EuroFiber Seminar
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Influence of Spruce Wood Properties on Thermomechanical Pulping – Pilot Scale Results

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EuroFiber Project

Project plan

1. Characterization and modelling of wood and fiber property variations
2. Laboratory refining study
3. Pilot scale study
4. Commercial scale mill studies

EuroFiber Project

Sampling strategy for wood

1. Based on the results of phases 1 and 2 it was decided that wood for pilot trials should be selected on
    1. Basic wood density
    2. Fiber length
2. Five types of wood were defined
3. For pilot study wood was taken from Norway, Sweden, France
4. Logs were selected according to
    1. Age
    2. Growth rate
    3. Height
5. Fiber length and basic density were separated into five categories

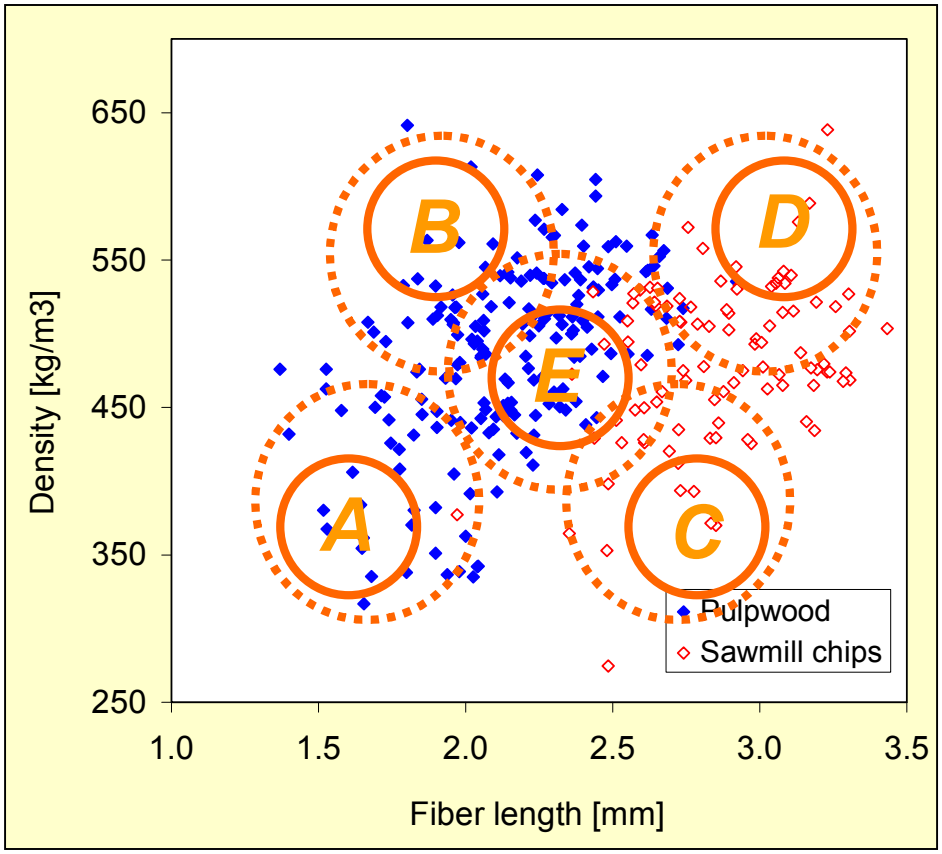
EuroFiber Project

Sampling strategy for wood

- Six wood assortments from 3 countries = totally 18 wood sortiments
- Segregated on wood density and virgin fiber length
  - Basic density from 332 kg/m3 – 435 kg/m^3
  - Virgin fiber length from 2.1 mm – 3.2 mm
- Processes used in pilot plant
  - Conventional TMP pulping
  - High-intensity thermomechanical pulping

Wood samples tested in the laboratory

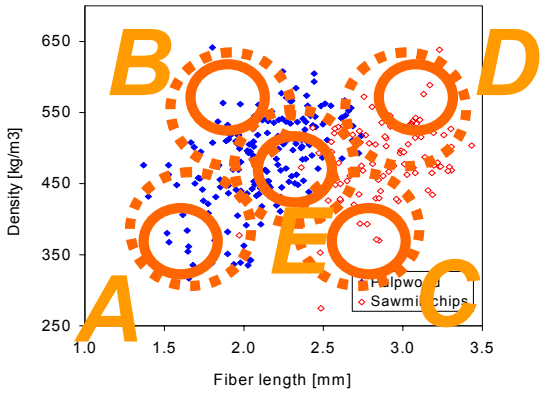
Classified by fiber length vs. density



A	Short fibers	Low density
B	Short fibers	High density
C	Long fibers	Low density
D	Long fibers	High density
E	Middle fiber length	Middle density
M	Mix of 50% A and 50% D	

Wood samples – Selection Criteria

Translated for sampling of stands and trees in the forest



*) average size tree

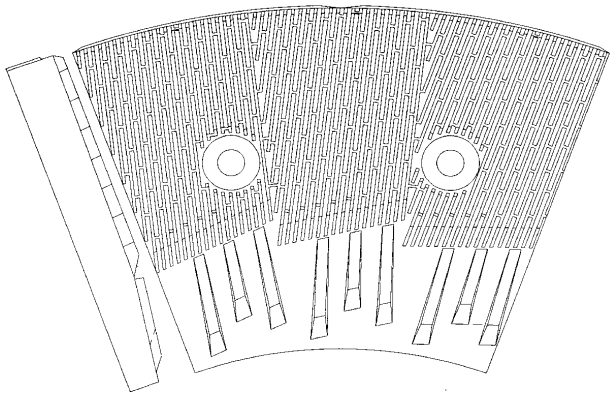
Refining Conditions

Conventional TMP and RTS

	TMP	RTS
Primary refiner	36-1CP (91 cm)	
Disc speed	1800 rpm	2600 rpm
Pressure	2.8 bar	5.9 bar
Retention time	3 min	10 – 12 sec
Plate pattern	Durametal 36604, low intensity directional pattern	
Secondary refiner	401 atmospheric Double disc (91 cm); 4 levels S.E.C.	
Samples used	A, B, C, D, E, M	Selected wood types

1/14/97
M

REFINER MANUFACTURER	Sprout
REFINER DISC DIAMETER	36 INCH
DURAMETAL CIRCLE DIAMETER	36 INCH
DURAMETAL PATTERN NUMBER	36604



(With Bar Angle Correction)

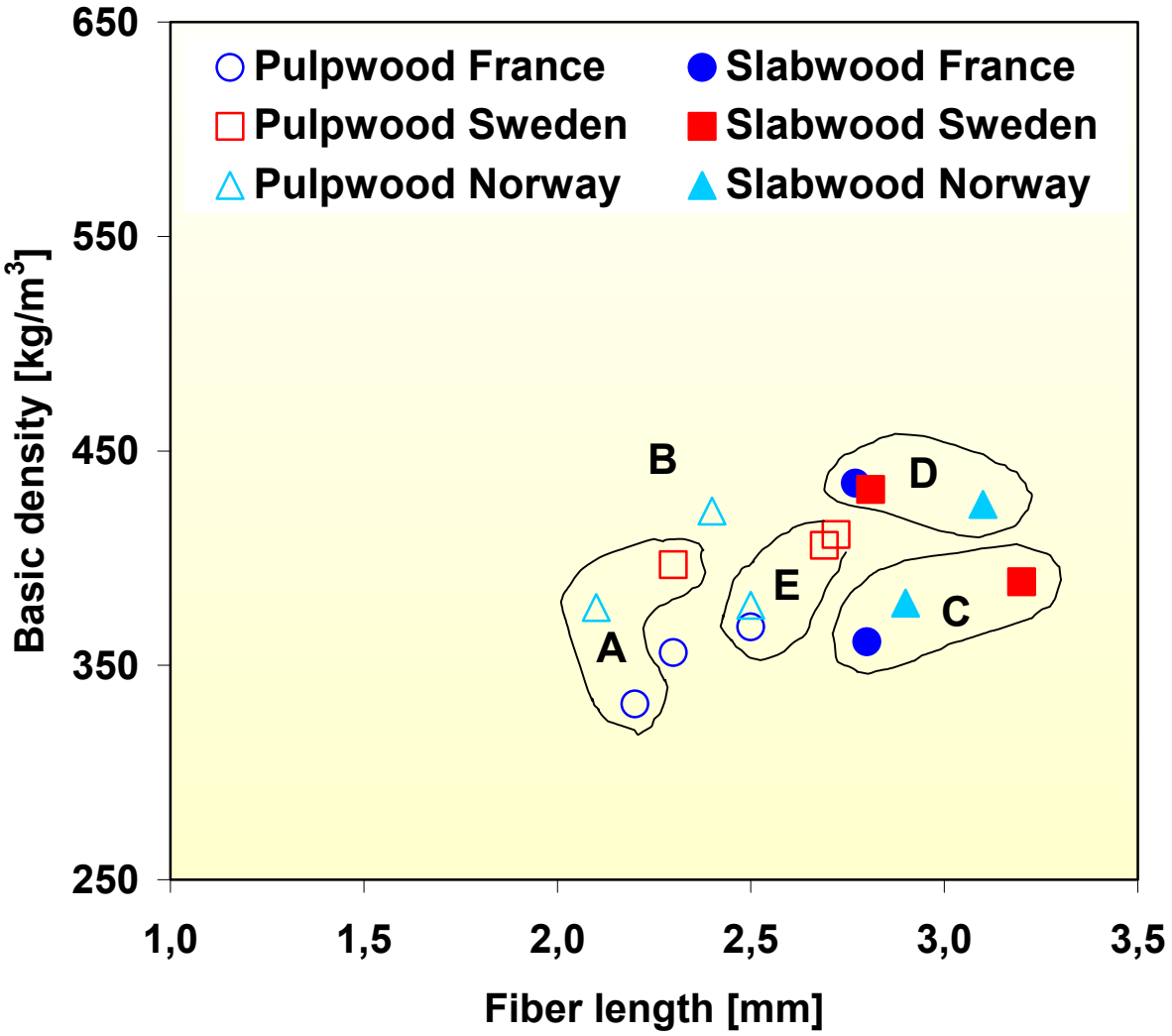
KM/S: 769 (775) RPM: 1500
ICPM: 2.18 (2.20) X 10^9 RPM: 1800 SEGMENTS / CIRCLE: 9

BAR WIDTH	GROOVE WIDTH	BAR HEIGHT	AVG BAR ANGLE	DAM TYPE
0.070 (1.80 MM)	0.100 (2.50 MM)	0.209 (5.30 MM)	7.00	SURF, SUB

BREAKER BARS

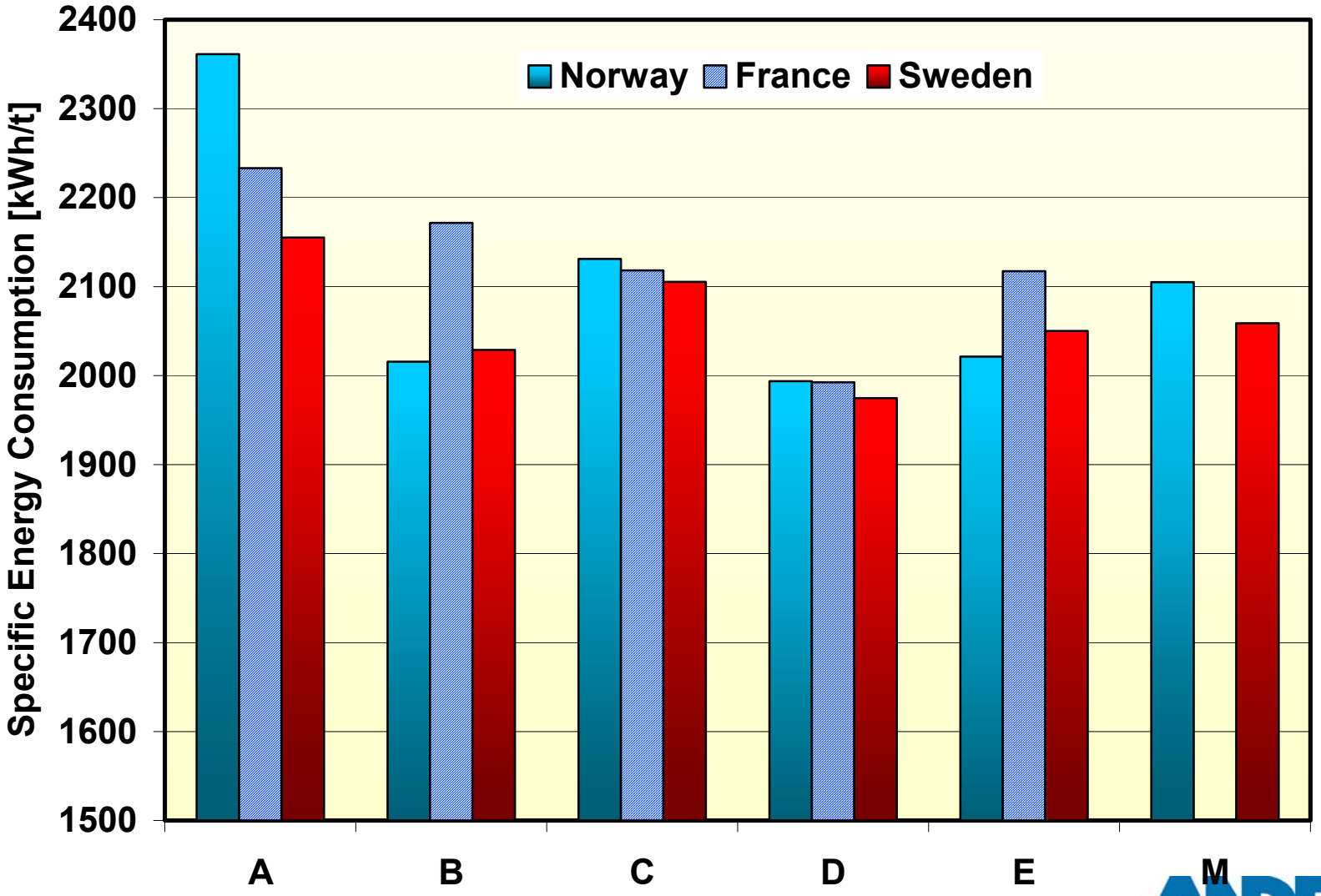
Wood sampling

Basic density vs. Fiber length



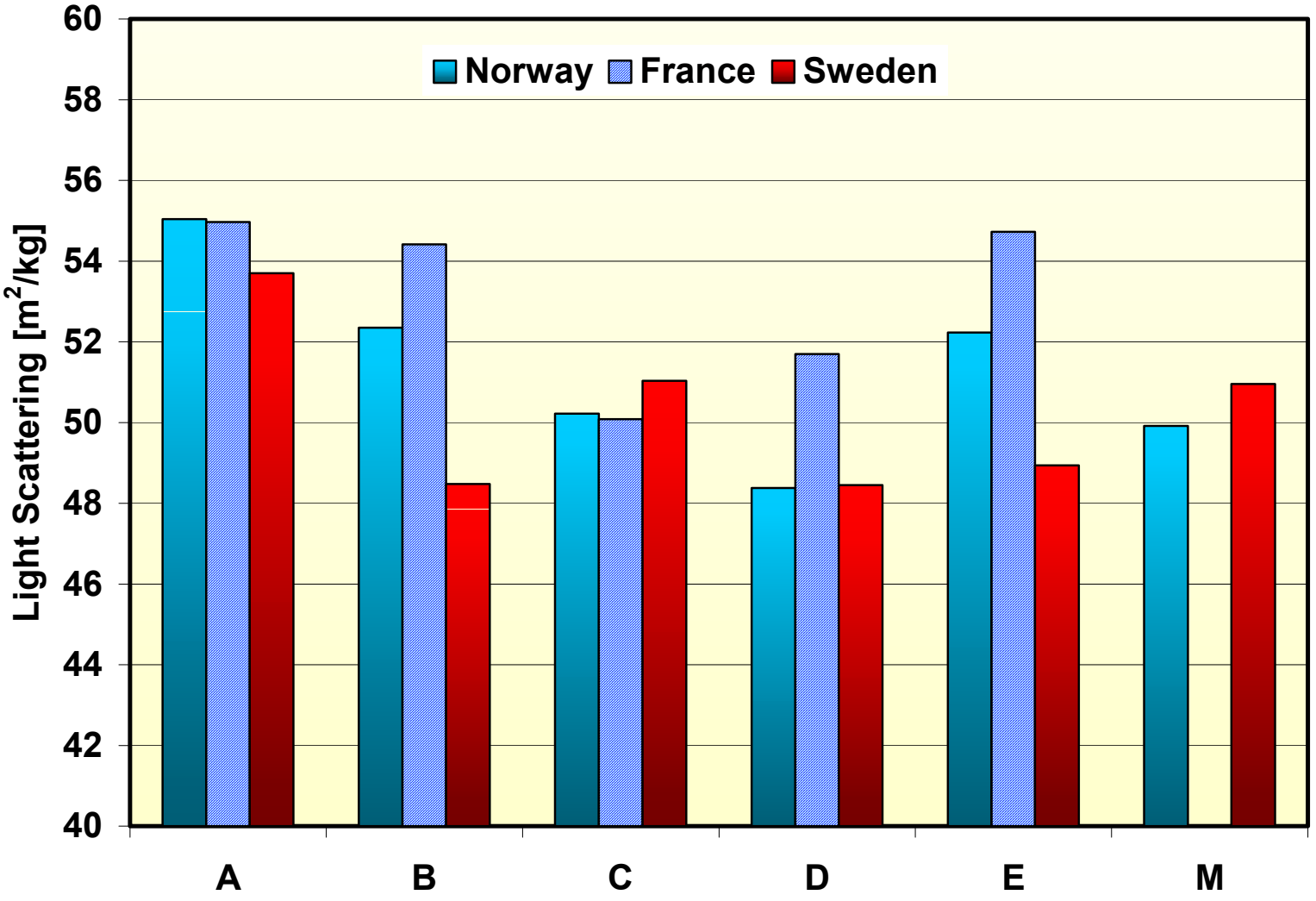
Specific Energy Consumption

Results interpolated at freeness o 130 ml CSF



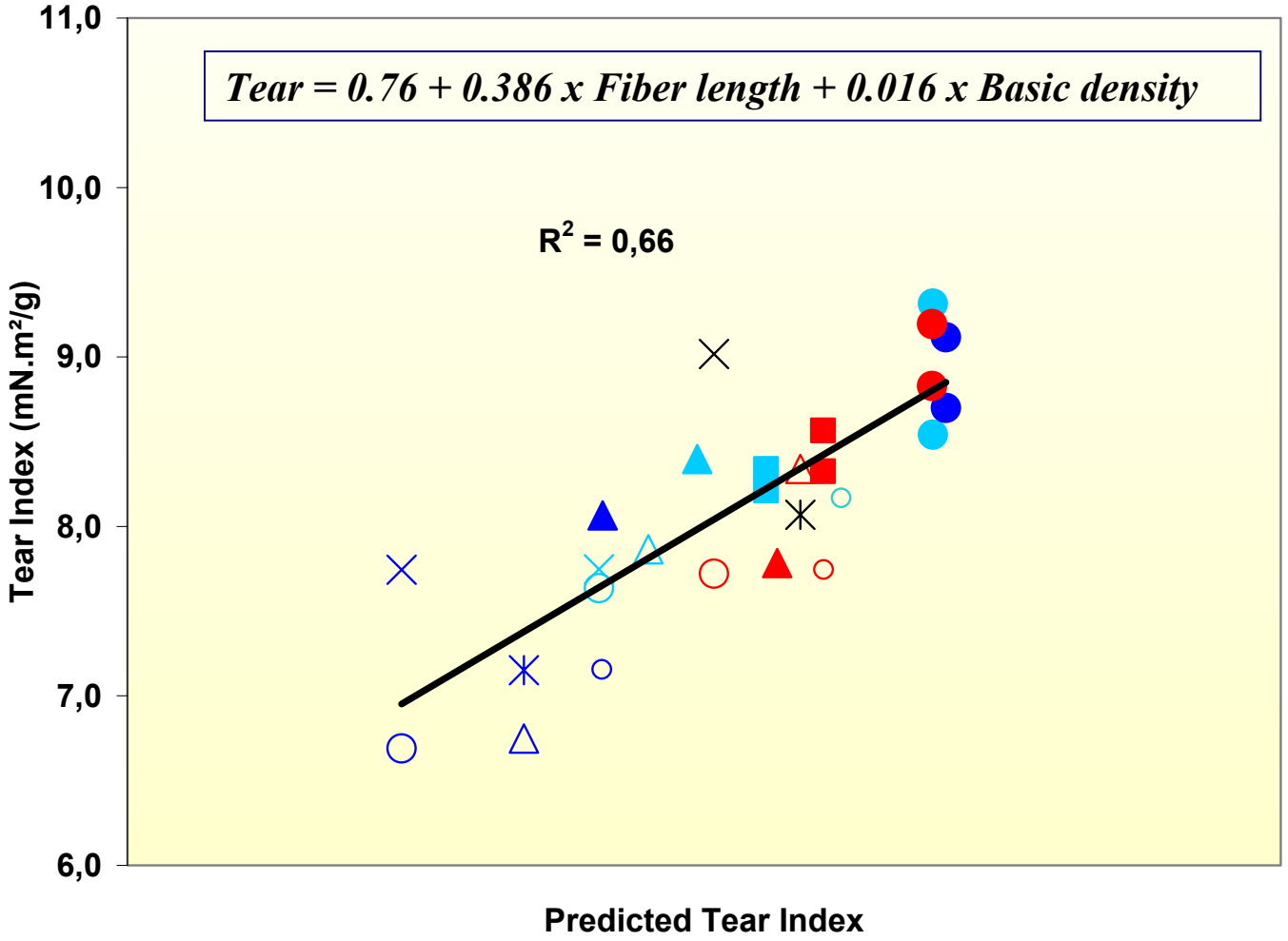
Light Scattering Coefficient

Results interpolated at 130 ml CSF



Tear Strength

Linear Regression analysis



NA NB
NC ND
NE NM
NA RTS ND RTS
NM RTS FA
FB FC
FD FE
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FE RTS SA
SB SC
SD SE
SM SA RTS
SD RTS SE RTS
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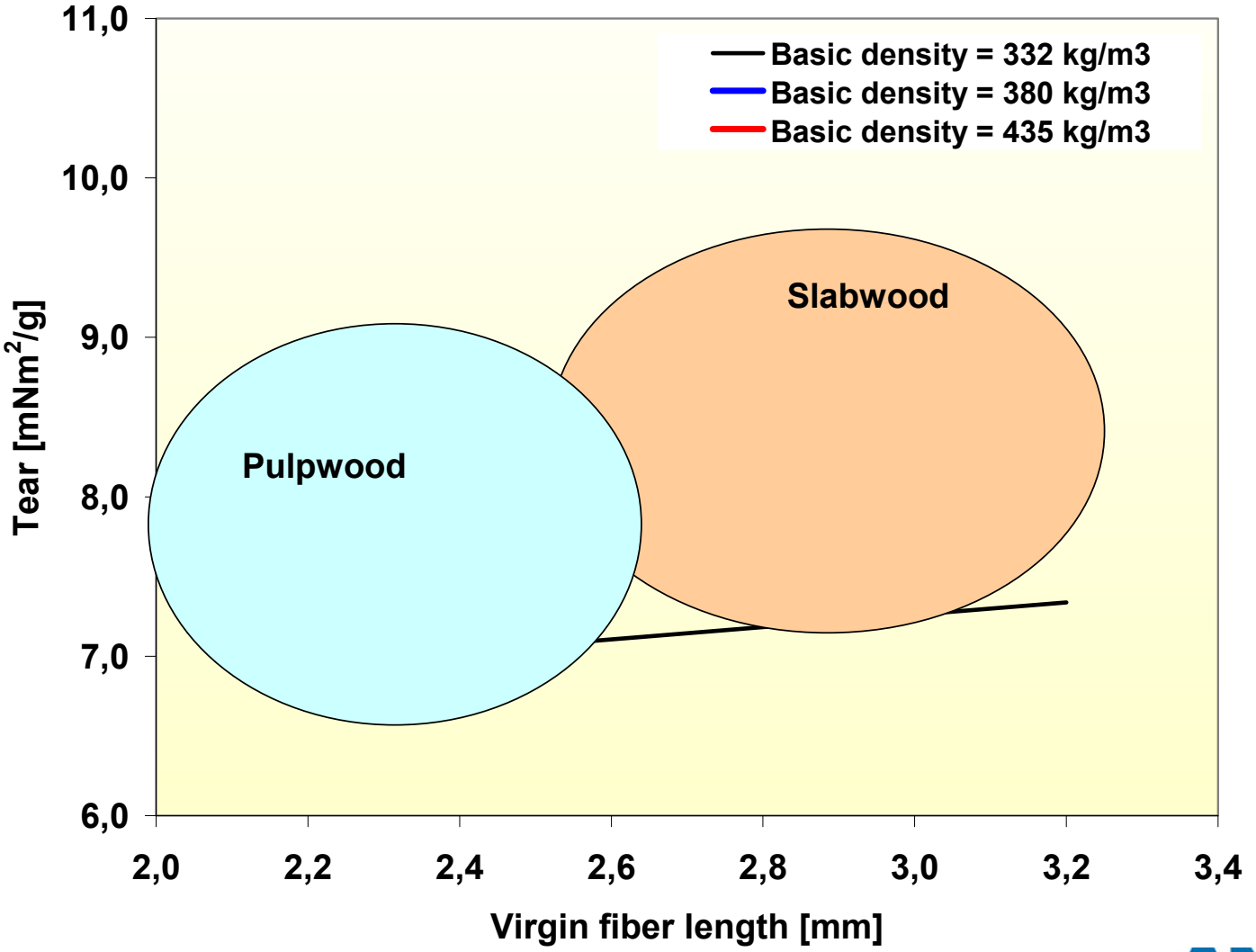
Tear Strength

Linear Regression analysis



Light Scattering Coefficient

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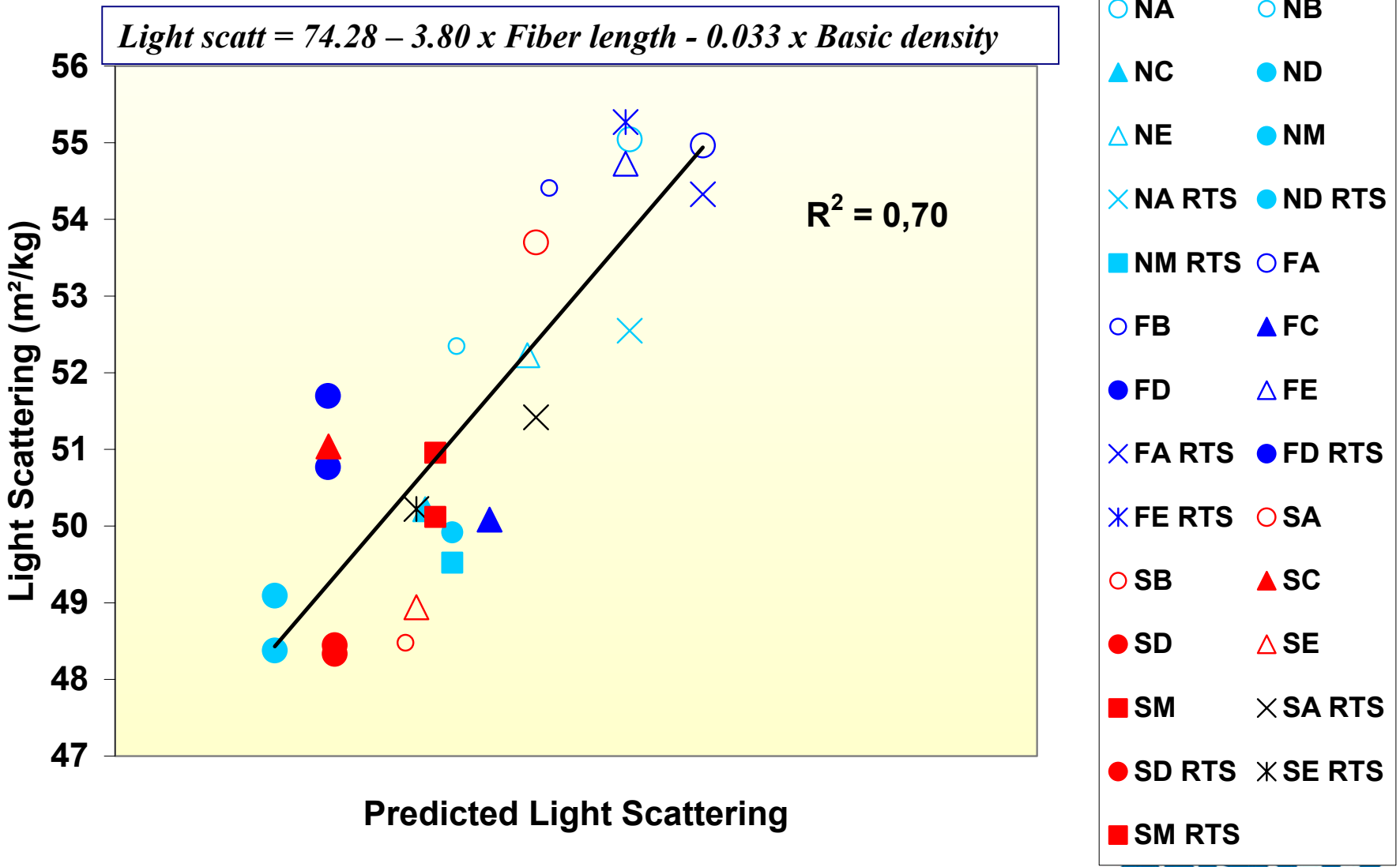

Light Scattering Coefficient

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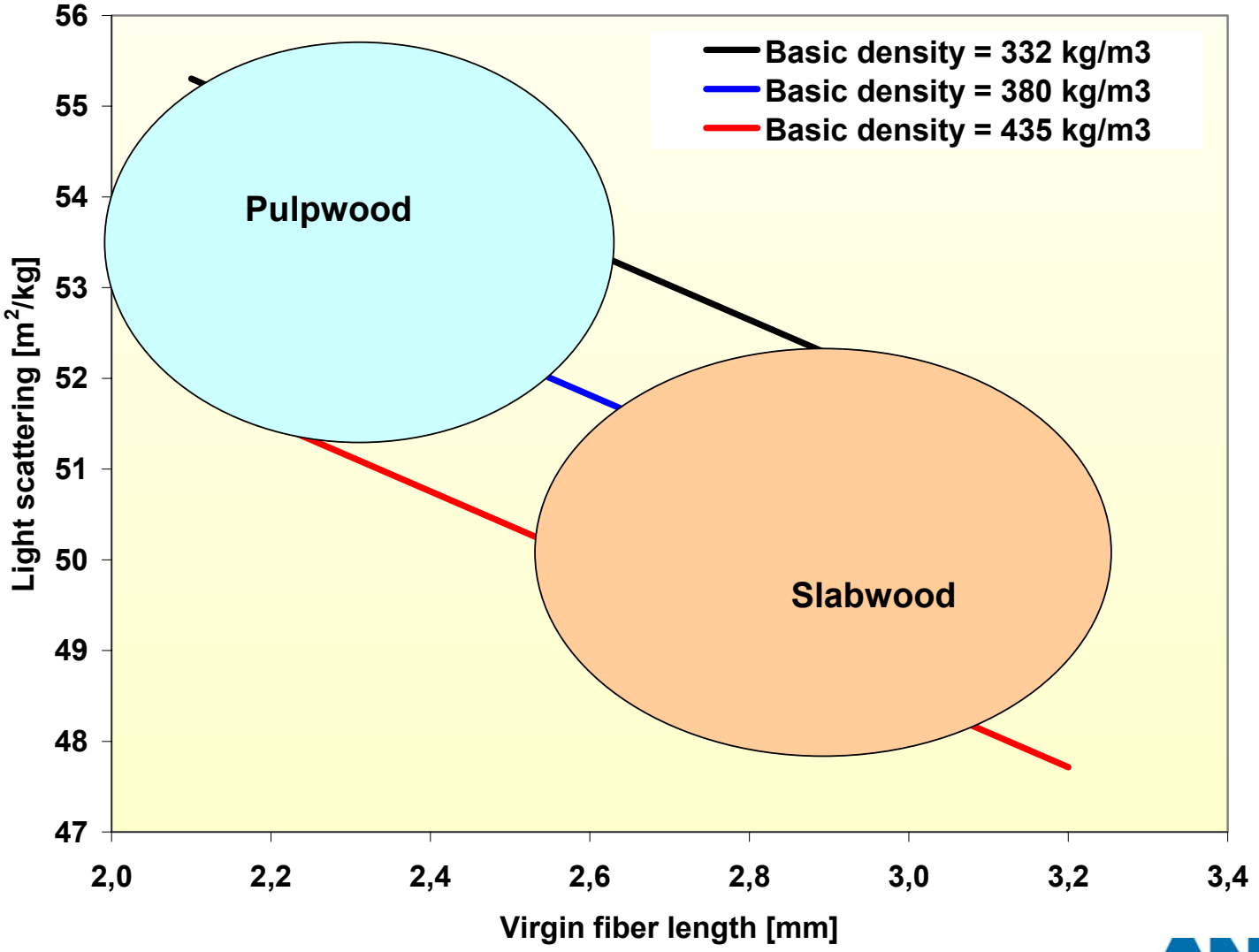
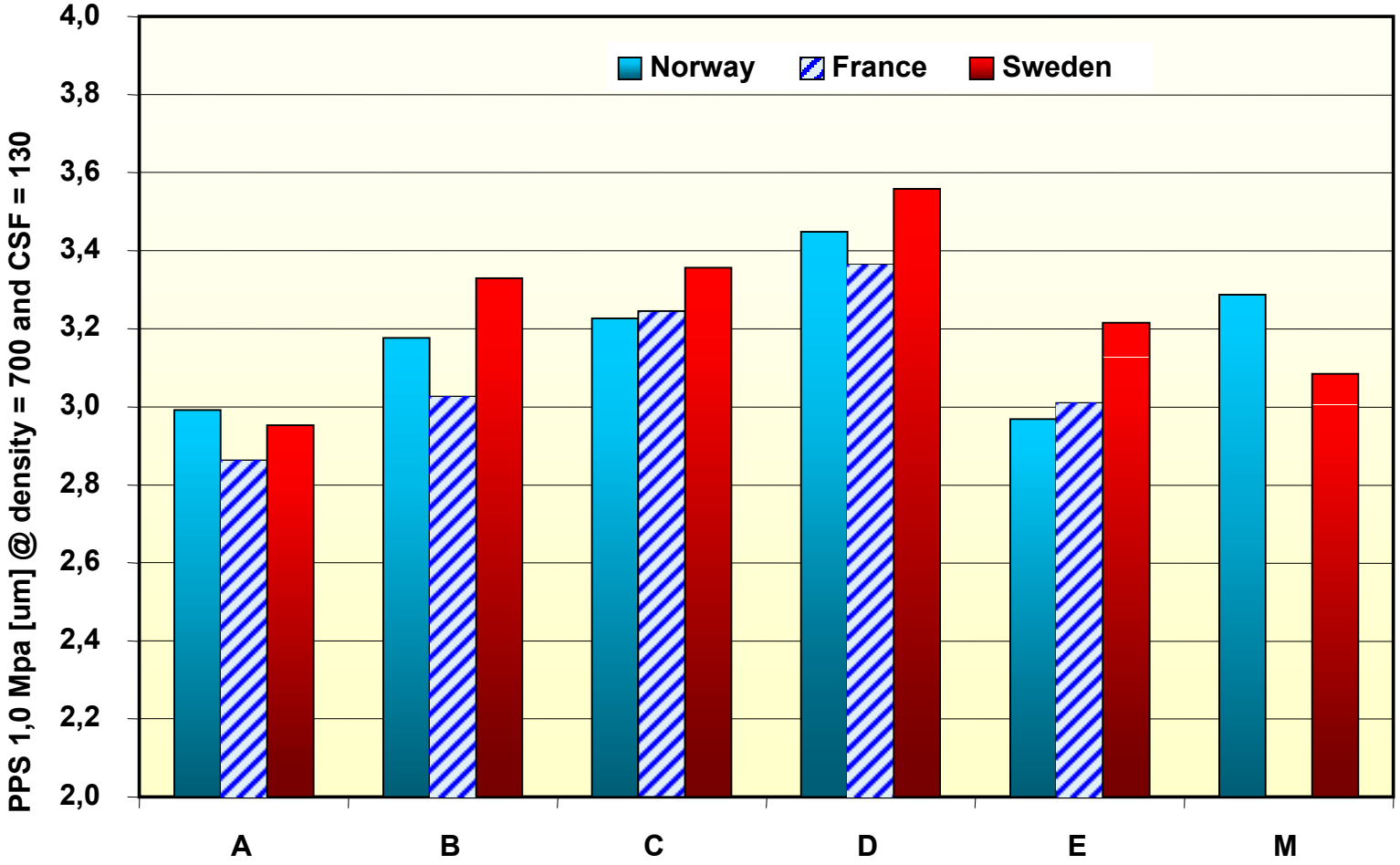


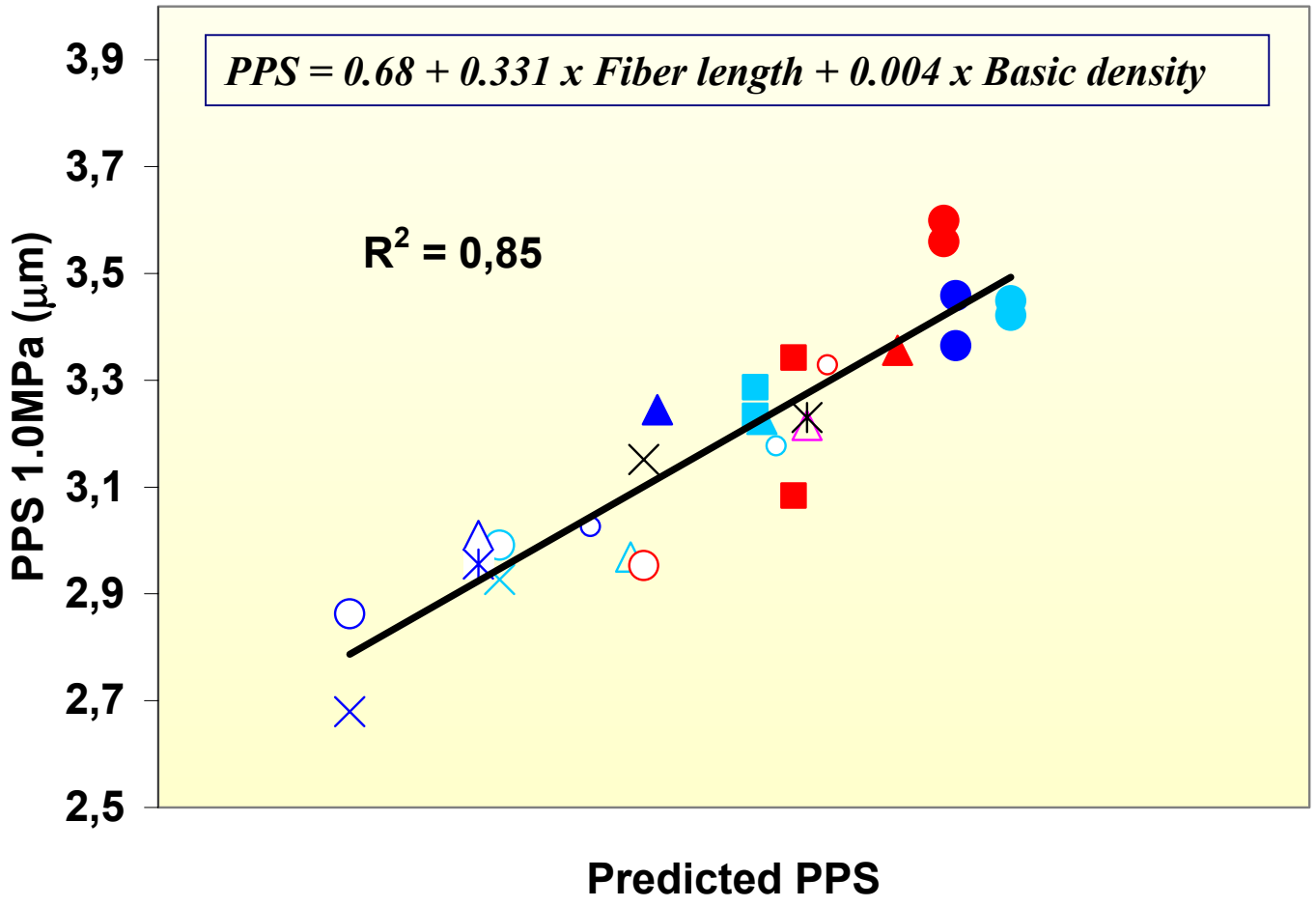
Surface properties

PPS - Results interpolated at 130 ml CSF



Surface Properties

Linear Regression analysis



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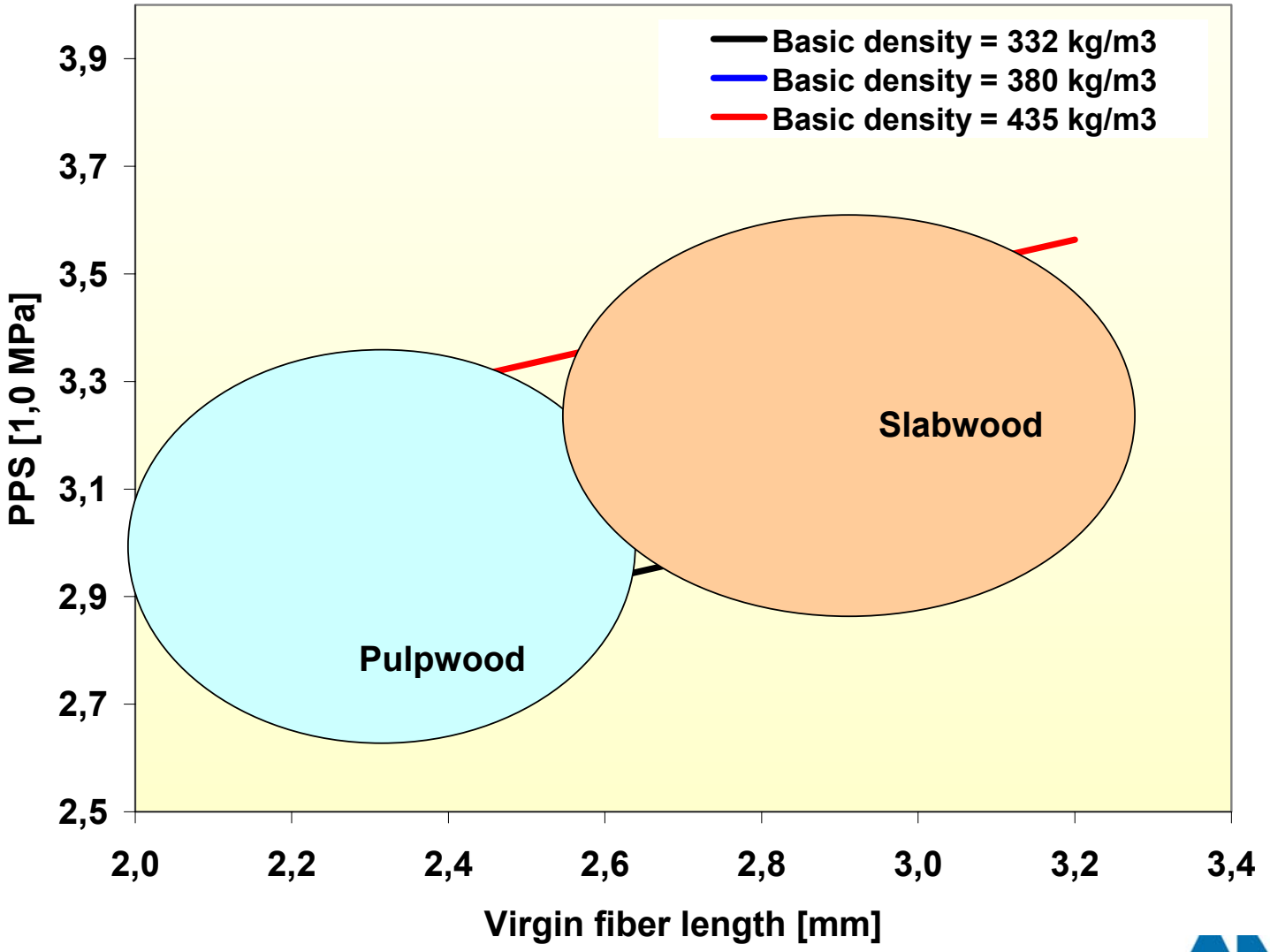
Surface Properties

Linear Regression analysis



Discussion

Results

- Large differences exist in wood and fiber properties, both between and within trees.
- Juvenile wood fibers have thinner fiber walls and tend to be shorter than mature fibers
- Wood assortments A and B were taken from first thinnings and top logs → consist of mostly juvenile wood.
- Assortments C and D were taken from the slabwood of final cuttings → 100% mature wood.

Discussion

Results

- Wood sorts from juvenile wood have short fibers and low basic density (thin walls, large lumens) → high LSC, low tear, low PPS, high S.E.C.
- Light scattering is promoted by thin, flexible fibers which create high specific surface (Kure, Reme).
- Low tear strength can be understood from shorter virgin fiber length of juvenile wood.
- High S.E.C. is explained by more flexible fibers which are more difficult to refine and defiberize than stiffer and thicker fibers from mature wood.
- No other fiber characteristics were measured (only fiber length). Assumption: low basic density corresponds with thin-walled and flexible fibers.

Discussion

Results

- Correlations and trends indicate that „wood density“ and „virgin fiber length“ are more influential than geography, latitude, altitude, age of tree for explanation of light scattering, tear strength and surface smoothness
- Basic density and fiber length are a result of latitude, altitude and age
- Equal density and fiber length in a tree grown in Norway or in France give identical paper properties

Discussion

Questions for the paper makers are:

- **What fiber raw material can we buy to meet our objectives ?**
- **What are the wood basic density and virgin fiber length of our raw materials**
- **Observe: basic density itself is not an explanation for paper properties, but reflects a set of basic fiber characteristics**

Conclusions

- **Wood type has greater impact on pulp properties than the refining method used to produce TMP**
- **Slabwood (C, D) gave significantly better strength properties than roundwood (A, B, E).**
  - **Long virgin fiber is preferable for strength properties (tear)**
  - **Mills which focus on strength should consider purchasing sawmill chips**
- **Roundwood chips with low density (A, B, E) gave pulps with better optical properties.**
  - **Mills which aim for high brightness and scattering coefficient should purchase a lot of wood with middle fiber length (E) and some short fiber wood (A, B).**

Conclusions (cont'd)

- **Slabwood (C, D) and short-fiber/high-density wood (B) resulted in the roughest paper surfaces.**
- **Wood sorts with short fibers and low or middle density (A, E) gave the best results concerning surface smoothness.**
  - **Mills which aim for high surface smoothness should use roundwood as an option.**
  - **Low-density wood (A, E) can be separated from high-density wood by selecting logs with wide annual rings**
- **High-intensity refining resulted in similar pulp strength and higher brightness at lower energy consumption.**

Conclusions (cont'd)

- Specific paper properties, i. e. PPS, tear, light scattering, could be predicted from wood basic density and fiber length.
- In the future, paper mills should specify the properties they are aiming for. Hence, the type of wood raw material can be purchased accordingly.
- The time has arrived to increase focus on the raw materials which mills are purchasing to meet quality criteria.