Dichroic Filters

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DUNE FD2 Photon Detection Workshop

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UNICAMP

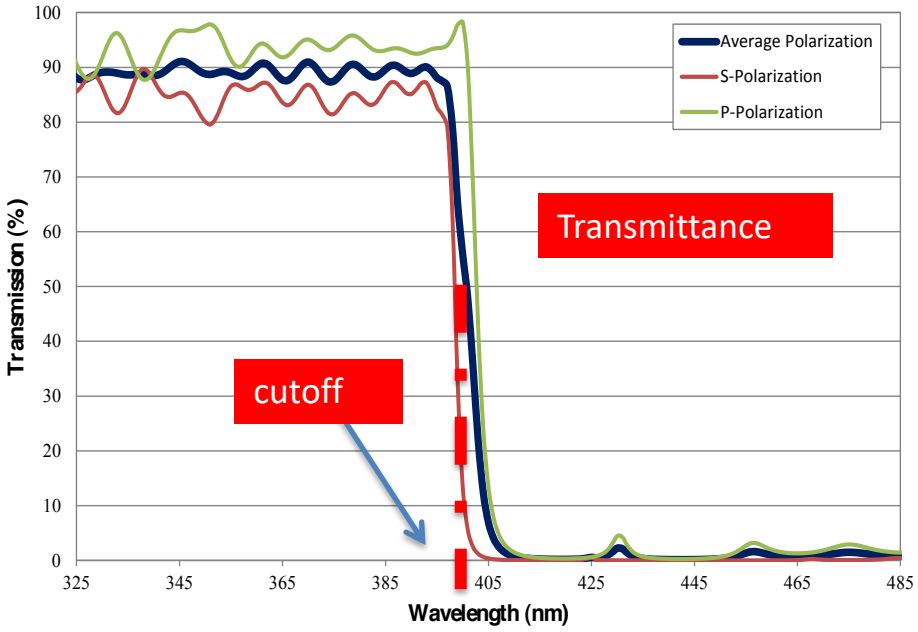
Content

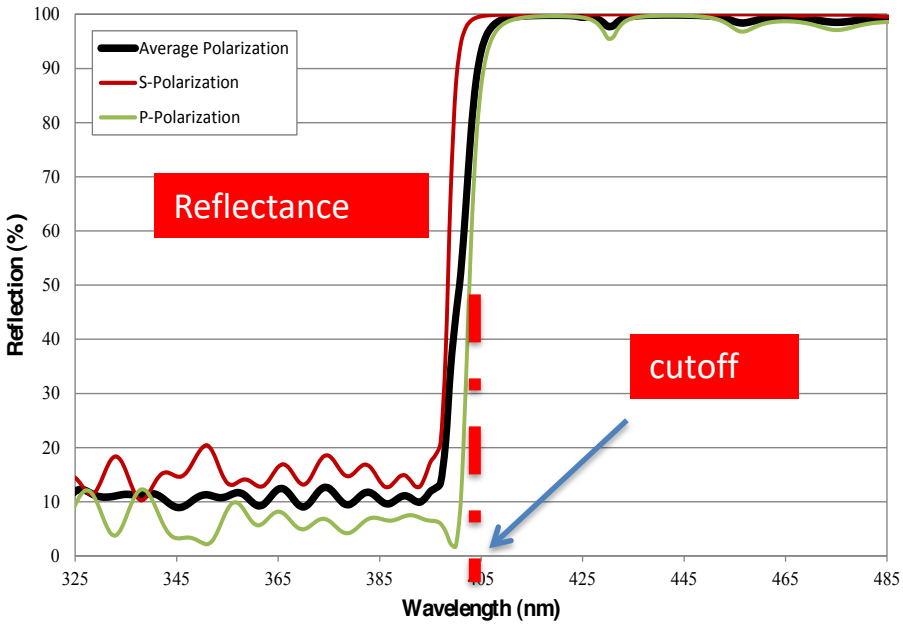
- Optical filters
- Filter Substrate
- R&D for FD1
  - Comparison between different companies
  - Measurements at three different incidence angles
- OPTO company
- OPTO filters characteristics
- Prototype production
- Alternative Manufacturer
  - OPTO dichroic filter vs. ZAOT substrate
  - ZAOT dichroic filter simulation
- Next Steps

Optical Filters

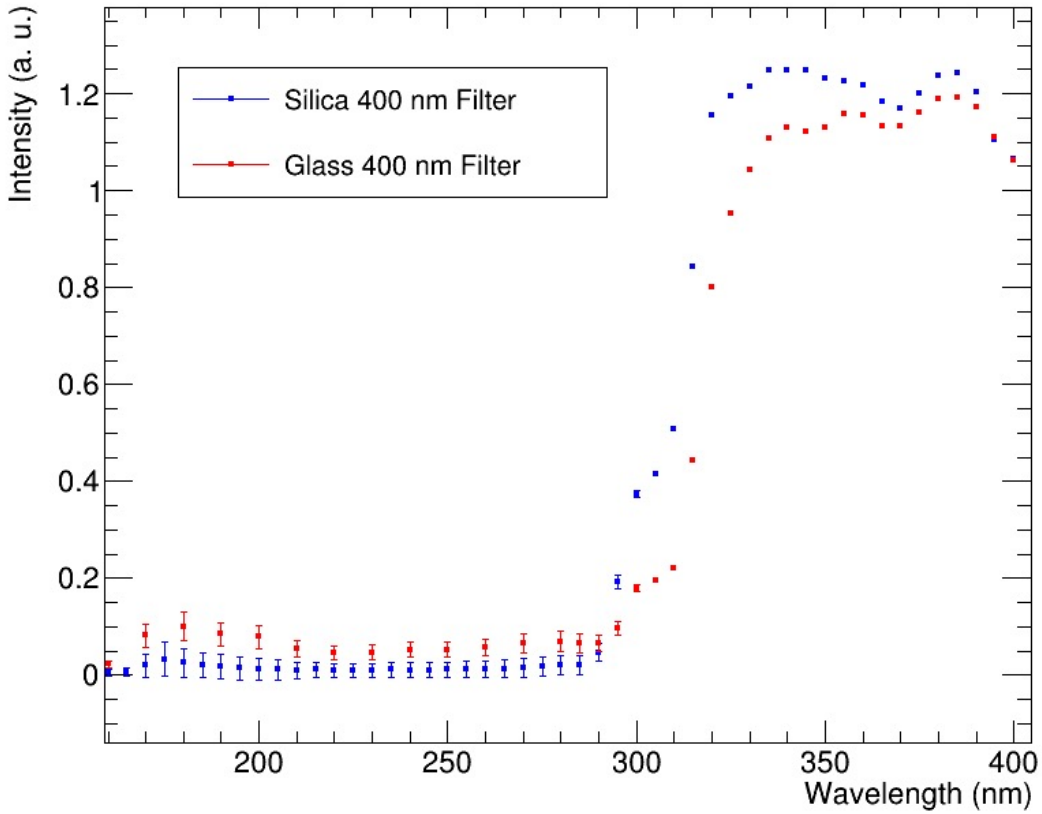
The optical filters need to have these characteristics:

- Transparent for wavelenghts bellow the filter cutoff
- Reflective for wavelenghts above the filter cutoff
- Designed for incidence angle of 45 degrees





Filter Substrate

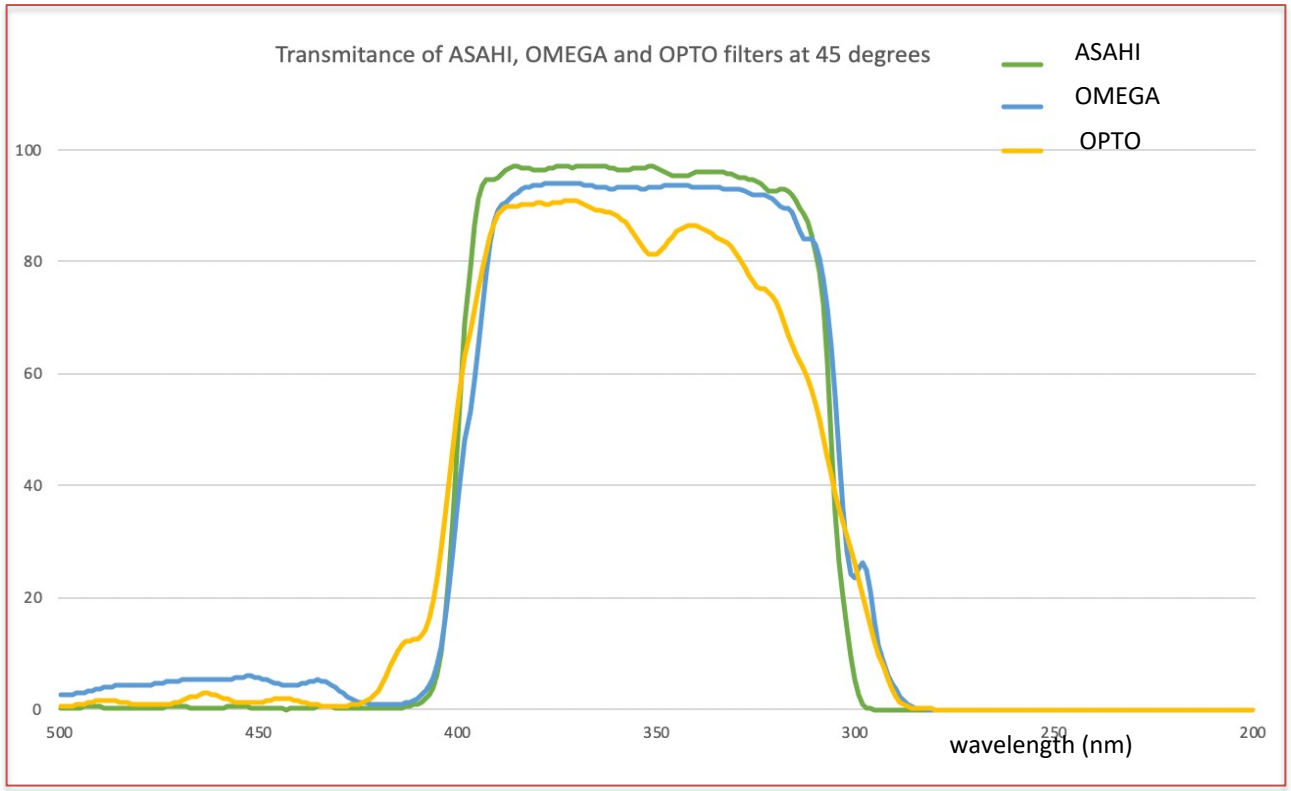


Above 350nm the transmitance spectrum of the two samples is similar.

The choice of B270 is convenient because it is cheaper

R&D for FD1

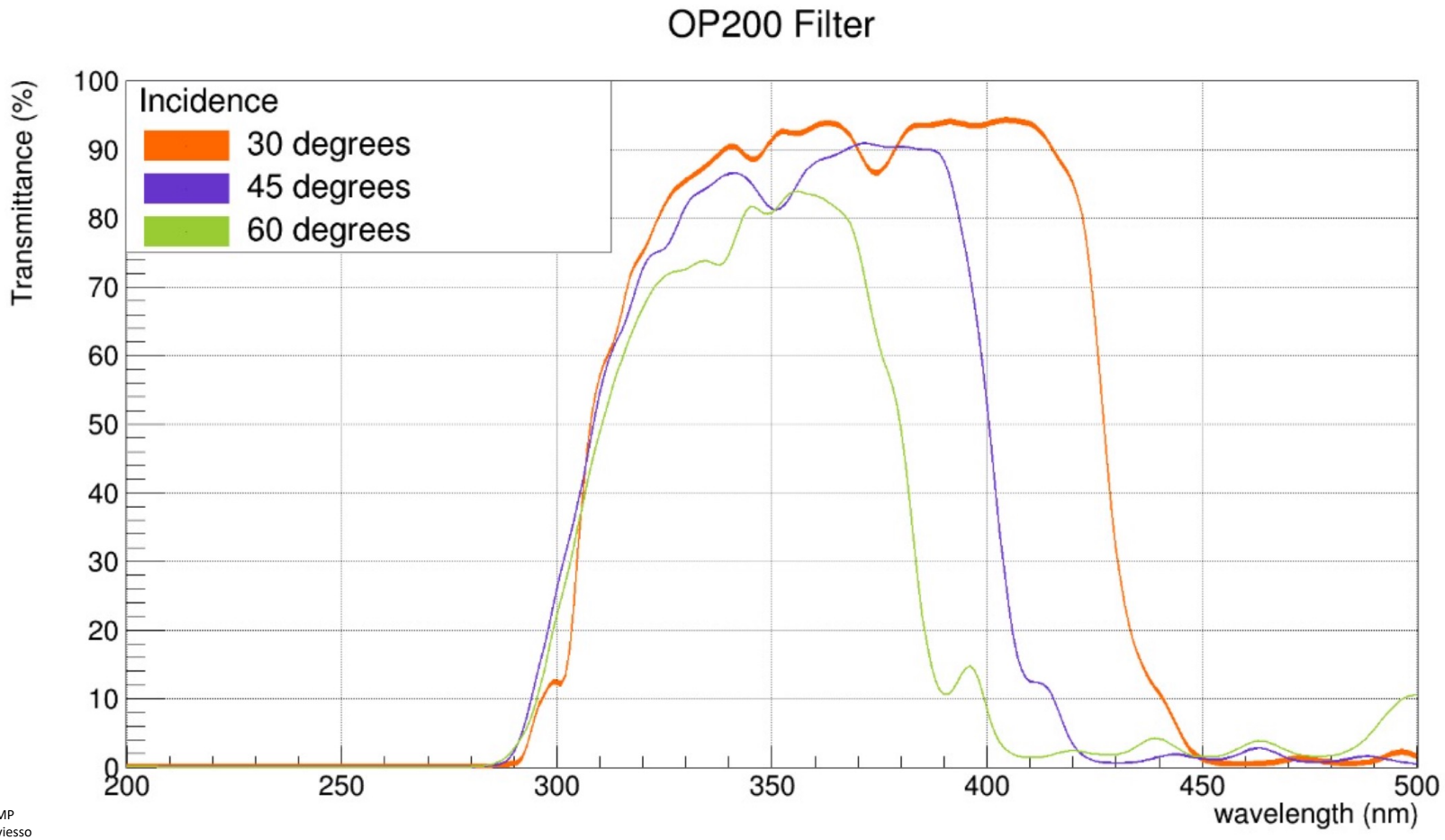
- ASAHI and OMEGA → Substrate Fused Silica
- OPTO → Substrate Optical Glass B270



OPTO filters was one of the best in terms of pTP adhesion

R&D for FD1

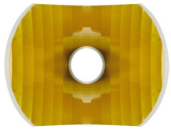
Measurement at different angles (30, 45 and 60 degrees)



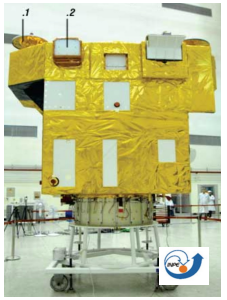
Data taken at UNICAMP
Plot made by G.Valdiviesso

OPTO Electronics - BR

https://www.opto.com.br/



- Spinoff of USP São Carlos, 35 years experience
- Antireflective lenses, medical equipments for eye surgery, odontologic reflectors, filters, mirrors, prismas, lasers.
- Space and defense: multispectral chambers for satellites, filters for space applications, thermal vision.



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OPTO Filters FD2

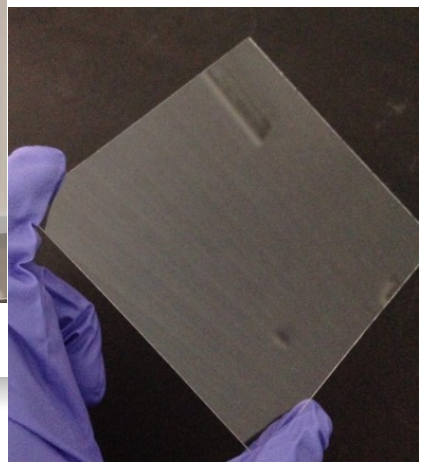
Coating specification:	Cut-off: 400 nm – transmission between 300nm and 400nm, and reflection between 400nm and 500nm. • Incidence angle – 45 degrees
Substrate:	Optical glass B270: - Transmission τvD65 (d = 2.0 mm) = 91.7% - Expansion coefficient (20 °C; 300 °C) (static measurement) = $9.4 \cdot 10^{-6}$ K^{-1} - Melting Temperature= T_g 542 °C - Dielectric Constant ε_r at 1 MHz = 7.5 - Refraction Index n_D = 1.5229 - Density ρ = 2.56 g/cm^3
Dimension:	Width: 97.0 (+0.0 - 0.3)mm Length: 97.0 (+0.0 - 0.3)mm Thickness: 1.0 (+- 0.1)mm

Improvement proposed by OPTO:

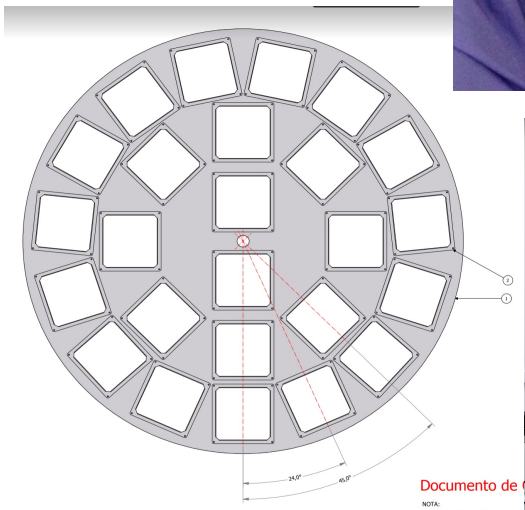
- Possible to **add a reflective band** in correspondence of the wavelenght of the lasers **to block the light leaking from the lasers**
- Production of larger area filters

Prototype production

- 75 substrate sent to CSU for mechanical tests
- 250 has been ordered to OPTO
  - 2 weeks for production



- NEW disc for pTP evaporation is under production with capacity of 25 filters
- Wavelenght shifter deposition ➔ p-Therphenyl
- Tickness of deposition ➔ around 400µg/cm^2
- Cleaning protocol well established and tested



Criticity for FD2 production

1) Person power for cleaning and pTP deposition

2) Shipping (special boxes need to be developed)

3) Storage to avoid humidity

Alternative Manufacturer

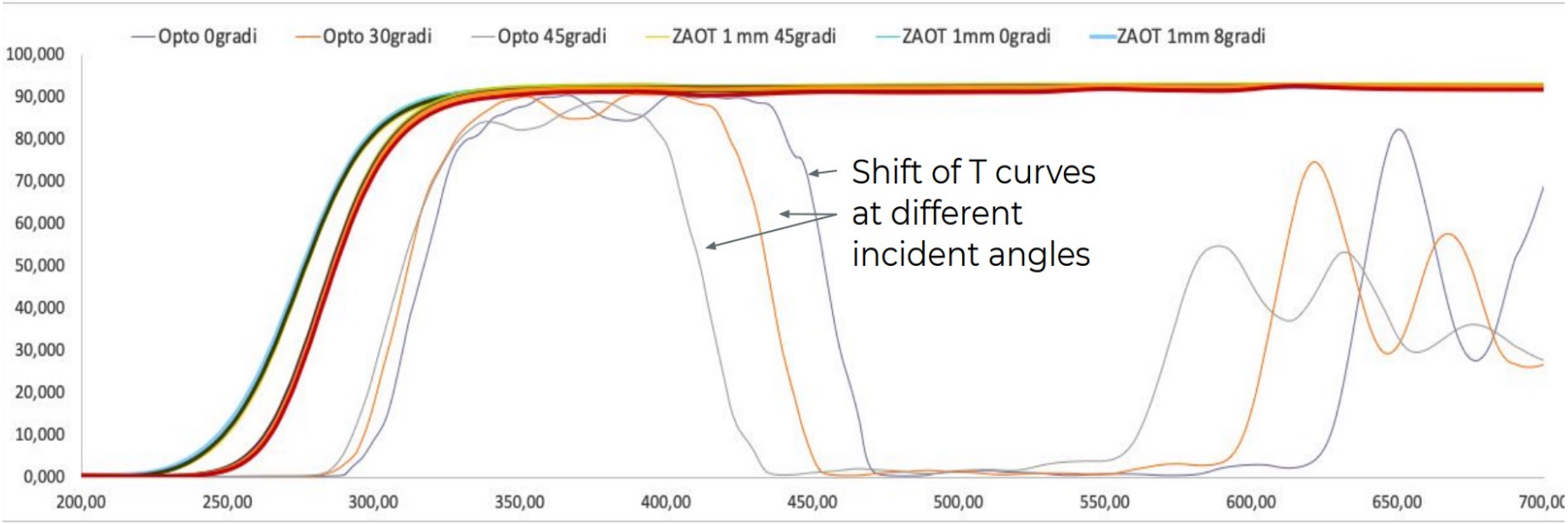
Motivations

- Found a second manufacturer to support OPTO in the massive production for VD and in case (if needed) for the HD
- For the VD-Megacell: produce dichroics in 200 x 200 mm side → the filter matrix will be of 9 elements instead of 36 elements
- For the 20 x 20 mm size it is mandatory to adopt the 2 mm thickness
- Found a company in the Milano metropolitan area: industrial partner of INAF (Istituto Nazionale di Astro Fisica) for optical mirrors and devices.
- ZAOT: https://www.zaot.com/en/ specialized in optical thin film coatings
  - Antireflective coatings
  - Beam splitters
  - Front surface mirrors
  - Heat protection mirrors
  - Cold light mirrors
  - Dichroic filters
  - Conversion Filters
  - UV coatings

Credits: Carla Cattadori

Dichroic (OPTO) X Substrate (ZAOT)

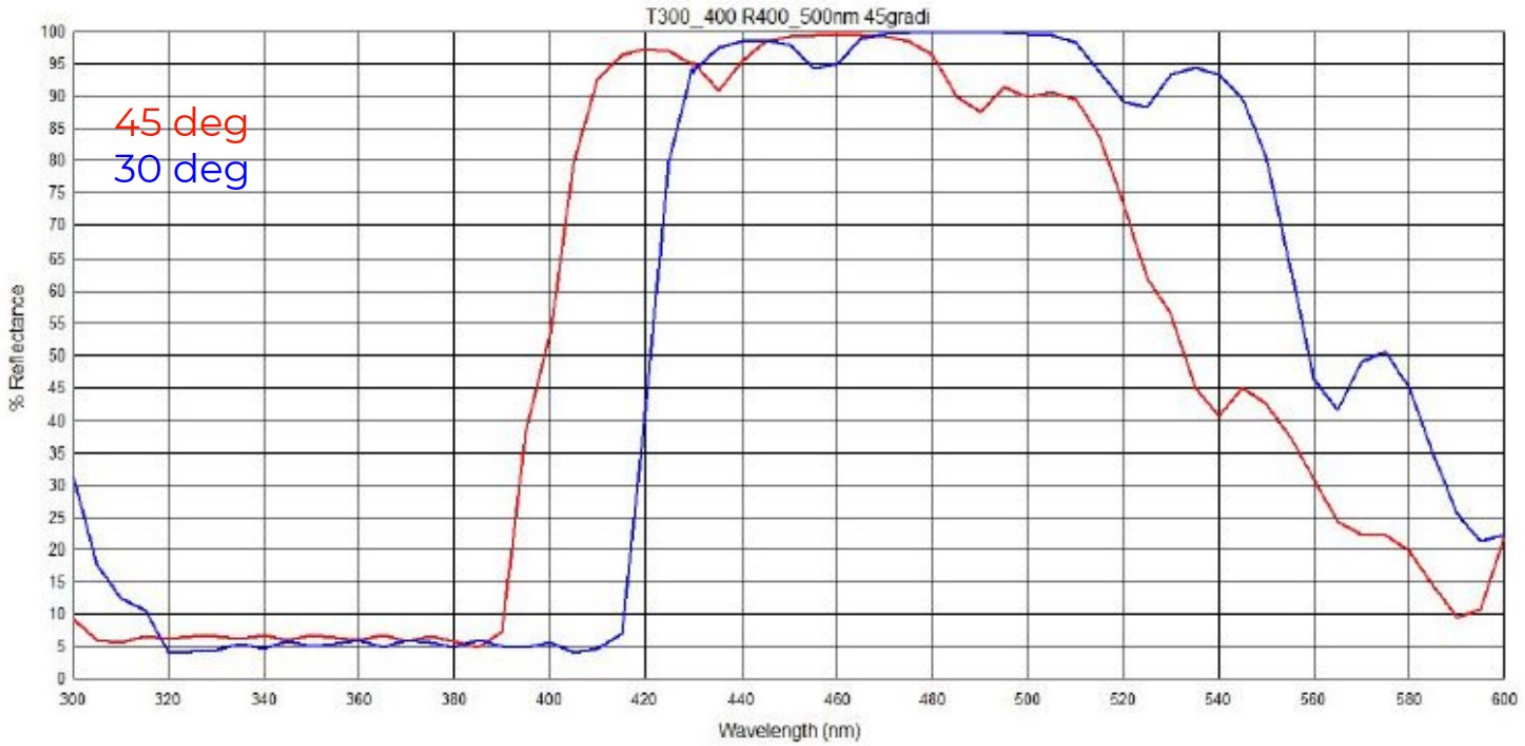
Comparative Transmittance measurements of OPTO Dichroic (pTP removed) and ZAOT optical glass (substrate only)



Credits: Carla Cattadori

Simulation

ZAOT simulated Dichroic thin film reflection curve for Fused Silica w. AR coating at 45 deg and 30 deg



Credits: Carla Cattadori

Next Steps

- Production of dichroic filters by OPTO for the prototype (August)
- pTP coating at UNICAMP (August/September)
- Production of substrate (Borofloat-33) by ZAOT company. (August/September)
- Comparative measurements between OPTO and ZAOT substrate @ UNICAMP → (ask to OPTO provide also the same substrate???)
- Production of dichroic filter samples by ZAOT
- Test pTP adhesion on ZAOT filters
- Comparative measurements between OPTO and ZAOT filters @ UNICAMP (ZAOT suggests that an Anti-Reflection layer will improve ~ 4% the transmission at the first interface)