

# Dichroic filter R&D in Spain

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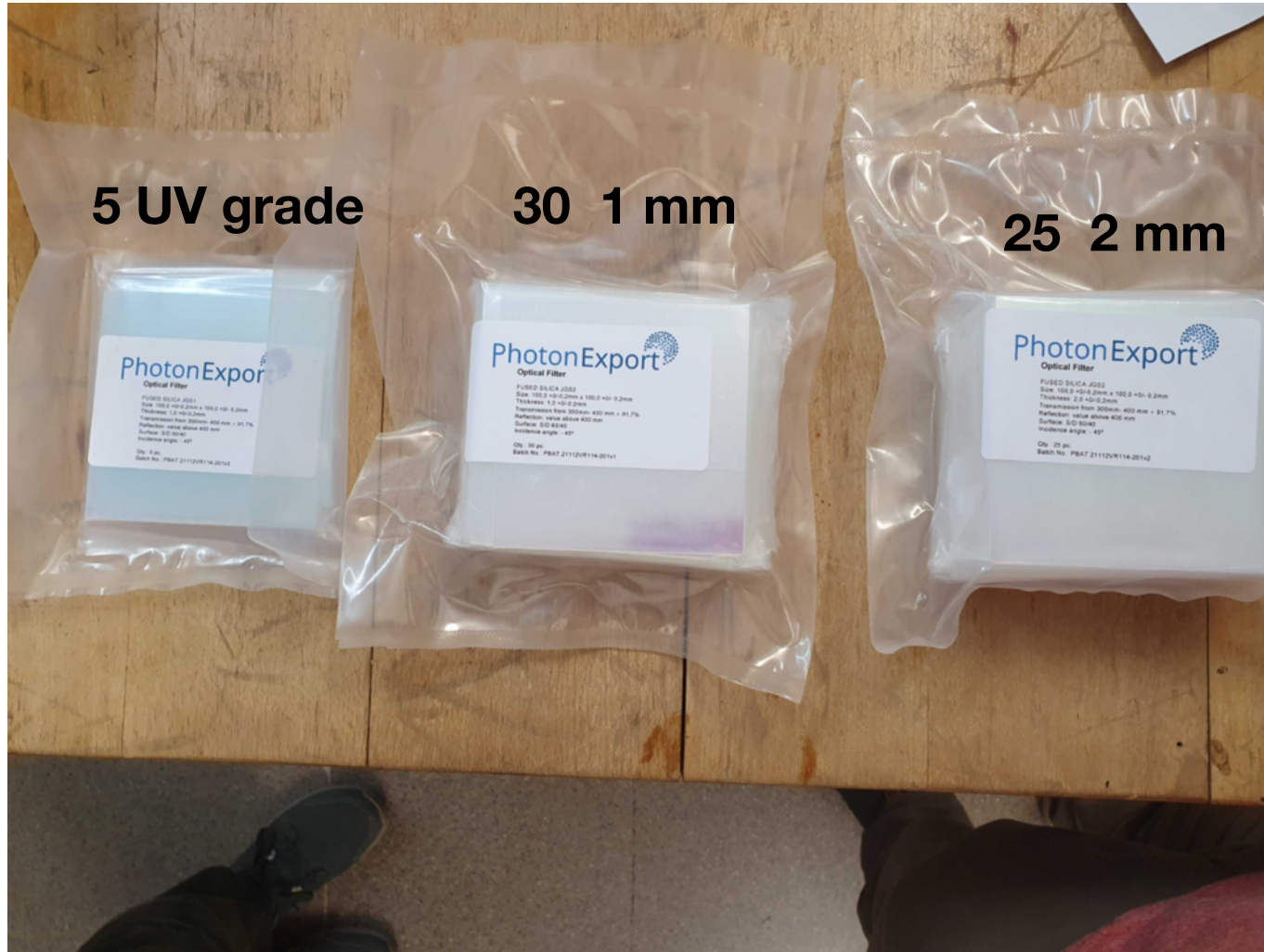
# Overview

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- We got the 60 photonexport (PE) filters two weeks ago
- We received the measured transmission curve few days after
  - the filters were worst than expected
- Since them we have been characterising the filters to verify the PE measurements
- We had a meeting with PE to:
  - Understand why the performance is not the one promised
  - Discuss the next steps
- We got the proposal from them this morning
- In parallel we have been discussing the specifications for the next iteration
- We are also working on the simulation to optimise the specifications

# Filters in Valencia

- Filter received two weeks ago



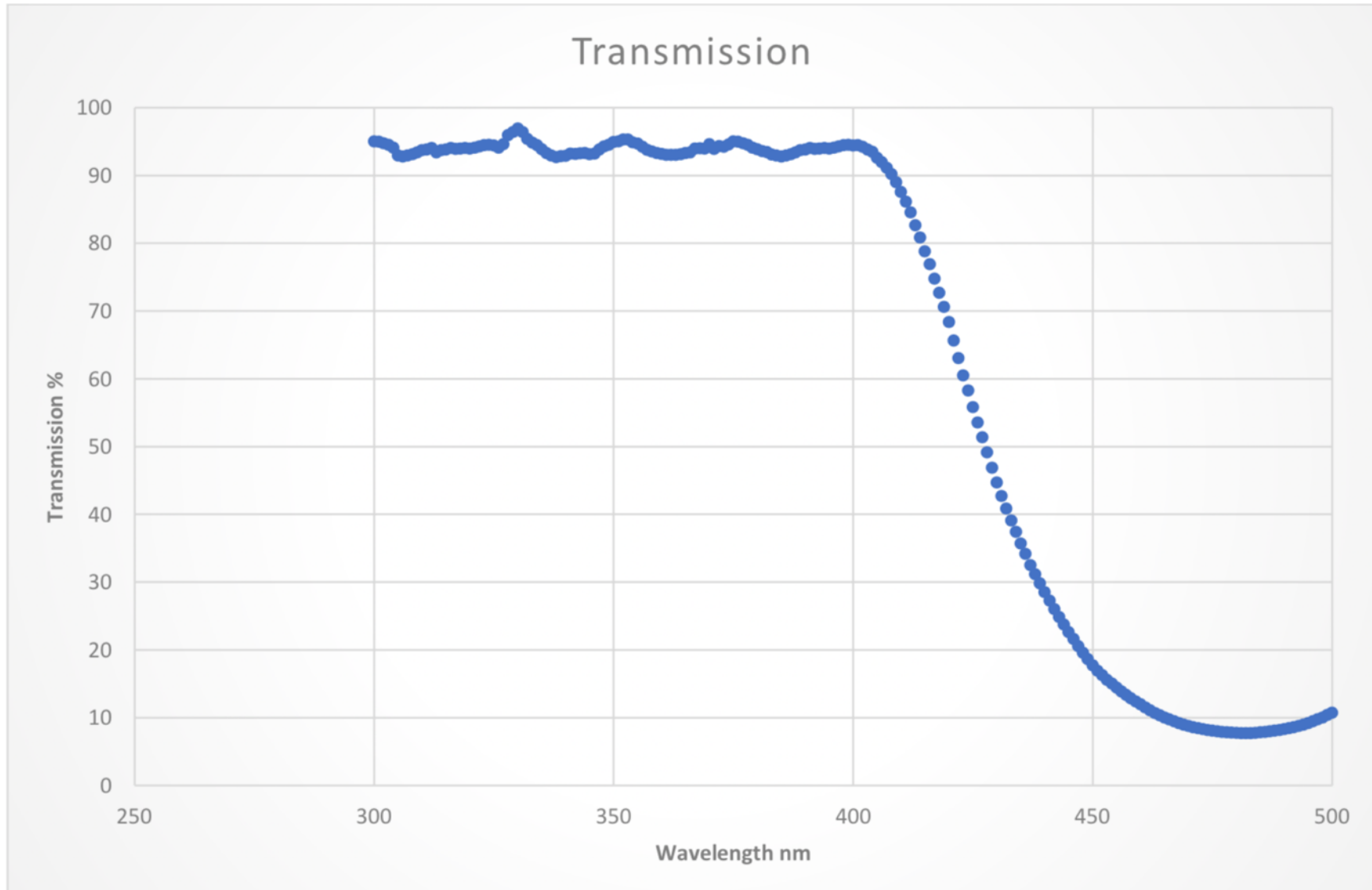
# Measurements at other labs

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- 4 filters were sent to CIEMAT. They are preparing the holder and will start taking measurements after eastern
- 4 filters will be set to Granada tomorrow
- We will send filters to Milano and Campinas as well

# Transmission curve

- Provided by photonexport



# Measurements at IFIC

Monochromator

Tungsten lamp

black box

PMT power supply

Keithley pA

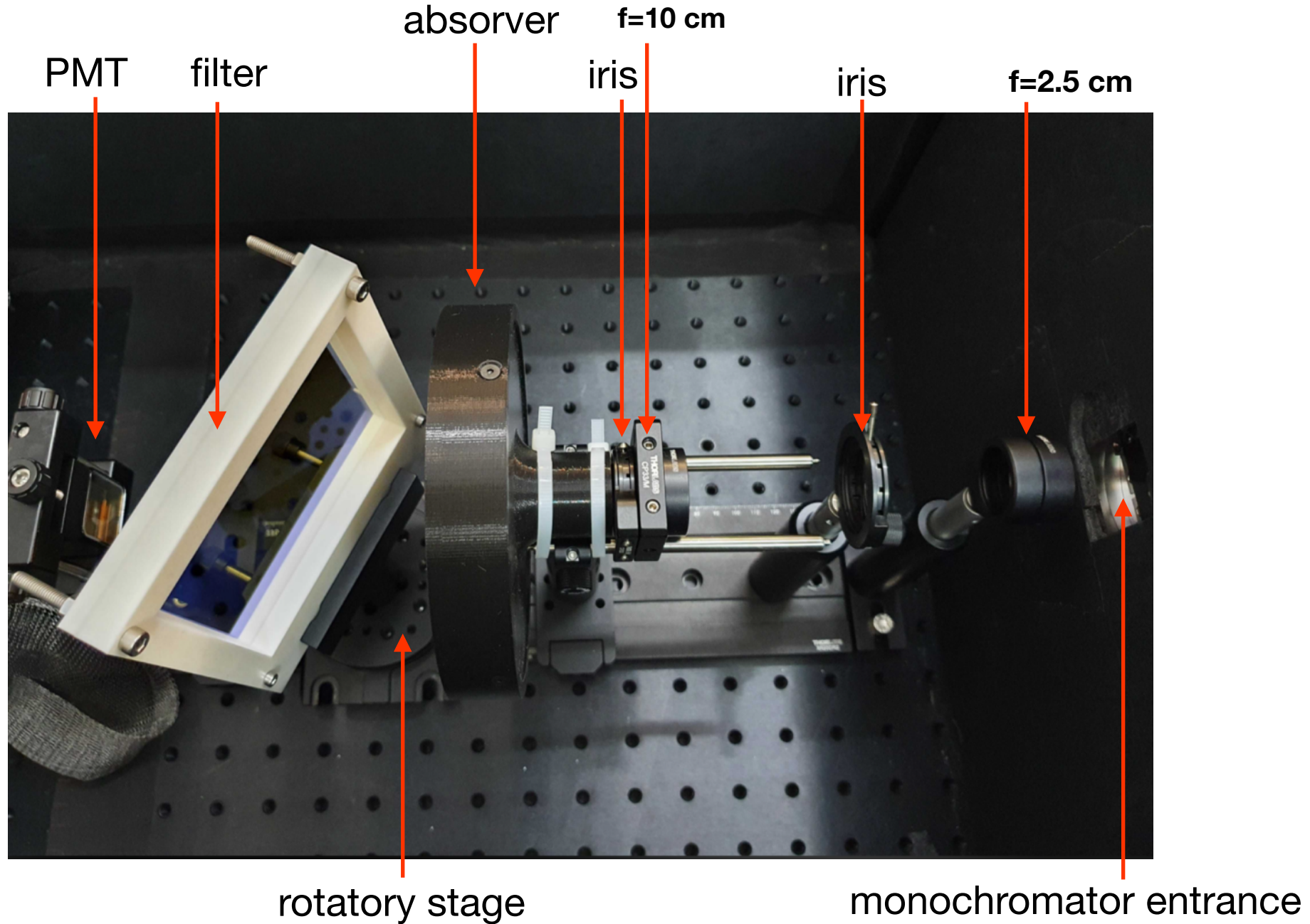
computer with  
Labview



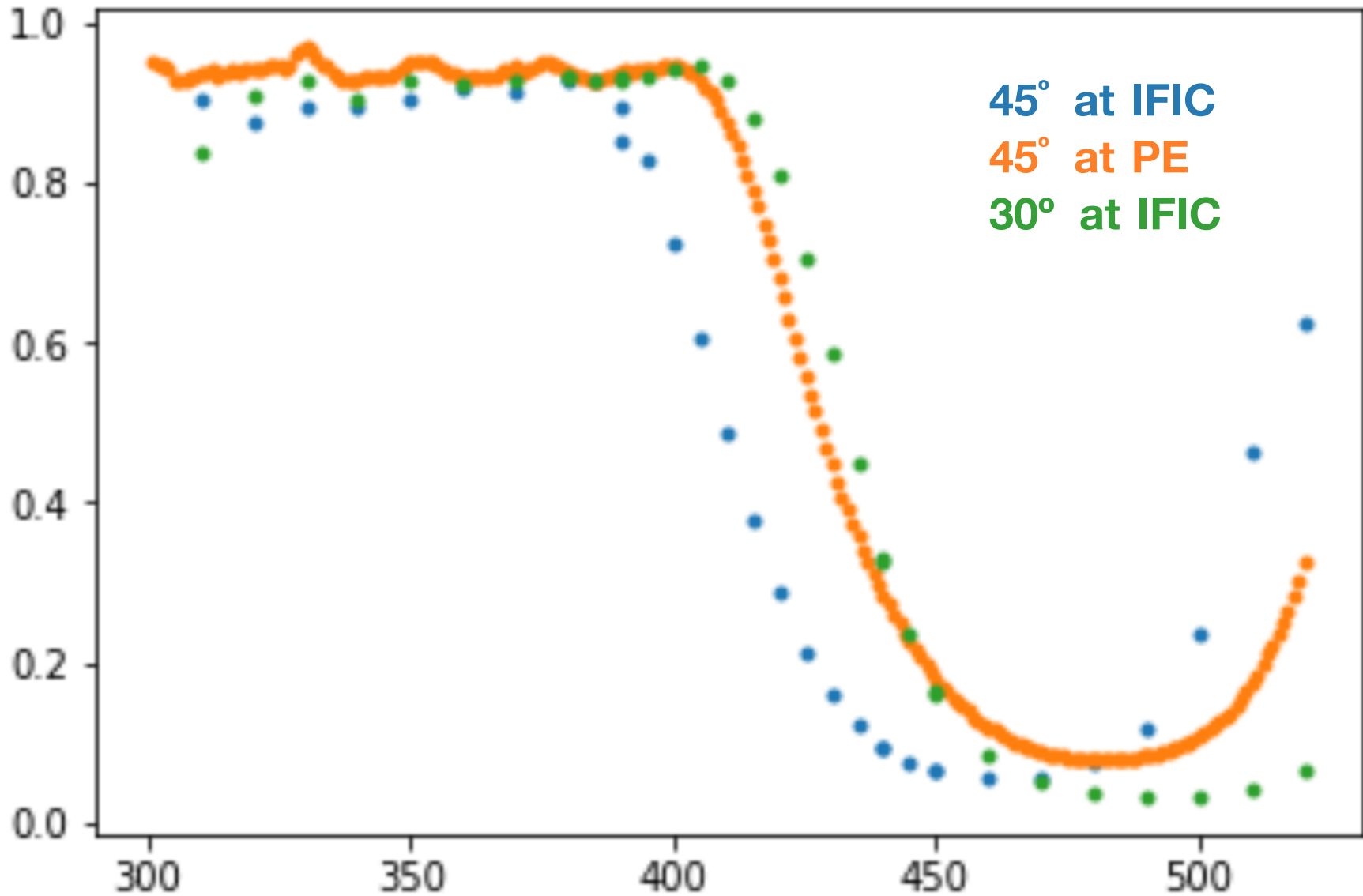
MC motor controller

Tungsten lamp PS

# Inside black box



# Results





# Meeting with photonexport

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- We had a meeting with them after receiving the transmission curve
- Since this is not what they promised we wanted to understand what happened
  - In summary, to lower the cost they implemented a reduced number of layers
- Agreement for next steps
  - Pay half of the price for the faulty production (14 euros/unit)
  - Perform another coating campaign for 1 mm only and **revised set of specifications**
  - **IMPORTANT !!!** They will cover the cost if specifications are not met within 2%

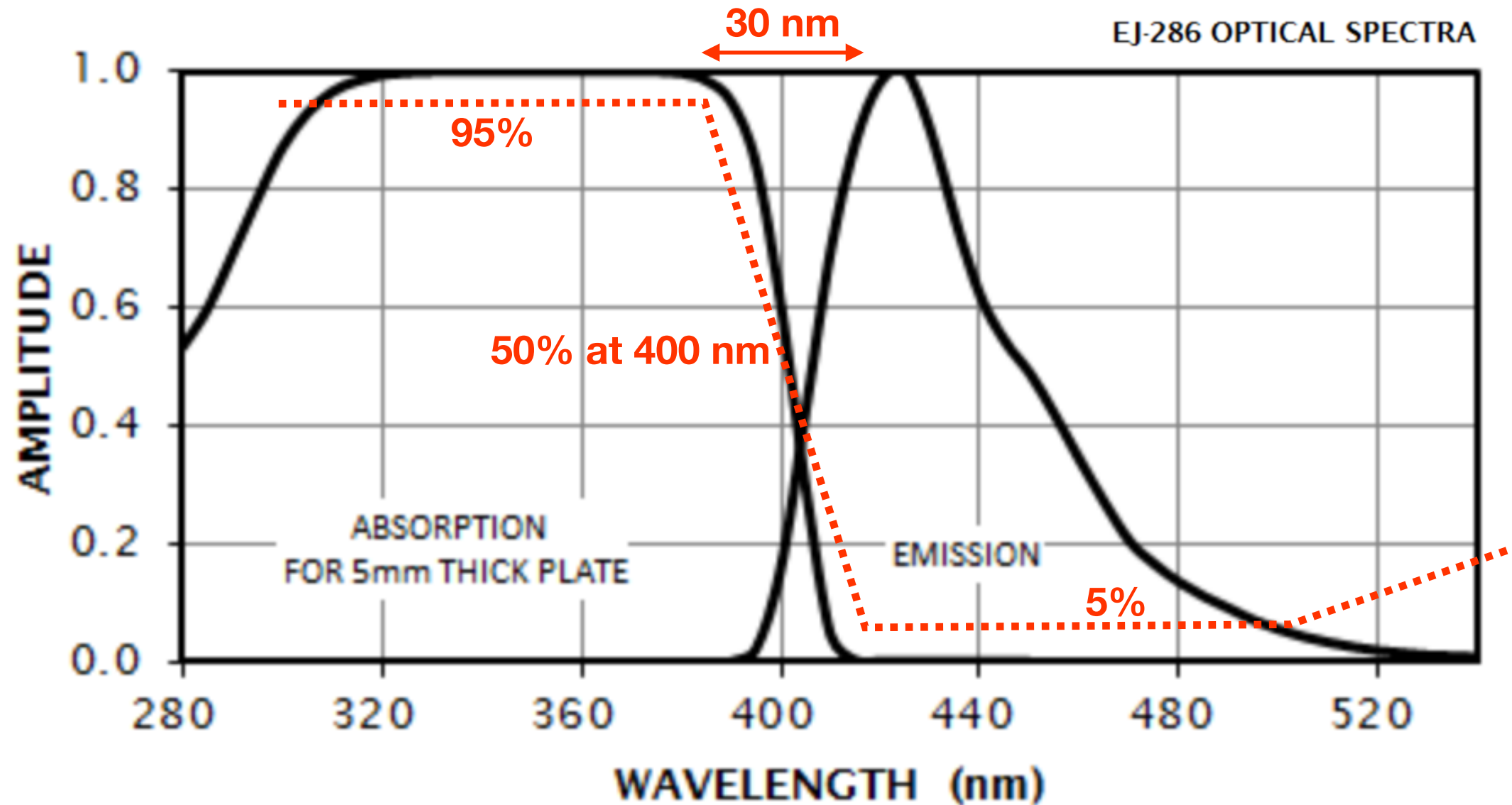
# Specifications for R&D phase

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- Cutoff at 400 nm at 45° in air ( 50% transmittance at 400 nm )
- Pass from  $T > 95\%$  to  $T < 5\%$  in 30 nm:
  - $T \sim 95\%$  at 385 nm and  $T < 5\%$  at 415 nm
- $T < 5\%$  up to 500 nm and as low as possible between 500 and 520 nm. We don't care above 520 nm. Study also 500 and 550 nm
- Dimensions: 97x97x1 mm

# Specifications

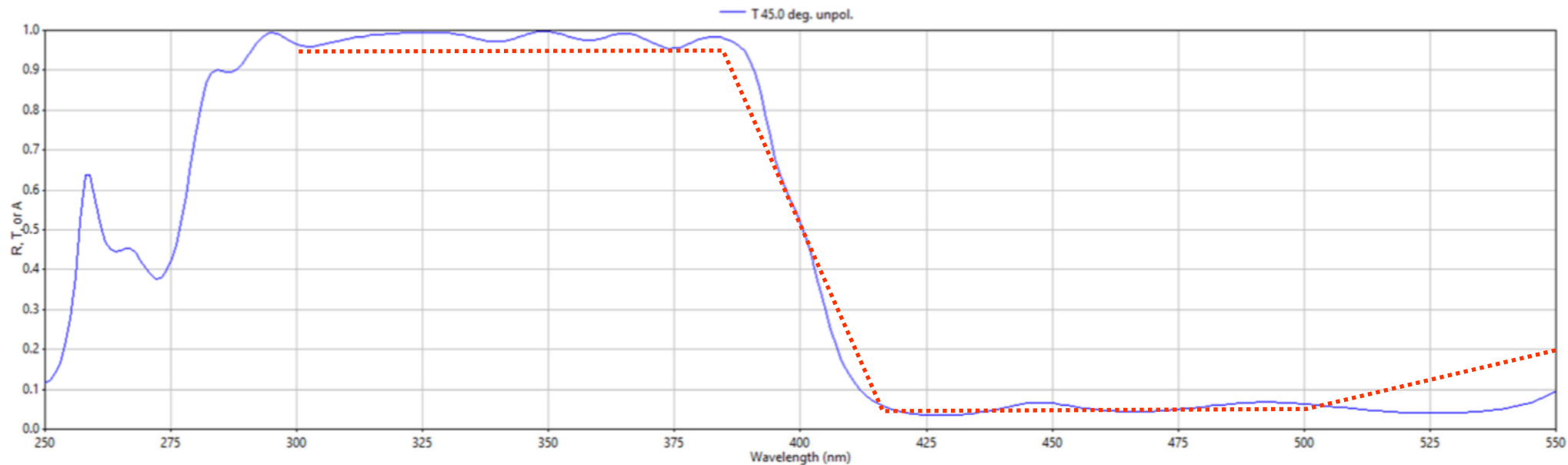
- Similar for G2P



# Simulation 1: 20 layers, 45°

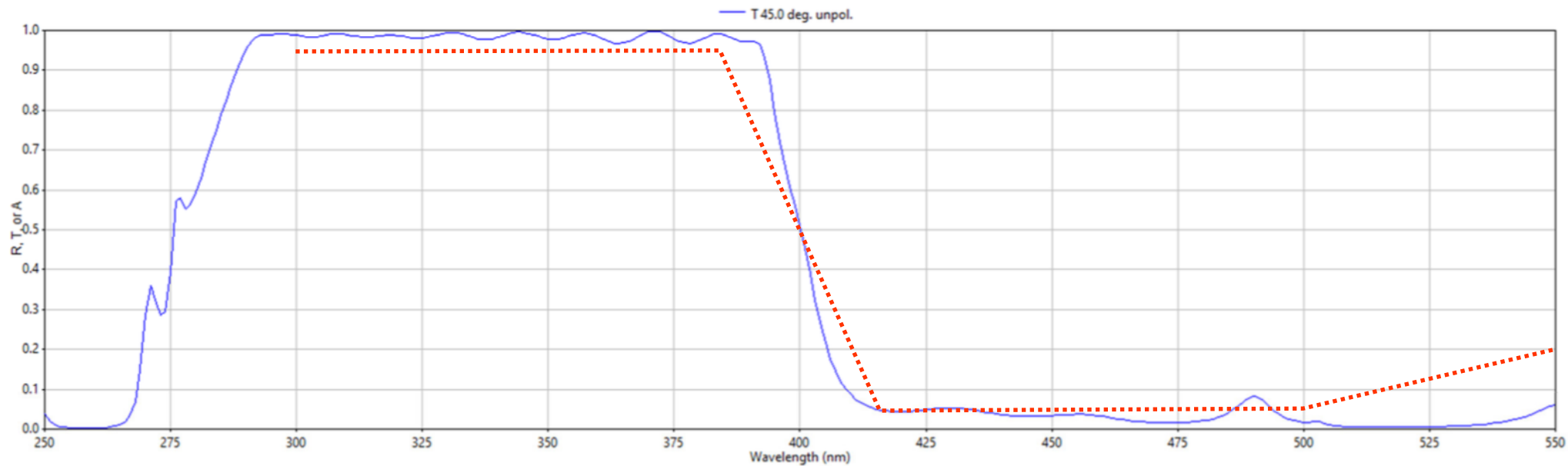
- Within specifications

1) Simulation with 20 layers and at an incidence angle of 45deg  
Total layer thickness : 2500nm



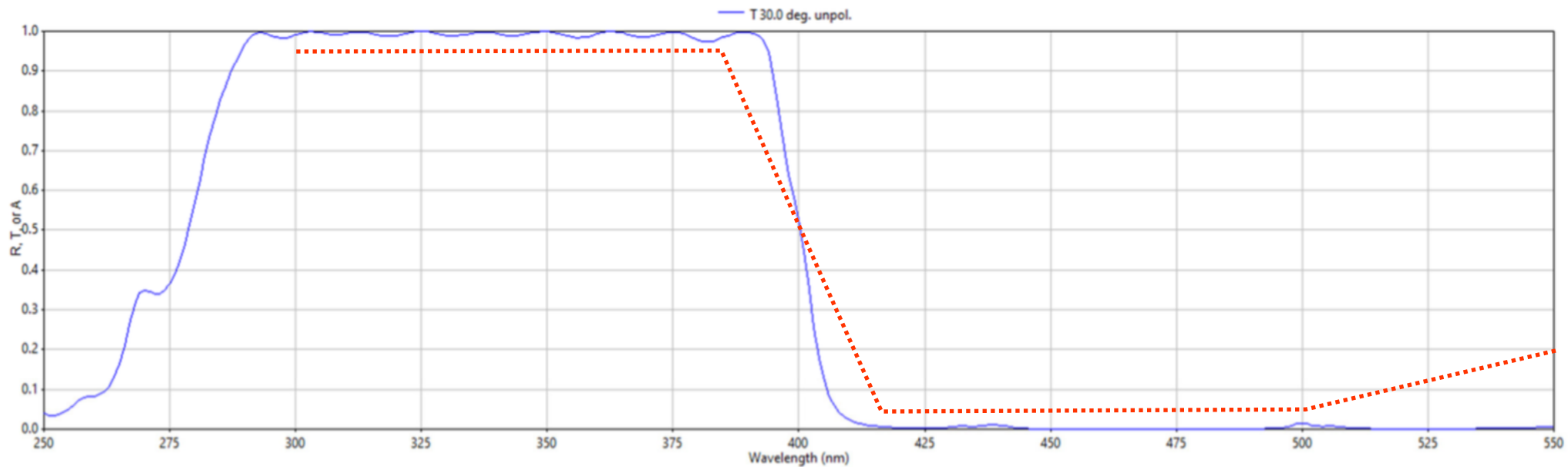
# Simulation 2: 31 layers, 45°

2) More precise simulation with 31 layers and at an incidence angle of 45deg (will be more expensive)  
Total layer thickness : 2900nm



# Simulation 3: 31 layers, 30°

3) More precise simulation with 31 layers and at an incidence angle of 30deg (will be more expensive)  
Total layer thickness : 2700nm



# Offer for R&D phase

- Offer for at least 30 layers

Item	Description	Qty	Unit Price in (€)	Total in (€)
1	<p>Optical Filter  Material FUSED SILICA JGS2  Surface: S/D 60/40  size 97 mm x 97 mm x 1 mm (Due to coating homogeneity it might be interesting but more expensive to cut after the coating a from a size of 100 mm x 100 mm x 1 mm)  incidence angle 45 °  300-385nm T&gt;95% (Tolerance: T&gt; 91,7%)  398nm T&gt;80% (Tolerance @385 T &gt; 85%)  @415nm T&lt;5%  420-500nm T&lt;1%  Values are indicative and can vary +/- 1.5% the objective being to have a cutoff wavelength at 400 nm and the sharpest slope on the wavelength cut.</p>	60,00	85,00	5.100,00
<b>Net Total</b>				<b>5.100,00</b>
Shipping & Handling				29,00
VAT 21%				1.071,00
Shipping & Handling VAT				6,09
<b>Total with Tax</b>				<b>6.206,09</b>

# Questions for photonexport

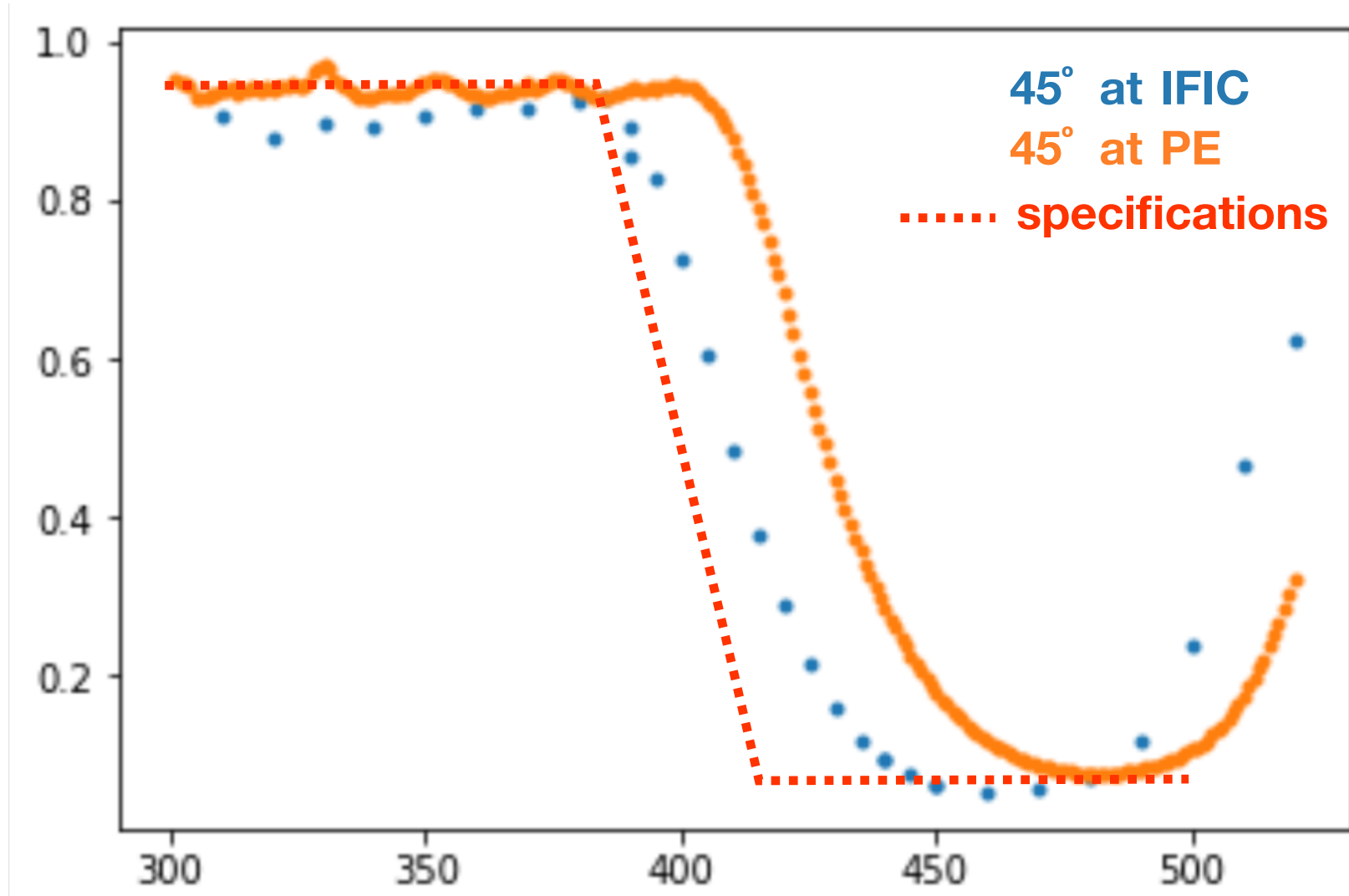
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- Cost/unit as a function of number of layers
- Cost/unit as a function of number of units
  
- They are working on that
- We told them that the target cost for 30000 filters would be 20 euros/filter and they didn't say it is impossible

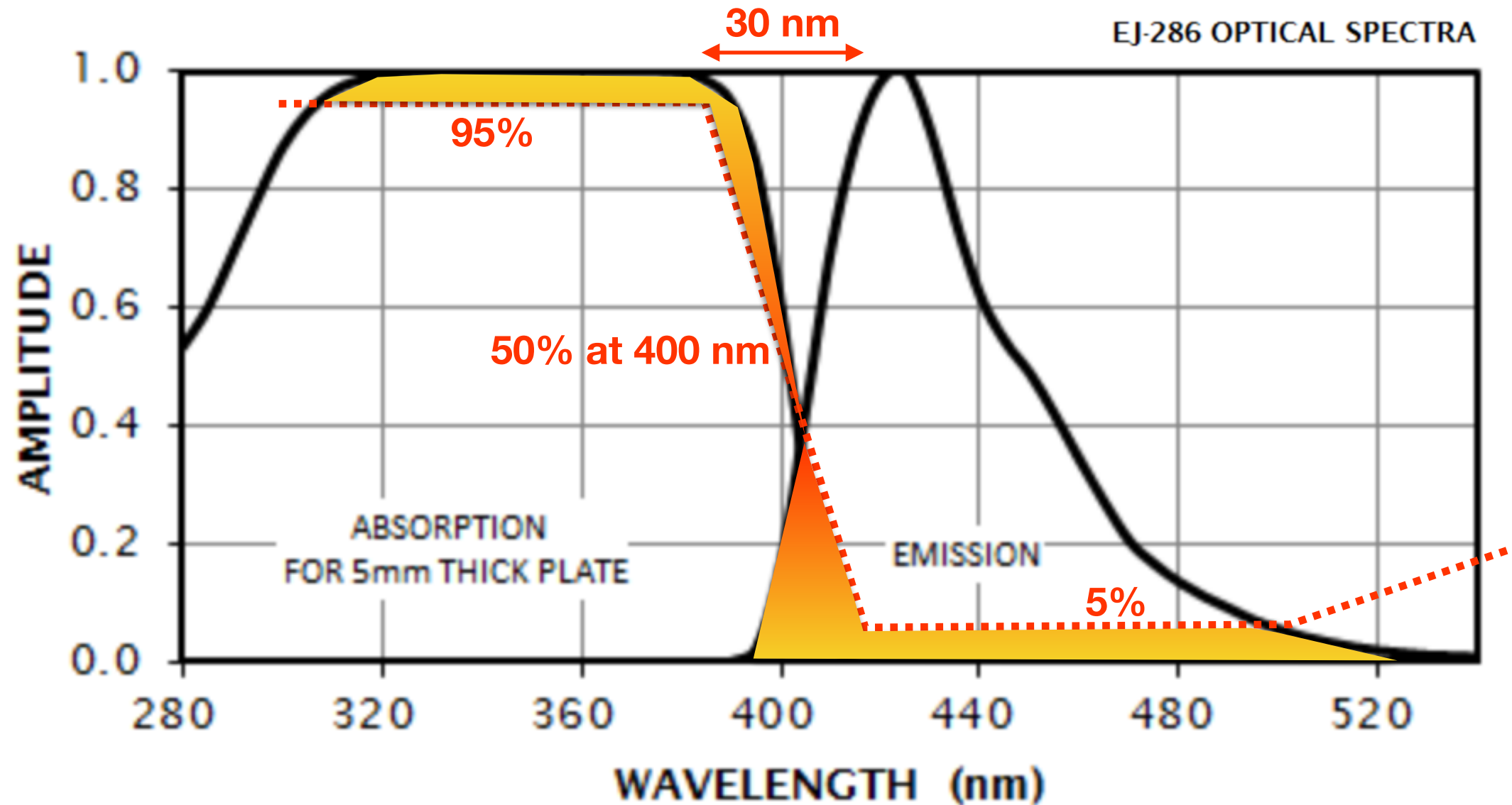


# Current filters

- Current filters are not that bad and they cost 24 euros/unit. So it should be possible to get to 20 euros/unit for a large production

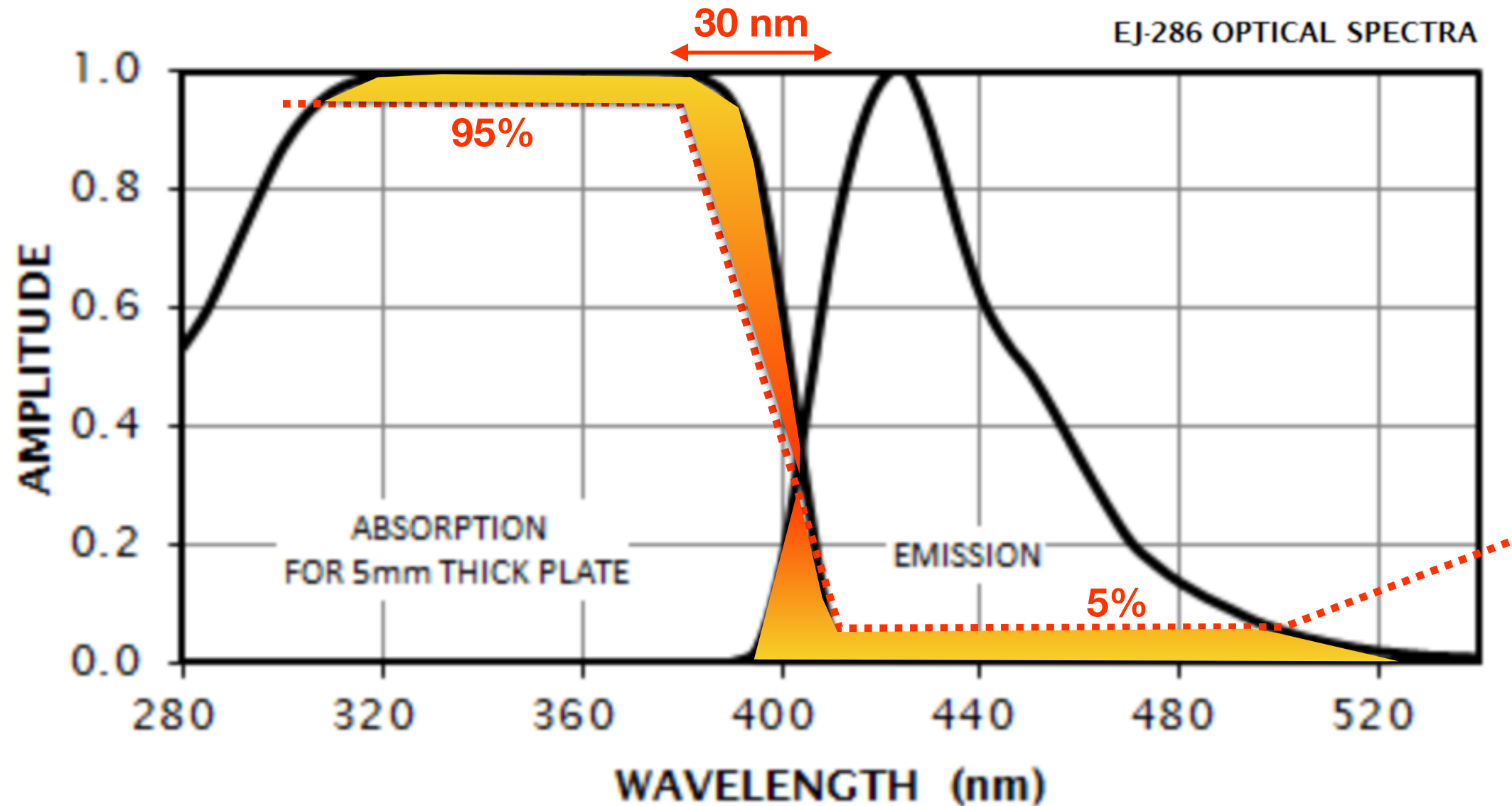


# Optimization



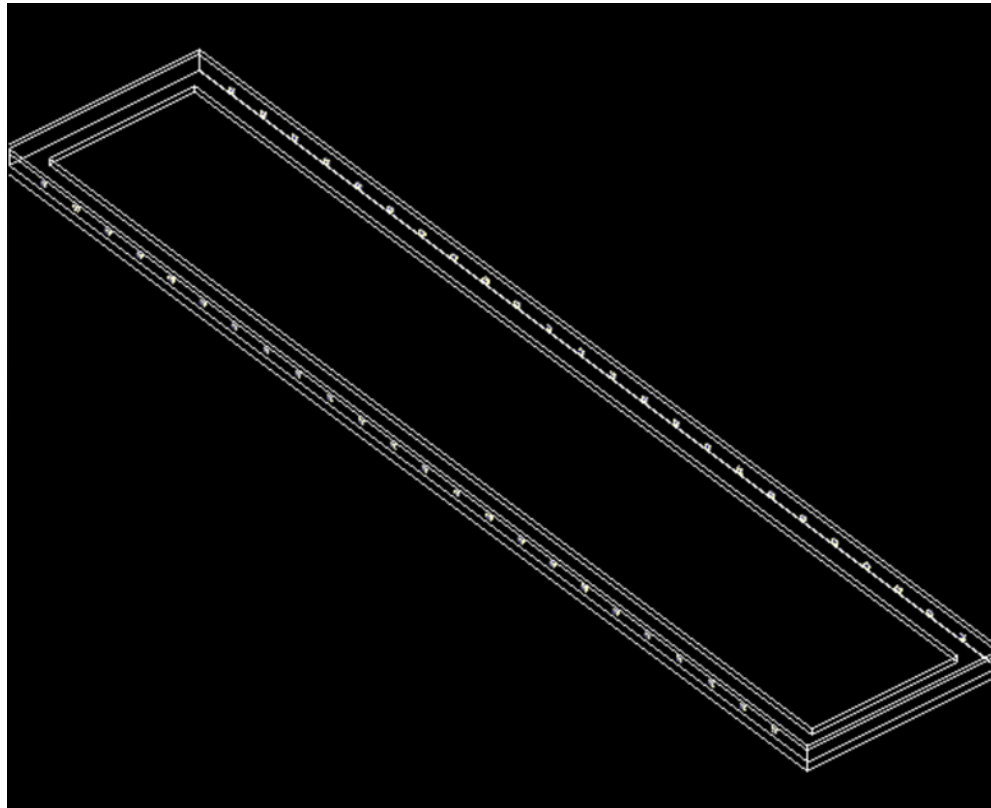
# Optimization

- It seems moving the cutoff to lower WL may help



# Arapuca simulation

- Justo, Julio and Mirald working on them. Will have results after eastern
- The idea is study collection efficiency as a function of filter cut-off position and slope

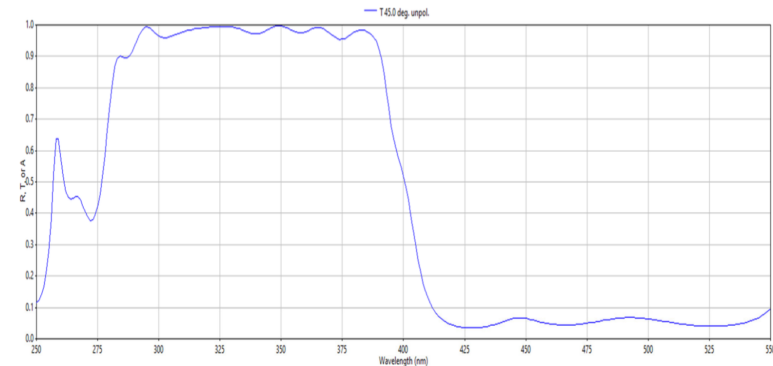


# Dichroic filter simulation

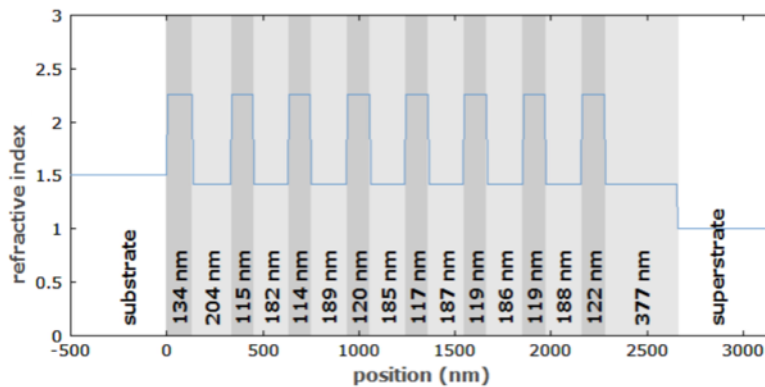
- Communication with manufacturer will be more fluid if we knew what they are doing
- They usually don't provide the multilayer structure for a given cutoff (i.e 400 nm) →
- Free software available to produce a transmittance plot for a given structure

## photonexport simulation for 400 nm cutoff

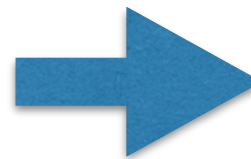
1) Simulation with 20 layers and at an incidence angle of 45deg  
Total layer thickness : 2500nm



## Design of the Multilayer Structure

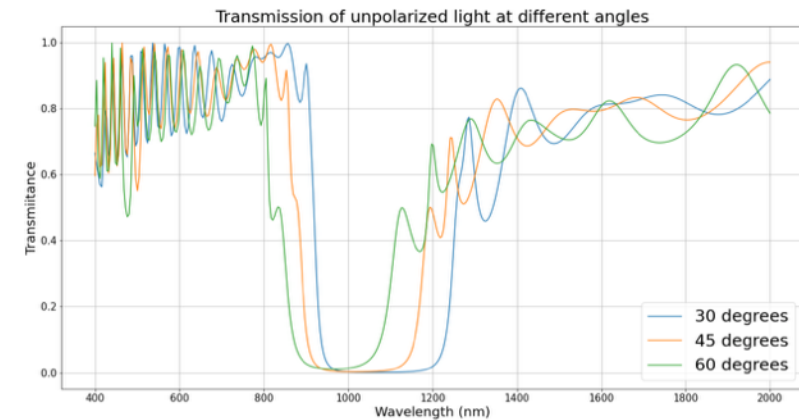


free simulation  
package



## our simulation

example for an arbitrary structure



- We are currently investigating how to reverse the problem by iterating over multiple structures to achieve the desired cutoff
- We can probably reduce the price with a simpler structure

backup

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# Final offer

Item	Description	Qty	Unit Price in (€)	Total in (€)
1	<p>Optical Filter                      Material FUSED SILICA JGS2                      Transmission from 300mm- 400 mm &gt; 91,7%                      Reflection: value above 400 mm as high as possible                      Surface: S/D 60/40                      Incidence angle - 45°                      Size: 100,0 +0/-0,2mm x 100,0 +0/- 0,2mm                      Thickness: 1,0 +0/-0,2mm</p> <p style="text-align: right;"><b>IR grade 1 mm</b></p>	30,00	29,50	885,00
2	<p>Optical Filter                      Material FUSED SILICA JGS2                      Transmission from 300mm- 400 mm &gt; 91,7%                      Reflection: value above 400 mm as high as possible                      Surface: S/D 60/40                      Incidence angle - 45°                      Size: 100,0 +0/-0,2mm x 100,0 +0/- 0,2mm                      Thickness: 2,0 +0/-0,2mm</p> <p style="text-align: right;"><b>IR grade 2 mm</b></p>	25,00	29,50	737,50
3	<p>Optical Filter                      Material FUSED SILICA JGS1                      Transmission from 300mm- 400 mm &gt; 91,7%                      Reflection: value above 400 mm as high as possible                      Surface: S/D 60/40                      Incidence angle - 45°                      Size: 100,0 +0/-0,2mm x 100,0 +0/- 0,2mm                      Thickness: 1,0 +0/-0,2mm</p> <p style="text-align: right;"><b>UV grade 1 mm</b></p>	5,00	190,00	950,00

- We got the final offer after Christmas and placed the order at the end of January
- 4/5 weeks delivery time (end of February). We talked to them today and filters will arrive next week