

# Sequence IVB Operational Analysis

By: Industry Stats Team

02-14-18

# Operational Analysis with Partial Least Squares

- All operational data was analyzed using Partial Least Squares (PLS)
  - Method is appropriate for multicollinear data and/or where the number of independent variables exceeds the number of observations
  - Some operational, surface finish, and camshaft related variable measurement data in analysis seems suspect (data entry error?), which will affect analysis results
- Factors identified in partial least squares does not imply root cause
  - It identifies factors that may be of interest for additional investigation
- PLS Model Related info:
  - Dependent variable analyzed: Sqrt(AVLI)
  - Number of observations = 28
  - Number of independent variables = 90
  - For the analysis, missing values were imputed using mean value substitution

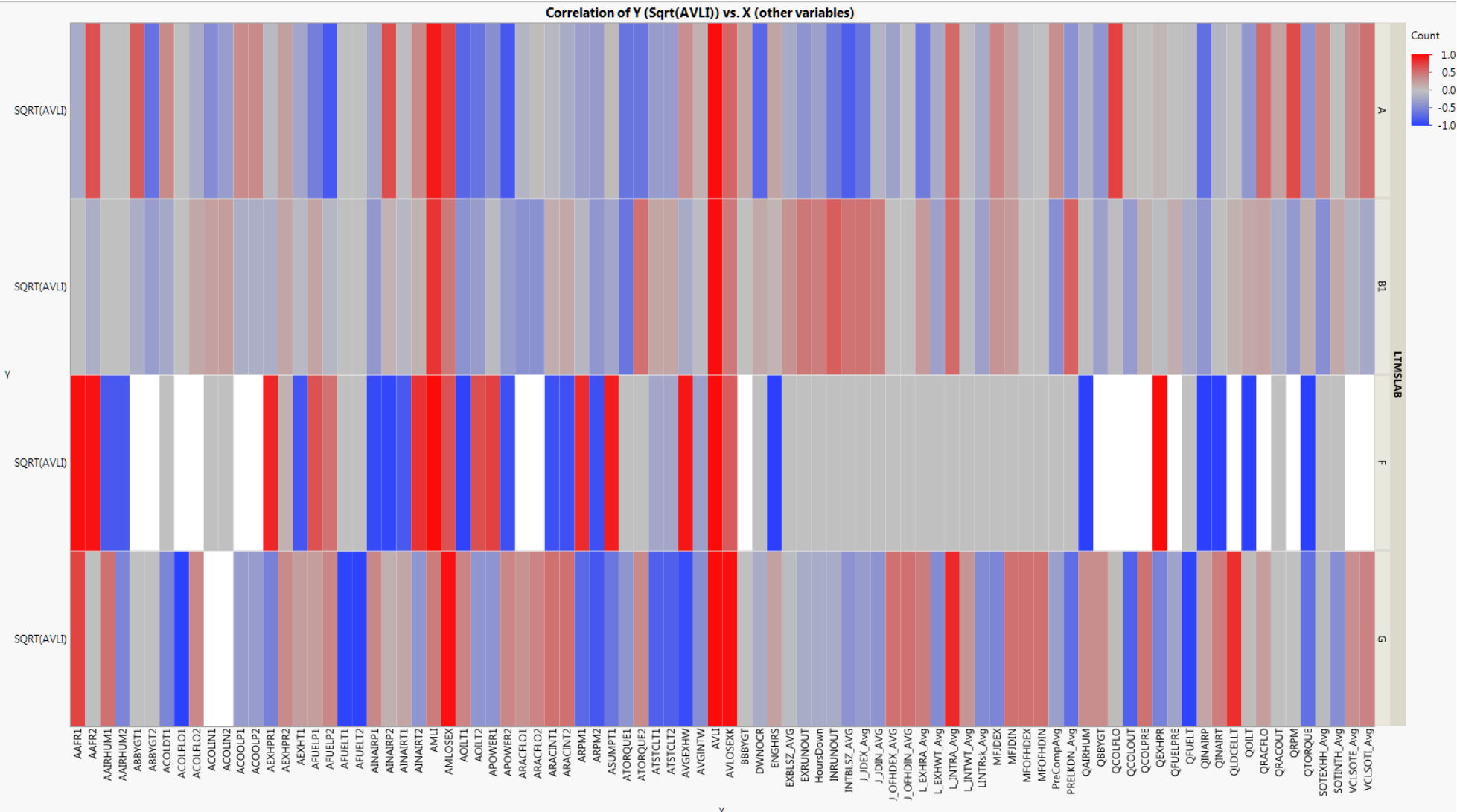
# Operational Analysis with Partial Least Squares

- Excluding lab-Stand & oil factors, the top 20 variables identified in the PLS analysis of the Sqrt(AVLI) are summarized below:

|    | Top 20 Factors | Variable Description                    |
|----|----------------|---|
| 1  | INRUNOUT       | Intake Camshaft Runout                  |
| 2  | L_INTRA_Avg    | Lobe Intake Surface Finish Average Ra   |
| 3  | EXRUNOUT       | Exhaust Camshaft Runout                 |
| 4  | DWNOCR         | Number of Downtime Occurrences          |
| 5  | ARPM2          | Average RPM - Phase 2                   |
| 6  | AAFR2          | Avg Air/Fuel Ratio Phase 2              |
| 7  | J_JDIN_AVG     | Journal to Journal Dia Intake Avg       |
| 8  | QOILT          | EOT QI Oil Gallery Temp                 |
| 9  | PreCompAvg     | Average Cyl Compression PreTest         |
| 10 | EXBLSZ_AVG     | Exhaust Lifter Bucket Size Average      |
| 11 | J_JDEX_Avg     | Journal to Journal Dia Exhaust Avg      |
| 12 | ATORQUE1       | Average Torque Phase 1                  |
| 13 | ACOOLP2        | Average Engine Coolant Pressure Stage 2 |
| 14 | ACOOLP1        | Average Engine Coolant Pressure Stage 1 |
| 15 | AFUELP2        | Average Fuel Pressure Phase 2           |
| 16 | SOTINTH_Avg    | Start of Test Heel to Toe Intake Avg    |
| 17 | MFJDEX         | Main Feed Oil Hole Dia, Exhaust Cam     |
| 18 | AINAIRT2       | Avg Intake Air Temp Phase 2             |
| 19 | QAIRHUM        | EOT QI Intake Air Humidity              |
| 20 | INTBLSZ_AVG    | Avg Intake Bucket Lifter Size           |

# Operational Analysis with Partial Least Squares

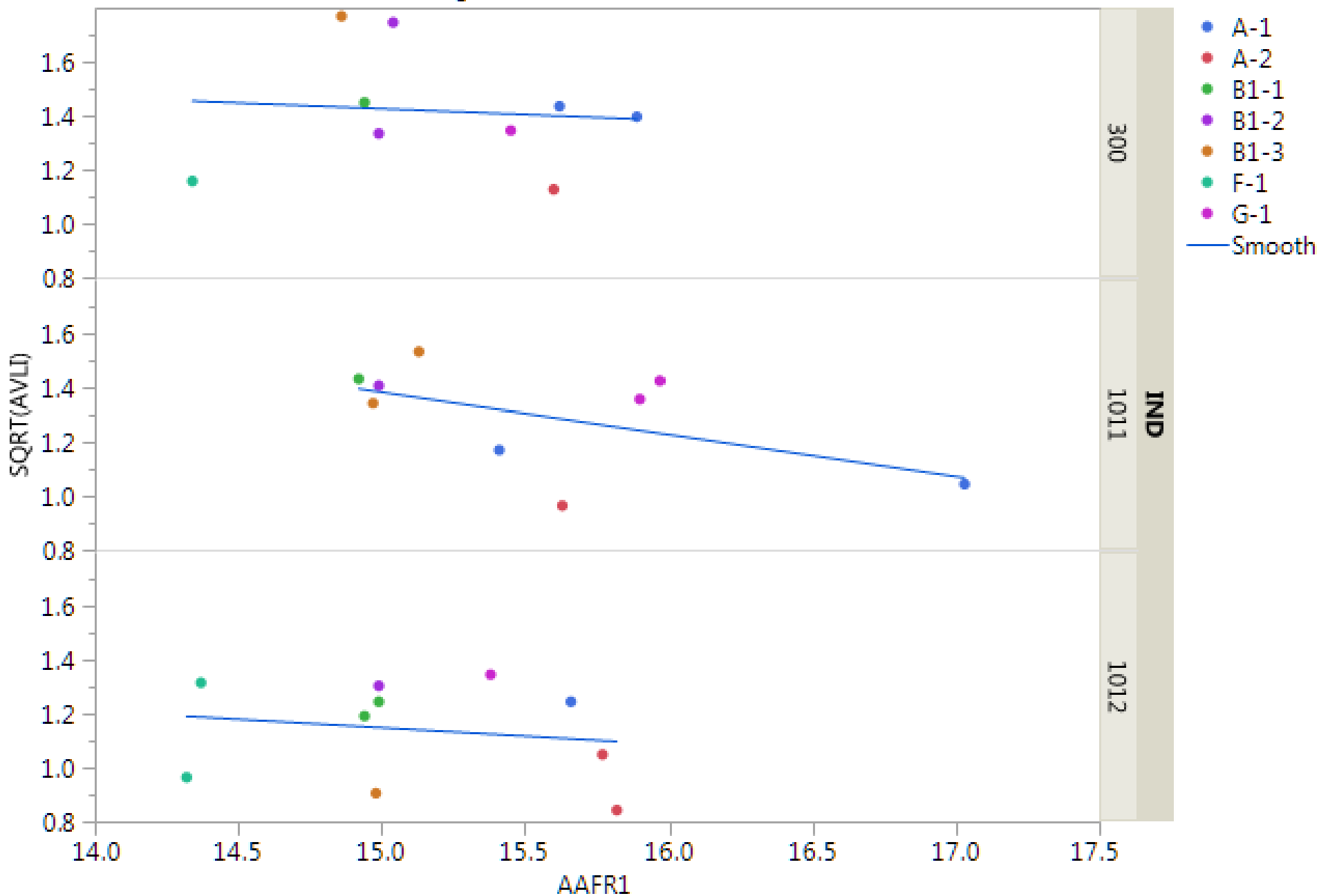
- A color heat map of the correlations between the Sqrt(AVLI) and the other remaining variables are summarized below - by test lab:



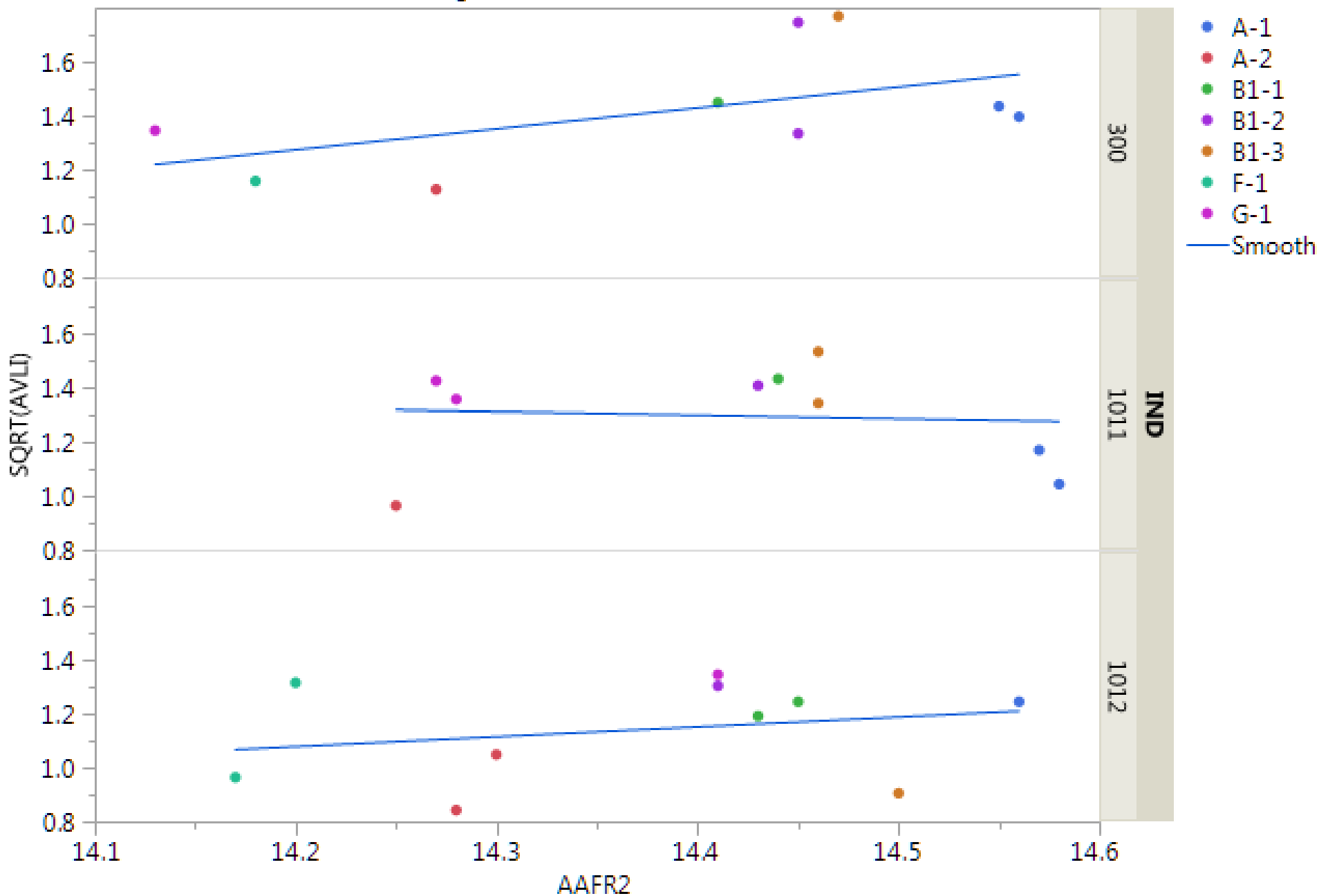
# Operational Analysis with Partial Least Squares

- Plots of all variables included in the analysis are provided in the following slides.

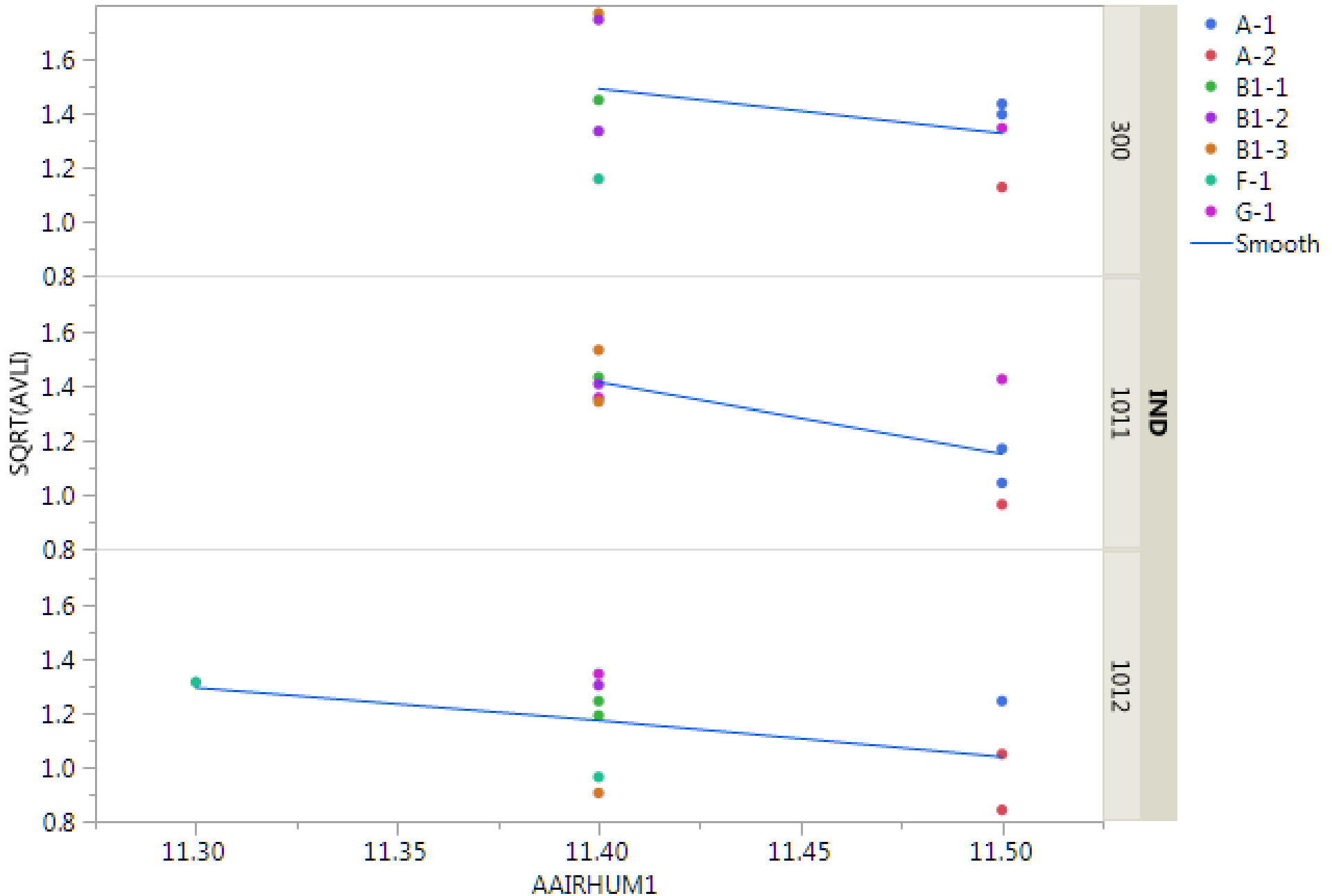
SQRT(AVLI) vs. AAFR1



SQRT(AVLI) vs. AAFR2

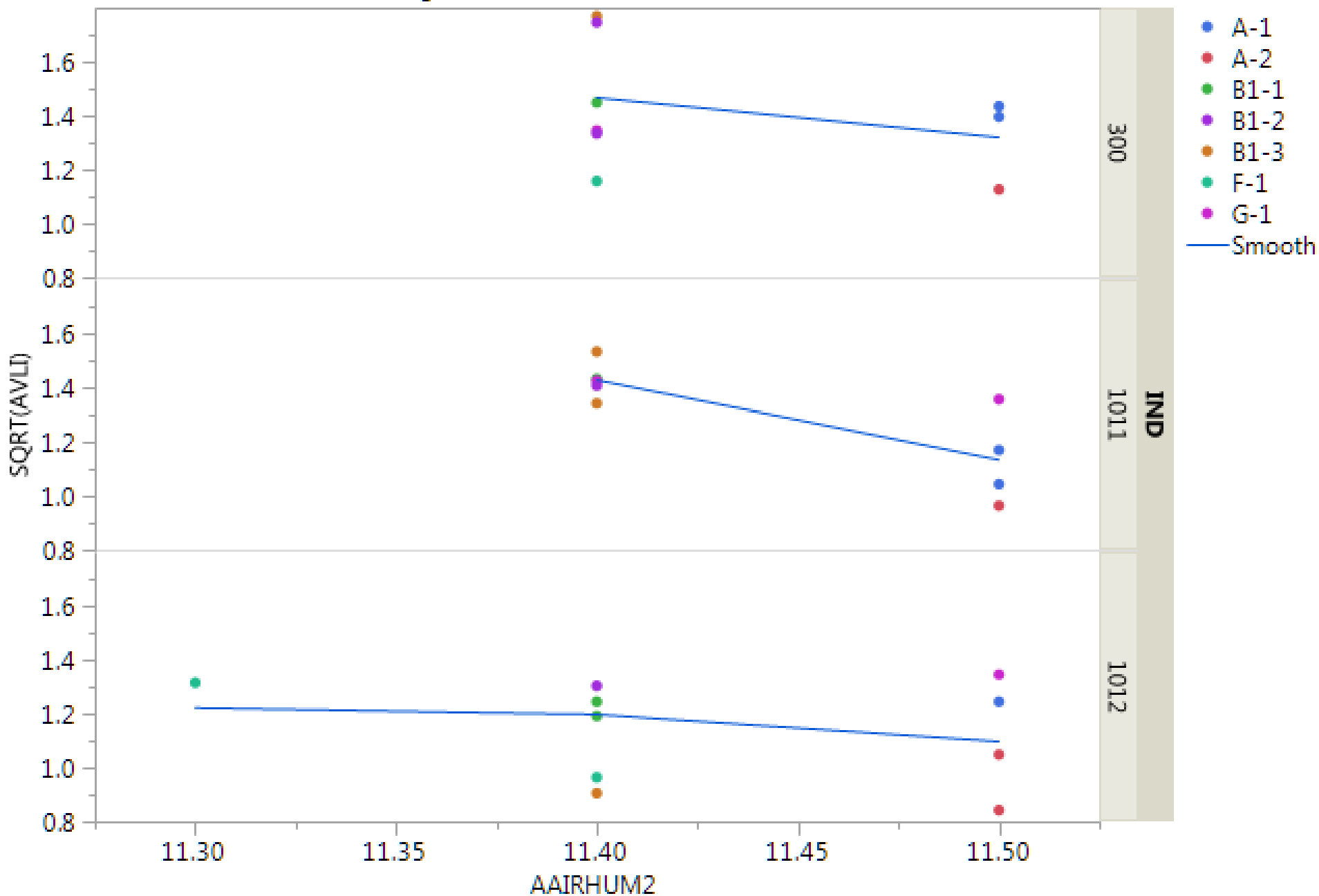


SQRT(AVLI) vs. AAIRHUM1

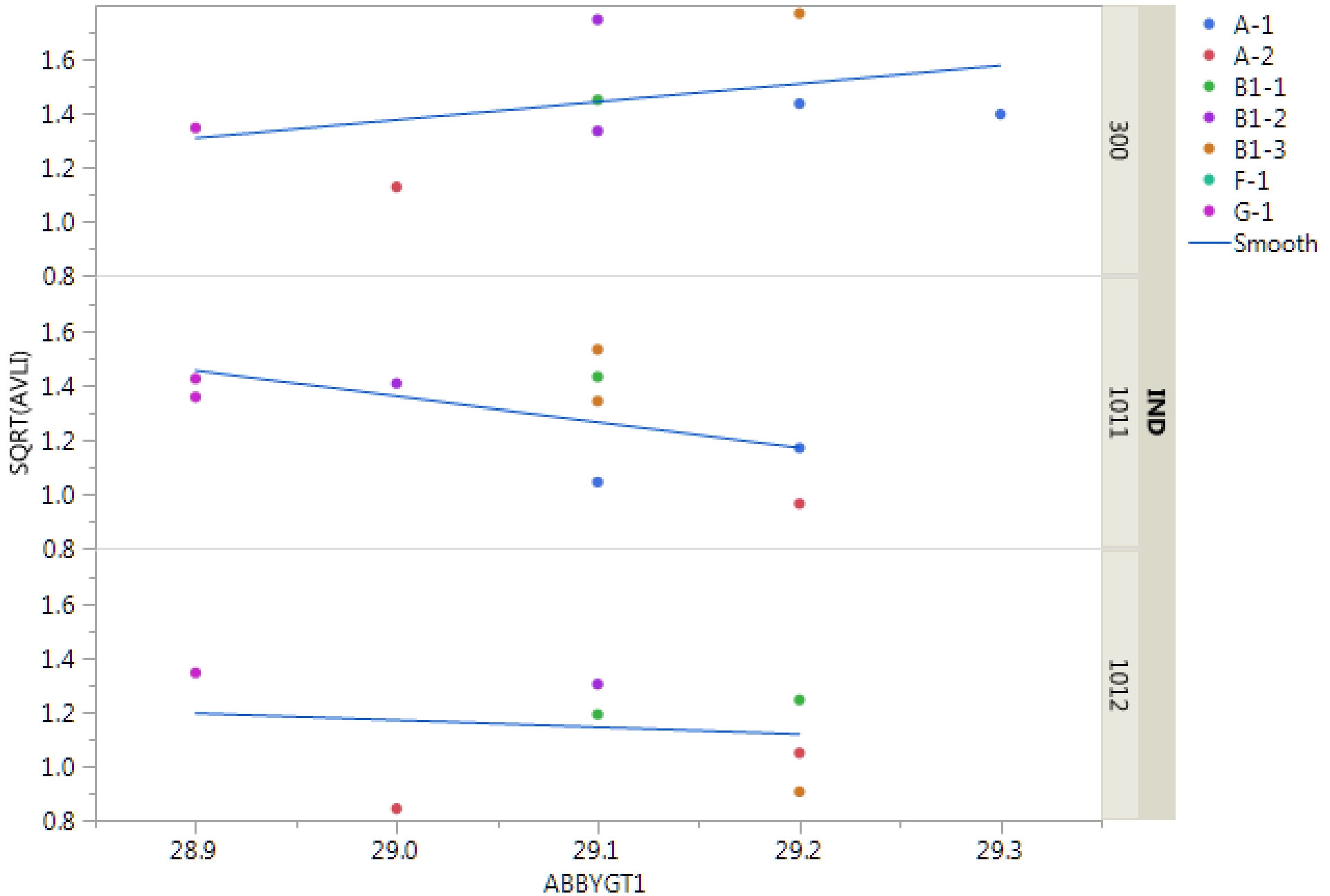




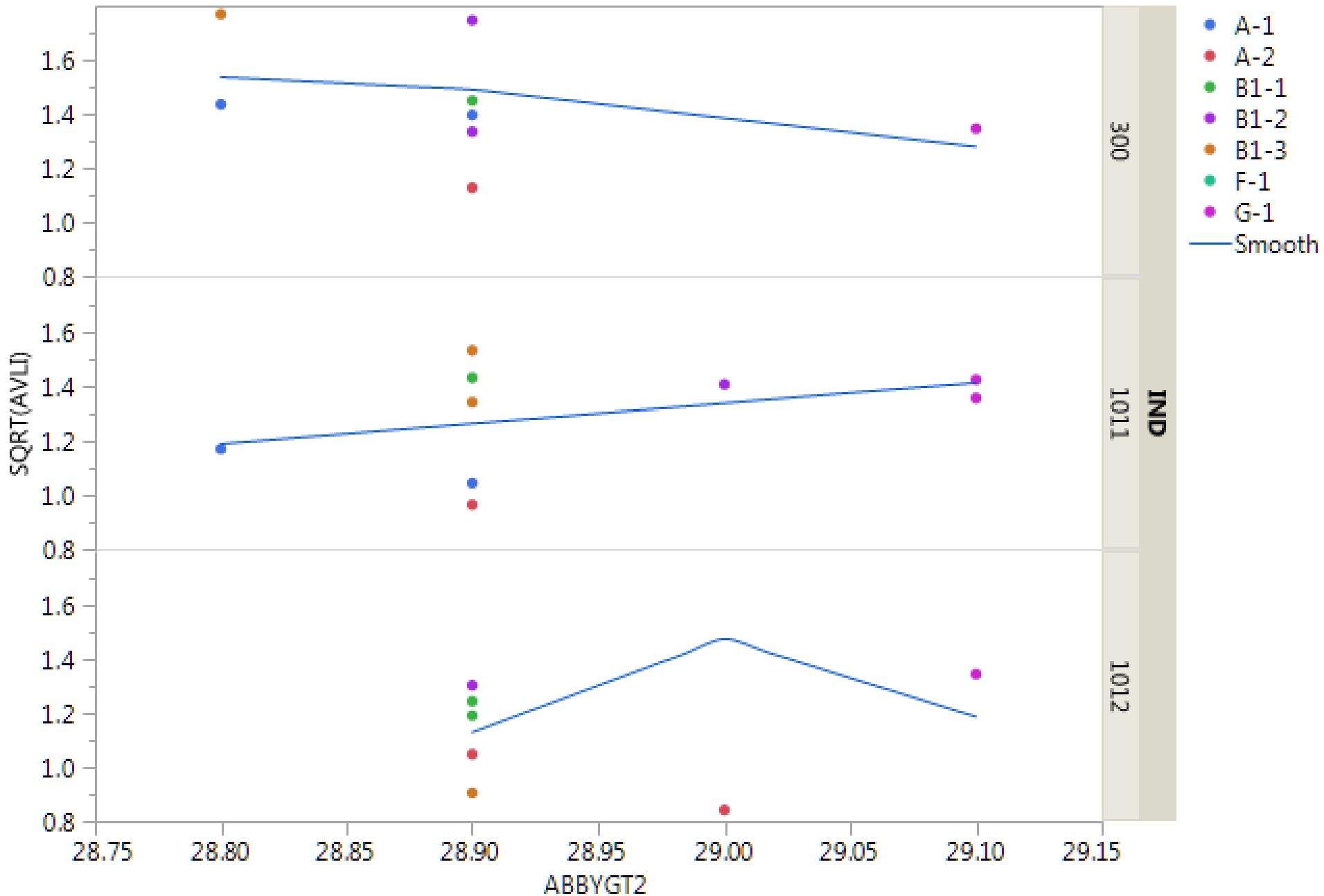
### SQRT(AVLI) vs. AAIRHUM2



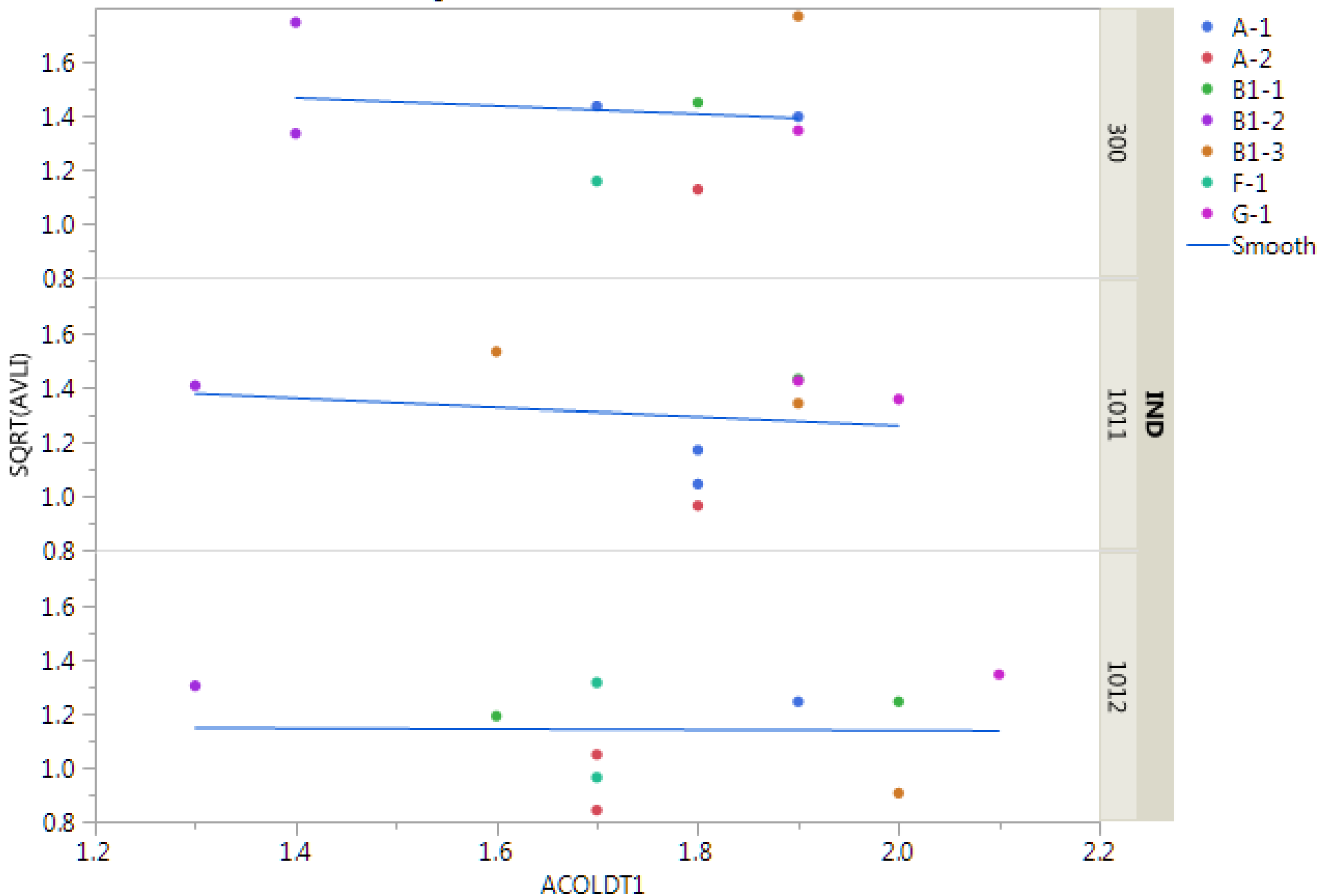
SQRT(AVLI) vs. ABBYGT1



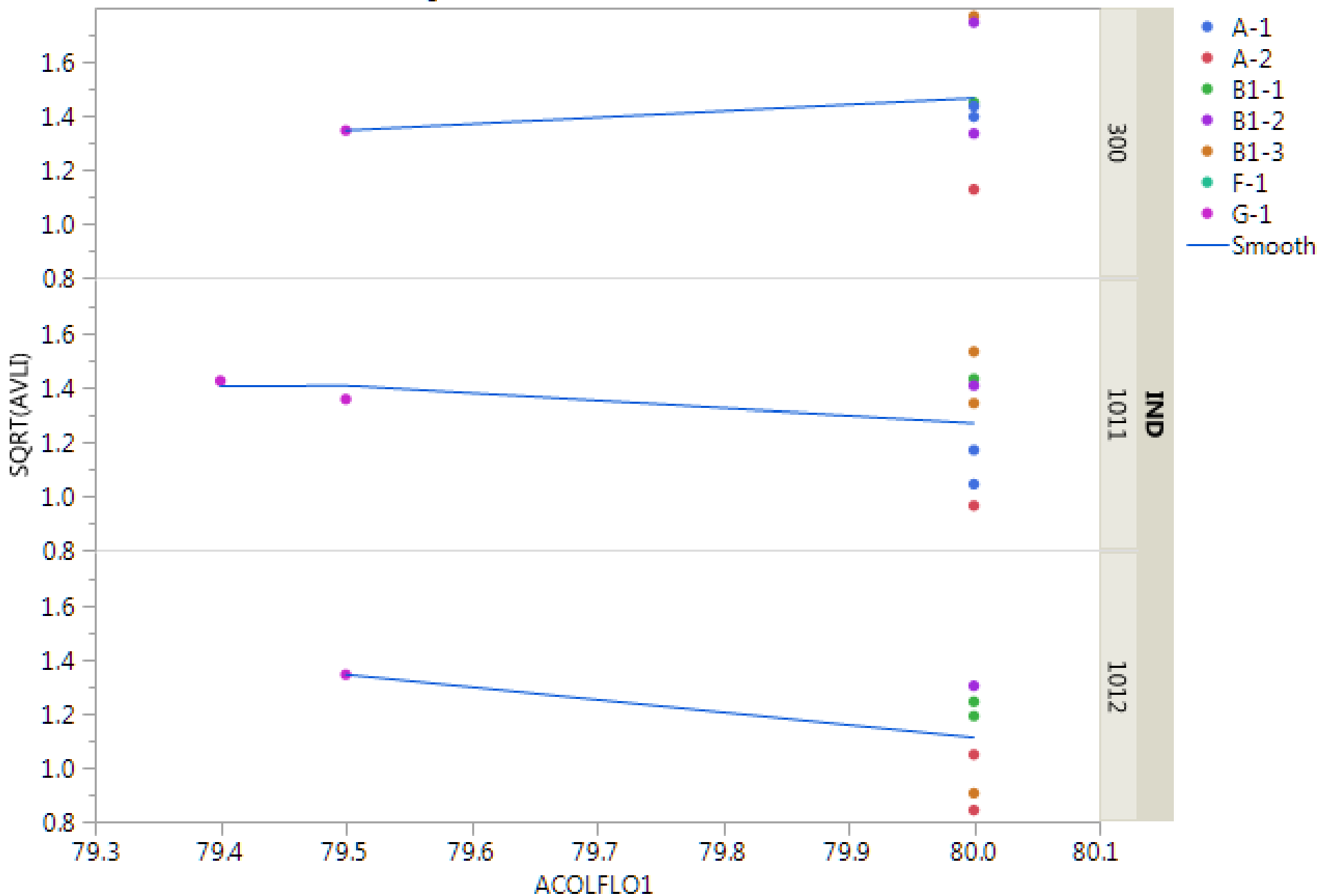
SQRT(AVLI) vs. ABBYGT2



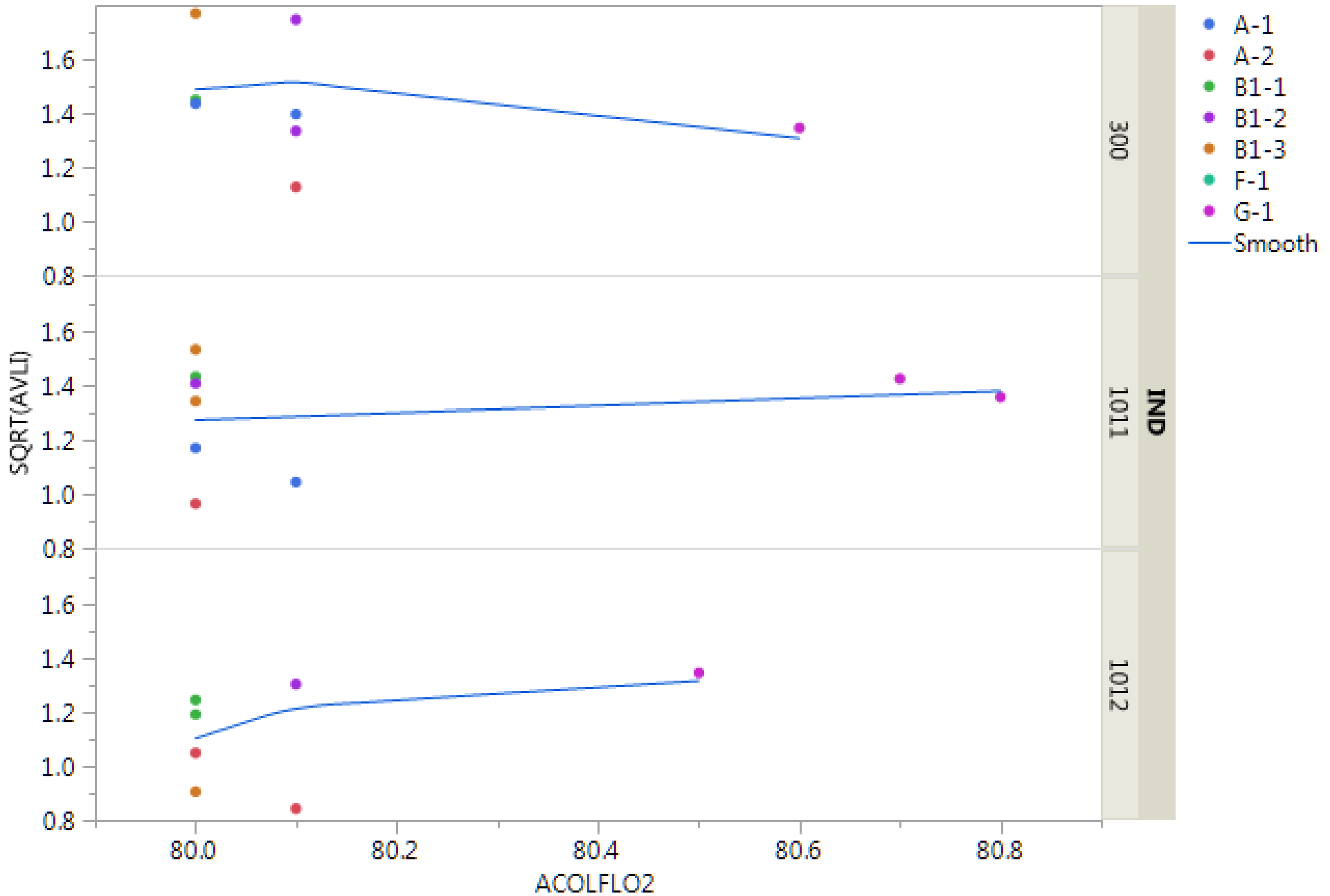
### SQRT(AVLI) vs. ACOLDT1



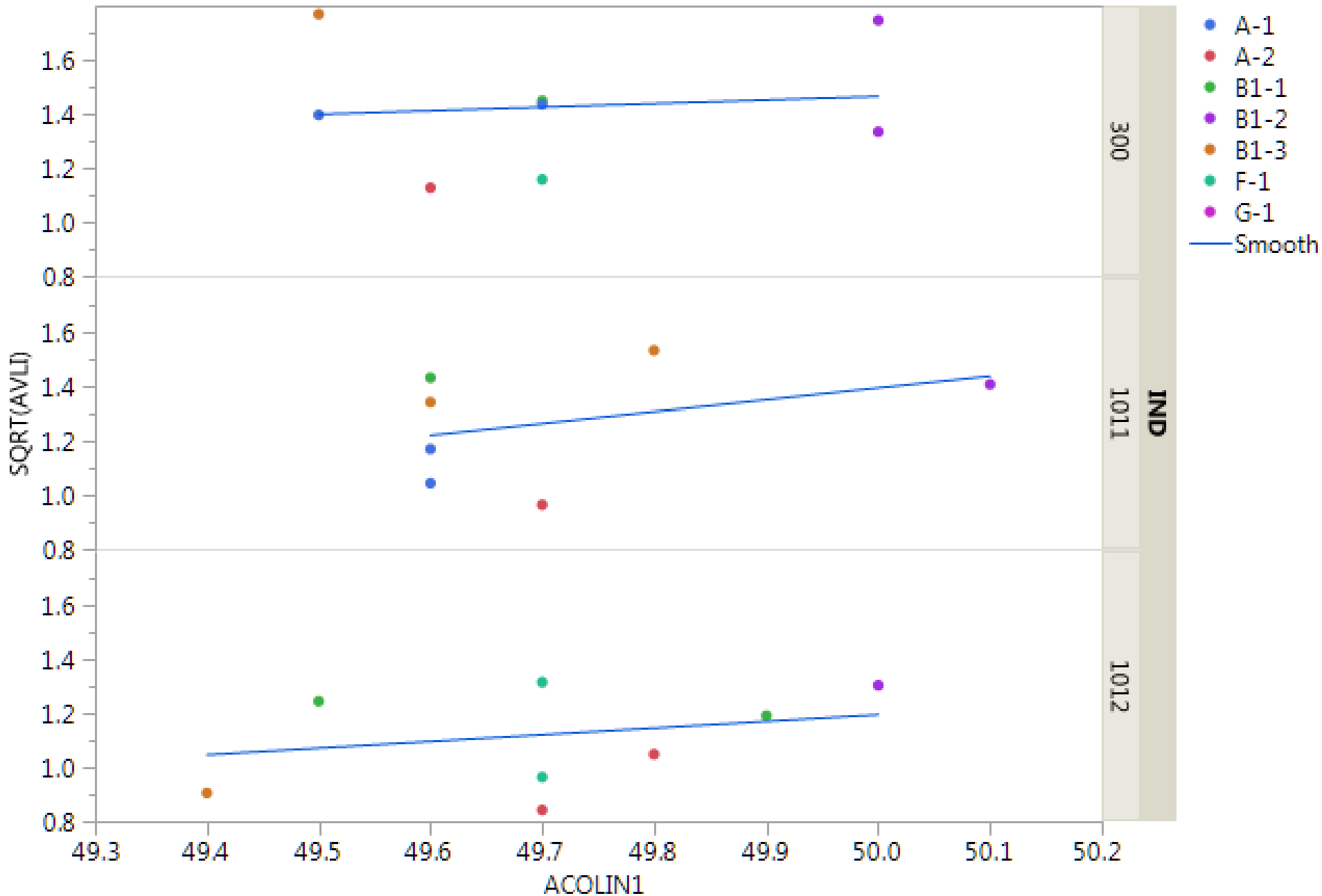
### SQRT(AVLI) vs. ACOLFLO1



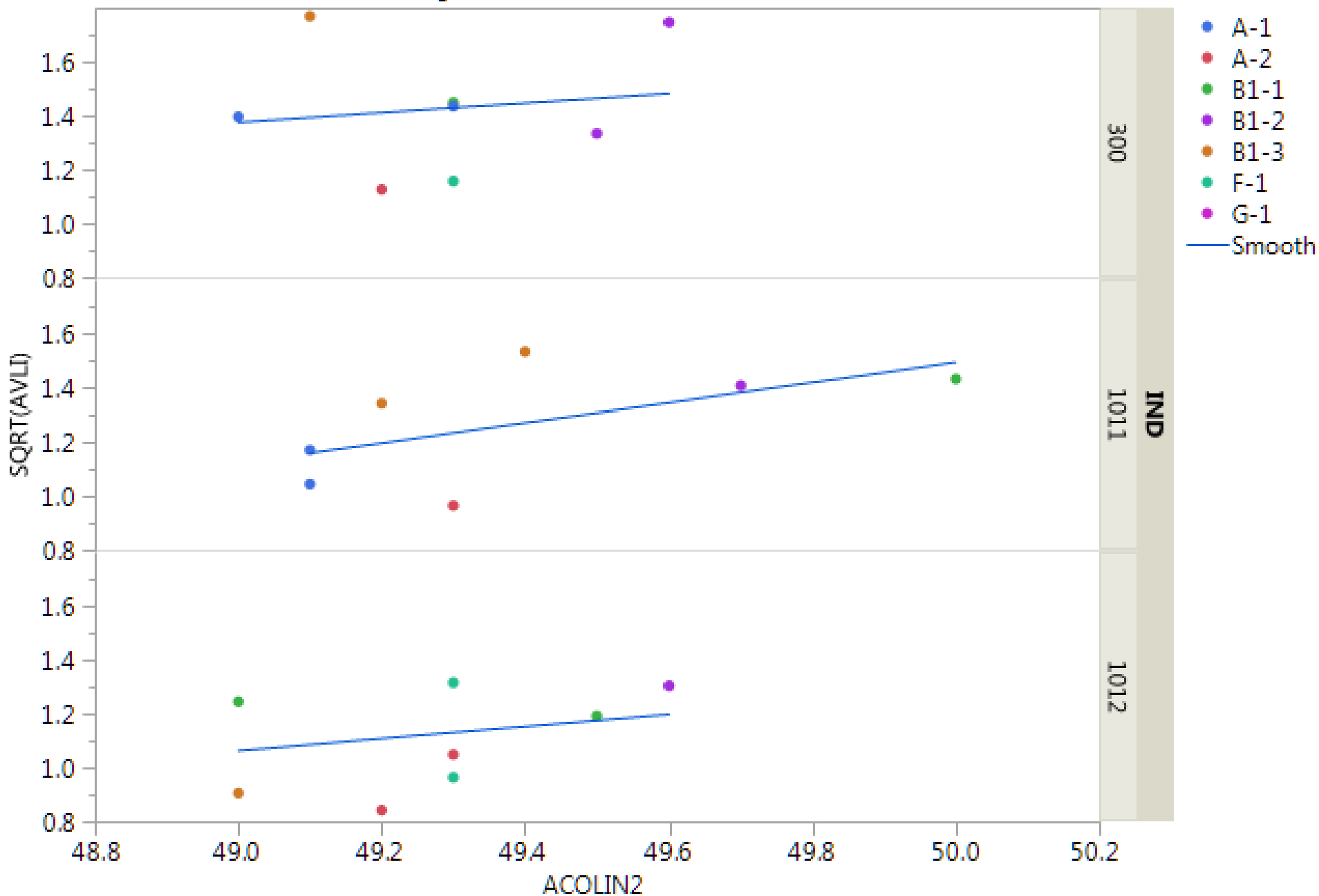
SQRT(AVLI) vs. ACOFLO2



SQRT(AVLI) vs. ACOLIN1

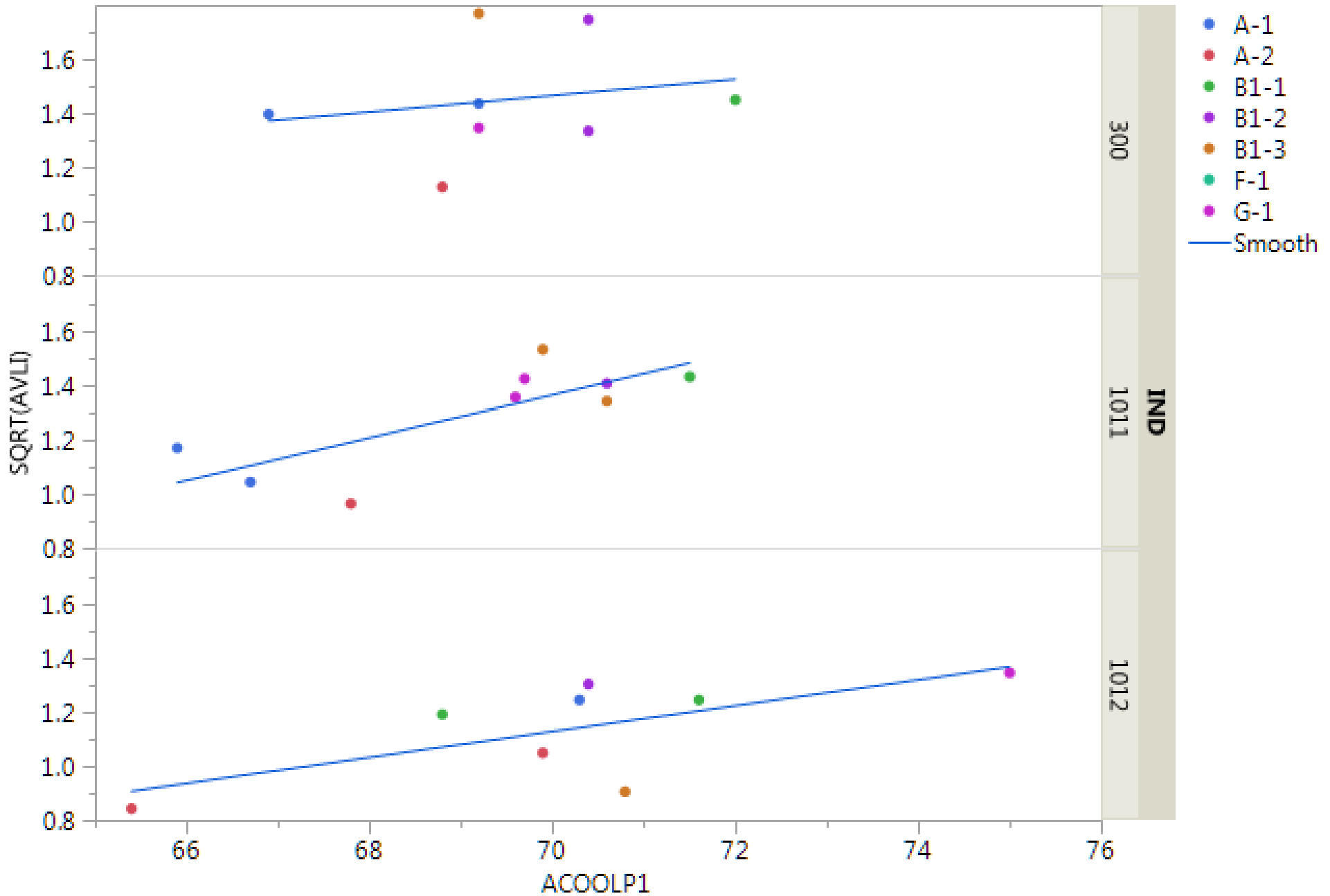


### SQRT(AVLI) vs. ACOLIN2

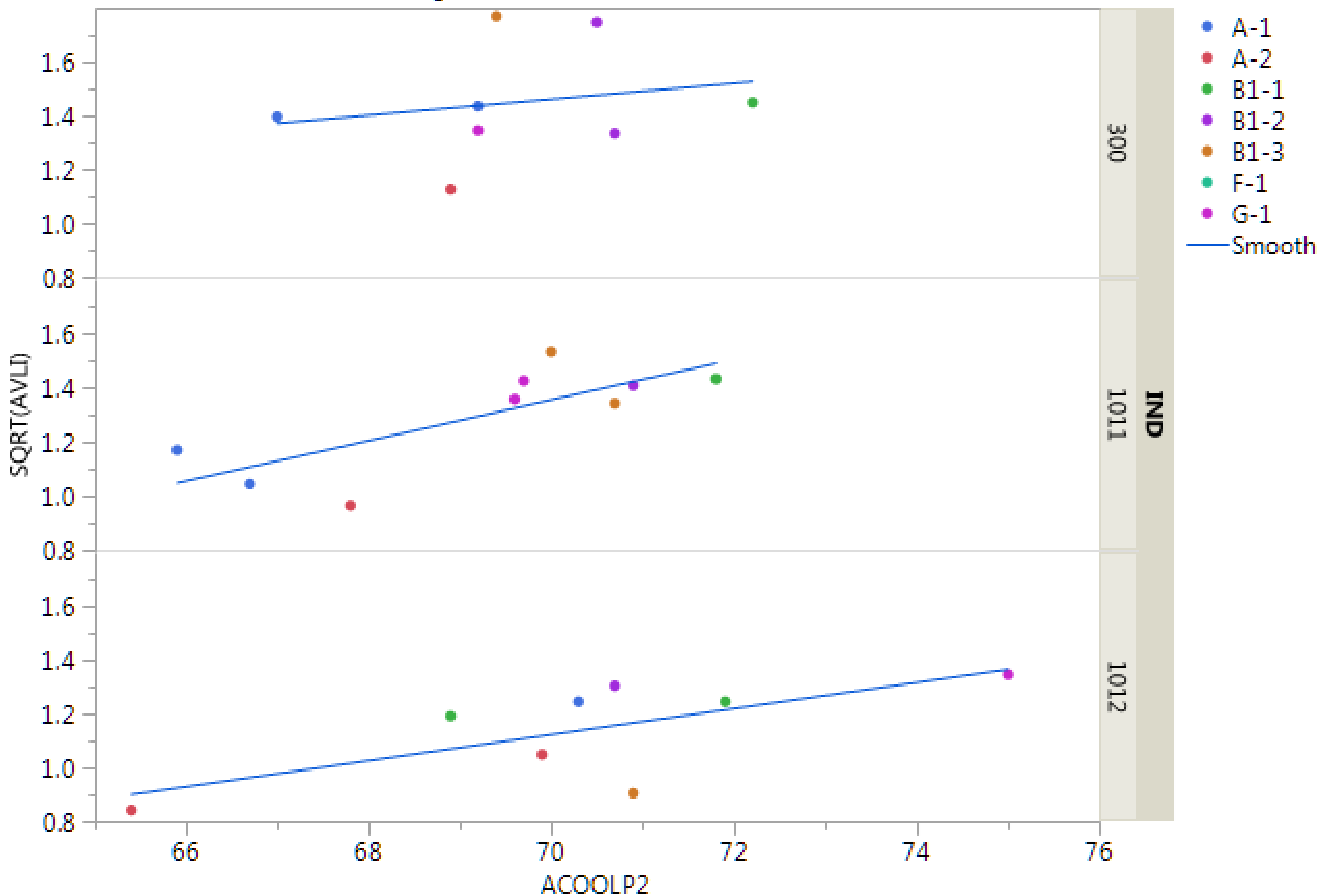




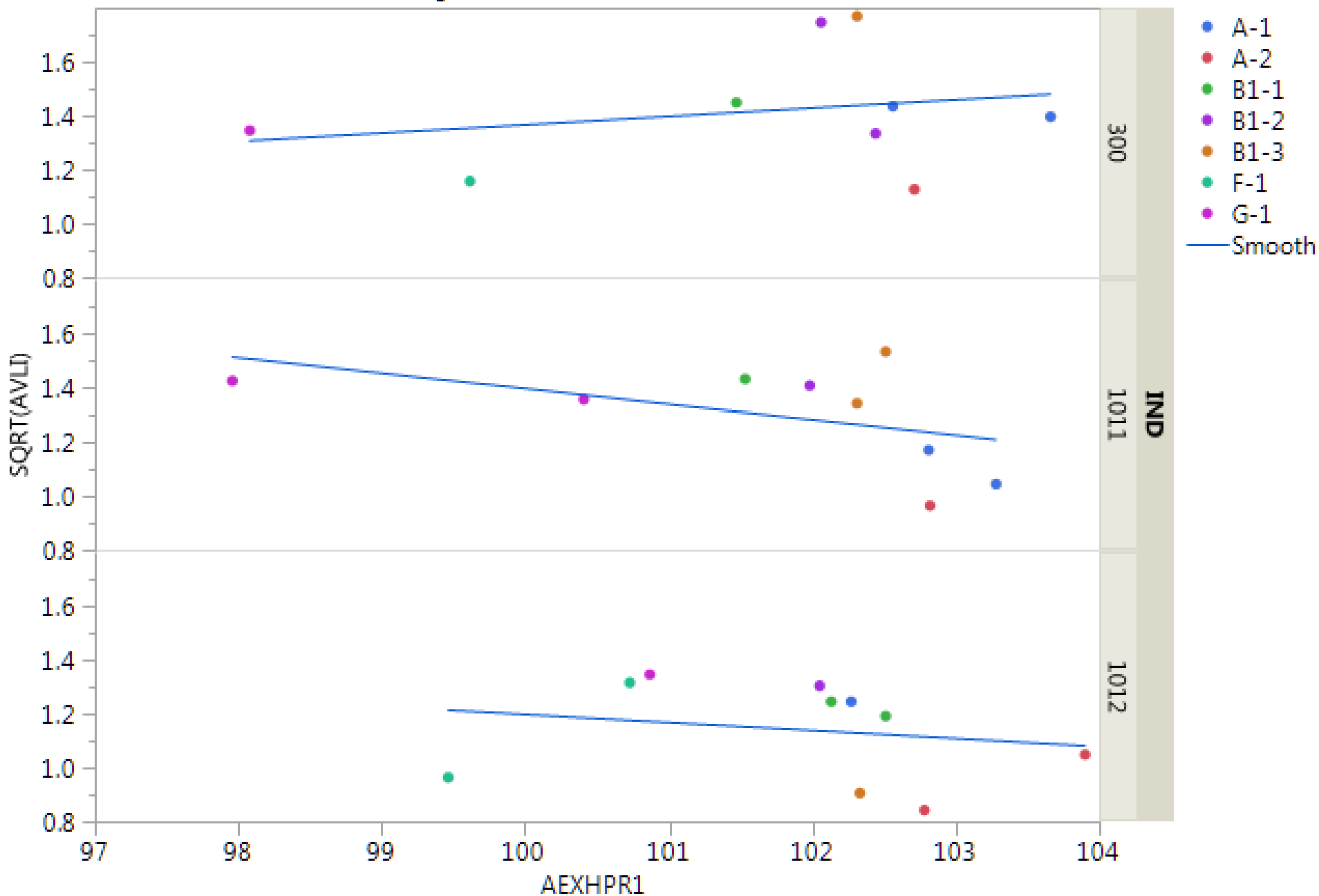
SQRT(AVLI) vs. ACOOLP1



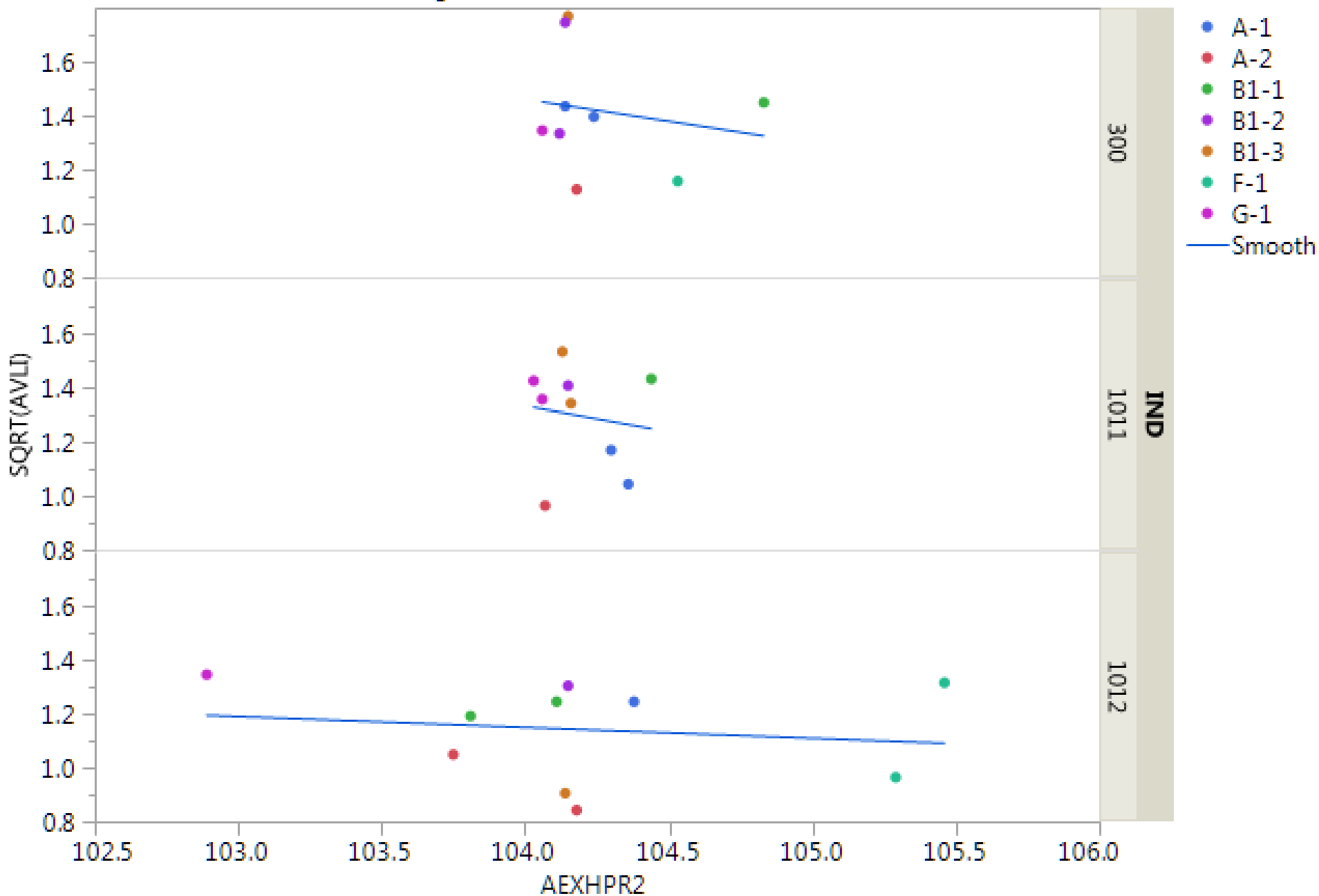
### SQRT(AVLI) vs. ACOOLP2



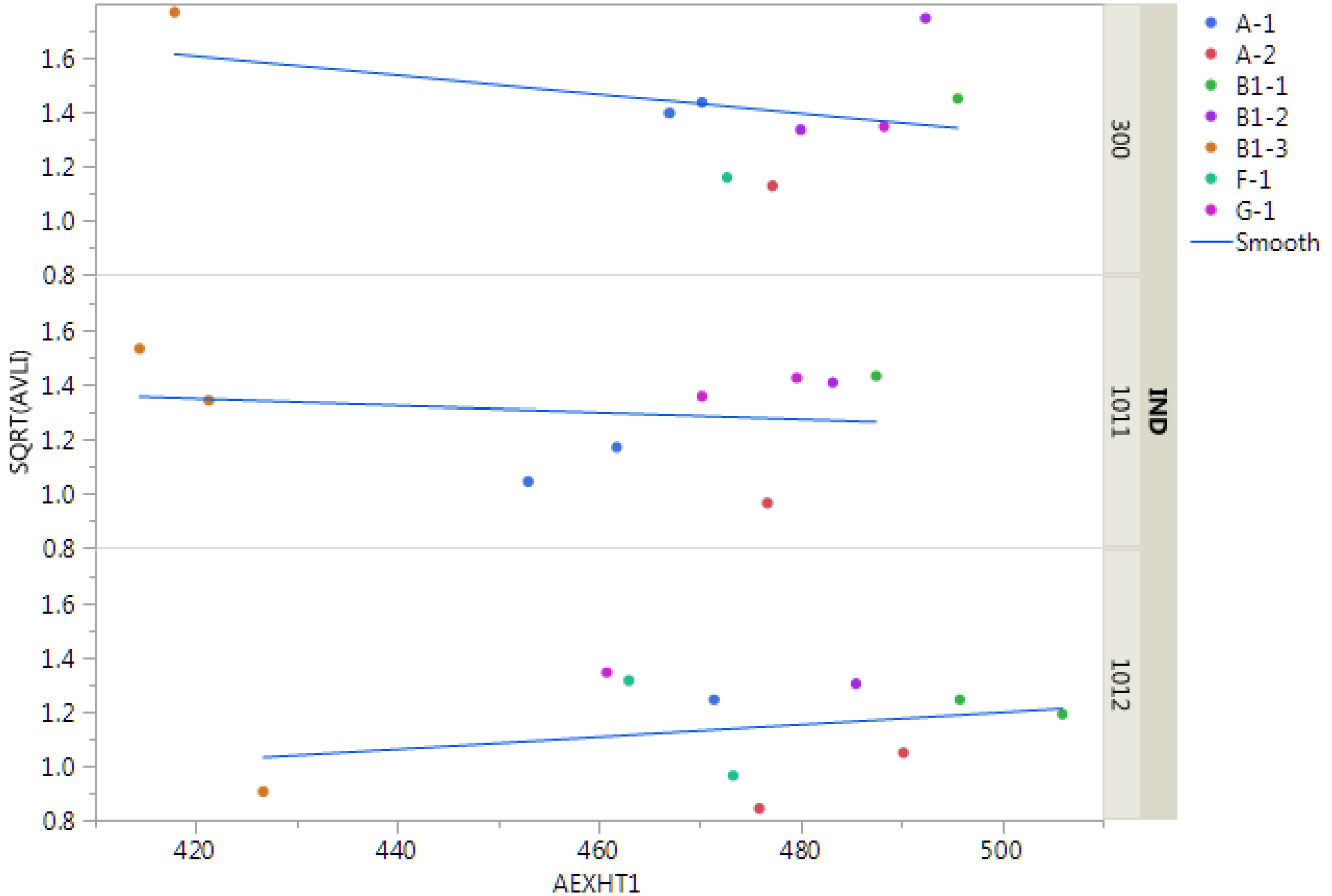
SQRT(AVLI) vs. AEXHPR1



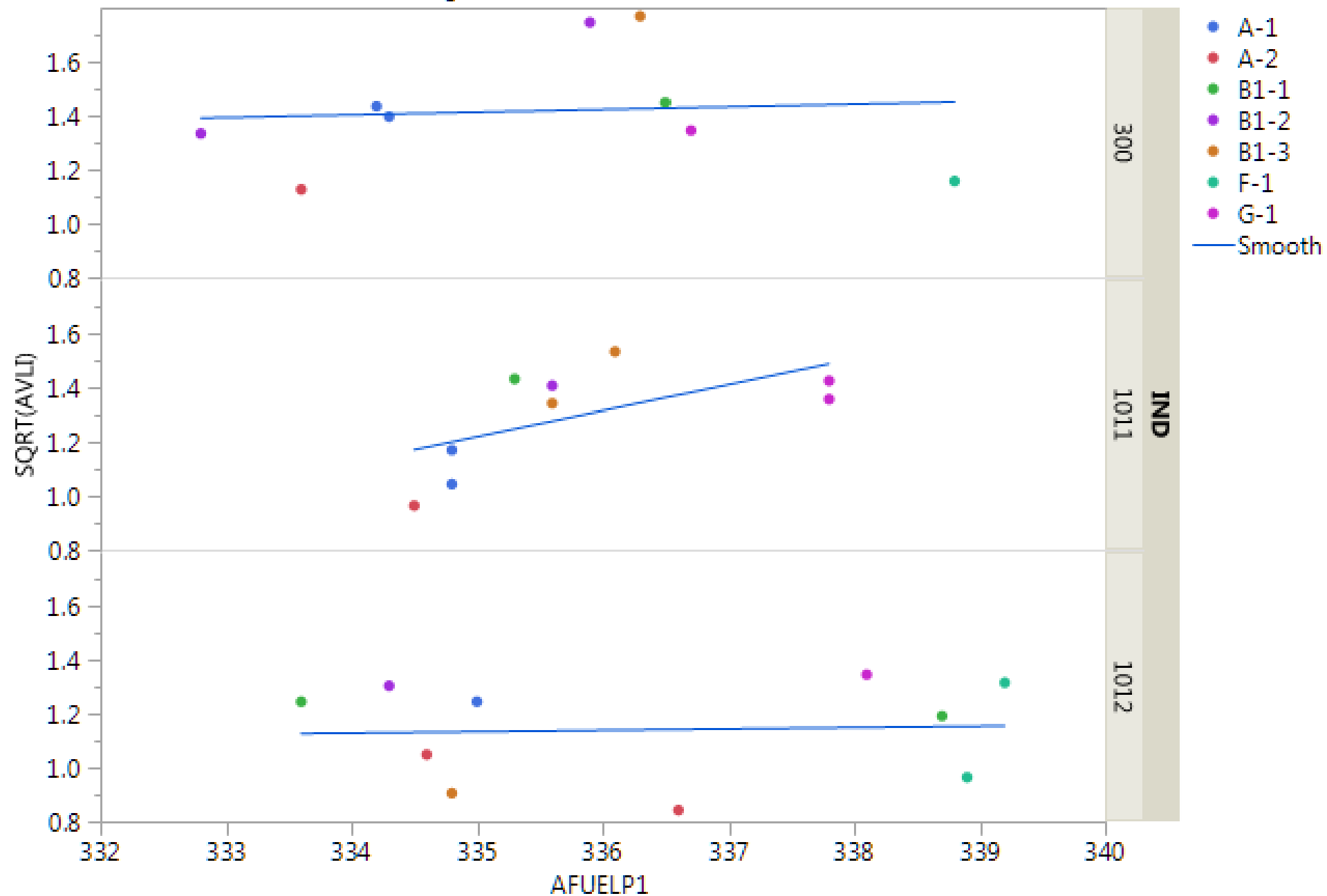
SQRT(AVLI) vs. AEXHPR2



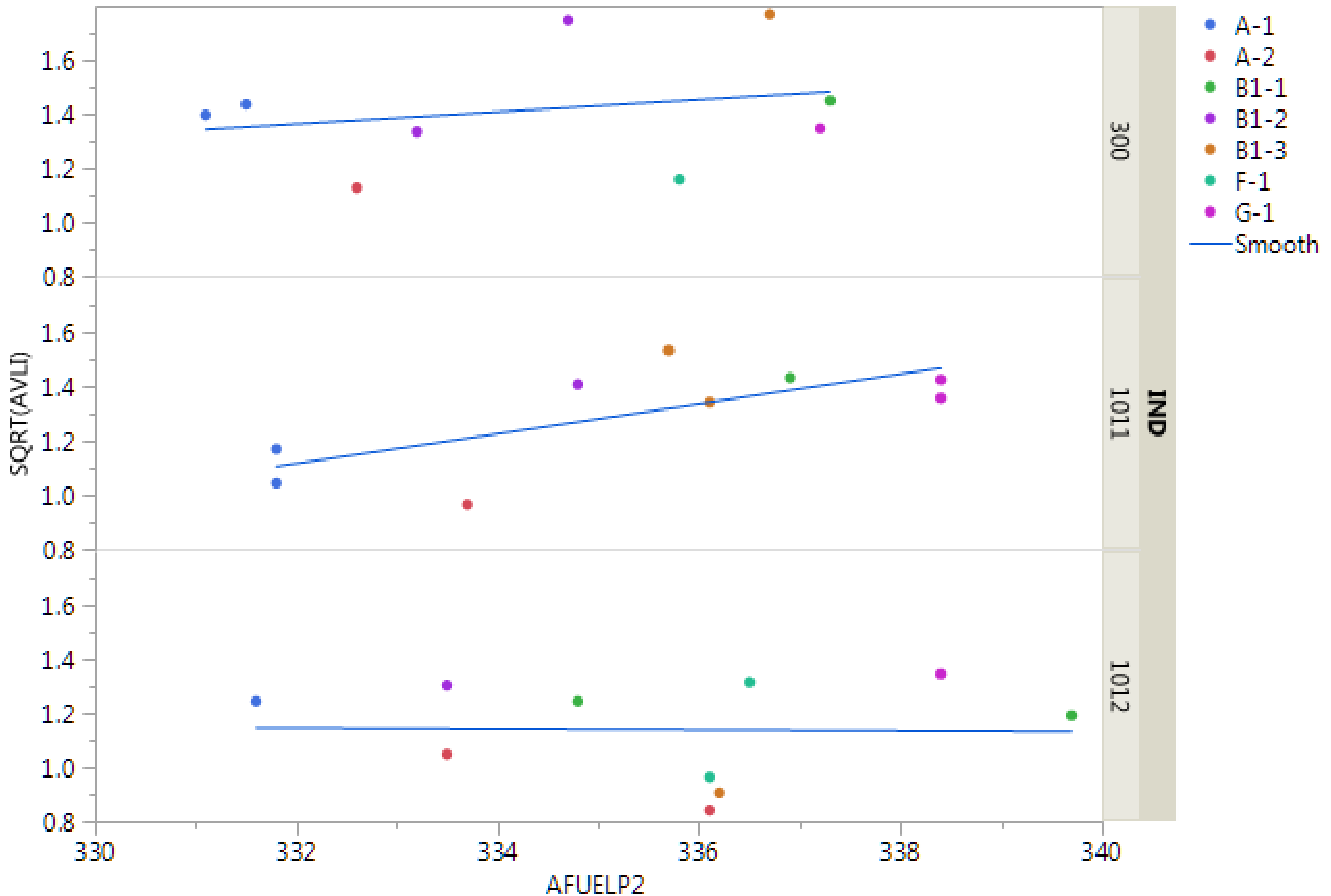
### SQRT(AVLI) vs. AEXHT1



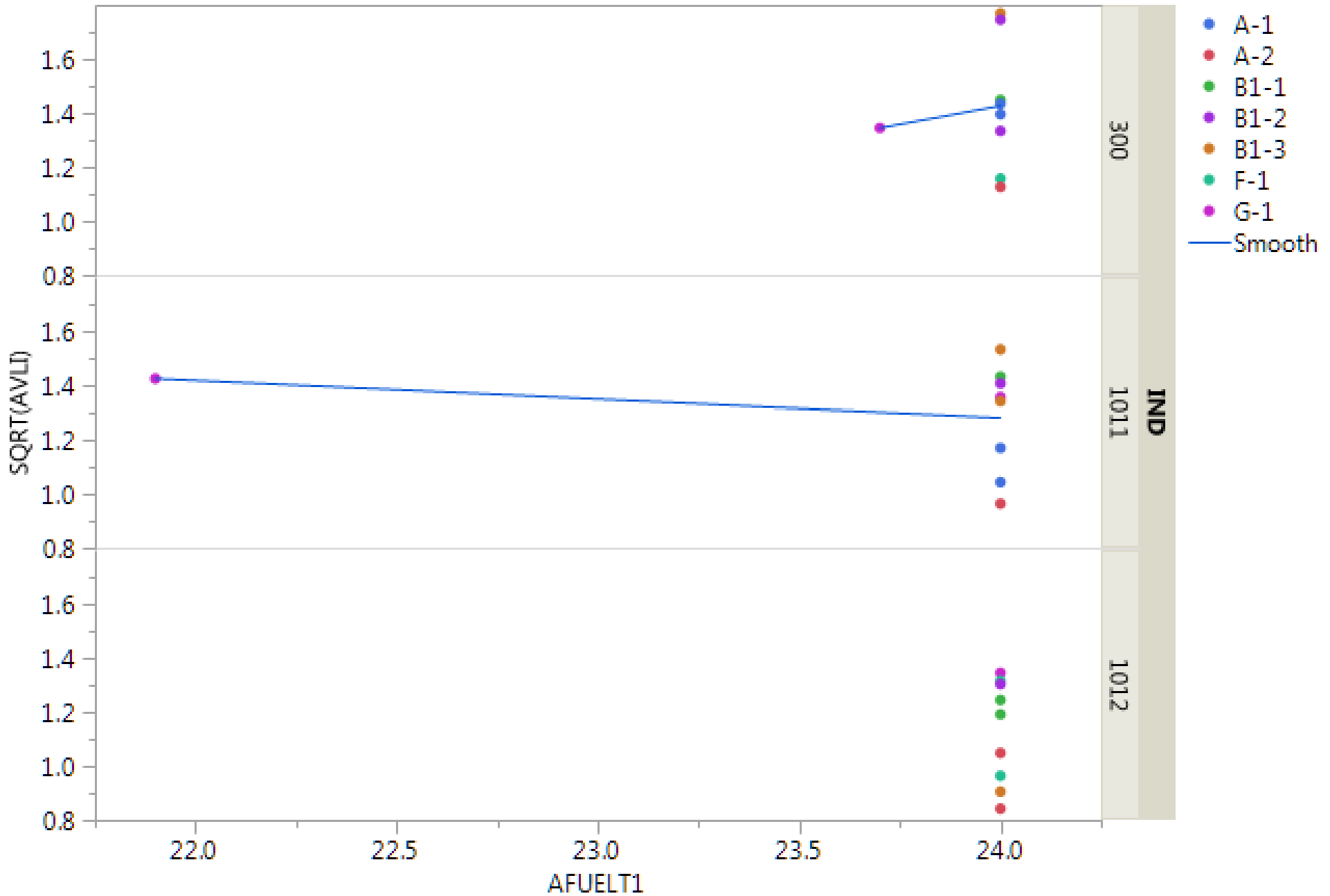
SQRT(AVLI) vs. AFUELP1



### SQRT(AVLI) vs. AFUELP2

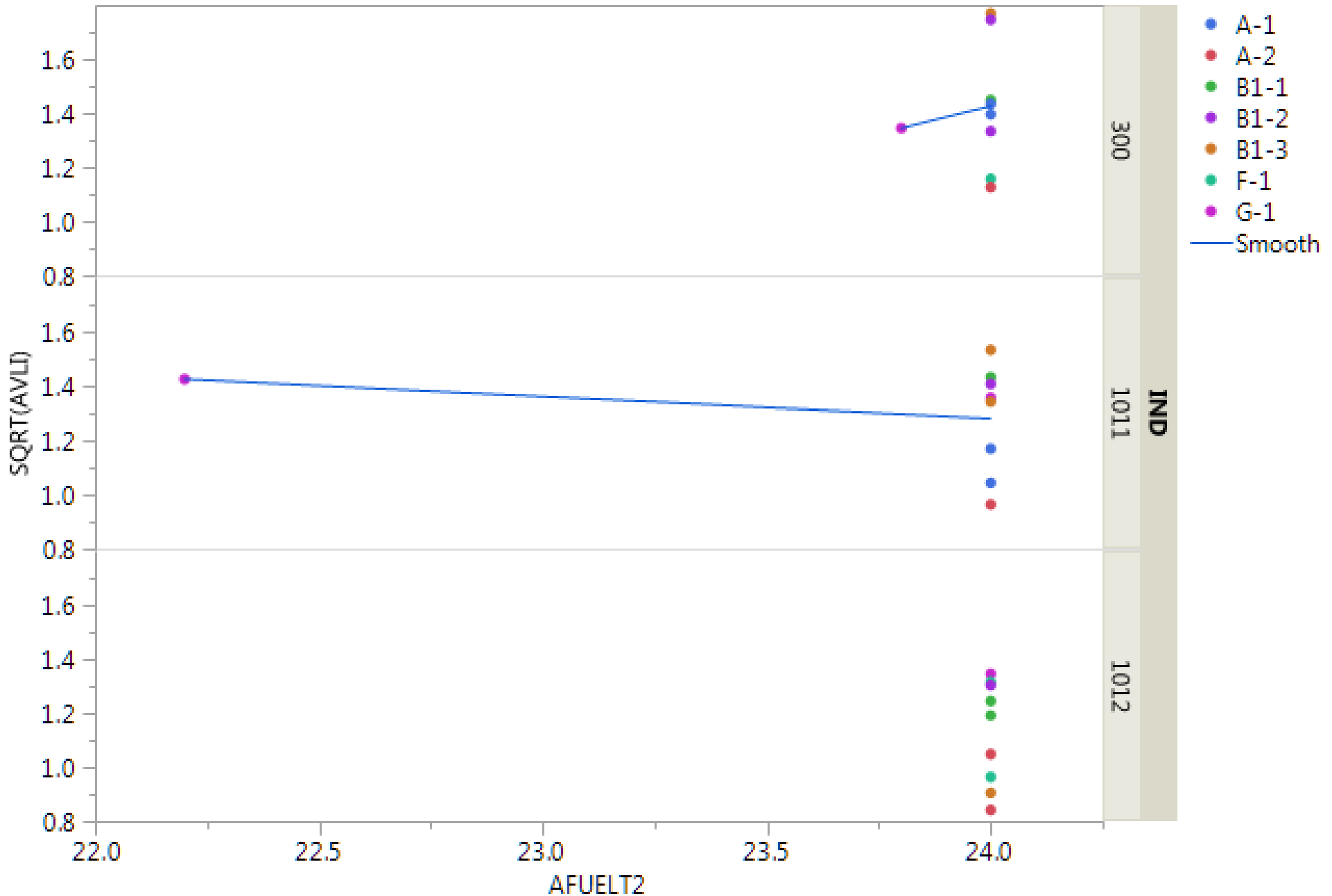


### SQRT(AVLI) vs. AFUELT1

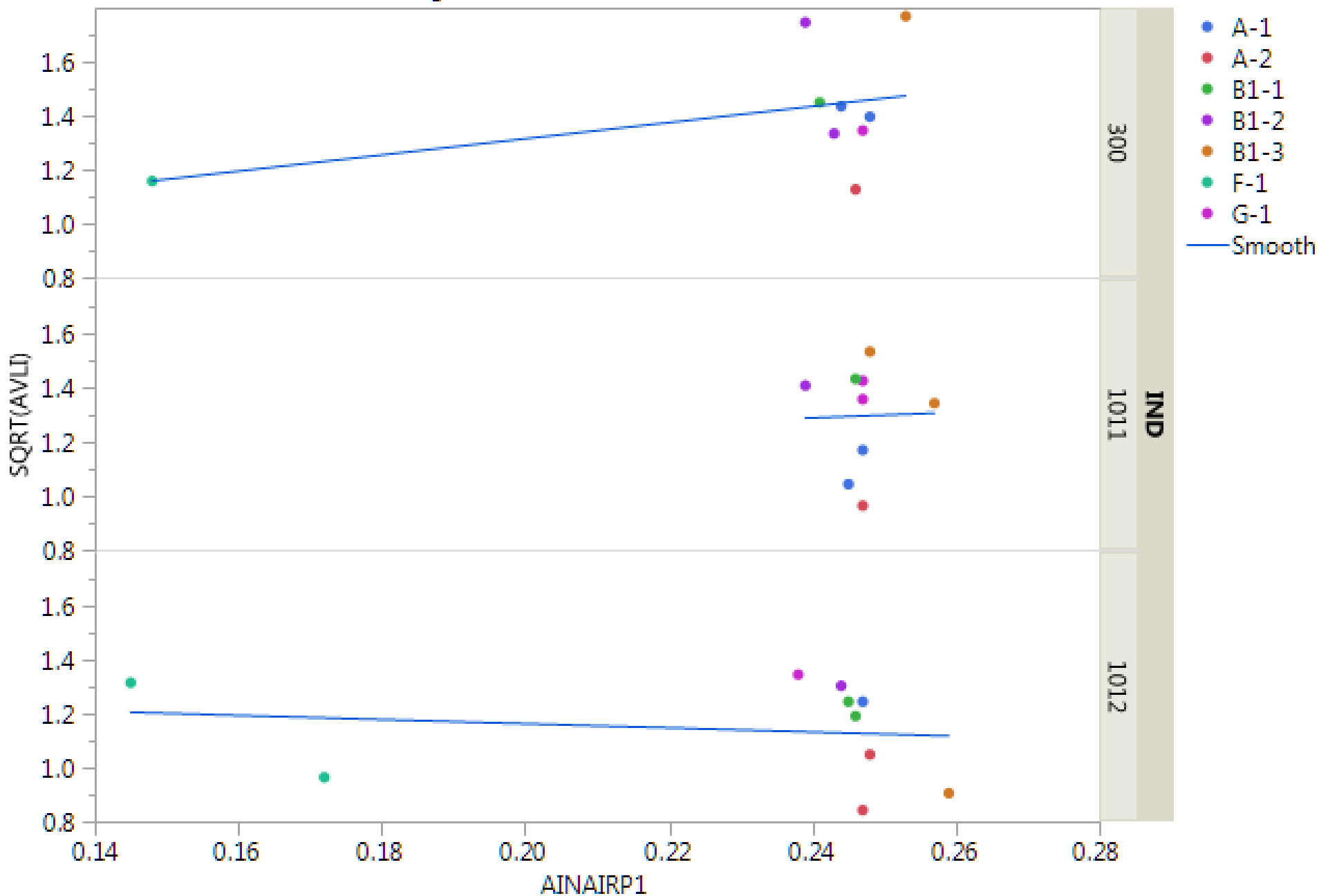




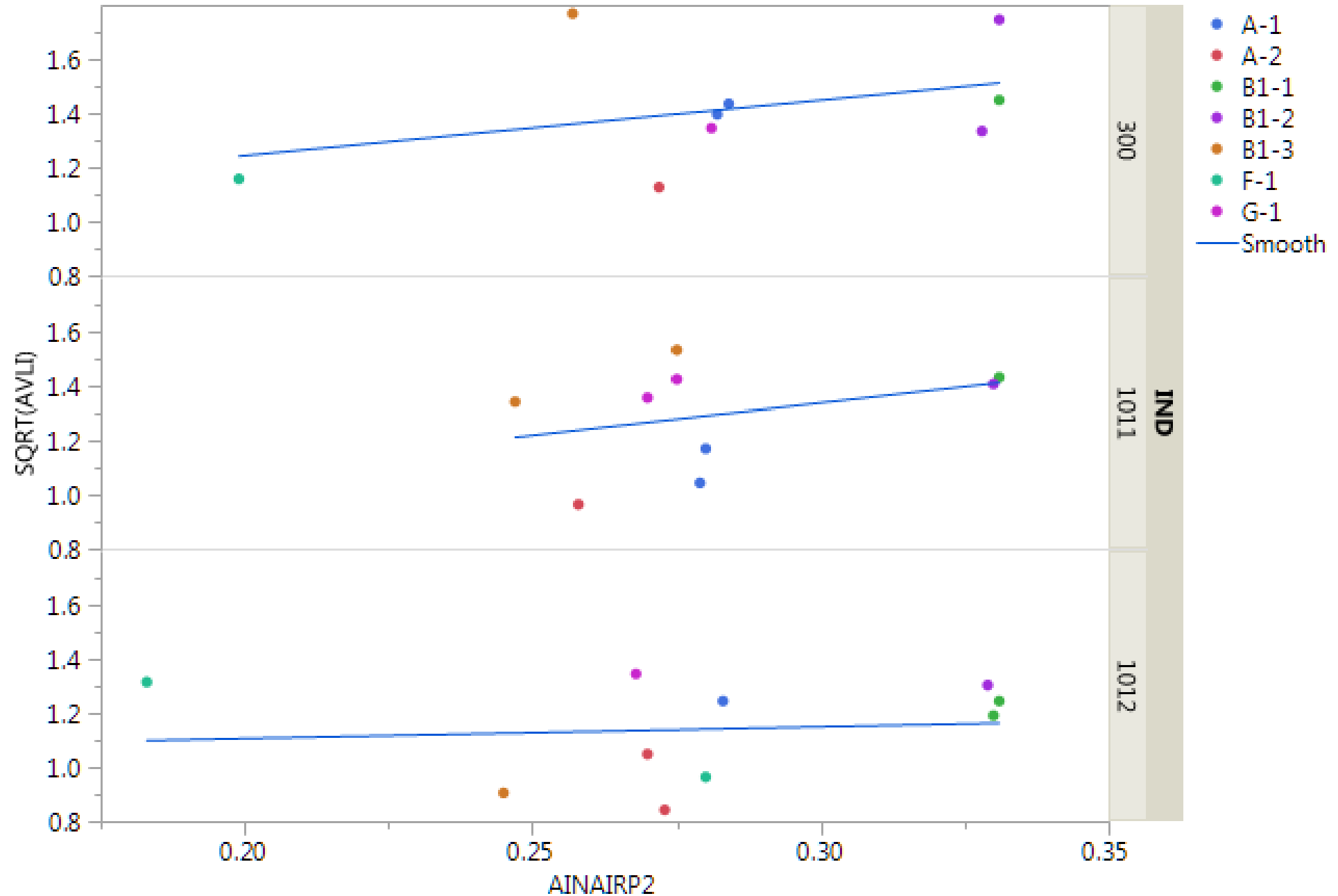
### SQRT(AVLI) vs. AFUFLT2



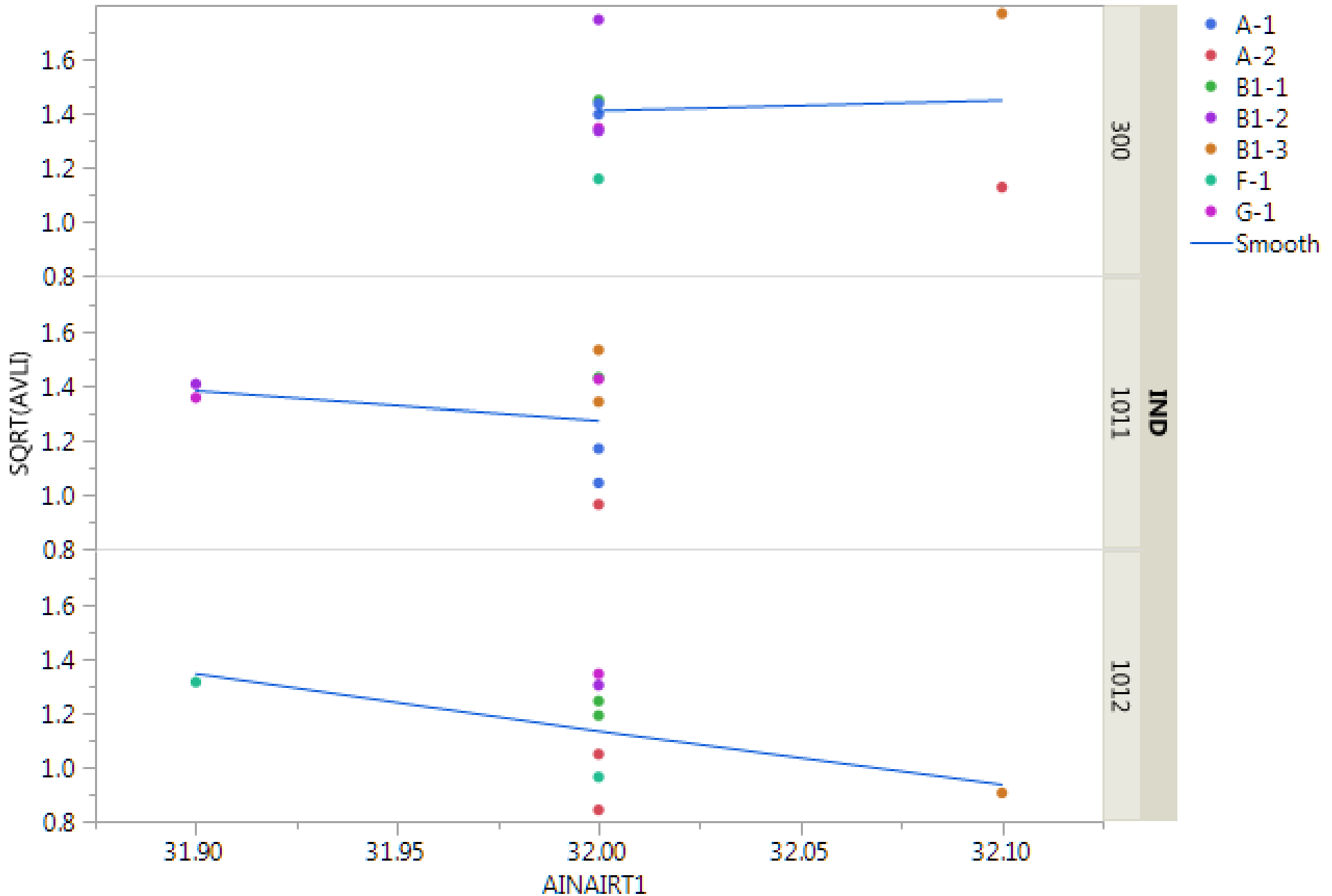
### SQRT(AVLI) vs. AINAIRP1



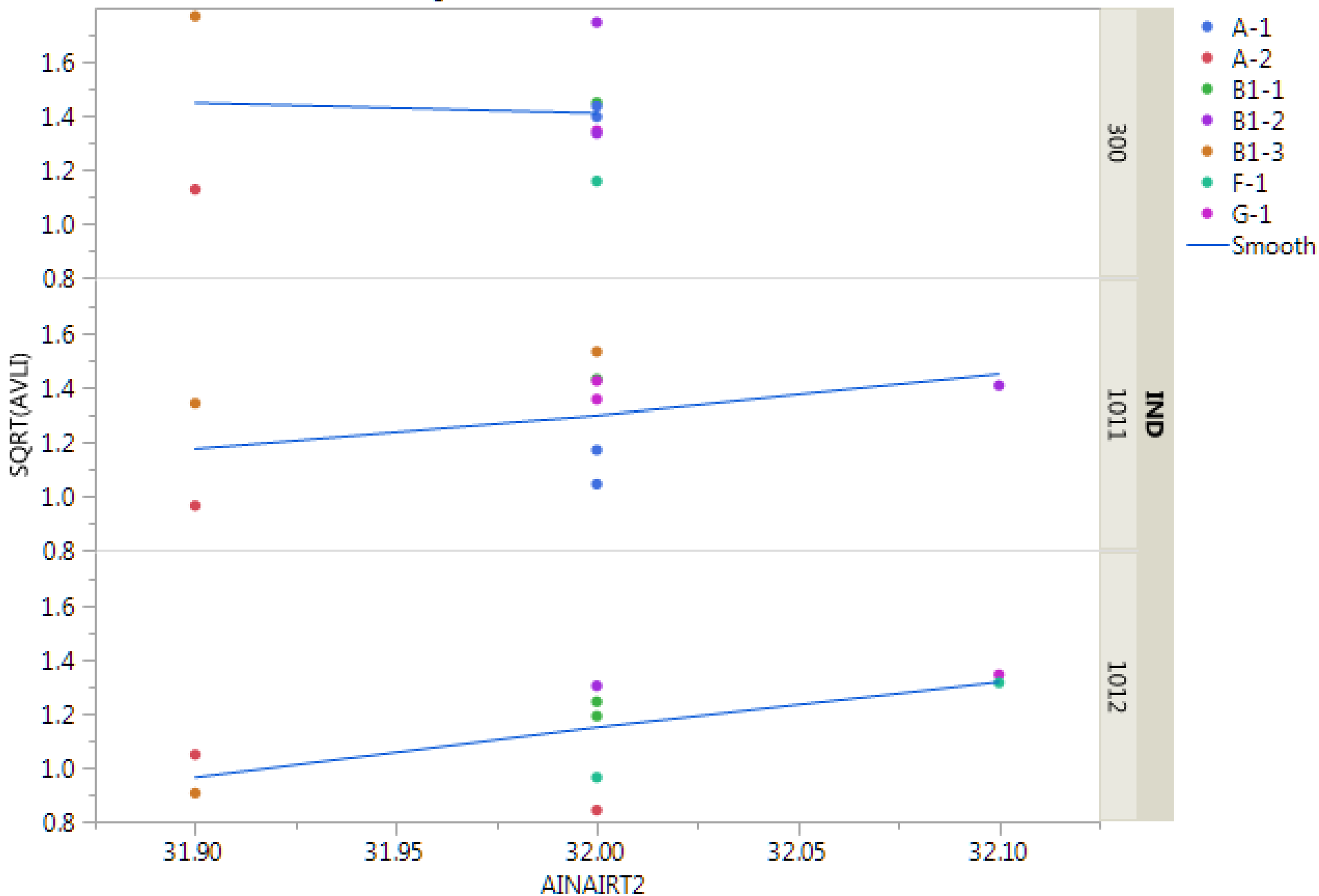
SQRT(AVLI) vs. AINAIRP2



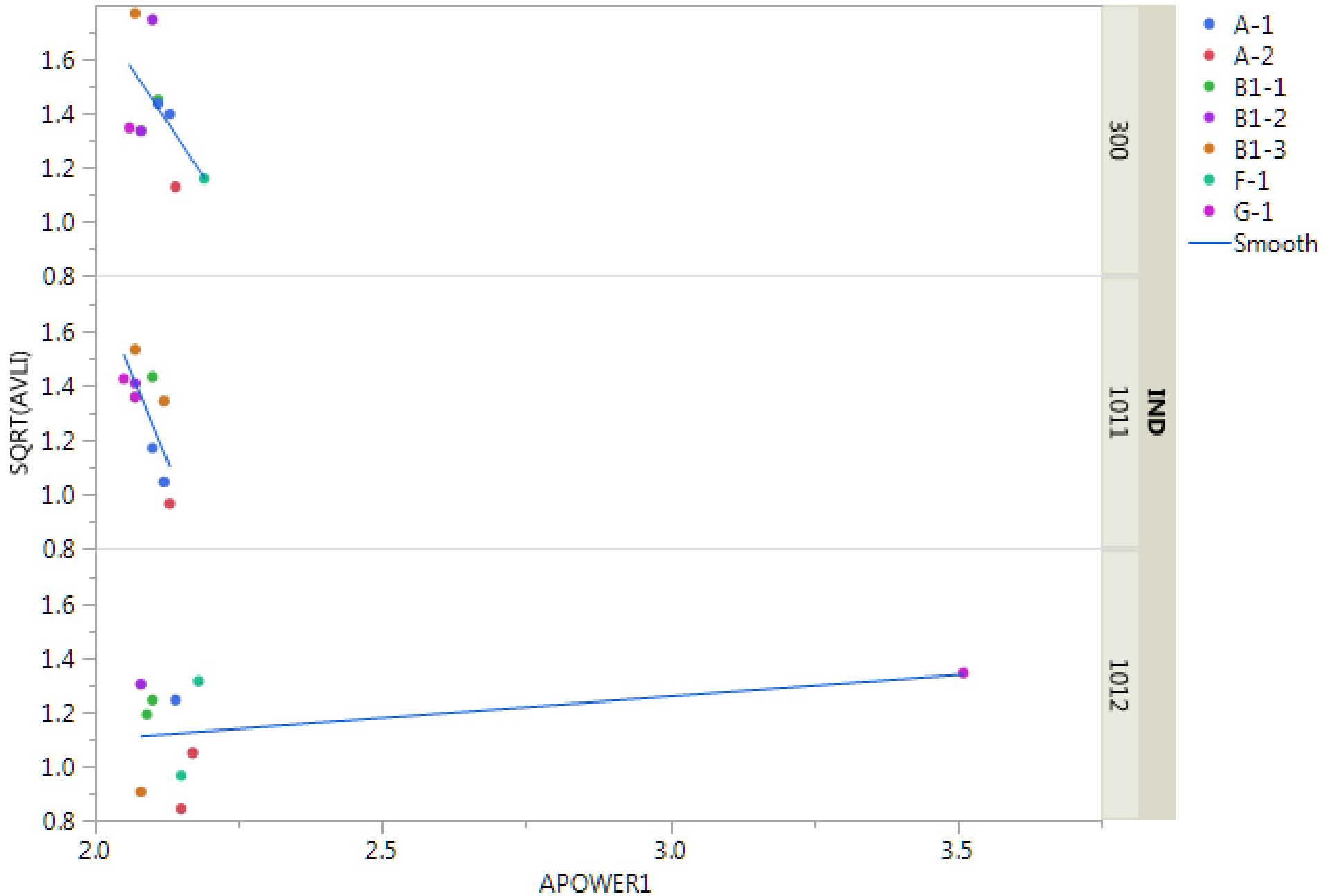
### SQRT(AVLI) vs. AINAIRT1



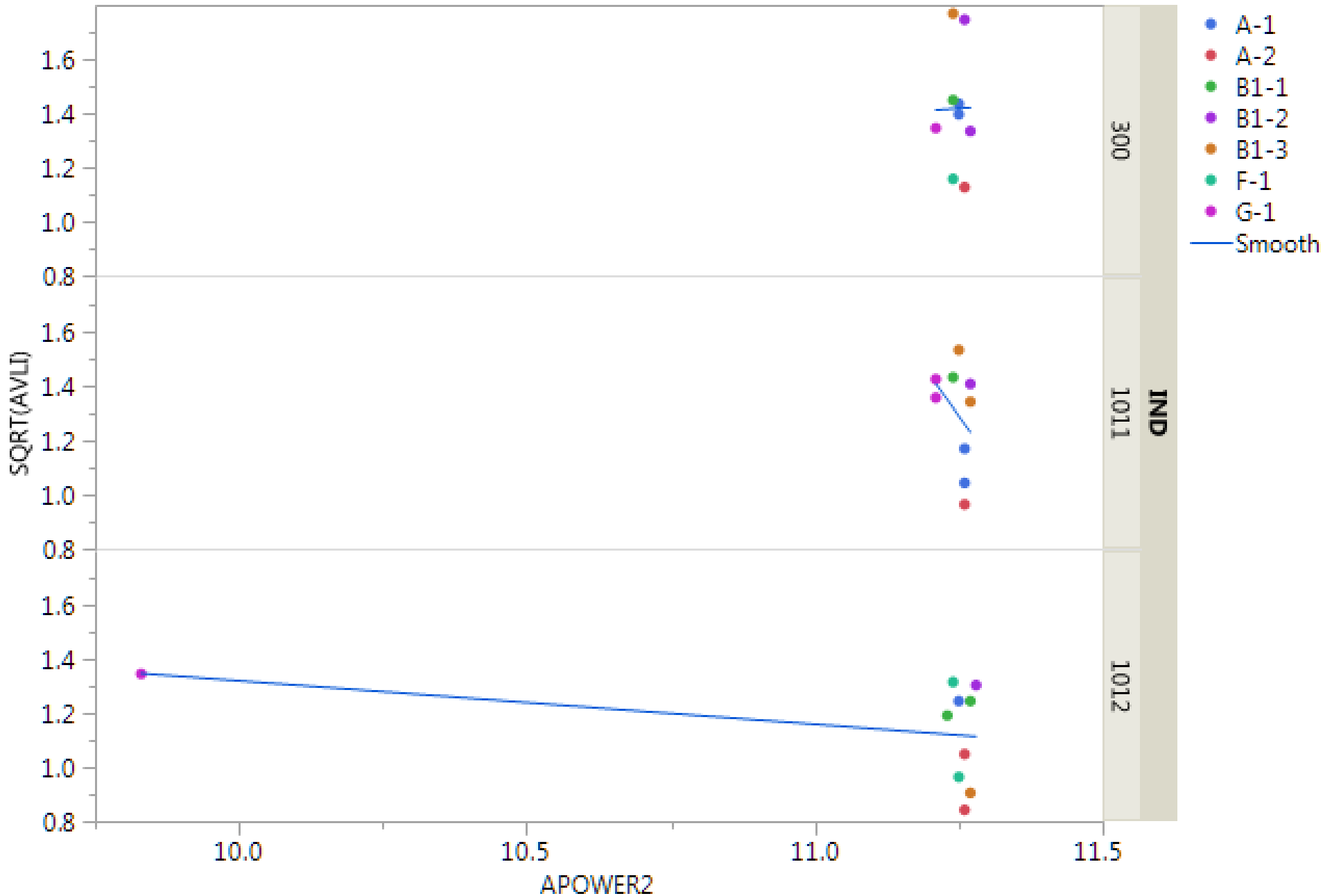
### SQRT(AVLI) vs. AINAIRT2



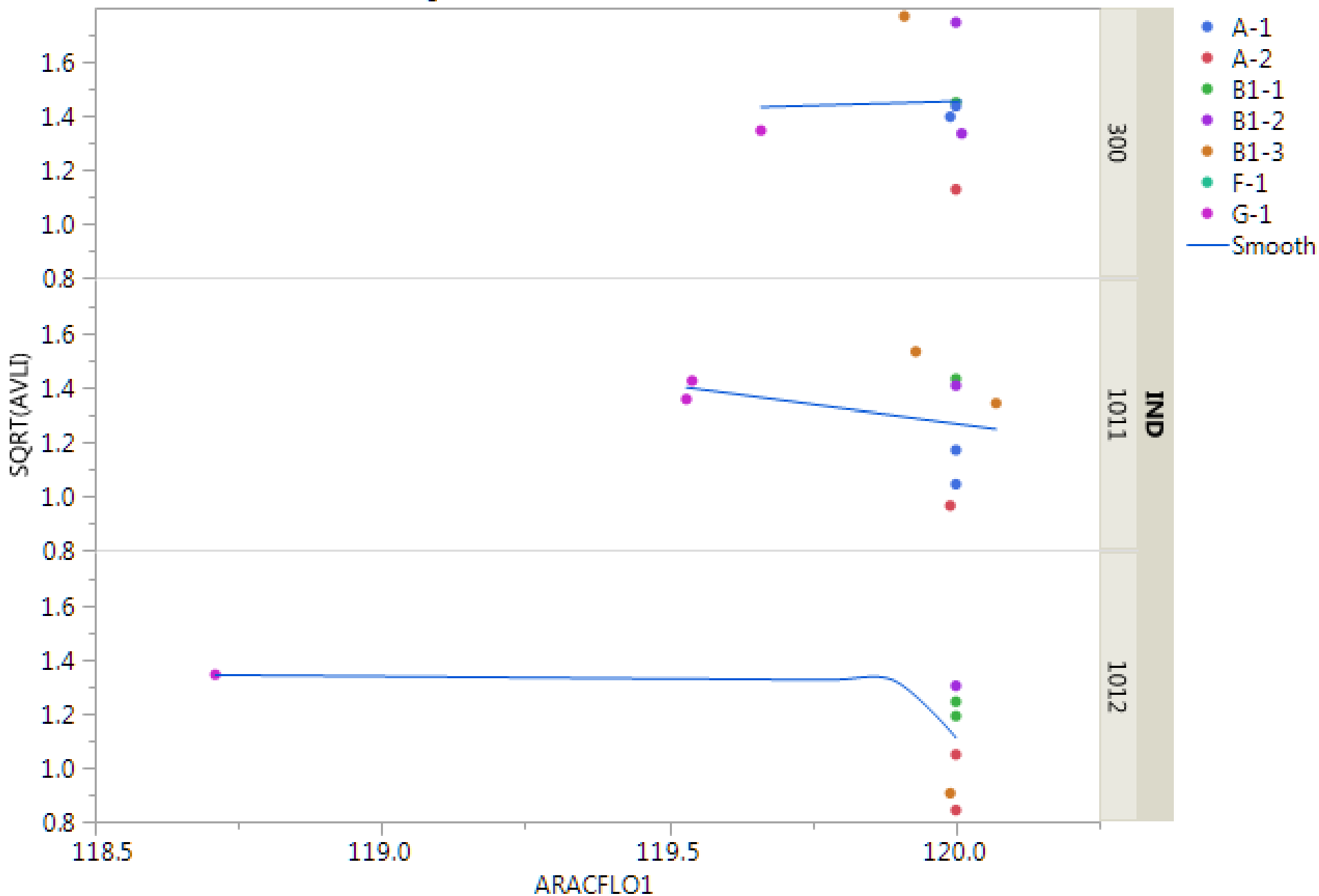
SQRT(AVLI) vs. APOWER1



### SQRT(AVLI) vs. APOWER2

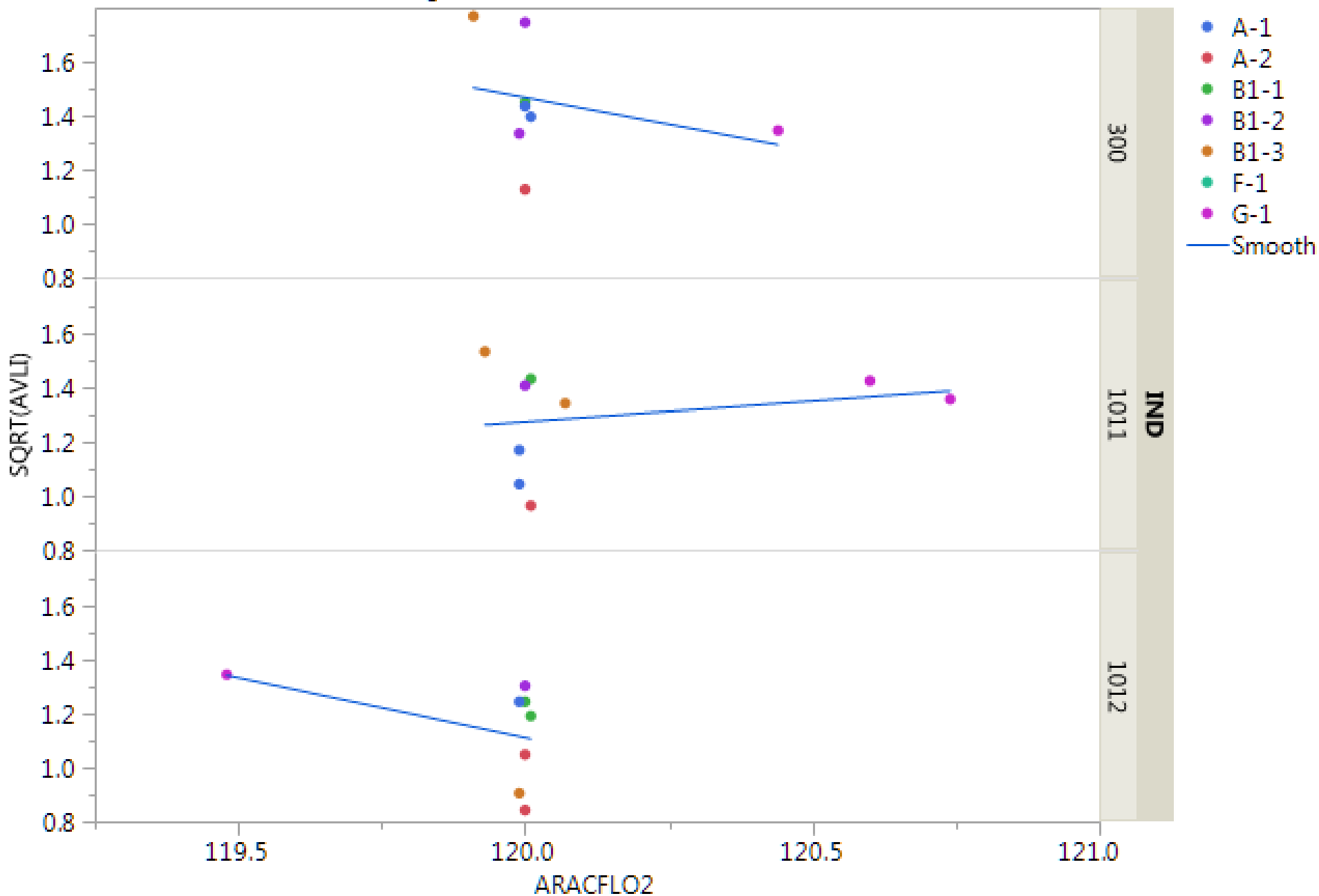


### SQRT(AVLI) vs. ARACFLO1

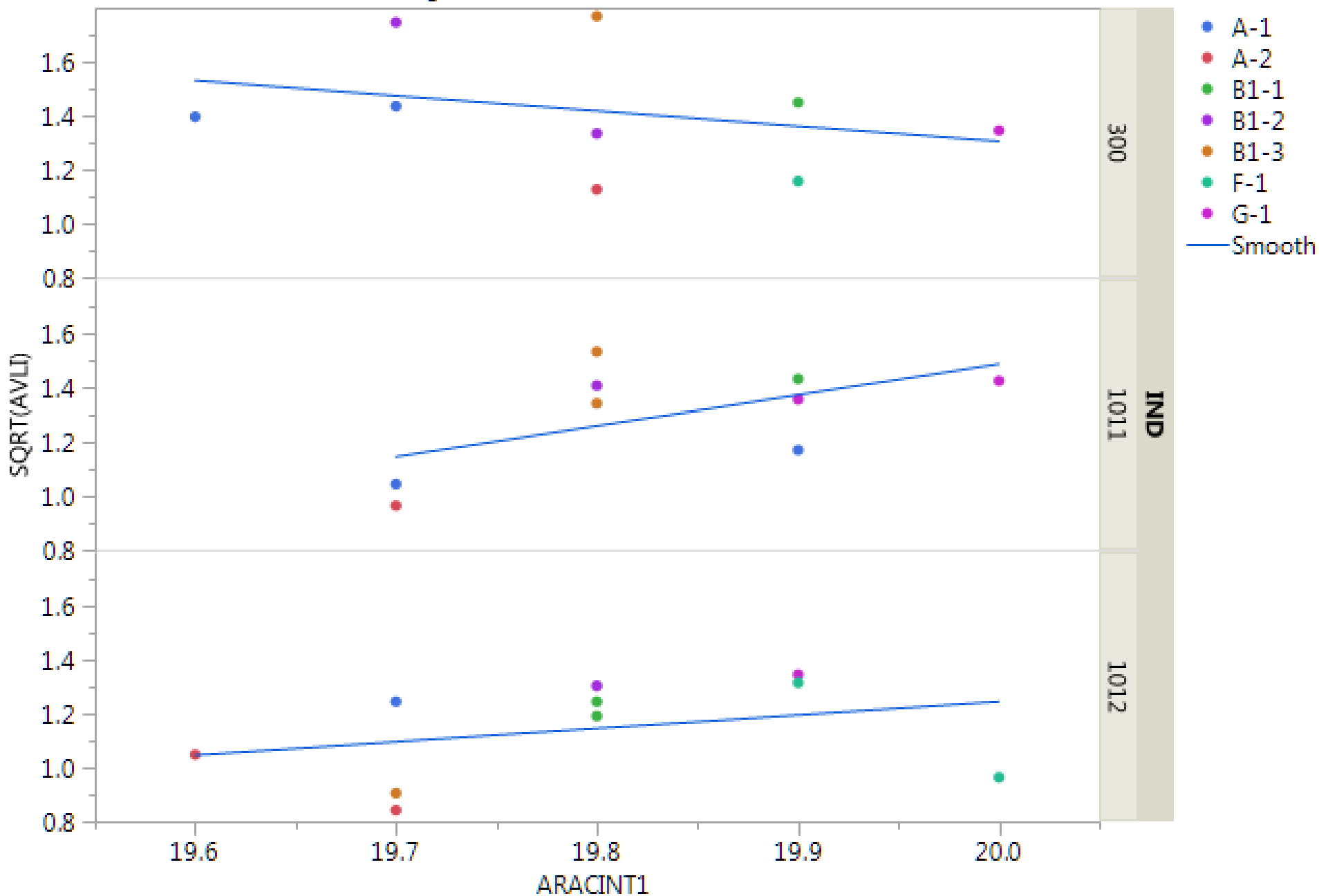




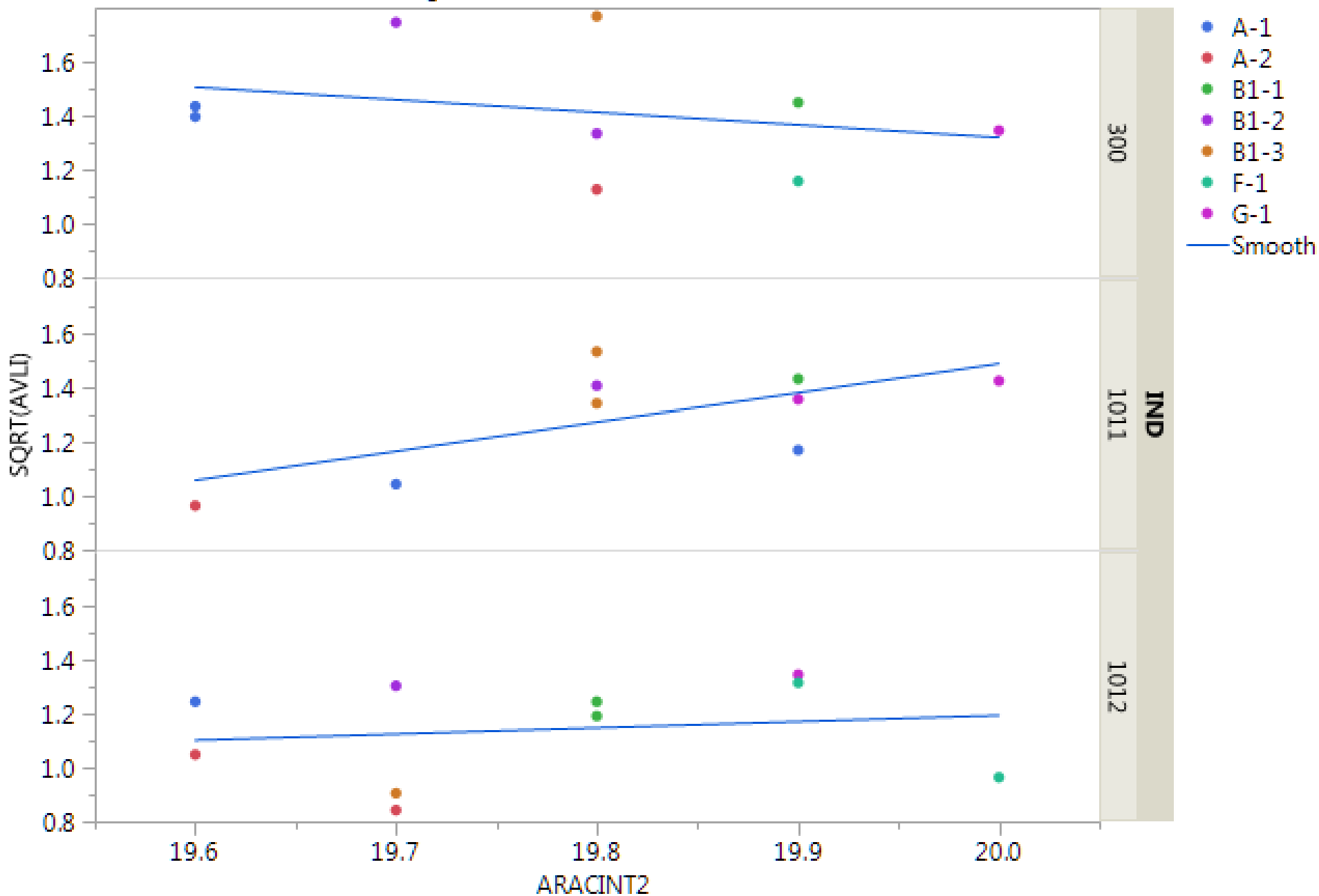
### SQRT(AVLI) vs. ARACFLO2



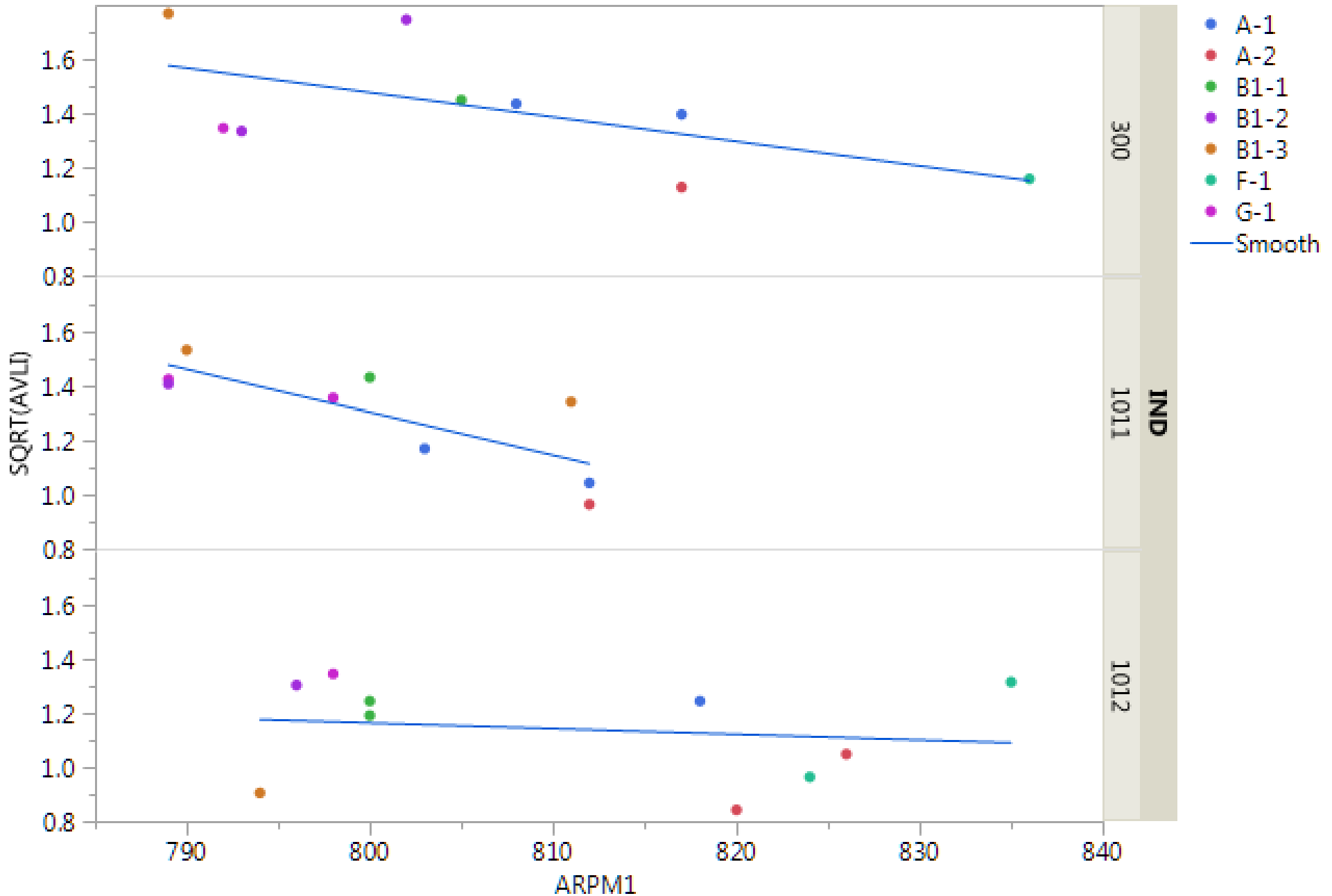
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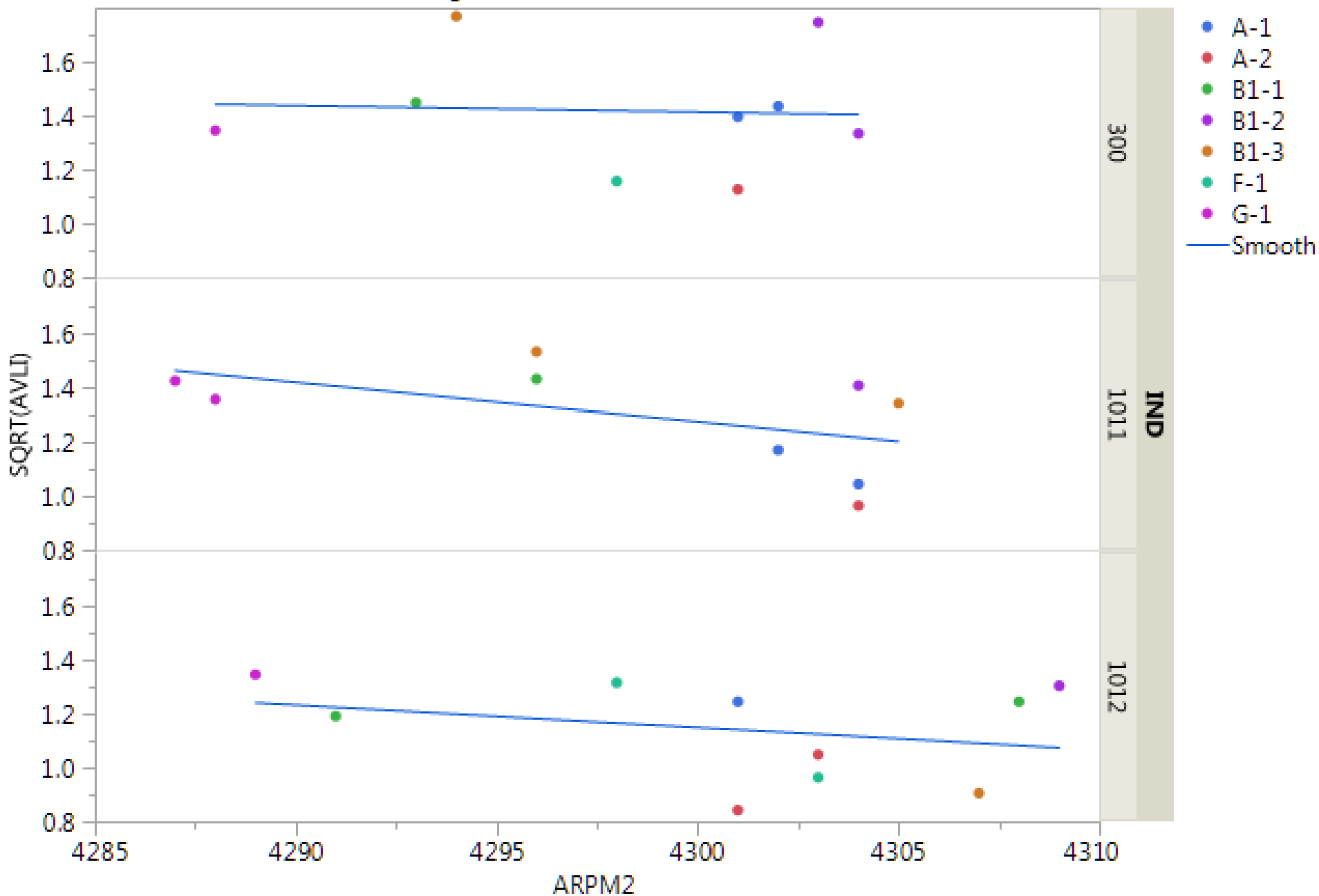
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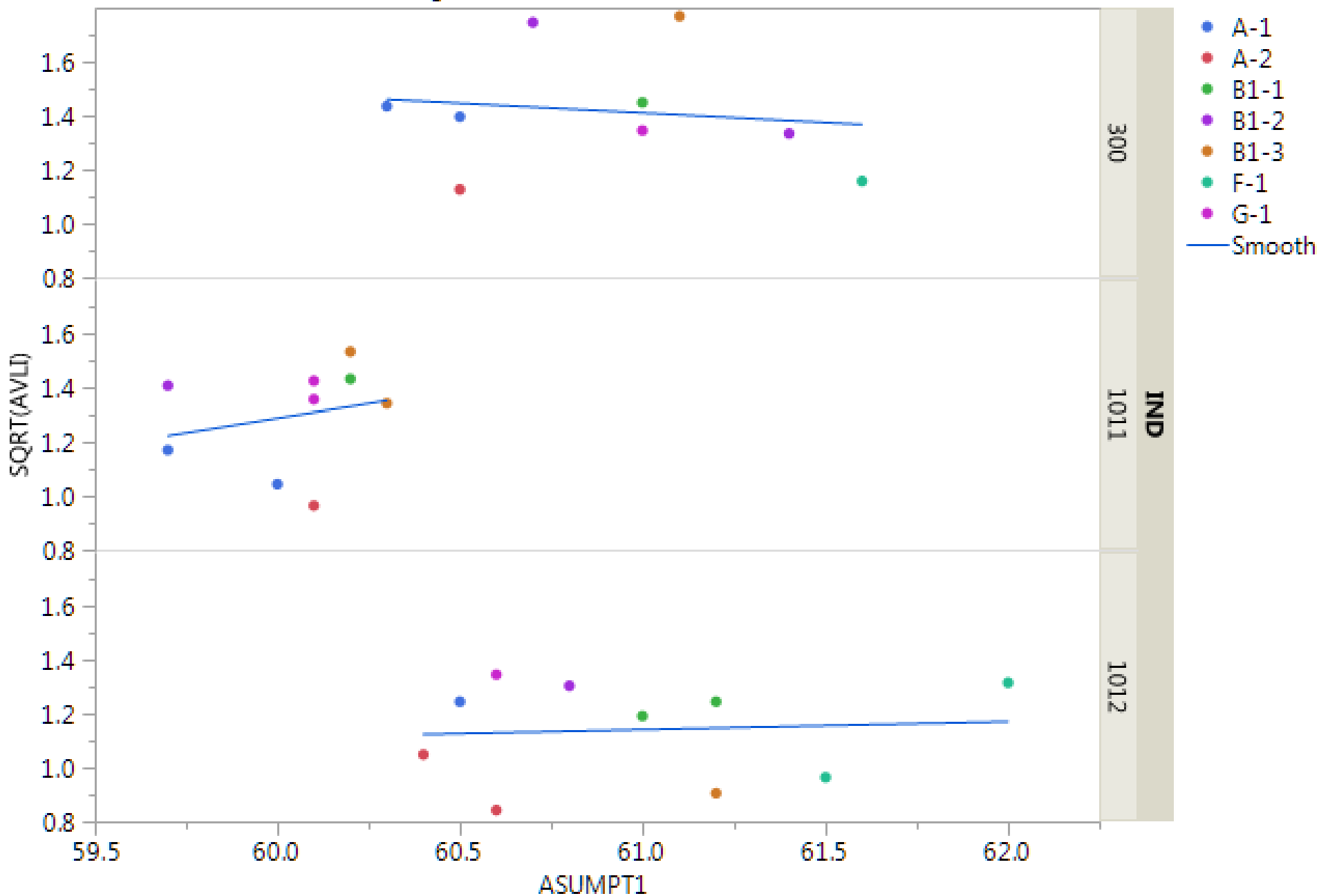
SQRT(AVLI) vs. ARPM1



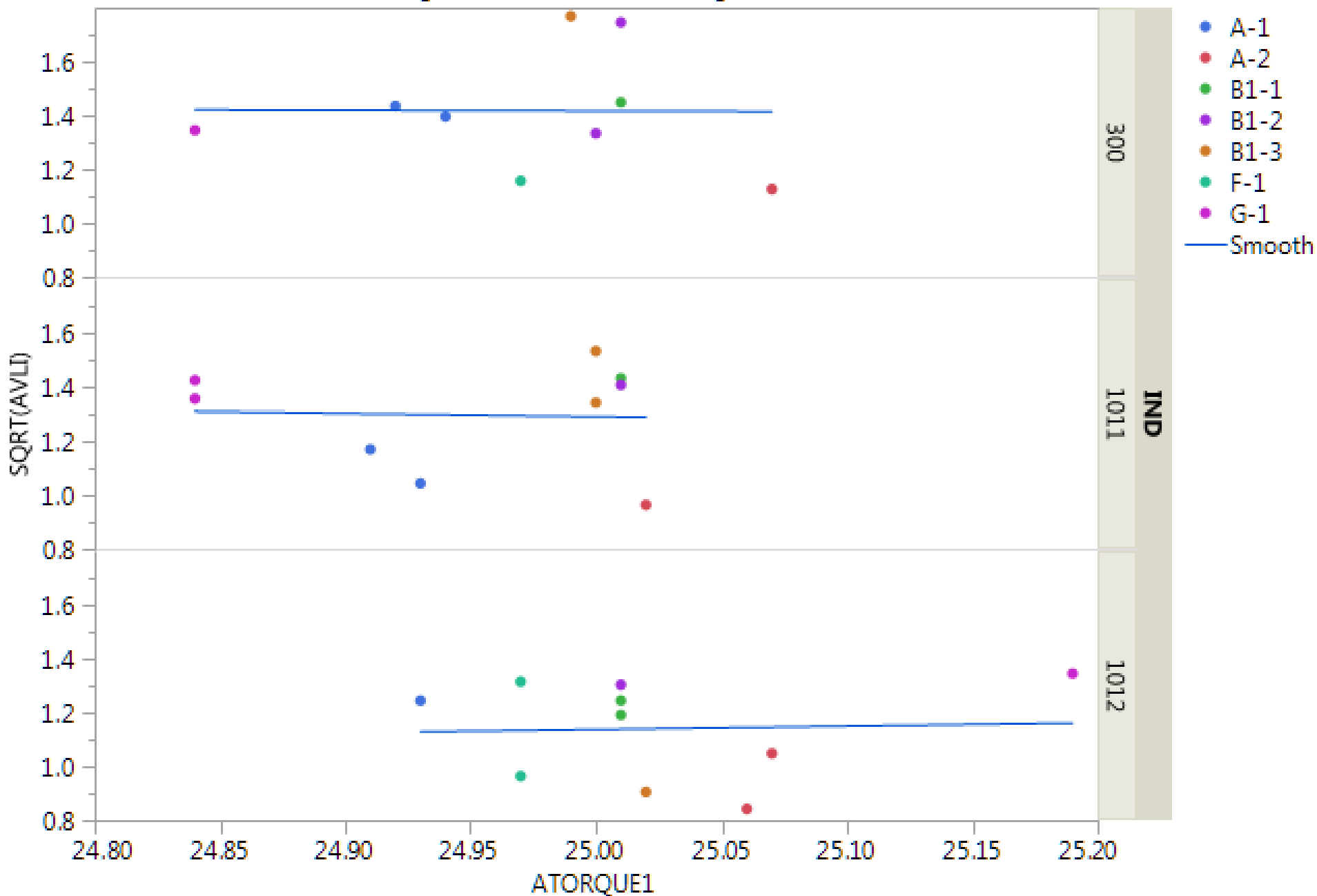
### SQRT(AVLI) vs. ARPM2



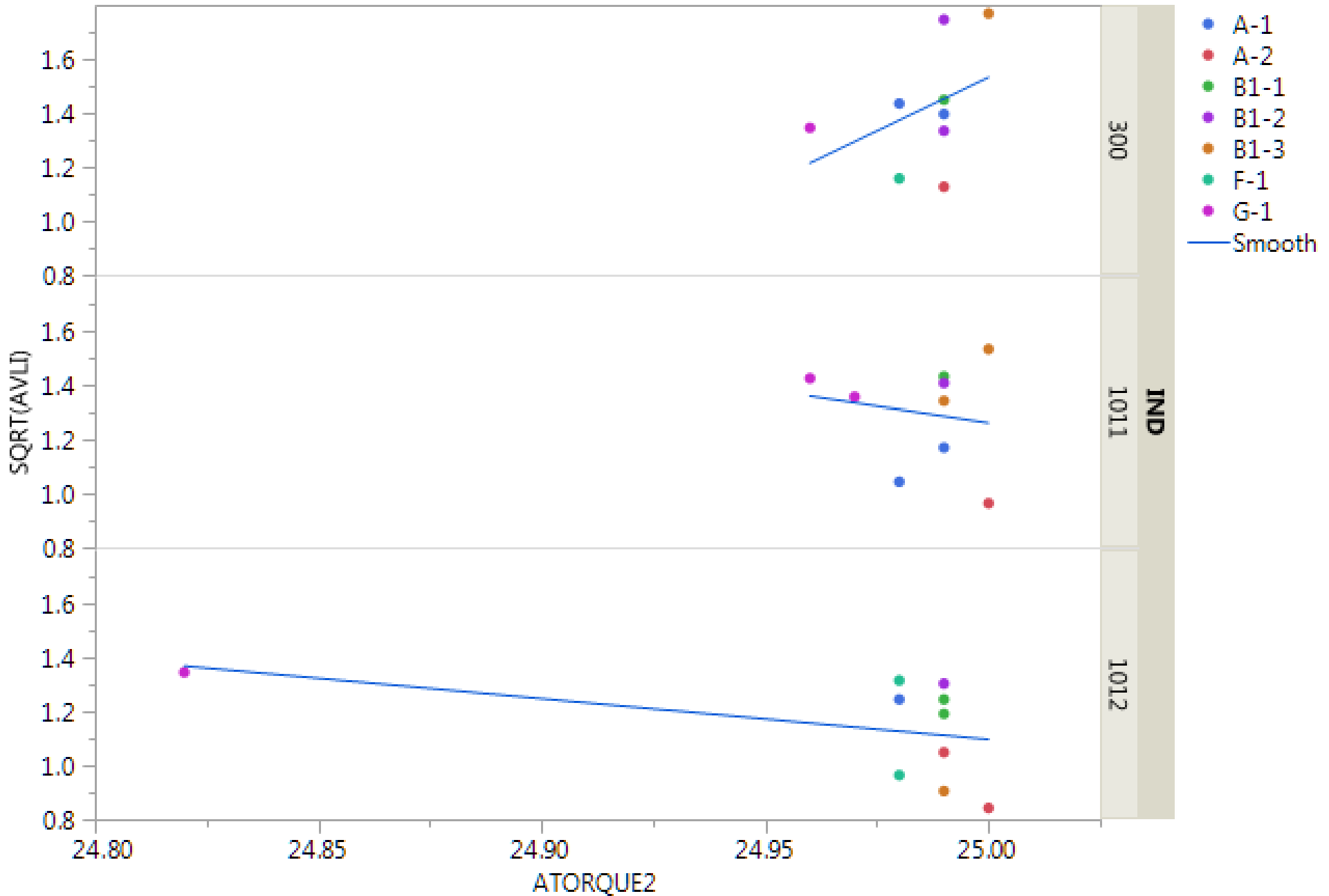
SQRT(AVLI) vs. ASUMPT1



### SQRT(AVLI) vs. ATORQUE1

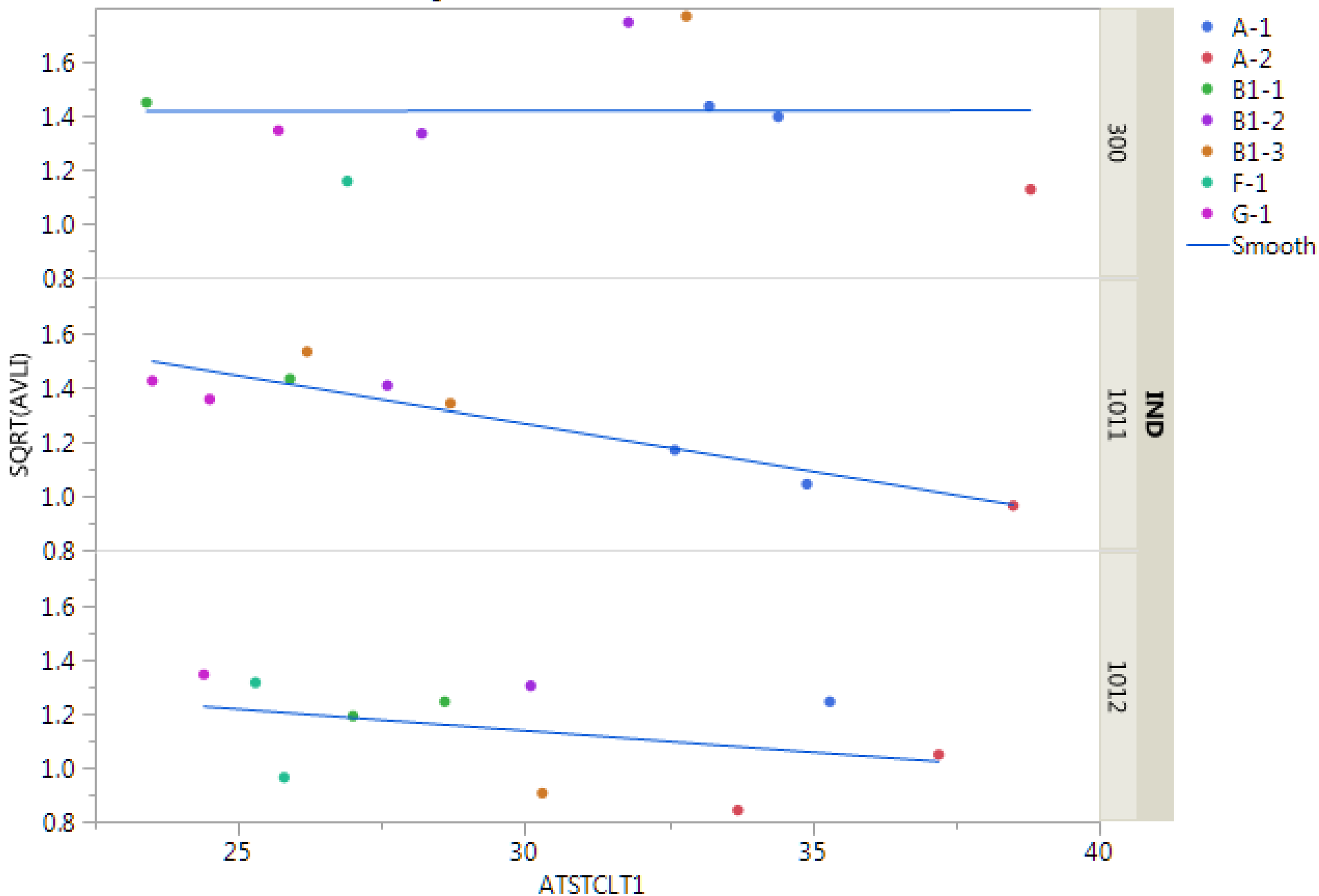


### SQRT(AVLI) vs. ATORQUE2

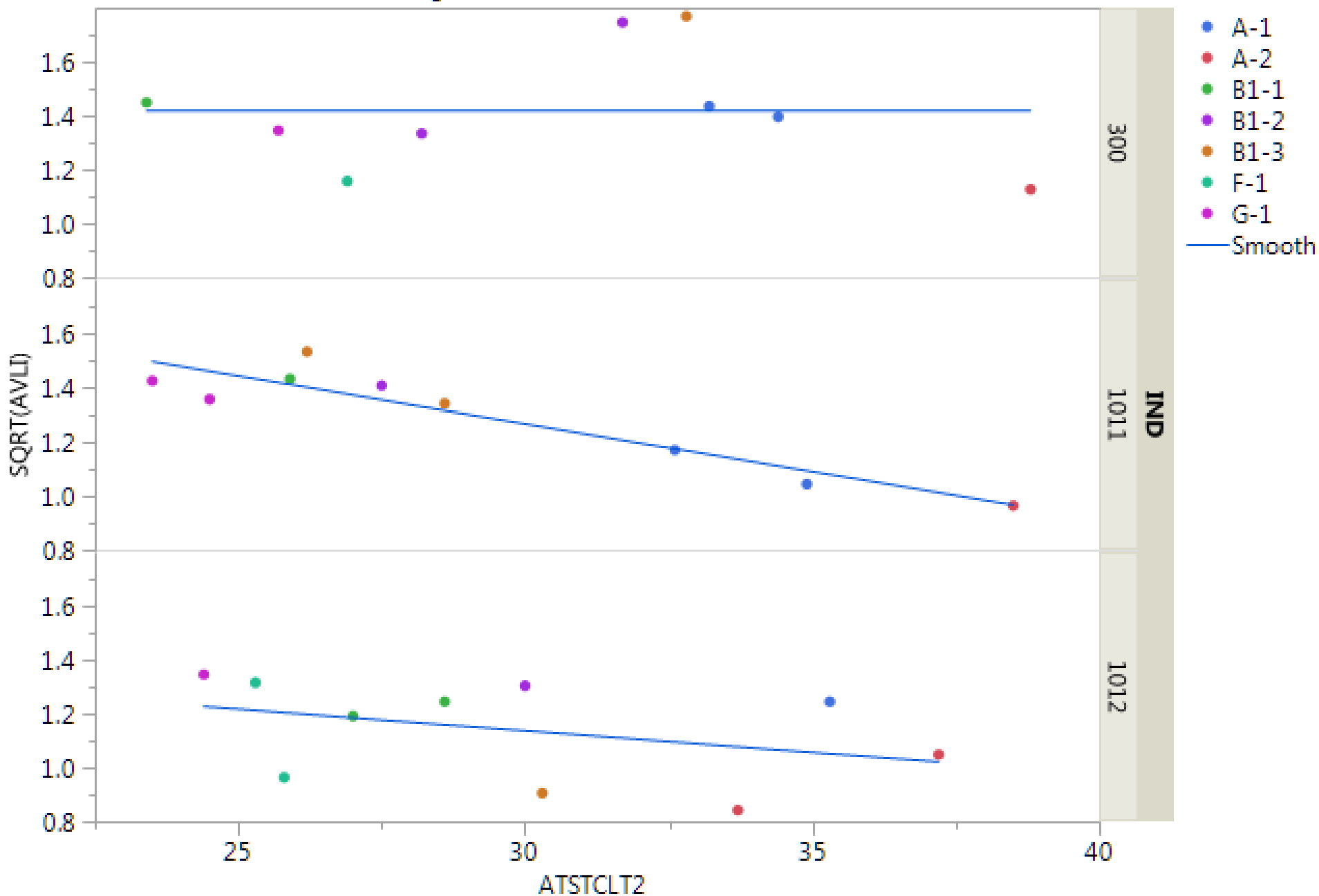




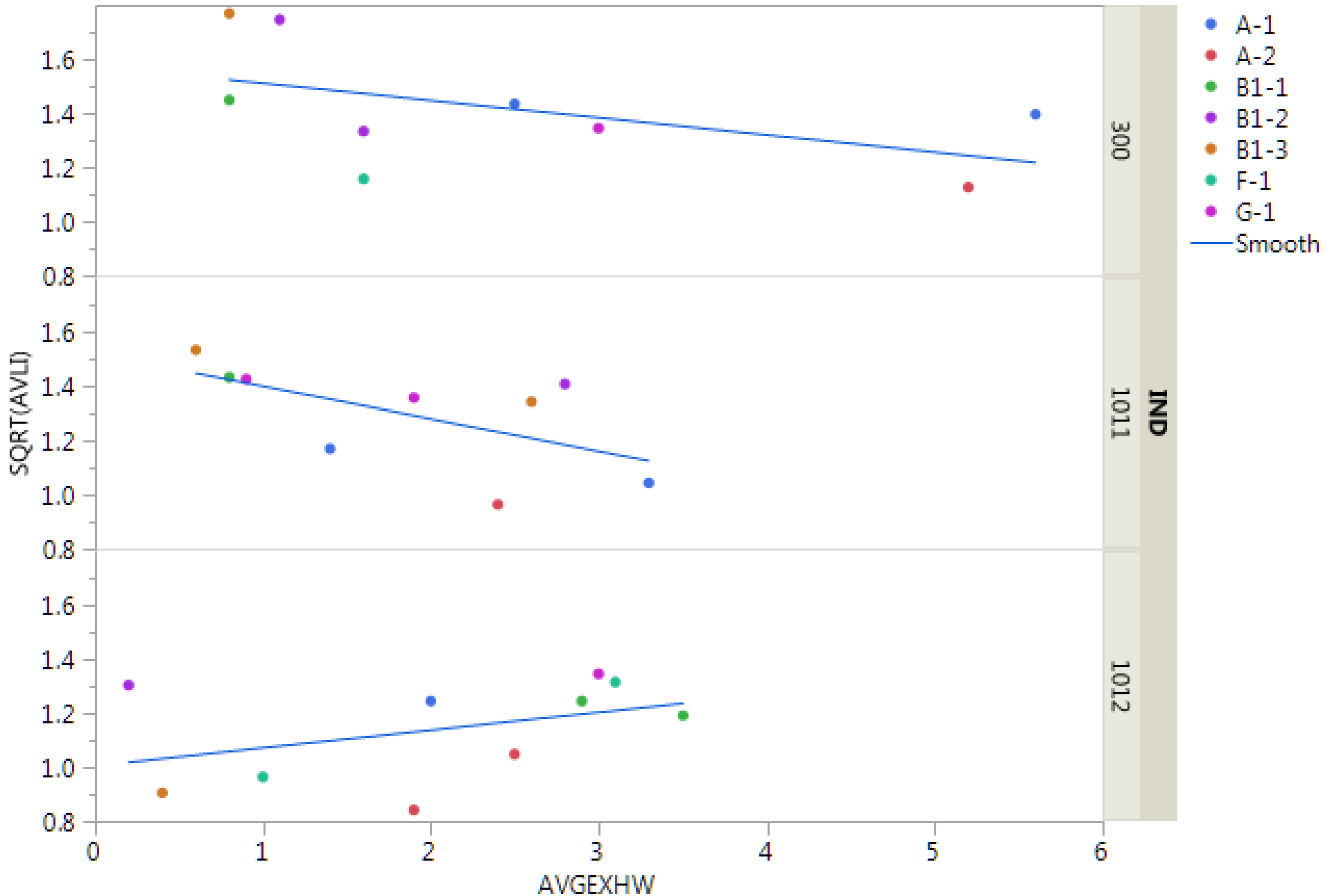
### SQRT(AVLI) vs. ATSTCLT1



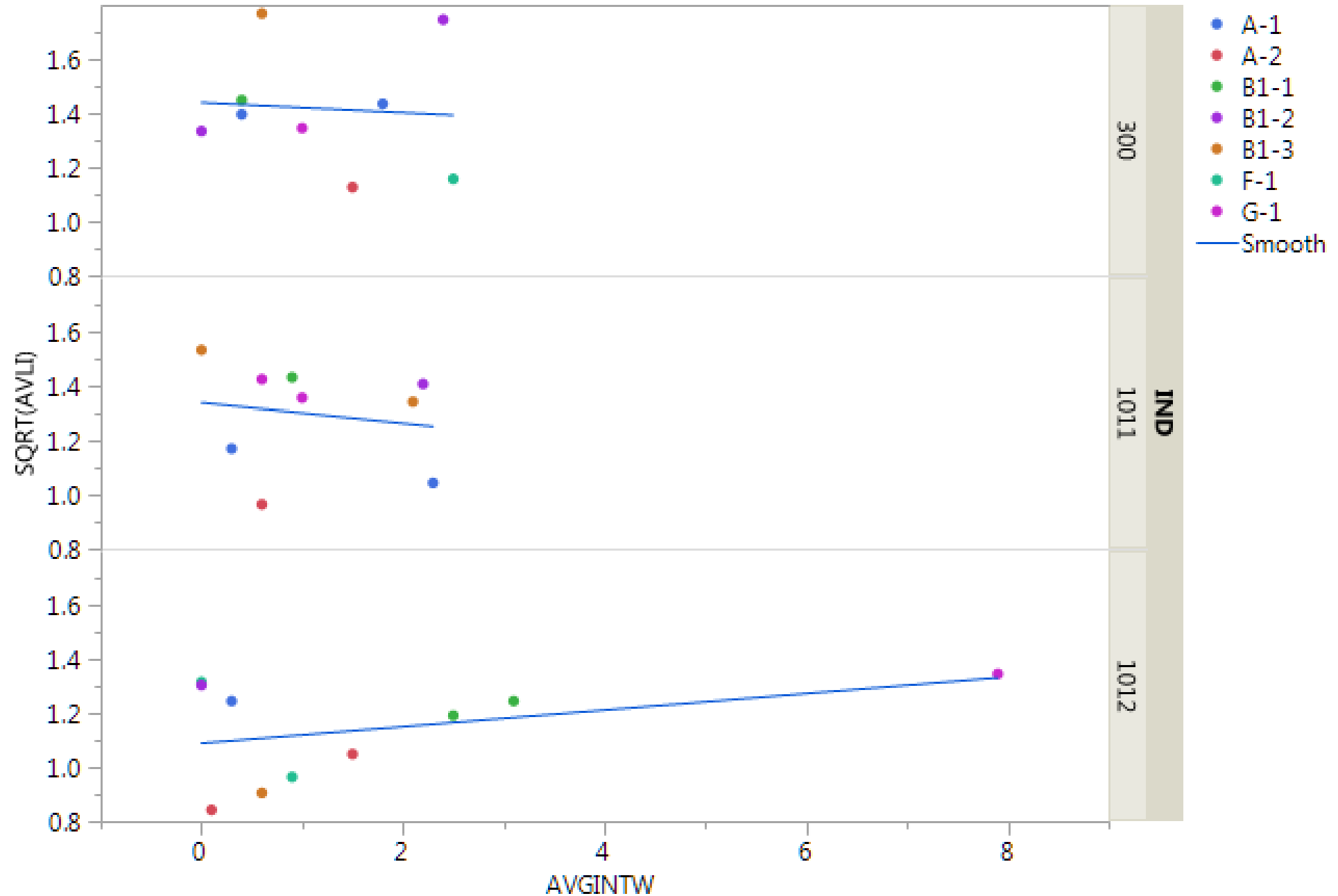
SQRT(AVLI) vs. ATSTCLT2



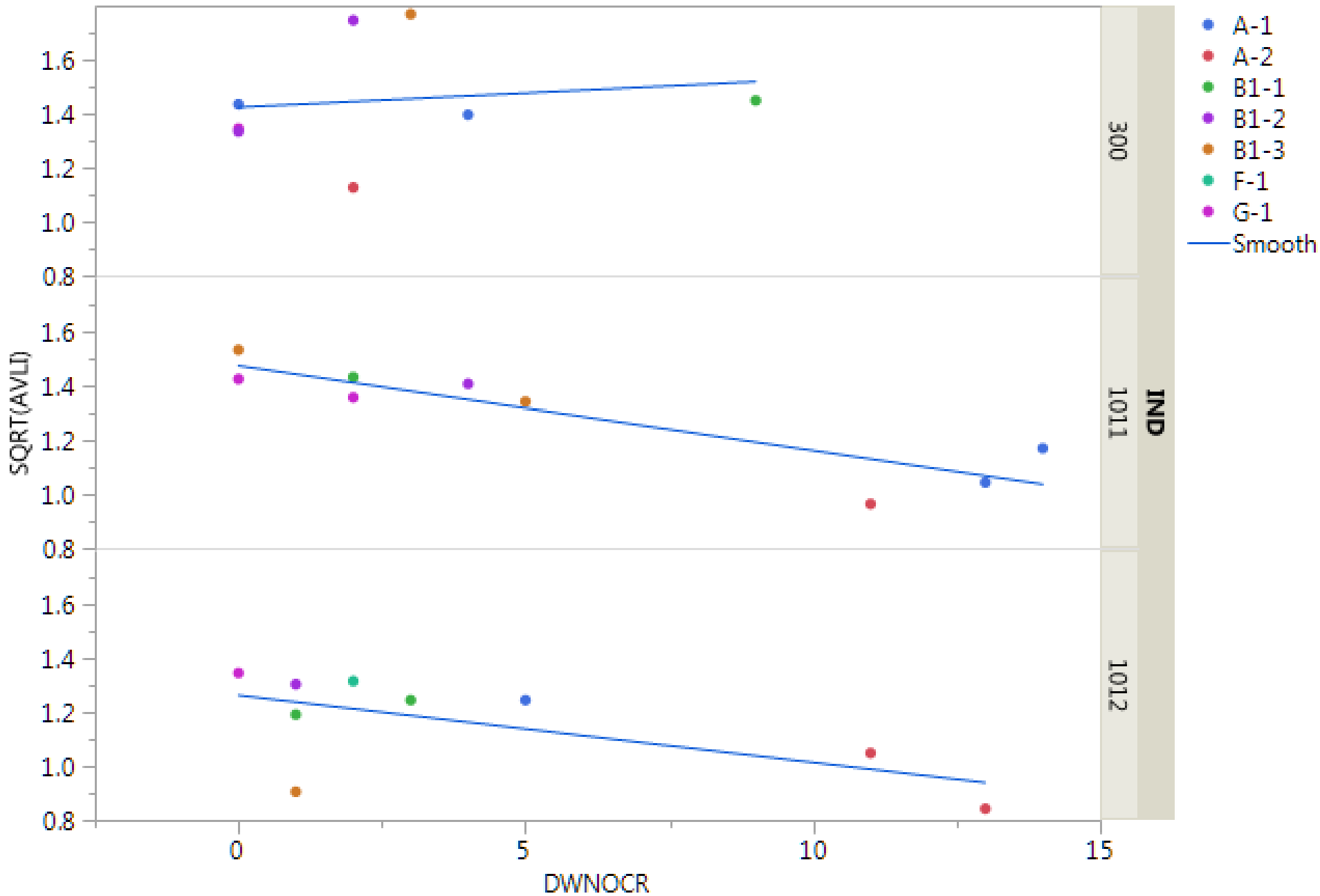
### SQRT(AVLI) vs. AVGEXHW



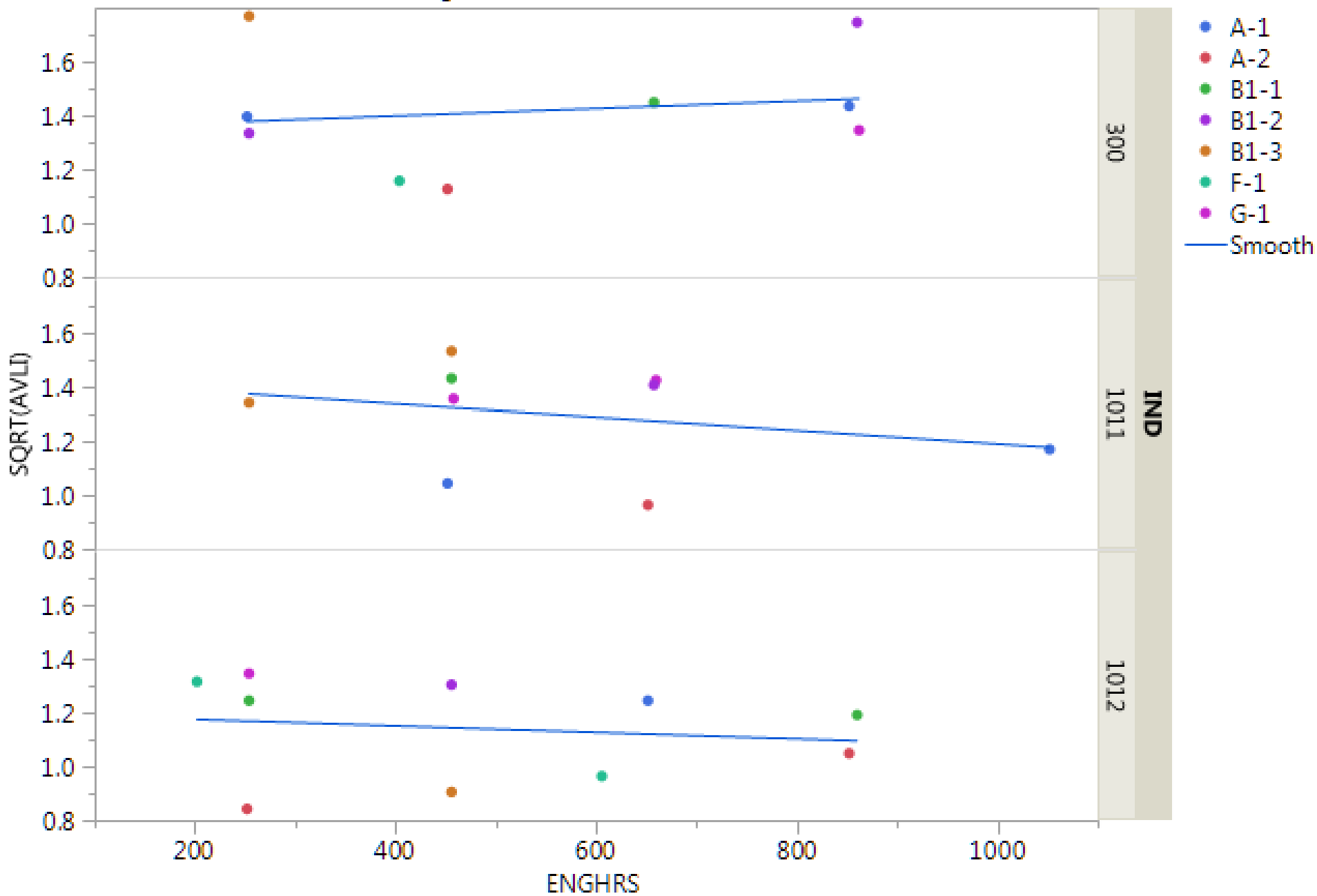
SQRT(AVLI) vs. AVGINTW



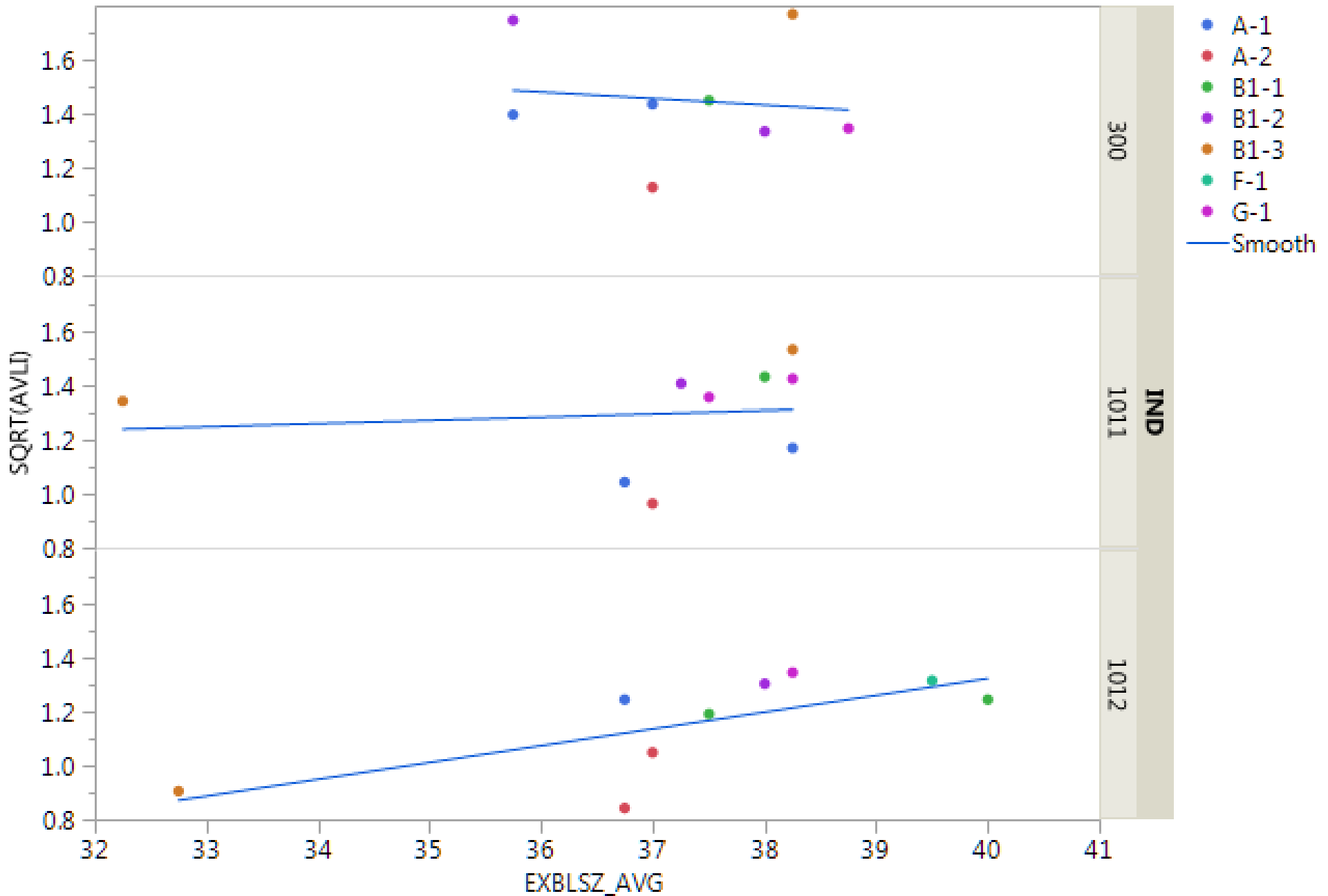
SQRT(AVLI) vs. DWNOCR



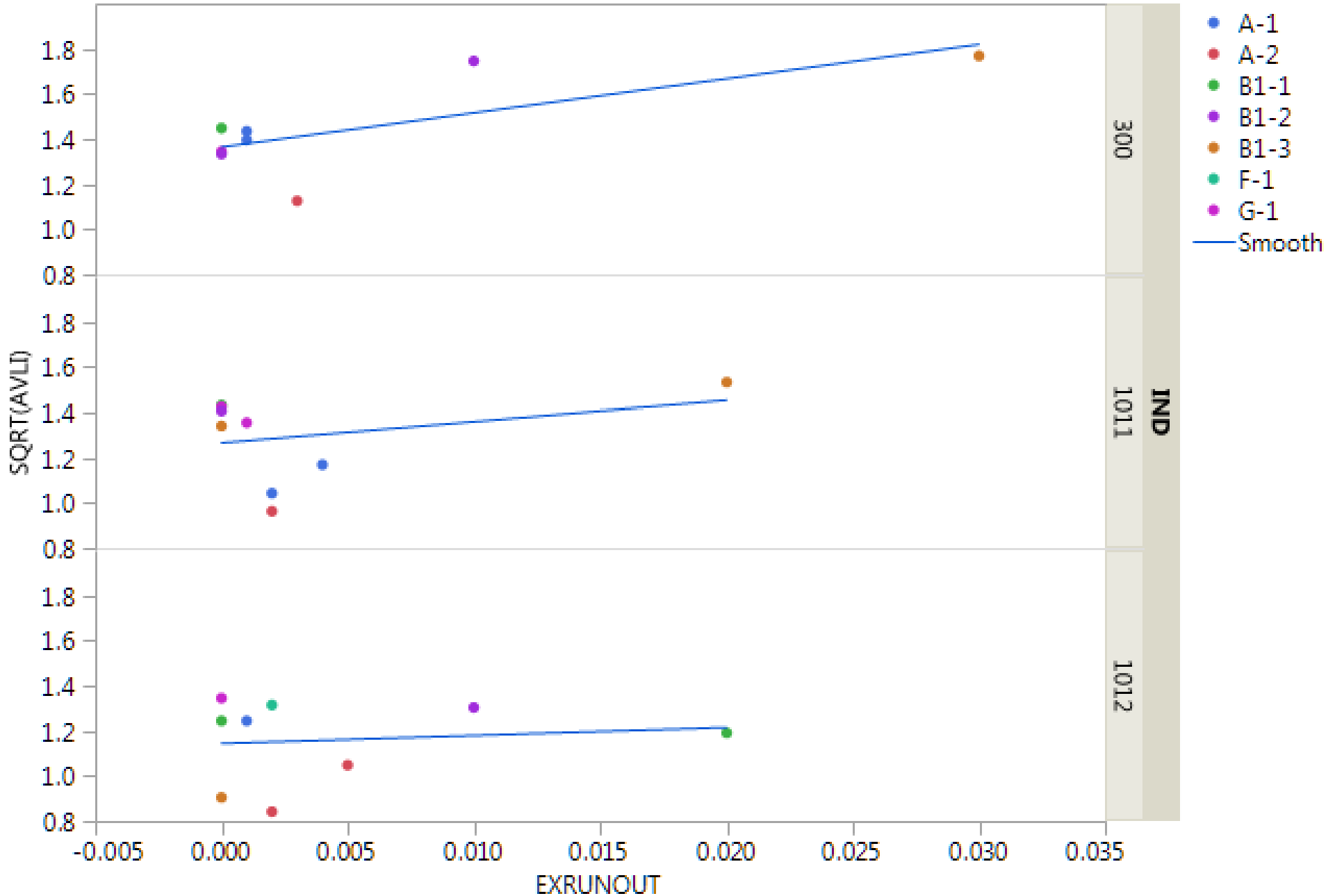
### SQRT(AVLI) vs. ENGHRS



SQRT(AVLI) vs. EXBLSZ\_AVG

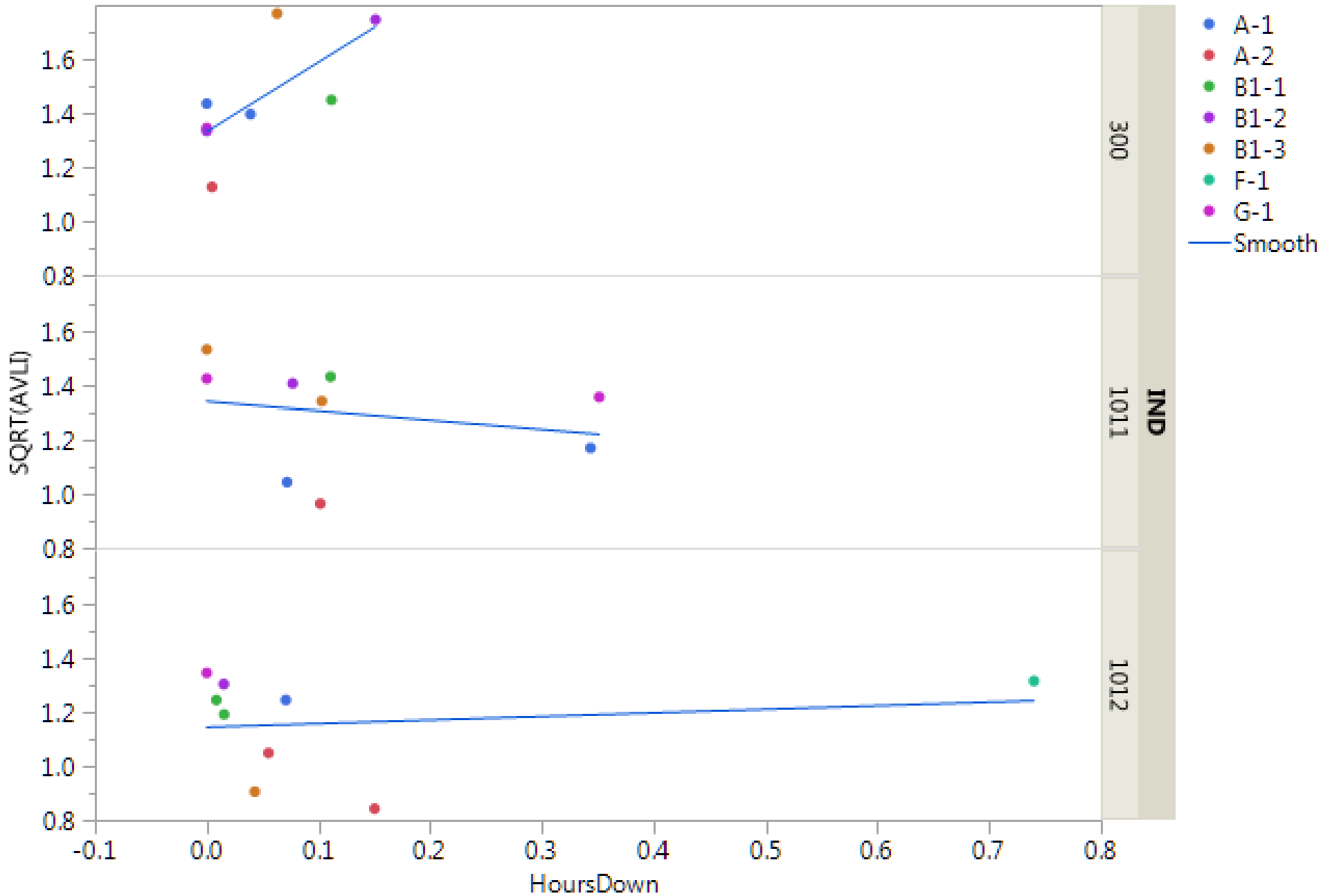


SQRT(AVLI) vs. EXRUNOUT

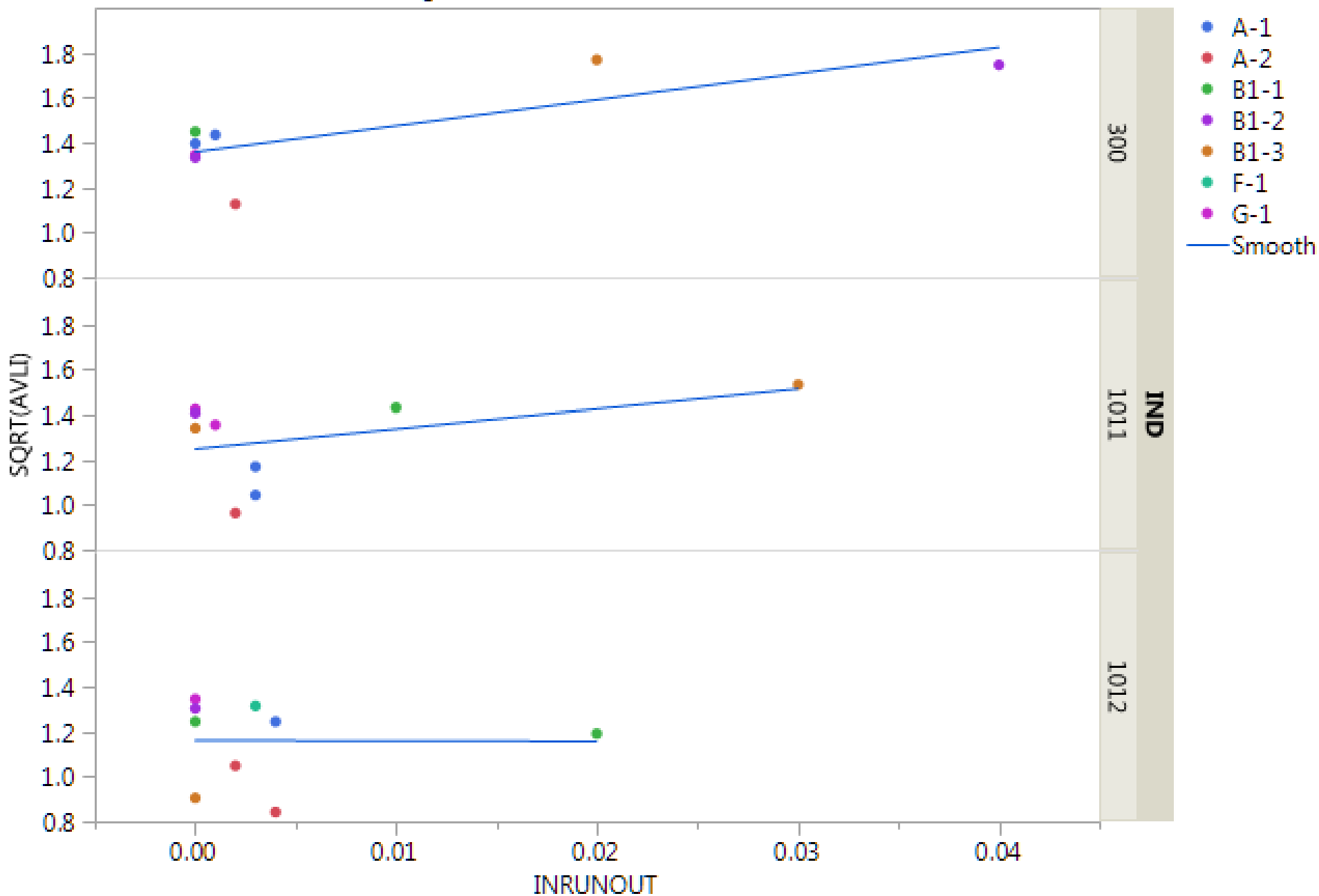




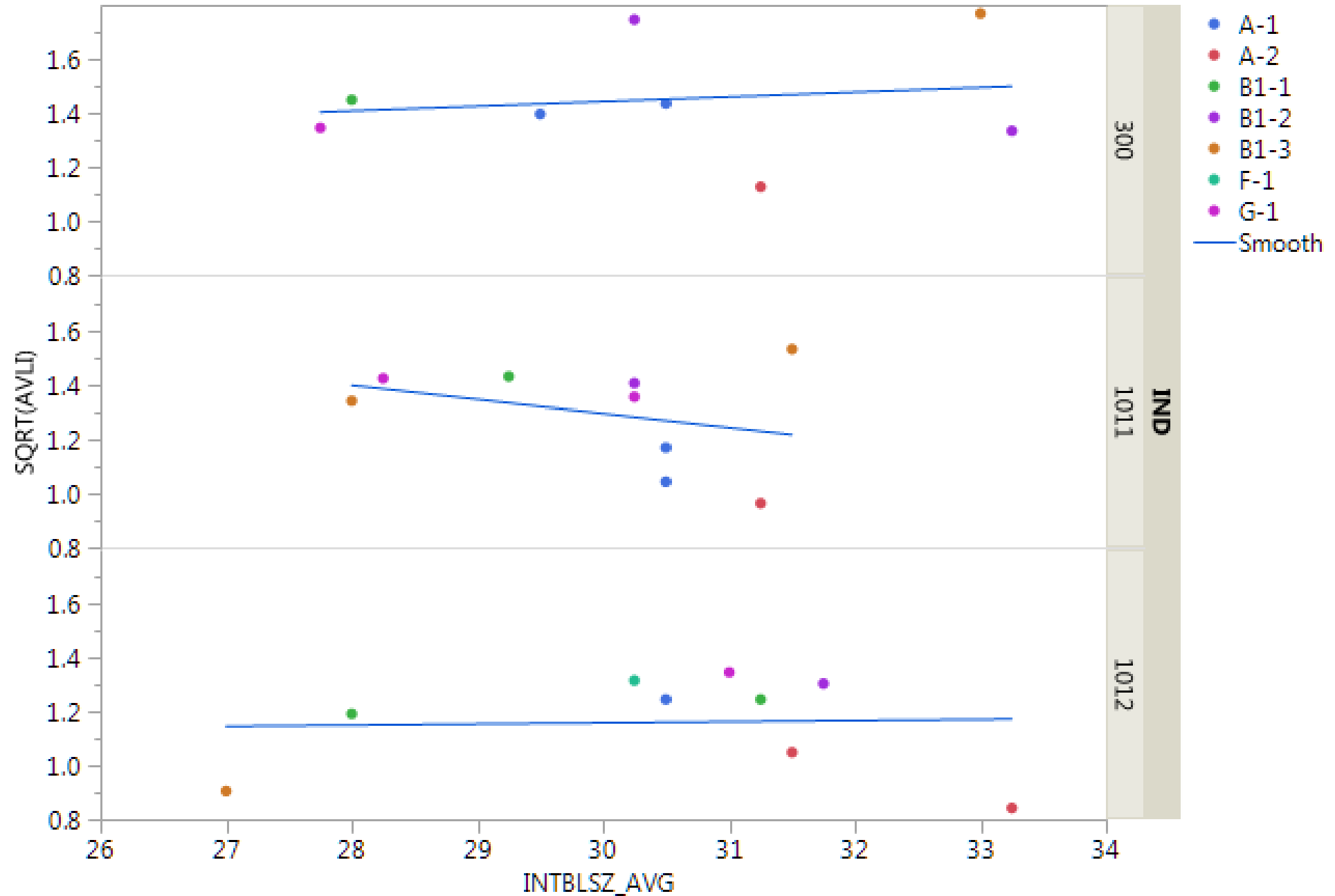
SQRT(AVLI) vs. HoursDown



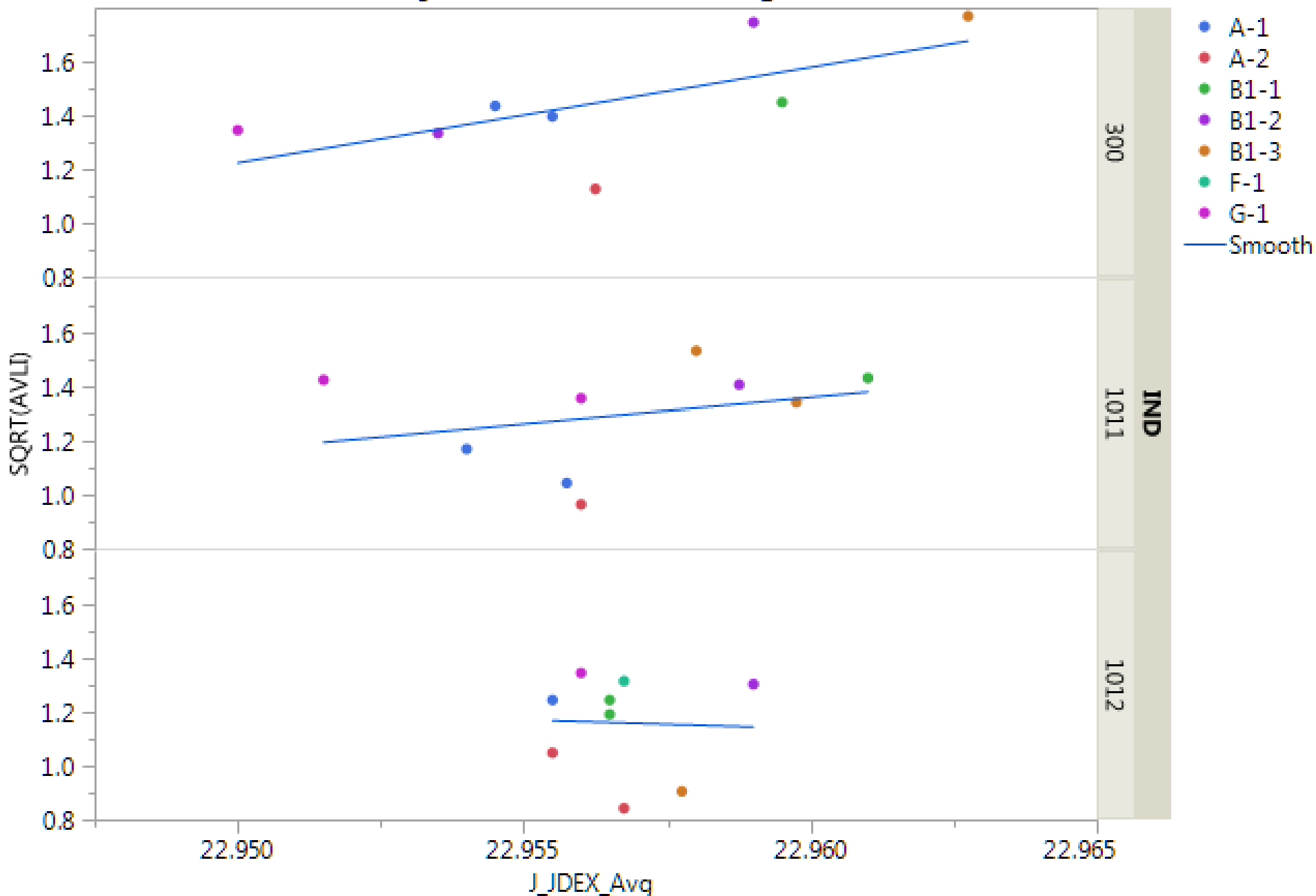
### SQRT(AVLI) vs. INRUNOUT



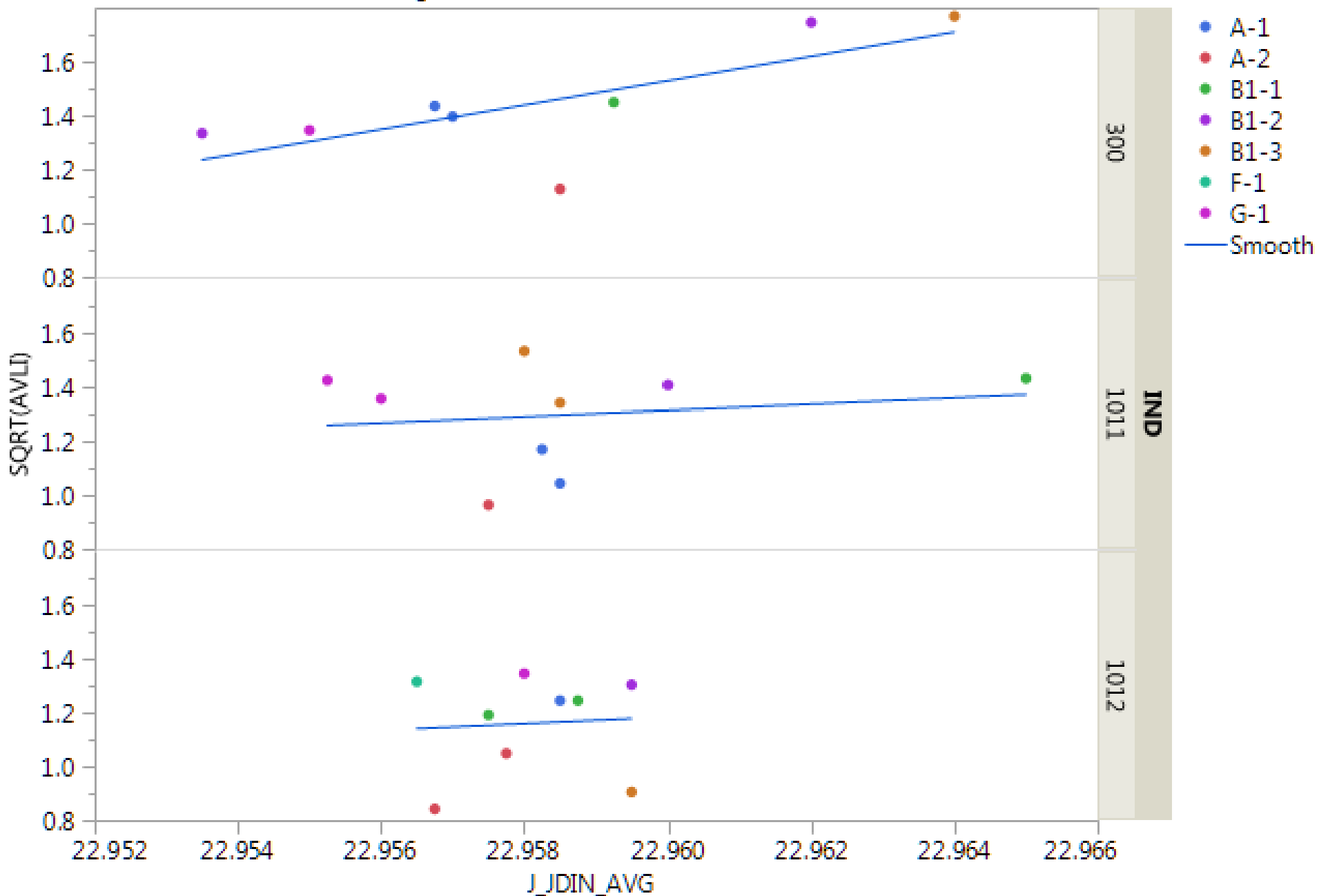
SQRT(AVLI) vs. INTBLSZ\_AVG



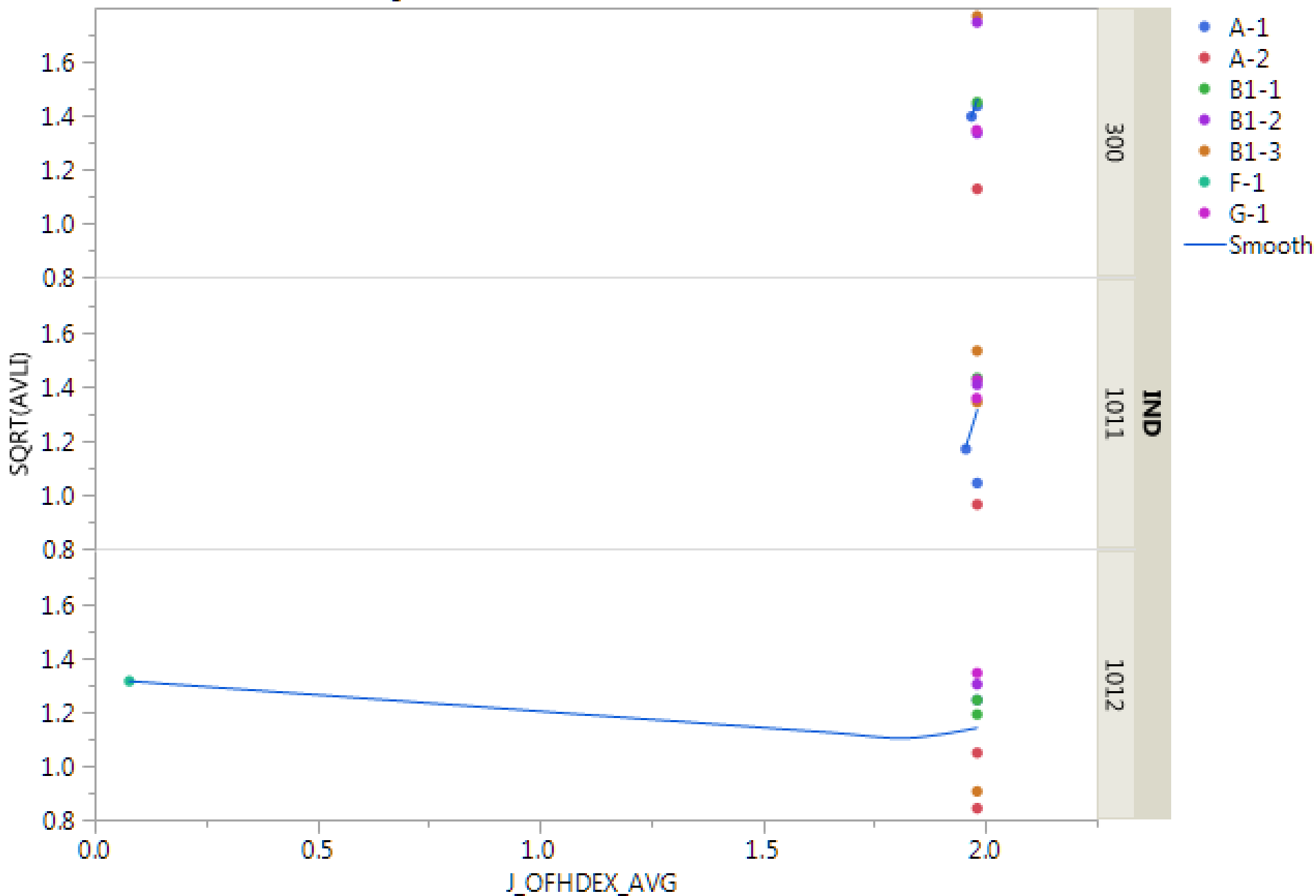
SQRT(AVLI) vs. J\_JDEX\_Avg



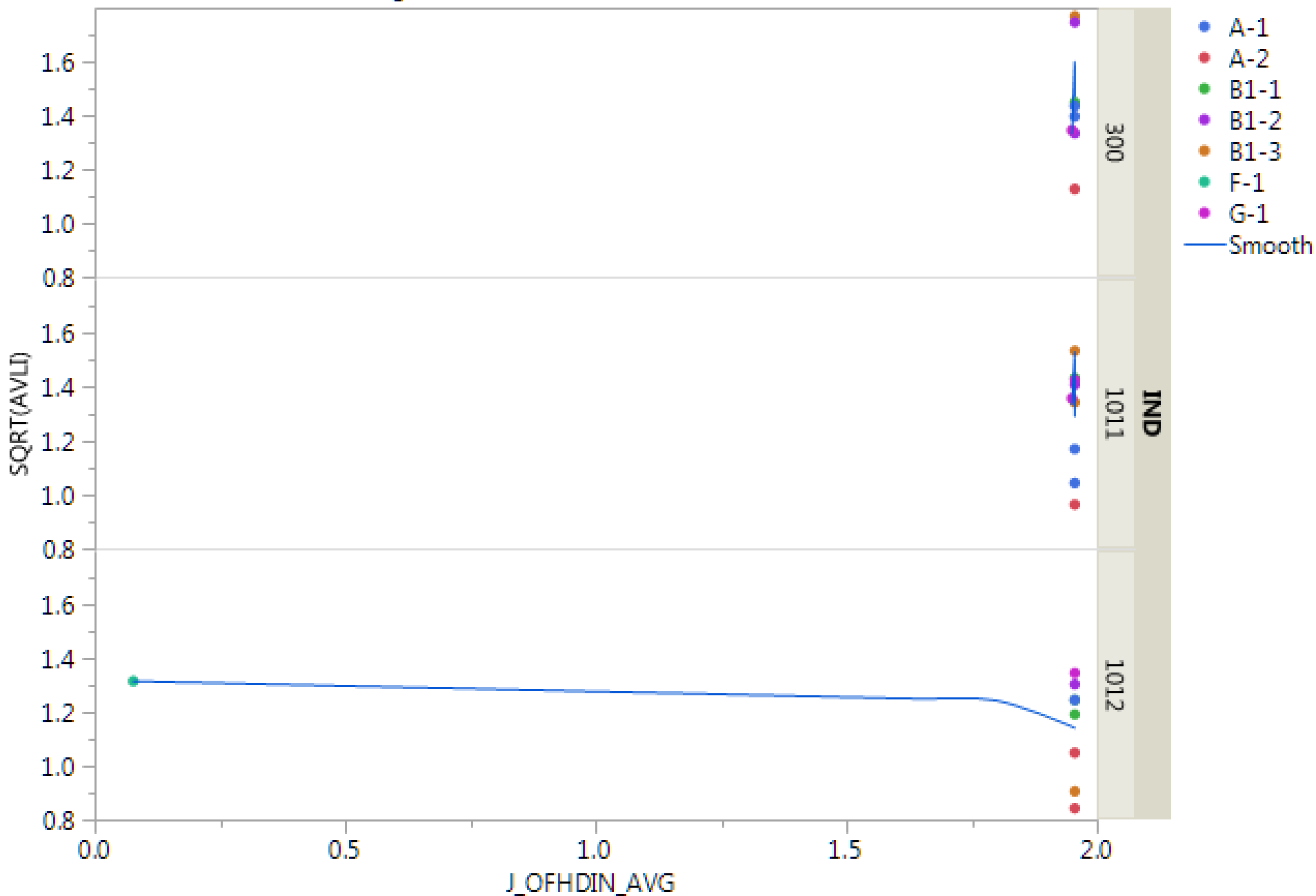
SQRT(AVLI) vs. J\_JDIN\_AVG



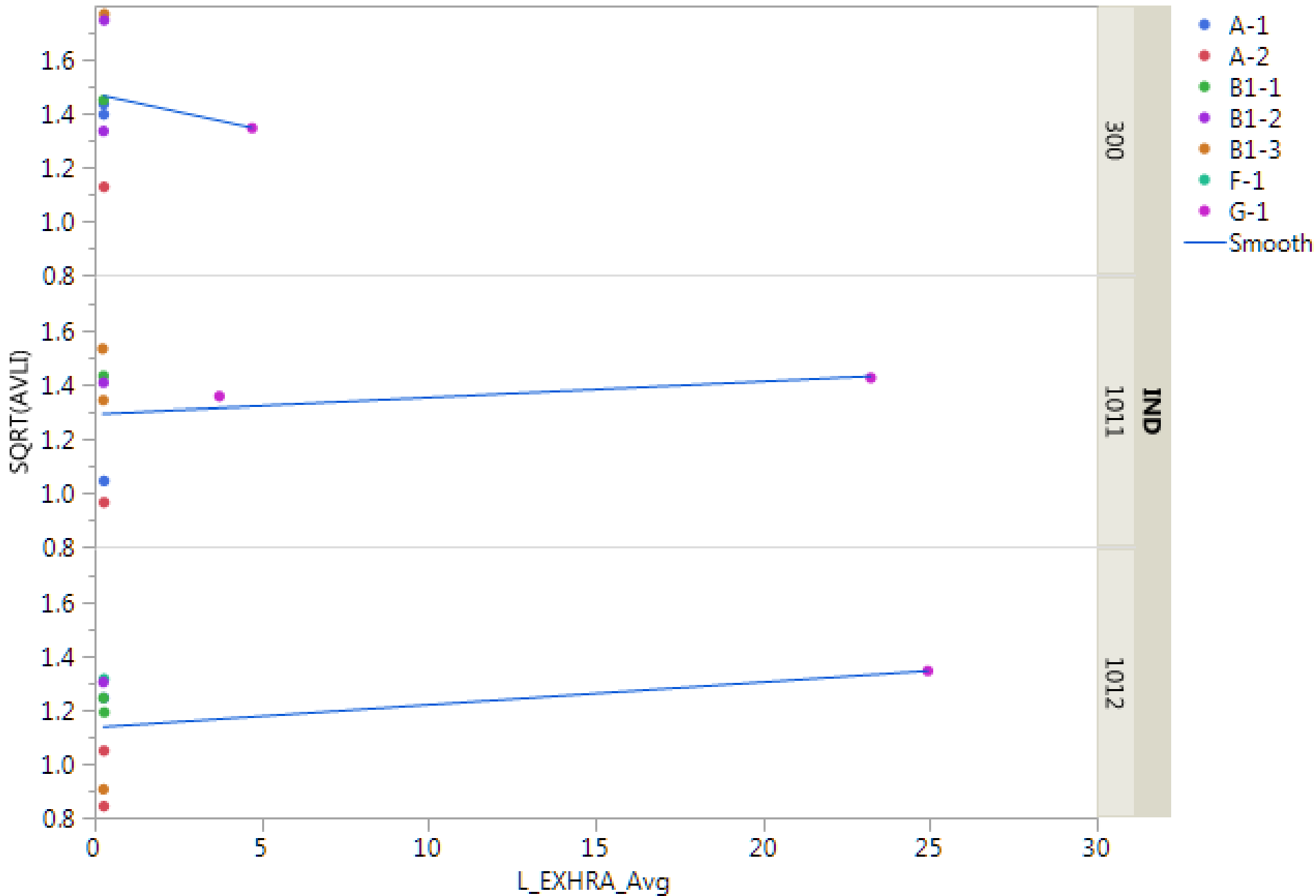
### SQRT(AVLI) vs. J\_OFHDEX\_AVG



### SQRT(AVLI) vs. J\_OFHDIN\_AVG

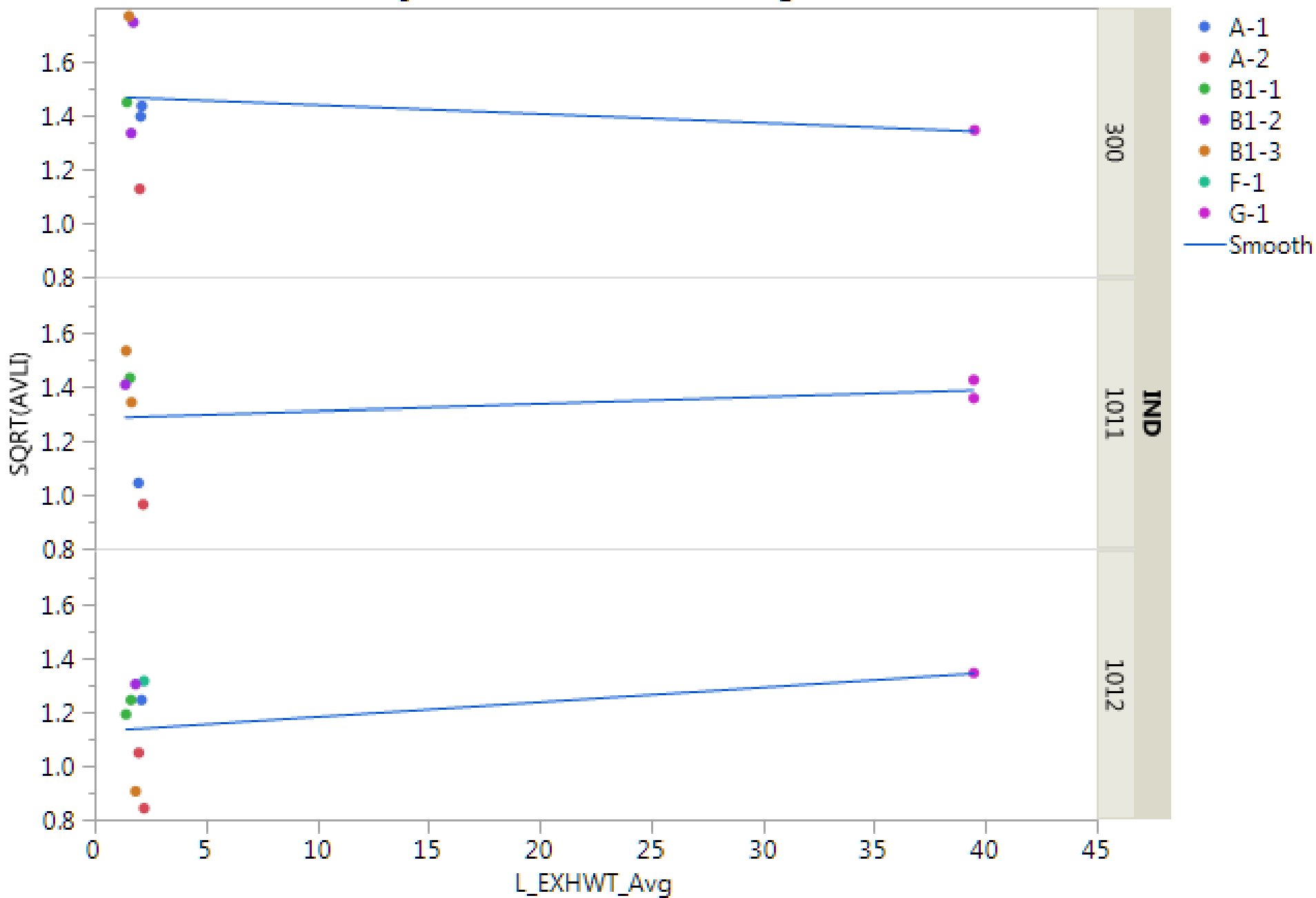


SQRT(AVLI) vs. L\_EXHRA\_Avg

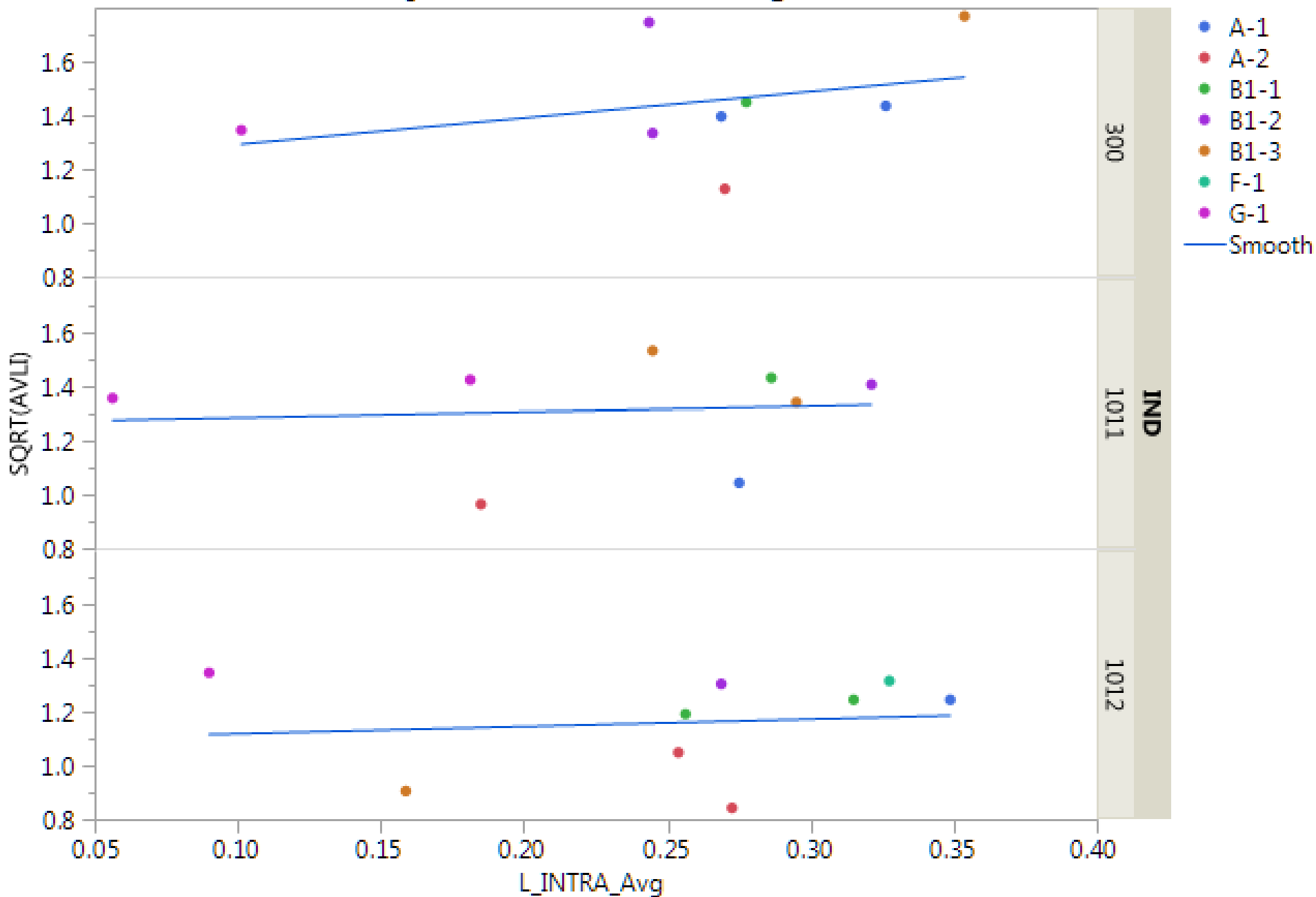




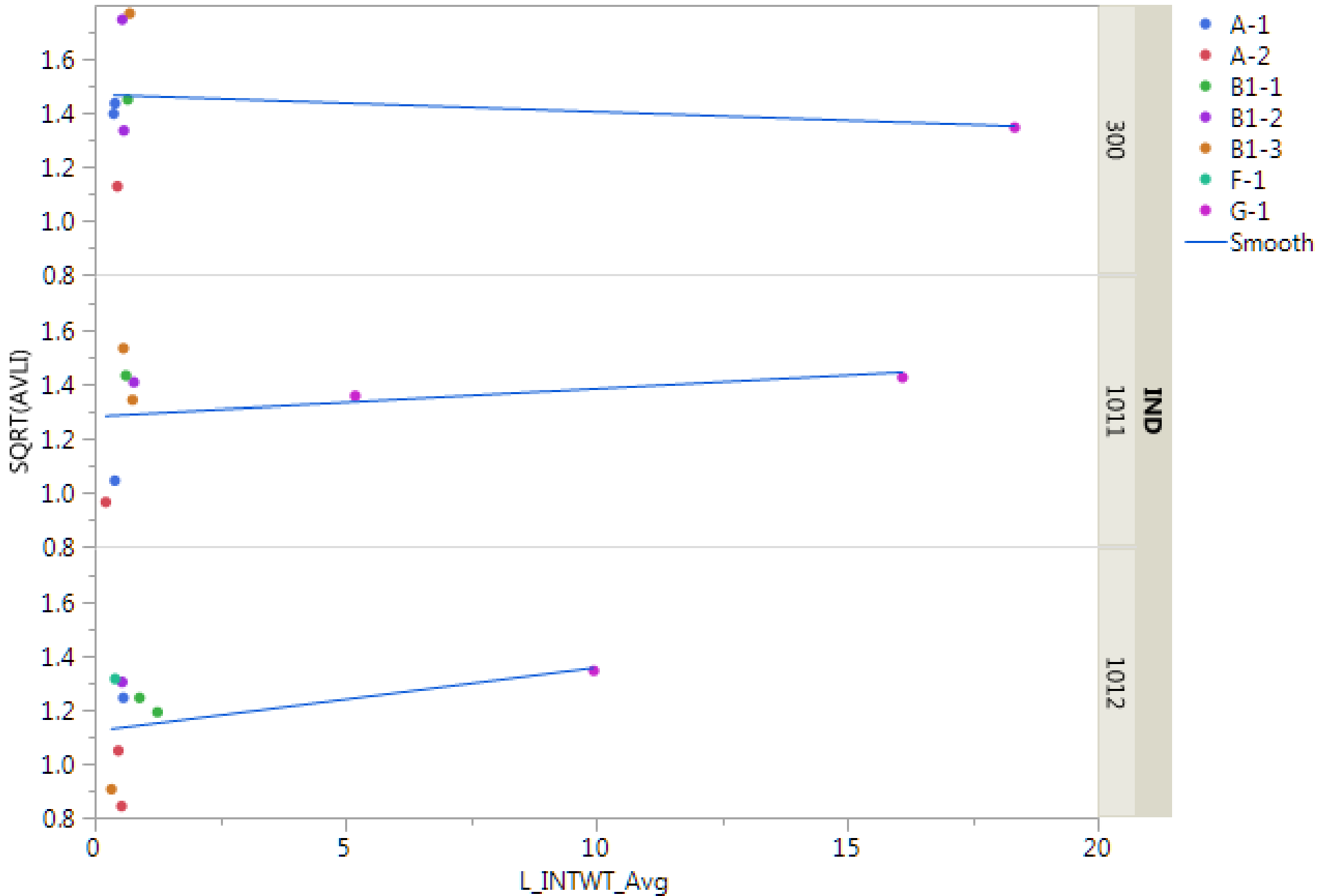
SQRT(AVLI) vs. L\_EXHWT\_Avg



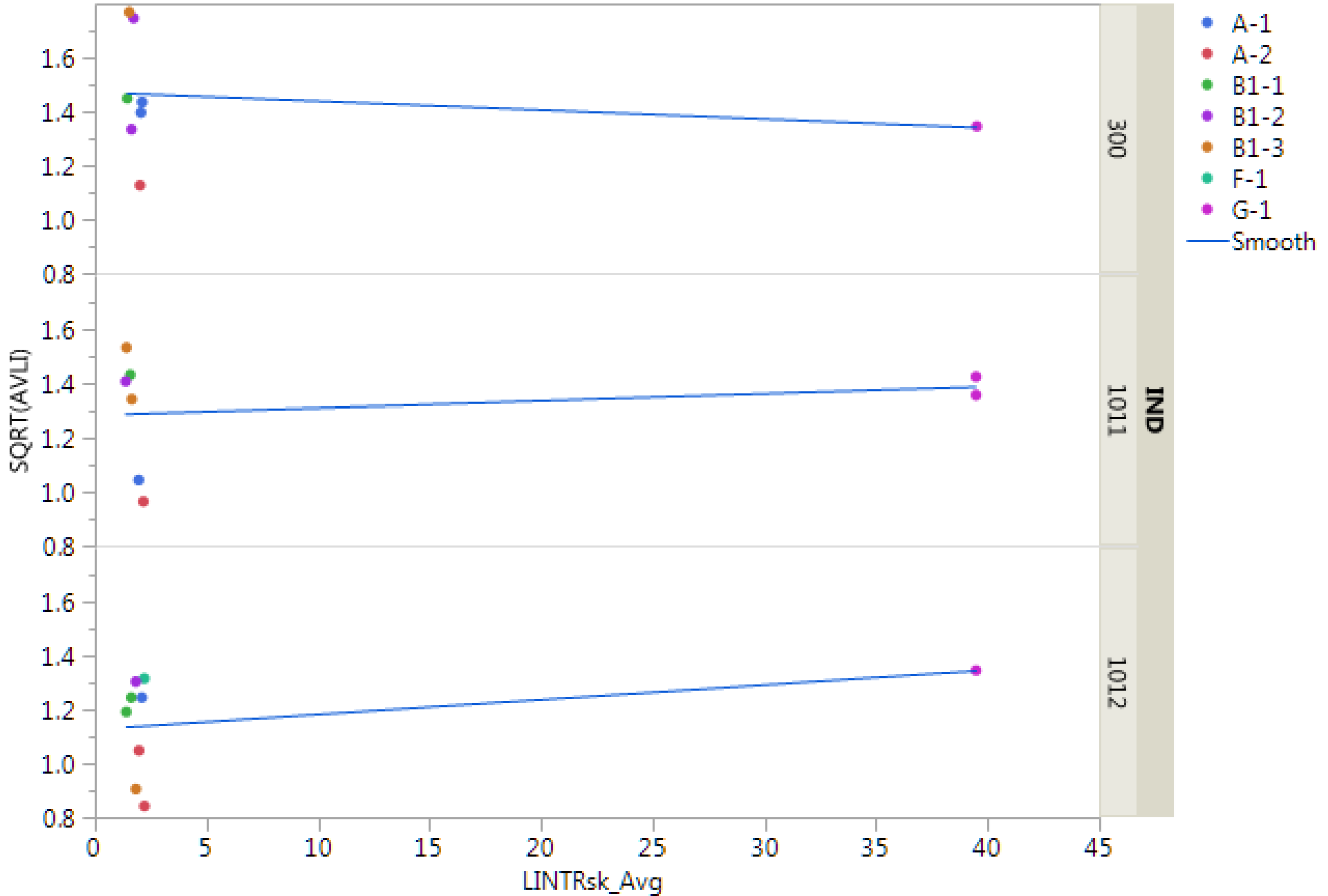
SQRT(AVLI) vs. L\_INTRA\_Avg



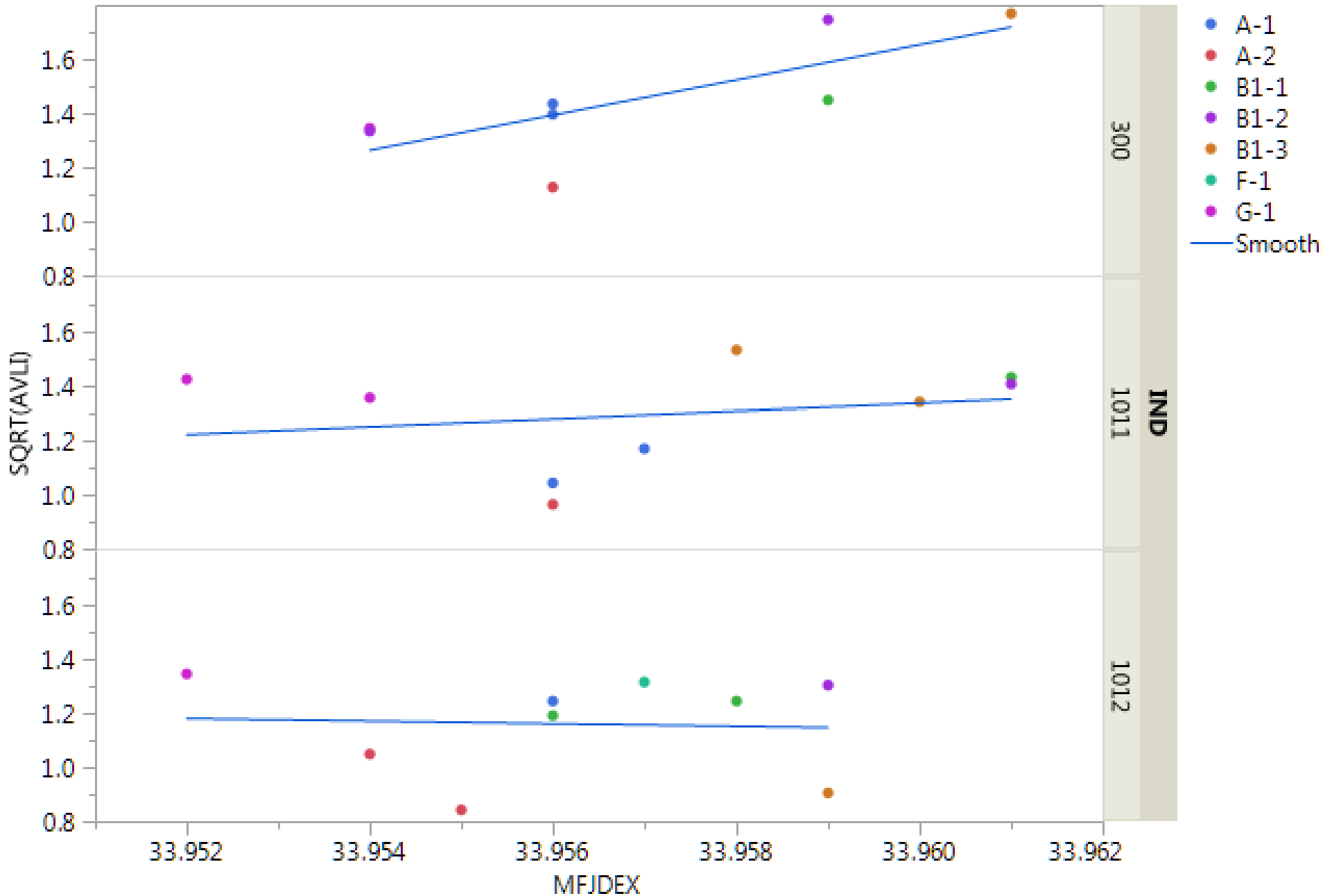
SQRT(AVLI) vs. L\_INTWT\_Avg



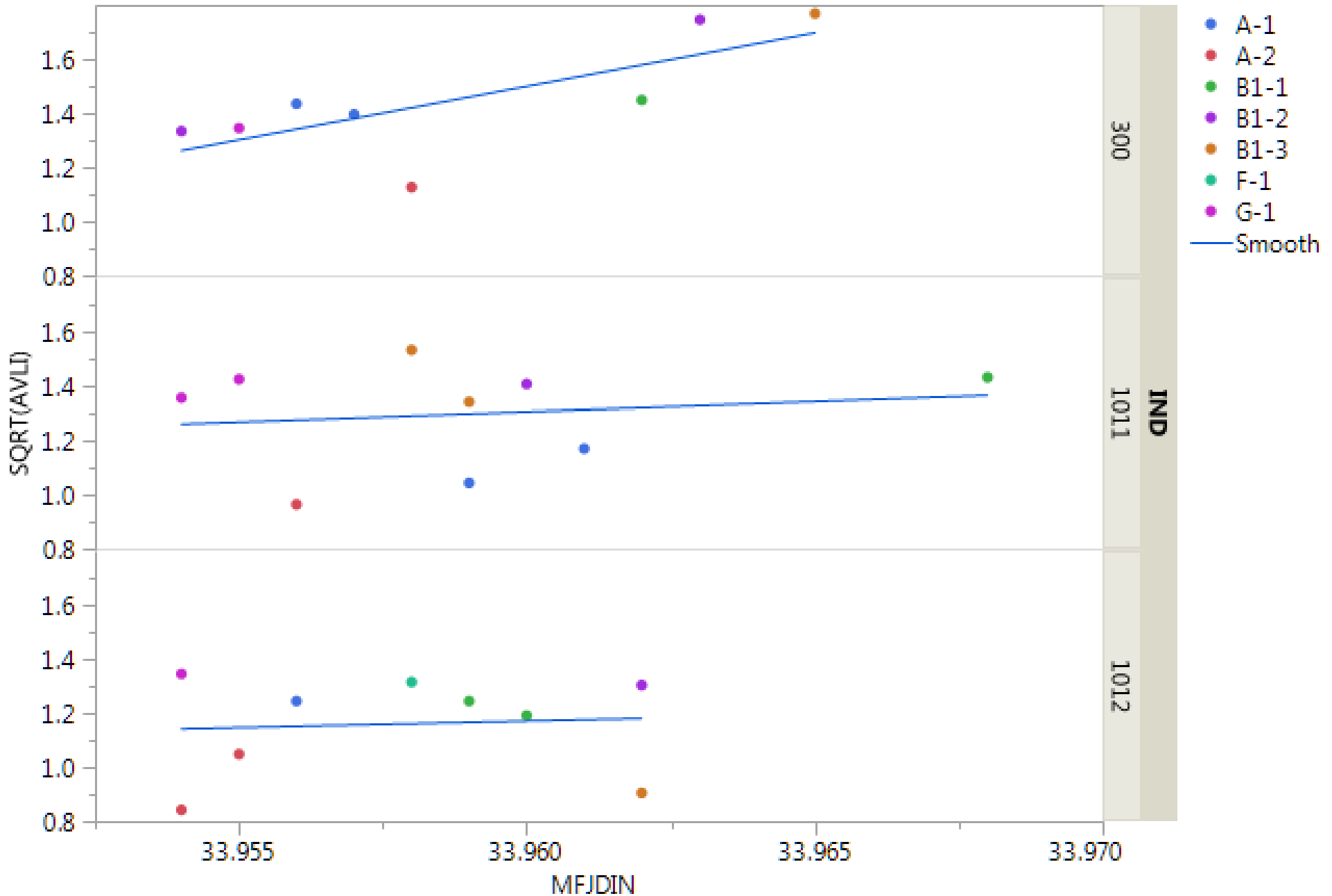
SQRT(AVLI) vs. LINTRsk\_Avg



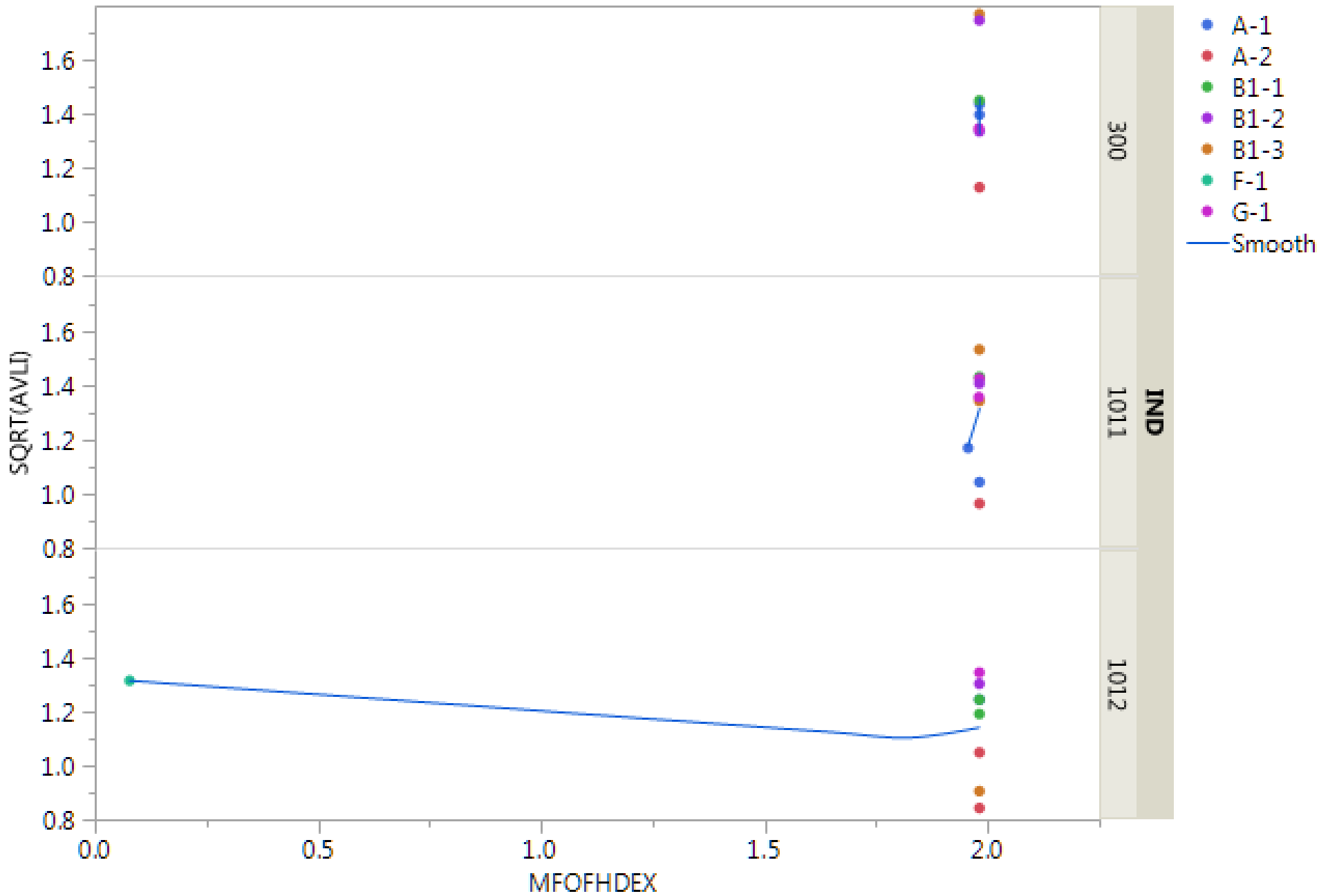
### SQRT(AVLI) vs. MFJDEX



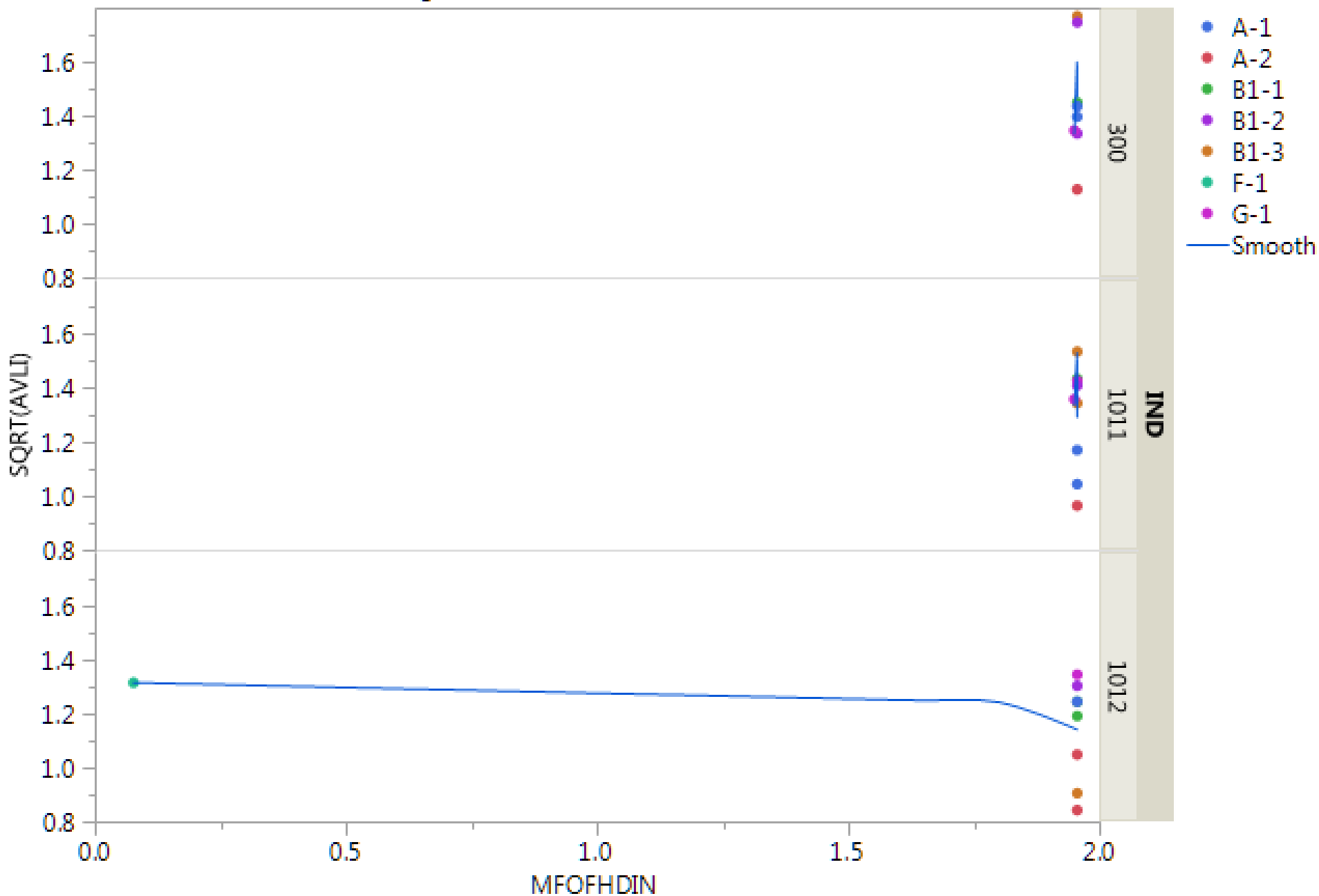
### SQRT(AVLI) vs. MFJDIN



### SQRT(AVLI) vs. MFOFHDEX

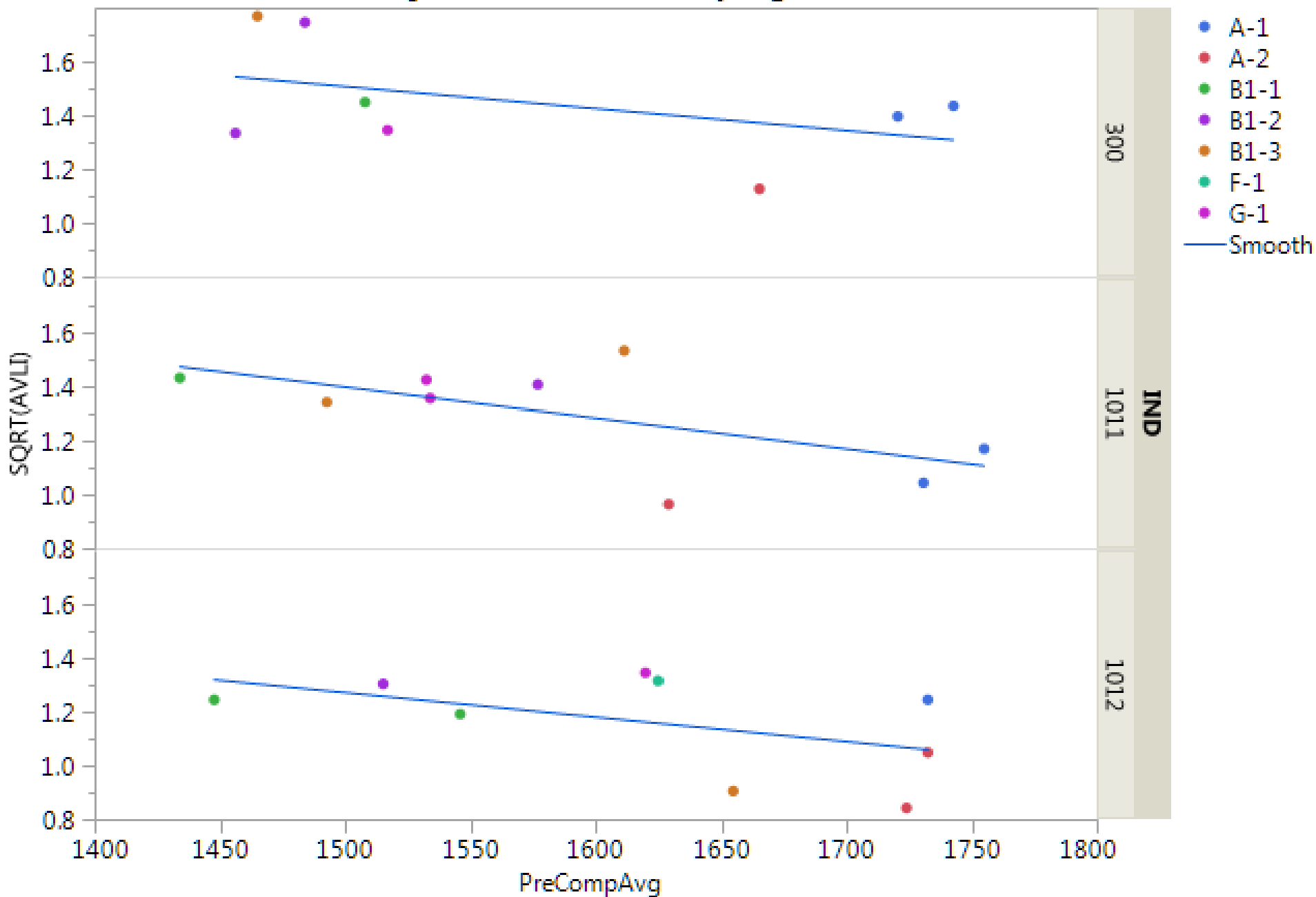


### SQRT(AVLI) vs. MFOFH DIN

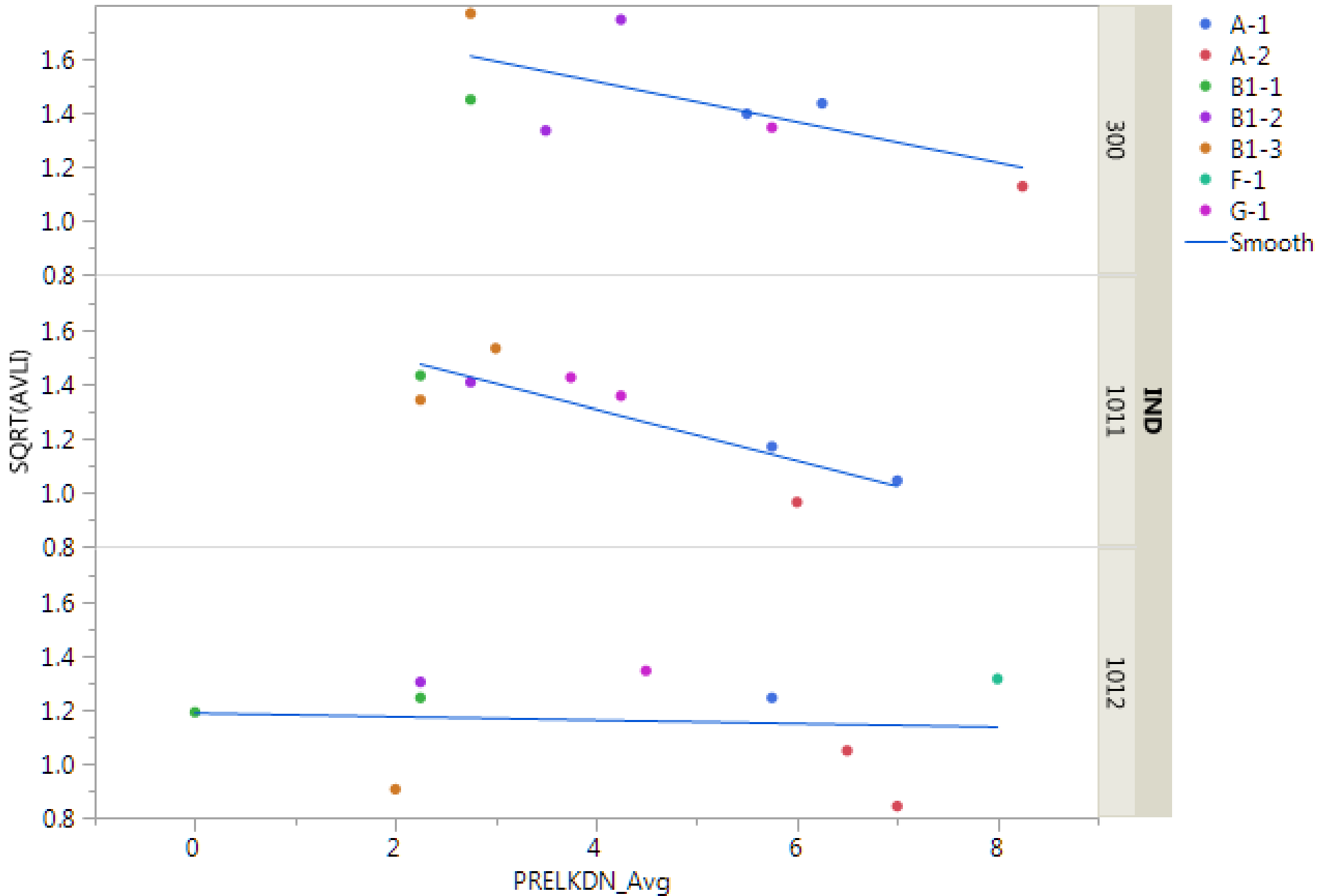




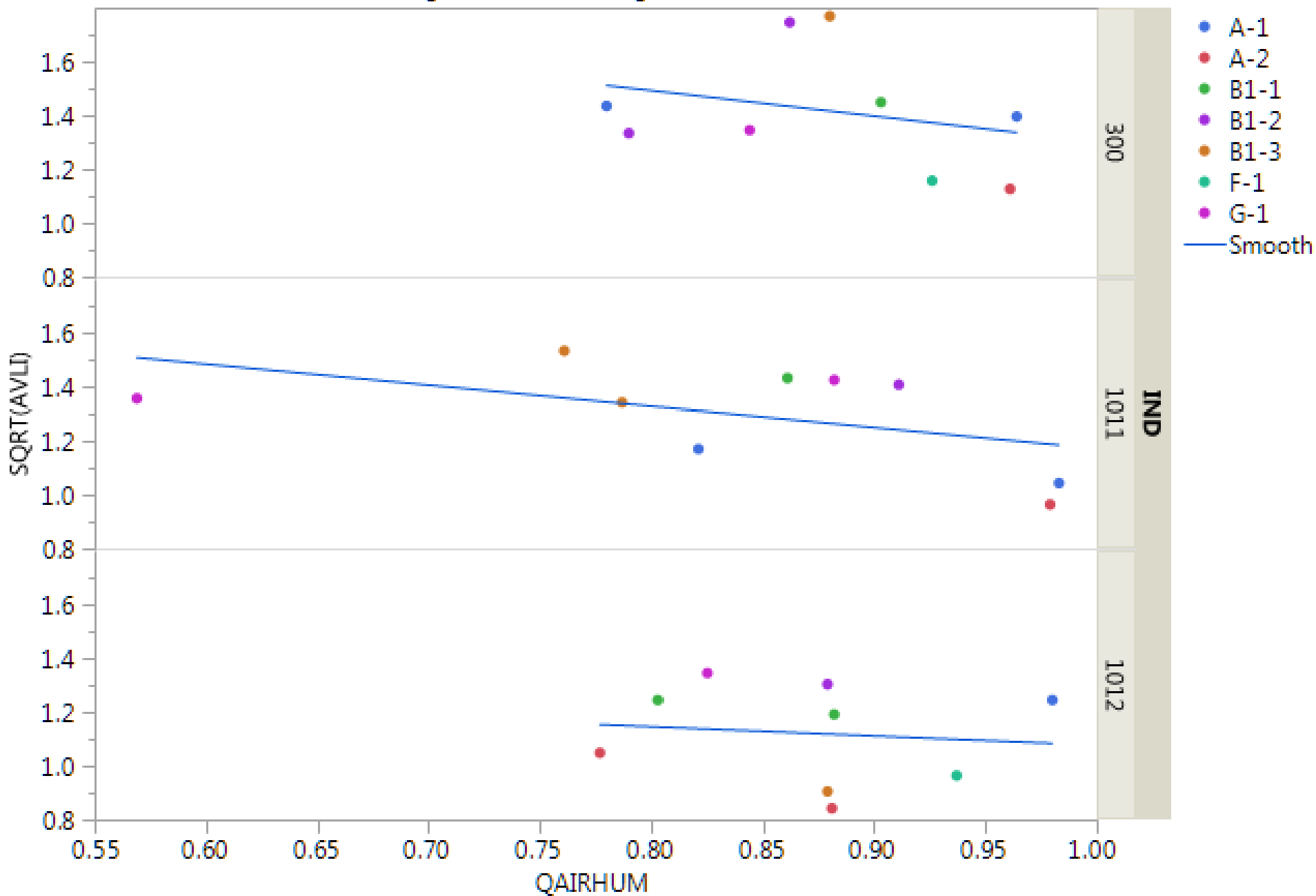
SQRT(AVLI) vs. PreCompAvg



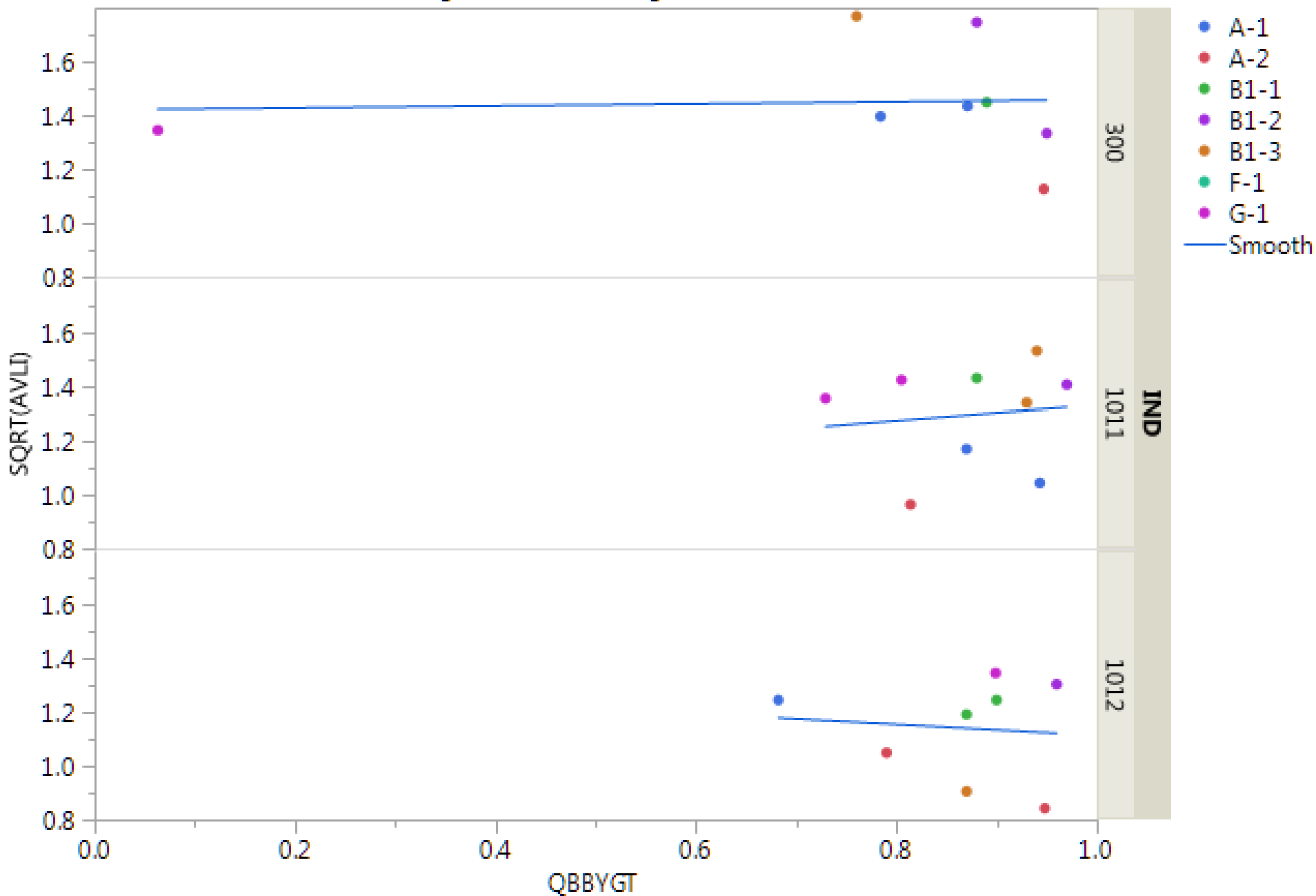
SQRT(AVLI) vs. PRELKDN\_Avg



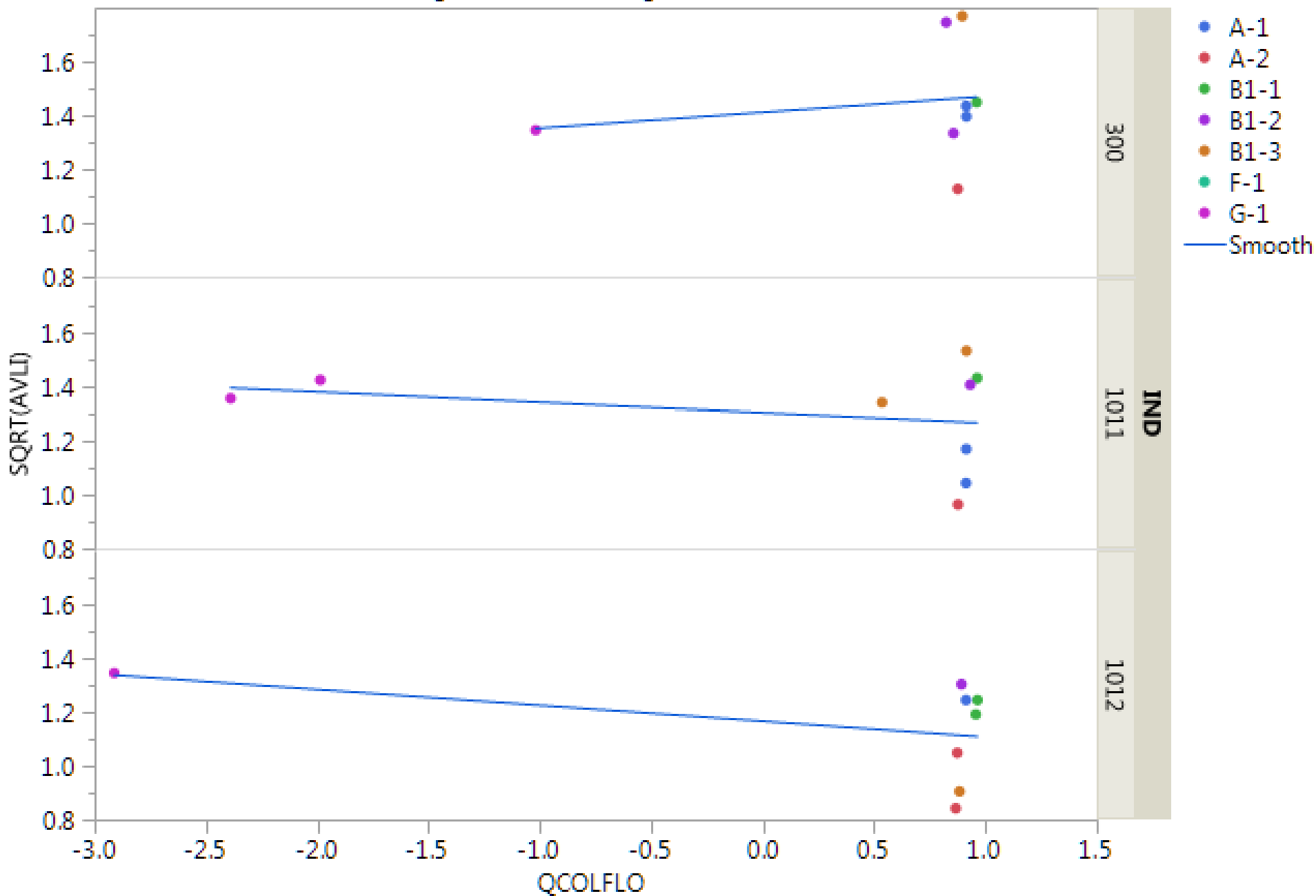
SQRT(AVLI) vs. QAIRHUM



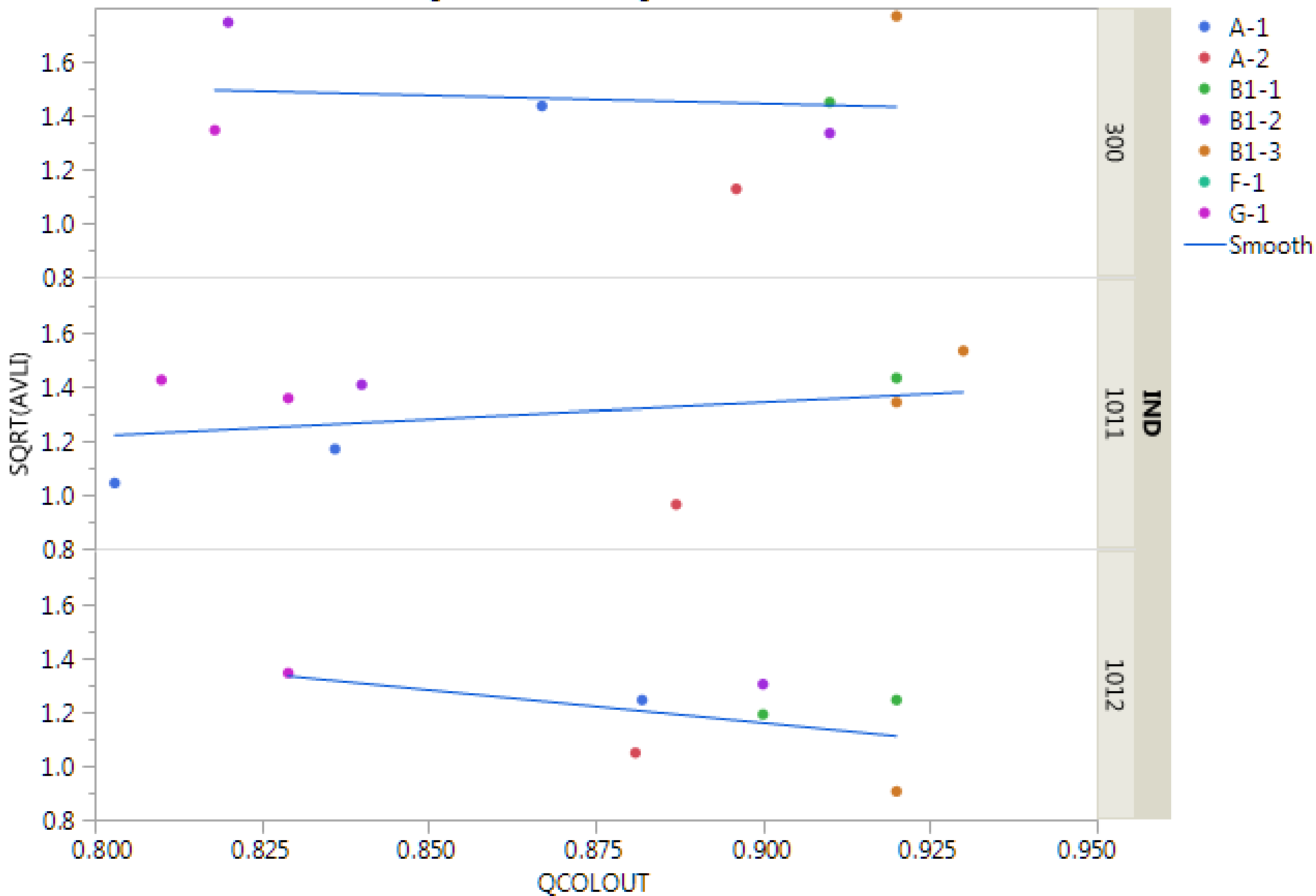
### SQRT(AVLI) vs. QBBYGT



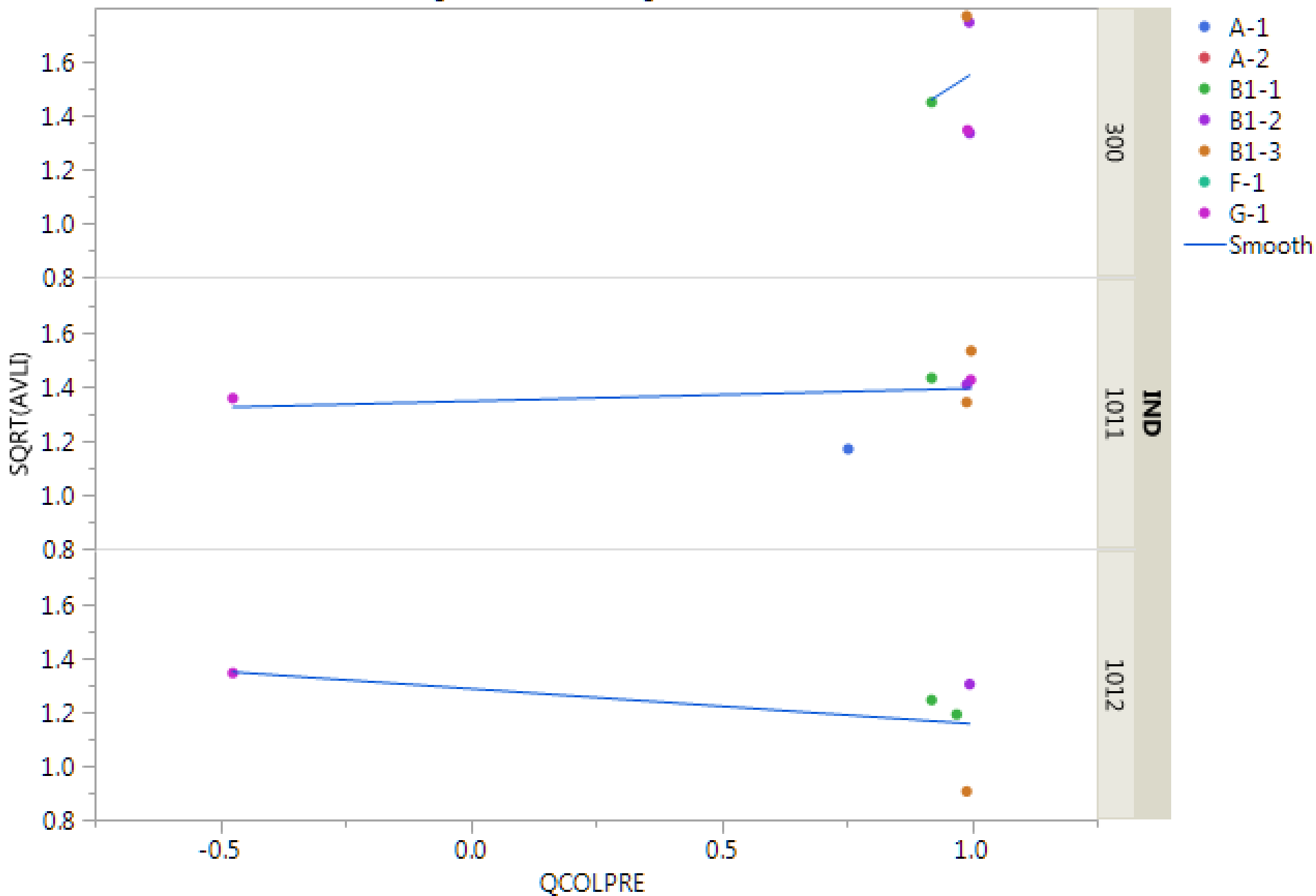
### SQRT(AVLI) vs. QCOLFLO



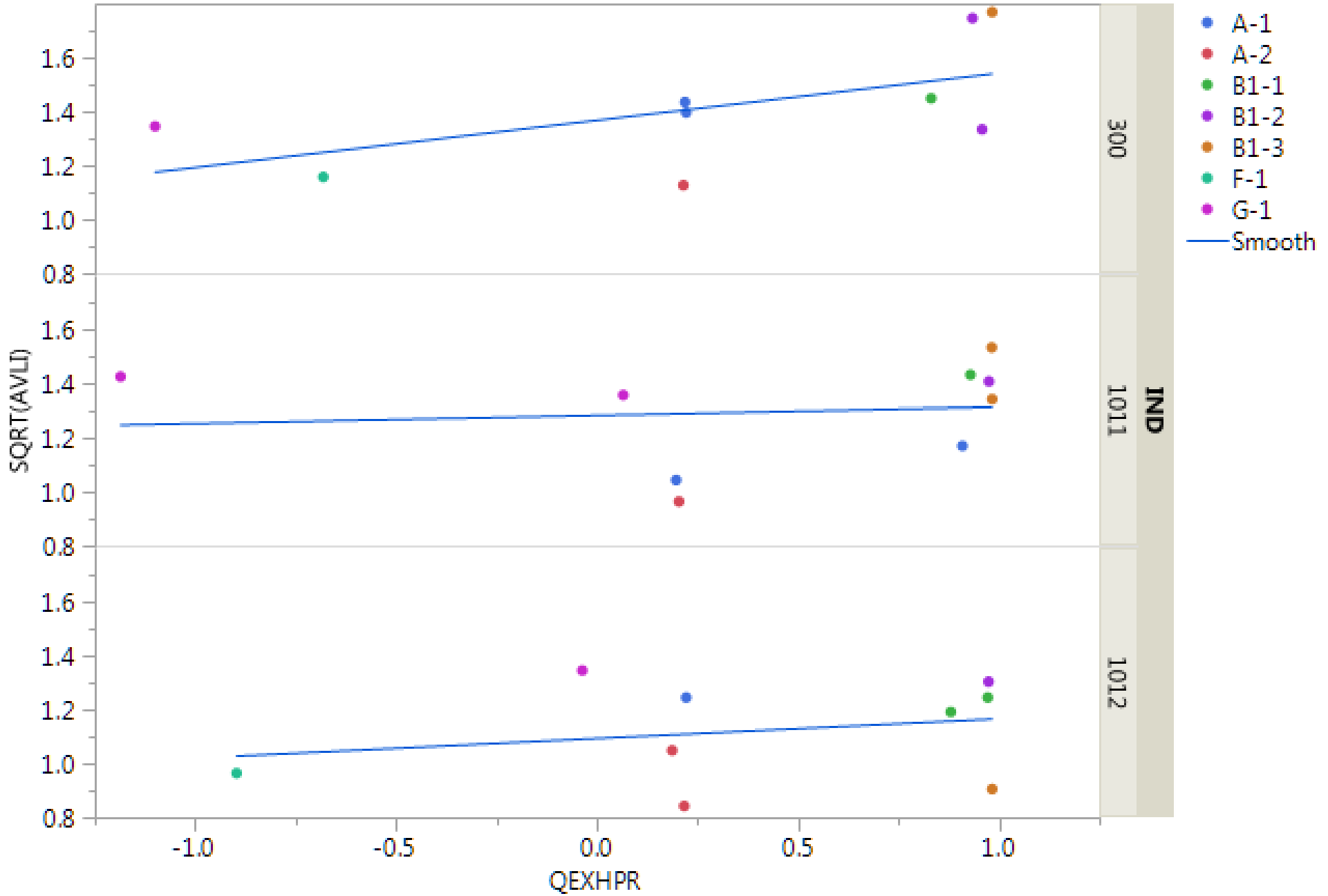
### SQRT(AVLI) vs. QCOLOUT



### SQRT(AVLI) vs. QCOLPRE

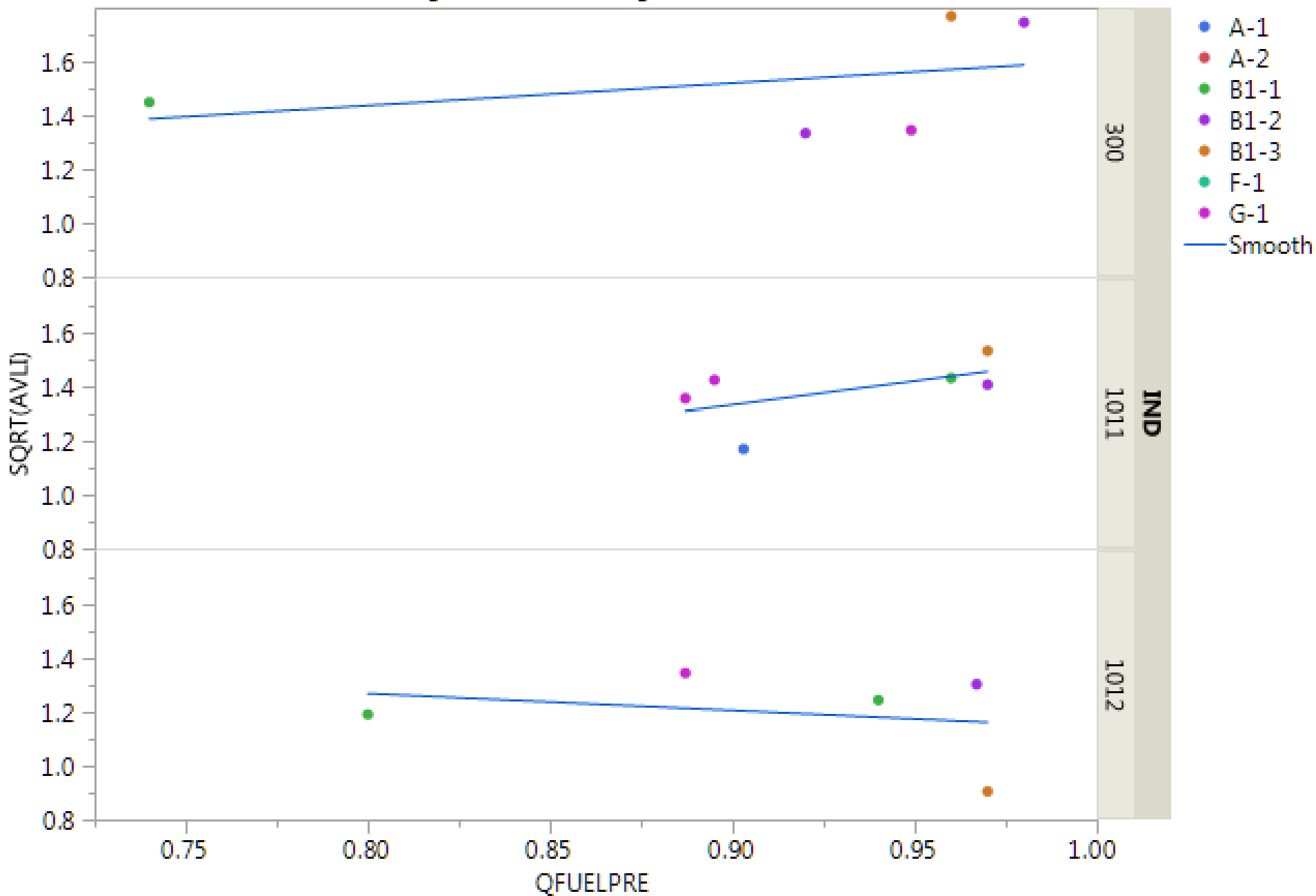


### SQRT(AVLI) vs. QEXHPR

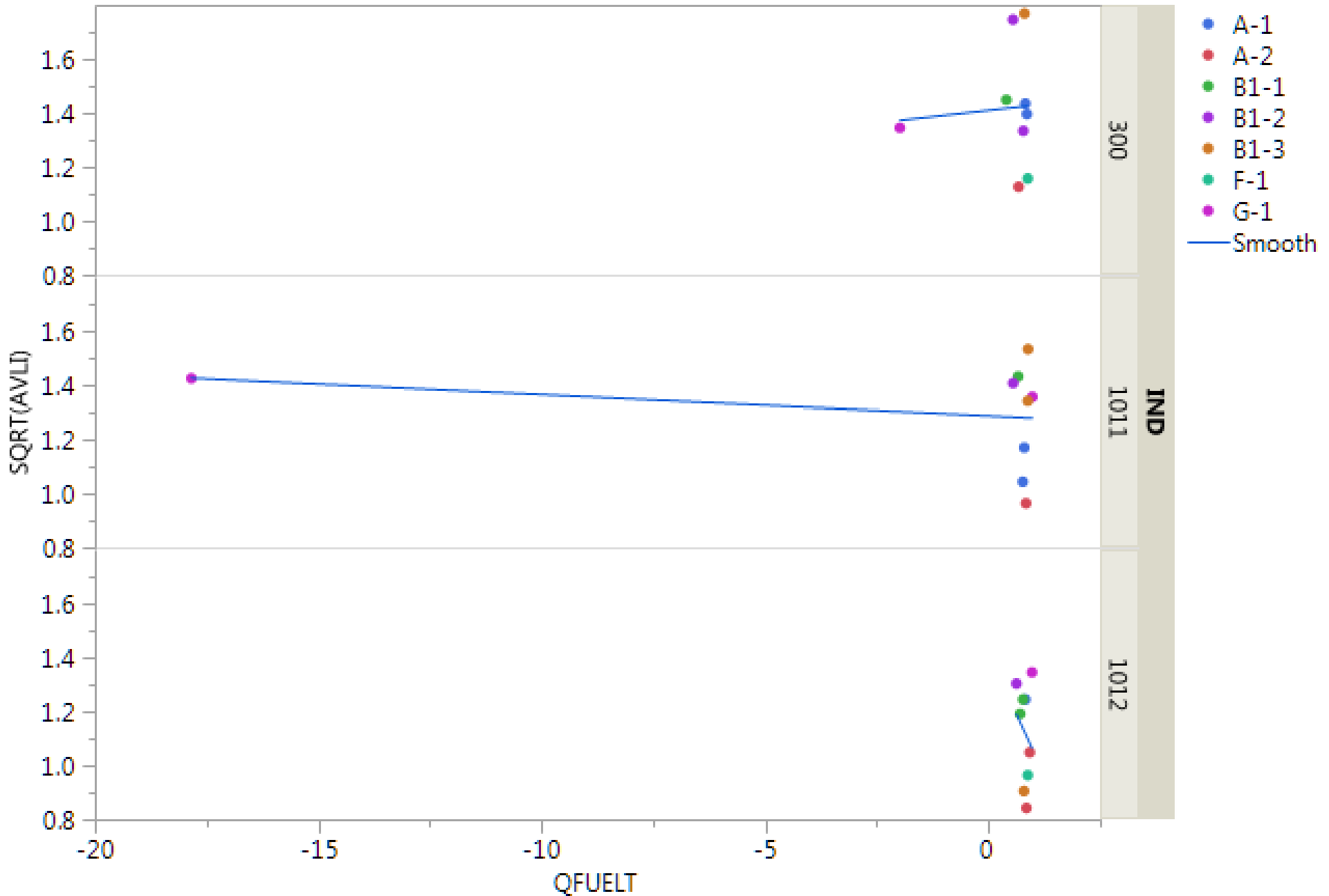




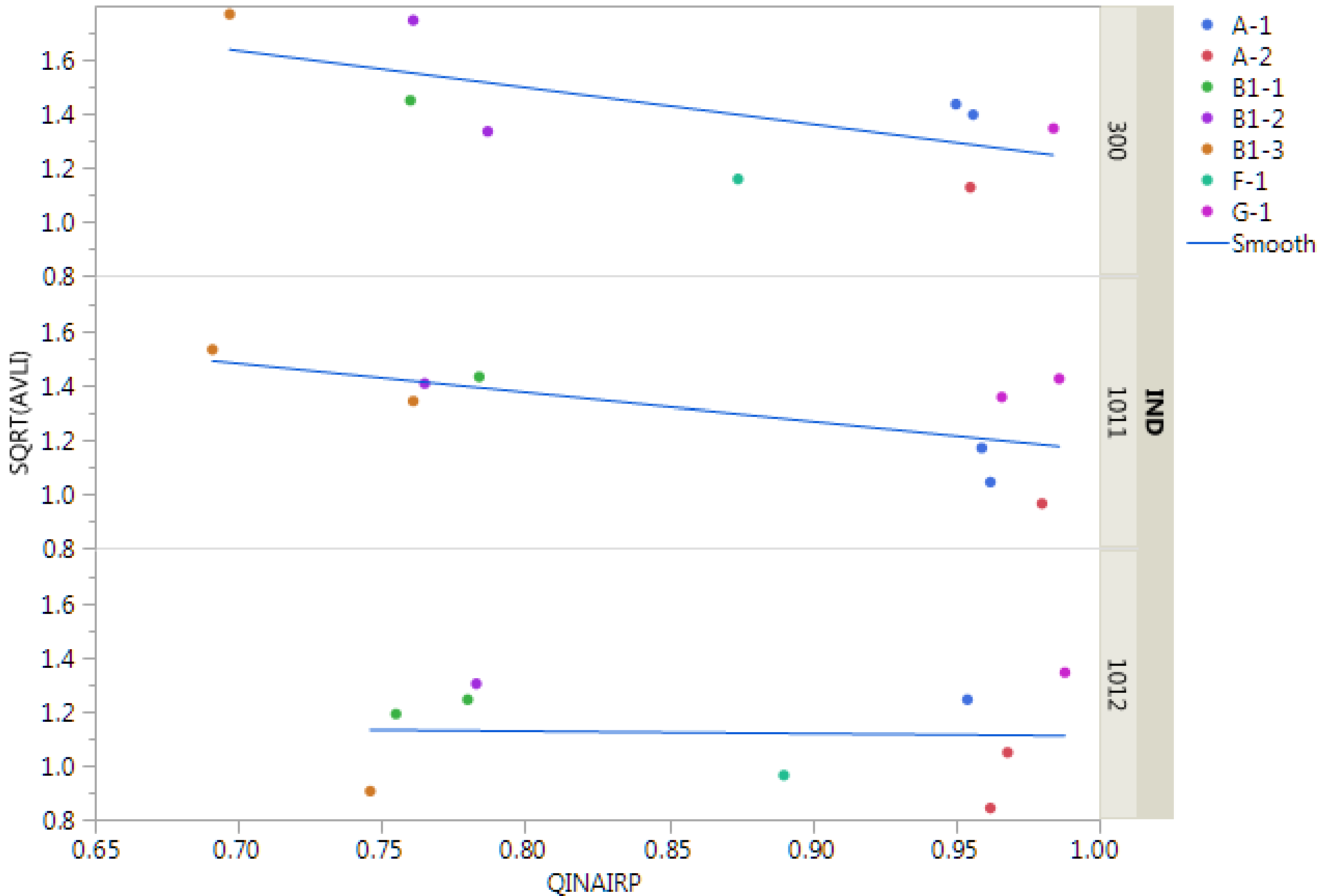
### SQRT(AVLI) vs. QFUELPRE



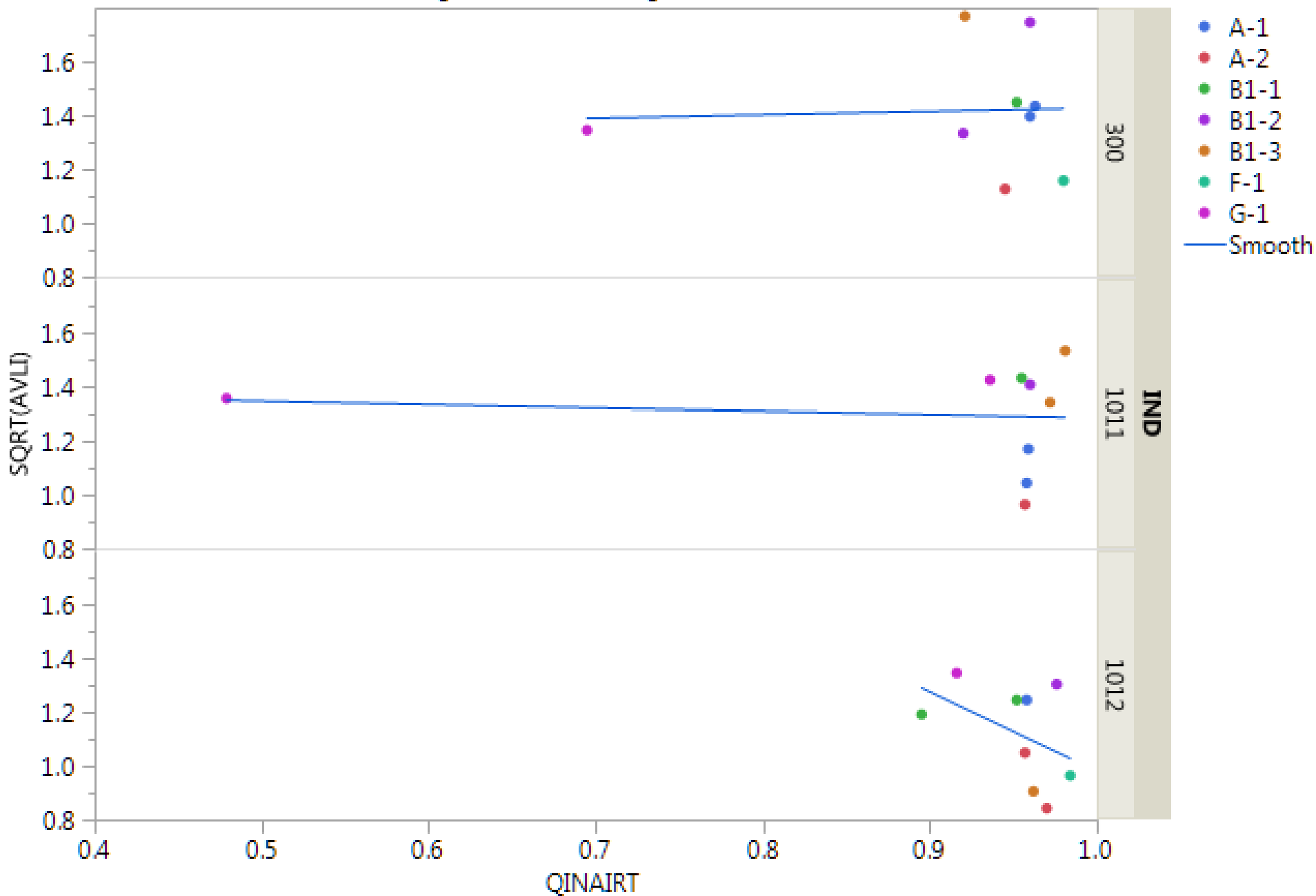
### SQRT(AVLI) vs. QFUELT



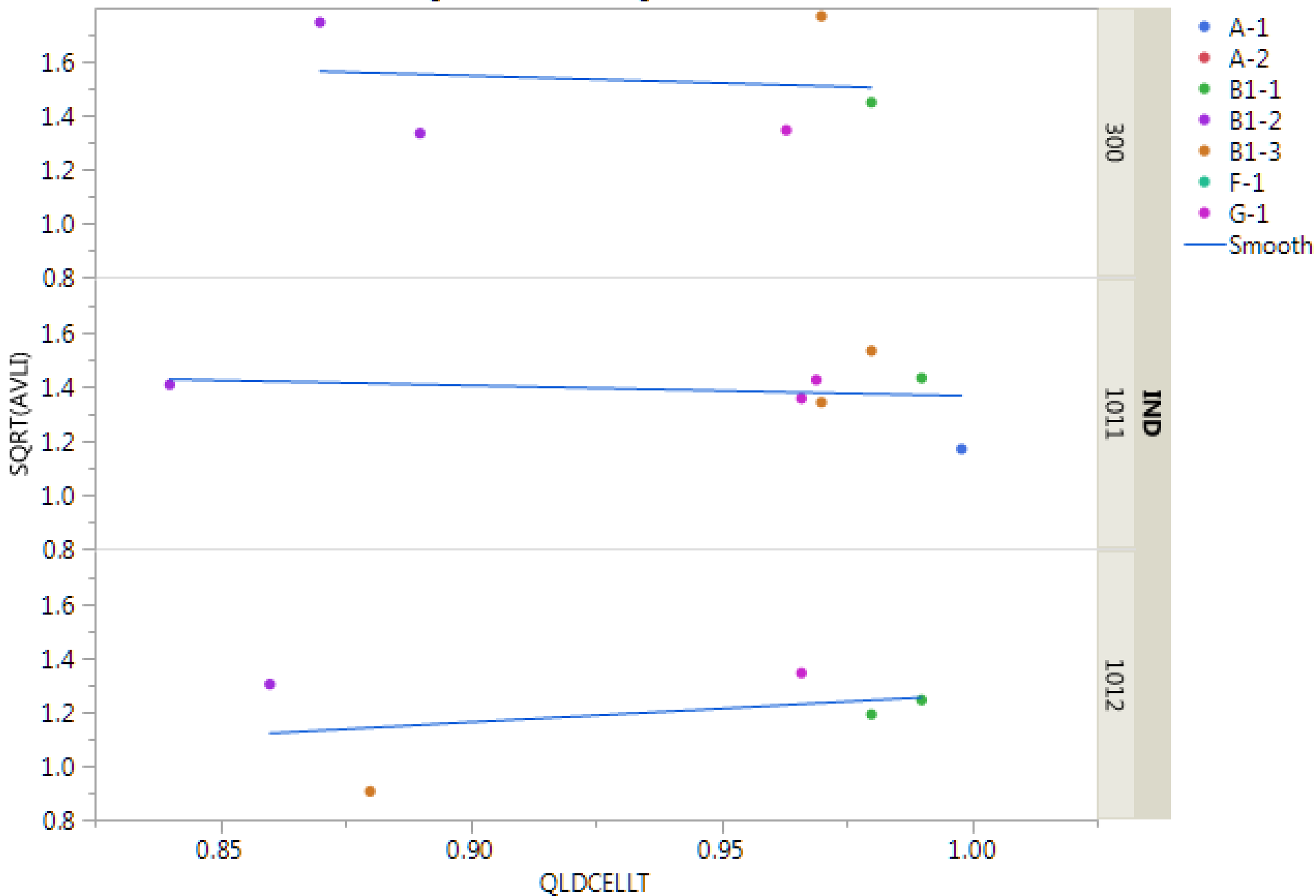
### SQRT(AVLI) vs. QINAIRP



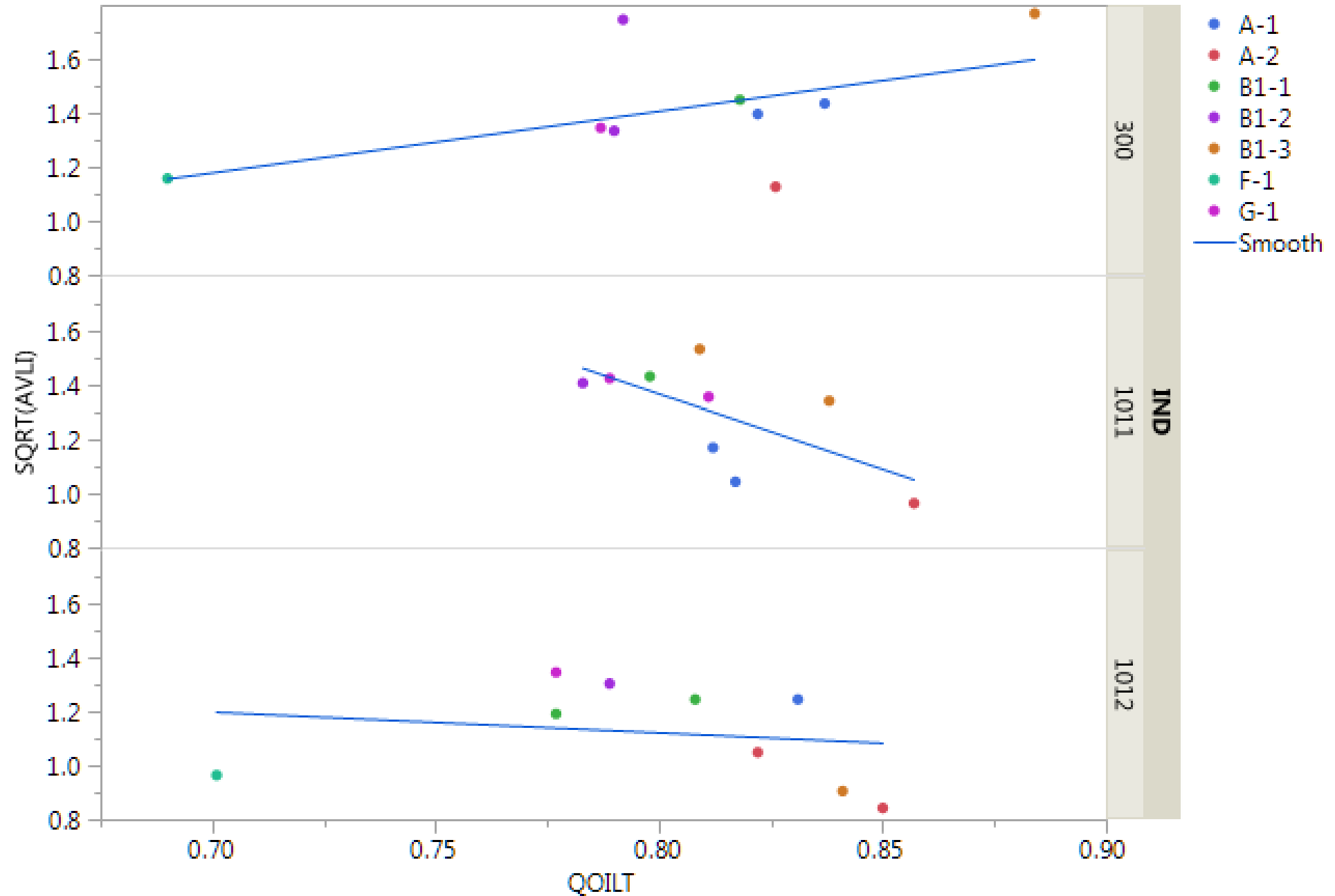
### SQRT(AVLI) vs. QINAIRT



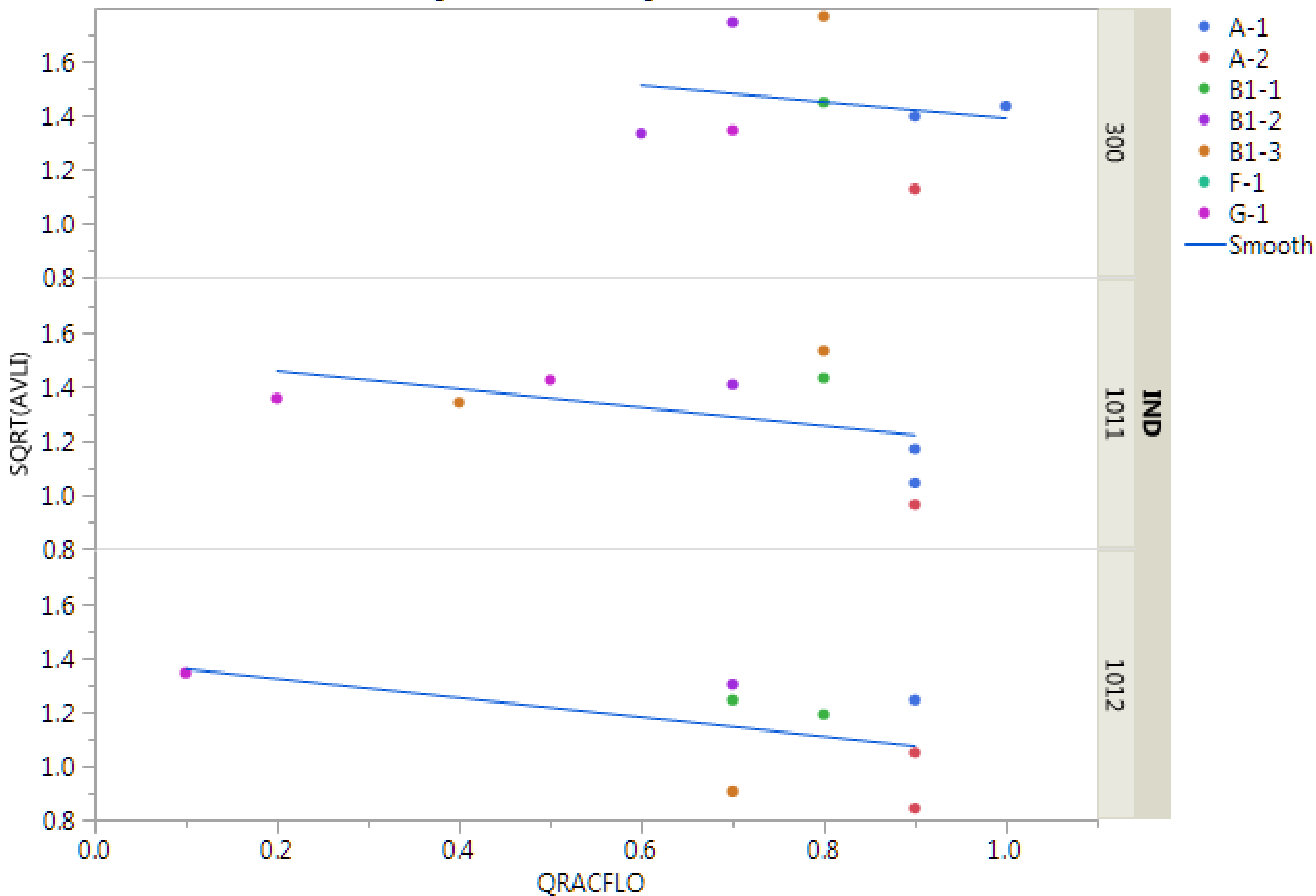
### SQRT(AVLI) vs. QLDCELLT



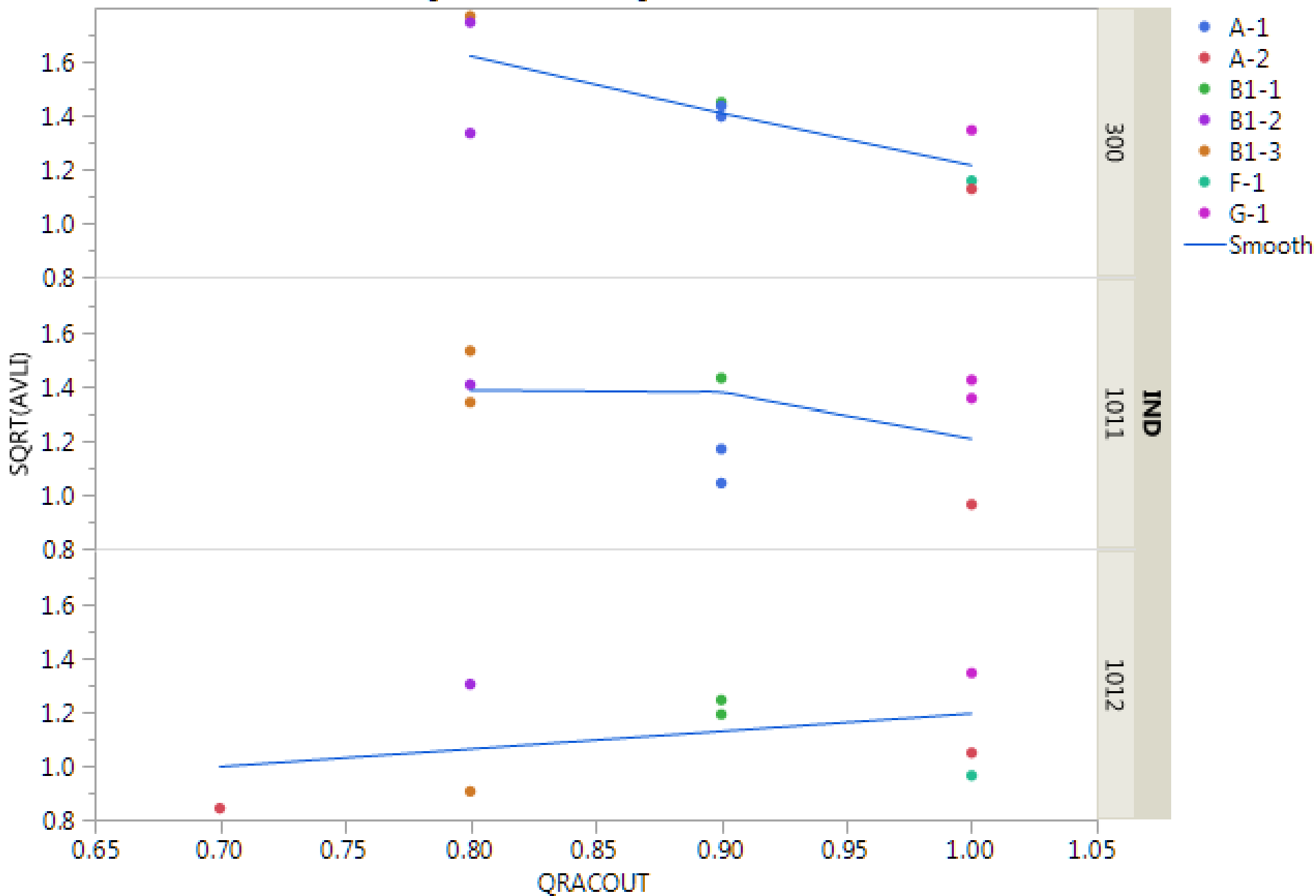
SQRT(AVLI) vs. QOILT



### SQRT(AVLI) vs. QRACFLO

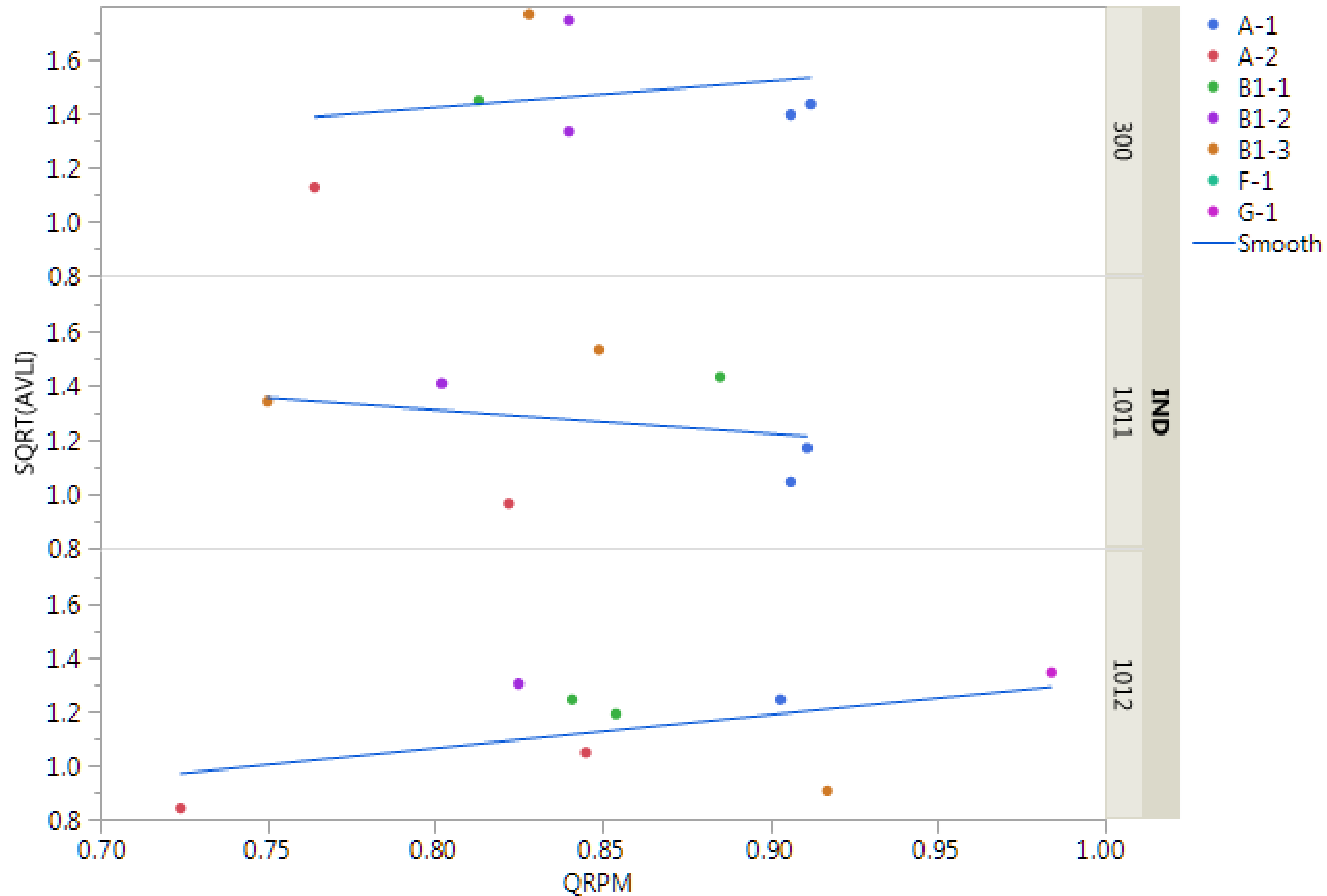


### SQRT(AVLI) vs. QRACOUT

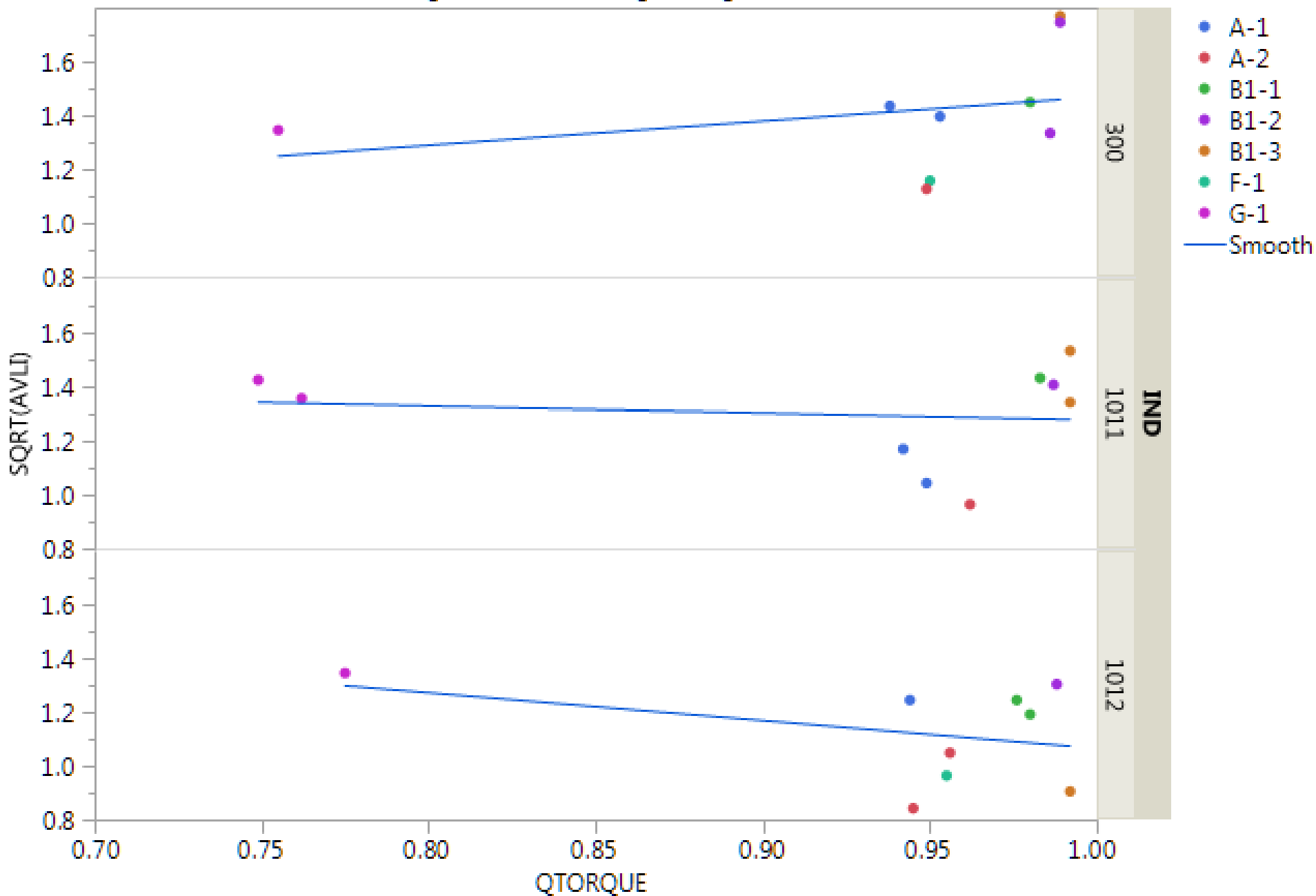




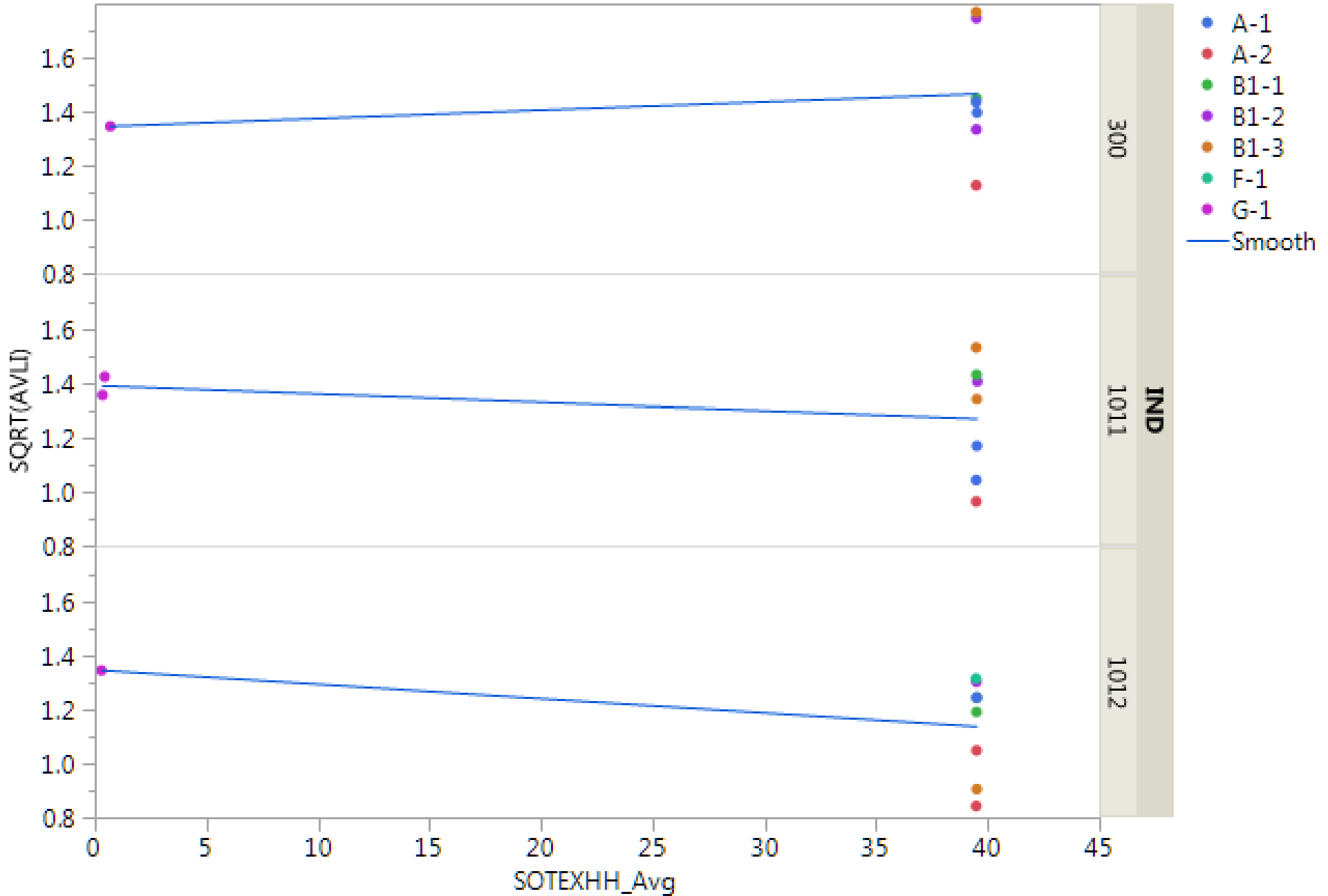
### SQRT(AVLI) vs. QRPM



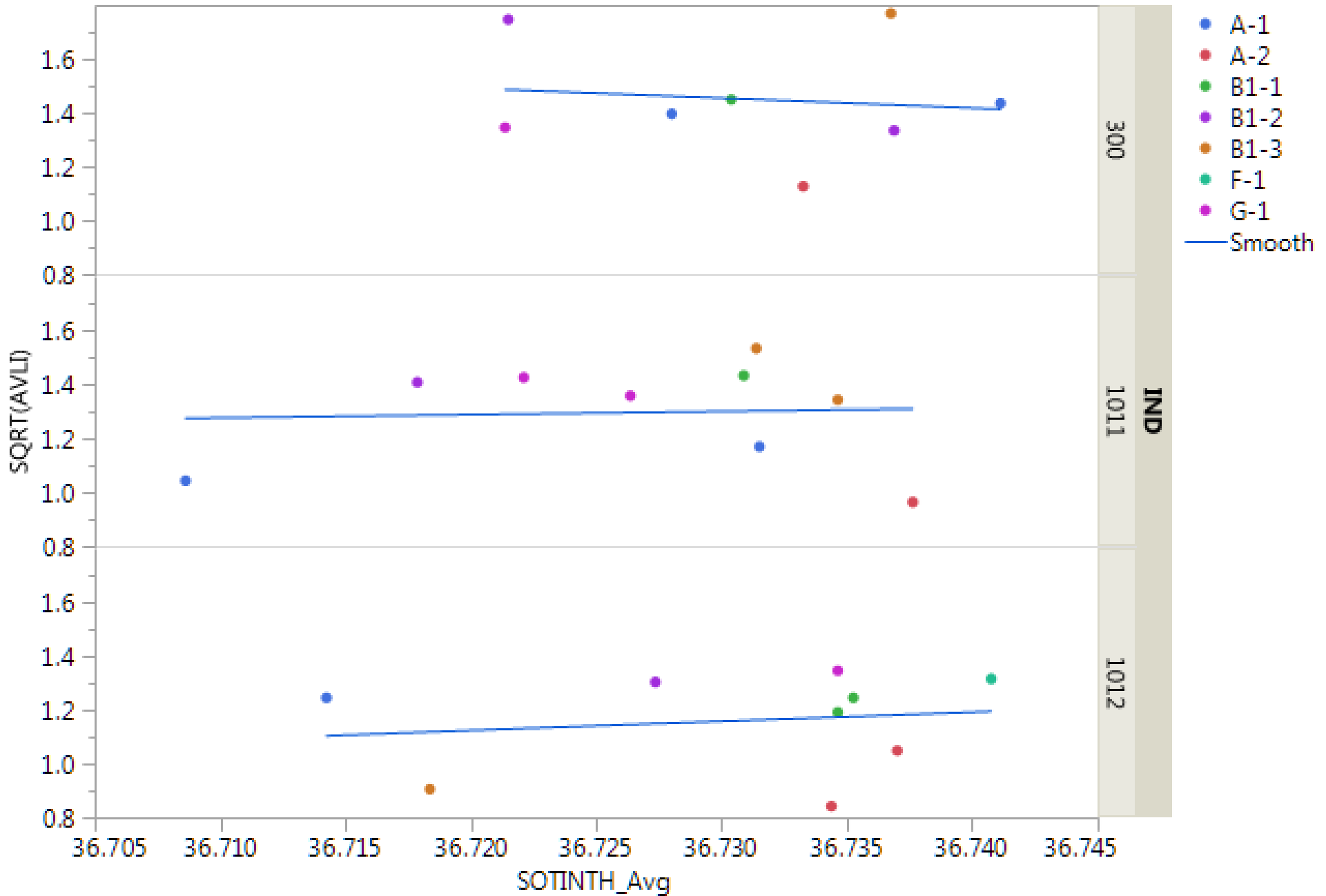
### SQRT(AVLI) vs. QTORQUE



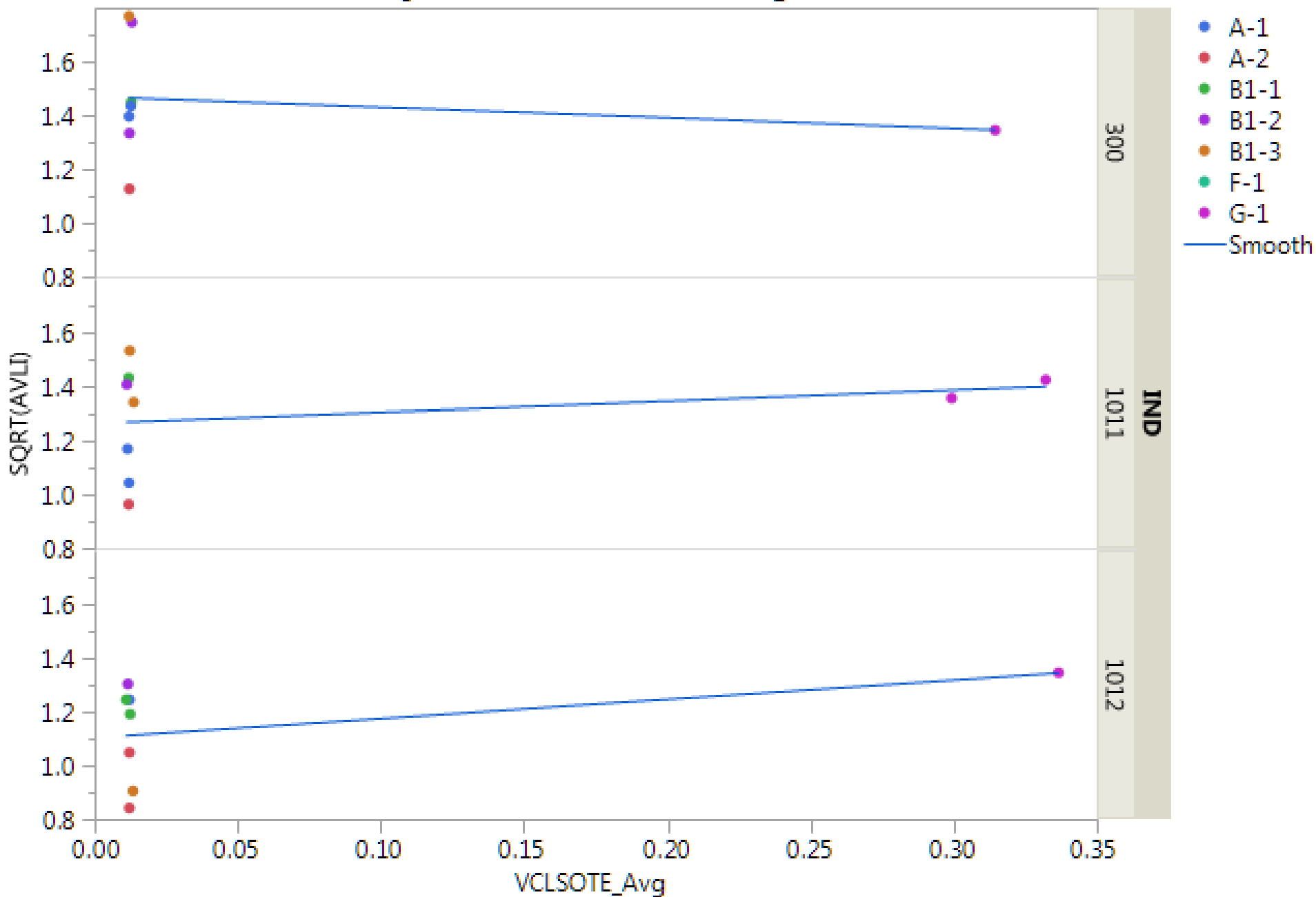
SQRT(AVLI) vs. SOTEXHH\_Avg



SQRT(AVLI) vs. SOTINTH\_Avg



SQRT(AVLI) vs. VCLSOTE\_Avg



SQRT(AVLI) vs. VCLSOTI\_Avg

