Responses to Comments

by Greg Brooks

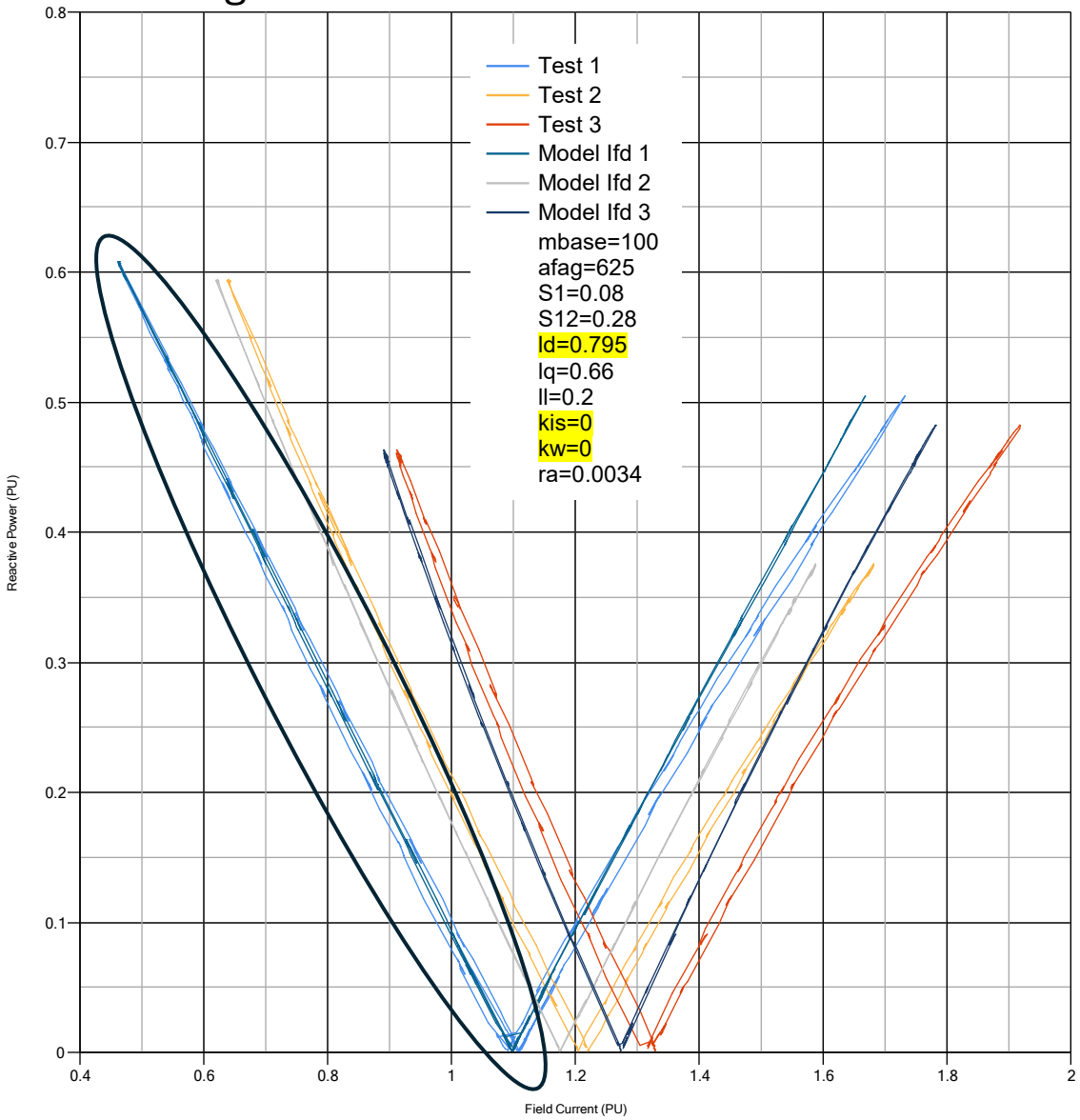
"Key Issues with the $\boldsymbol{Kis}$ Term in Generator Models GENTPJ and GENQEJ"

1. Inflated Unsaturated D-axis Reactance (Xd) Verification Result

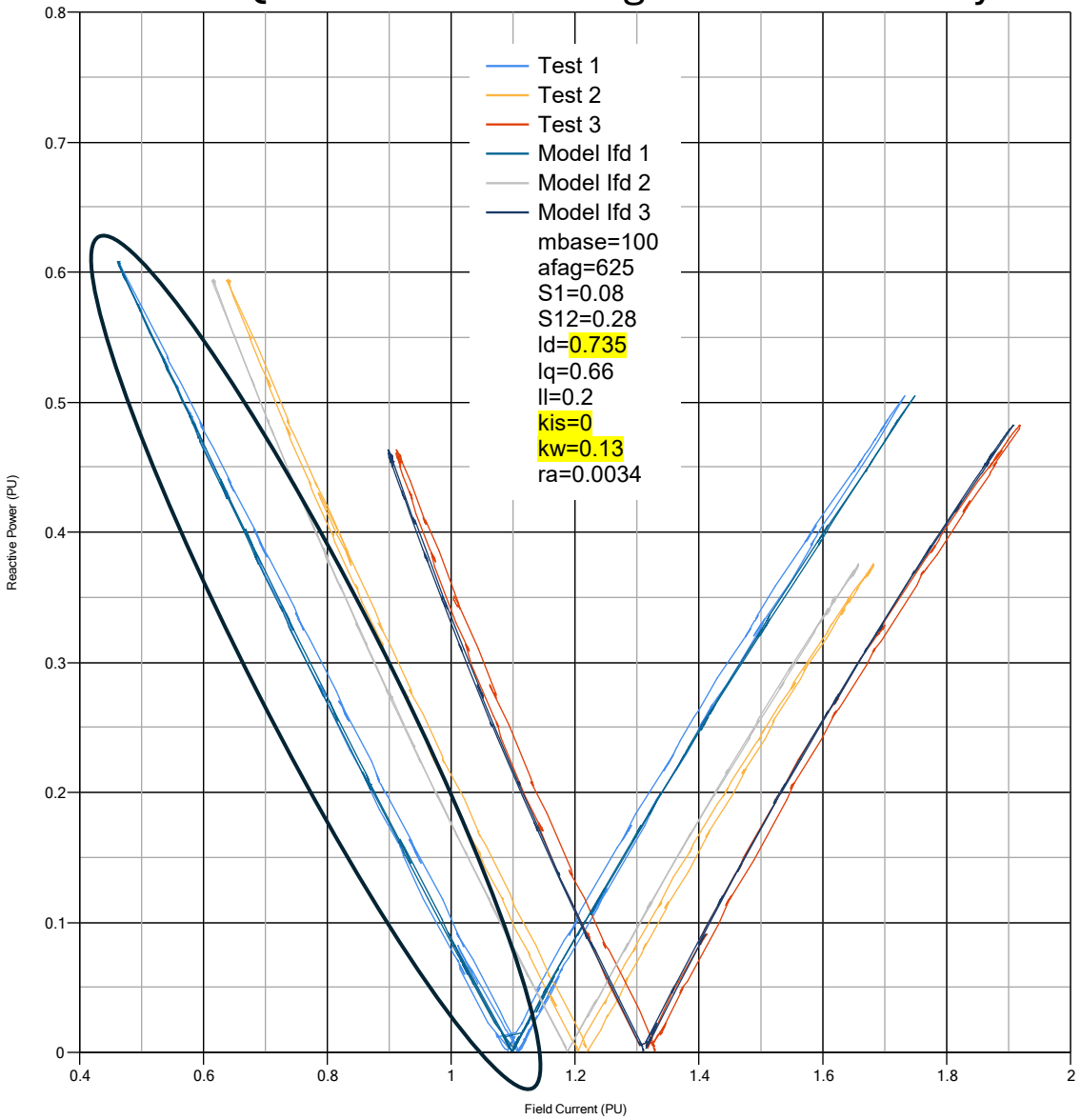
- Both GENQEC and GENQEJ effect the fit in the under-excited no load region, but in opposite ways. This is understood. For this unit, and all the machines we have tested, GENQEJ most nearly fits the expected Ld while also matching the rest of the data. This is illustrated with an example below.
- Saturation of iron will act to slightly diminish the effect of stator current on flux. This is not in conflict with the common understanding that stator current contributes to MMF in the no-load under-excited region. This merely implies that the effect is slightly reduced to the extent that there is saturation.

Ld affected by Kw in GENQEC (7.5% variation of Ld)

Mfg. Parameters with no Kis or KW

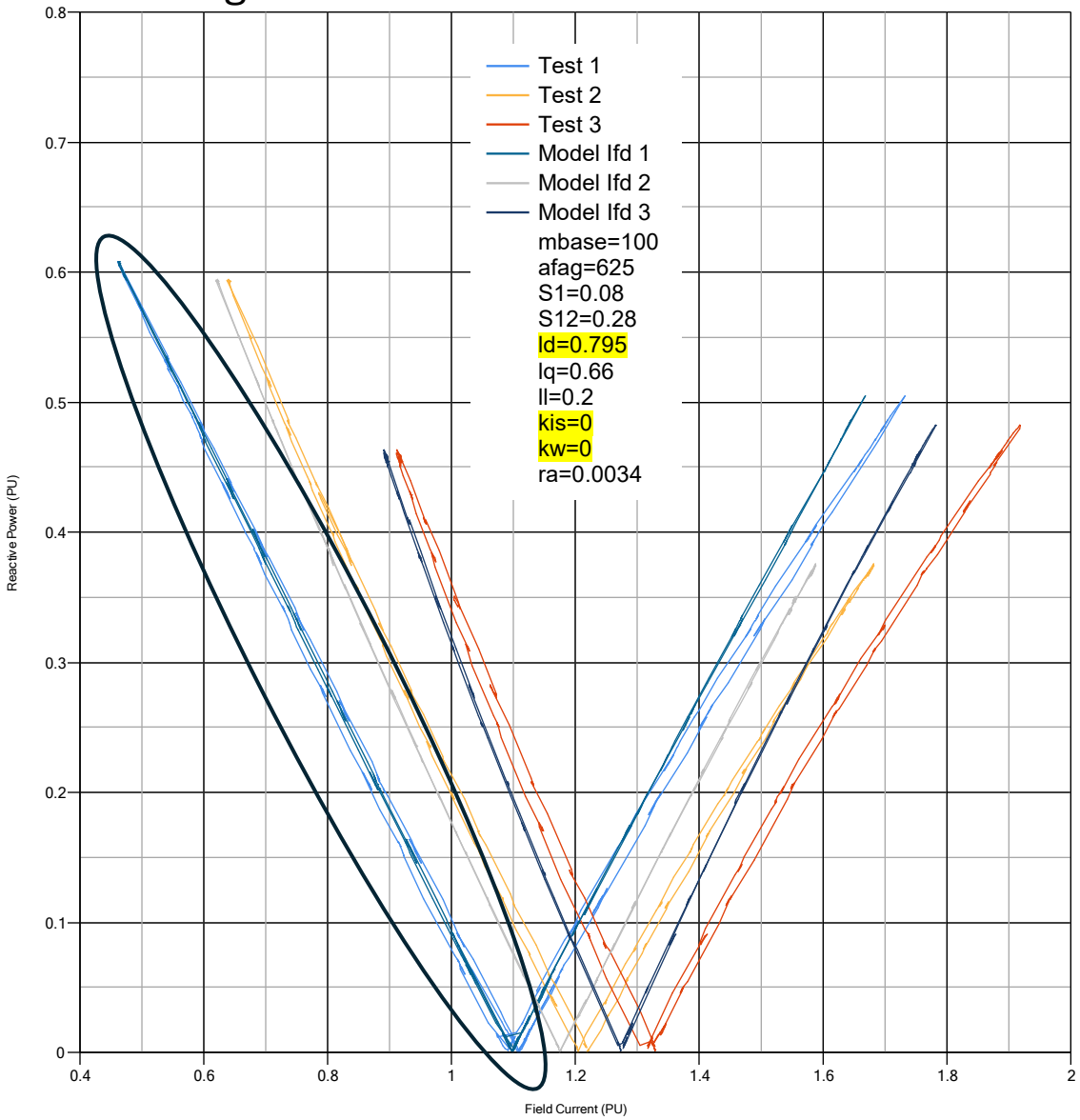


GENQEC best fit allowing Ld and Kw to vary

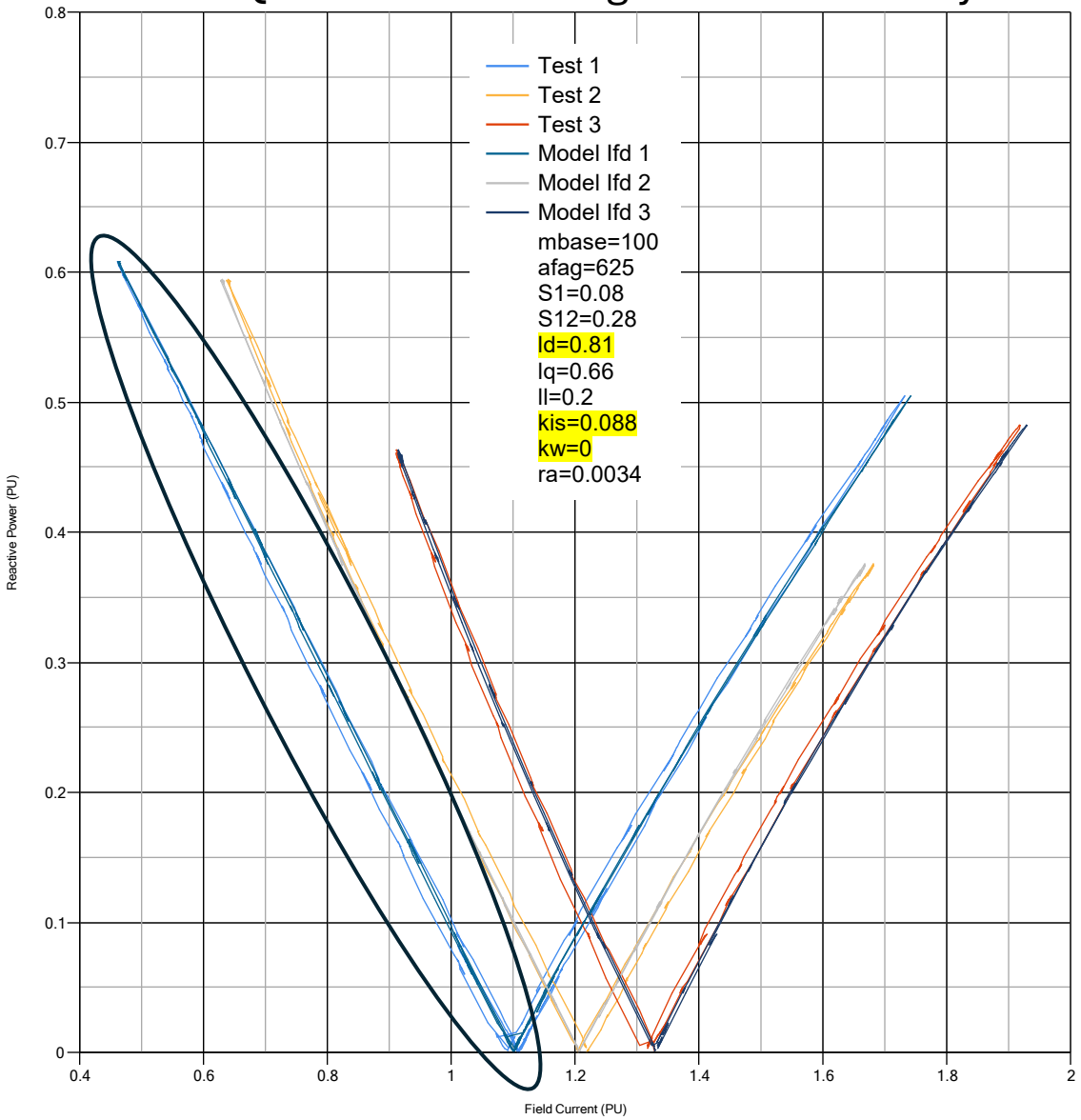


Ld affected by Kis in GENQEJ (1.9% variation of Ld)

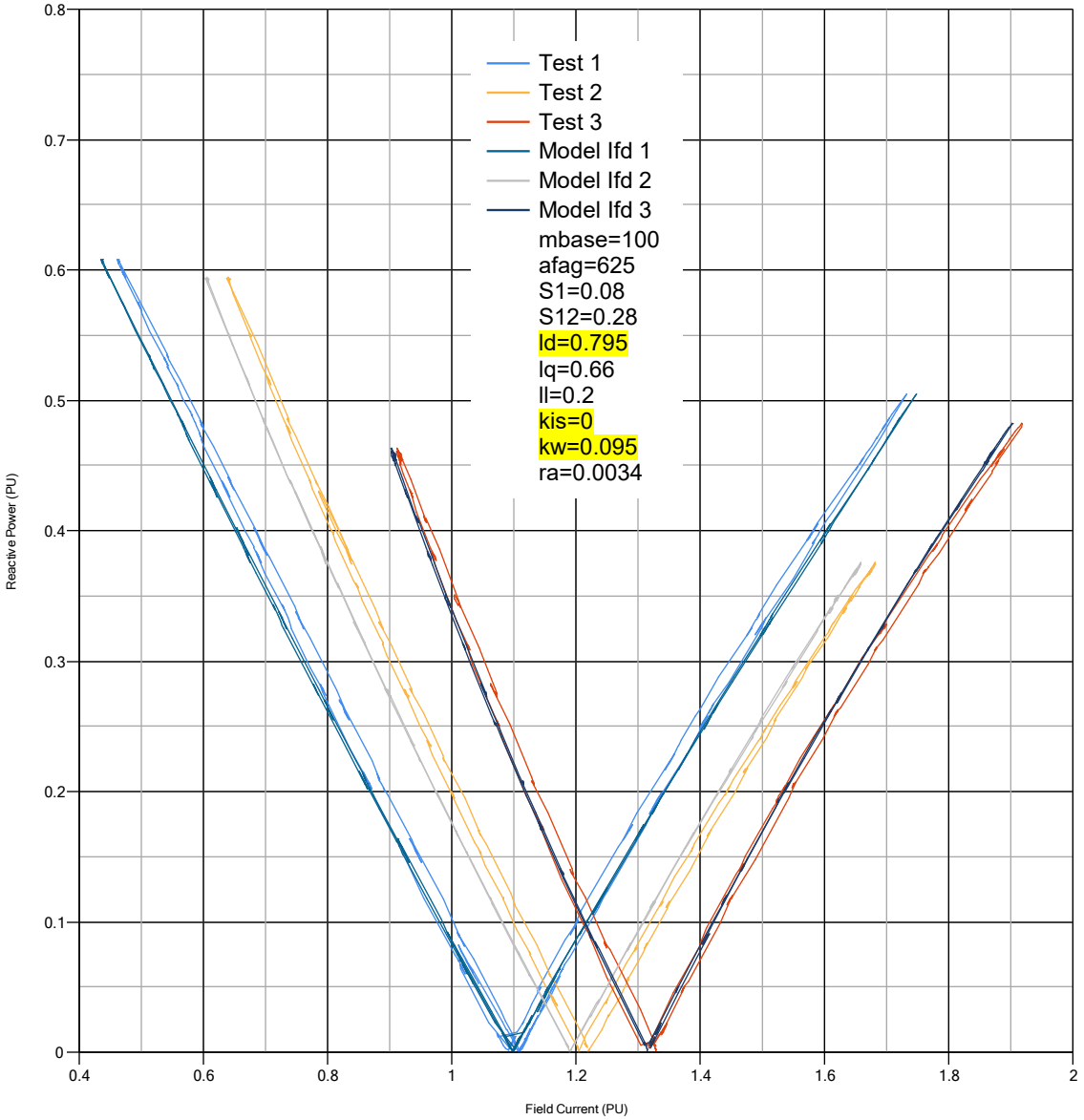
Mfg. Parameters with no Kis or KW

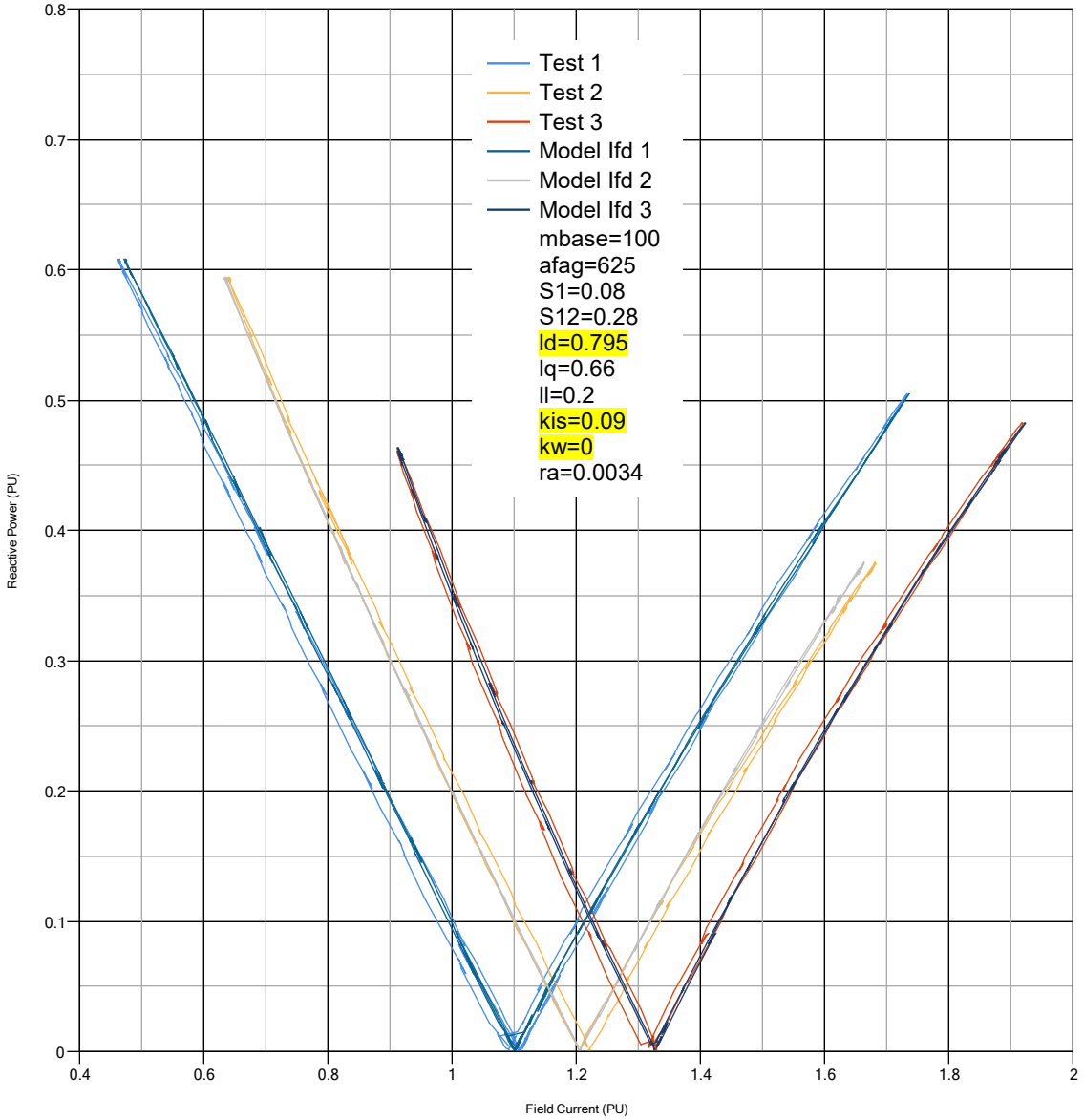


GENQEJ best fit allowing Ld and Kis to vary



GENQEC vs GENQEJ with Mfg Ld





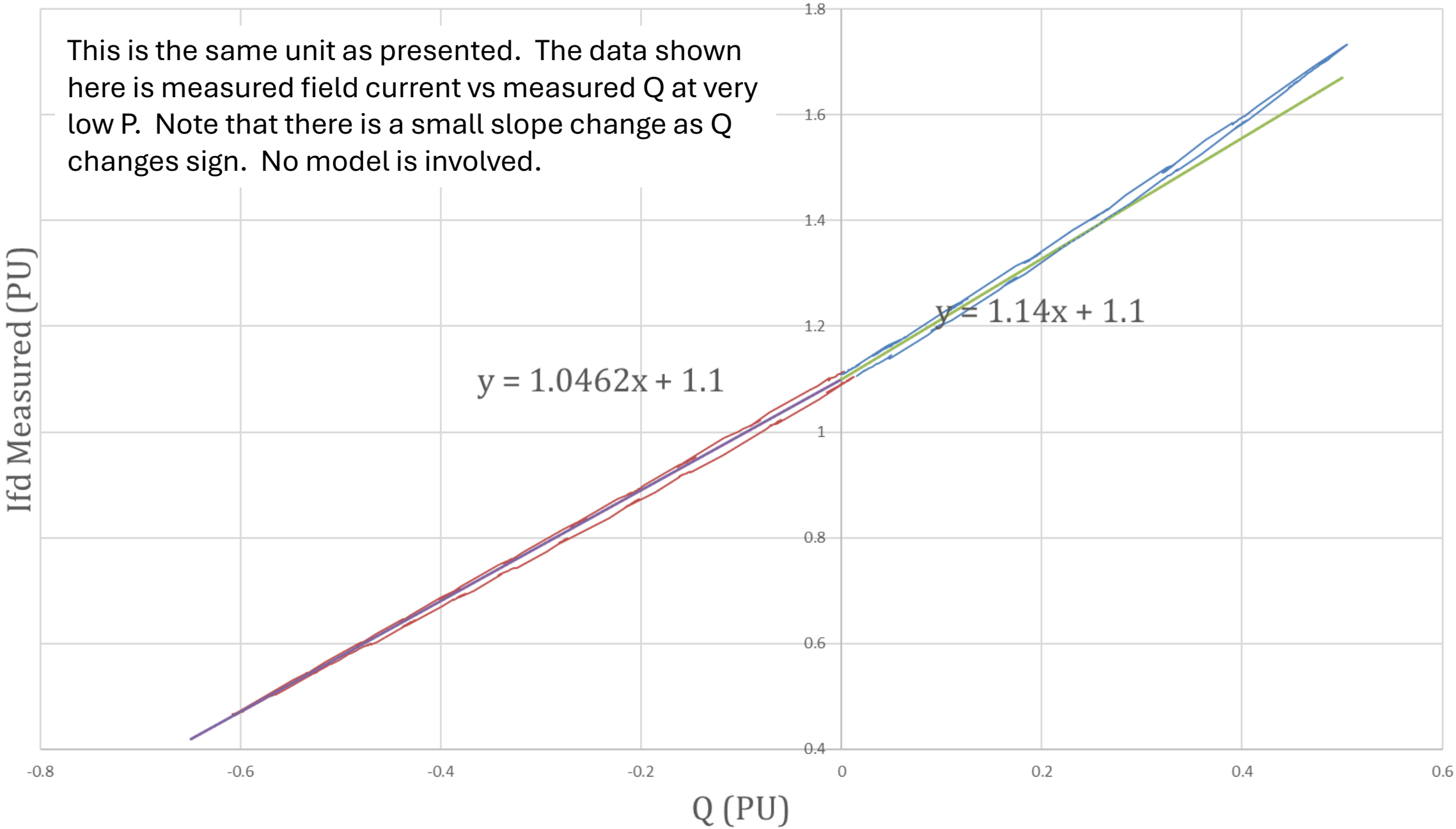
- For this unit, the required Kw has much more effect on Ld (-7.5%) vs Kis (+1.9%) vs the manufacturer's reported Ld. For these units, a good fit can be achieved by GENQEJ without changing Ld, but not with GENQEC.

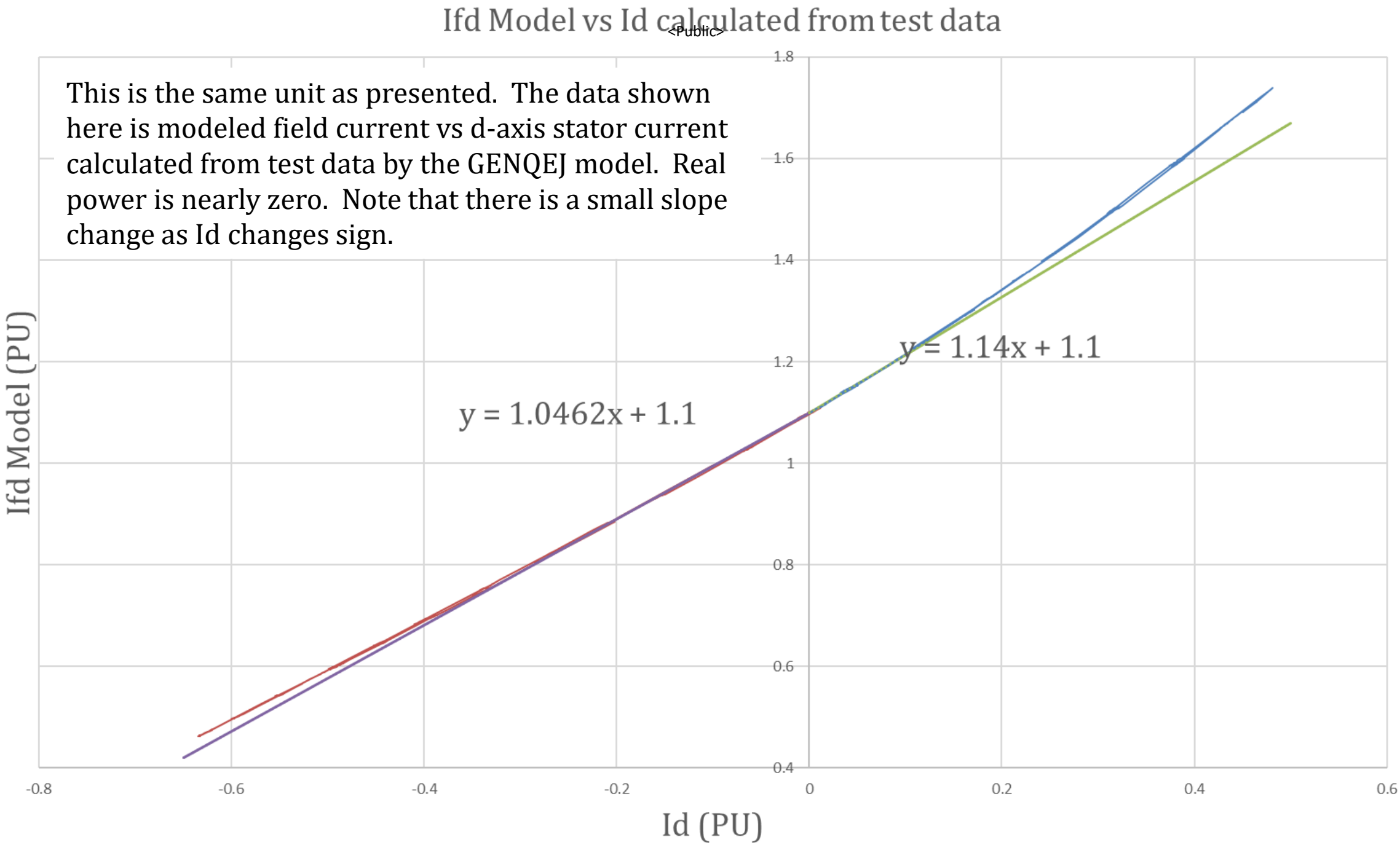
2. Non-continuous Field Current Rate of Change with Respect to Stator D-axis Current

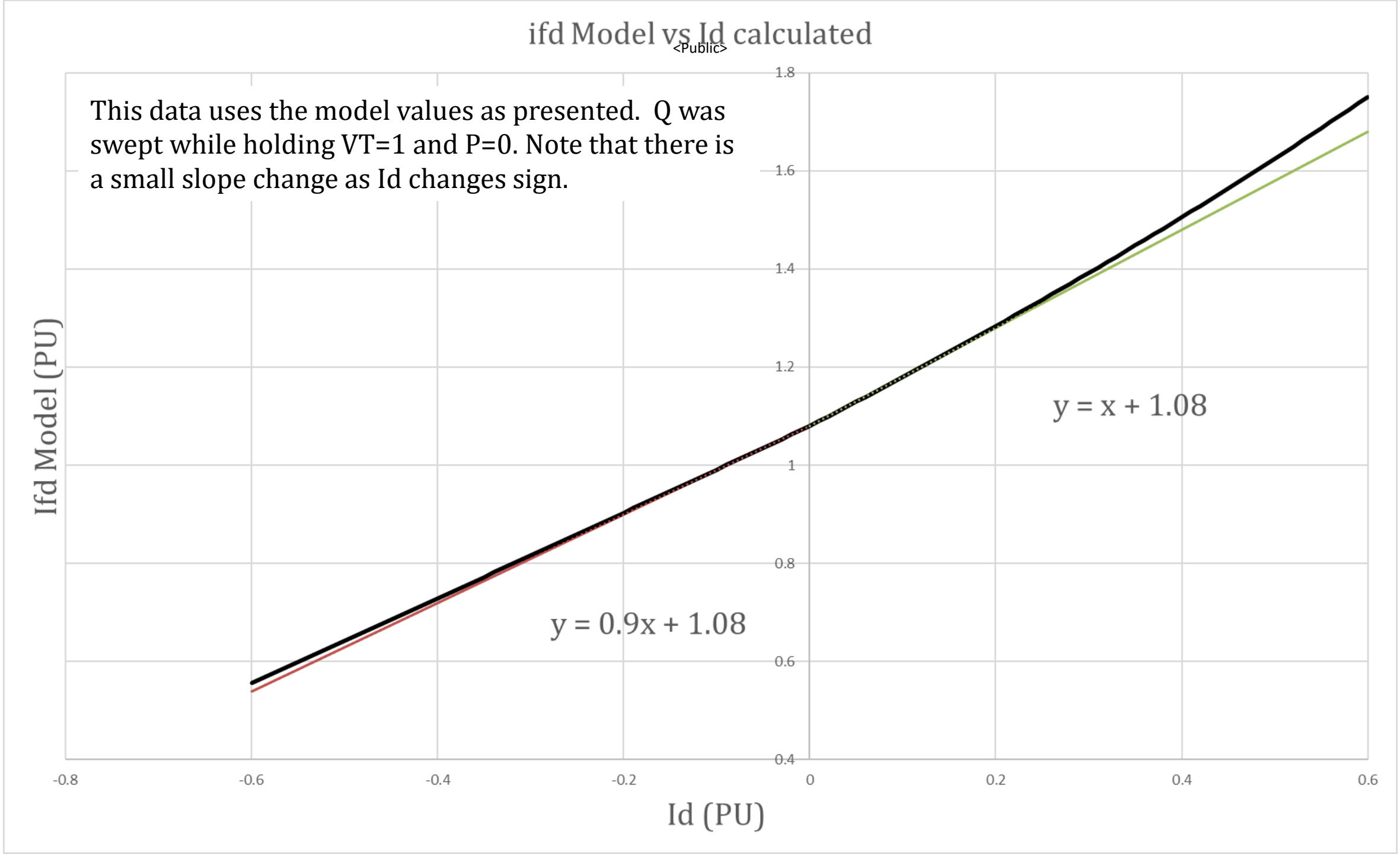
- Saturation effect due to stator current is introduced by Kis*hypot(stator current). This means that increasing stator current magnitude will increase saturation. This is as intended and expected. This effect is present in every GENTPJ model in the WECC case.
- Don’t use the model if it doesn’t fit the test data.

Ifd measured vs Q

This is the same unit as presented. The data shown here is measured field current vs measured Q at very low P. Note that there is a small slope change as Q changes sign. No model is involved.




Ifd Model vs Id calculated from test data
This is the same unit as presented. The data shown here is modeled field current vs d-axis stator current calculated from test data by the GENQEJ model. Real power is nearly zero. Note that there is a small slope change as Id changes sign.
y = 1.14x + 1.1
y = 1.0462x + 1.1
Ifd Model (PU)
Id (PU)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6


ifd Model vs Id calculated
This data uses the model values as presented. Q was swept while holding VT=1 and P=0. Note that there is a small slope change as Id changes sign.
y = x + 1.08
y = 0.9x + 1.08
Ifd Model (PU)
Id (PU)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6

- For our units, GENQEJ gives the best correlation of Ld
- The saturation effect introduced by Kis is in proportion to the hypot(stator current), and that effect matches our units. The effect on slope is expected.
- Remember, GENQEJ uses the transfer function of GENROU with the saturation function using Kis. These are well tested and have been implemented for many years. GENTPJ was removed due to inferior transfer function, not saturation treatment.
- The proposed model is the best fit for the units we are concerned about.

Conclusion

- The objective of the motion IS NOT TO REQUIRE that GENQEJ be used in WECC studies - it IS TO PROVIDE THE OPTION to use GENQEJ where comparison with testing and observed disturbance responses shows that it is appropriate.