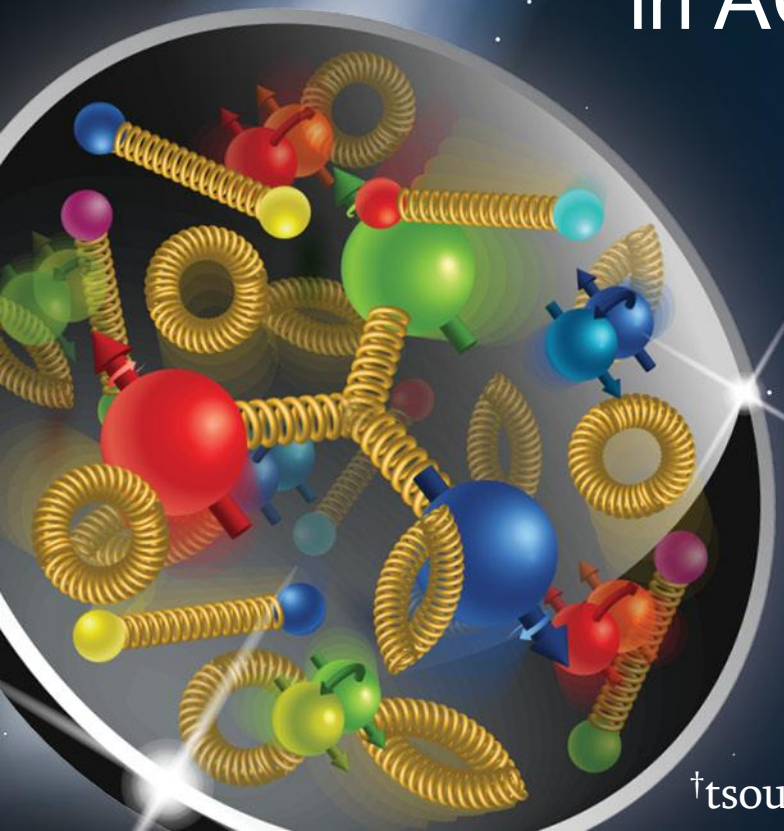

Closed Beam Orbit Calculations in AGS and Fast Beam Extraction

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Brookhaven National Laboratory

S. Machida

STFC Rutherford Appleton Laboratory England

Electron Ion Collider – eRHIC

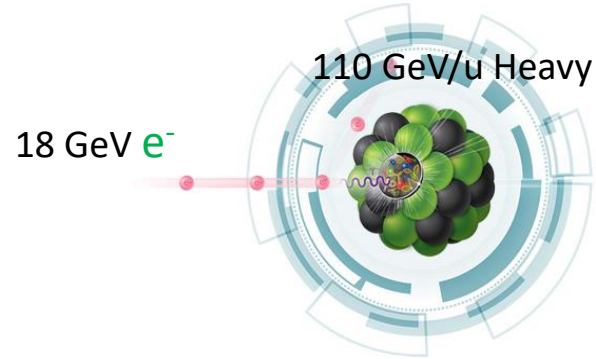
BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY | Office of Science

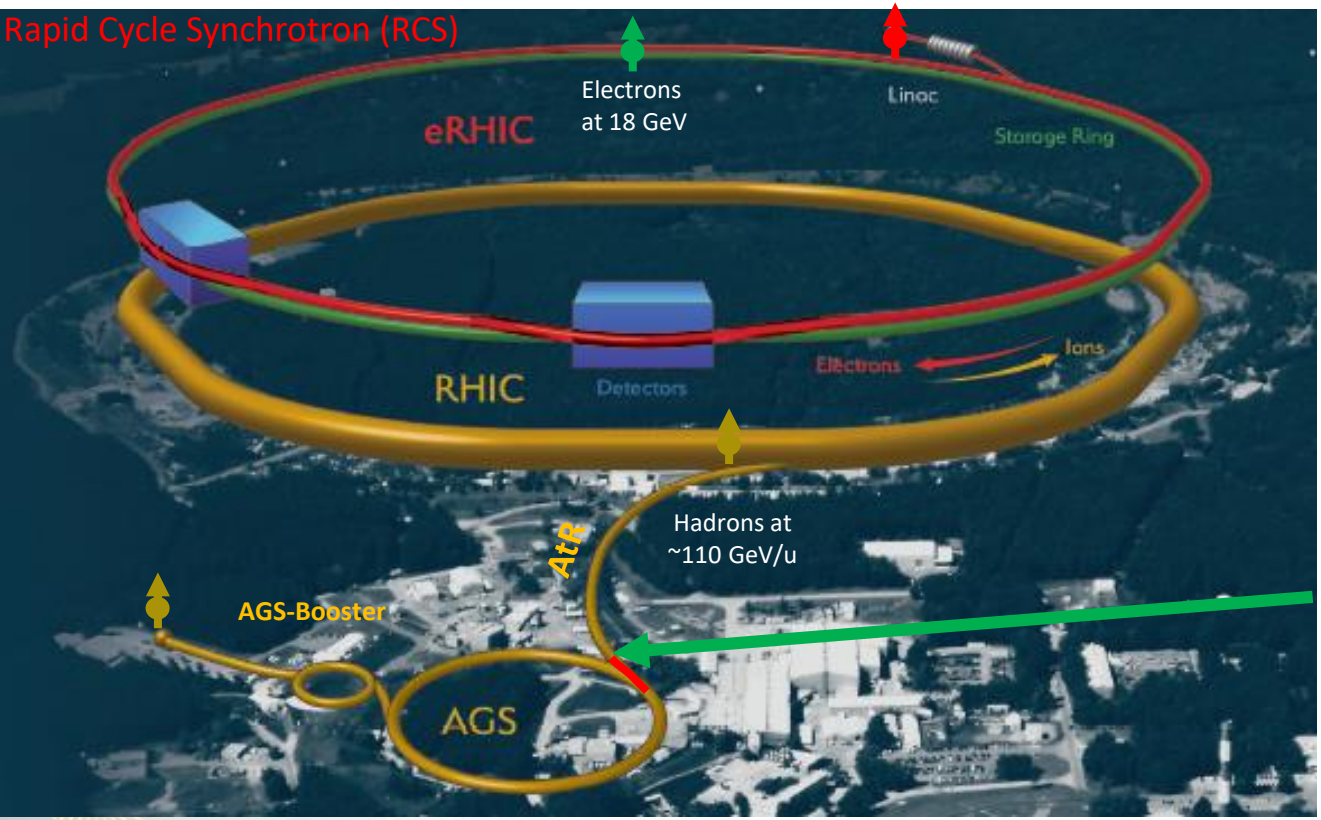
†tsoupas@bnl.gov


FROM ALBANY, SYRACUSE, BUFFALO, NORTHERN N.Y. AND CANADA
HUDSON RIVER
TAPPAN ZEE BRIDGE
NEW YORK STATE THRUWAY
CROSS WESTCHESTER EXPRESSWAY
287
GEORGE WASHINGTON BRIDGE
CROSS COUNTY PKWY.
HUTCHINSON RIVER
NEW ENGLAND THRUWAY
MERRITT PARKWAY
BRIDGEPORT
15
95
FERRY INFORMATION AND VEHICLE RESERVATION
FROM PORT JEFFERSON (516) 473-0286
FROM BRIDGEPORT (203) 367-8571
FERRY INFORMATION AND VEHICLE RESERVATION
MAIN OFFICE (203) 443-7394
FROM NEW LONDON (203) 443-5281
FROM ORIENT (516) 323-2743
NEW LONDON
FROM BOSTON AND THE NORTHEAST
FERRY RUNNING TIME APPROX. 2 HOURS
Long Island Sound
ORIENT POINT
STATE UNIVERSITY STONY BROOK
FERRY RUNNING TIME APPROX. 2 HOURS
THROGS NECK BRIDGE
CROSS BRONX
LINCOLN TUNNEL
HOLLAND TUNNEL
BRONX WHITESTONE BRIDGE
NICHOLS RD.
PORT JEFFERSON
112
25
JERICHO TURNPIKE
CORAM
MEDFORD AVENUE
WM. FLOYD PKWY.
Brookhaven National Laboratory
Upton, N.Y.
RIVERHEAD
EXIT 68
LONG ISLAND EXPRESSWAY
495
VETERANS MEMORIAL HWY.
SAGTIKOS STATE PKWY.
SUNRISE HIGHWAY
GOETHALS BRIDGE
QUEENS MIDTOWN TUNNEL
278
27A
SOUTHERN STATE PARKWAY
27
PATCHOGUE
NEW JERSEY TURNPIKE
STATEN ISLAND
SHORE PKWY.
VAN WYCK EXPRESSWAY
VERRAZANO BRIDGE
OUTERBRIDGE CROSSING
Atlantic Ocean
FROM PHILADELPHIA, WASHINGTON, THE SOUTHEAST AND WEST
LEGEND
0 5 10
miles
Airports
1 LaGuardia
2 Kennedy Int'l.
3 Long Island MacArthur

The future eRHIC Collider



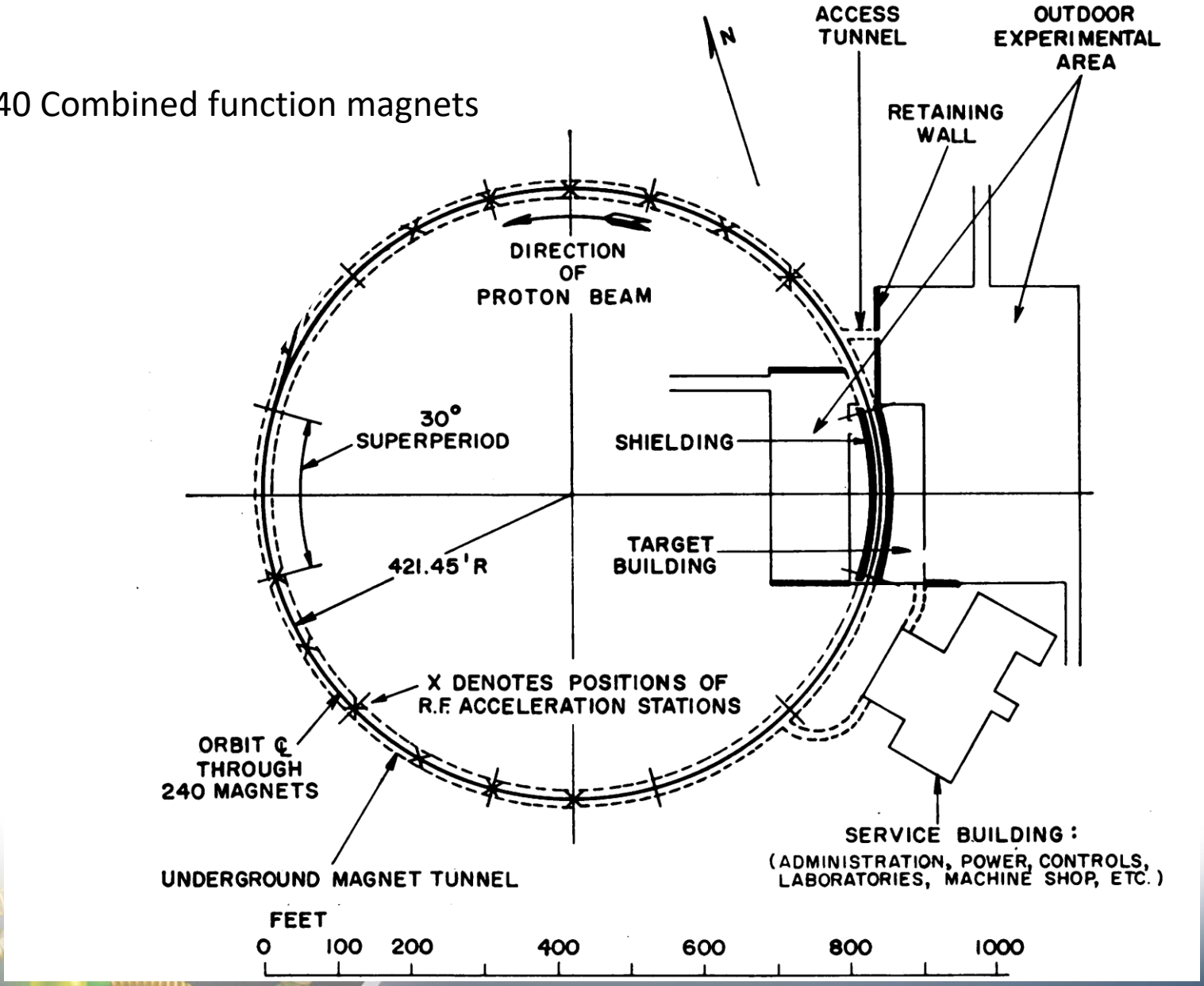
Work performed in 1994 published in a BNL internal report
But never reported in a conference.



Beam Optics of AGS
based on
measured magnetic fields

Beam parameters at the
Fast Beam Extraction of AGS
or the start of
AGS to RHIC (AtR) line

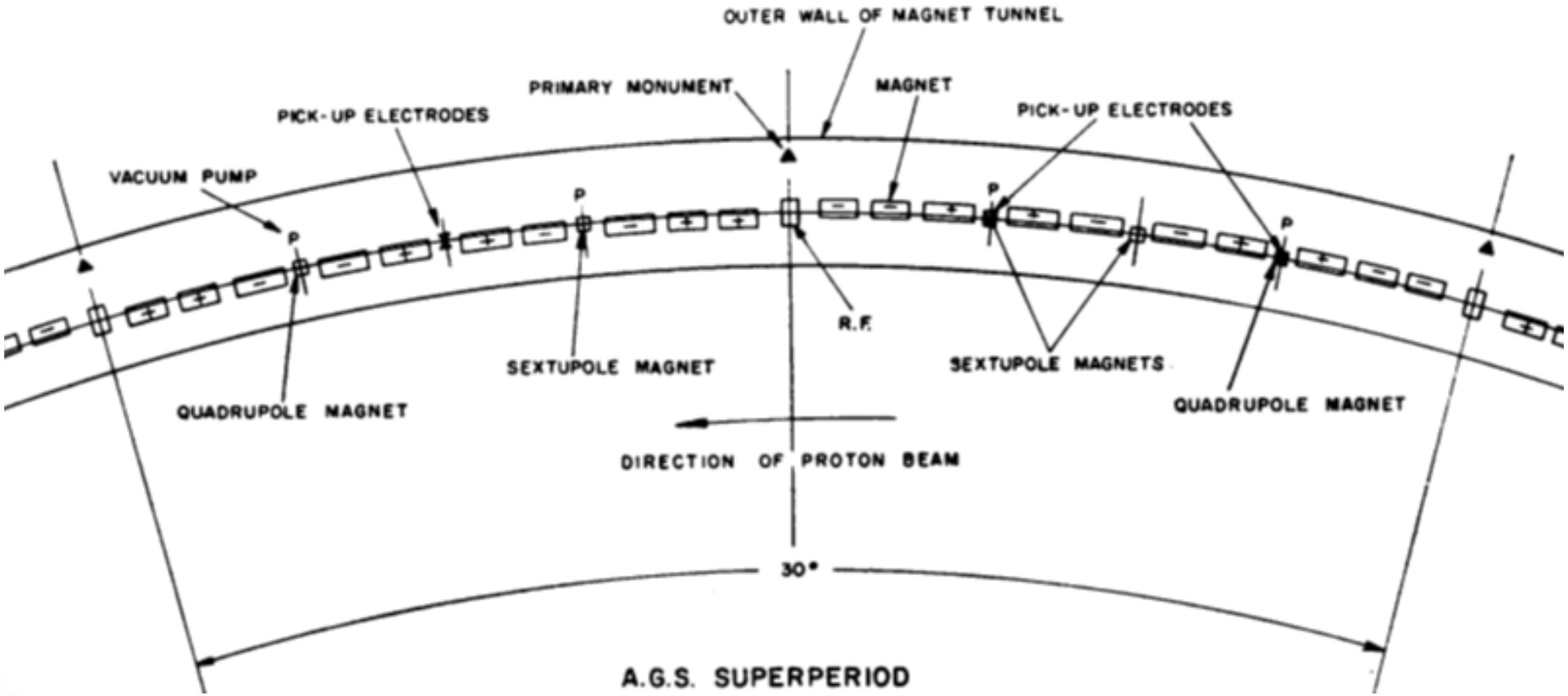
240 Combined function magnets



AGS Superperiod

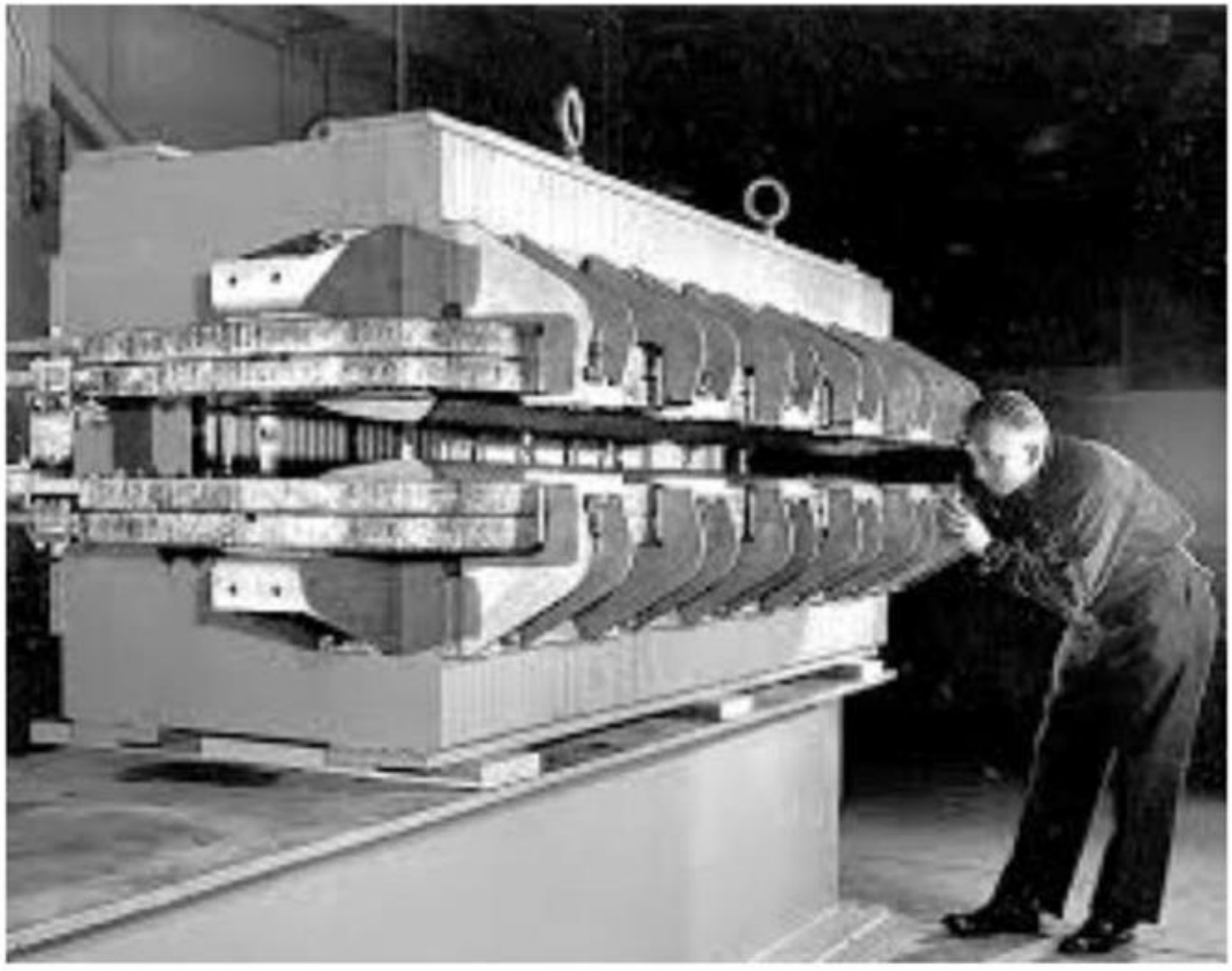
Tune quadrupoles SS03 and SS17

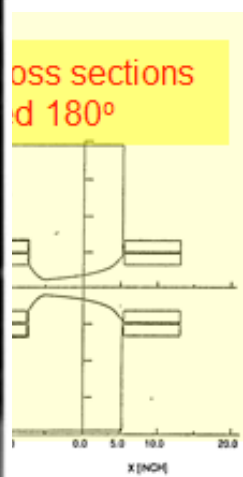
Chromaticity Sextupoles SS05 and SS13

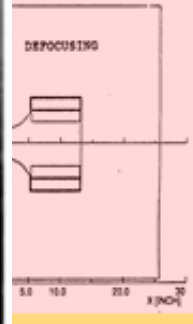


The three types of the AGS Magnets

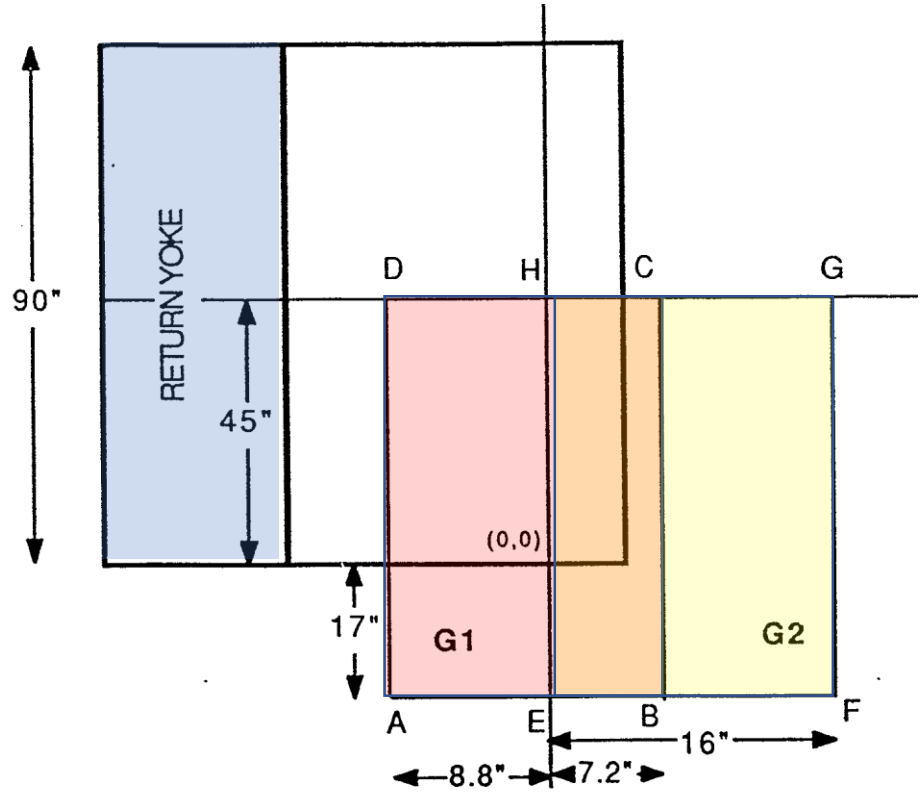
Type
A
B
C







The 2D field maps on plane grids



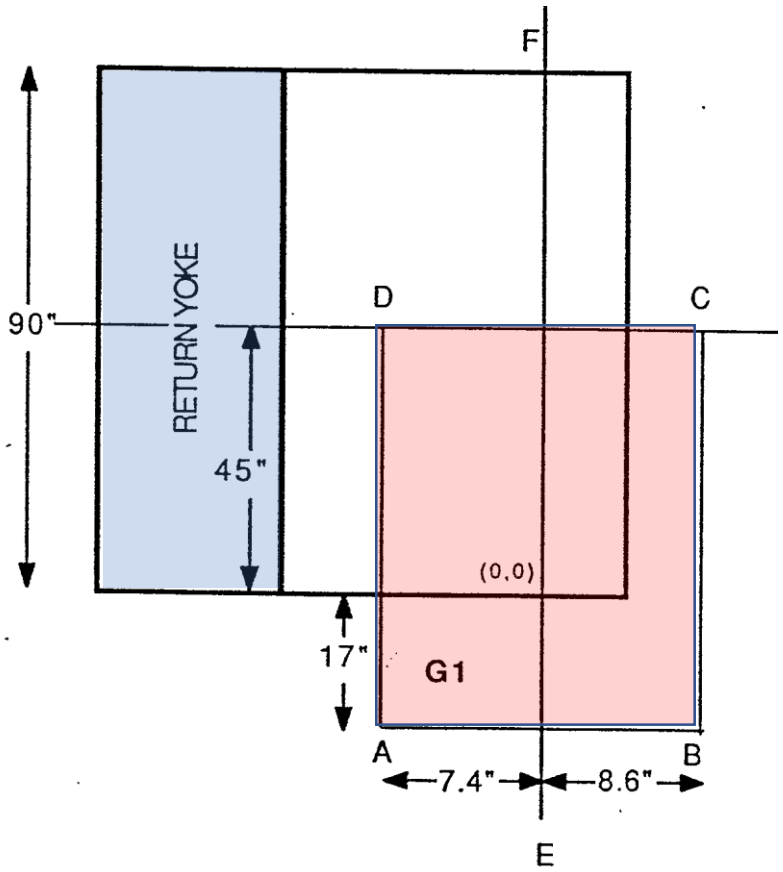
Magnet type A (L=90)

G1 plane 8.8"≤x ≤-7.2"

G2 plane 0.0"≤x ≤-16"

Step in x-transverse 0.10"

Step in z-longitudinal 0.25"



Magnet type C (L=90)

G1 plane 7.4"≤x ≤-8.6"

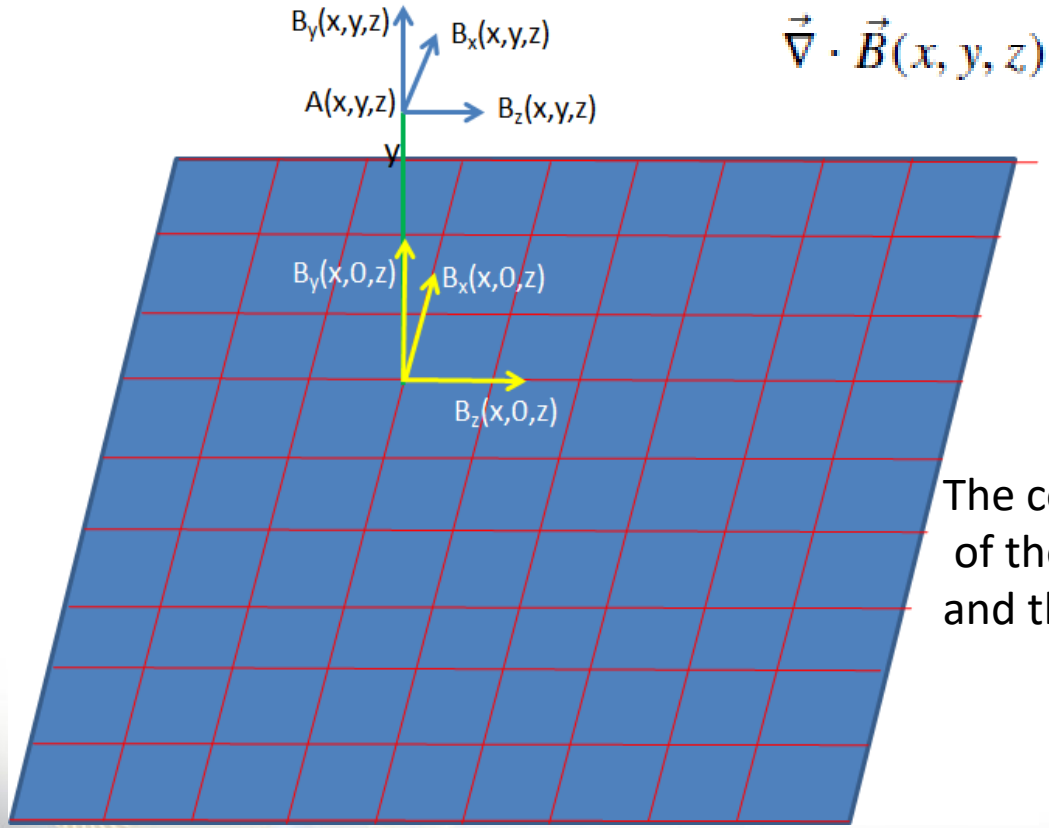
Step in x-transverse 0.10"

Step in z-longitudinal 0.25"

Algorithm to calculate 3D Fields from field maps on a plane

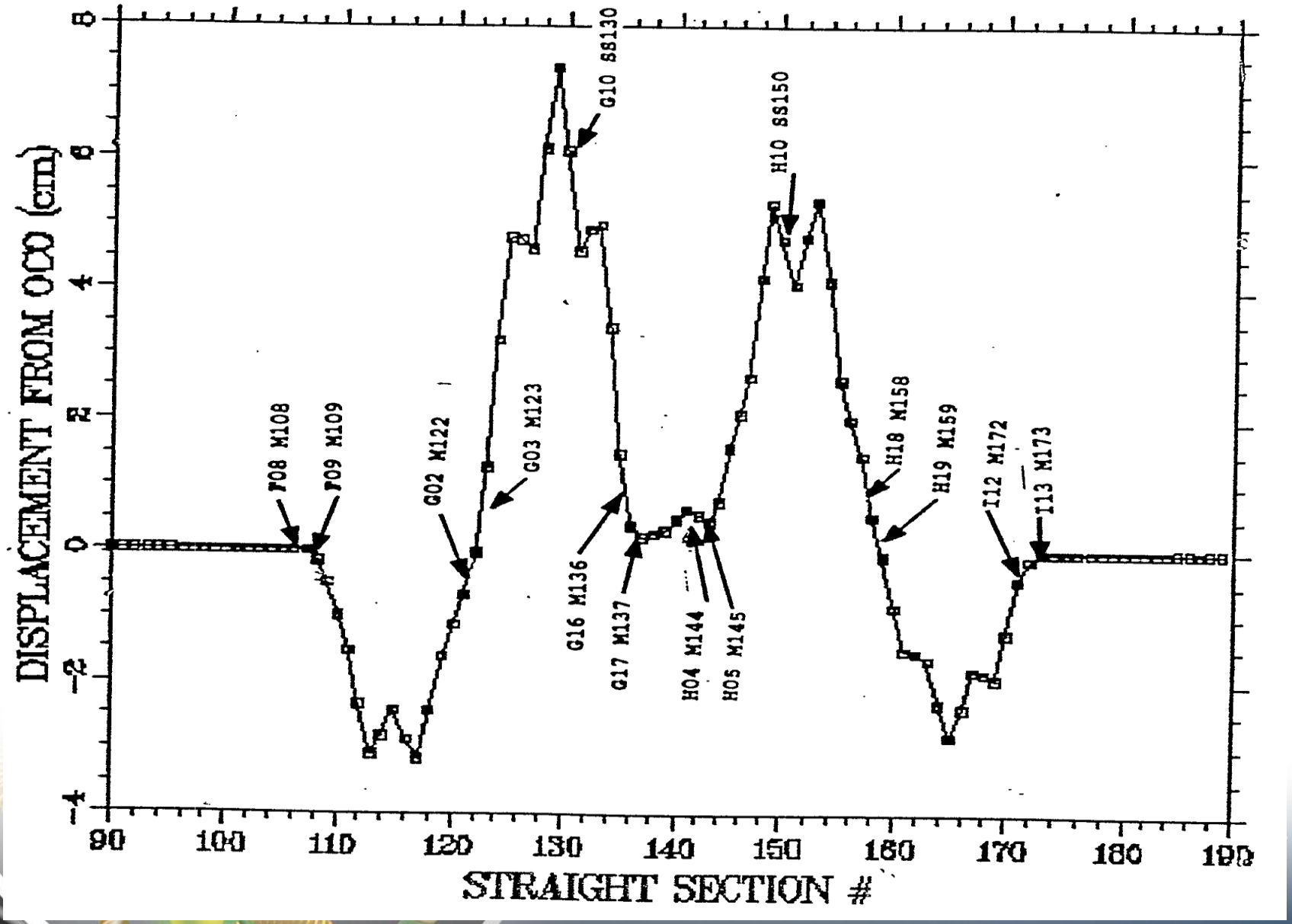
$$B_i(x,y,z) = \sum_{j=0}^{4} \frac{1}{j!} \frac{\partial^j B_i(x,y,z)}{\partial y^j}|_{y=0} y^j = \sum_{j=0}^{4} a_{ij}(x,z) y^j \quad (1)$$

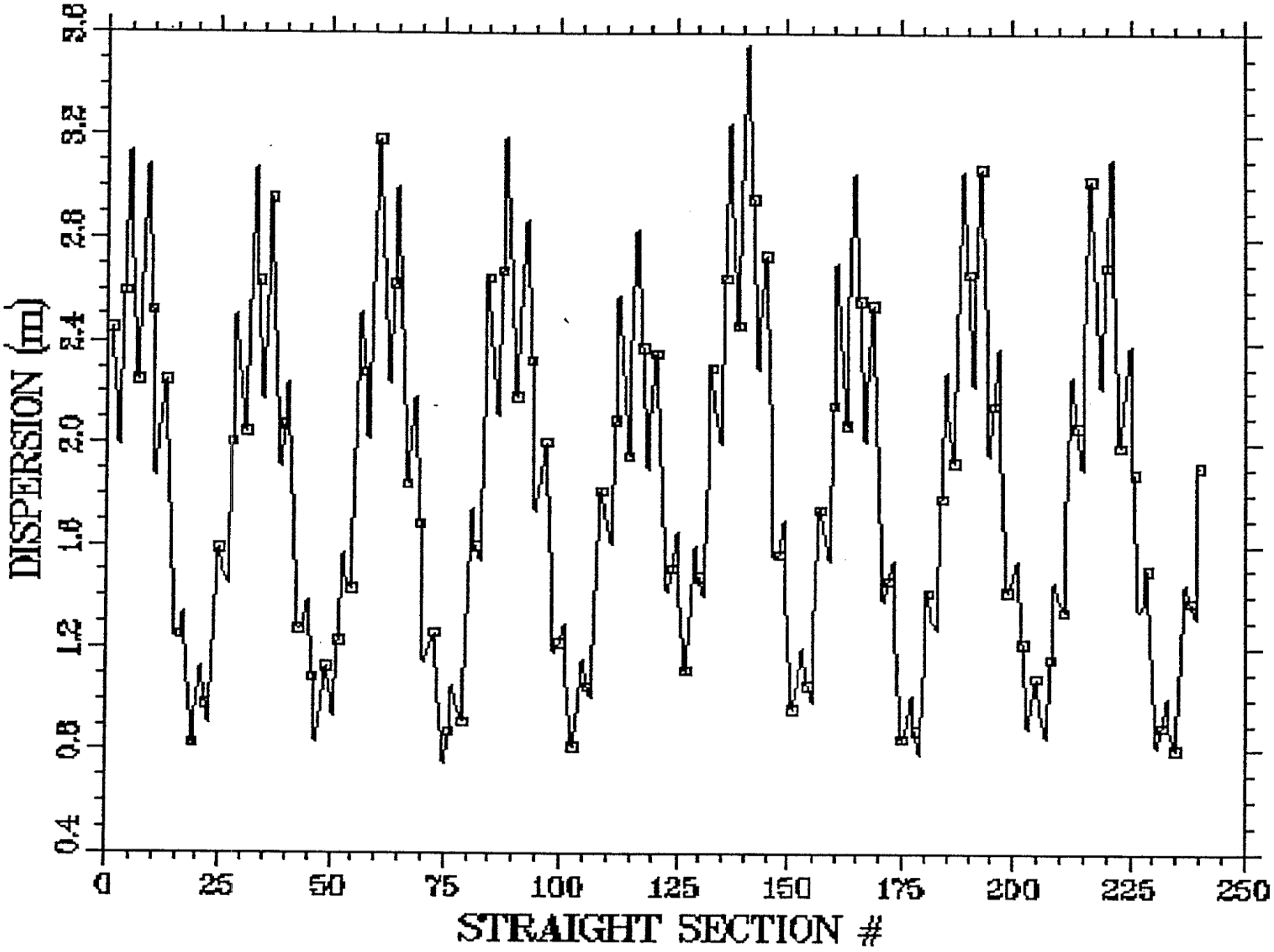
$$\vec{\nabla} \cdot \vec{B}(x,y,z) = 0 \quad and \quad \vec{\nabla} \times \vec{B}(x,y,z) = 0$$

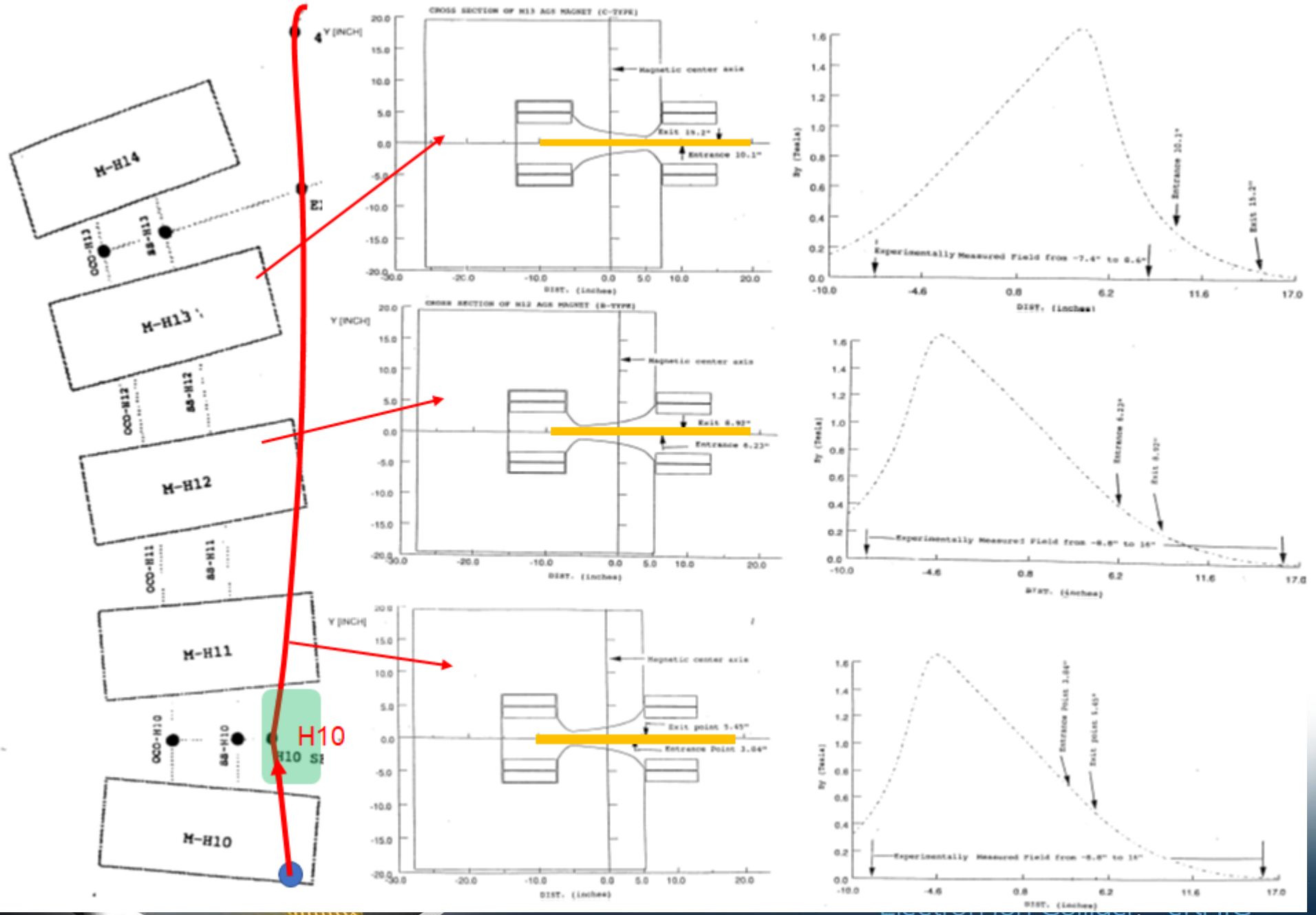


The coefficients α_{ij} are expressed in terms of the measure field components on the plane and their derivatives with respect to x,z.

The Extraction Beam bumps G10 and H10

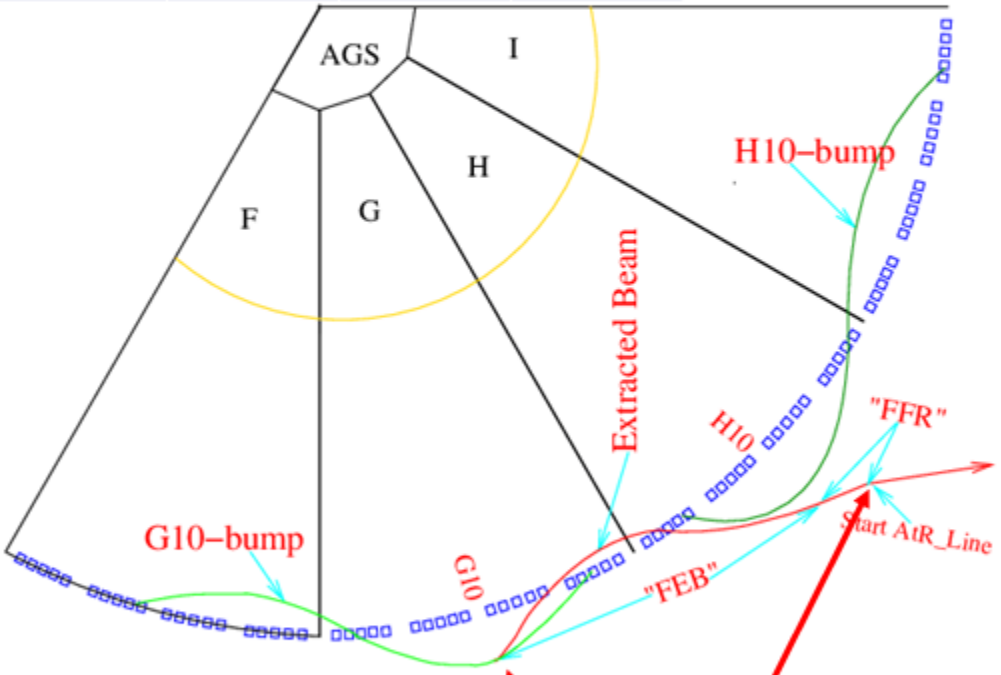



DISPERSION (m)
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
0
25
50
75
100
125
150
175
200
225
250
STRAIGHT SECTION #


M-H14
M-H13
M-H12
M-H11
M-H10
H10
CROSS SECTION OF H13 AGS MAGNET (C-TYPE)
CROSS SECTION OF H12 AGS MAGNET (H-TYPE)
Y [INCH]
DIST. (inches)
Magnetic center axis
Exit 15.2"
Entrance 10.1"
Exit 8.92"
Entrance 6.23"
Exit point 5.45"
Entrance Point 3.84"
By (Tesla)
Experimentally Measured Field from -7.4" to 6.4"
Experimentally Measured Field from -8.8" to 16"

R Matrix G10-kicker to Start-AtR					
−1.8261	−17.443	0.0	0.0	0.0	−2.5889
0.17912	1.1634	0.0	0.0	0.0	0.2517
0.0	0.0	1.125	−15.016	0.0	0.0
0.0	0.0	0.186	−1.5855	0.0	0.0
−0.0041	1.3785	0.0	0.0	1	0.0
0.0	0.0	0.0	0.0	0.0	1.0

	H13
β_x	34.7 [m]
α_x	-3.4
η_x	-1.06 [m]
η'_x	-0.68
β_x	8.1 [m]
α_x	1.06



$$\begin{pmatrix} R_{11}^2 & -2R_{11}R_{12} & R_{12}^2 \\ -R_{11}R_{21} & R_{12}R_{21}+R_{11}R_{22} & -R_{12}R_{22} \\ R_{21}^2 & -2R_{21}R_{22} & R_{22}^2 \end{pmatrix} \begin{pmatrix} \beta \\ \alpha \\ \gamma \end{pmatrix}_{start} = \begin{pmatrix} \beta \\ \alpha \\ \gamma \end{pmatrix}_{end}$$

Thank you for your attention