ASSESSMENT OF THE SIGNAL LEVEL DURING DIGITAL DIAPHANOSCOPY OF THE MAXILLARY SINUSES BY THE MONTE-CARLO METHOD

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Introduction

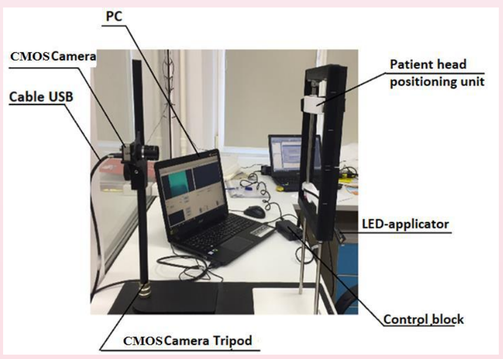
The pathologies of the paranasal sinuses occupy a leading place among all diseases in otolaryngology (**more than 50%**).
The diagnostic methods used today have disadvantages that the digital diaphanoscopy method haven't.

Advantages of digital diaphanoscopy: simplicity, quick analysis, safety (no radiation), portability, non-invasive, painlessness

The aim of research

- ✓ To evaluate the applicability of the digital diaphanoscopy method to investigate diseases of paranasal sinuses ;
- ✓ to identify factors that influence on the diagnostics result;
- ✓ to justify the medical and technical requirements for the instrument by a signal simulation.

Experimental method and equipment



a)

b)

Scheme of the experimental setup without (a) and with a protective case (b)

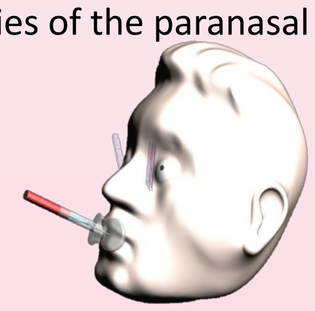
LED-applicator has wavelengths:
- ✓ 650 nm
- ✓ 850 nm

Camera: UI-3240CP Rev.2

Quantum efficiency:
- ✓ 75% (650 nm)
- ✓ 45% (850 nm)

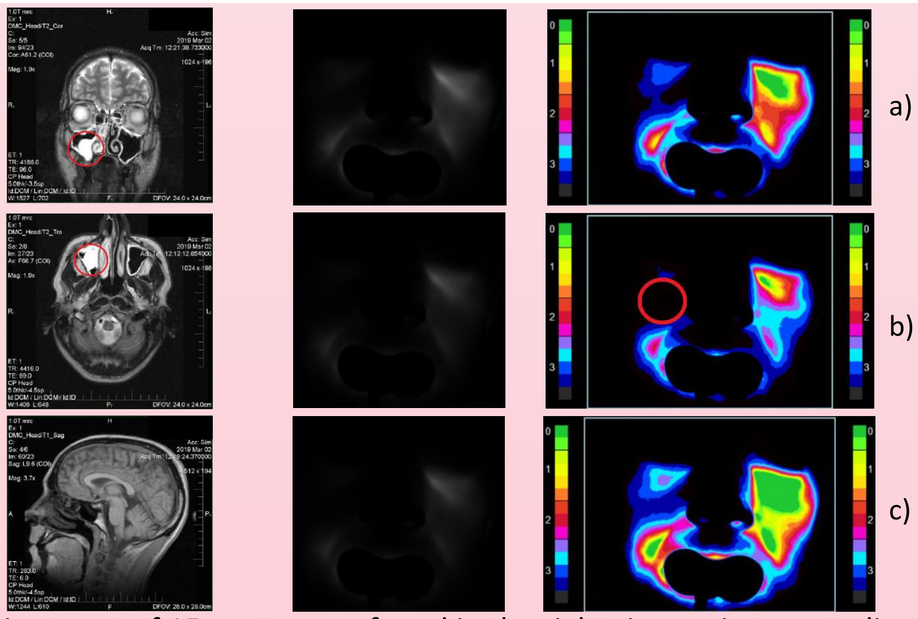
1T MRI Scanner of the Magnetom series (Siemens)

Diagnostics methods: digital diaphanoscopy and magnetic resonance imaging (MRI)
20 healthy volunteers
15 patients with pathologies of the paranasal sinuses



Results and Discussion

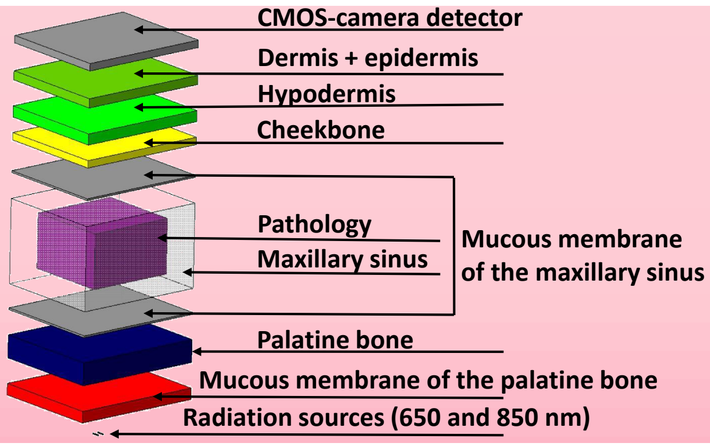
MRI study examples (left) and examples of registered and processed images (right) at exposure time 20.7 ms for 650 nm (a), 850 nm (b) and combination 650 and 860 nm (c) radiation sources



a)
b)
c)

- ✓ In 4 patients out of 15, cysts were found in the right sinuses in two studies.

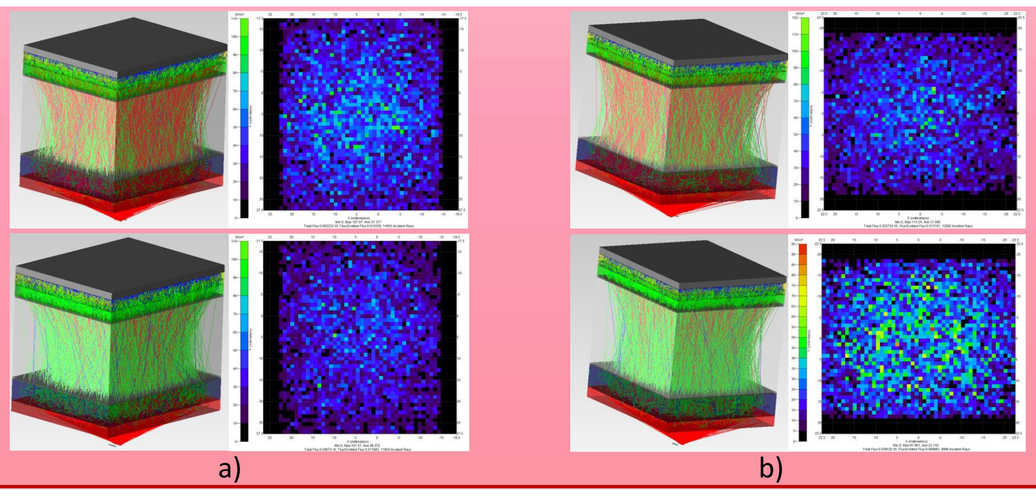
Head tissue layers for Monte Carlo model (TracePro software)



Radiation sources:
- ✓ 650 nm (4 mW) – 200 000 rays;
- ✓ 85 nm (4 mW) – 200 000 rays

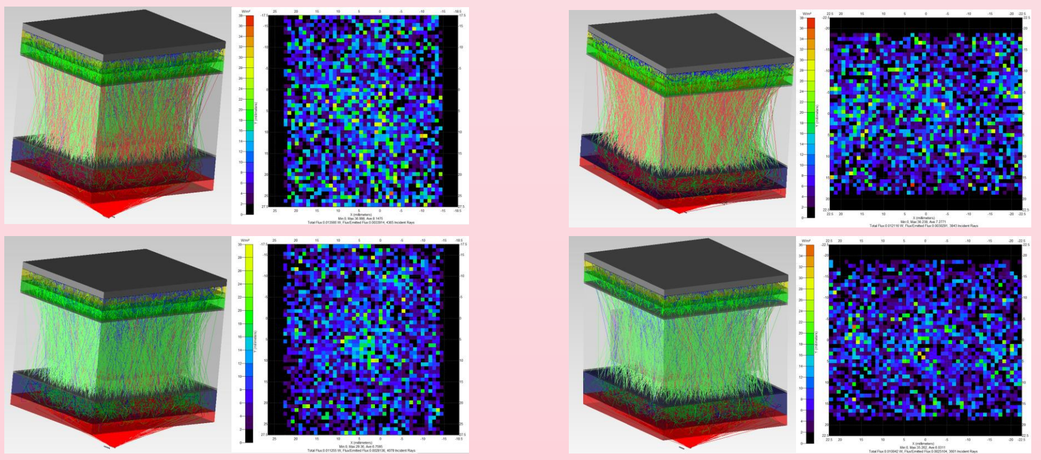
Parameters of the simulated environment:
- ✓ Layer thickness **L**
- ✓ Scattering coefficient μ_s
- ✓ Absorption coefficient μ_a
- ✓ Refractive index **n**
- ✓ Anisotropy **g**

The simulation results of probing signal passing through the maxillary sinus of a female (a) and male (b) WITHOUT PATHOLOGY for 650 nm (top) and 850 nm (bottom)



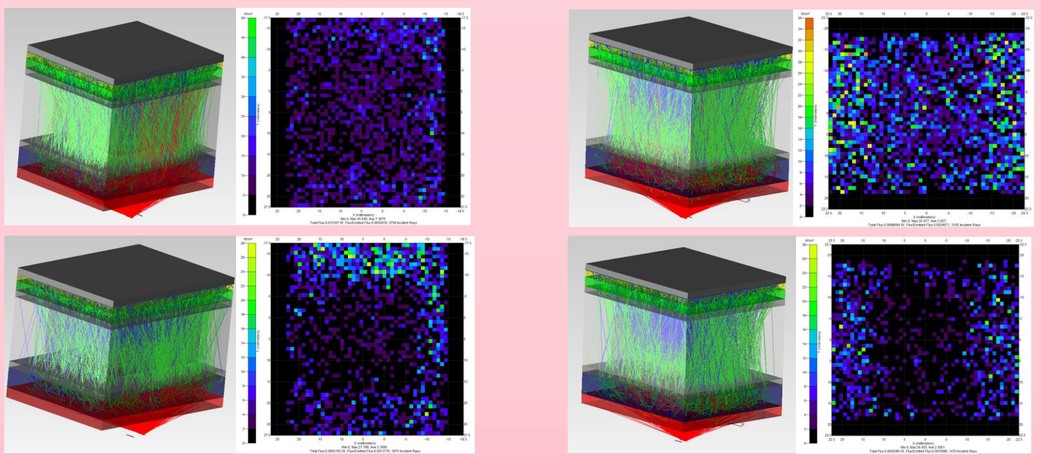
a)
b)

The simulation results of probing signal passing through the maxillary sinus of female (a) and male (b) with a CYST for 650 nm (top) and 850 nm (bottom)



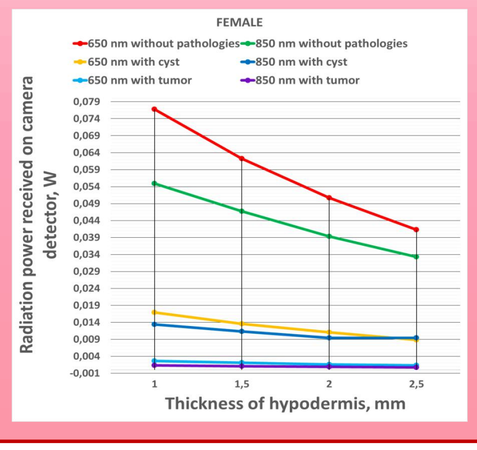
a)
b)

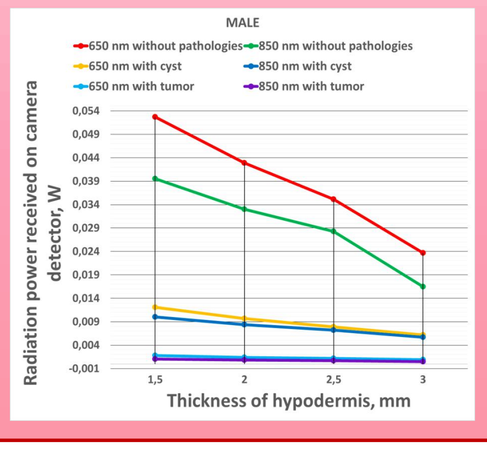
The simulation results of probing signal passing through the maxillary sinus of female (a) and male (b) with a TUMOR for 650 nm (top) and 850 nm (bottom)



a)
b)

The dependence of the power on the detector of camera for different wavelengths depending on the hypoderm thicknesses and the presence of pathologies in the sinuses





Conclusion

- ✓ The experimental results demonstrate that the digital diaphanoscopy has potential to separate normal and pathological conditions.
- ✓ The decrease in the radiation power has a more pronounced character at 850 nm wavelength both for female and male, but depends on anatomical and gender features.

Acknowledgments

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