Softwood Kraft Pulps For Specialty Papers Where Strength Is Required

CANFOR

More Value, Less Impact

Who we are

- 2nd largest global producer of softwood lumber
- Fifth largest producer of NBSK worldwide, largest in North America
- Global leader for NBSK to specialty paper segments
- Innovation Center with state of the art measuring equipment and refining knowledge
- Company with top quartile mills, strong reputation for sustainability, quality, customer service and excellence in logistics support
- 6000 employees
- **Manage 21 million hectares of certified forests**

2017 Pulp Sales
$1.2 Billion

■ Americas ■ Asia ■ Europe

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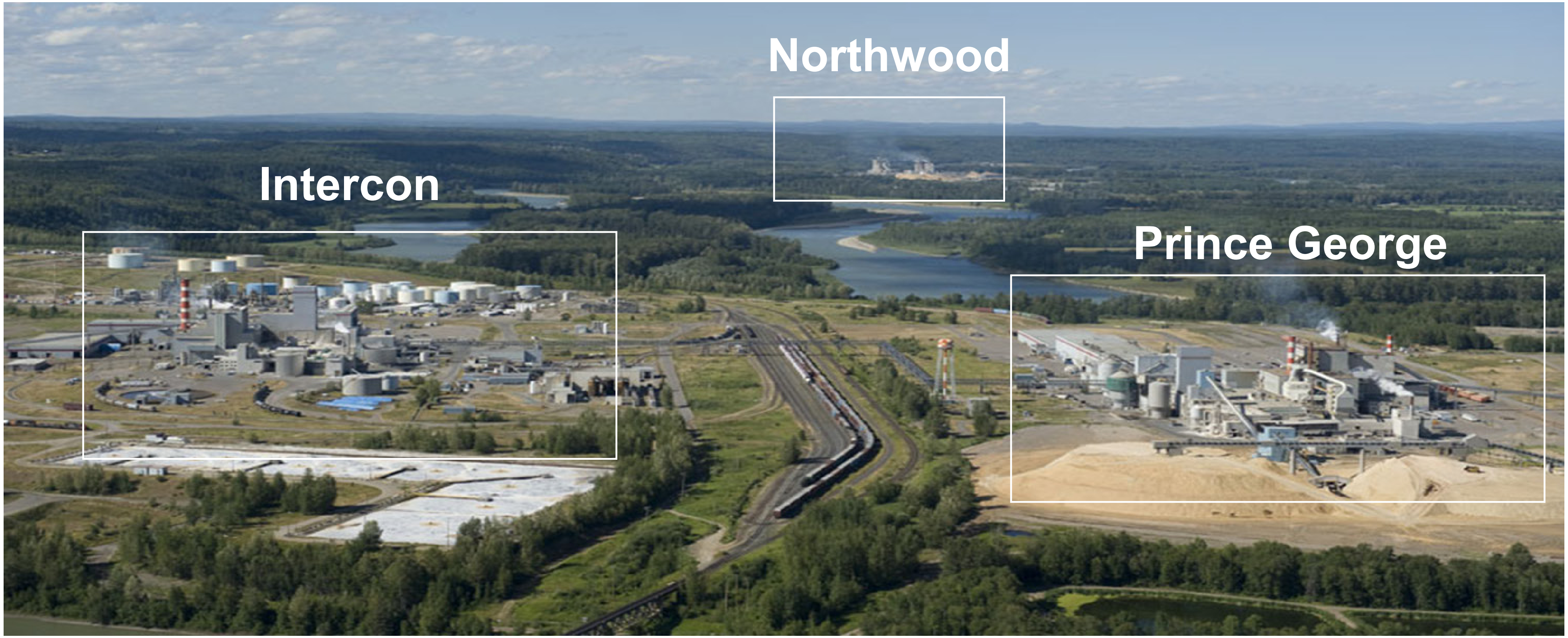
Strategic Advantage – Location of our Kraft Pulp Mills

- Canfor's Specialty paper mill has an annual mill capacity of 150,000 t
- The paper machine produces both Unbleached (Kodiak) and Bleached (Polar) paper grade with basis weight ranging from 35# (57 g/m^2) to 93 # (150 g/m^2) per 3,000 ft^2



Customer Support Services - Pilot Plant Refiner

Refining protocols established based on bar-to-bar principle

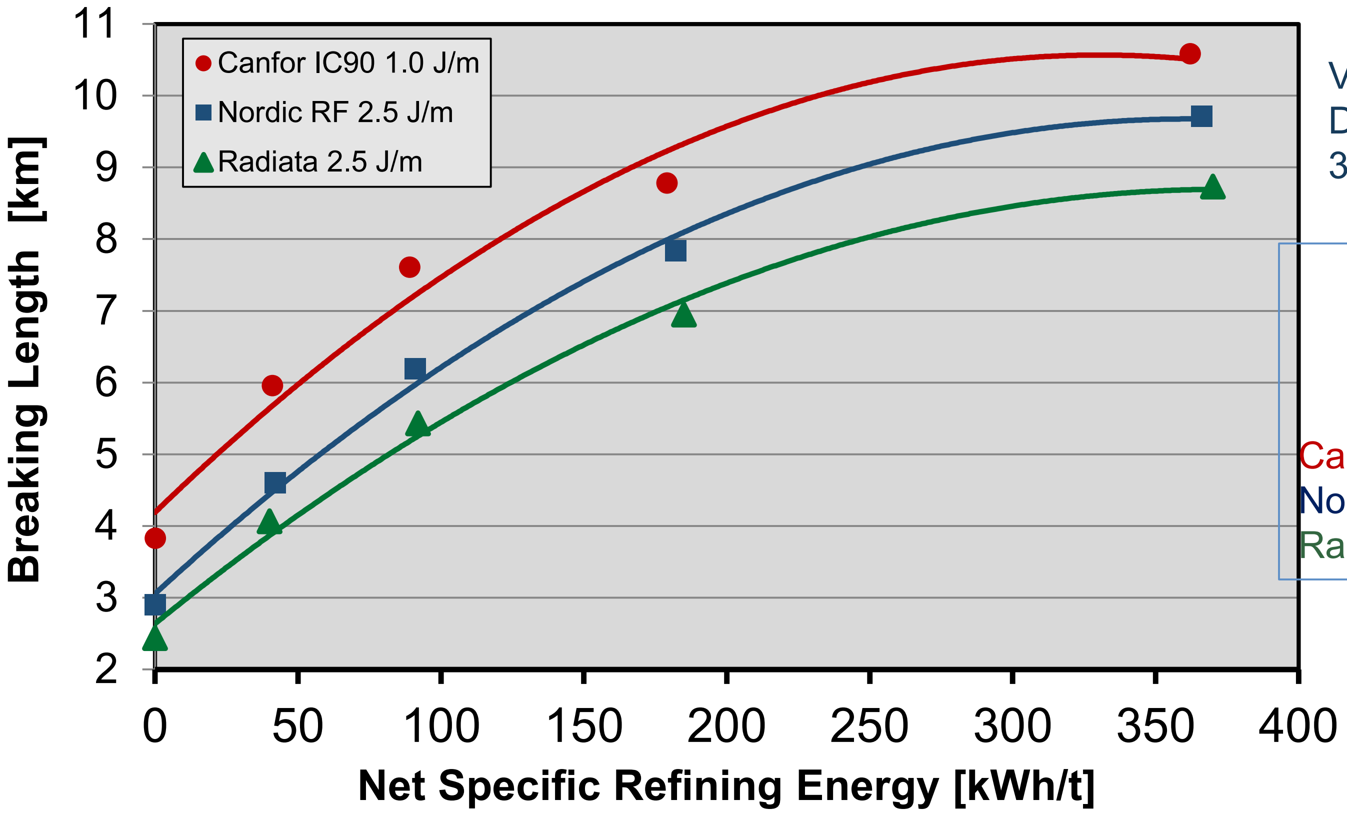
- SEL 1.0J/m,
- 2200 rpm

Results are directly transferred to industrial refining (unlike PFI and other laboratory equipment)

Pilot refiner used together with online evaluation of refiners for troubleshooting

Canfor's refining expertise is unique amongst NBSK producers

Fibre Morphology and Its Impact on Refining Behaviour

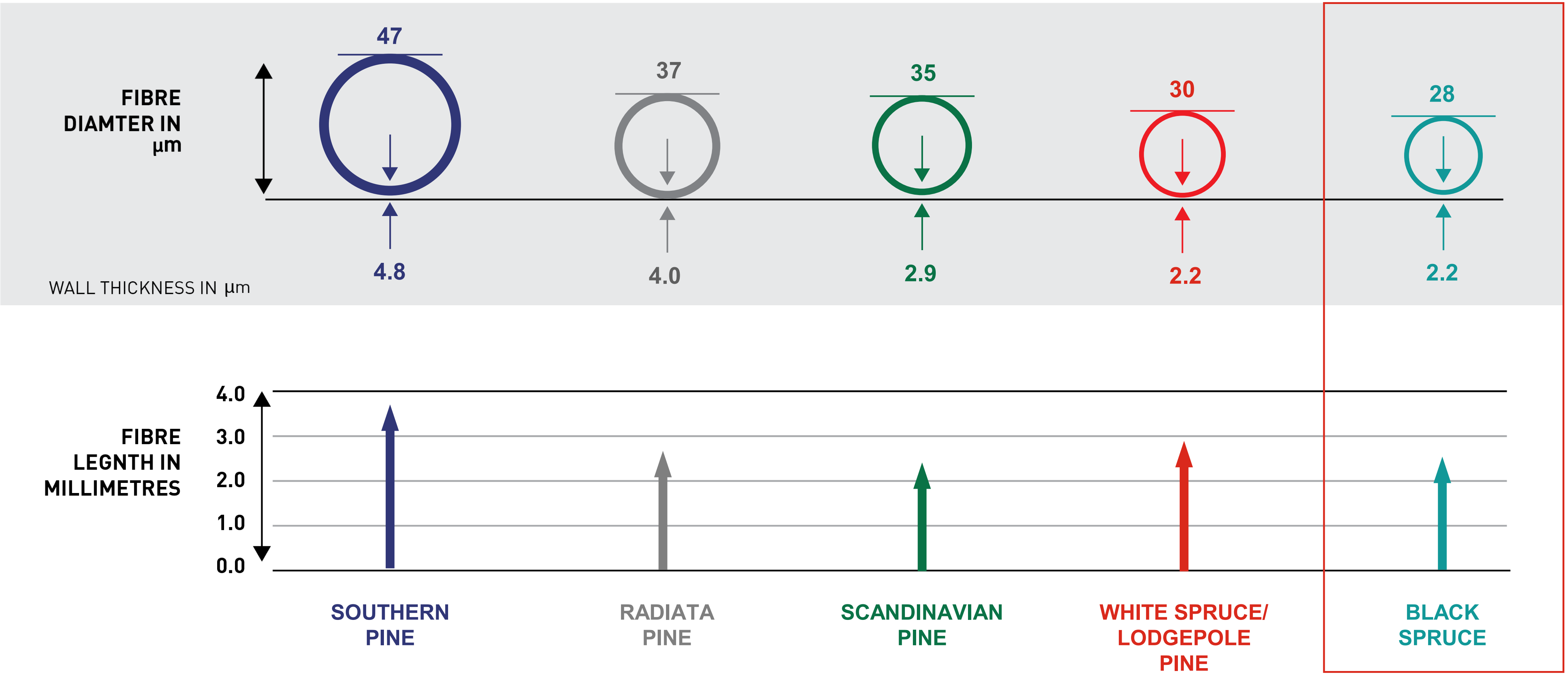


Voith LR40 refiner
Disk filling
3 mm bar width

	F_L mm	F_C mg/ 100 m
Canfor	2,58	13,1
Nordic RF	2,28	16,1
Radiata	2,28	20,3

Distinctiveness of Canfor Pulp Fibers (Morphology)

Northern spruce & pine fibre grown in the central interior of British Columbia are recognized as one of the strongest in the world due to the unique combination of high fibre population, long fibres and a narrow distribution of fibre wall thickness



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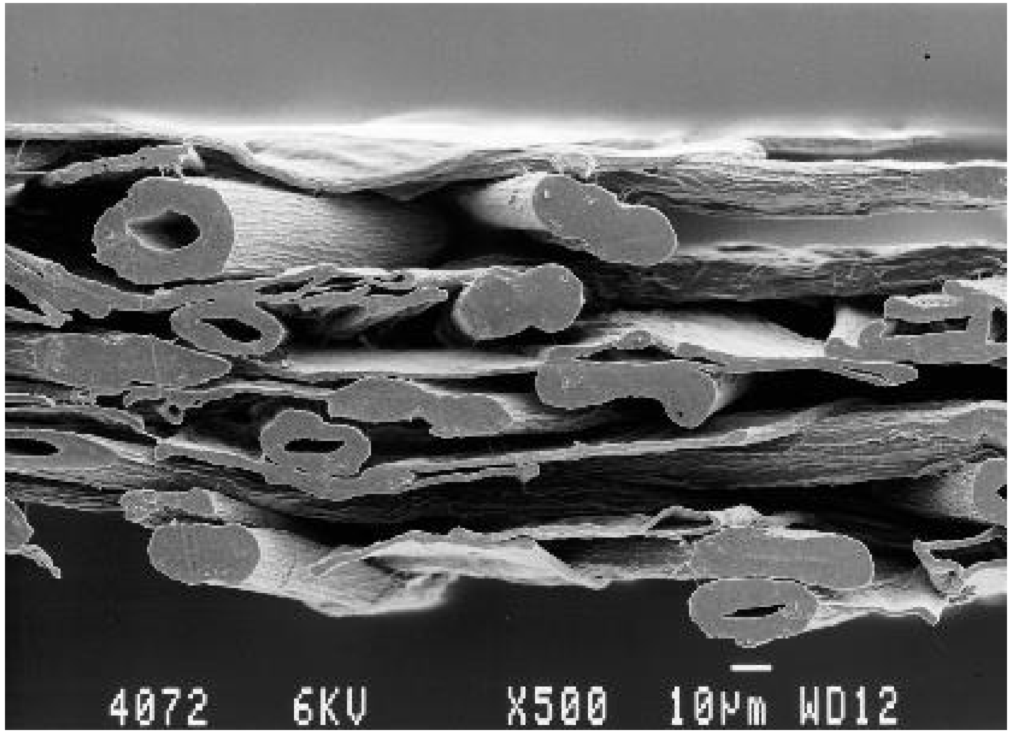
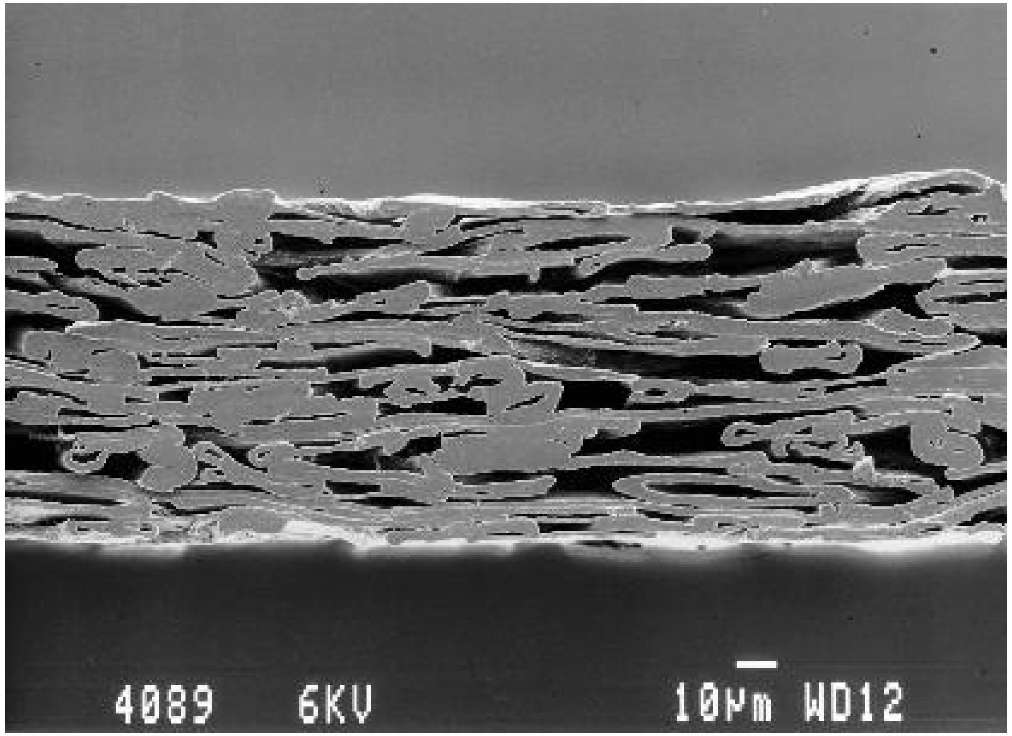
Importance of Fibre Coarseness

Increased fibre contact points with good bonding and high tensile strength further enhanced through low intensity refining



Coarse Fibre ≈ 18,9 mg/100 m



Fine Fibre ≈ 10,0 mg/100 m

Thin-walled (fine) fibres have the ability to collapse more easily.

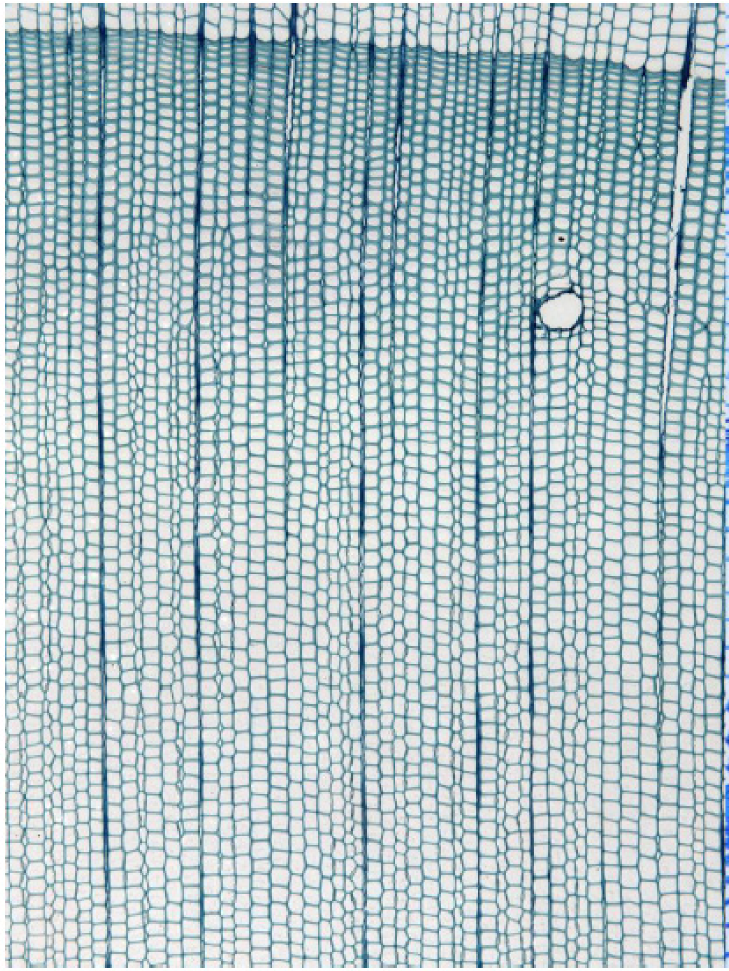
Annual Growth Rings

Canadian Softwood

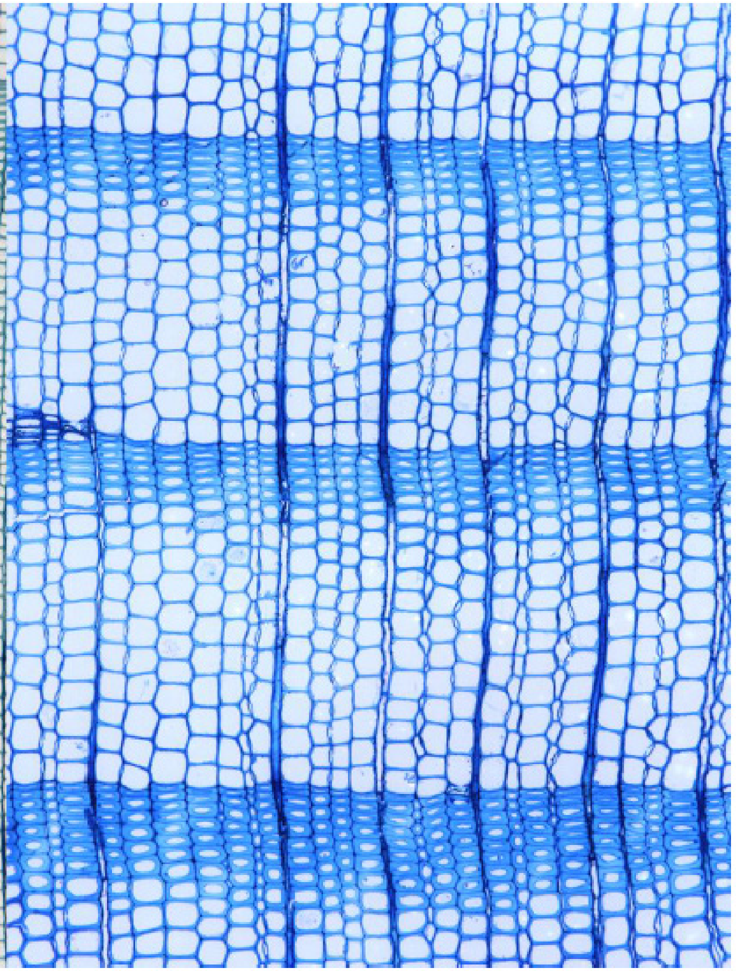
- Slow growing
- Consistent fibre dimensions
- High number of fibres

Plantation Softwood

- Fast growing
- Varied fibre dimensions
- Low number of fibres



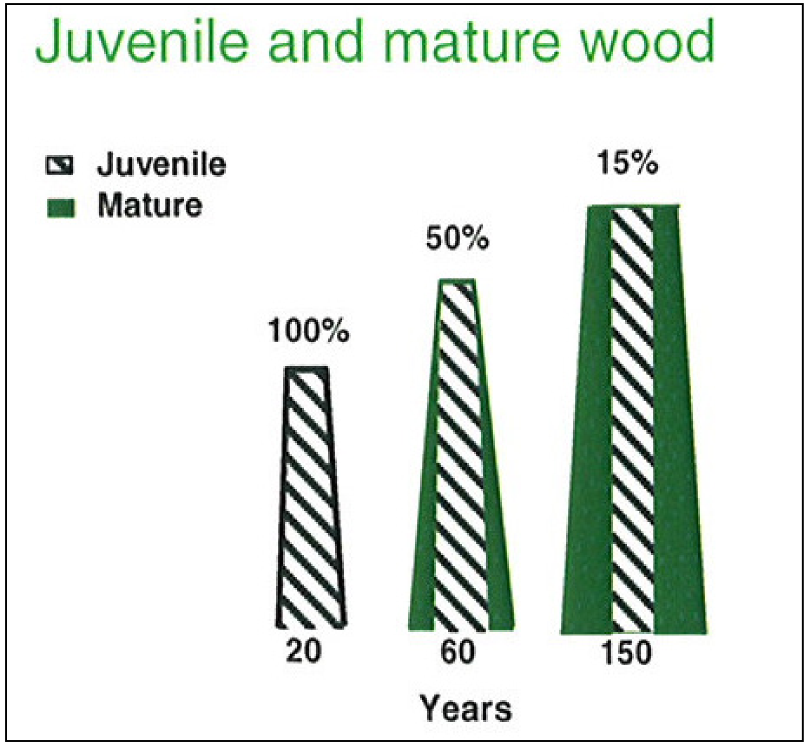
Canadian Softwood



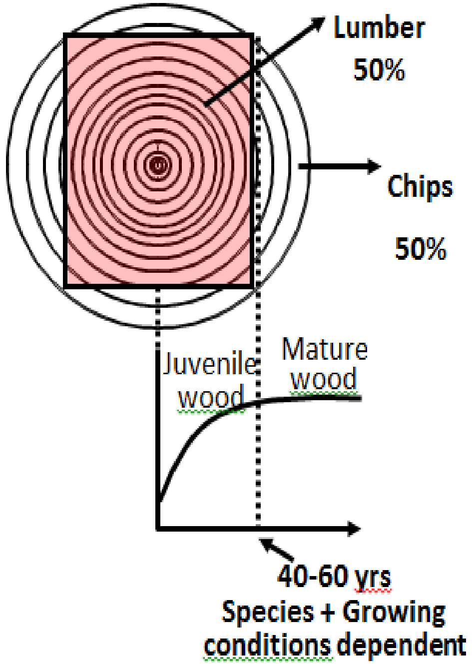
Plantation Softwood

Whole Log vs. Residual Chips

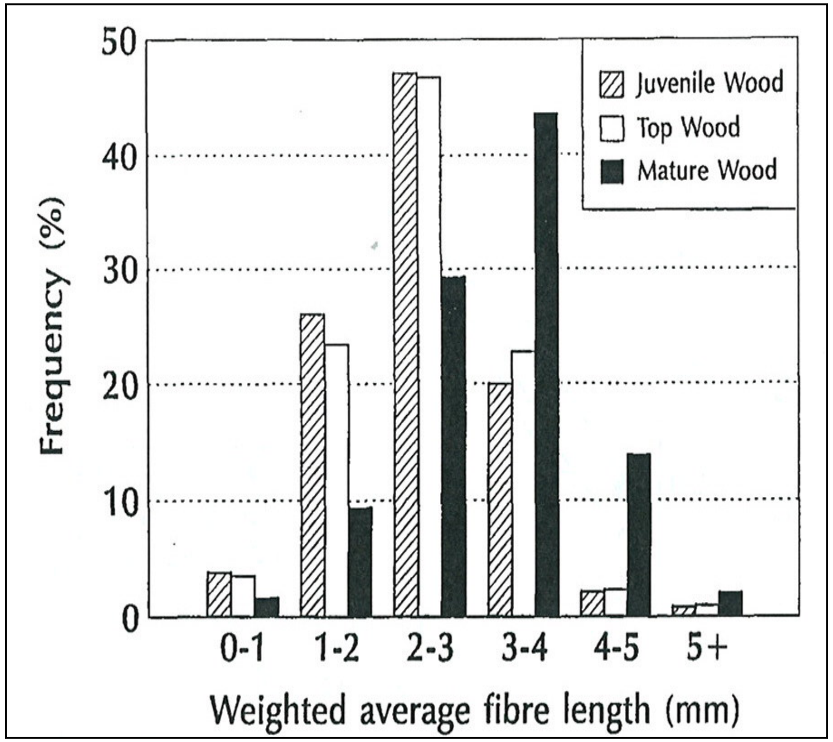
Proportion of mature wood increases as tree ages



Canfor Fibre Input
90% Sawmill chips 10% Whole log



Mature wood has longer fibres than juvenile wood



- Mature wood from growth rings 60 yrs or higher = longest fibres
- In Canfor, trees trend to be 100 yrs or older at time of harvest - high proportion of long fibres

Approach

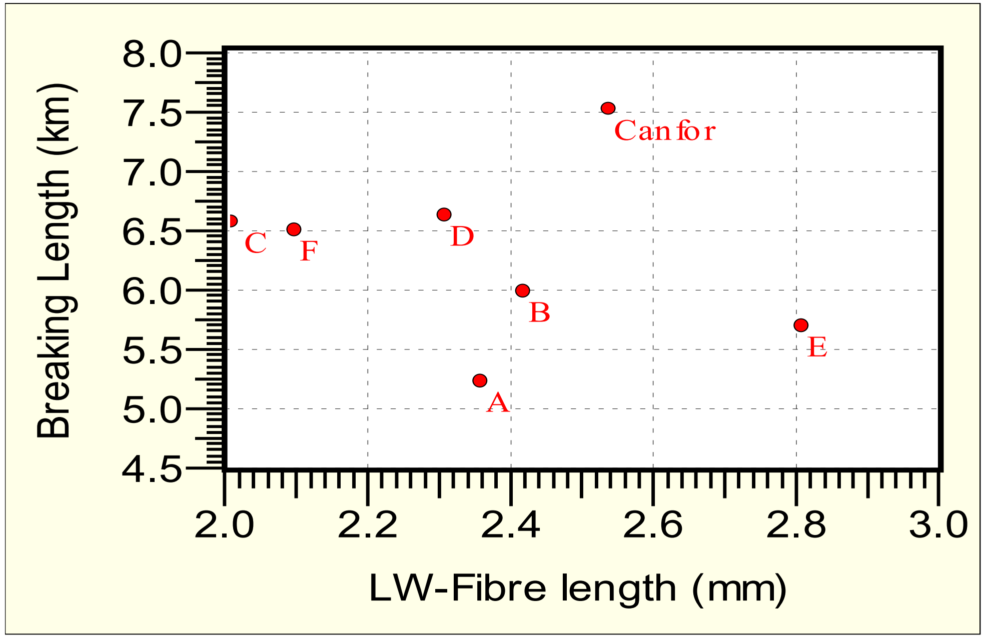
Compared effects of Length-Weighted Fibre Length (LWFL) and coarseness of 7 different pulps on strength properties

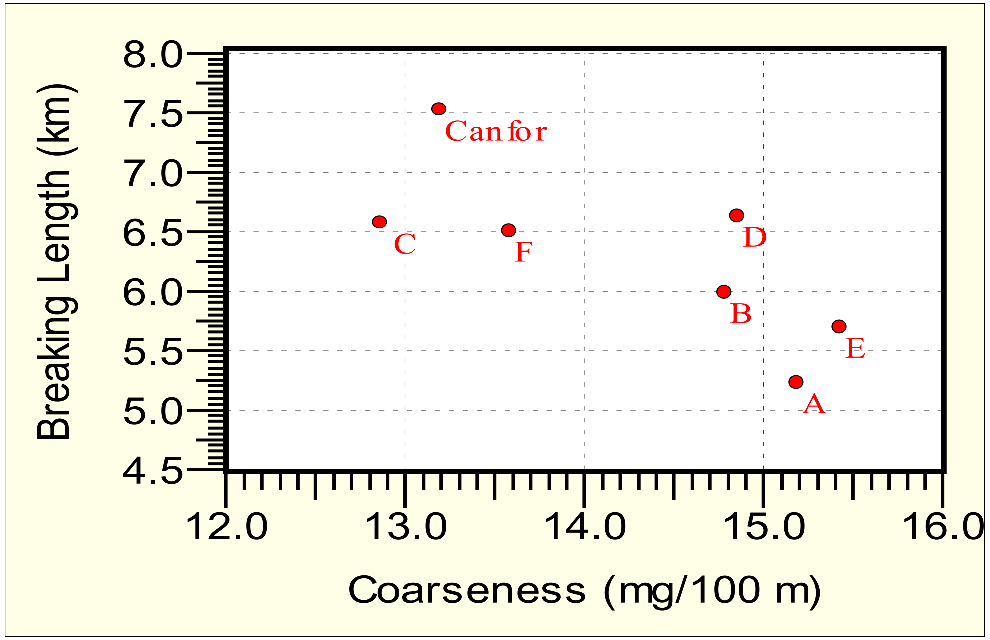
- Breaking length, TEA and Tear Index
- Pulps refined to 100 kWh/t and standard handsheets made

Compared effects of Length-Weighted Fibre Length (LWFL) and coarseness of 9 different commercial papers on Breaking Length, TEA and Tear index

Results compared via Linear regression

Breaking Length (km) at 100 kWh/t of Refining

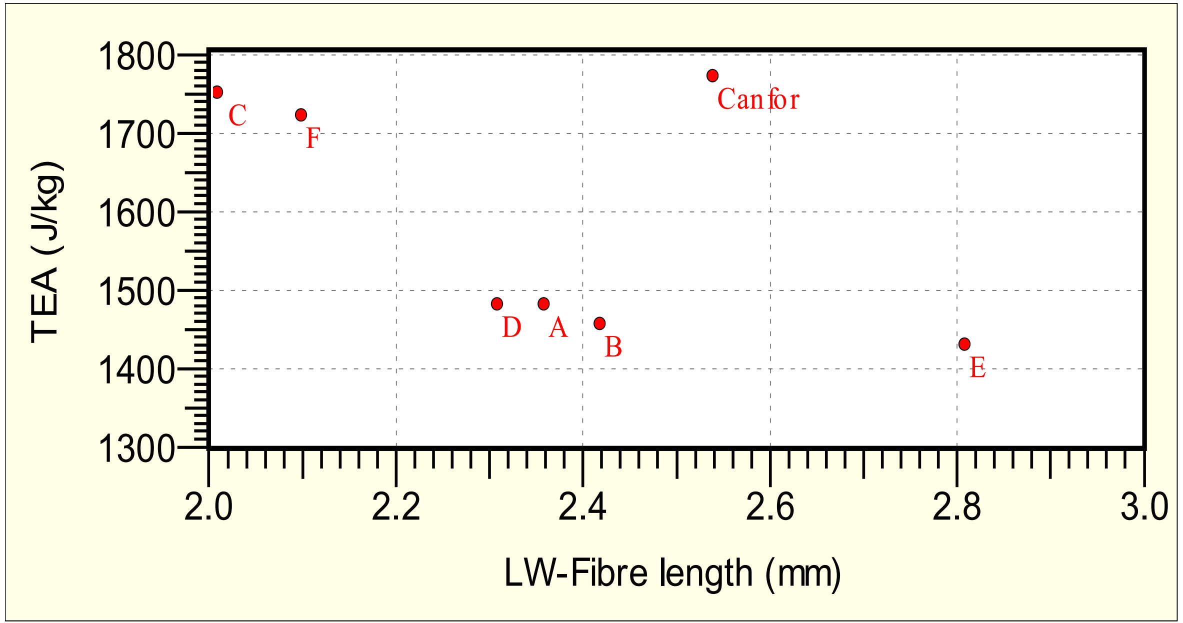


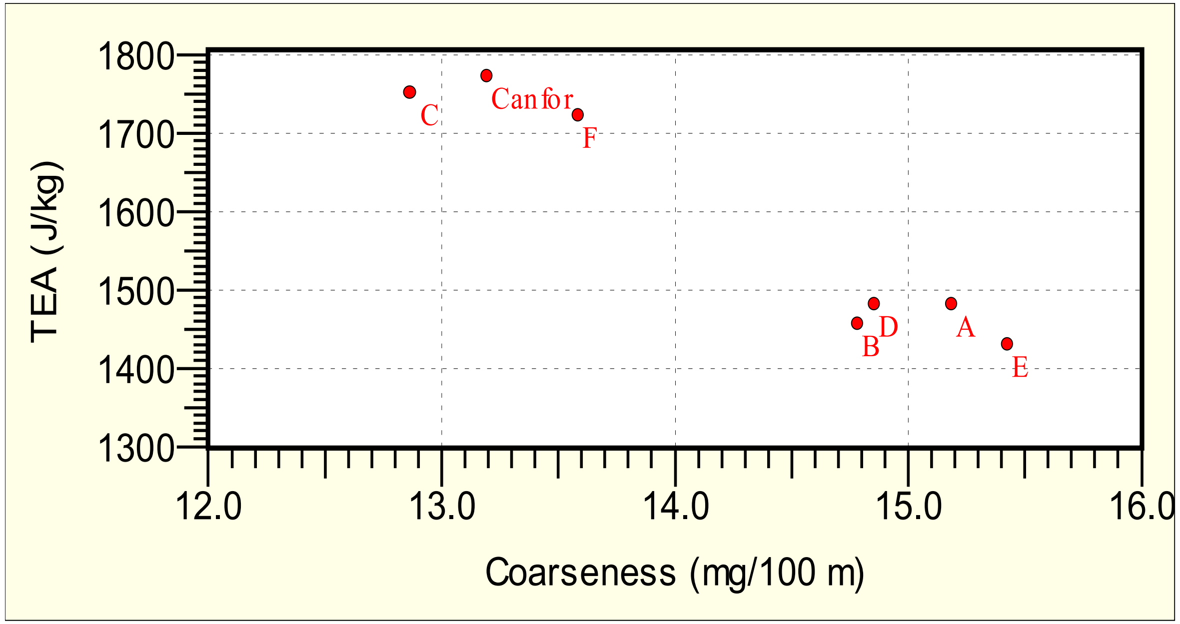


Linear regression coefficients

BL = (13.6)*LWFL+ (1.4)*Coarseness +(-0.88)*LWFLXCoarseness -15.5
R2 =0.88 (p value=0.17)

TEA (J/kg) at 100 kWh/t of Refining

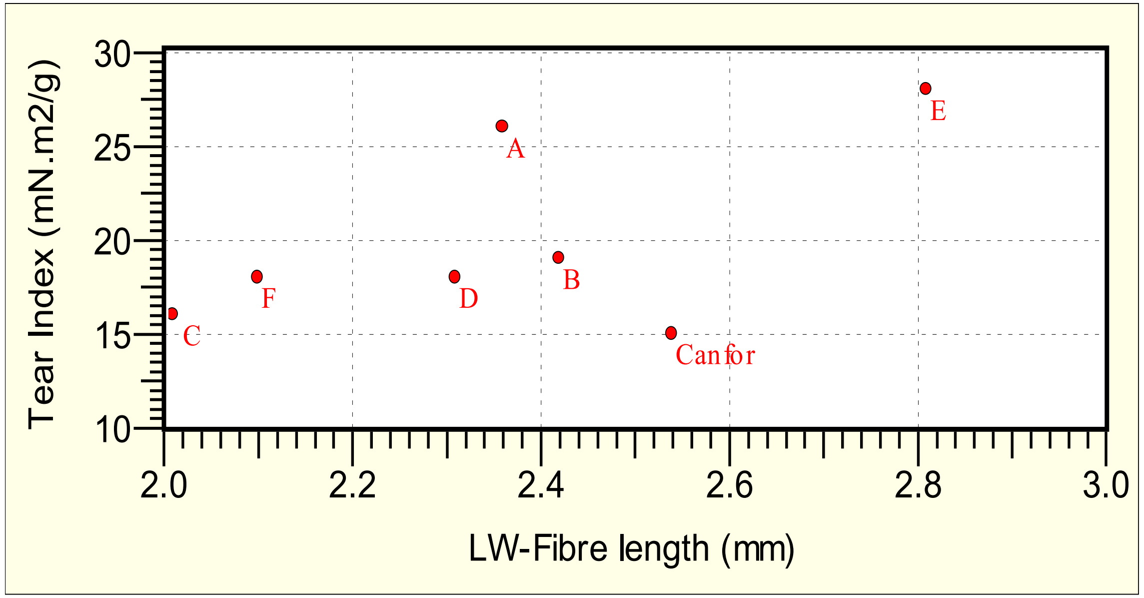


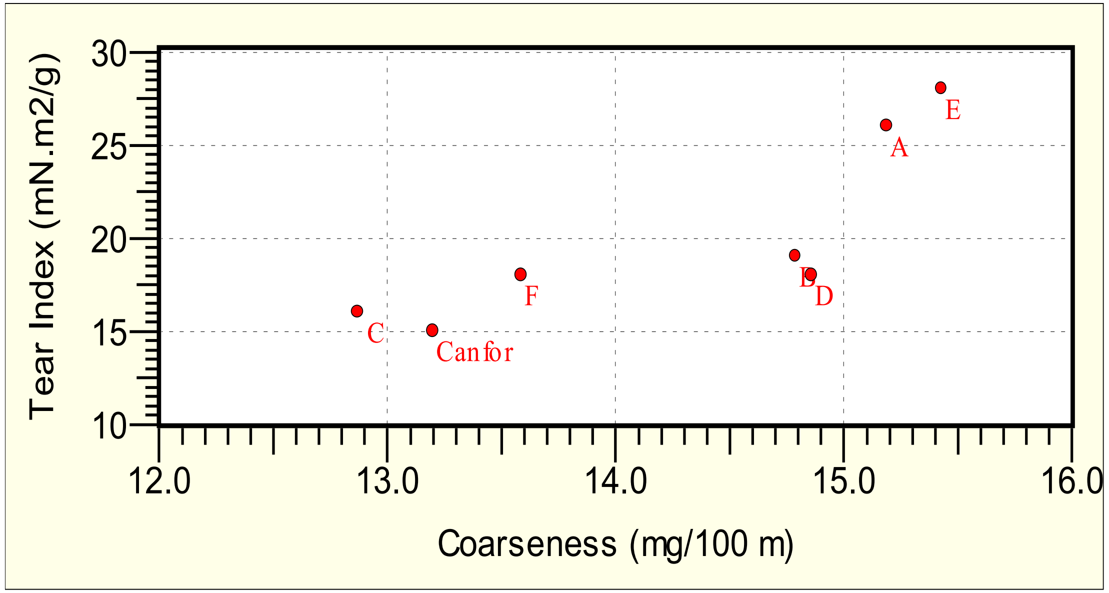


Linear regression coefficients

BL = (415)*LWFL+ (-91)*Coarseness +(-26)*LWFLXCoarseness + 2788
R^2 =0.95 (p value=0.019)

Tear Index (mN·m²/g) at 100 kWh/t of Refining

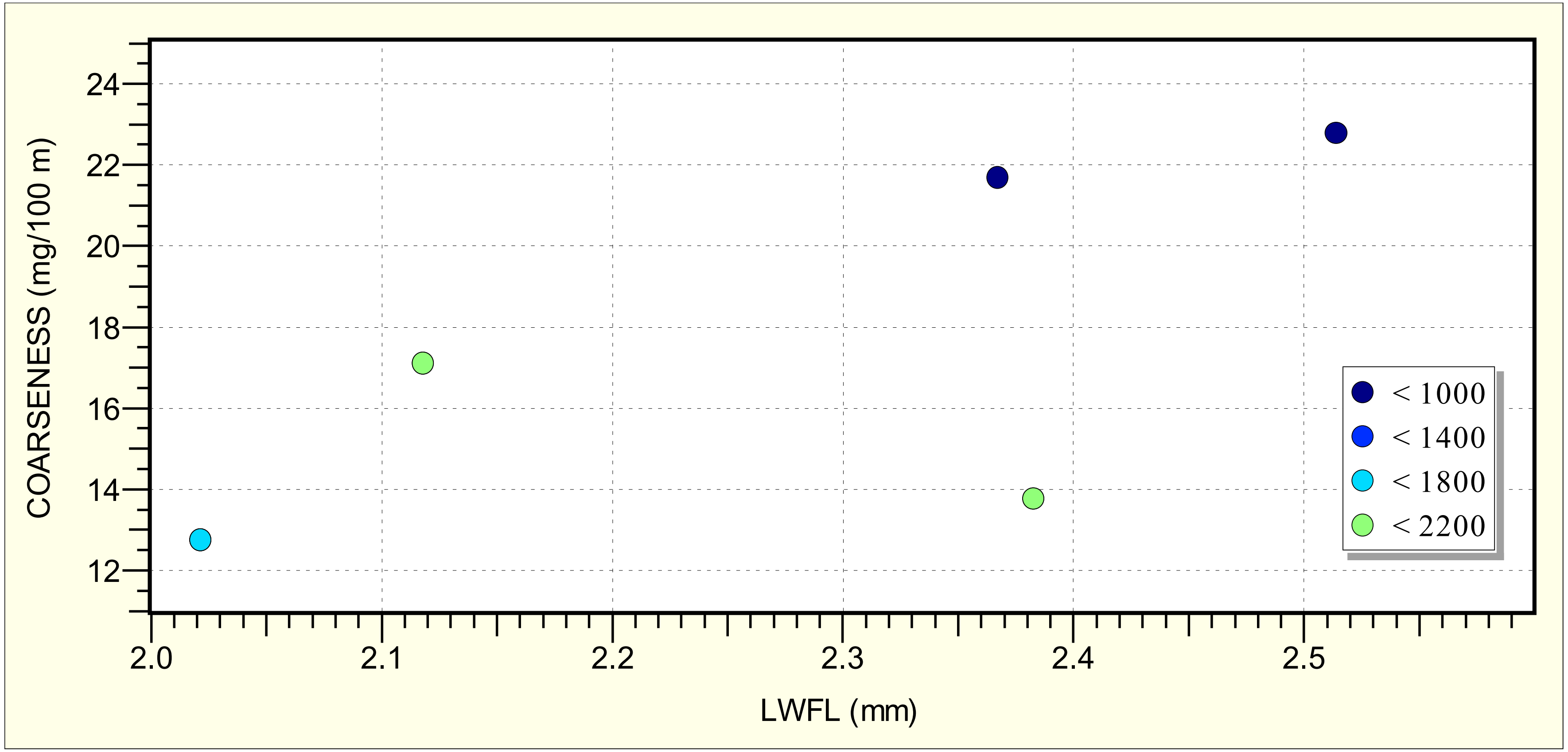




Linear regression coefficients

BL = (-91.4)*LWFL+ (-12.1)*Coarseness +(-6.6)*LWFLXCoarseness + 184
R^2 =0.81 (*p* value=0.128)

TEA of Different Commercial Papers



Linear regression coefficients

BL = (3899)*LWFL+ (631)*Coarseness +(-293)*LWFLXCoarseness -6734

R^2 =0.625 (*p* value=0.15)

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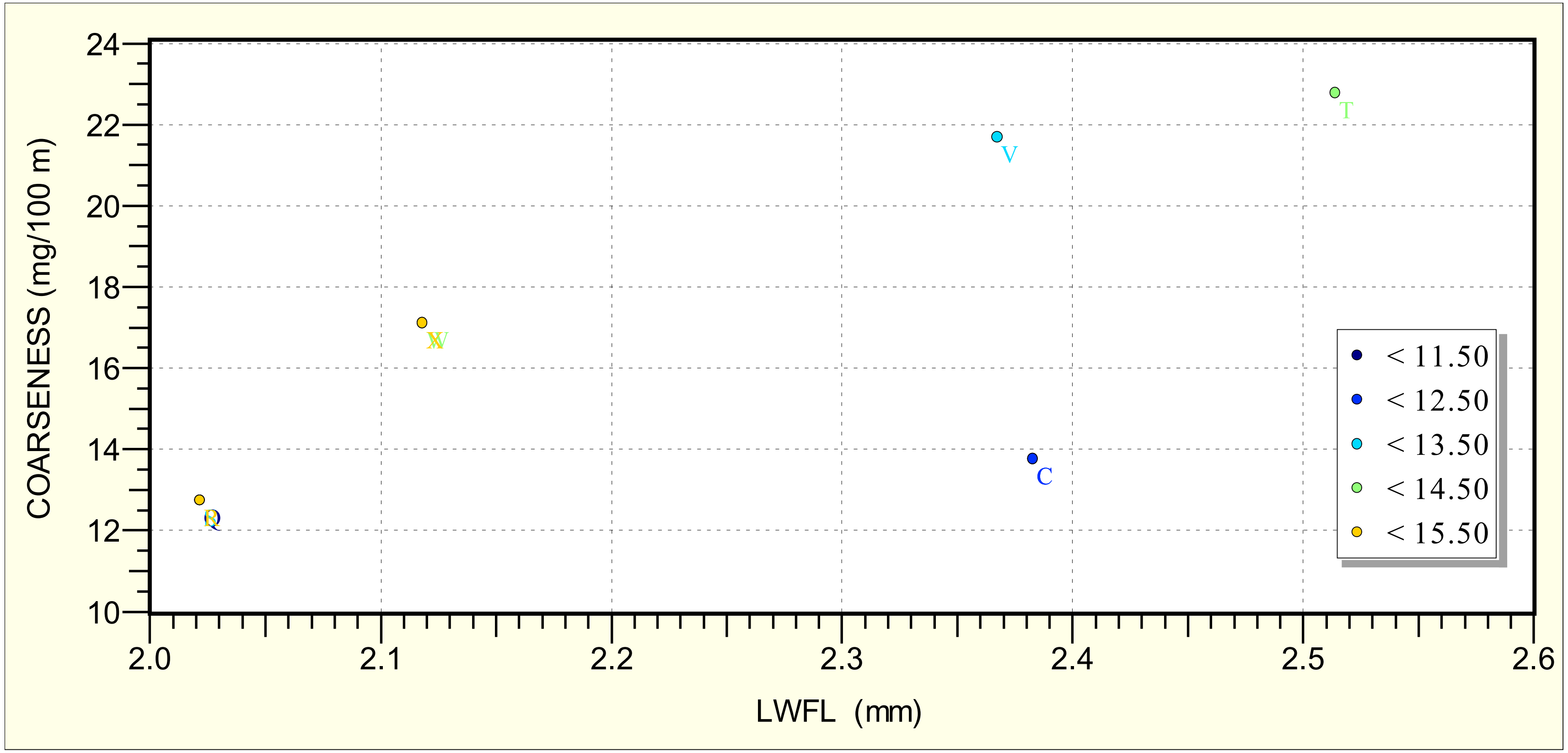
Tear Index (mN·m²/g) of Different Commercial Papers



Linear regression coefficients

BL = (0.71)*LWFL+ (1)*Coarseness +(-0.33)*LWFLXCoarseness -8.1
R^2 =0.292 (*p* value=0.598)

Summary

Coarseness and Fibre length account for

- Over 80% of the variability in tensile strength, TEA and tear index in standard handsheets
- Over 60% of the variability in tensile strength and TEA (but not Tear index) in commercially papers
  - Lower correlation could be due to processing factors such refining and papermaking
  - Many consider TEA a better indicator of paper toughness than Tear index

Long, fine fibred pulps produce papers with higher tensile strengths and TEA

- Gives versatility in paper making (through refining) to control other properties of interest

Thank you

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