“Incorporating” the AtR line to AGS
APEX Workshop

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N.Tsoupas

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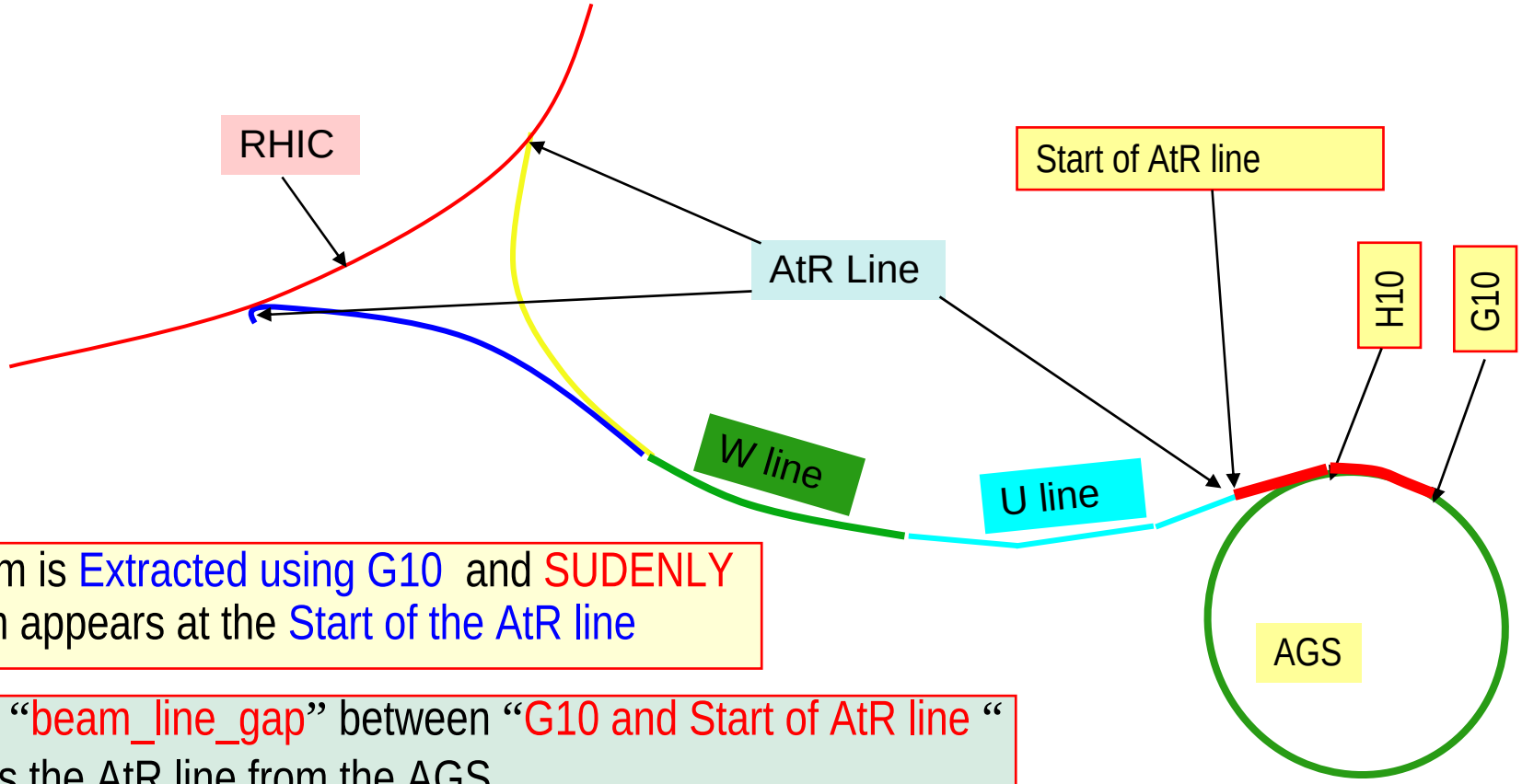
Outline

- Explain the Title of the Presentation
- Scope of Presentation
- AGS at Extraction
- AtR Line
- How to incorporate AtR line with the AGS
- Summary

Explaination of the Title



The Beam is Extracted using G10 and SUDENLY the beam appears at the Start of the AtR line

Thus the "beam_line_gap" between "G10 and Start of AtR line " separates the AtR line from the AGS

"Incorporating" the AtR to the AGS⇔Include the "beam_line_gap" section, into the AtR and Start AtR line from the G10 point

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Scope of Presentation

- How we cope with AtR presently
- How to make the AtR line an Integral part of AGS

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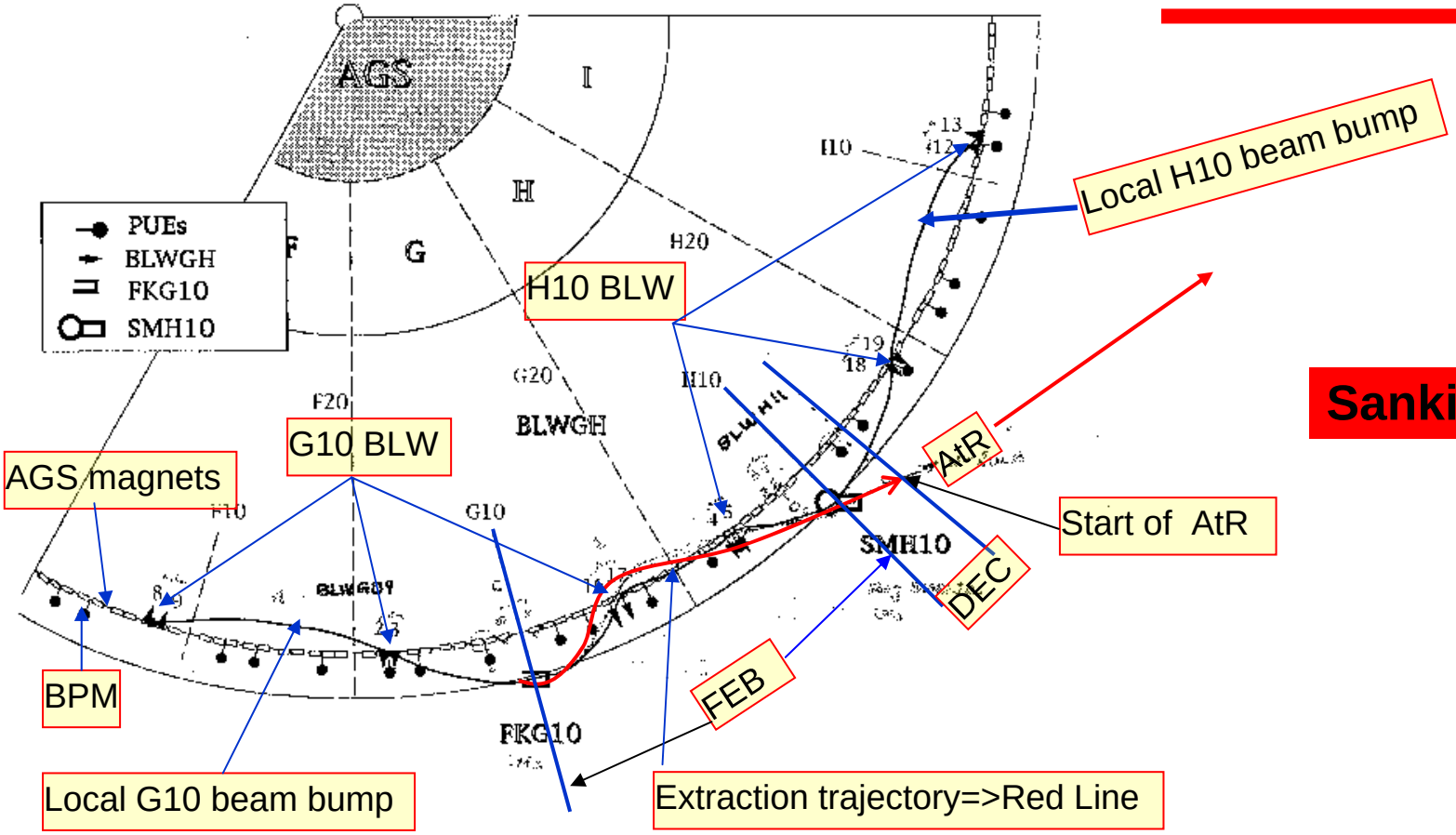
AGS Extraction



Sanki Tanaka

- Generate two local beam bumps G10 and H10 at extraction
- Kick the beam with G10_kicker and further extract the beam using H10 Septum
- We calculate the beam parameters at the "Start of the AtR"

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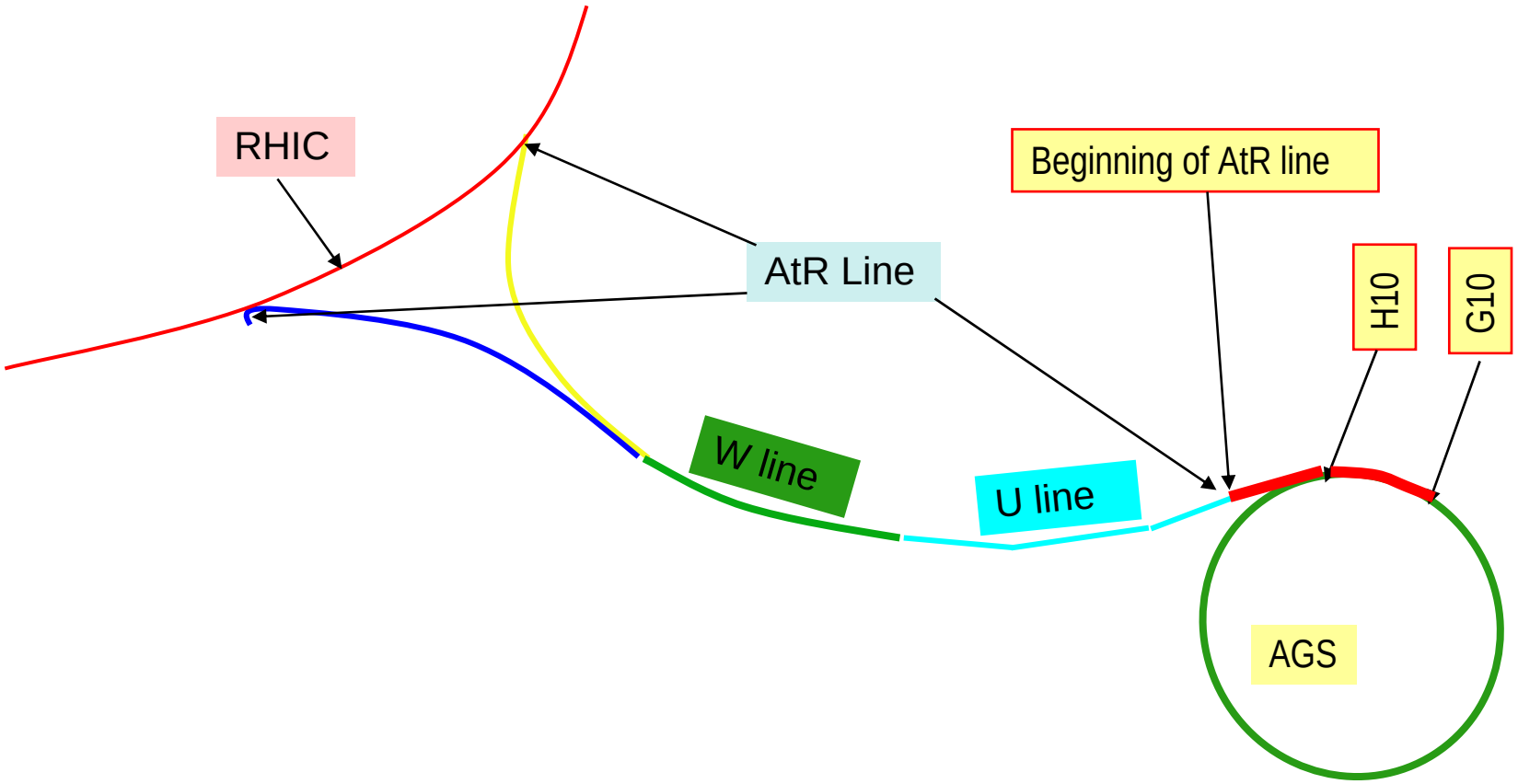
AtR line



Starting with the beam parameters at the beginning of the AtR line, the U line, is matched to the W line (Additional beam constraints must also be satisfied)

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How we cope with AtR presently

- For a particular AGS setup at Extraction:
  - The beam parameters ($\alpha_{x,y}$,$\beta_{x,y}$) and ($\eta_{x,y}$) at the beginning of the AtR line are calculated
  - Using these parameters we calculate the beam transport optics of the AtR line, which should satisfy beam constraints

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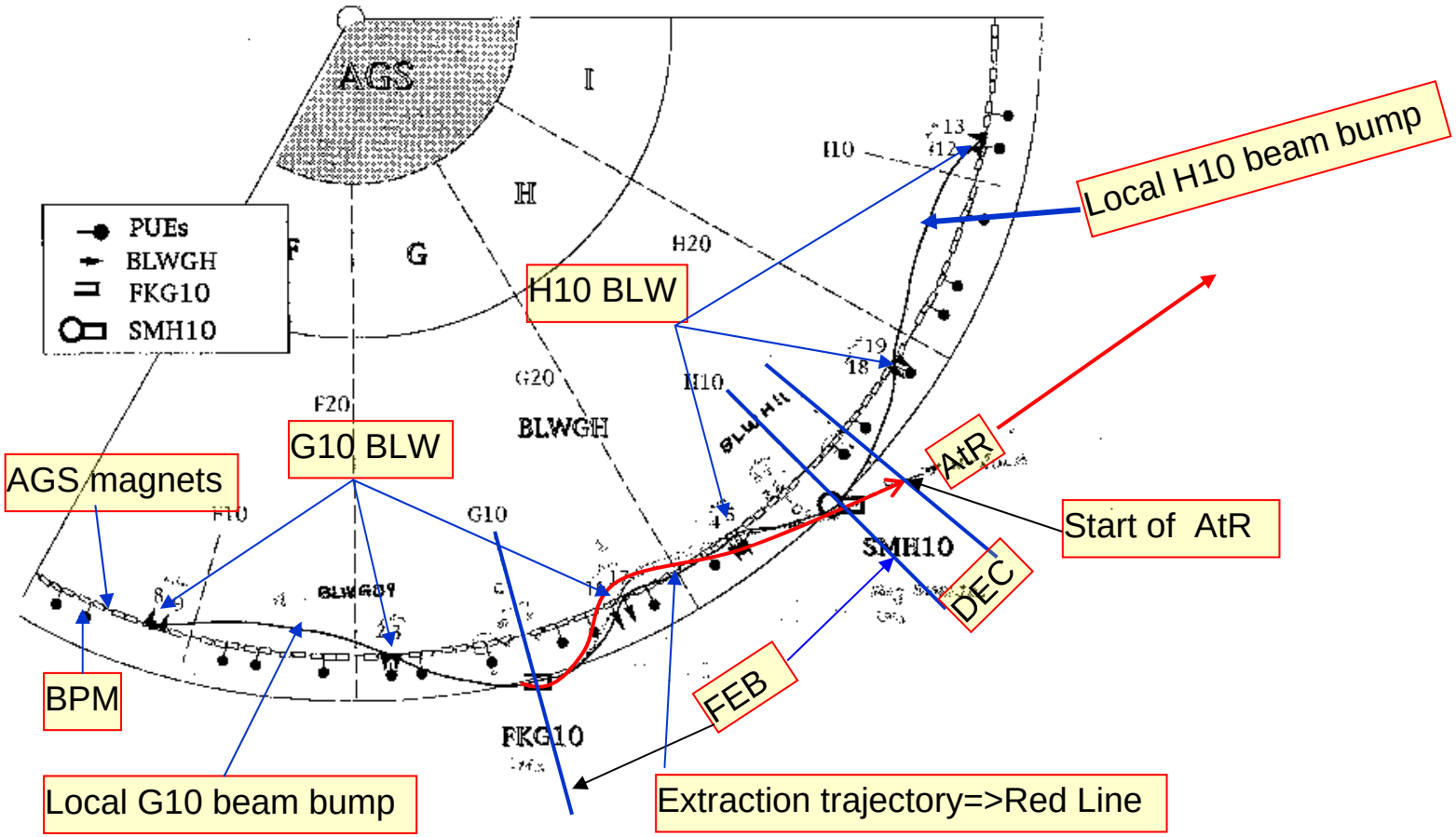
What does it mean to “Incorporate” AtR in AGS



“Incorporated” AtR=>FEB(G10_Kicker)+DEC(H10_Septum)+AtR

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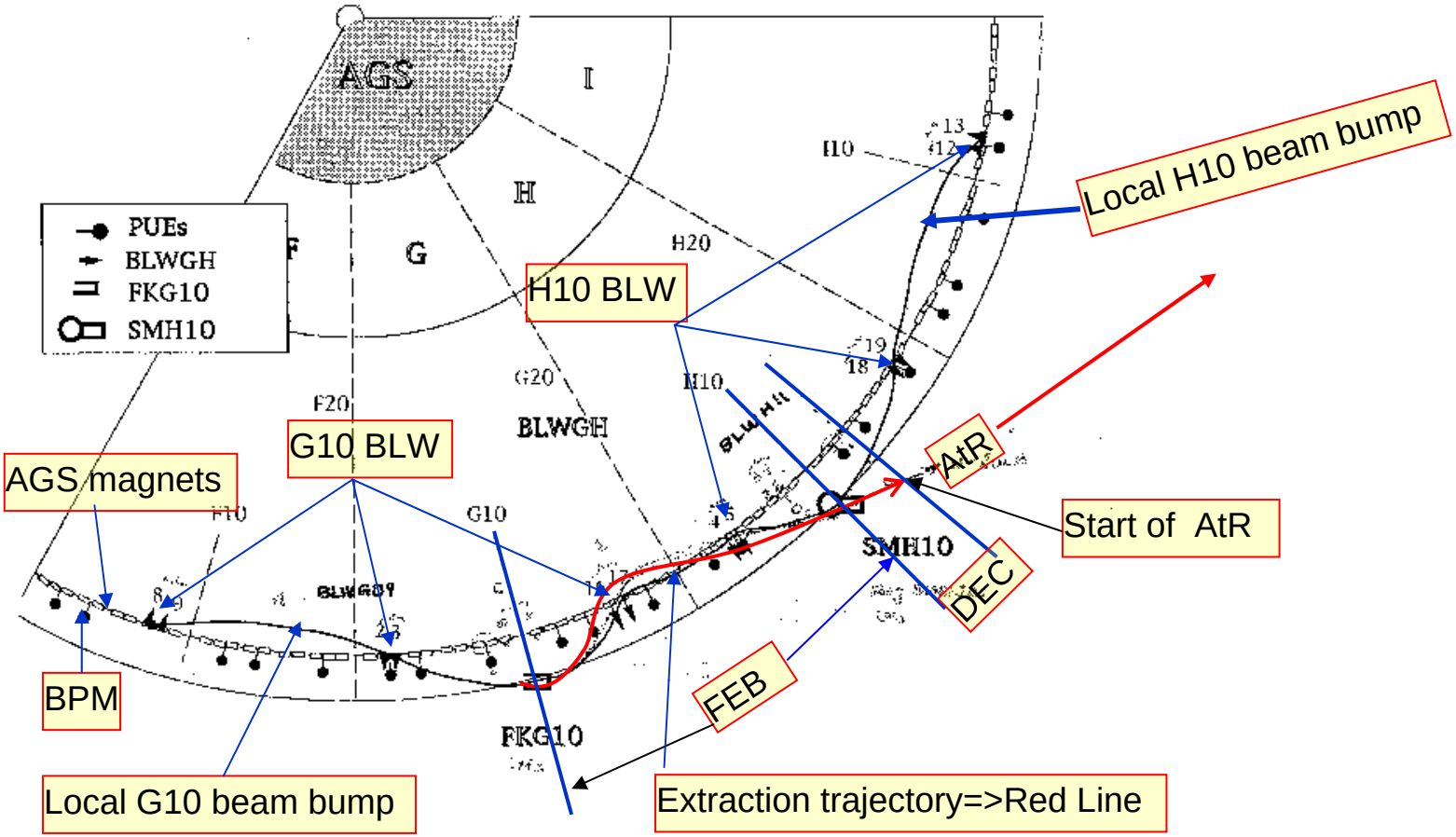
Why to "Incorporate" AtR in AGS



- The model of the "Incorporated" AtR line will include the G10_kicker and H10_septum therefore we will be able to track any malfunction of either device.
- Easier to perform studies on the optics of the AtR line

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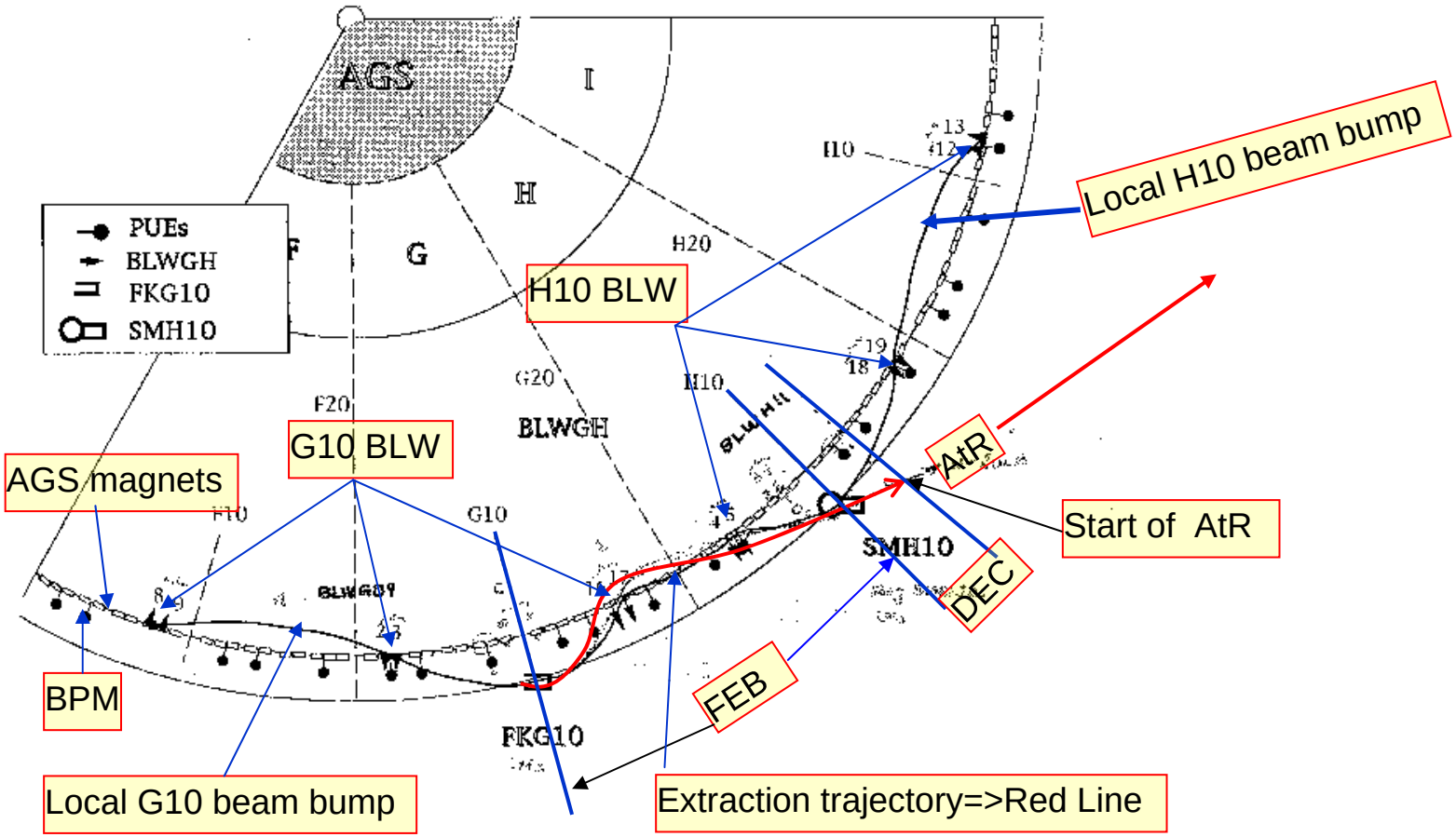
How to "Incorporate" AtR in AGS



- For a given AGS_setup at Extraction Calculate:
  - The R_Matrix of the G10_FEB and H10_DEC sections are calculated
  - Incorporated" AtR=>FEB(G10_Kicker)+DEC(H10_Septum)+AtR

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Method of calculating the R_matrix of FEB section

- The FEB section consists of discrete elements (Dip,Quads Sext) therefore the R matrix can be easily calculated
  - The R matrix should include:
    - The effect of the G10_Kicker
    - The effect of the central orbit's deviation from the optic axes of the elements

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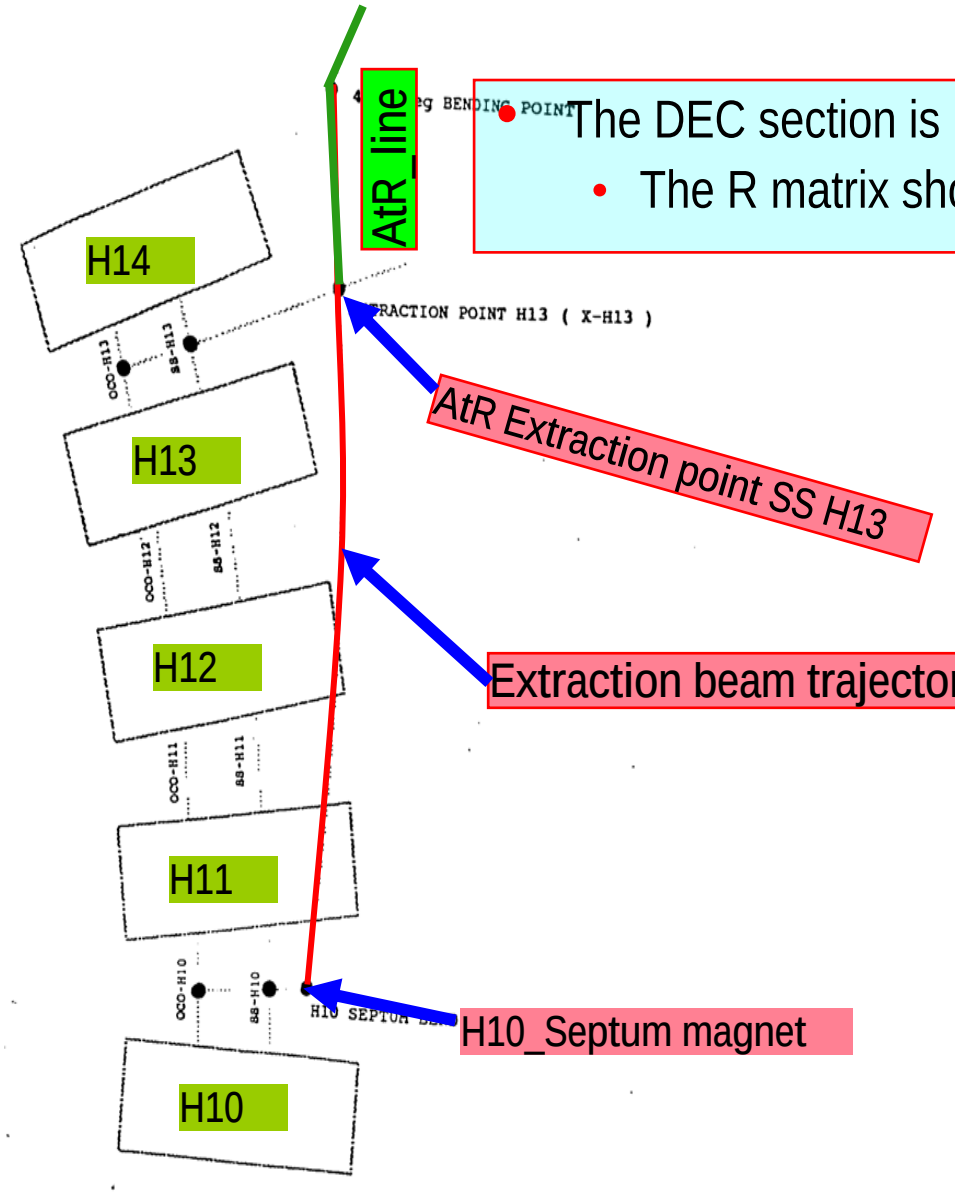
Method of calculating the R_matrix of DEC section



- The DEC section is in the fringe field of the H11, H12 and H13
  - The R matrix should include the effect of the H10_kicker

AtR Extraction point SS H13

Extraction beam trajectory. The “DEC” section is the red line

H10_Septum magnet

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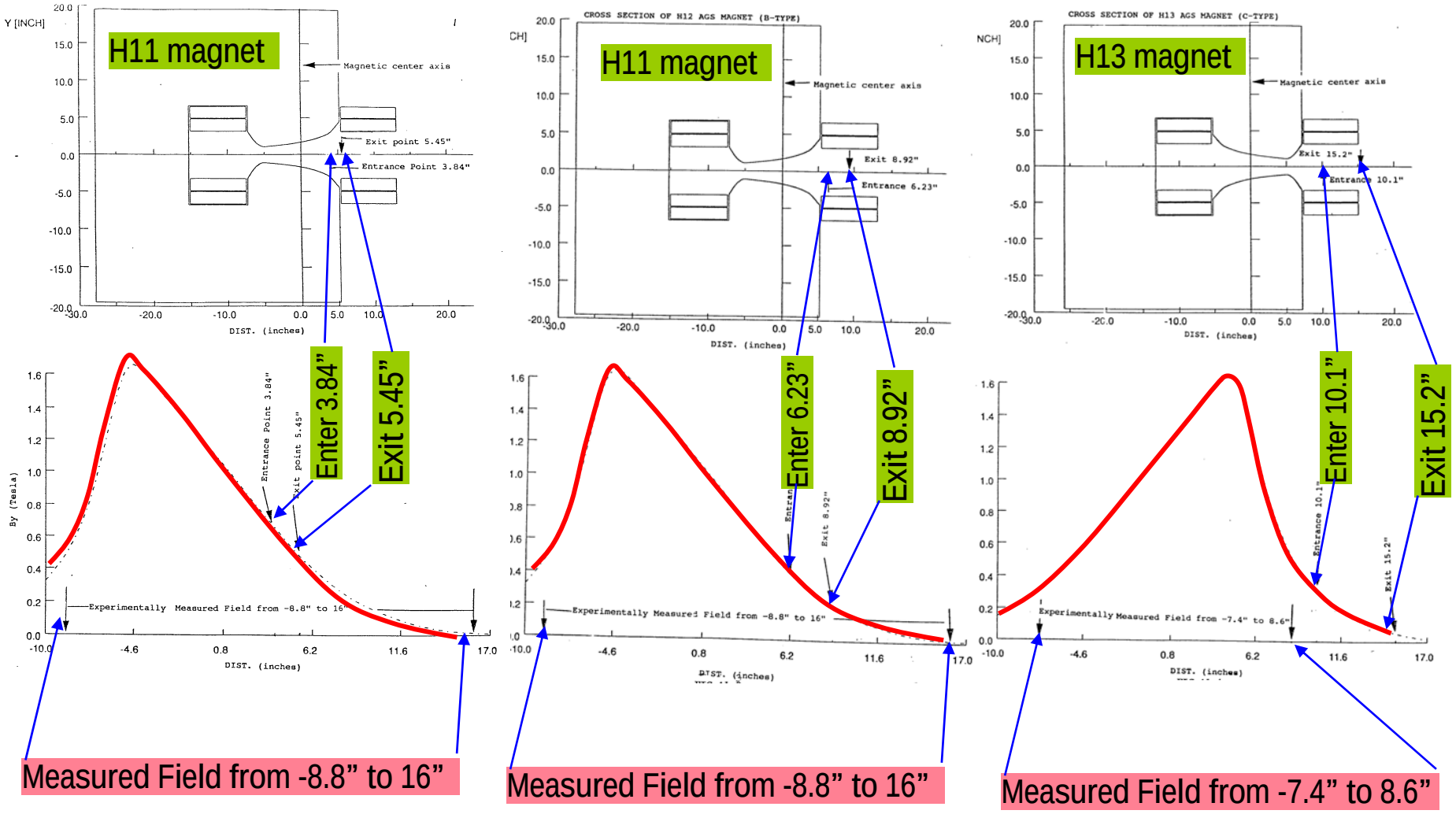
Geometrical limits of field maps



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Converting field maps into a functional form

- The field map of each magnet was measured on a rectangular grid on the median plane
- The measured values of the fields were fitted into a polynomial
  - $B_z(x,y,z=0)=\sum\sum C_{IJkm}x^k y^m$ (k=0…5) (m=0…3) (AD/RHIC/RD-75)
- Using:
  - Median plane symmetry
  - $\nabla\bullet B=0$, $\nabla\times B=0$, $B_x(x,y,z)=\sum a_i z^i$, $B_y(x,y,z)=\sum b_i z^i$, $B_z(x,y,z)=\sum c_i z^i$ {i=0…4}
  - The a_i, b_i and c_i are calculated thus the B_x, B_y, B_z are computed

Raytracing in the fringe field to calculate R-matrices

- Raytrace code: Raytracing in three dimensional field (B_x,B_y,B_z)
- Modified BEAM code: Ratracing on the median plane field (B_z)
  $\partial B_z/\partial x$ is required

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FEB extraction and AtR line: Presently

- Calculate the beam parameters at the beginning of the AtR

Ion	P[GeV/c]	β_x[m]	α_x	η_x[m]]	η'_x	β_y[m]	α_y
D	20.557	33.8736	-3.4299	-1.35	-0.096	7.5726	1.000
Au	26.452	35.1662	-3.4864	-1.60	-0.121	7.7344	0.9702

- Match U line to the W line.

FEB extraction and AtR line: Proposed

- Incorporate "FEB" and "DEC" sections in the AtR line
- For the specific AGS extraction:
  - Calculate values of $\{\beta_{x,y}, \alpha_{x,y}, \eta_x, \eta'_x\}$ functions of circ. beam at G10 location
  - Calculate R matrices for "FEB" and "DEC" sections using an "On-line" AGS model
  - Match "Incorporated" U line to the W line "automatically"

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Conclusions and Summary

- The required computational work for the “Incorporated” AtR line is done
- This work justifies and materializes the effort to measure the field maps of the AGS main magnets
- In order to implement an automatic “Incorporated” AtR line, a collaboration between a scientist and software engineer is needed
- The automatic “Incorporated” AtR line will :
  - Eliminate any errors that may be introduced in the calculations for the separated AtR line from the AGS
  - Will enable a “non expert” to calculate the required magnet setting of the AtR line for a particular AGS extraction setup
  - Provide a diagnostics tool for the AtR optics and the various extraction devices