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### ► To cite this version:

Capucine Carlier, Iris Brémaud, Joseph Gril. Clarifying the concept of “resonance wood”: luthiers’ empirical expertise versus assessment of wood structural/visual and vibrational properties. WoodMUSIC Opening Conference, Feb 2014, Paris, France. hal-01960483

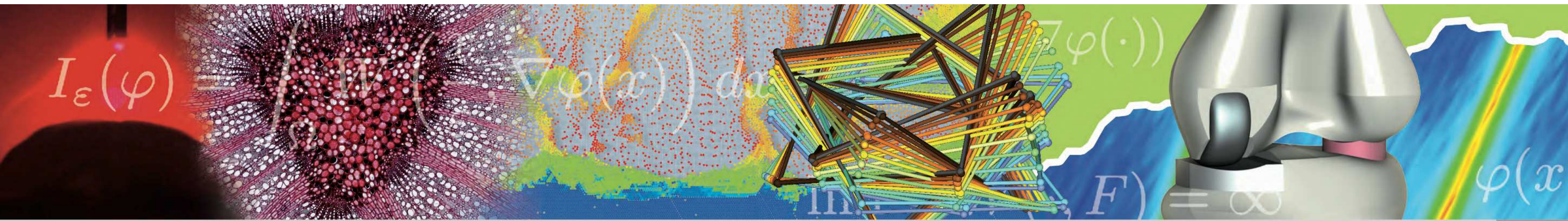
**HAL Id: hal-01960483**

**<https://hal.science/hal-01960483>**

Submitted on 19 Dec 2018

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# Clarifying the concept of "resonance wood": luthiers' empirical expertise versus assessment of wood structural/visual and vibrational properties



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## 1. Introduction

Wood as material of many musical instruments plays an essential role in their acoustic, aesthetic or technical quality, therefore in their identity. Among the many wood used in musical instruments, the term "resonance wood" is often used to describe those used for the soundboard of string instruments (spruce) and for the resonator box ("fiddleback" maple).

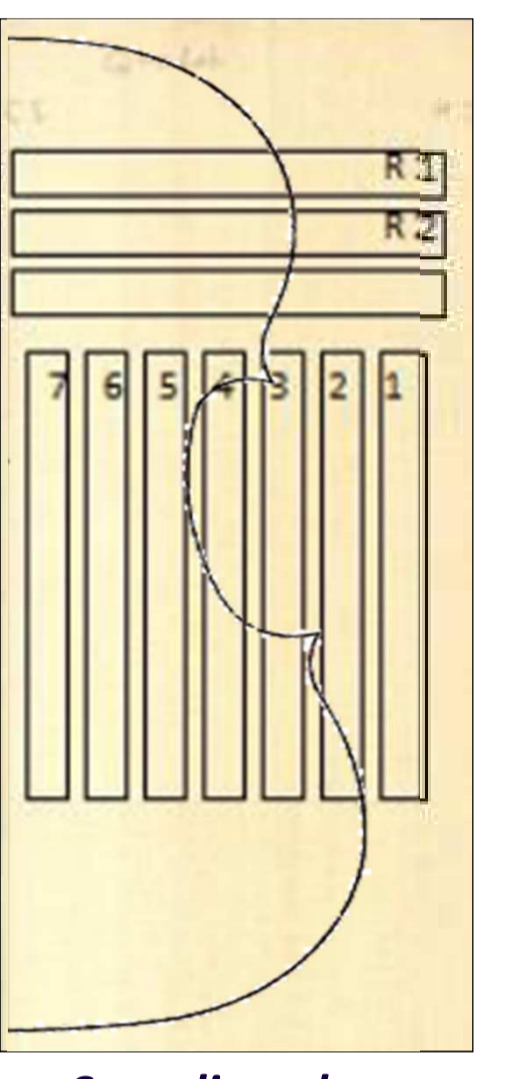
The "resonance woods" for the making of violin family have benefited from more research than other instrument making woods, but the interactions between different disciplines and viewpoints in this field has seldom been addressed.

## 2. Objective

The objective of this study is to improve the understanding of the interactions between physic-mechanical properties of resonance wood, their natural variability, and the actual expertise of violin makers in the selection and qualification of their raw material.

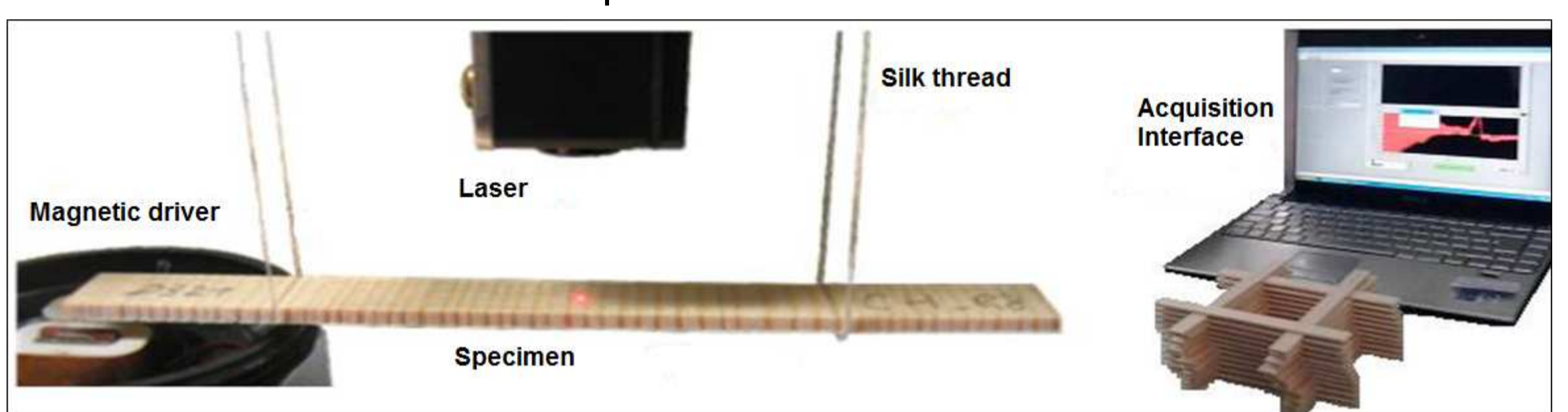
## 3. Materials and methods

### → Characterization of tonewood :



- Spruce (*Picea abies* [L.] Karst)
- Viola and violin soundboard, Quality grades "Excellent" and "Master grade"
- 70 samples in radial direction (120 × 2,5 × 12mm, R × T × L) and 116 samples in longitudinal direction (12 × 2,5 × 150mm, R × T × L).

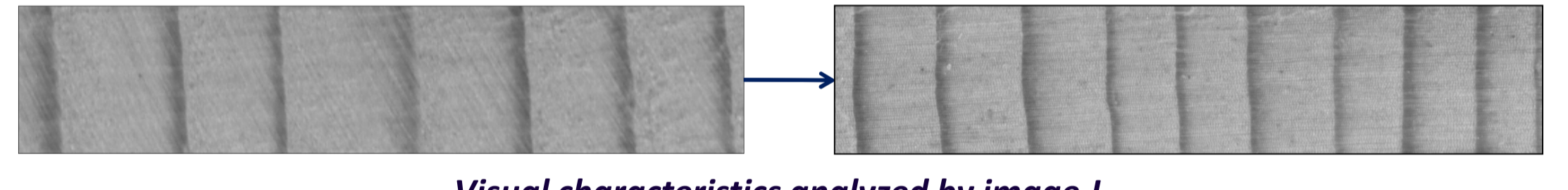
- Characterization of the **physical and vibrational properties** and **acoustical indexes** of the specimens



Vybris device, a non contact forced vibrations of free-free beams developed in LMGC

- Measurement of visual/structural characteristics (growth-ring uniformity and percentage of latewood).

⇒ Acquisition and image processing techniques in improvement



Visual characteristics analyzed by image J

### → Development of a survey to identify violin makers' opinions and practices on both qualitative and quantitative grounds

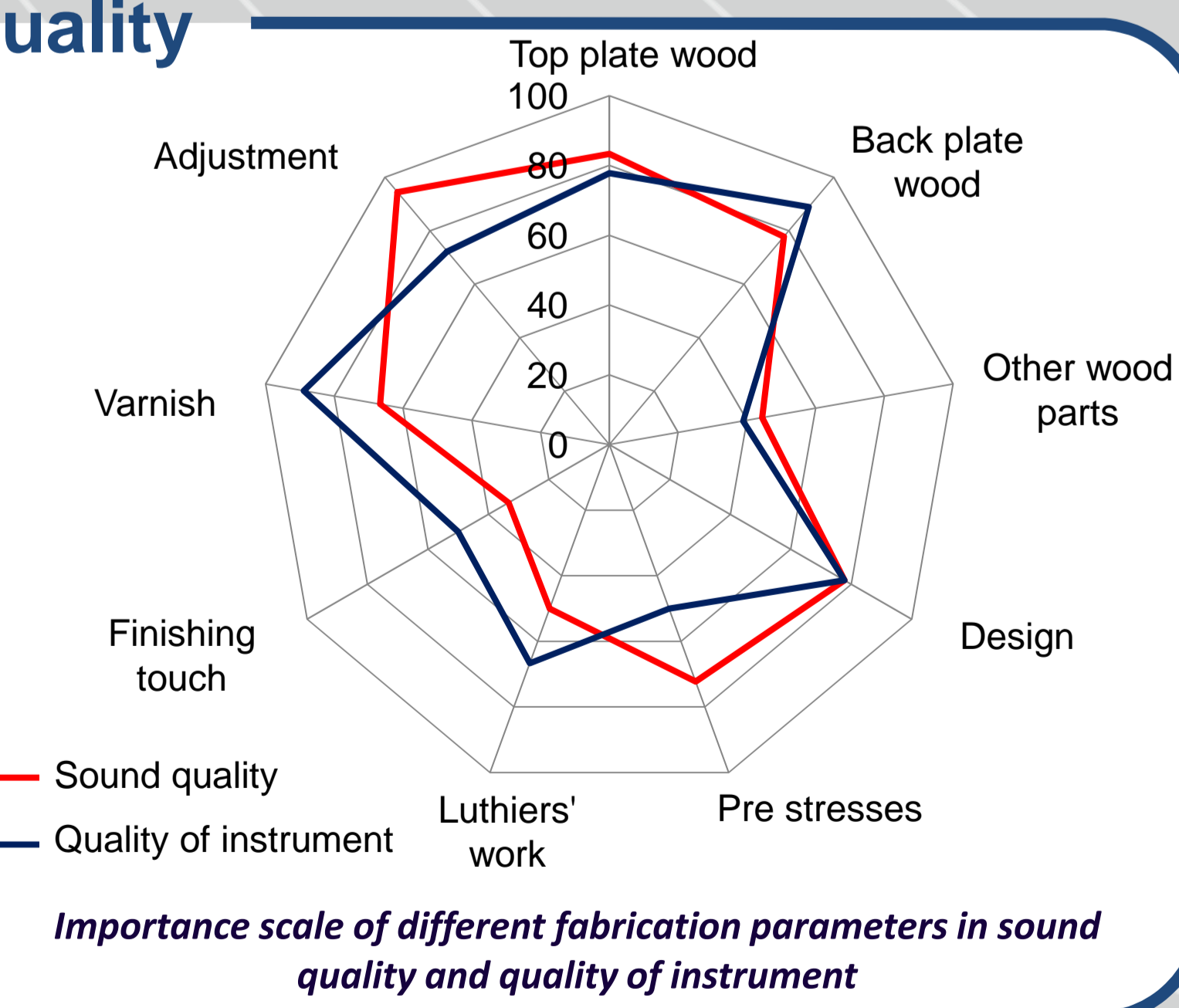
- face to face interview
- First step: Luthiers of Montpellier
- Organized by module (Maker's Profile, Concept of quality, Wood supply, Wood Criteria Choices for top plates, for back & sides, for bows, Treatments and varnish Relation to scientific and historical research, Questions and remarks)
- Survey suitable to be adapted to different kind of instrumental making

## 4. Concept of instrument quality

To clarify this concept of quality, the makers defined a good instrument by using :

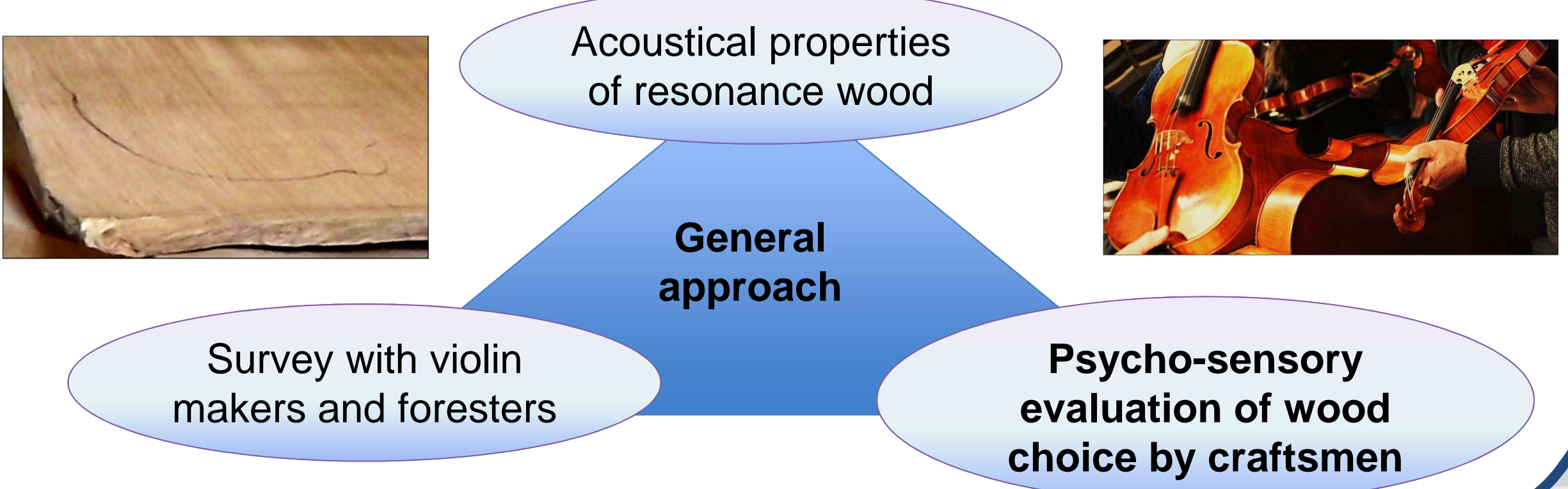
- **Physical criteria**, "powerful", "with timbre" and "easy to play"
- a **notion of pleasure** "sensation of evidence", "instrument that is unanimously "that pleases the one who plays"

Resonance wood choice appears for craftsmen to be a determining factor in sound quality of the instrument.



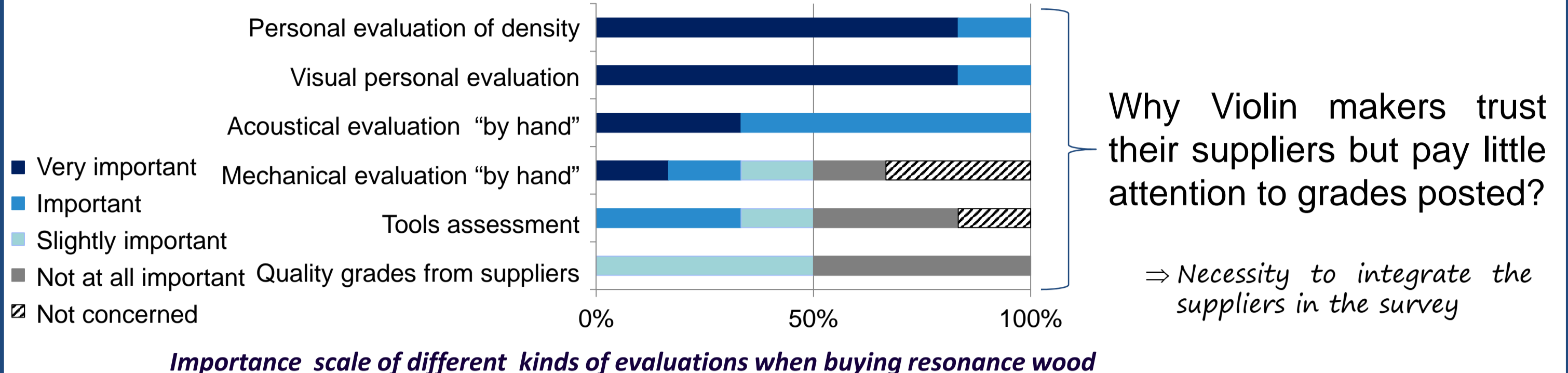
## 8. Conclusion and perspectives

This study shows the **peculiarity of spruce "resonance wood"** in regards to classical softwoods. Empirical choice by violin makers, based on **perceptual criteria** that can be visual, physic-mechanical, auditory, **are relevant to the acoustic properties** measured but will require a more detailed study to evaluate the respective contribution of these different fields of perception.



## 5. Supply and wood choice

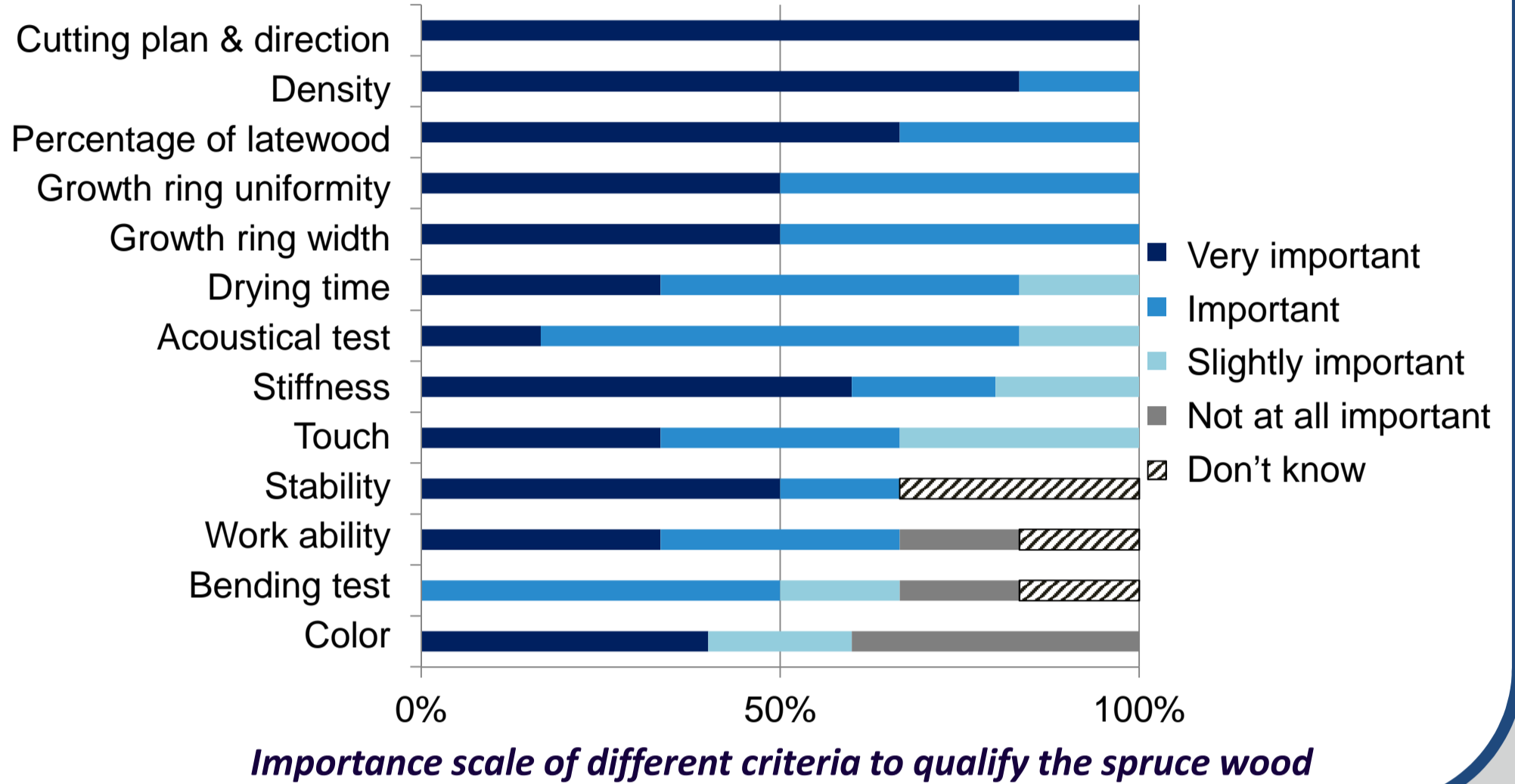
All makers buy their wood from a **specialized supplier**, whom they trust and never choose directly in the forest. To choose their tonewoods, they mainly assess **density and visual criteria**.



Why Violin makers trust their suppliers but pay little attention to grades posted?

⇒ Necessity to integrate the suppliers in the survey

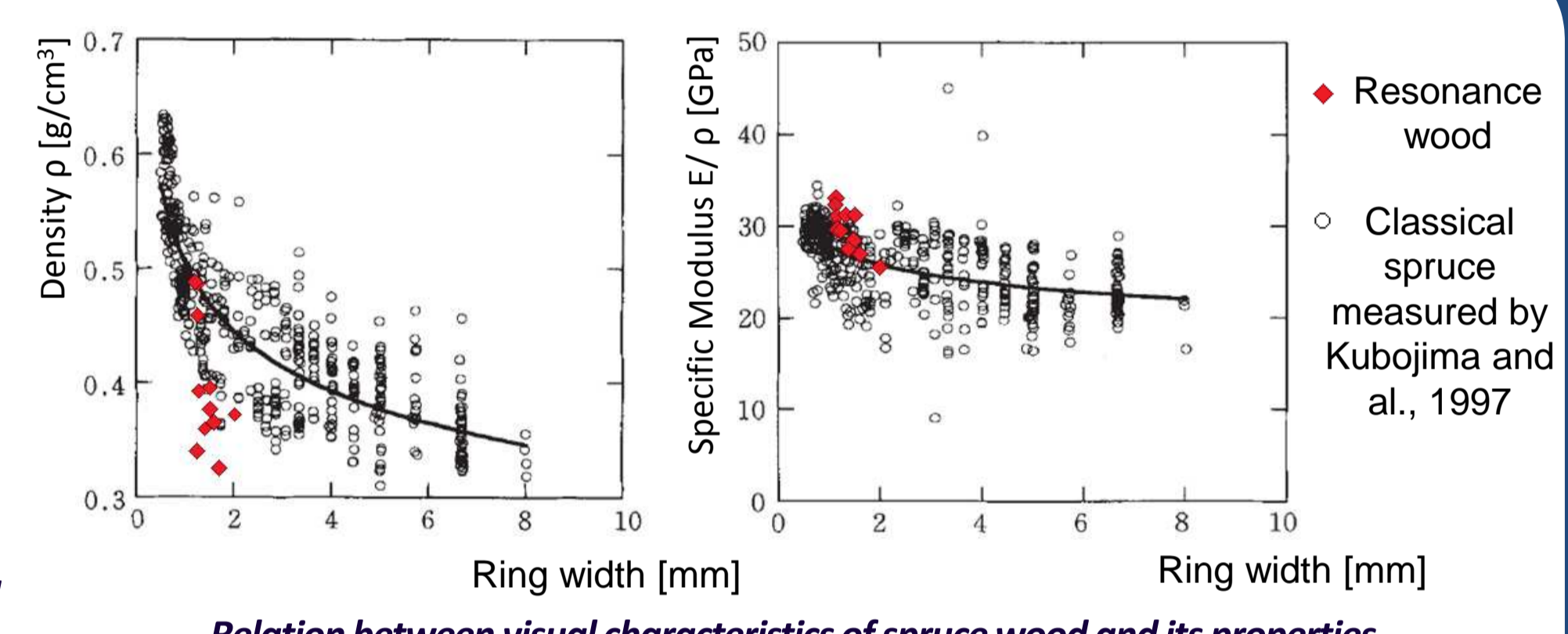
Main criteria to qualify the spruce wood are: cutting, density, percentage of latewood, growth ring uniformity and width.



What is the relationship between these visual criteria and the mechanical and acoustical properties of wood?

## 6. Properties

R	Rw (mm)	Lw (%)	Density ρ
Density ρ	-0,53	0,99	
E <sub>t</sub> /ρ	-0,8	0,69	0,63
E <sub>l</sub> /ρ	0,69	-0,16	-0,07
tanδ <sub>t</sub>	0,72	-0,4	-0,31
tanδ <sub>l</sub>	-0,85	0,4	0,33
Z <sub>t</sub>	-0,62	0,99	0,99
R <sub>L</sub>	0,31	-0,92	-0,95
ACE <sub>L</sub>	-0,01	-0,68	-0,74



Correlations between properties, acoustical index and visual characteristics of wood

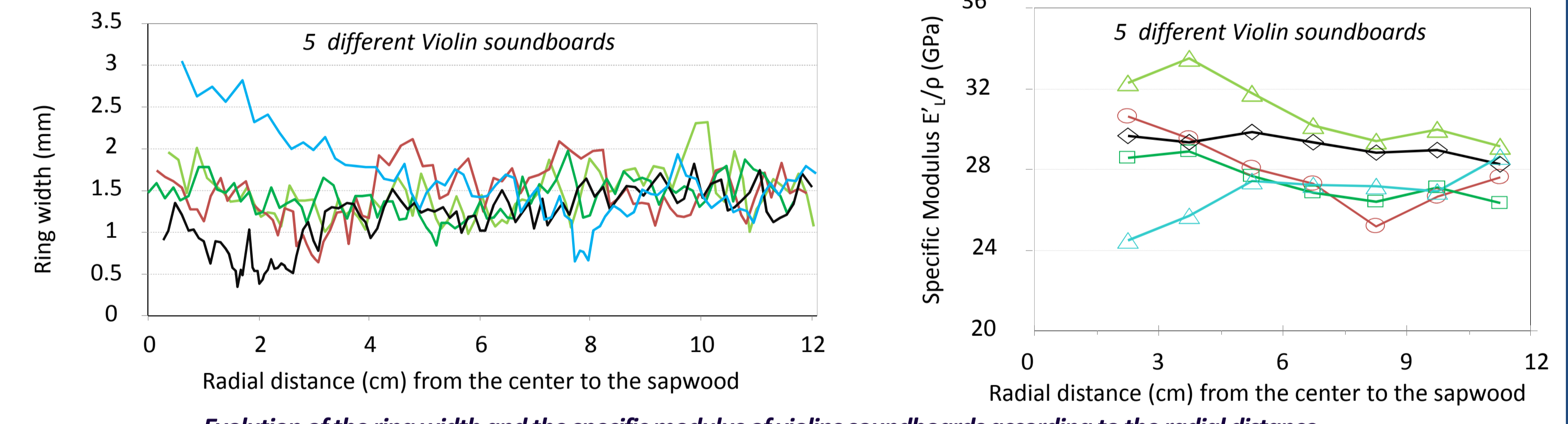
Relation between visual characteristics of spruce wood and its properties

Ring width reflects the vibrational properties, while latewood provides informations on the acoustical indexes.

Our correlations between visible structural characteristics, density and vibrational properties in spruce "resonance wood" are not typical of classical softwoods

Visual parameters = Good perception of wood mechanical phenomena

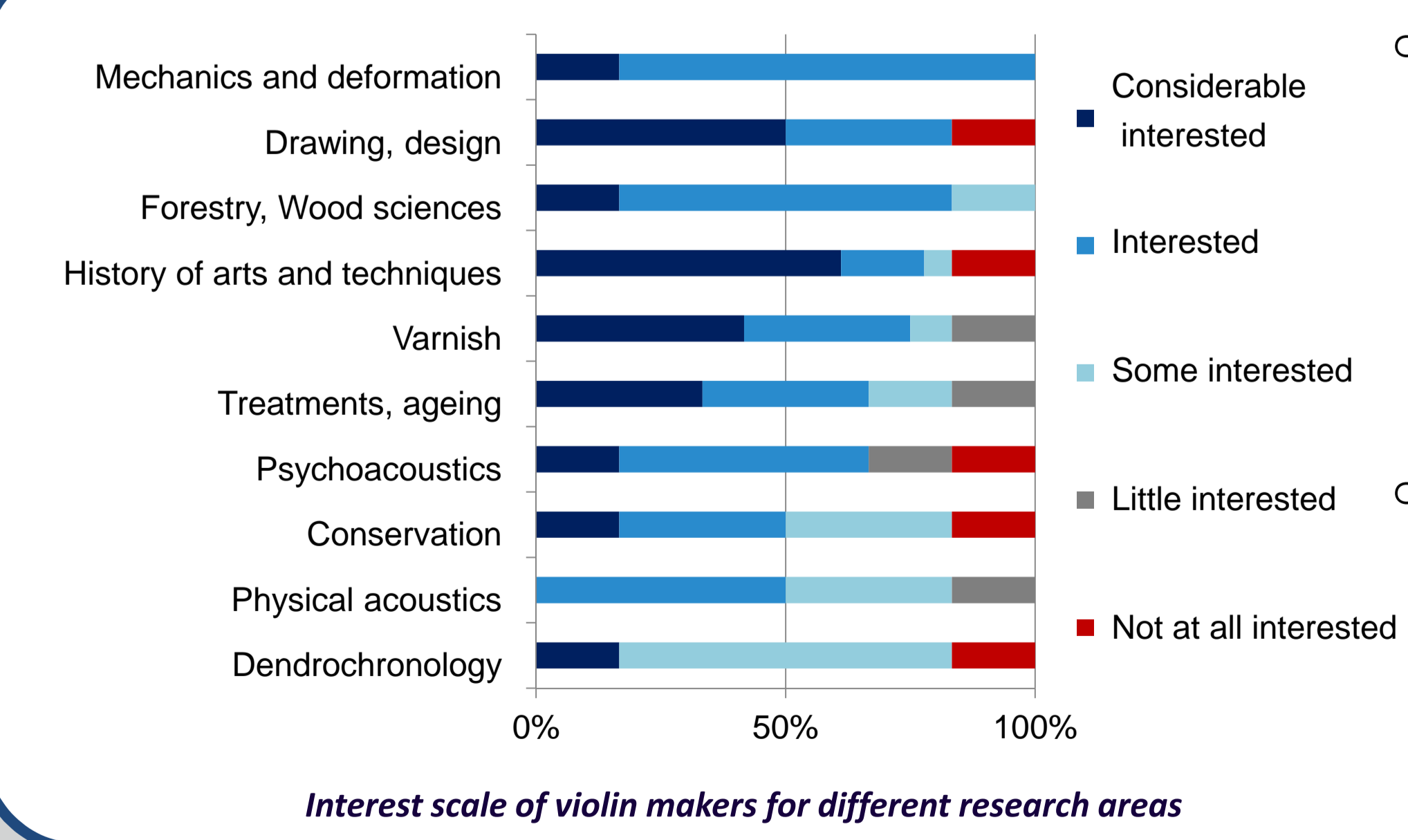
⇒ Is the confidence of the makers in the suppliers coming from the peculiarity of this pre-selected material?



High variability intra and inter board suggesting that a single specimen may not be representative of the properties of the entire board.

⇒ Necessity to construct a model to evaluate the properties of a full violin plate from sampling fabrication offcuts

## 7. Relation to sciences



- Makers rely mainly on **empirical approaches**, and also **historical** for their practices, but report a lot of interest in the scientific approach of resonance wood.
- Their interests are mostly related to the history of art and techniques, to the drawing, varnishes and to the mechanics and wood science.

### ⇒ Perspectives

- To broaden our survey to a **national and international scale**
- To collect sampling fabrication offcuts from violin makers
- To construct a **model** to evaluate the properties of a full violin plate
- To study **microstructural characteristics** of resonance woods
- To enlarge the study to 'fiddleback' maple