Science & Technology Facilities Council

Matching of dispersion function

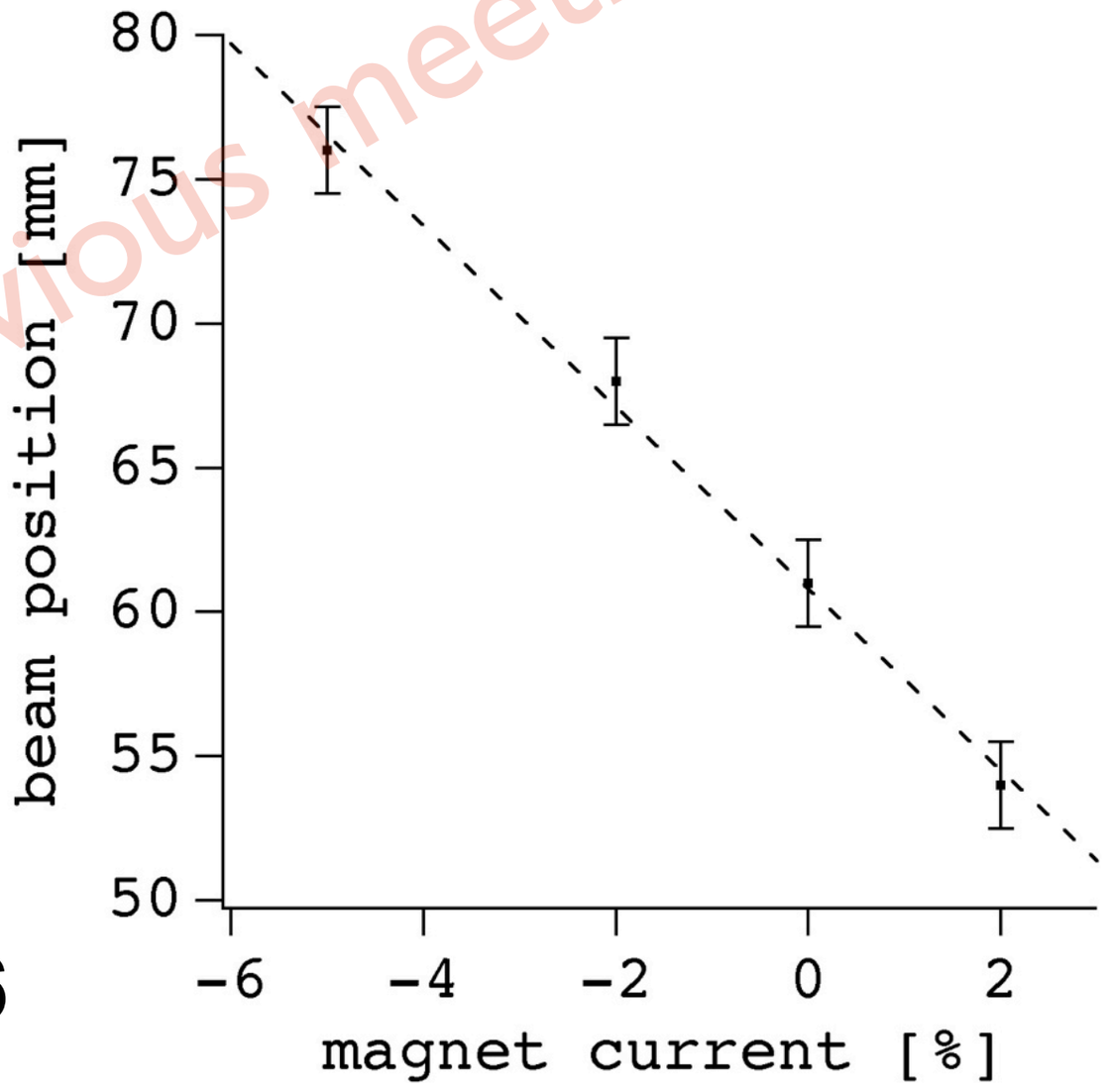
S Machida
ASTeC/STFC Rutherford Appleton Laboratory
5 June 2014

- Measured dispersion function (not its derivative) at the foil.
- Measured dispersion function at the probes.
- Strategy for better matching.

Dispersion function of the injection line

- Results
  - Increasing magnet current (equivalently decreasing momentum) move the beam position outward.
  - Note the value of beam position increase toward the machine centre.
  - Dispersion is negative.

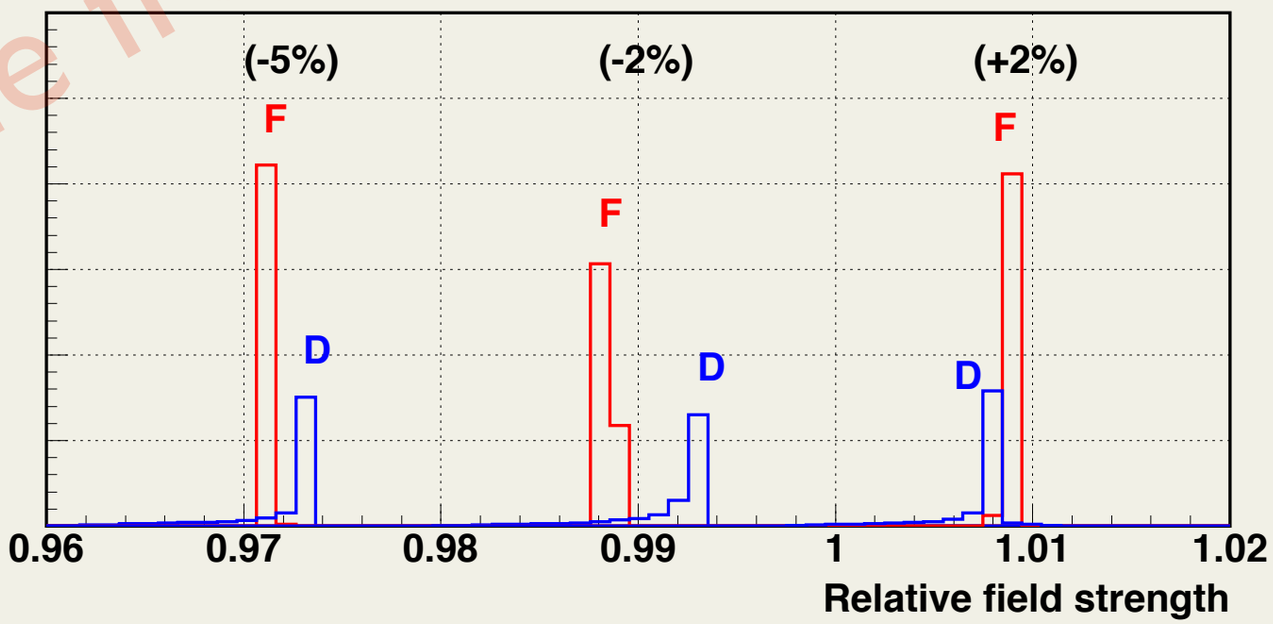
dr/(-dI/I)=-0.315+/-0.016



TOSCA calculation by Uesugi

Field reduction (summary)

Current factor	Power supply I_F / I_D	File name	Average field dB_F / dB_D
-5%	773.30 / 1140	20140502_773_1140.table	-2.86% / -2.75%
-2%	797.72 / 1080	20140503_797_1080.table	-1.10% / -0.81%
0%	814.00 / 1012	20140502_814_1012.table	0% / 0%
+2%	830.28 / 940	20140504_830_0940.table	+0.87% / +0.80%



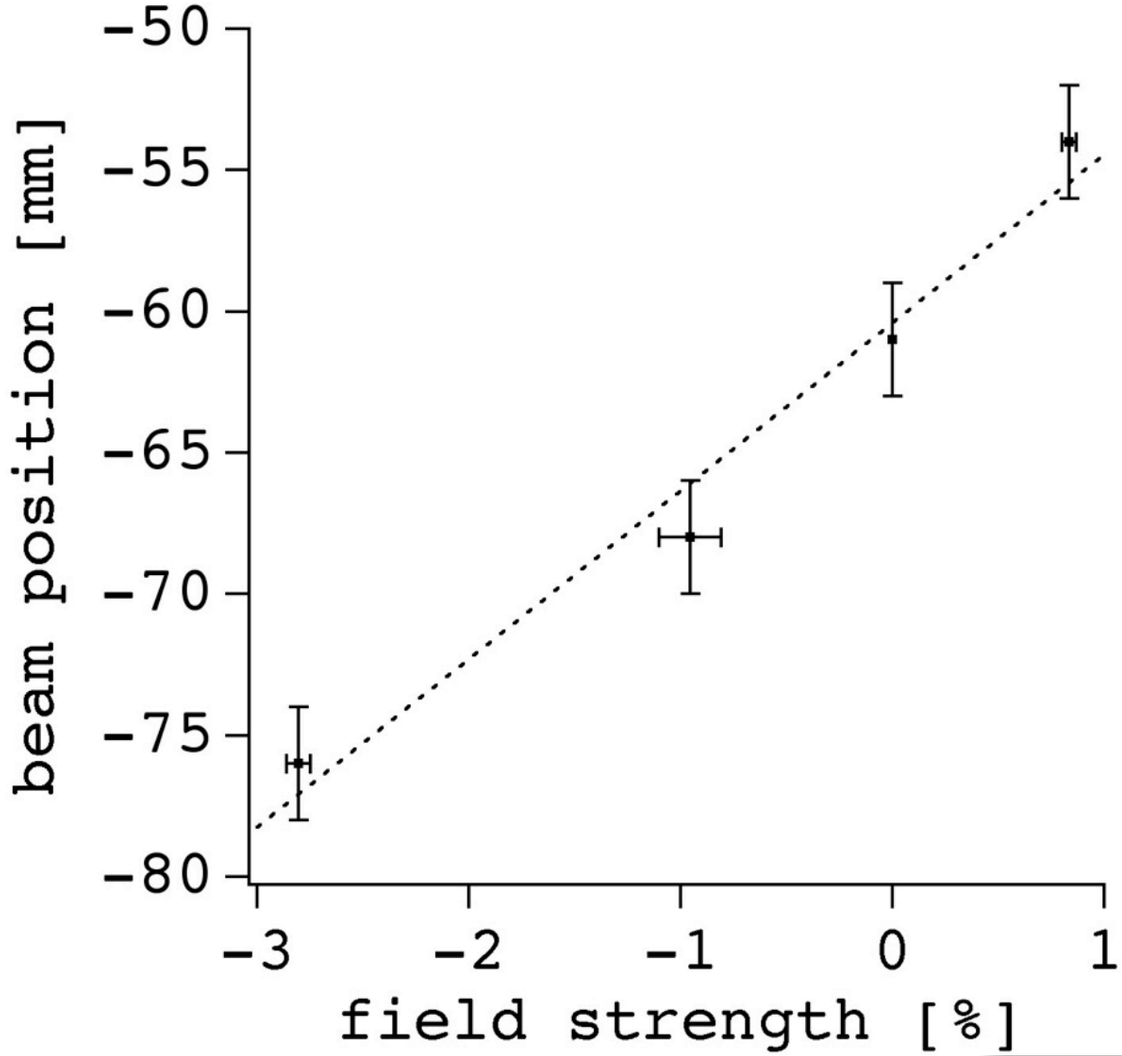
Science & Technology Facilities Council

- Measured dispersion function at foil after B calibration.

$$dr/(-dB/B) = -0.59 \pm 0.07$$

- Good agreement with Malek's calculation.

$$dr/(dp/p) = -0.57$$



Science & Technology Facilities Council

However

- This is the results when the initial D_i and D'_i are zero outside of the main magnet.
- We want to know the dispersion without this constraint.

$$\begin{pmatrix} D_f \\ D'_f \end{pmatrix} = \begin{pmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{pmatrix} \begin{pmatrix} D_i \\ D'_i \end{pmatrix} + \begin{pmatrix} D_p \\ D'_p \end{pmatrix}$$

transfer matrix

- My interpretation is that we measured $\begin{pmatrix} D_p \\ \cancel{D'_p} \end{pmatrix}$.
- If we know $\begin{pmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{pmatrix}$ from Zgoubi and $\begin{pmatrix} D_i \\ D'_i \end{pmatrix}$ from SAD, we can calculate $\begin{pmatrix} D_f \\ \cancel{D'_f} \end{pmatrix}$.

Science & Technology Facilities Council

Transfer of the measured data

Ishi-san and Uesugi-san's Transfer Matrix of the main magnet

$$\begin{pmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{pmatrix} = \begin{pmatrix} -3.36 & -1.31 \\ -2.50 & -1.27 \end{pmatrix}$$

Dispersion function before the main magnet by SAD

$$\begin{pmatrix} D_i \\ D_i' \end{pmatrix} = \begin{pmatrix} -1.28 \\ 2.44 \end{pmatrix}$$

Dispersion vector from the experiment

$$\begin{pmatrix} D_p \\ D_p' \end{pmatrix} = \begin{pmatrix} -0.591 \\ -0.139 \end{pmatrix} -> \begin{pmatrix} -0.57 \\ -0.139 \end{pmatrix}$$ replaced

Fairly good agreement with the following measured dispersion in a ring.

Finally the dispersion function at the foil

$$\begin{pmatrix} D_f \\ D_f' \end{pmatrix} = \begin{pmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{pmatrix} \begin{pmatrix} D_i \\ D_i' \end{pmatrix} + \begin{pmatrix} D_p \\ D_p' \end{pmatrix} = \begin{pmatrix} 0.52 \\ -0.033 \end{pmatrix}$$

Science & Technology Facilities Council

Target

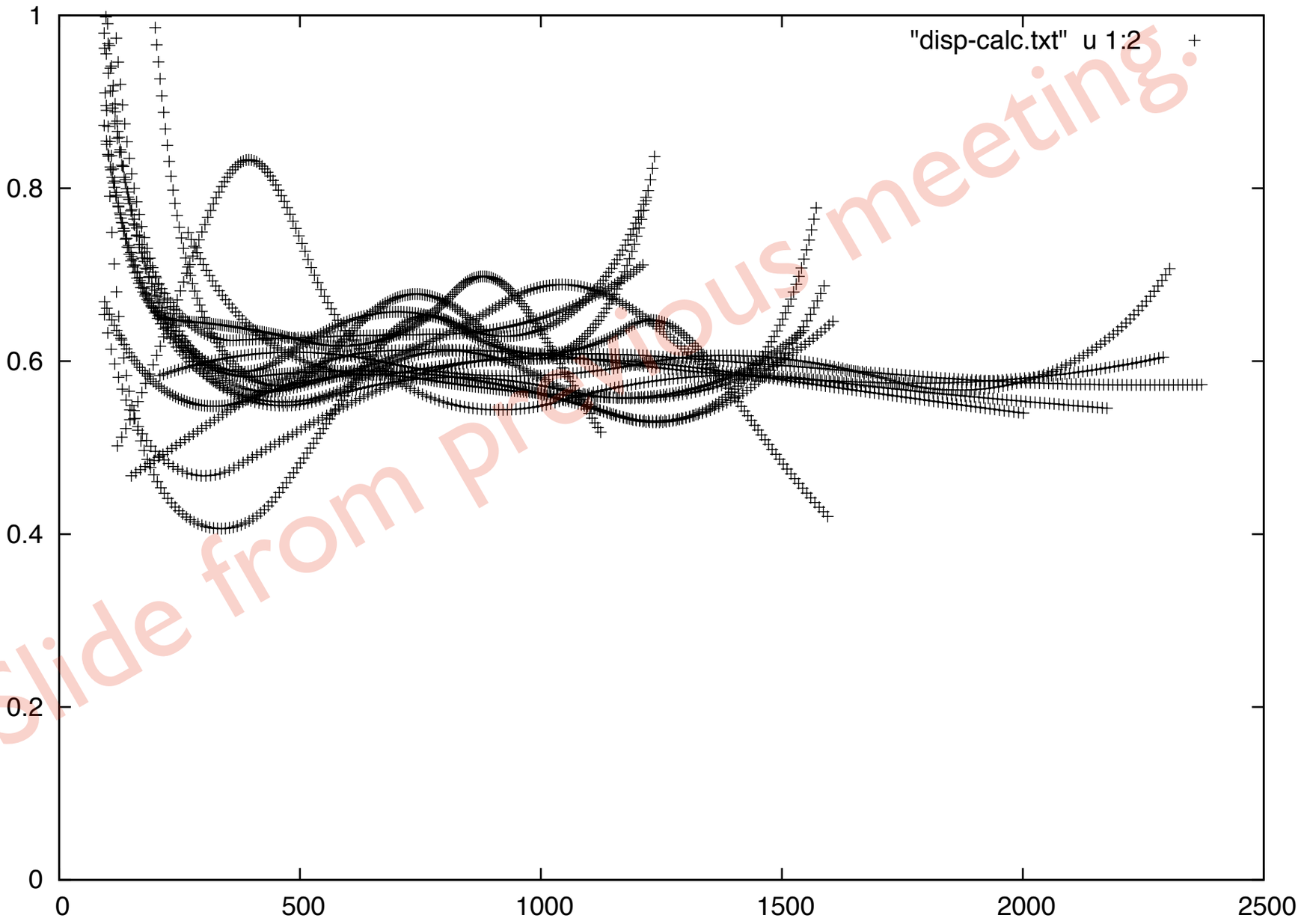
- Following 2 pages show the measured dispersion functions at the centre of F-mag in the ring.

http://hadron.kek.jp/FFAG/colabo/meetings/Results_140404.pdf

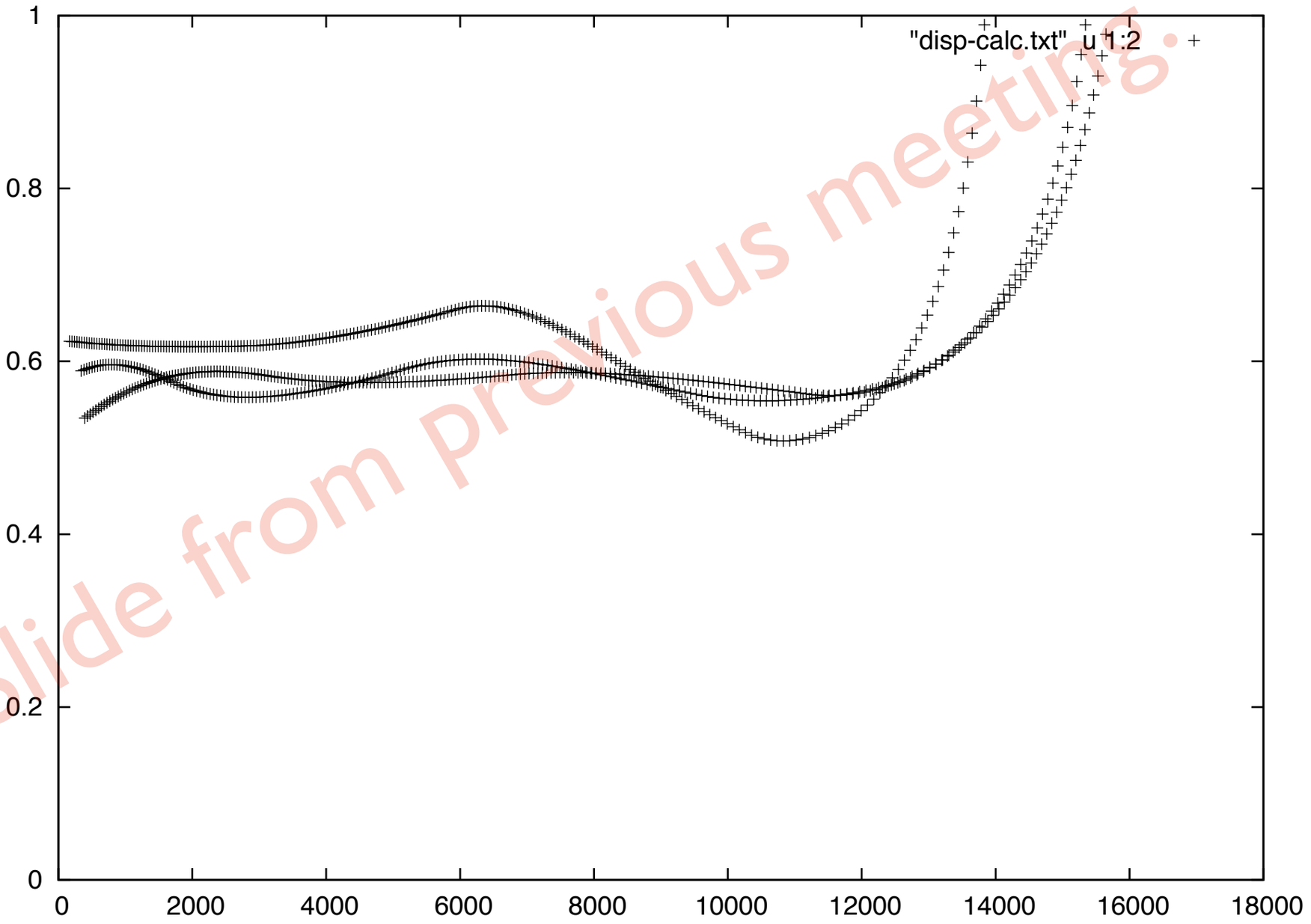
- Can we get a number as the target of matching?

Science & Technology Facilities Council

Dispersion Calculations



Dispersion Calculations



Before June experiment

- Refine measured dispersion function at the centre of F-mag to use as the target value.
- Identify which quadrupole(s) in the injection line is most effective to make the matching better.

Science & Technology Facilities Council