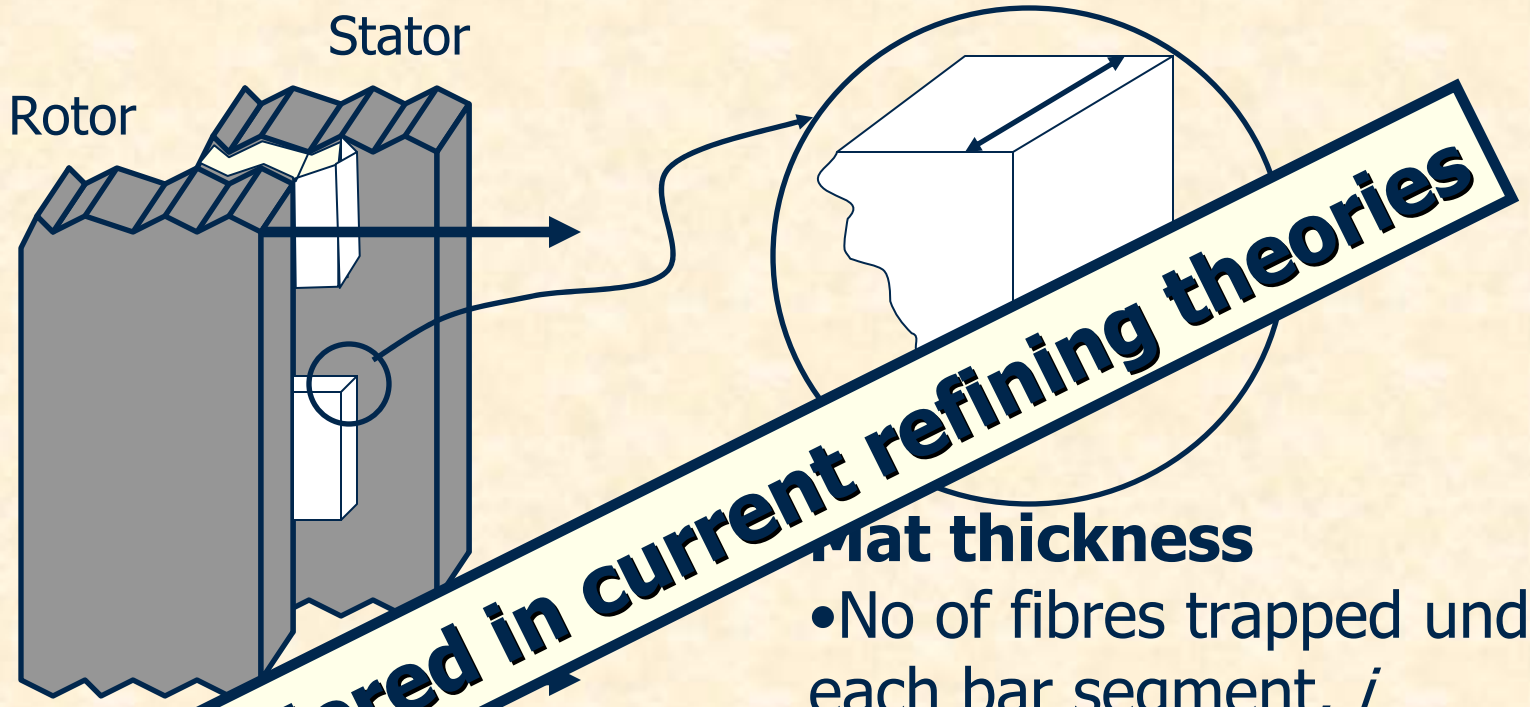
Effect of consistency and refiner speed on bar coverage in refining

Warren Batchelor[1] and Tom Lundin[2]

[1]APPI, Monash University, Australia

[2]Åbo Akademi, Finland

Mat thickness, *i* and bar coverage, *f*- refining variables



Not considered in current refining theories

Ba ge

of rotor bar with
mpressed fibre mat

- Labelled *f*

Mat thickness

- No of fibres trapped under each bar segment, *i*
- Thickness of mat- first takes compressive load: g_o
- For given specific energy, $g_o \propto i$

Experimental

- ProLab refiner with LM conical fillings
- Speed range 600-4000 rpm
- 6%, 4%, 3% consistency examined here
- Dried, bleached Finnish softwood reinforcement kraft pulp
- More details- see Tom's talk

Nominal and Effective Specific Edge Load

- Nominal Specific Edge Load (SEL_n)- normal SEL calculation. Intrinsically assumes: $f = 1$
- Effective Specific Edge Load (SEL_e)- If $f < 1$, more energy applied to bar areas with a mat and

$$SEL_e = SEL_n / f$$

$\overline{F_N} \propto \frac{SEL^n}{f}$

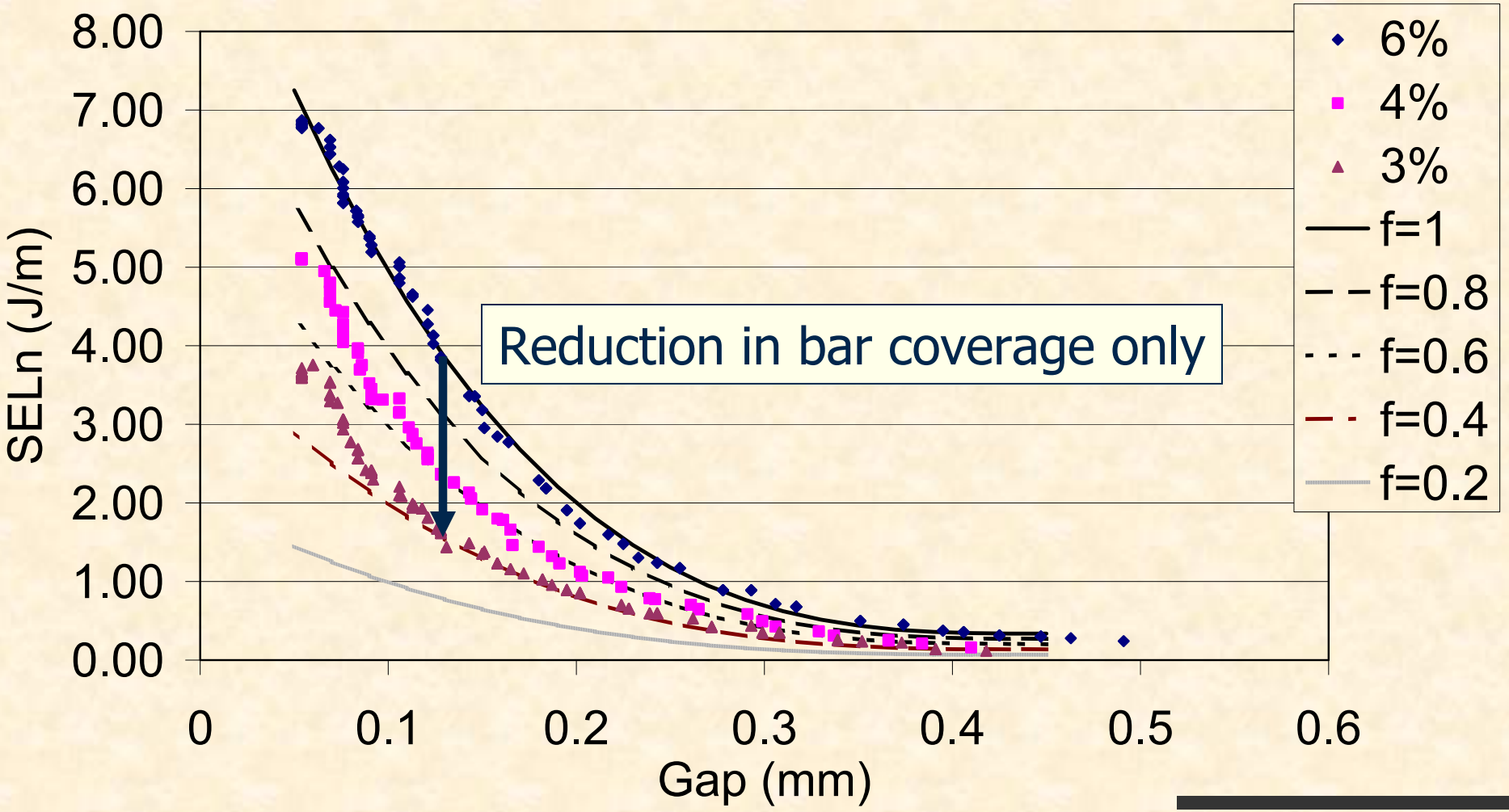
Theory: effect of *f* and *i* on refining

$$F \propto \frac{SEL_n}{f}$$

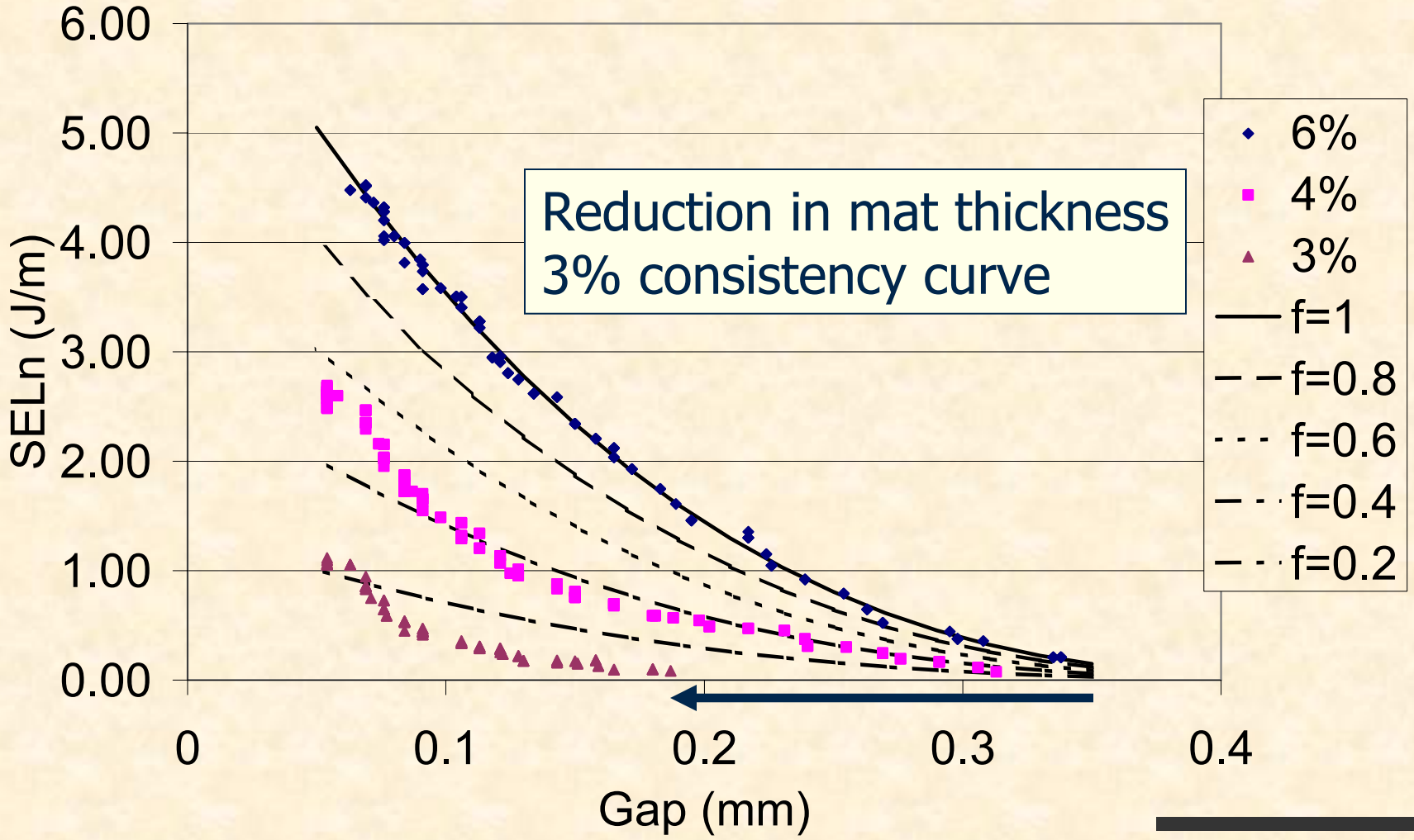
$$N \propto E\, i \frac{SEL_n}{f}$$

- *F* is force per fibre, *N* is the number of impacts, *E* is specific refining energy
- Equivalent refining treatment when *N* and *F* are equal.
- **Lower *f*: harsher refining**
- **Lower *i*: less efficient refining**

Reduction in *f*- less Power/thrust/SEL to obtain a given gap



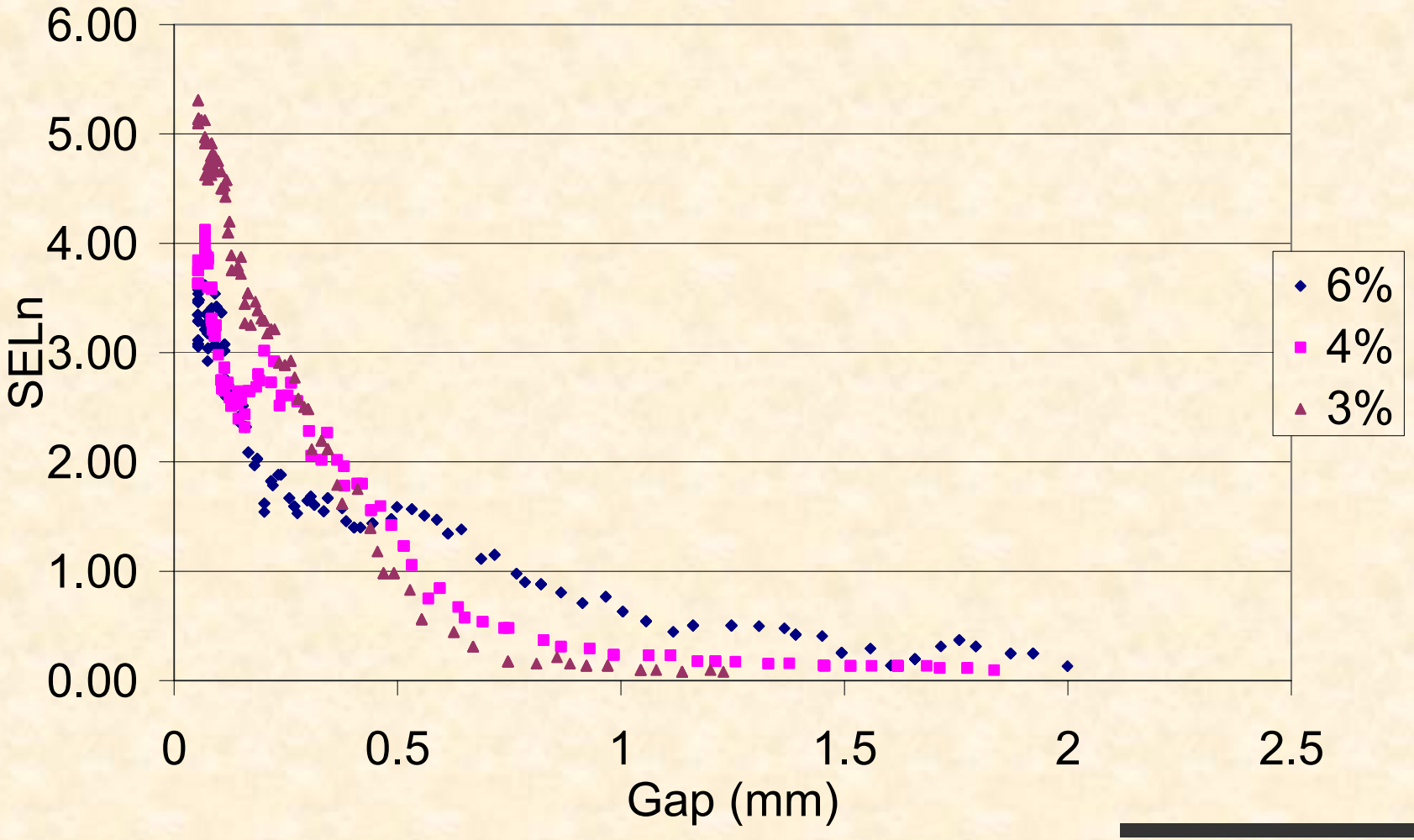
Reduction in *i*- gap at which first draw net power ie have SEL is reduced.



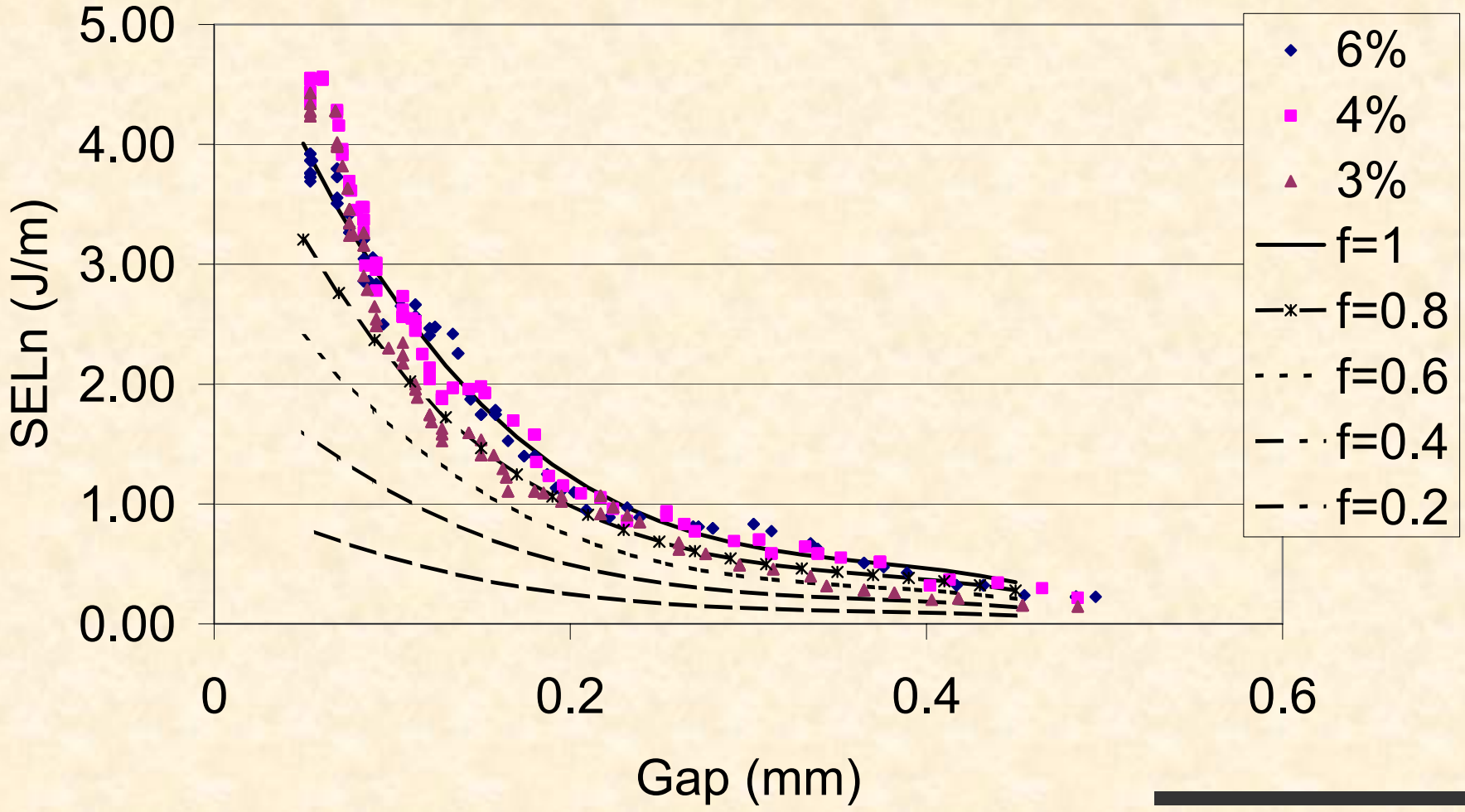
Complete data set

- 600-4000 rpm
- Data at different speeds not directly comparable as data collected sequentially- 600 rpm then upwards
  - 600 rpm: specific energy ≈ 0
  - 4000 rpm: specific energy ≈ 500 kWh/t

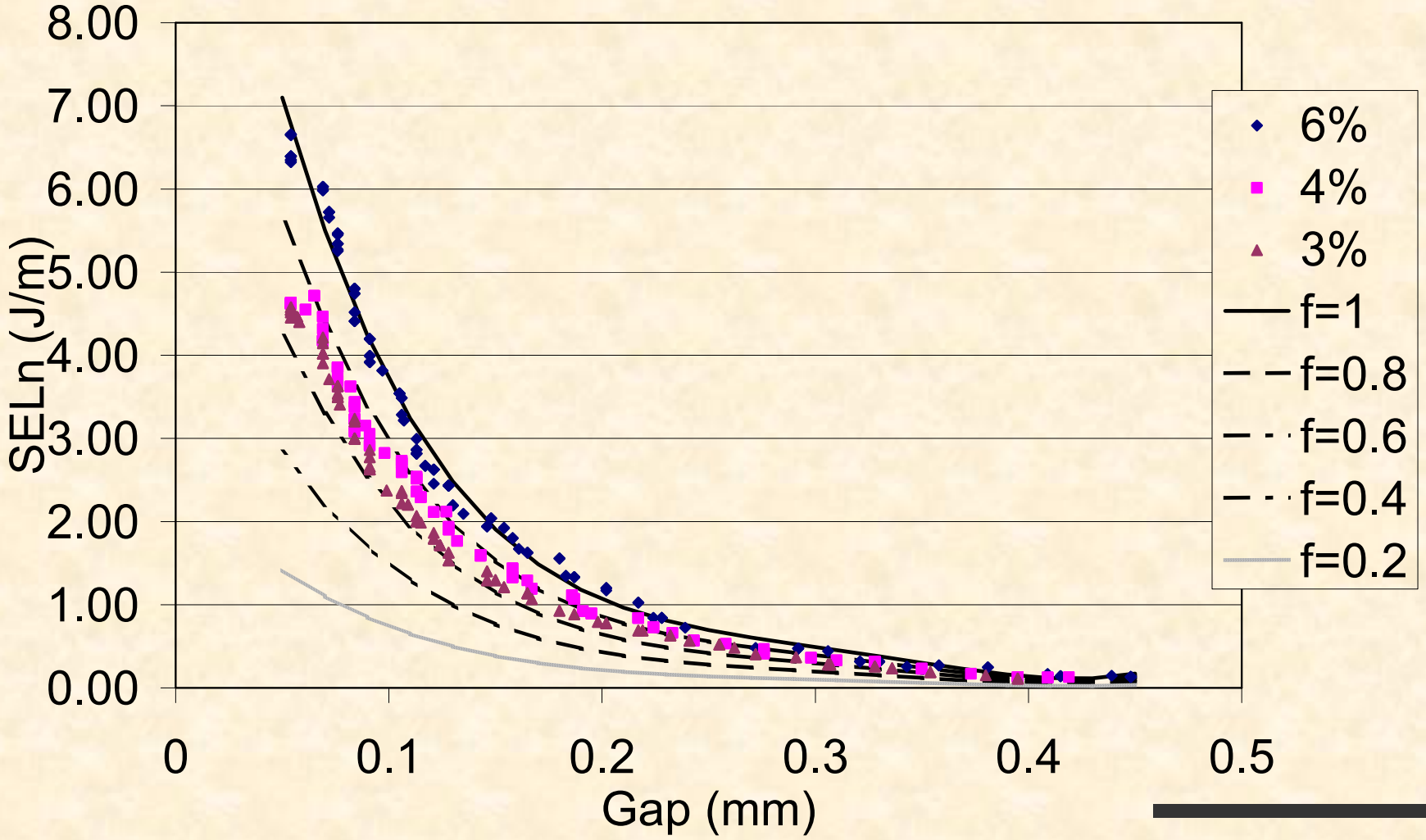
600 rpm



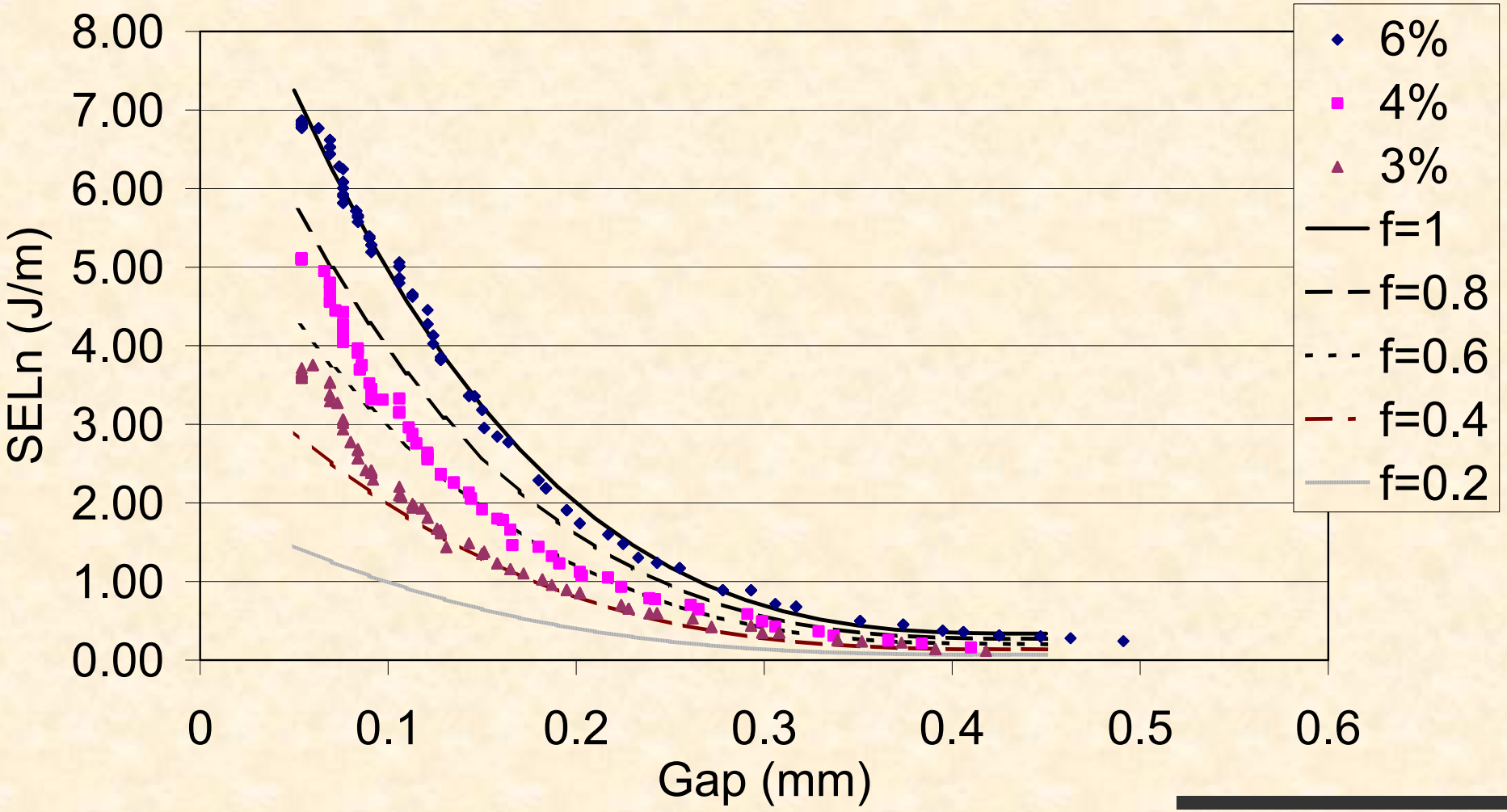
1000 rpm


5.00
4.00
3.00
2.00
1.00
0.00
SELn (J/m)
0
0.2
0.4
0.6
Gap (mm)
6%
4%
3%
f=1
f=0.8
f=0.6
f=0.4
f=0.2

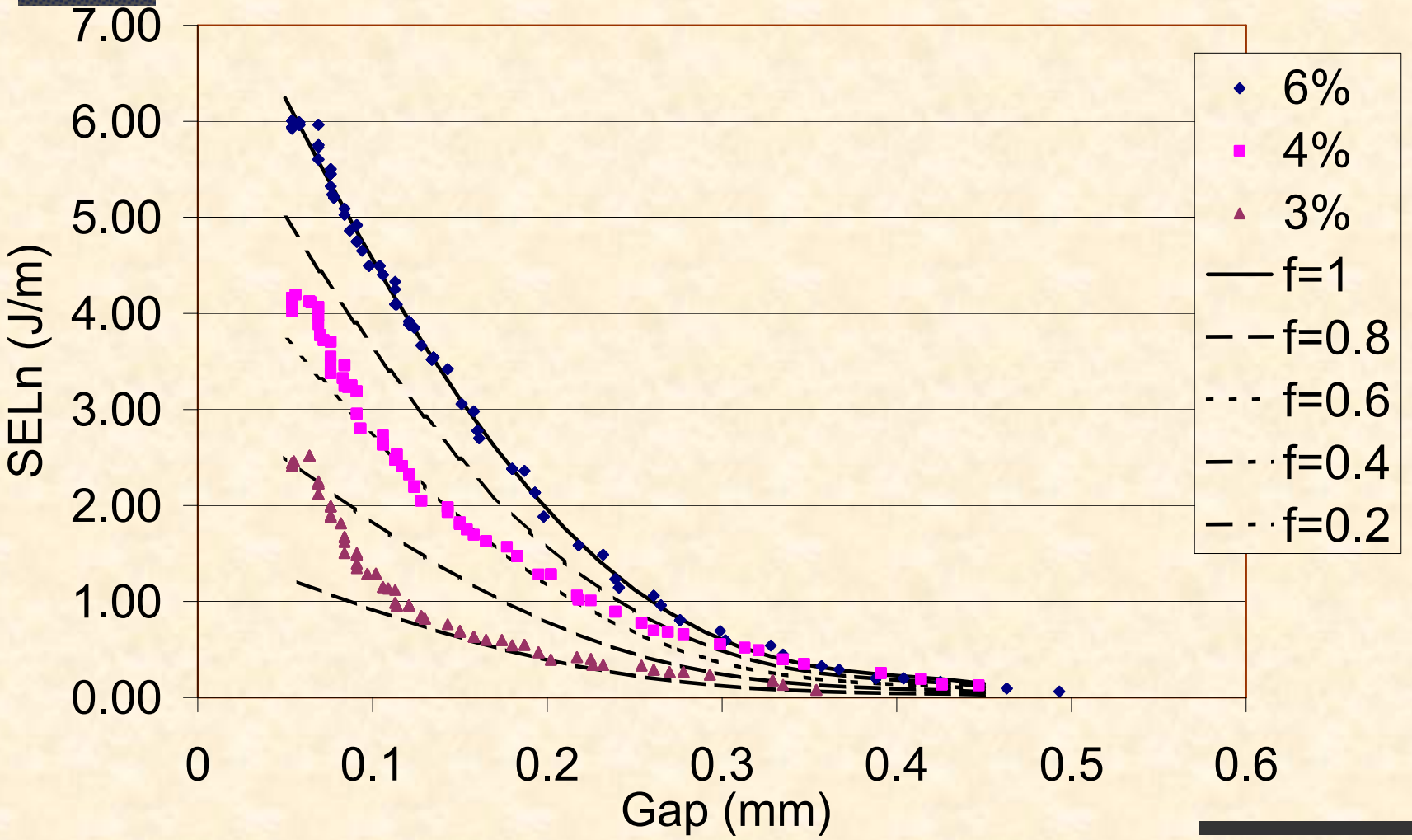
1500 rpm


8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SELn (J/m)
0
0.1
0.2
0.3
0.4
0.5
Gap (mm)
6%
4%
3%
f=1
f=0.8
f=0.6
f=0.4
f=0.2

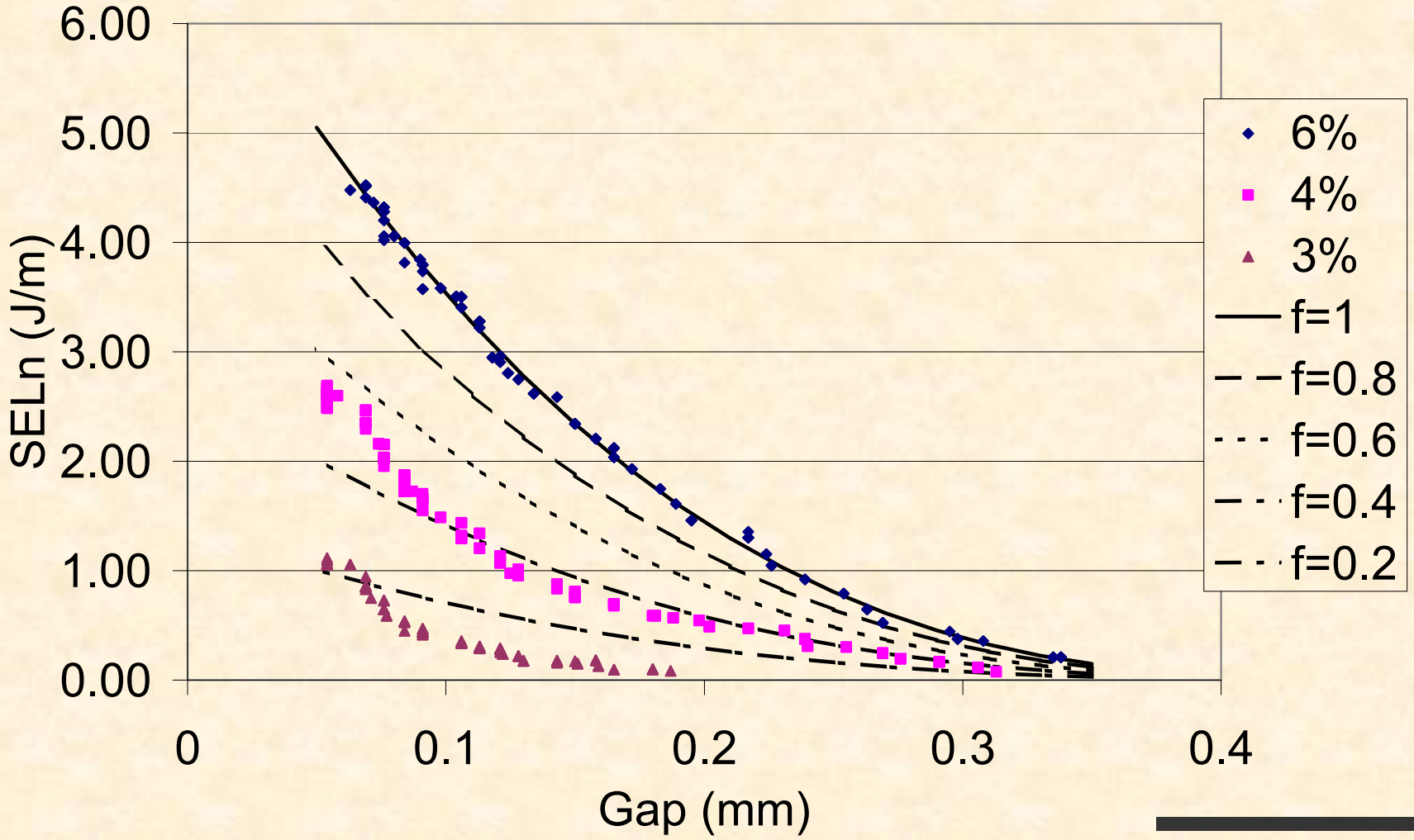
2250 rpm


8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SELn (J/m)
0
0.1
0.2
0.3
0.4
0.5
0.6
Gap (mm)
6%
4%
3%
f=1
f=0.8
f=0.6
f=0.4
f=0.2

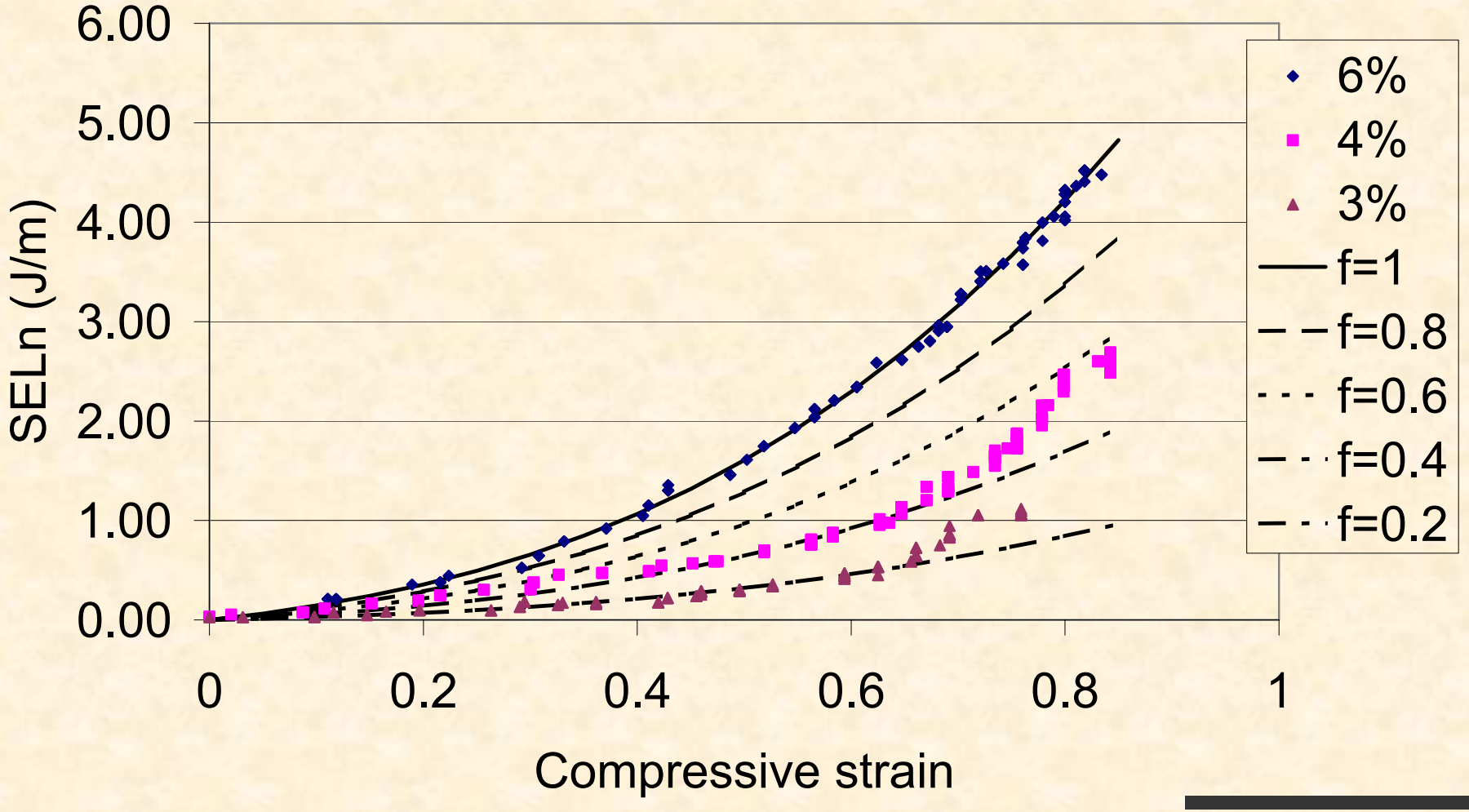
3000 rpm


7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SELn (J/m)
0
0.1
0.2
0.3
0.4
0.5
0.6
Gap (mm)
6%
4%
3%
f=1
f=0.8
f=0.6
f=0.4
f=0.2

4000 rpm


6.00
5.00
4.00
3.00
2.00
1.00
0.00
SELn (J/m)
0
0.1
0.2
0.3
0.4
Gap (mm)
6%
4%
3%
f=1
f=0.8
f=0.6
f=0.4
f=0.2

4000 rpm- SELn vs strain- adjusts for different g_o



Values of f and g_o from these experiments

	6% consistency		4% consistency		3% consistency	
	f	g_o (mm)	f	g_o (mm)	f	g_o (mm)
600 rpm	1.0*	1.11	1.0	0.93	1.2	0.97
1000 rpm	1.0*	0.55	1.0	0.71	0.8	0.57
1500 rpm	1.0*	0.45	0.7	0.42	0.7	0.40
2250 rpm	1.0*	0.49	0.6	0.43	0.4	0.42
3000 rpm	1.0*	0.45	0.4	0.45	0.2	0.42
4000 rpm	1.0*	0.43	0.4	0.38	0.2	0.16

* **6% consistency data is taken as reference curve and assumed that $f = 1$**

Conclusions

- Bar coverage reduces with consistency
  - Small reduction at 1000 rpm
  - Large reduction at 4000 rpm
  - Explains differences: lab vs. mill refining?
- 4000 rpm- mat thickness is reduced for 3% consistency
- Mat thickness independent of consistency for other speeds