Aerogel optical properties: systematics studies

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Basic formalism

Transmittance

Hunt formula

$$\mathrm{T} = e^{-\frac{t}{\Lambda_{tot}}} = e^{-t\left(\frac{1}{\Lambda_A}+\frac{1}{\Lambda_S}\right)} = e^{-\frac{t}{\Lambda_A}} \cdot e^{-\frac{t}{\Lambda_S}} = A \cdot e^{-\frac{Ct}{\lambda^4}}$$

$$\mathrm{A} = TF = e^{-\frac{t}{\Lambda_A}} \quad \Longrightarrow \quad \Lambda_A = \frac{-t}{lnA}$$

Absorption length

Transflectance

$$\Lambda_S = \frac{\lambda^4}{Ct}\,t$$

Scattering length

Basic formalism

Transmittance

Hunt formula

$$\mathrm{T} = e^{-\frac{t}{\Lambda_{tot}}} = e^{-t\left(\frac{1}{\Lambda_A}+\frac{1}{\Lambda_S}\right)} = e^{-\frac{t}{\Lambda_A}} \cdot e^{-\frac{t}{\Lambda_S}} = A \cdot e^{-\frac{Ct}{\lambda^4}}$$

$$\mathrm{A} = TF = e^{-\frac{t}{\Lambda_A}} \quad \Longrightarrow \quad \Lambda_A = \frac{-t}{lnA}$$ **Absorption length**

Transflectance

$$\Lambda_S = \frac{\lambda^4}{Ct}t$$ **Scattering length**

Procedure: measure $T(\lambda)$ → fit with Hunt formula → extract Λ_A and Λ_S

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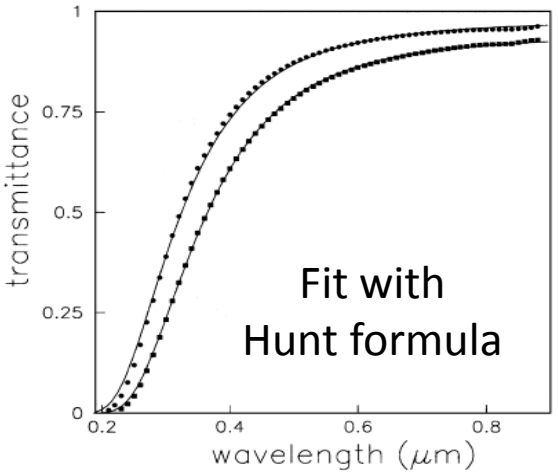
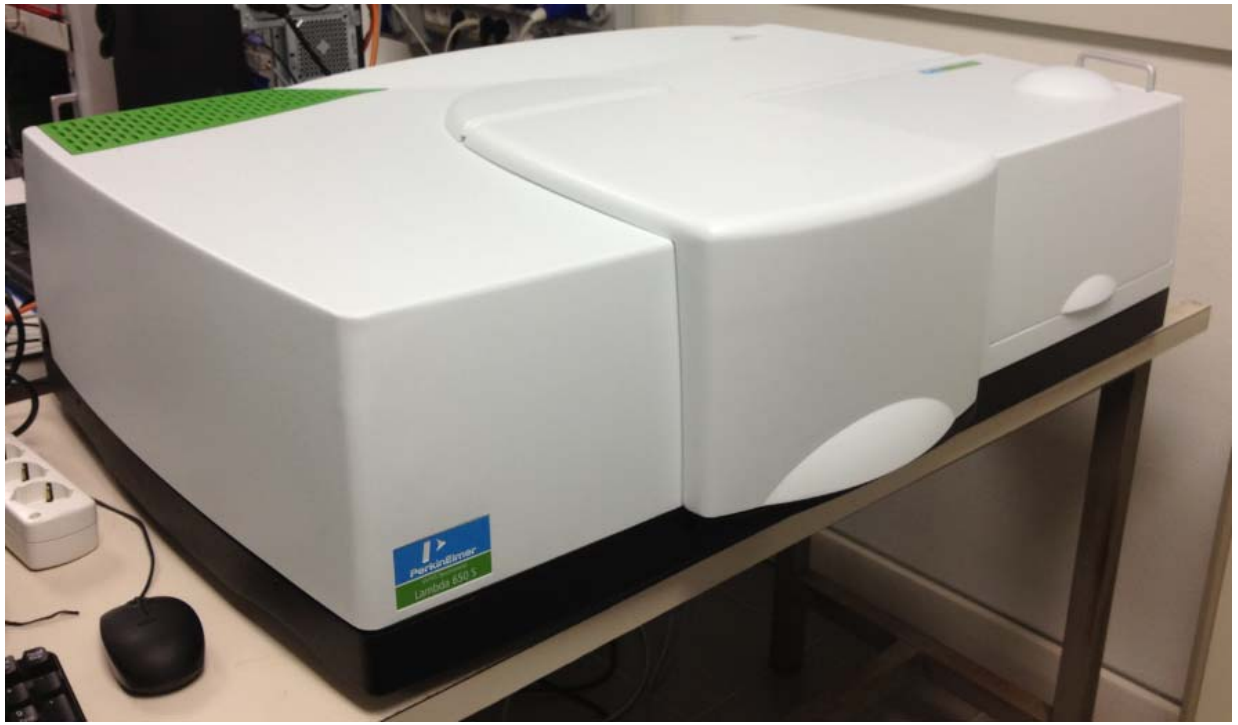
Optical characterization of $n = 1.03$ silica aerogel used as radiator in the RICH of HERMES

Hunt parameter	Average value	σ (%)
A	0.964	2.4
Ct (μm^4)	0.0094	8.3



Our brand new spectrophotometer



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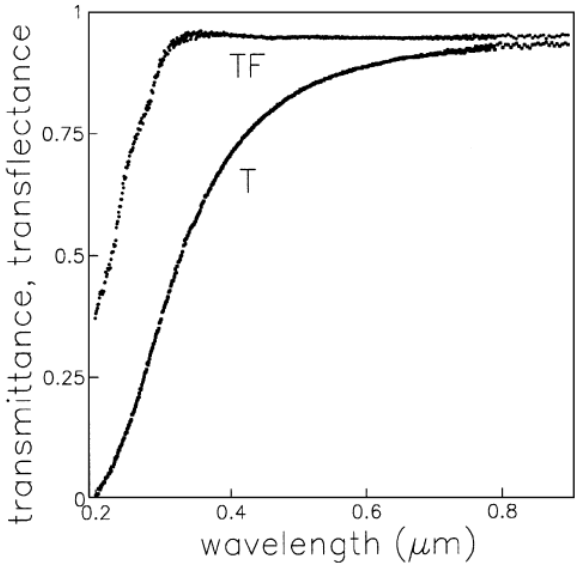
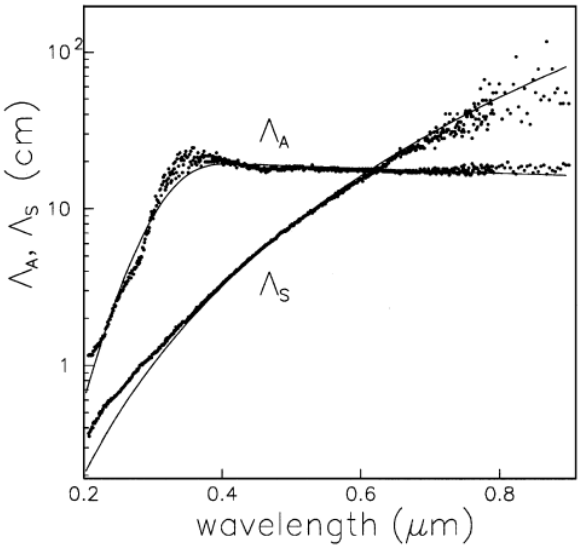
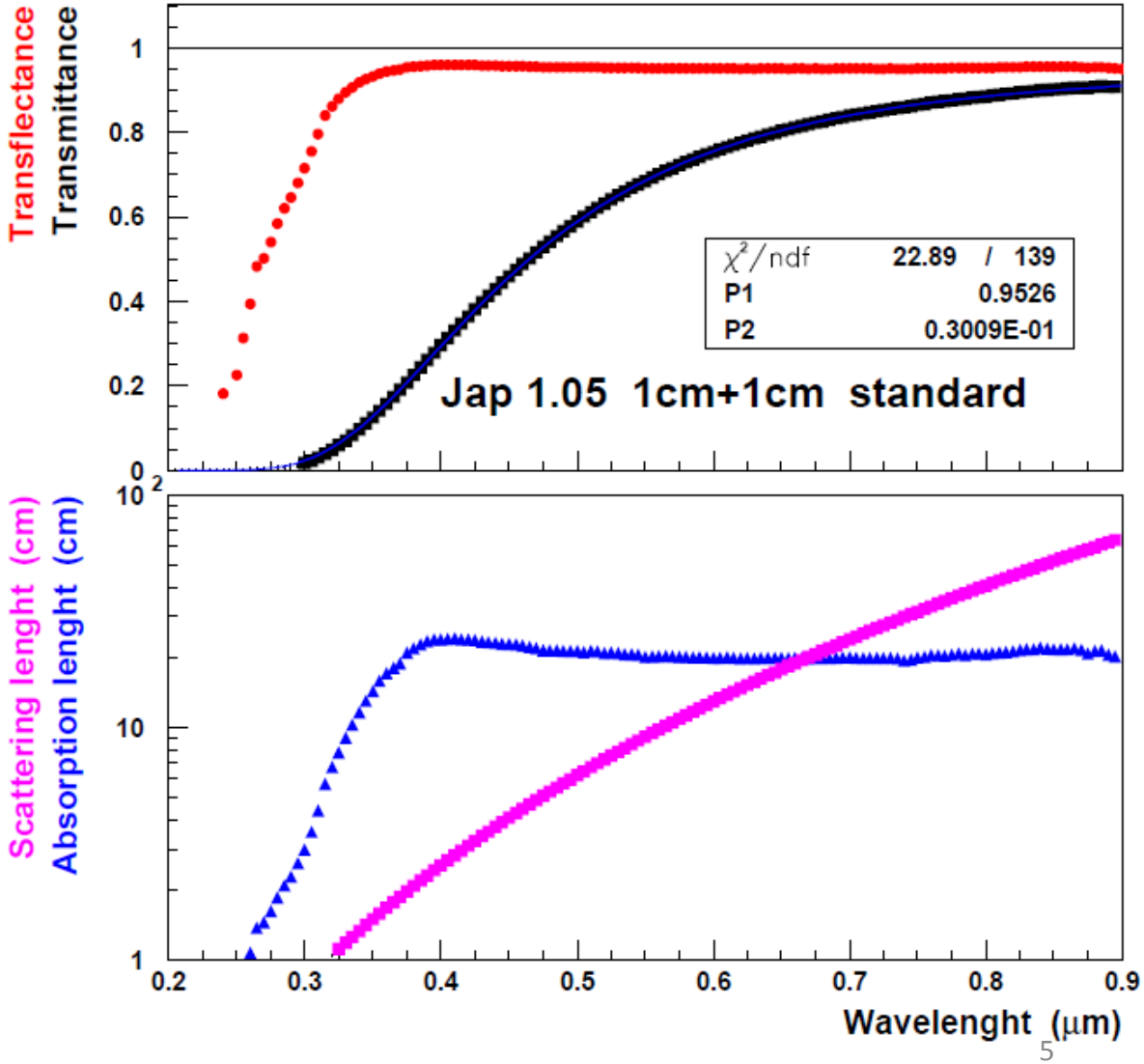


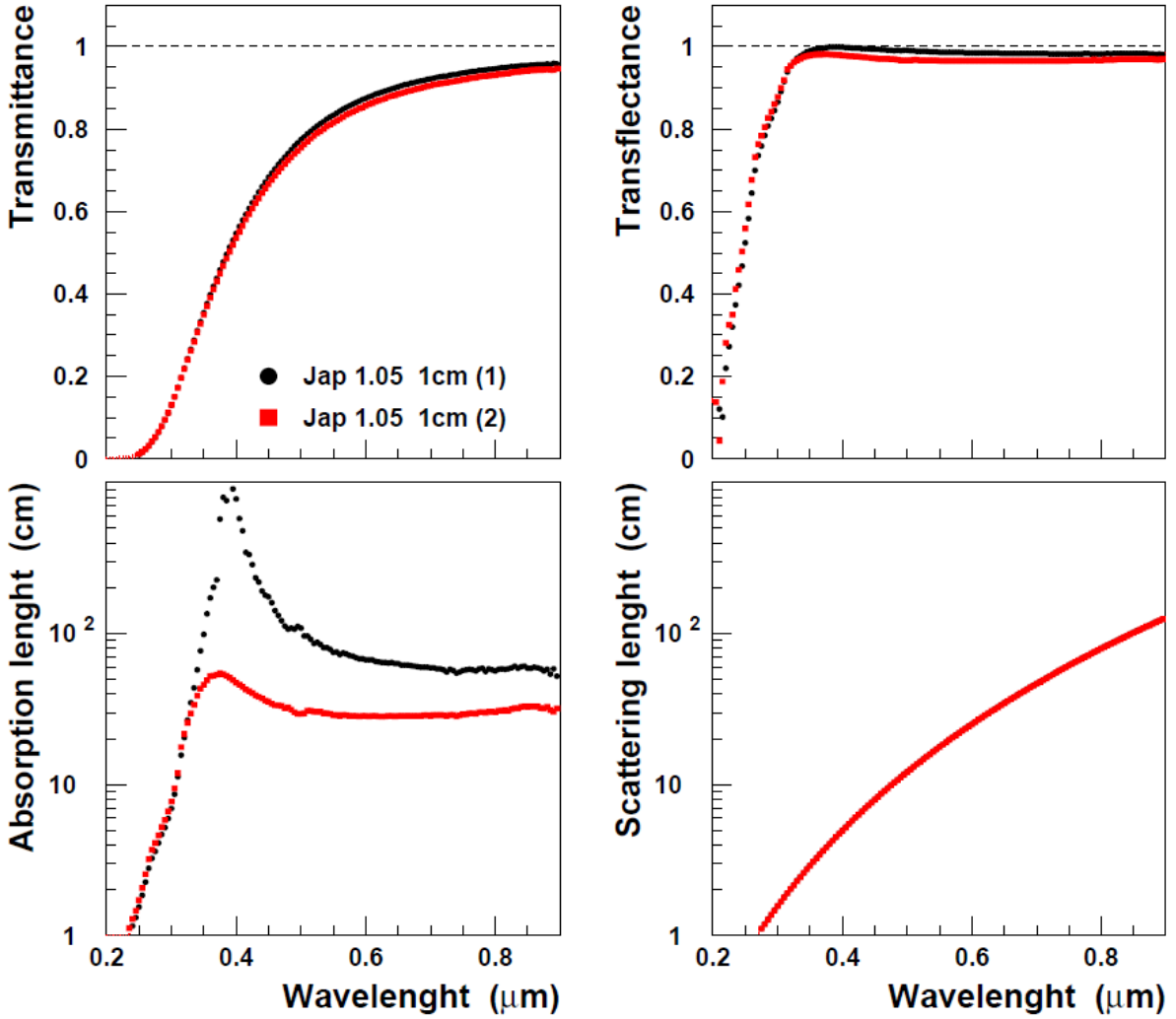


Ferrara measurements



Systematic studies

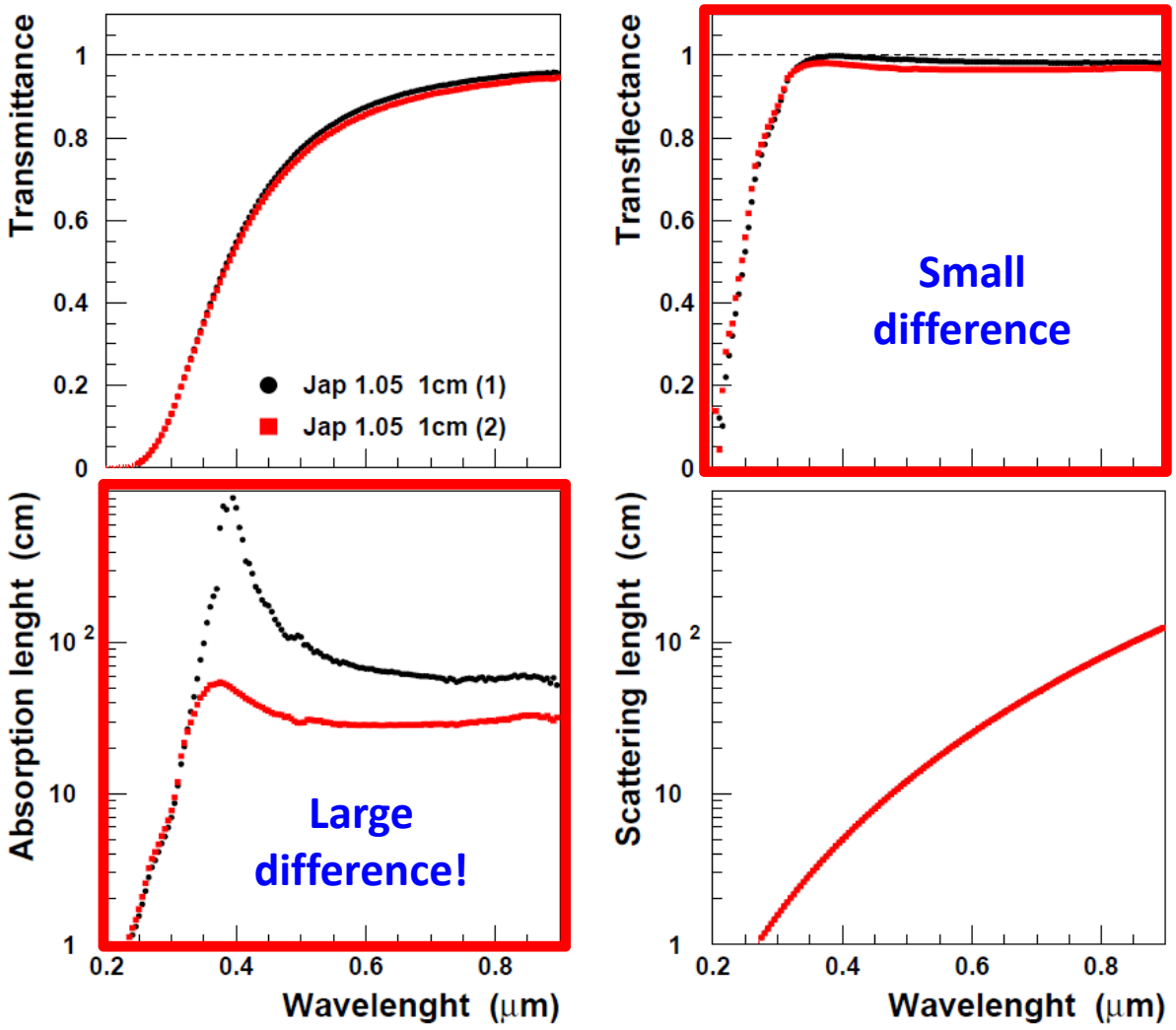
Comparing 2 tiles with same nominal properties



Comparing 2 tiles with same nominal properties

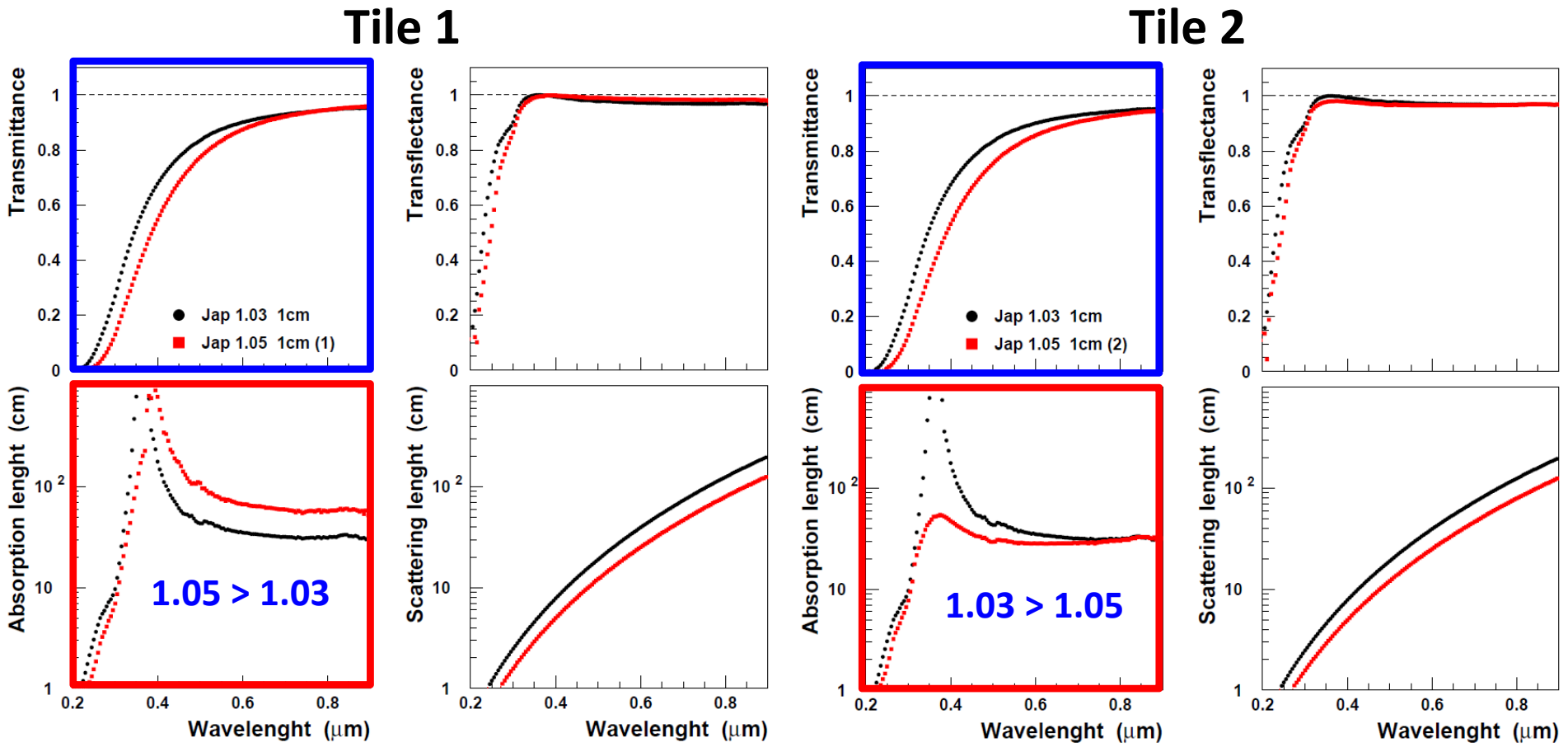
$$\Lambda_A = \frac{-t}{\ln(TF)}$$

TF	Λ_A (cm)
0.900	10
0.950	20
0.980	50
0.990	100
0.995	200
0.998	500
0.999	1000



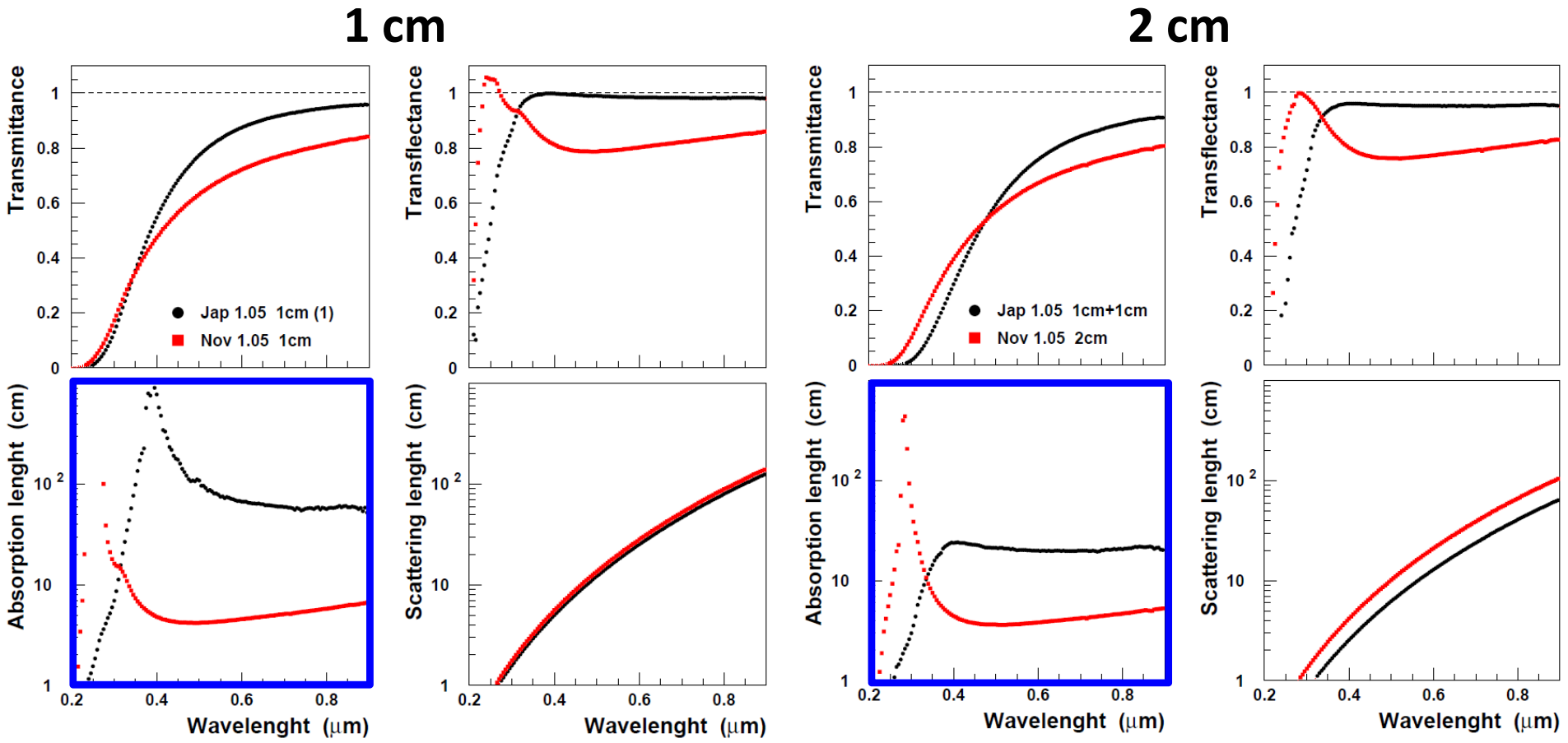
Similar tiles can have very different absorption!

Same thickness, different refractive index: 1.03 vs 1.05



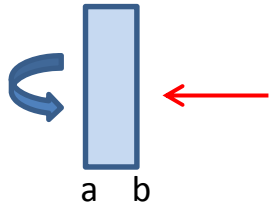
- **1.03 has higher transmittance than 1.05 (as expected)**
- **Different tiles can have very different absorption length, regardless of the refractive index**

Japan vs. Novosibirsk

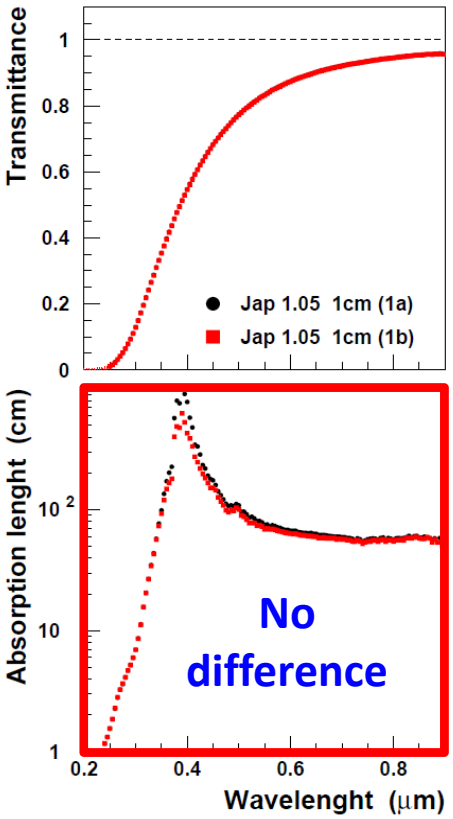


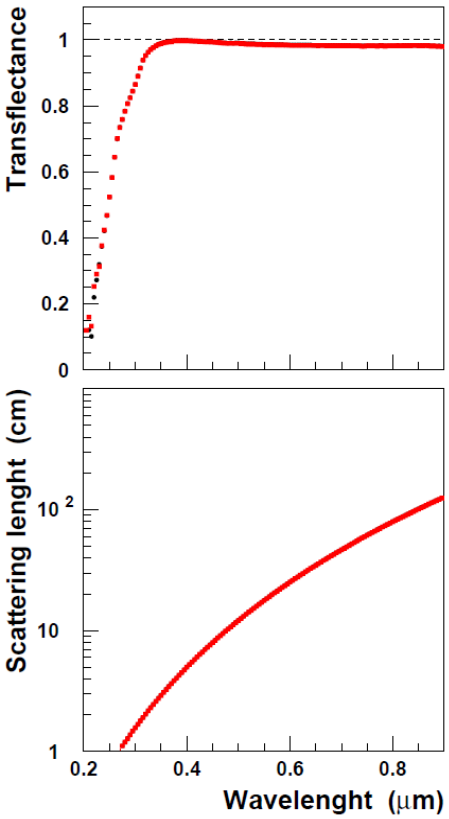
- **Japanese aerogel is more performant!**
- **Novosibirsk aerogel is hydrophilic (absorbed humidity?)**

Same tile, different front face ($\pm 180^o$)

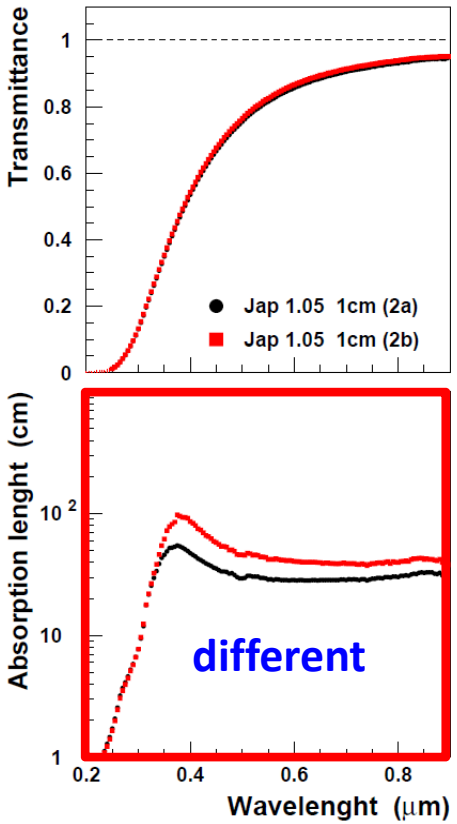


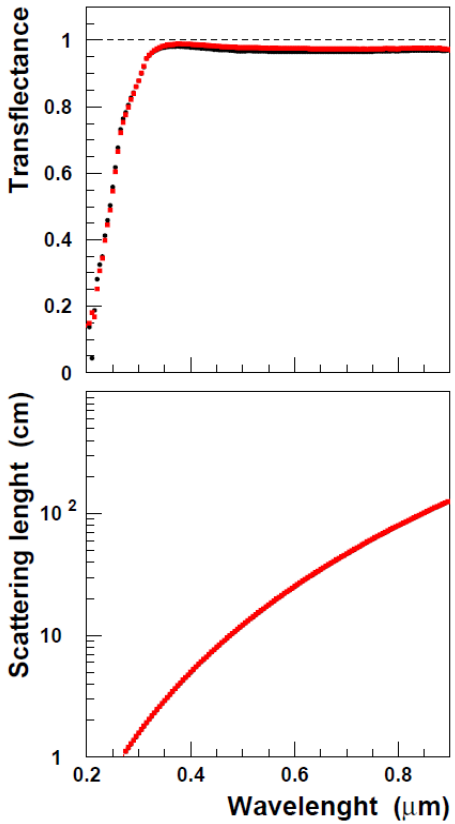
Tile 1





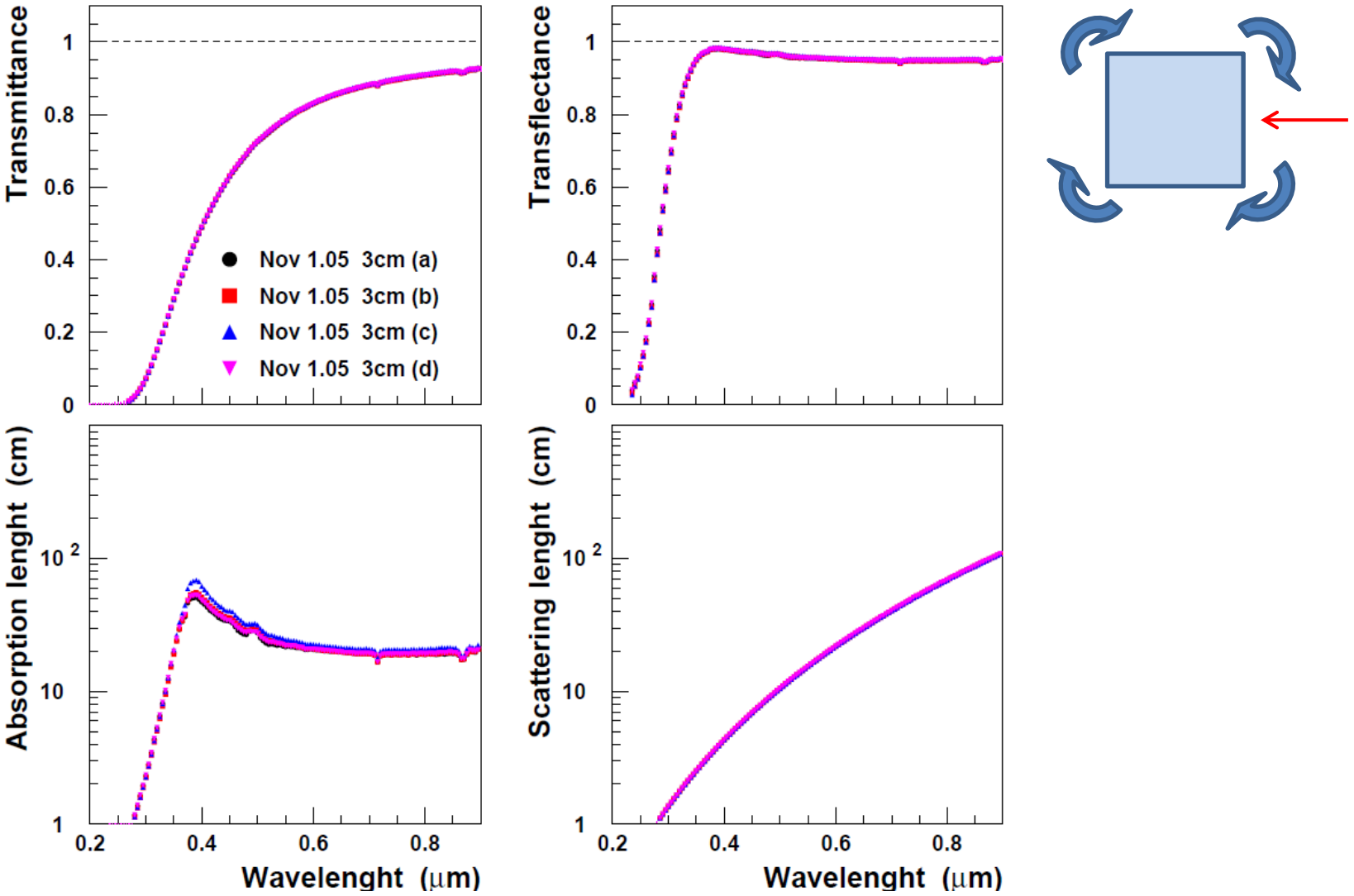
Tile 2





Again, depends on the tile!

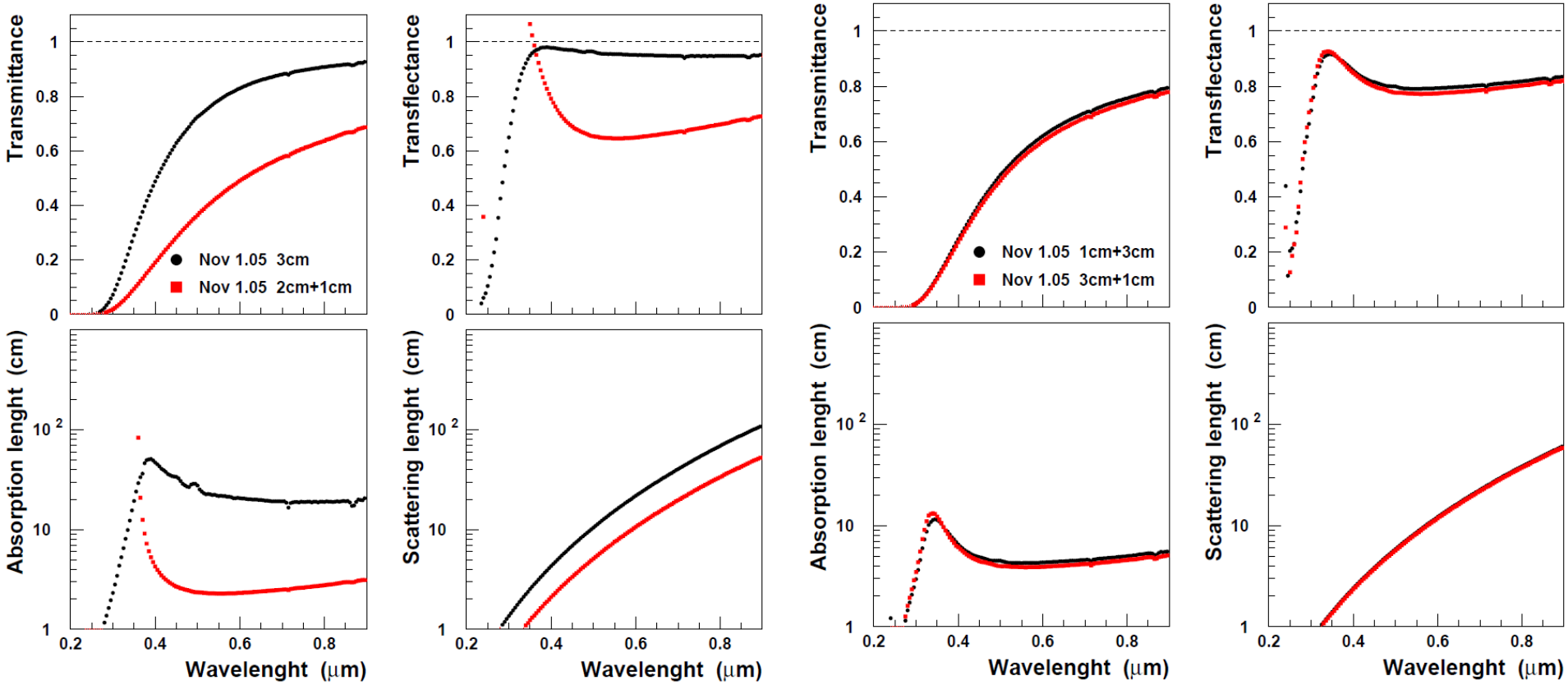
Check for anysotropies ($0^0, +90^o, +180^0, +270^o$)

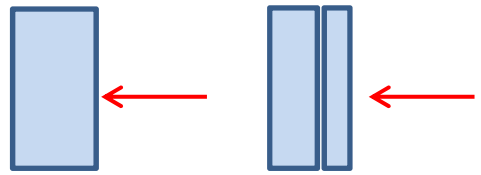


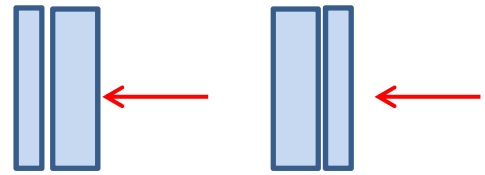
No anysotropies are observed

Same thickness: surface effects

3 cm **4 cm**





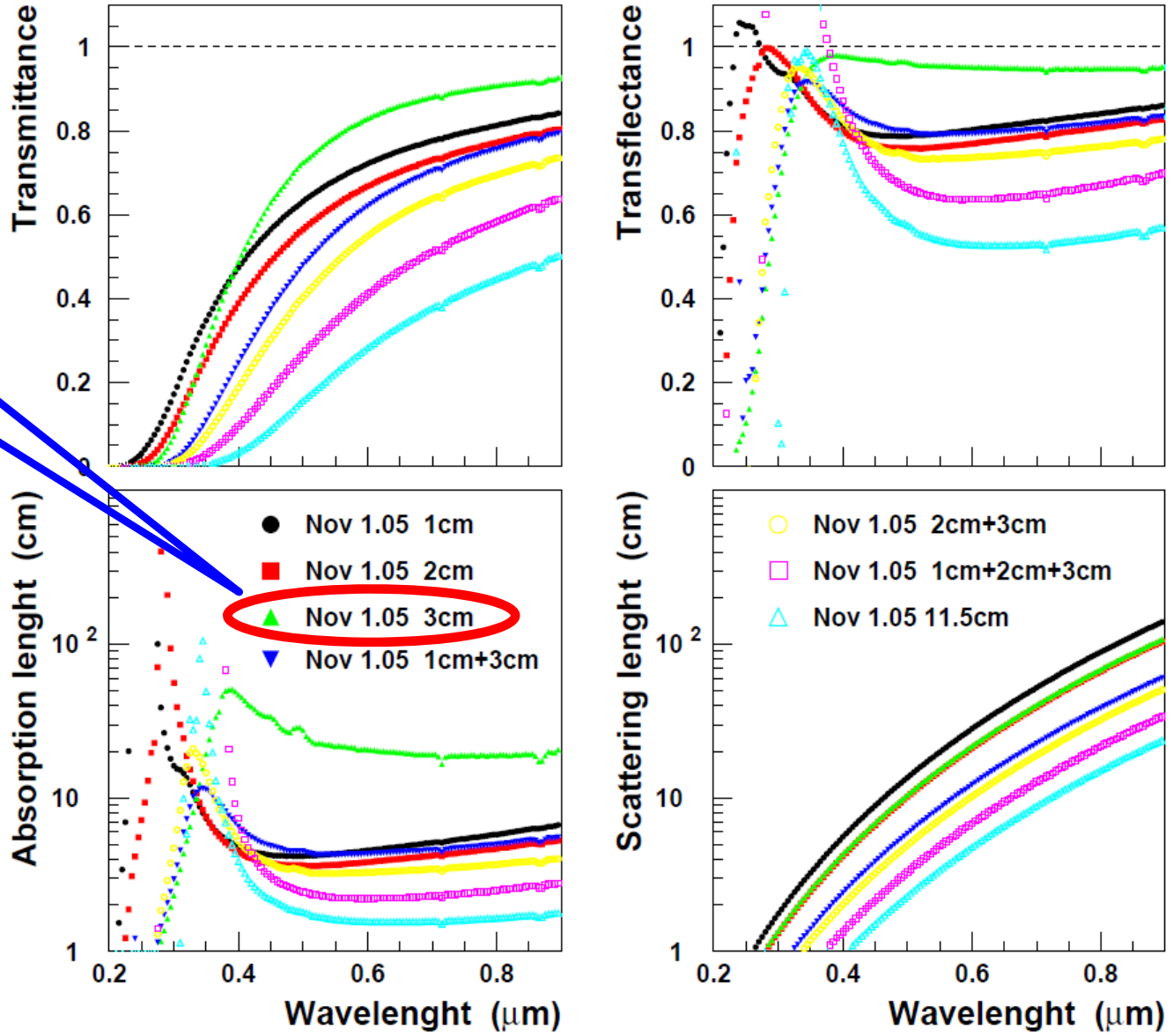


Surface effects can be large...
but depend also on the properties of each tile

No dependence on the order

Same n, different thicknesses

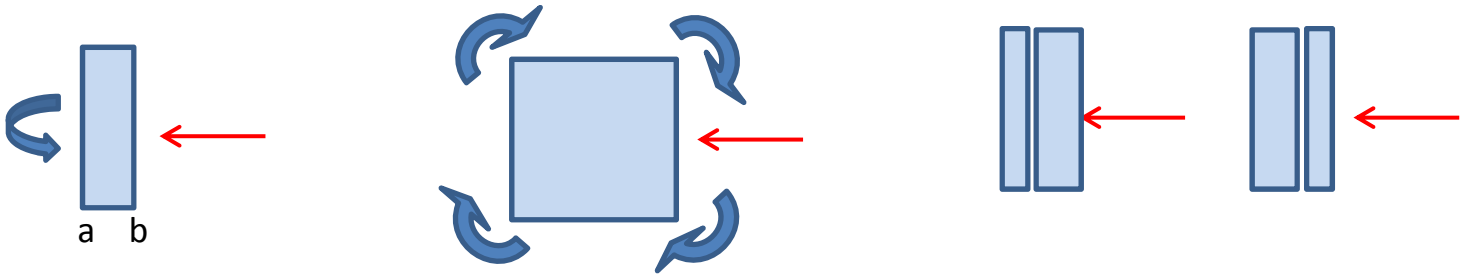
Regular patterns, except for



Conclusions

Several systematic studies have been performed using the Ferrara spectrophotometer

- **Similar tiles can have very different absorption!**
- **Japanese aerogel is more performant!**
- **Novosibirsk aerogel is hydrophilic (absorbed humidity?)**
- **No significant differences observed in:**



- **Some difference observed due to surface effects (?)**