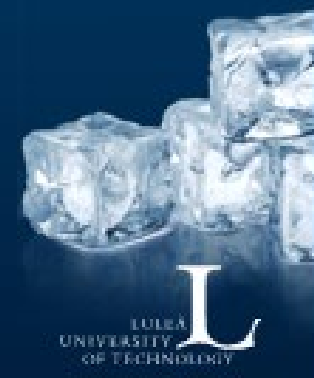
READiStrength

Resource-Efficient And Data-driven integrated log and board Strength grading

Olof Broman



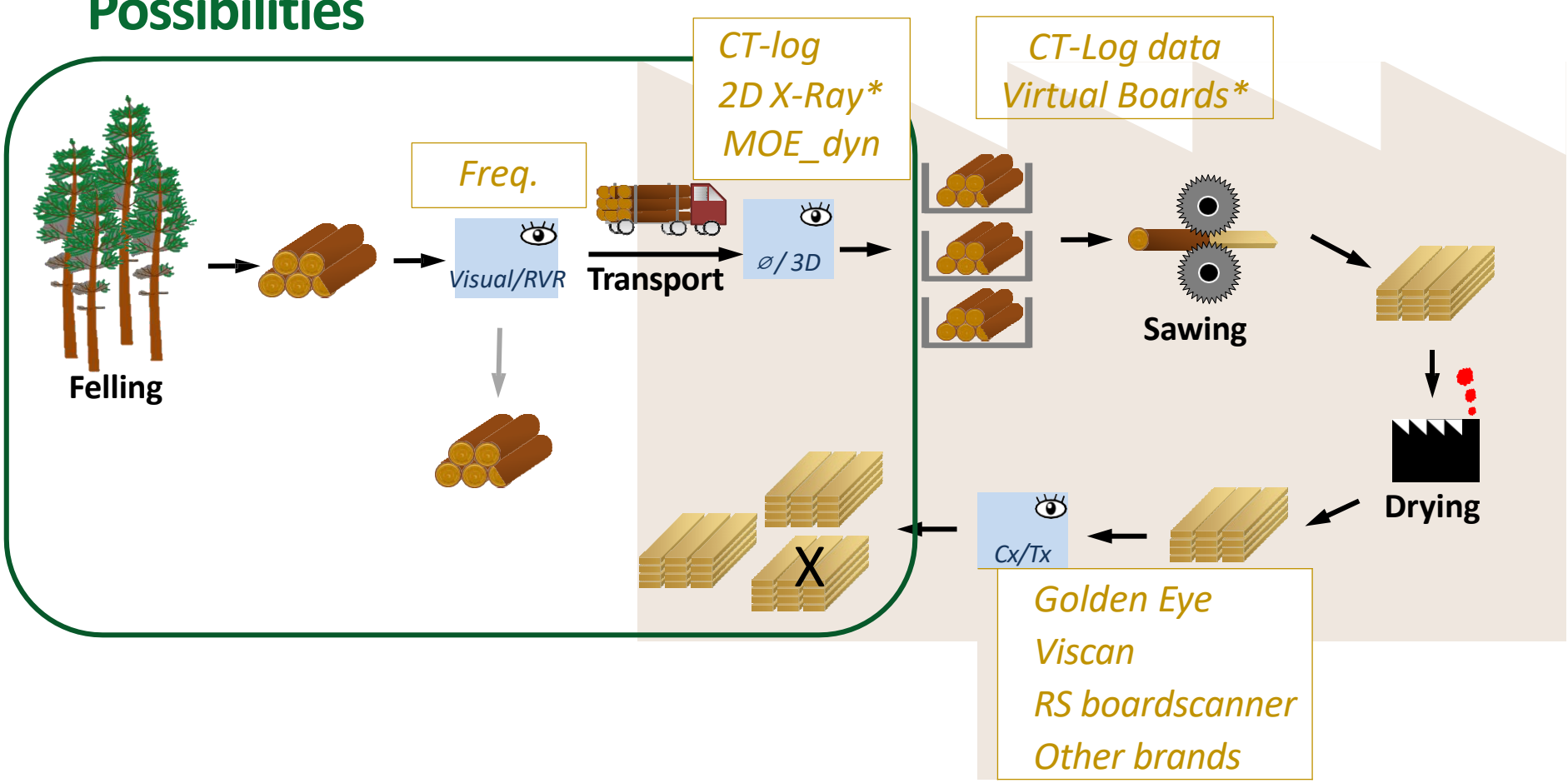
Project [READiStrength] is supported under the umbrella of ERA-NET Cofund ForestValue by Vinnova & Formas (Sweden), BMNT (Austria), BMEL ,FNR &BLE (Germany]. ForestValue has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 773324.

Project aim

To improve the current concepts of saw timber strength grading towards more flexible and adaptive approaches prior conversion of the raw material to make best use of Europe's wood resources.

Sawing, measurements and grading for strength

Possibilities



Three countries and four species

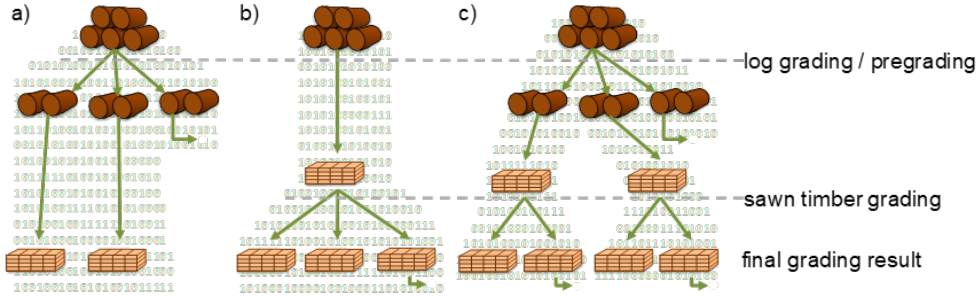
Austria: Douglas fir

Germany: Silver fir

Sweden: Pine and Spruce

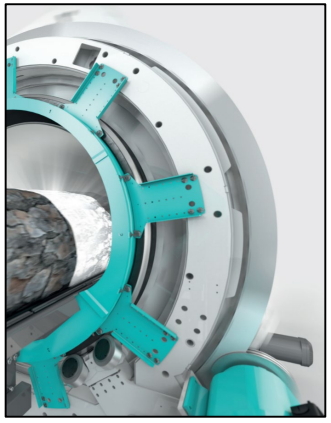
Main question

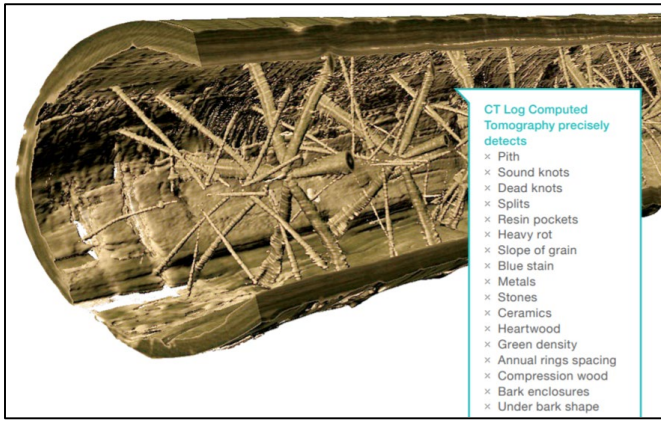
How and when to strength-grade timber?



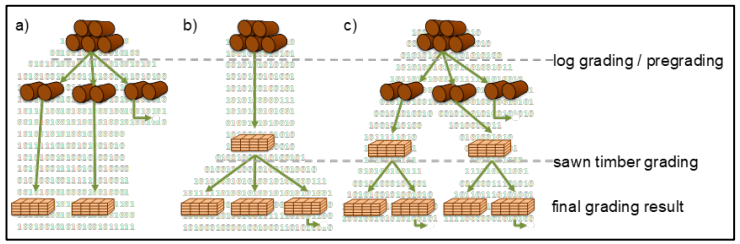
Hyphotesis (one of several)

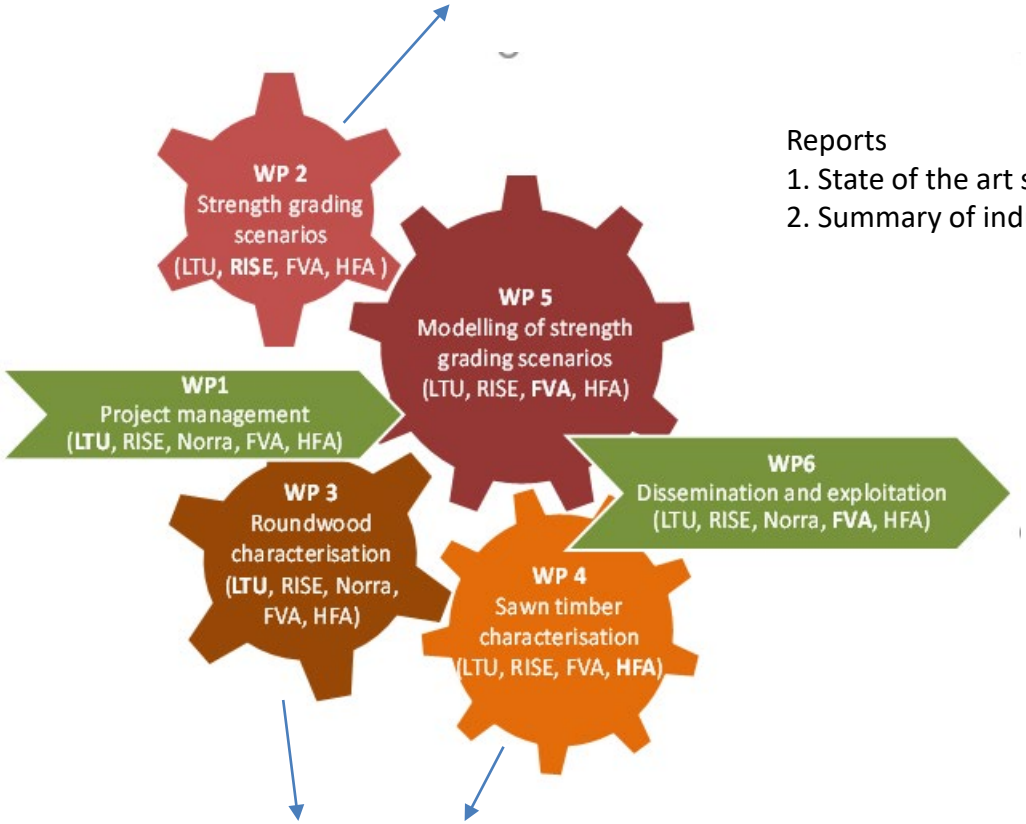
It should be possible to improve the strength grading with aid of data early in the process (CT-log or discrete X-ray + traceability)





Interviews with small and large sawmillers and manufacturers of scanning technology

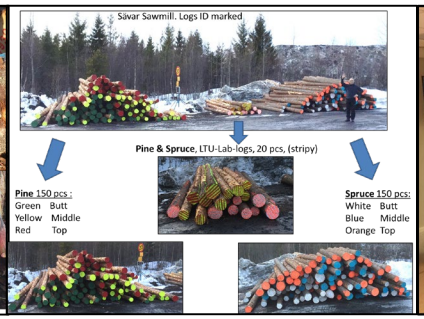


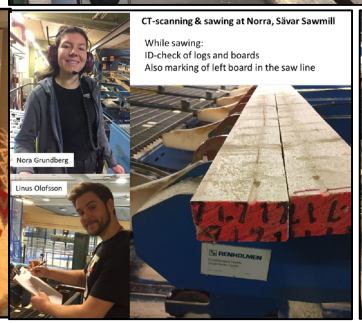


Reports

1. State of the art summary on industrial strength grading, including standards
2. Summary of industrial view on strength grading based on interviews

Collection of empirical data from industry at log and board level





Data collection in the project, data for 1200 boards!

		SE_1	SE_2	AT	DE
	Species (according to EN 13556)	PCAB, PNSY		PSMN	ABAL
	Diameter	14-22 cm	14-22 cm	30-60 cm	20-60 cm
WP3: logs	**3D (N_R)**	300	20	54	50
	Discrete X-ray (N_R)	300	20	(simulated)	(simulated)
	CT (N_R)	300	20	54	50
	$MoE_{dyn,\ log}$ (N_R)	-	20	54	50
	Conversion to sawn boards (N)	300 → 600	20 → 40	54→ 272	50 → 375
	Dimensions	50x100 mm		49x159 mm 49x245 mm	49x245 mm
WP4: sawn timber	**Optical scanner (N_S)**	600	-	272	375
	Laser tracheid scanner (N_S)	600	-	272	375
	X-ray (N_S)	600	40 CT/LTU	272	375
	$MoE_{dyn,board}$ (N_S)	600	-	272	375
	$MoE_{dyn,board}$ (lab) (N_S)	600	40	272	375
	Destructive test (N_S)	600	40	272	375

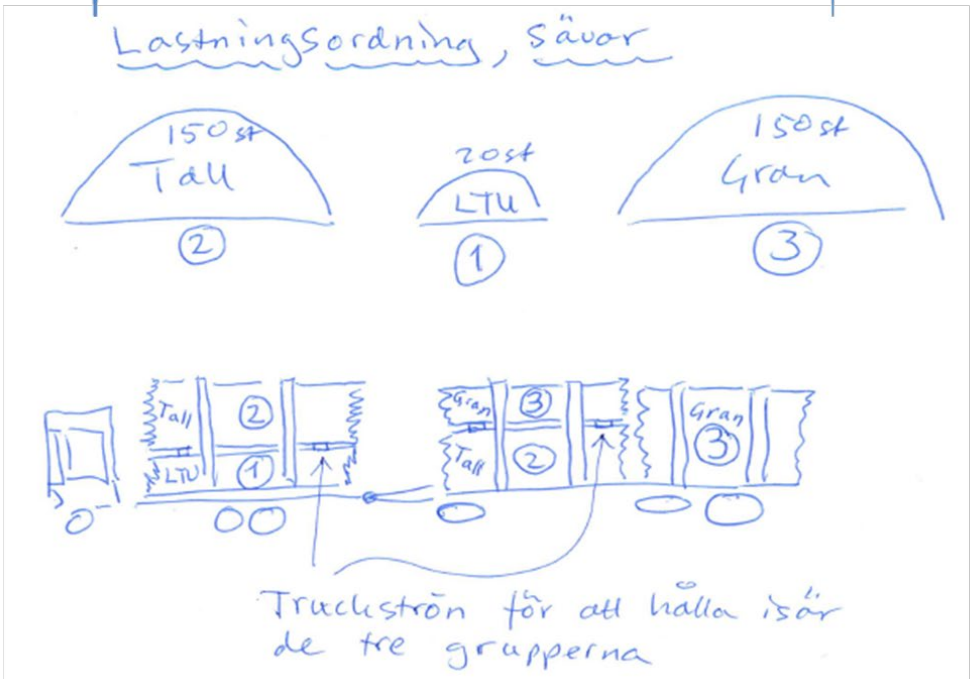
Logistics, a lot of it

Transport plan, all 320 logs to Stenvalls Sawmill for discrete X-ray scanning

Furu 10 topp:
155-172 mm
Topp och mellan

Furu 11:
156-167 mm
Topp och mellan

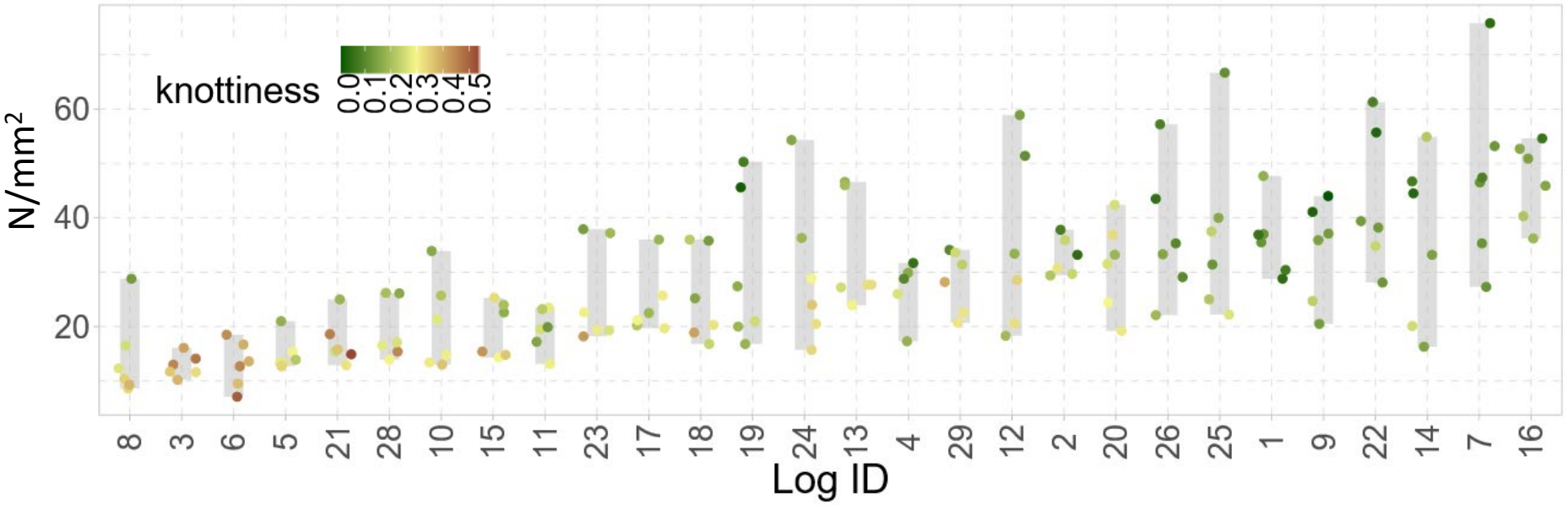
Gran12
169-175 mm
Blandat stocktyper

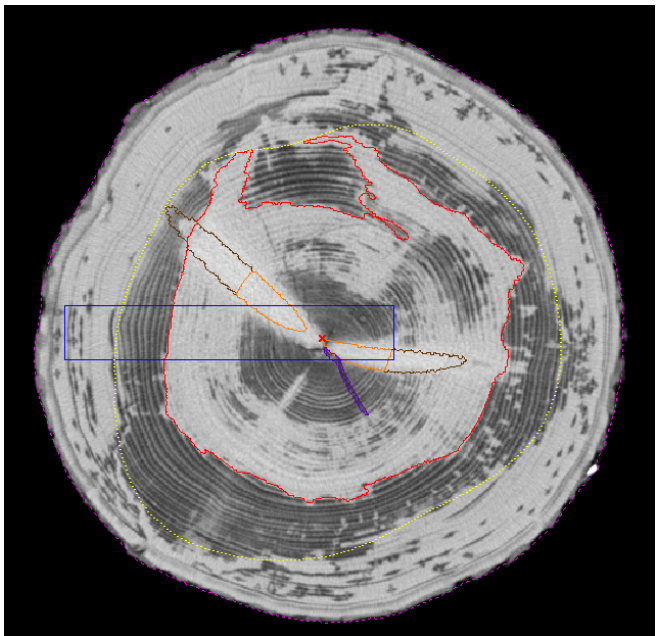


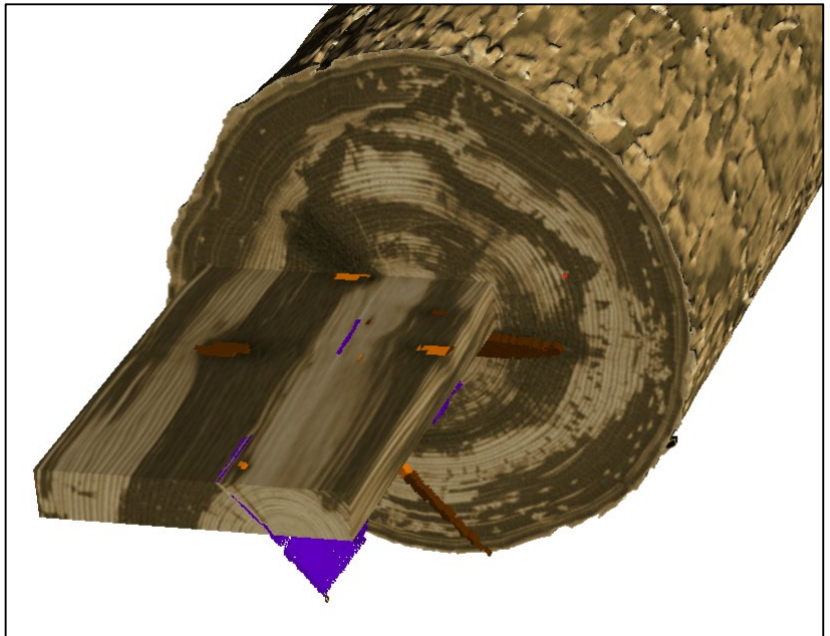
…and back to Sävar!
20 LTU-lab logs was dropped at Campus

Analysis started

Tension strength per log and board. SILVER FIR







Multivariate prediction PLS-models of bending strength (SWE)

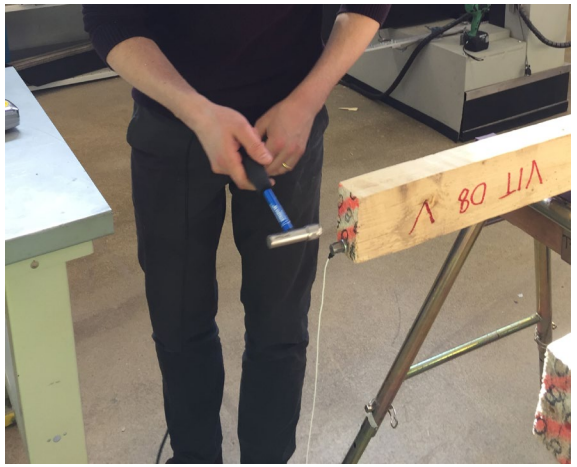
Y

640 Boards
320 logs
50/50 Pine/spruce

Prov	Bredd	Tjocklek	Längd	Vikt	Korrigerad Böjhållfasthet	Korrigerad MOE lokal	Korrigerad MOE global	Beräknad MOE lokal	Korrigerad Densitet	Fuktkvot	Frekvens	MOE_{dyn} lab	Avstånd numrerad	Avstånd nurmerad ände till brott
Board	Width	Thickn.	Length	Weight	Flexural strength	MOE corr local	MOE corr global	MOE local calc.	Density corr	MC	Frequency		MOEdyn	
	(mm)	(mm)	(mm)	(kg)	(MPa)	(MPa)	(MPa)	(MPa)	(kg/m³)	(%)	(Hz)		(mm)	(mm)
Vit 01 h	99,7	50,9	3 724	9,8	56,5	17 603	14 204	15 776	490	12,0	752	16 307	1 520	1 660
Vit 01 v	101,9	50,6	3 724	10,0	55,8	17 435	14 026	15 544	501	12,1	714	14 649	1 520	1 820
Vit 02 h	101,0	51,0	4 280	9,3	34,1	8 286	7 623	7 220	409	10,3	526	8 570	1 520	1 800
Vit 02 v	100,6	51,1	4 280	9,7	33,2	7 993	7 233	6 712	426	11,2	482	7 529	1 520	1 780
Vit 03 h	101,0	50,8	3 727	9,6	68,4	16 129	13 270	14 561	491	11,7	745	15 458	820	1 120
Vit 03 v	101,2	50,7	3 727	9,6	73,4	15 270	14 220	15 796	484	12,6	742	15 373	820	830
Vit 04 h	100,6	51,1	3 985	7,7	28,3	8 728	8 204	7 975	357	11,2	621	9 238	900	1 000
Vit 04 v	101,2	51,3	3 985	7,7	27,7	6 669	7 265	6 755	360	11,0	582	7 979	900	1 160

Breakage tests at RISE

MOEdyn (ViScan) of dried boards:
At Sävar Sawmill and Derome Sawmill x2

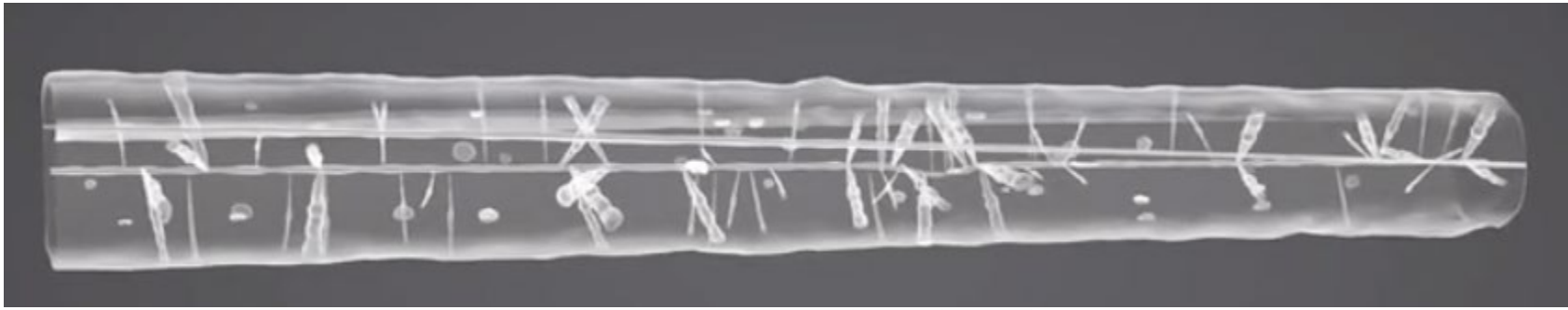


MOEdyn dry boards at RISE

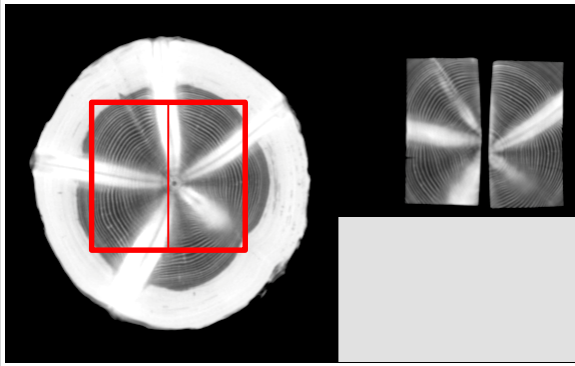
With descriptors from the industrial CT log

Heart- and Sapwood density, Heartwood content, Rot, Pith deviation, Spiral grain, Knots (position, size, type) , Log curve and taper

X



board_ID	knot_ID	face	width	length	diam	diamNTR	kar	posZ	posX	dead	spike	border	steep
2	25	BOTTOM	24.926004	26.843384	24.863518	25.882416	23.879910	1467.7843	17.275095	0	0	0	0
2	31	BOTTOM	23.017288	24.587891	20.973742	23.788555	23.226030	1682.2333	70.117645	1	0	1	0
2	49	BOTTOM	12.946091	13.799072	12.755615	13.365472	12.355869	2098.2031	17.927439	1	0	0	0
2	113	BOTTOM	6.014629	23.703369	6.014629	14.858999	12.737666	3009.4365	0.000000	0	0	1	0
2	124	BOTTOM	21.340157	22.879883	21.020576	22.097225	21.340155	3151.3989	66.563545	1	0	0	0
2	157	BOTTOM	7.580261	6.640137	6.628605	7.109564	7.580261	3519.5629	88.301117	1	0	0	0
2	172	BOTTOM	23.203915	24.593262	23.203915	23.898588	24.147923	3739.0639	0.000000	1	0	1	0
2	192	BOTTOM	13.739510	13.703613	13.476344	13.719355	13.739493	4014.4550	33.959564	1	0	0	0
2	220	BOTTOM	21.610161	30.242676	21.610161	25.926418	23.994976	4673.4550	0.000000	1	0	1	0
2	250	BOTTOM	29.820251	29.821289	26.299473	29.633934	29.247198	5507.2324	69.291336	1	0	0	0
2	273	BOTTOM	8.082703	7.528320	7.512960	7.805171	8.082717	6046.6606	71.584625	1	0	0	0
2	3	TOP	7.689636	21.566498	7.689636	14.628067	3.072889	942.18432	94.710358	0	0	1	0
2	69	TOP	3.843880	3.454102	3.441895	3.648371	0.183171	2374.1376	14.268085	1	0	0	0
2	78	TOP	0.651398	7.067749	0.651398	3.859573	0.007433	2657.4580	101.74859	0	0	1	0
2	99	TOP	8.888496	9.135254	8.869568	9.011630	7.225569	2973.2949	52.535908	1	0	0	0
2	211	TOP	2.411392	5.749756	2.411392	4.080574	0.346833	4442.8383	99.988602	0	0	1	0
2	240	TOP	5.617893	5.185547	5.136332	5.399669	4.505992	5055.3598	33.927879	1	0	0	0
2	25	TOP	22.833817	24.590332	22.776573	23.709949	23.879910	1478.3240	59.407555	0	0	0	0
2	31	TOP	23.434769	24.725830	21.091461	23.922073	23.226030	1698.0209	21.410061	0	0	0	0
2	49	TOP	11.765648	12.540771	11.592543	12.146791	12.355869	2108.8911	67.624077	0	0	0	0
2	113	TOP	19.460693	31.913086	19.460693	25.686890	12.737666	3022.3891	82.939301	0	0	1	0

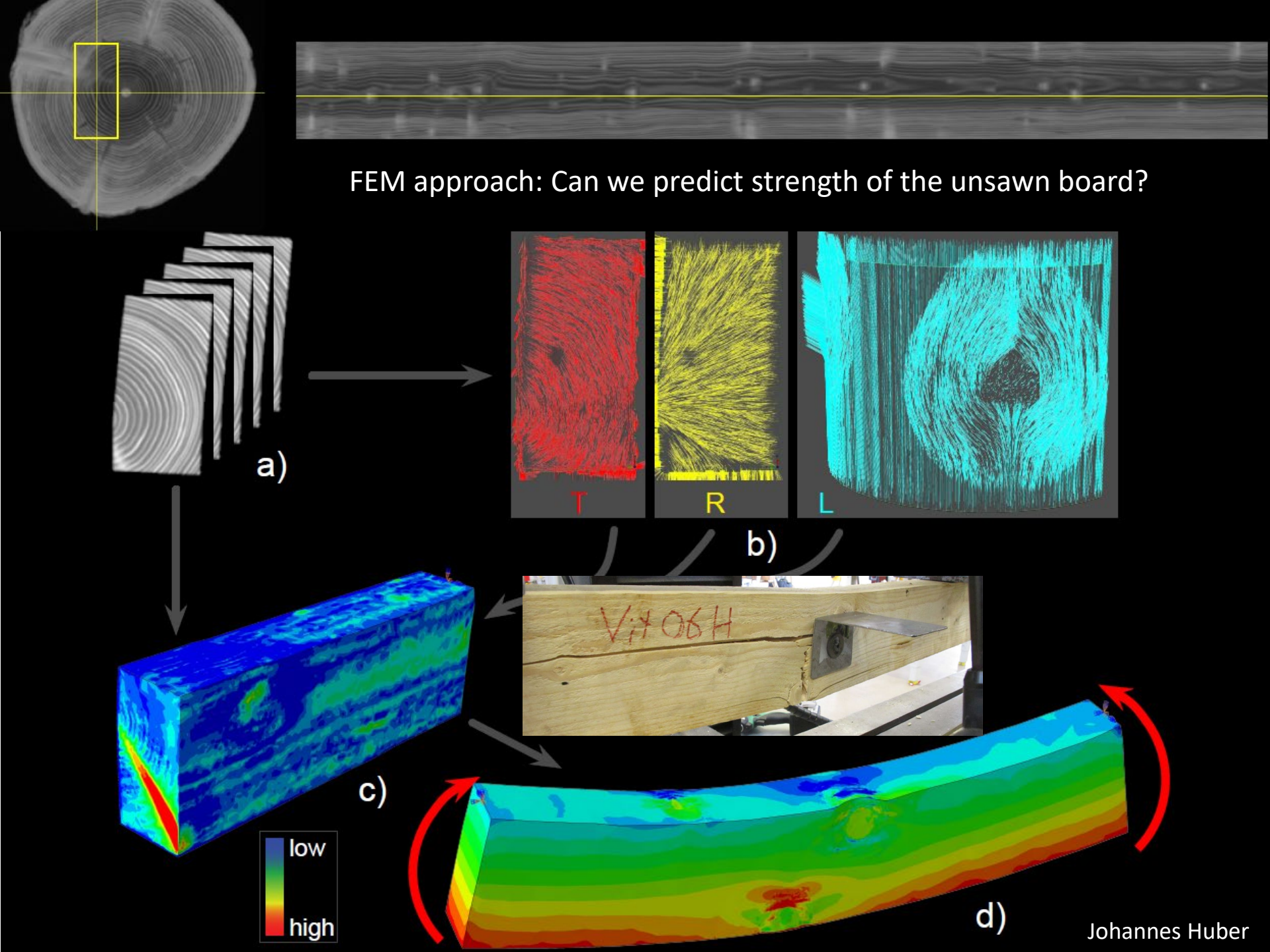


Knot detection, industrial CT-log

Virtual CT-board

Real sawn board

….variable construction started


FEM approach: Can we predict strength of the unsawn board?
a)
T
R
L
b)
c)
low
high
d)
Johannes Huber

Publications so far:

Trade journal article in Holz-Zentralblatt: "Big Data" in der Festigkeitssortierung (in German; English title: "**Big data" in strength grading**)

WCTE 2020- World conference on timber engineering, Santiago, Chile
Improved Strength Grading Based on Log and Board Measurements – Review and Outlook: The Research Project READiStrength

14th World Congress on Computational Mechanics (WCCM), ECCOMAS Congress 2020, Paris, France.
Using Computed Tomography Data for Finite Element Models of Wood Boards

Covid

Reports (soon available)

1. State of the art summary on industrial strength grading, including standards
2. Summary of industrial view on strength grading based on interviews

CONTACTS

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