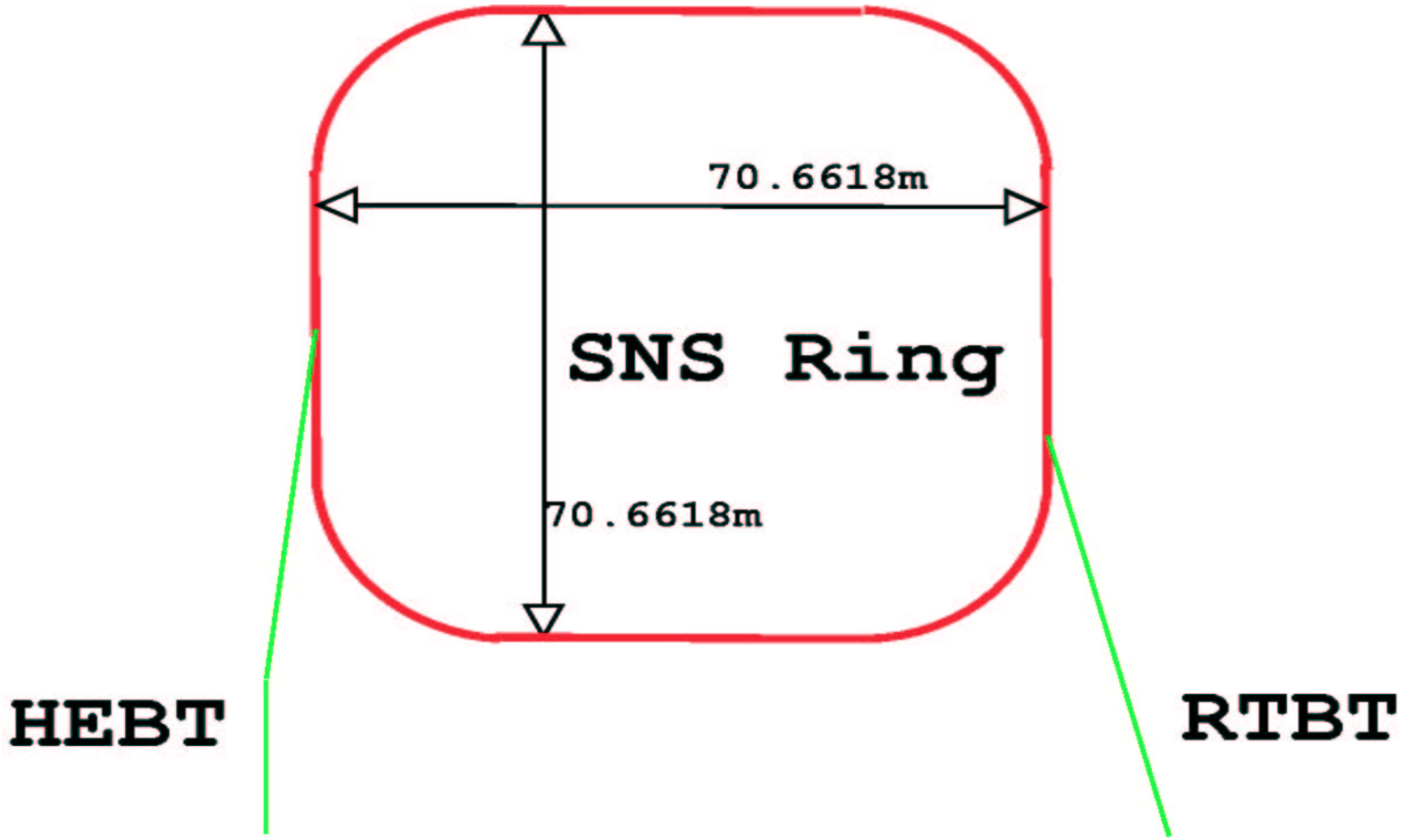
Aperture, Injection Region

(N. Catalan-Lasheras, D. Davino, A. Fedotov)



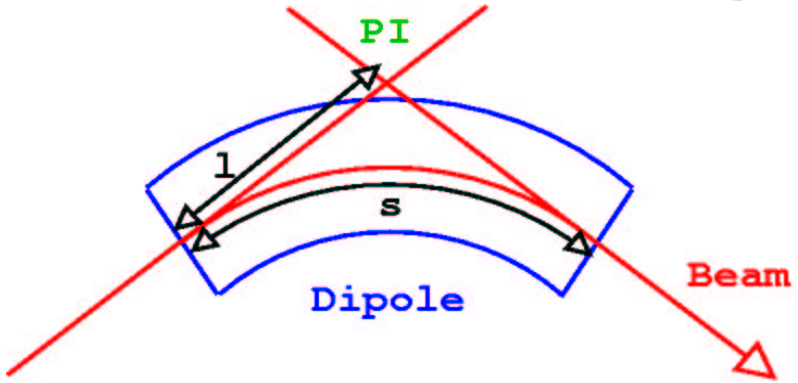
Envelope at 480π mm-mrad

Ring Schematic



Ring Geometry

- **Freeze the geometry to match the HEBT and RBTB lines**
  - *Match to the survey of the lattice with 1.5m dipoles*
- **Fix the ring center (J. Galambos)**
  - *North: 10110.611218m*
  - *Height: 2000m*
  - *East: 20000m*
- **Use the measured length for the dipoles**
  - *The dipole SD1717 was selected as the standard*
  - *Using 1.4407m*



$$s = \rho\,\theta$$

1.5m

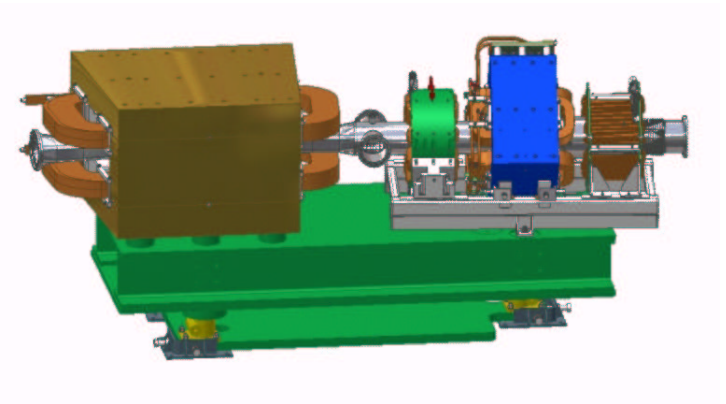
$$l = \rho \tan\left(\frac{\theta}{2}\right)$$

$$\Delta d = \frac{s_0 - s}{\theta} \tan\left(\frac{\theta}{2}\right)$$

SD1717 Dipole

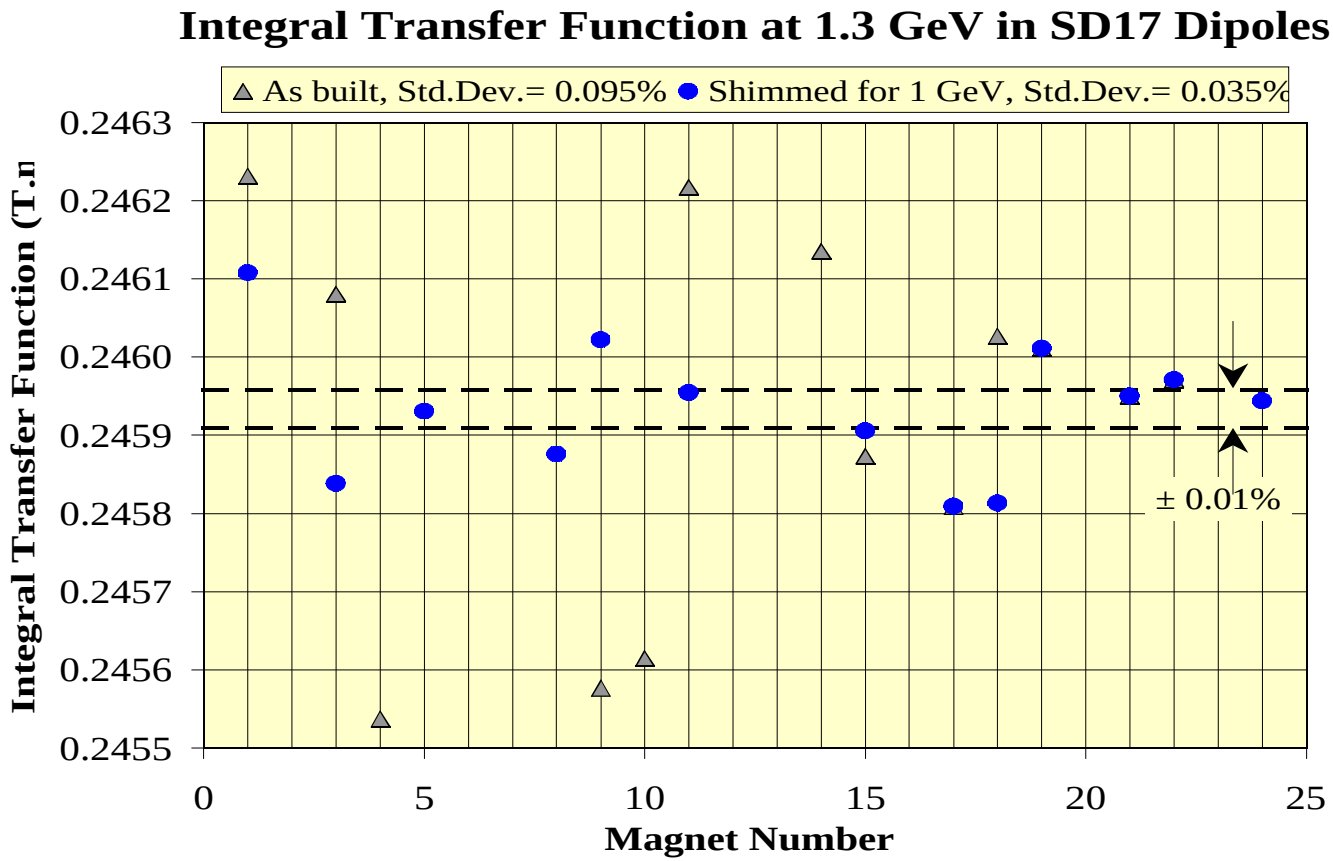
- **Measured Early in the program (Dec, 2001), (A. Jain)**
- **Magnetic length: 1.4387m (straight coil)**
- **Integrated Transfer function: 0.25240 Tm/kAmp**
- **Straight section: 0.17543 T/kAmp (not with largest coil)**
  - *Largest coil: 0.02% higher*
  - *NMR measurement: 0.04% lower than large coil values*
- **Recommended magnetic length: 1.4384m**
- **Path length through the dipole: 1.4407m**

(From N. Tsoupas ASAC talk)



Sorting Ring Dipoles

(From P. Wanderers/A. Jain Talk)



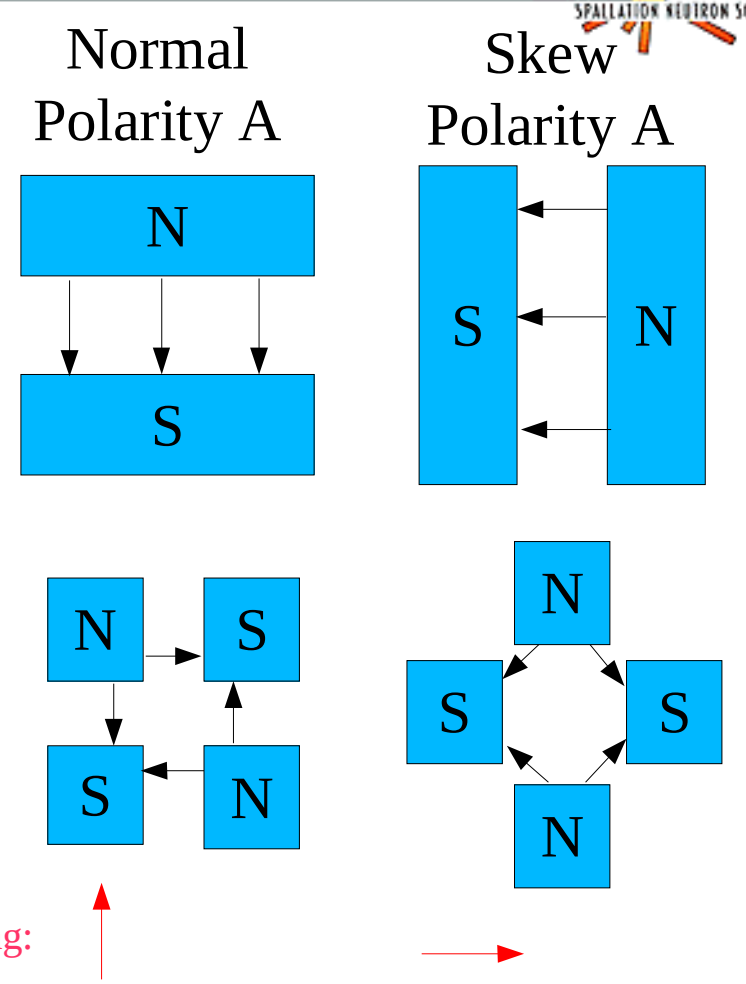
Sorting Ring Dipoles

- **Ring dipoles need to be sorted for 1.3GeV operation**
- **Pair the out of range dipoles in the arcs**
  - Place two dipoles of equal errors 180° apart in phase for cancellation
  - Or place two dipoles with opposite errors 360° apart
- **Any residual errors will be fixed using the dipole correctors**
- **This may impact how spares are to be handled**

Multipole Polarities

- **Define the polarities for the Dipoles, Quadrupoles and their corresponding skews**
  - *Even order multipoles follows the dipoles*
  - *Odd order multipoles follows the quadrupoles*
- **Field should be the same on the midplane (C. Gardner, BNL/SNS Technote, #053)**
- **Need correct translation of the signs of multipoles for MAD and other programs**

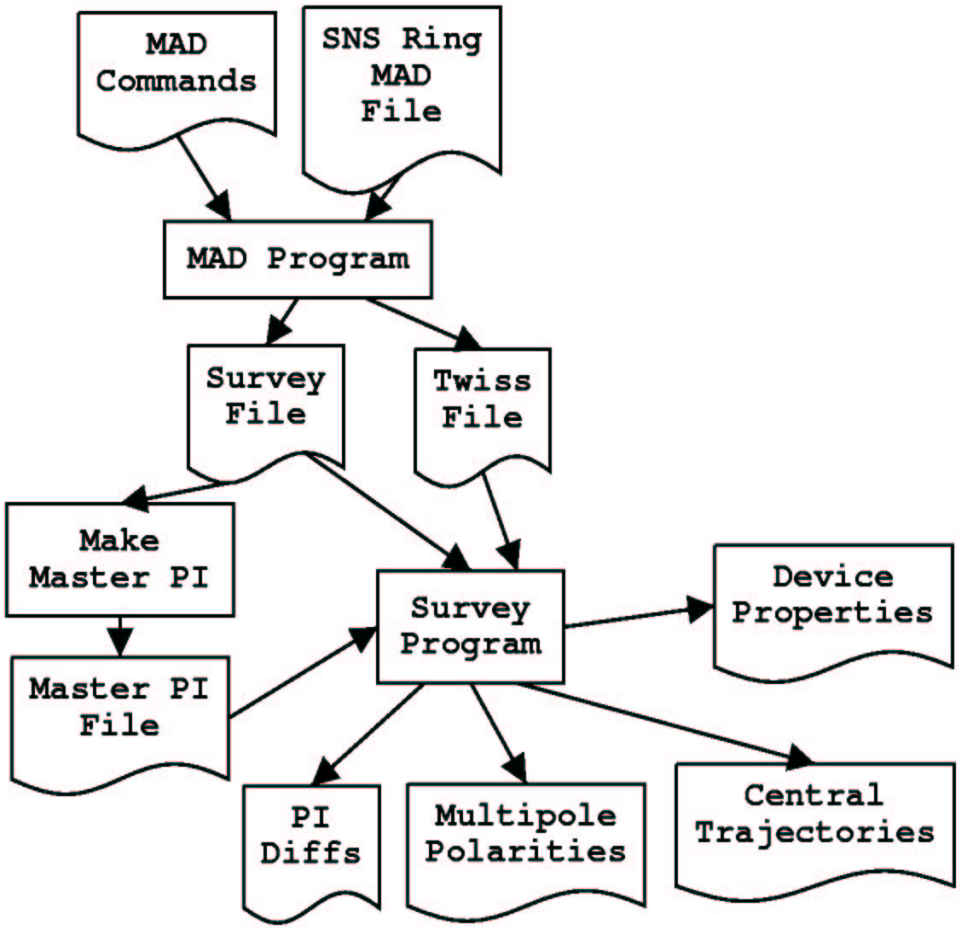
$$B_y(x,0,z)=\sum_{n=0}^{\infty} B_n(z)\frac{x^n}{n!} \qquad B_x(x,0,z)=-\sum_{n=0}^{\infty} A_n(z)\frac{x^n}{n!}$$



Design Optics

- **Need a single source for the design optics**
  - *File(s) or Database*
  - *Handle different working points, energy, etc.*
- **Preliminary setup uses a MAD file for the source**
  - *Generate SURVEY and TWISS files using MAD*
  - *Create a master PI file from a MAD file using 1.5m dipoles*
  - *Create a file with Global Survey Coordinates from the MAD SURVEY file*
    - **Check the coordinates against the master PI file for errors**
  - *Create a file giving the polarities for each magnet*
  - *Create a device definition file*
- **These files can be uploaded into the operations database**

Optics Design Schematic



The Lambda tool

- **Database used for the design optics of RHIC**
  - ***Used at three labs: Fermi Lab, SSC and BNL***
  - ***G. Trahern, S. Peggs, J. Holt, et al., "LAMBDA Manual", RHIC/AP/13***
  - ***Also includes twiss and survey programs***
  - ***Uses SYBASE, requires porting to ORACLE database***

```
Usage: dbsf [-CSMs8egfFbtpPd] [-V view_flags] [-T str_tbl_name] key [source_db]
-C               output an SDS file
-d               add dimension info to SDS, MAD (make non-standard MAD)
-S               output a SYNCH format file
-M               output a MAGIC format file
-s               conform to MAD 4.03 standards
-8               conform to MAD 8.1 standards
-e               evaluate expressions
-g               group parameter, element and beam definitions separately
-f               produce old flat file format
-F               produce new flat file format
-b               try to produce gradient & brho vals for elements in SYNCH file
-t               output a TRACE3D format file
-p               output a TEAPOT format file (like -sd sans DRIFT aperture info)
-P               output a TRANSPORT format file
-V view_flags    character flags indicating which view rules to apply
-T str_tbl_name run with the specified strength table
key              the name of the item to be defined
source_db        db to search ( default is environment variable DBSF_DB )
```

Summary

- **Aperture considerations were discussed**
- **Freeze the geometry of the ring, any changes to the ring devices must be done in a way that preserves the geometry**
  - *Selected the dipole length of 1.4407m based on the SD1717 magnet*
- **A plan for sorting the ring dipoles for 1.3GeV operations was presented**
- **Have a single source for the design optics. All lattice work should be done on files that originate from this one source**
- **Develop tools to generate the files (or tables in a database) that characterize the global coordinates, design parameters of the ring devices, polarity settings for the magnets, etc.**
  - *Port some of the LAMBDA tools for SNS*