In today’s world, in which nanoscale has become the state of the art, Fe$_3$O$_4$ nanoparticles have won their place. This is related to the fact that differently of the magnetic properties of its bulk counterpart, which are well known and studied, the magnetic properties of the nanoparticles (NP) of this material are strongly dependents on the way they are synthesized and the substrate utilized.

Starting from an iron target made by arc melting, we made a deposition by the Pulsed Laser Deposition method using the wavelengths of 532 and 1064 nm with beam energy of 300 and 600 mJ, respectively, work pressure of 1.3 mbar and argon atmosphere.

The as deposited NP were exposed to the air for 5 days, in order to oxide the nanoparticles, and after that thermally treated in 600 °C for 1 hour in order to accelerated the diffusion of oxygen through the material. The film has been analysed by X-ray diffraction whose diffractograms were refined by Rietveld’s Method. The results confirm that the NP are mostly Fe$_3$O$_4$ and α-Fe. The percentages obtained were: 58.31% of Fe$_3$O$_4$ and 41.69% of α-Fe (532 nm) and 85.18% of Fe$_3$O$_4$ and 14.82% of α-Fe (1064 nm). By the same X-ray diffractograms, we have calculated by Scherer’s Equation the medium diameter as being: 22.3 nm (532 nm) and 17.8 nm (1064 nm). Before the thermal treatment, the 1064 nm as deposited NP had a diameter of 29 nm, estimated by the Scanning Electron Microscopy.

Besides the X-ray diffraction, measurements of AC magnetization in different frequencies were carried out for the thermal treated NP deposited in 532 and 1064 nm. These results were compared (f = 100 Hz) to the ones of Fe$_3$O$_4$ NP synthesized by chemical route in which 100% of Fe$_3$O$_4$ was obtained. With the curves of the real part of magnetization (M') versus temperature (T) we got an estimation of the blocking temperature (T$_B$) of the NP as being: 257.6, 220.3 and 195.8 K for the ones obtained by chemical route, deposited in 532 nm and in 1064 nm, respectively. As T$_B$ is proportional to the medium diameter of the NP, we can see that the decreasing in the former is related to the decreasing in the later. The NP deposited in 1064 nm have a narrower M' X T curve than the others, this shows that the diameter distribution curve of these NP is also narrow.