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LARG Week Feb 00

EST Resistivity Window Re-visited

- Work Continues, but we are at a stage where we could consider a new "allowed window"
- Discussion of Issues
  - Maximum X-talk allowed
  - Maximum signal loss allowed
- Inputs into the Calculation
  - Pile-up: Use HV P/S current limit
  - X-talk: Use Analytic Calculation by L. Kurchaninov times 1.3

Discussion of Issues

- What Maximum X-talk do we allow?
  - Loss of signal to noise for Muons
  - Spreading of Shower (somewhat correctable if X-talk well known)
  - My opinion: <5%
  - My proposal: <4.8%
- What Maximum Signal loss do we accept?
  - Adds to constant term
  - Correction is “in-data”
  - My opinion/proposal:
    - 1%/0.24% absolute
    - 0.2% after correction

Inputs

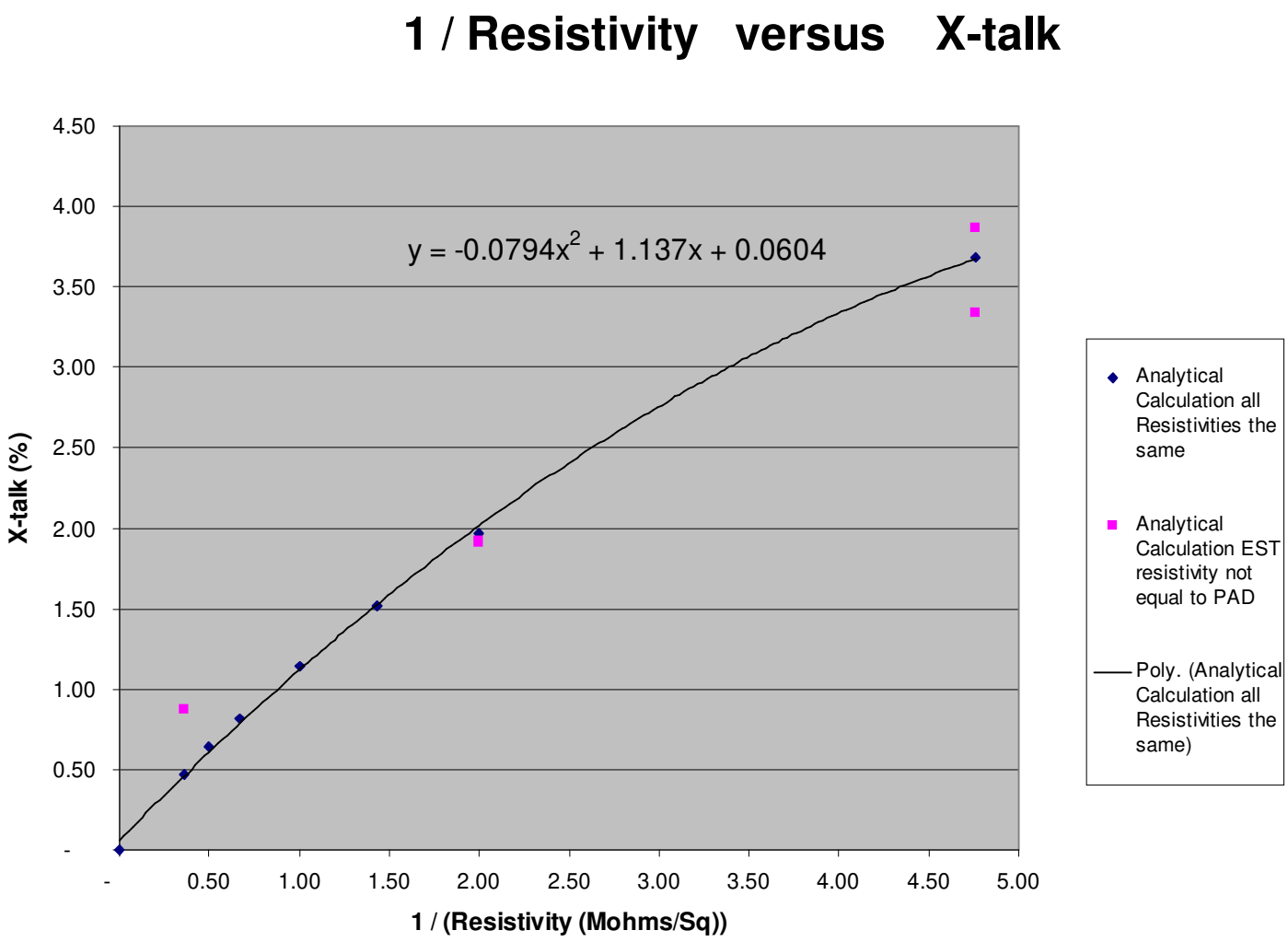
- X-talk…. Sets Low Resistance Limit
  - Analytic Calculation by L. Kurchaninov
  - Old PSPICE calculation
  - Simple models
  - Real Measurements at Test beam
  - Good Agreement … Use conservatively Kurchaninov times 1.3
- Pile-up Current … Sets High Resistance limit
  - HV P/S limit
  - LARG 24 limit
  - Monte-Carlo estimate by A. Kiryunin LARG Week Dec 99… difference to LARG 24 well understood.
  - Use VERY conservatively HV P/S limit

Pile-up

Max in Gaps	Pile-up (HV P/S limit 1-8) nA	Kiryunin nA
1 to 8	5000	696
9 to 24	703	253
25 to 32	90	98
33 to 40	20	27

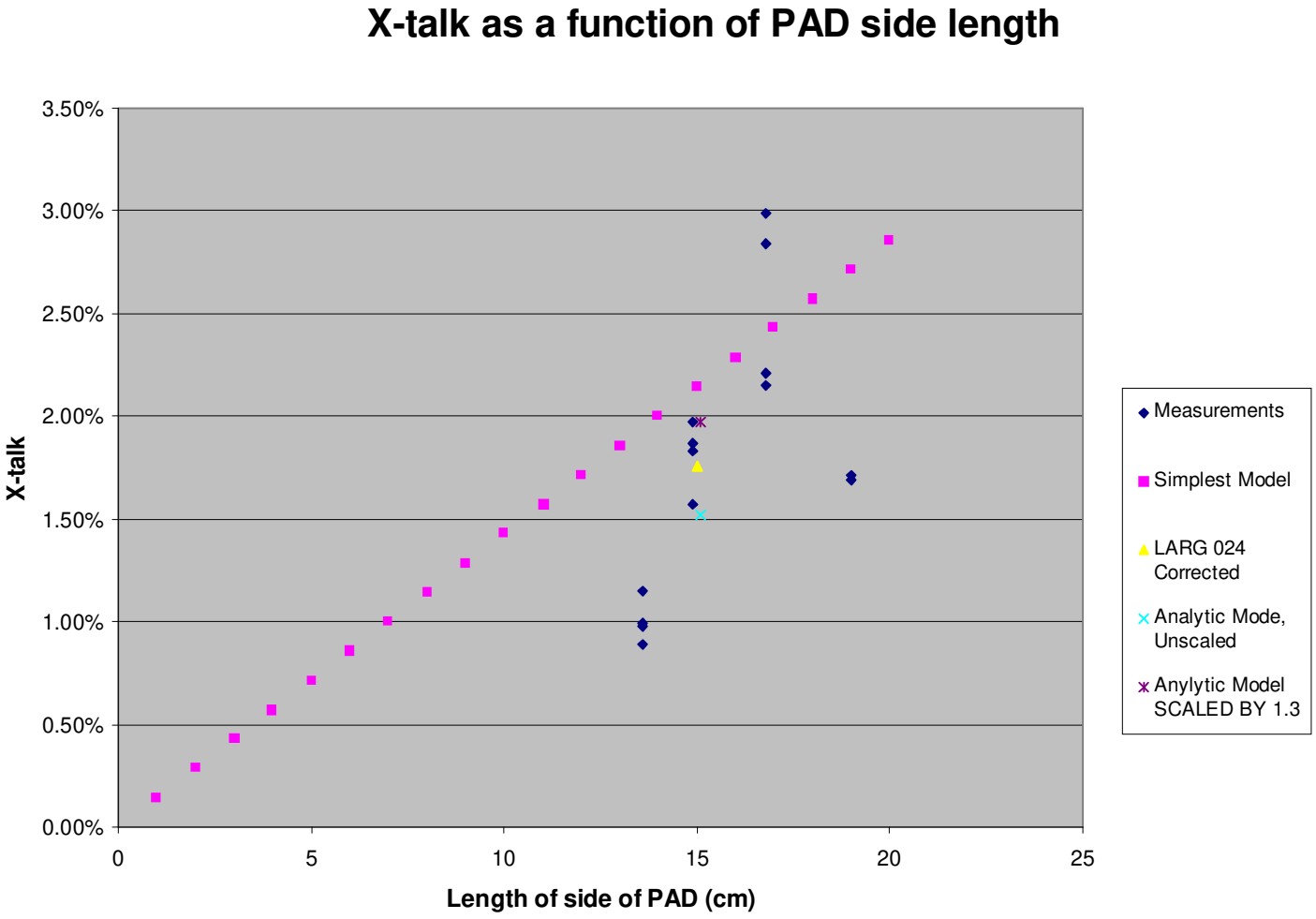
- VERY conservatively I take the HV P/S limit numbers
- This leaves room for the maximum number of minimum bias events to rise from 17.5 in 1995, to 23 today, to 160 in 2010

X-Talk Analytic Calculation



- Note model is reasonably independent of EST resistivity in HIGH X-Talk region where we need to use it

X-Talk



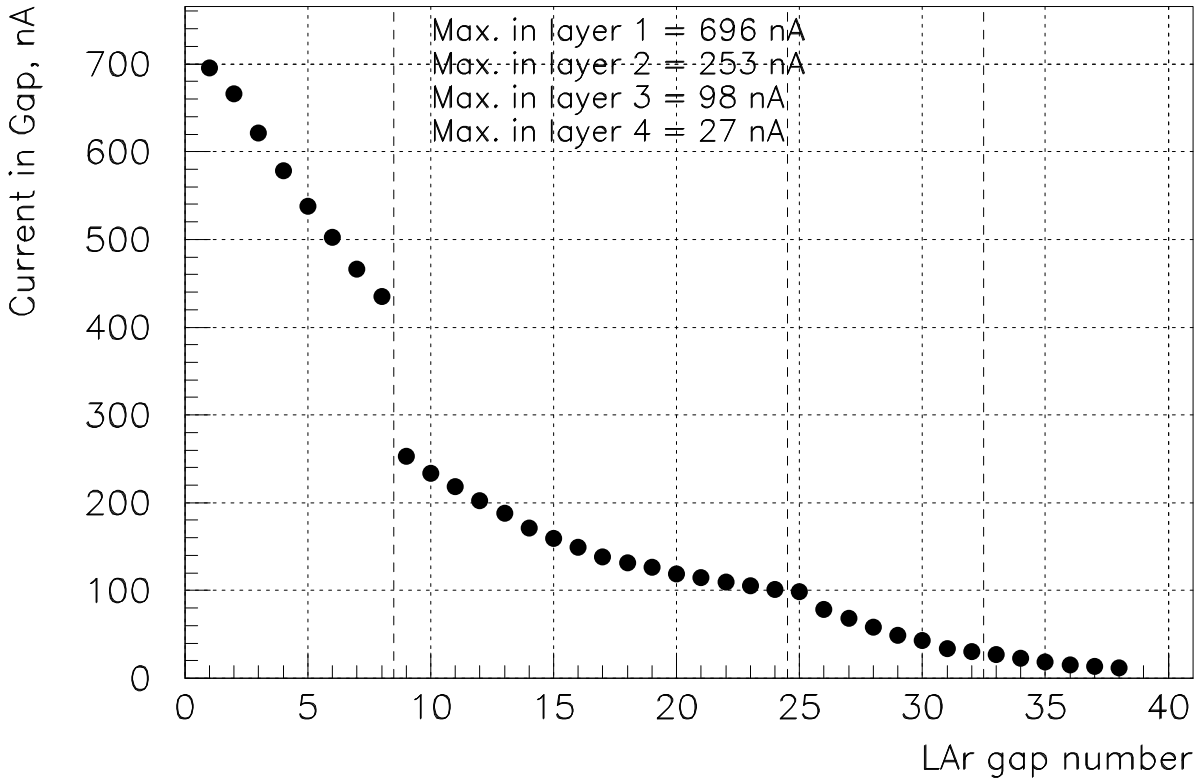
- Use Analytic Model times 1.3 as that agrees with data

Overview of Changes since Window was last set

- Pile-up: Four times lower than LARG 24 because of changes in the layout of the $\eta > 2.9$ region… See next 2 slides
- X-talk: Four times higher than LARG 24 because tiles in pairs and input impedance amplifier twice as high.
- So we would nominally like to increase the average resistivity by FOUR
  - But we now have measured X-talk and purchased CLK… unknowns are pileup X-sections and luminosity

Pileup Current

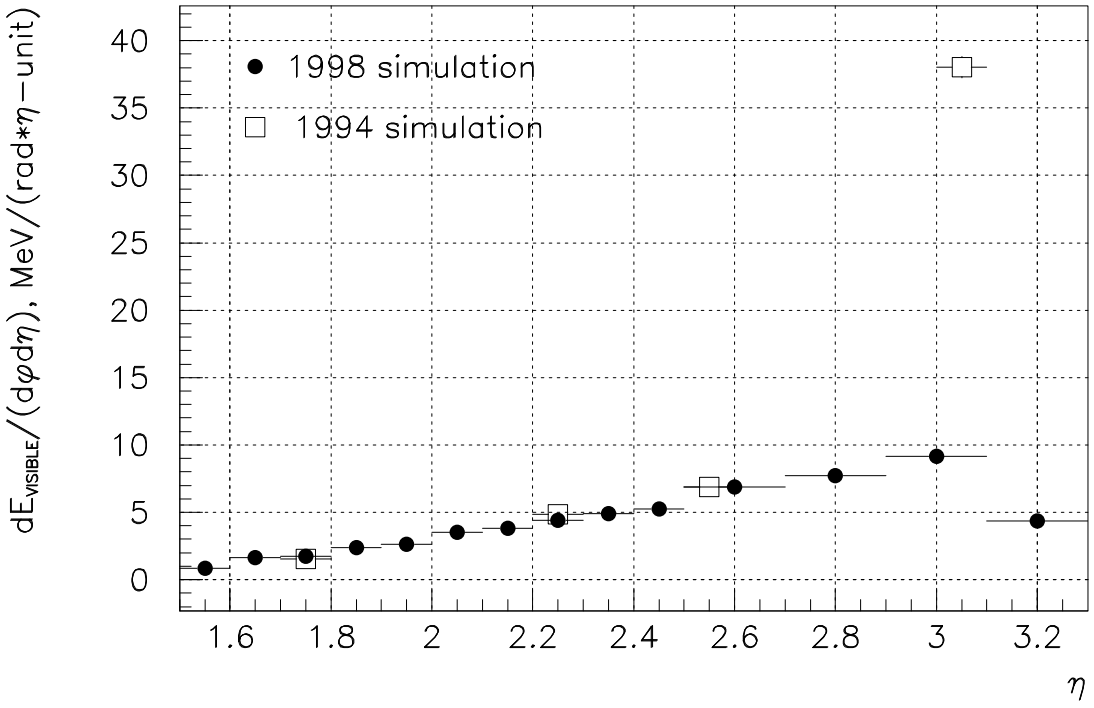
Signal in LAr Gaps of One HEC Module after Pileup of 23 MB Events



Mean current

Pileup in front of HEC LARG24 versus this Analysis

Energy in LAr Gap no. 2 in a Single MB Event



- Note that the above is per minimum bias event… it must be multiplied by 23 for per bunch crossing

Overview of Changes since Window was last set (Continued)

- So while if we knew nothing more than at LARG 24 time we would simply increase limits by FOUR. We should however note:
  - The X-sections giving the pile-up and the LHC maximum luminosity are not well known.
  - The X-talk is well known, and is rather unlikely to increase.
  - So we are in a reasonable situation, we have the X-talk as high as reasonable… and have left maximum room for the X-sections and luminosity to increase before we have problems
- Hence I propose to widen the window both at the low and high end… so we are assured of staying in our constraints… BUT use all our material.

Proposal…. Details

Proposal designed to allow use of all CLK on-hand

Depth	Nominal Resist-ivity	Pile-Up current per gap	Allowed Resistivity PAD board Min MΩ/□	Allowed Resistivity PAD board Max MΩ/□	Allowed Resistivity EST board Min MΩ/□	Allowed Resistivity EST board Max MΩ/□	Finished End-to-End R Window PAD board Min MΩ	Finished End-to-End R Window PAD board Max MΩ	Finished End-to-End R Window EST board Min MΩ	Finished End-to-End R Window EST board Max MΩ	No Damage Max Signal Change All η %	No Damage Max Signal Change η<2.5 %	X-talk Max %	Inner HV tab Broken Max Signal Change All η %	Inner HV tab Broken Max Signal Change η<2.5 %
1	0.7	5.00E-06	0.21	2.8	0.21	2.8	1.91	25.7	1.91	25.7	**0.24**	**0.04**	4.8	2.75	1.89
2	0.7	7.03E-07	0.21	6.2	0.10	6.2	1.91	56.5	0.95	56.5	0.08	0.01	4.8	0.85	0.59
3	0.7	8.97E-08	0.21	6.2	0.10	6.2	1.91	56.5	0.95	56.5	0.01	0.00	4.8	0.11	0.07
4	0.7	2.00E-08	0.21	6.2	0.10	6.2	1.91	56.5	0.95	56.5	0.00	0.00	4.8	0.02	0.02

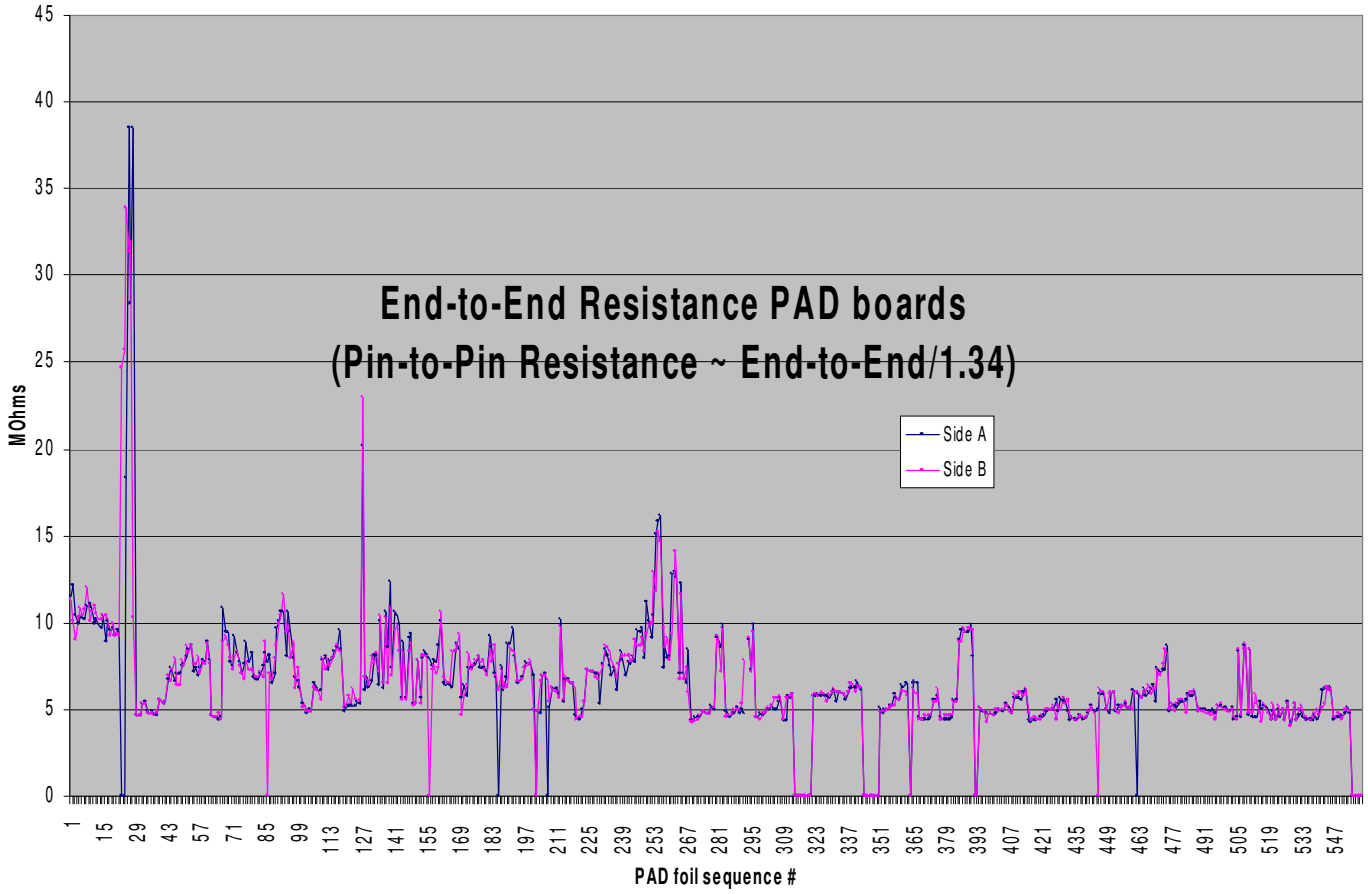
Actual achieved limits to date… (COLD)

I personally guess 95% of the boards will be as good as these first 29% of PAD's

Depth	Nominal Resist-ivity	Pile-Up current per gap	Allowed Resistivity PAD board Min MΩ/□	Allowed Resistivity PAD board Max MΩ/□	Allowed Resistivity EST board Min MΩ/□	Allowed Resistivity EST board Max MΩ/□	Finished End-to-End R Window PAD board Min MΩ	Finished End-to-End R Window PAD board Max MΩ	Finished End-to-End R Window EST board Min MΩ	Finished End-to-End R Window EST board Max MΩ	No Damage Max Signal Change All η %	No Damage Max Signal Change η<2.5 %	X-talk Max %	Inner HV tab Broken Max Signal Change All η %	Inner HV tab Broken Max Signal Change η<2.5 %
1	0.7	5.00E-06	0.44	0.97			4.03	8.89			**0.08**	**0.01**	2.7	0.95	0.65
2	0.7	7.03E-07	0.44	0.97			4.03	8.89			0.01	0.00	2.7	0.13	0.09
3	0.7	8.97E-08	0.44	0.97			4.03	8.89			0.00	0.00	2.7	0.02	0.01
4	0.7	2.00E-08	0.44	0.97			4.03	8.89			0.00	0.00	2.7	0.00	0.00

- Beware the maximum cross-talk above is for a typical cell, and we suffer from variations about this value (see X-talk versus cell size graph)

Achieved Resistance Window to-date (Warm)



Resistance change, Warm to LN2

- A narrow strip was measured:
  - Warm 41.70 GΩ
  - Cold 49.38 GΩ
  - Ratio 84.4% (±0.7%)

Proposal … "New limits"

ACCEPTANCE RANGES (WARM)

	Pin-to-pin resistance Low	High
Present Ranges:		
Low Resistivity	3.2	12.8
High Resistivity	6.4	25.5
Proposed Ranges:		
1 to 8 Foils:		
Resistivity (PAD)	1.6	21.7
Resistivity (EST-Low)	0.8	21.7
Resistivity (EST-High)	0.8	21.7
9 to 40 Foils:		
Resistivity (PAD)	1.6	47.7
Resistivity (EST-Low)	0.8	47.7
Resistivity (EST-High)	0.8	47.7

- Request on best effort basis PAD boards to stay within present ranges
  - X-talk ~ 3.2% Pile-up ~ 0.7%
- Relax requirement of Low Resistivity ~ Half High Resistivity