Summary 14/10-21/10

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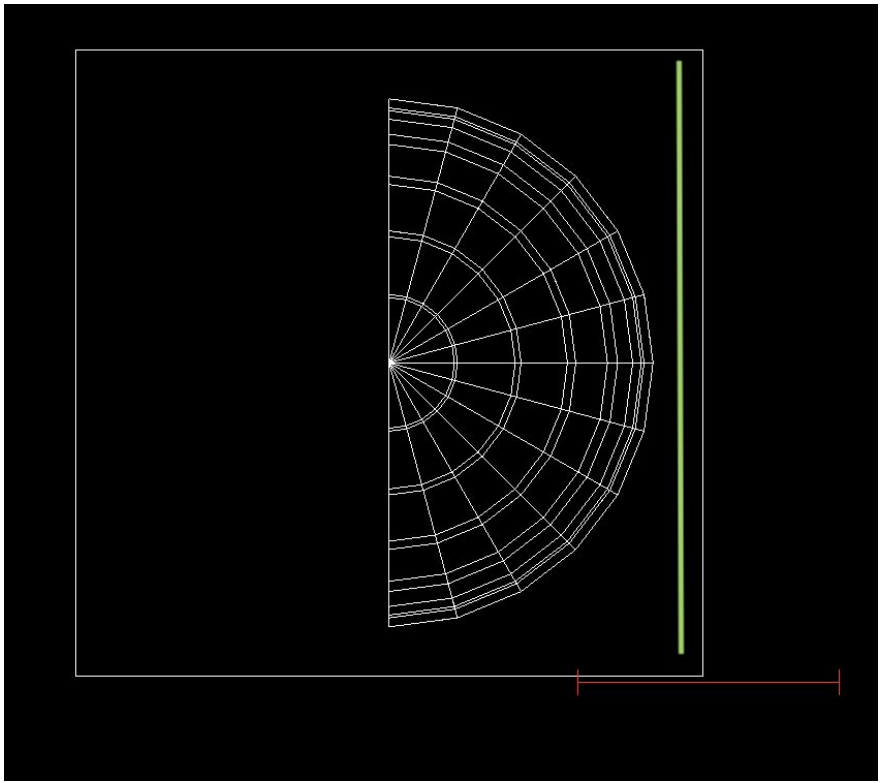
UNIVERSIDAD DE GRANADA

Simulation



- New simulation to assess the importance of the refractive index on the single-PMT efficiency.
- Single PMT with a TPB coating layer and a detector.
- Shoot photons pointing to the center of the PMT with incidence angle varying from 0º to 89º.

Introduction

- Reflexion and refraction in Geant4 are described through Fresnel equations.
- If $\theta_i > \theta_{lim}$ the photon is reflected. Otherwise reflection and refraction probability given by reflectance and transmissivity.
- *p* refers to the direction parallel to the incidence plane
- *s* refers to the direction normal to the incidence plane

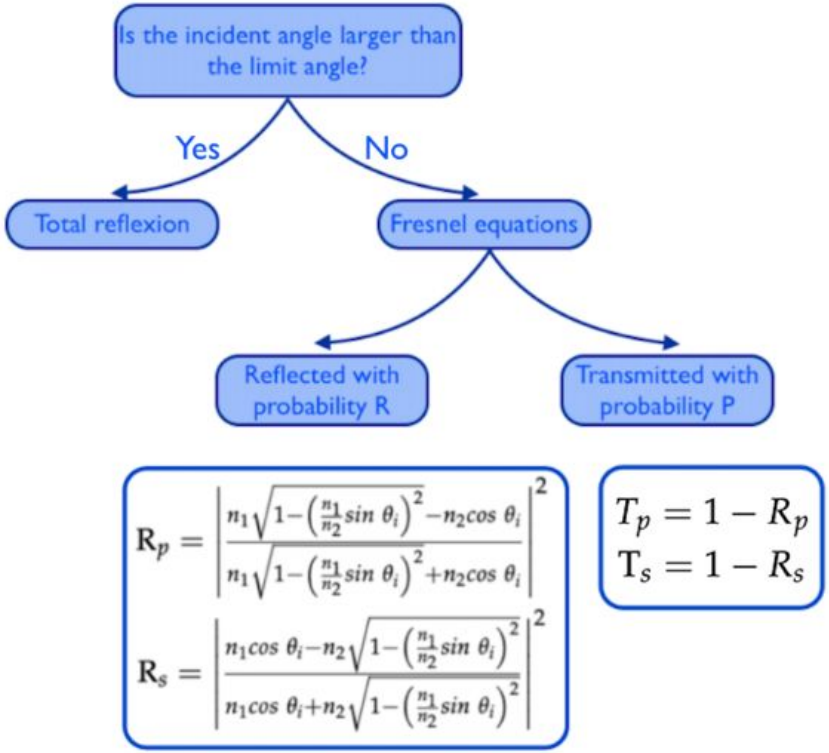
$$R_p = \left| \frac{n_1 \sqrt{1 - \left(\frac{n_1}{n_2} \sin\theta_i\right)^2} - n_2 \cos\theta_i}{n_1 \sqrt{1 - \left(\frac{n_1}{n_2} \sin\theta_i\right)^2} + n_2 \cos\theta_i} \right|^2$$

$$R_s = \left| \frac{n_1 \cos\theta_i - n_2 \sqrt{1 - \left(\frac{n_1}{n_2} \sin\theta_i\right)^2}}{n_1 \cos\theta_i + n_2 \sqrt{1 - \left(\frac{n_1}{n_2} \sin\theta_i\right)^2}} \right|^2$$

$$T_p = 1 - R_p$$

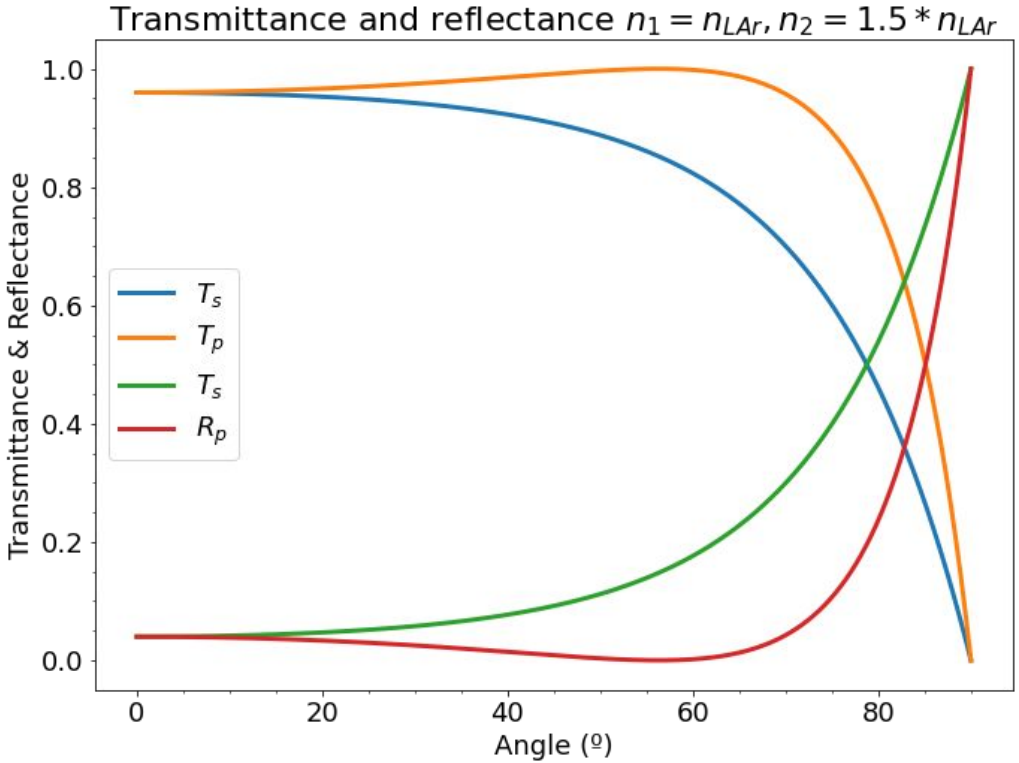
$$T_s = 1 - R_s$$

Introduction



- Two reflectances and transmissivities for each of the possible photon polarizations.
- In our simulation polarization is random, so we will have a combination of both.

Introduction



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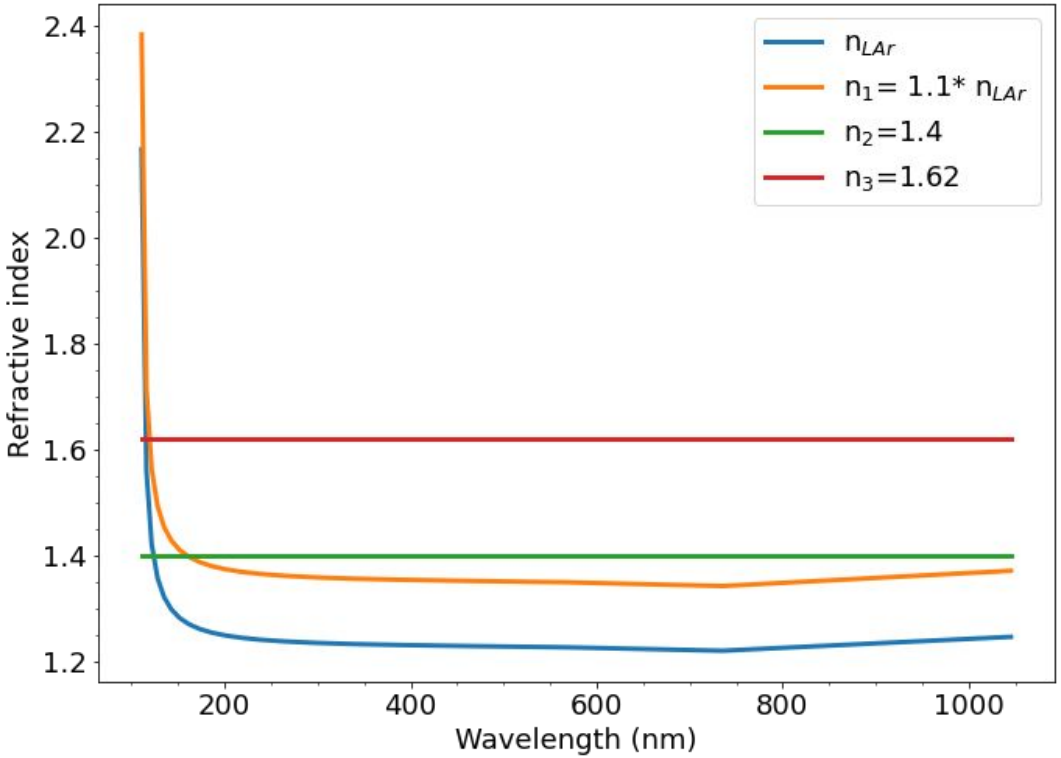
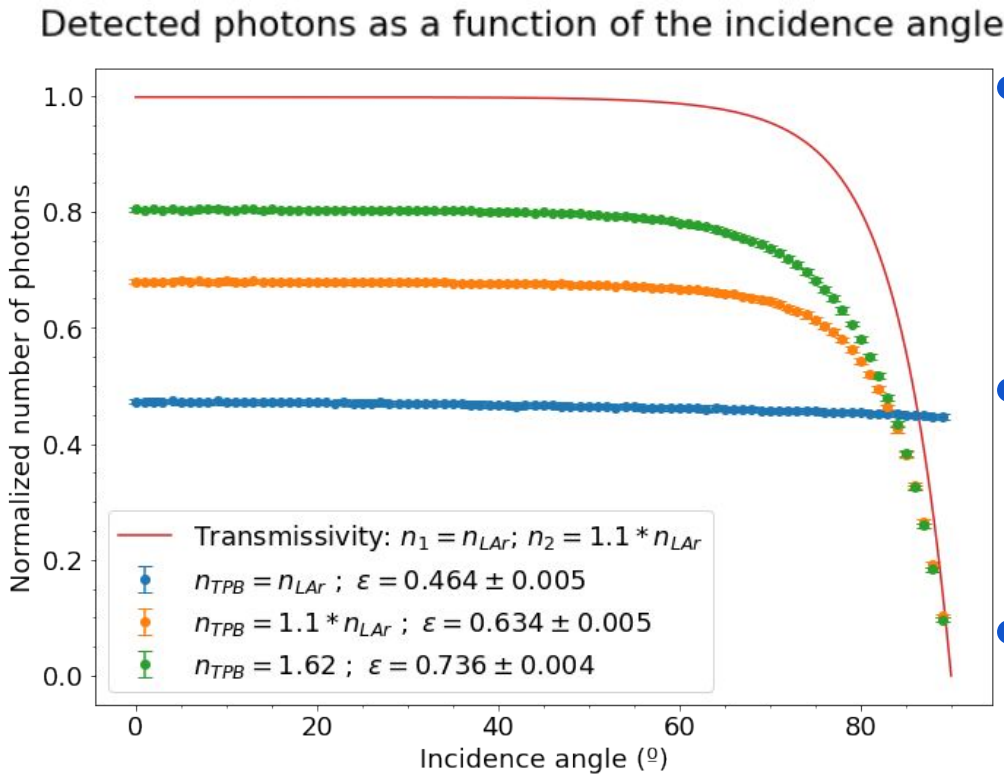
Introduction



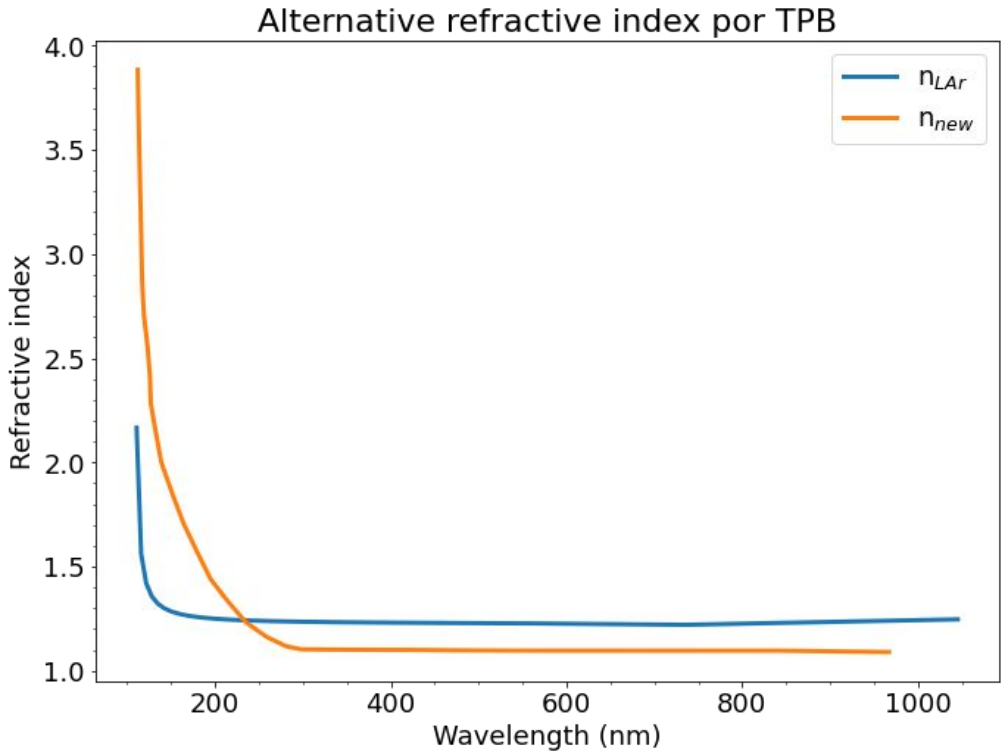
- Try with different refractive index.
- n_2 from: Dunton, E. (2022). A Search for Axion-like Particles at the Coherent CAPTAIN Mills Experiment. Columbia University.
- n_3 from: Kumar, A. (2020). Growth and characterization of organic scintillation single crystal 1,1,4,4,-Tetraphenyl-1,3-Butadiene (TPB) using vertical Bridgman technique.

Results



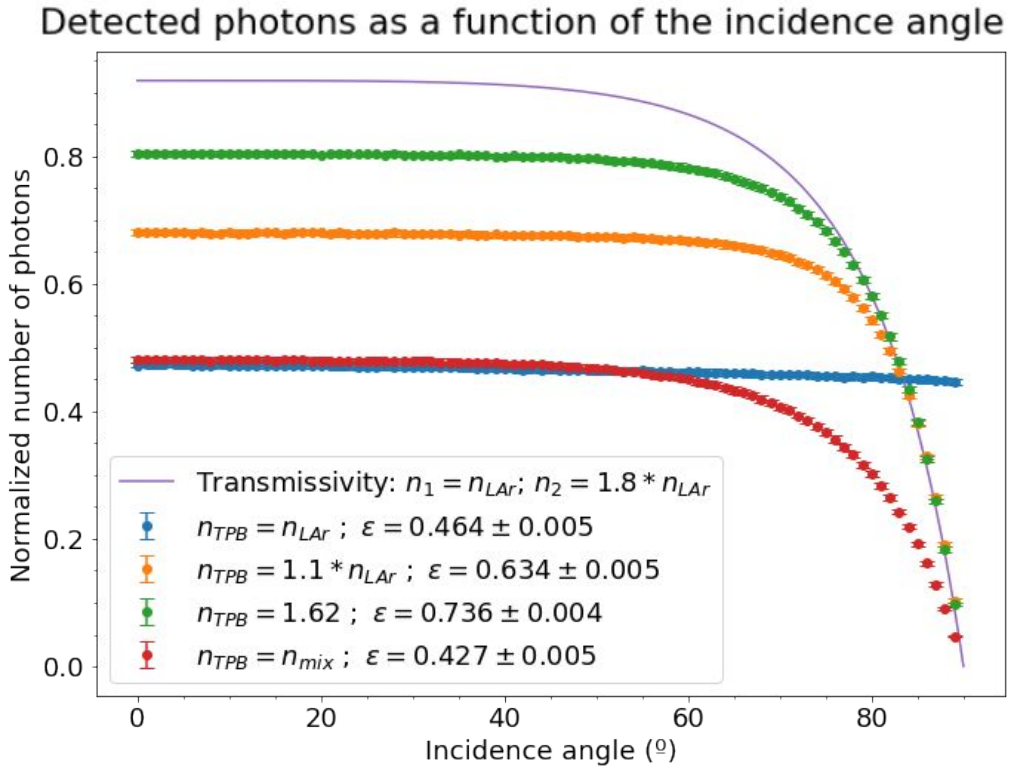
- Some of the outwardly re-emitted photons do not get to leave the TPB layer because there is total reflexion ($n_{TPB} > n_{LAr}$).
- For large angles reflectance increases making VUV photons not enter the TPB.
- In none of the cases we reach the sought efficiency.

Alternative



- For this refractive index $n_{TPB}(VUV)>n_{LAr}(VUV)$ and $n_{TPB}(VIS)<n_{LAr}(VIS)$.
- Find a refractive index spectrum such that for large angles the transmissivity decreases and total reflexion inside TPB is removed.

Results



- Efficiency more similar to what is sought.
- Still a ~10% discrepancy.

Completing the simulation

Photomultiplier tube

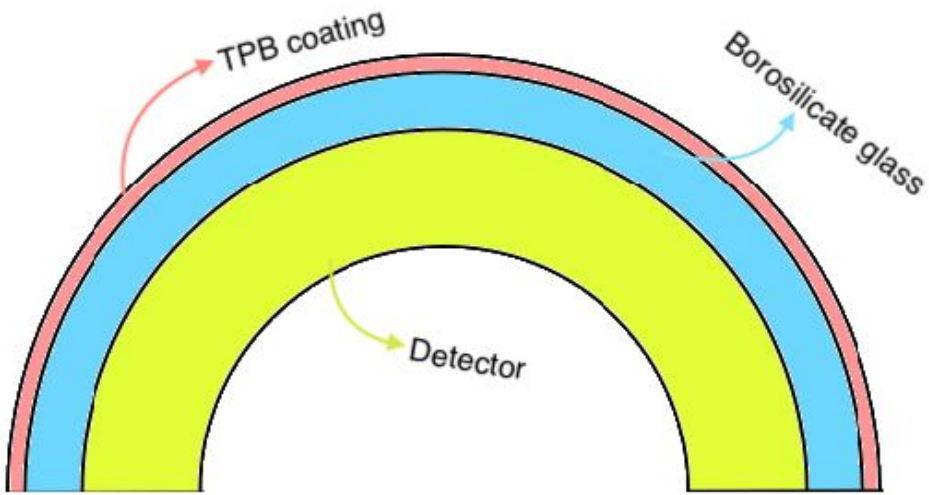
R5912

COMMON SPECIFICATIONS

Parameter	Description / Value
Spectral response	300 nm to 650 nm
Peak wavelength	420 nm
Photocathode material	Bialkali
Window material	Borosilicate glass

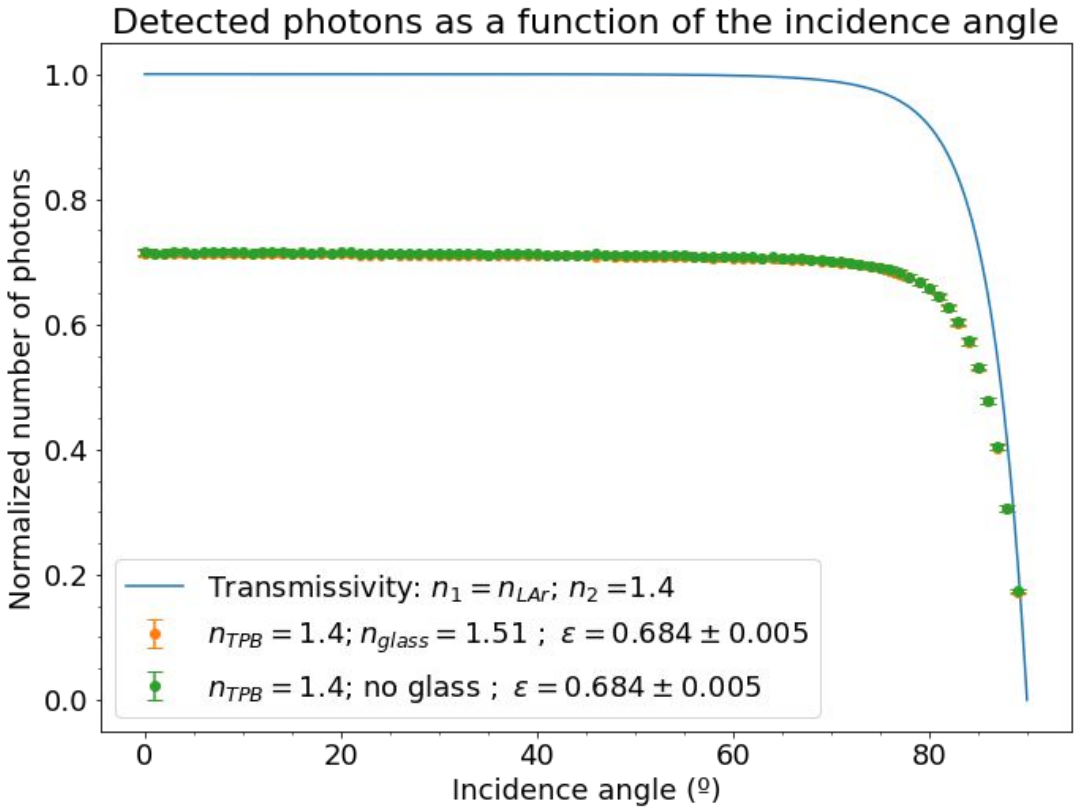
- If reflection/refraction between layers is important, we might need to include the crystal that covers the PMT.
- Borosilicate glass with n~1.51

Completing the simulation



- Now the glass layer is placed between the detector and the TPB.

Results



- Compare glass vs no glass for n_{TPB}=1.4
- Same number of photons and efficiency including the glass layer.
- As long as there is no total reflexion between the TPB and the glass the result will barely change.

Lab work

Amidata S.A.U.
Avda. Bruselas 6 Planta 3ª
28108 MADRID
ESPAÑA

Oferta	
Nº Oferta:	A1006701545
Válida desde:	19/oct/2022
Válida hasta:	18/nov/2022
Nº Cliente:	14944554
Ofertado por:	Jesús Torrejón López
Email:	jesus.torrejon@rs-components.com
Teléfono:	

Datos de la oferta	
Empresa:	UNIVERSIDAD DE GRANADA
Dirección 1	Avda. del Hospicio s/n
Dirección 2	Edificio 6
Dirección 3	Granada
Dirección 4	
Código Postal	18010
CIF/NIF	ESQ1818002F
Referencia Solicitud:	UNIVERSIDAD DE GRANADA
Contacto:	Alejandro Sanchez
Teléfono:	618877250
Fax:	
Email:	asanchezcastillo@ugr.es

Dirección de envío	
Empresa	UNIVERSIDAD DE GRANADA
Empresa (cont.)	
Dirección 1	P.T. Ogijares C/ Zamora 111 112
Dirección 2	Ogijares-GRANADA
Dirección 3	
Dirección 4	
Código Postal	18151
Contacto:	Alejandro Sanchez

Resumen de la oferta

Valor Neto Total	IVA (21 %)	Total
996,54 €	209,27 €	1.205,81 €

Líneas de la oferta

Art.	Ref. propia cliente	Código RS	Código Fabricante / Fabricante	Su Cantidad	Multiplo de Pedido	Unidad de Venta	Cantidad Pedida	Precio Unitario (€)	Valor Total de la Línea (€)	Plazo de Entrega	NCNR	RoHS
1		390-0032	Le ofrecemos: 3842992425/2000 Bosch Rexroth	6	1	Unidad	6	61,49	368,940	6 Disponible para entrega en 24/48 horas		
	Perfil de Aluminio Plateado, perfil de 45 x 45 mm x 2000mm de longitud											
2		493-8296	Le ofrecemos: 3842992425/1000 Bosch Rexroth	8	1	Unidad	8	35,84	286,720	8 Disponible para entrega en 24/48 horas		

- Aluminium structure ordered. Waiting for delivery. Expected next week.