



Applying of experiences from NATO SCI collaboration into the field of military professionals education

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Presentation structure

- Introduction of Departments of Weapon and Ammunition
- The reflection of SCI collaboration in educational process
- Conclusion





Department of Weapons and Ammunition

- Education Activities
- Scientific and Expert Activities





Education – providing by DoWA

- long-cycle Master's study: full-time, 5 years, Czech study language, for military students,
- bachelor's study: full-time, 3 years, Czech and English study language, for civilian students,
- master's study: full- and part-time, 2 years, Czech study language, for military and civilian students,
- doctoral study: full- and part-time, 3 years, Czech and English study language, for military and civilian students,
- special courses for the military, police and civilian technical personnel.





Education content

- ballistics, explosives, initiators,
- design and usage of ammunition,
- design and usage small arms,
- design and usage of artillery weapons,
- design and usage of military optical devices and fire control systems,
- theory and practice of logistic support of the army with stress on the armament.





Scientific and Expert Activities

- the design and assessment of the small arms,
- the interior, exterior and terminal ballistics of small arms and artillery ammunition,
- the design and assessment of ammunition,
- the design and assessment of military electronic and optical devices,
- the usage, maintenance and diagnosis of the weapon systems.

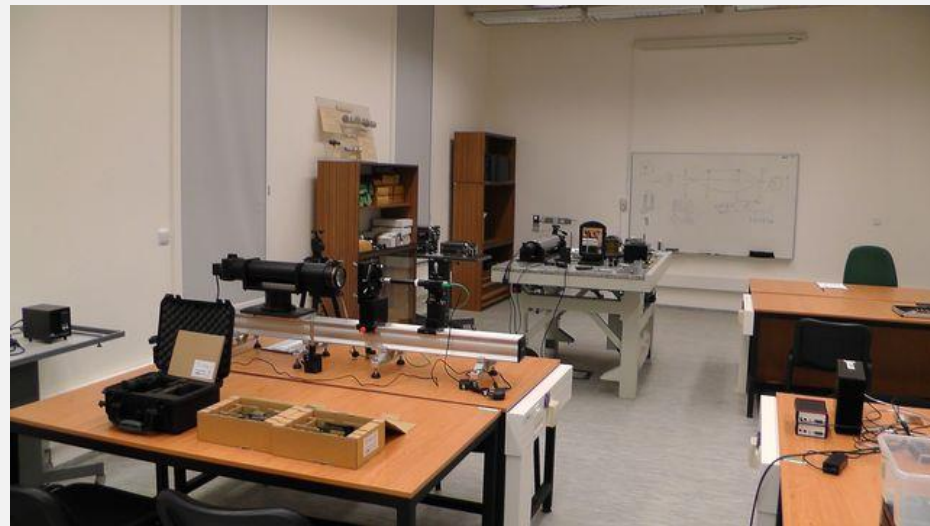
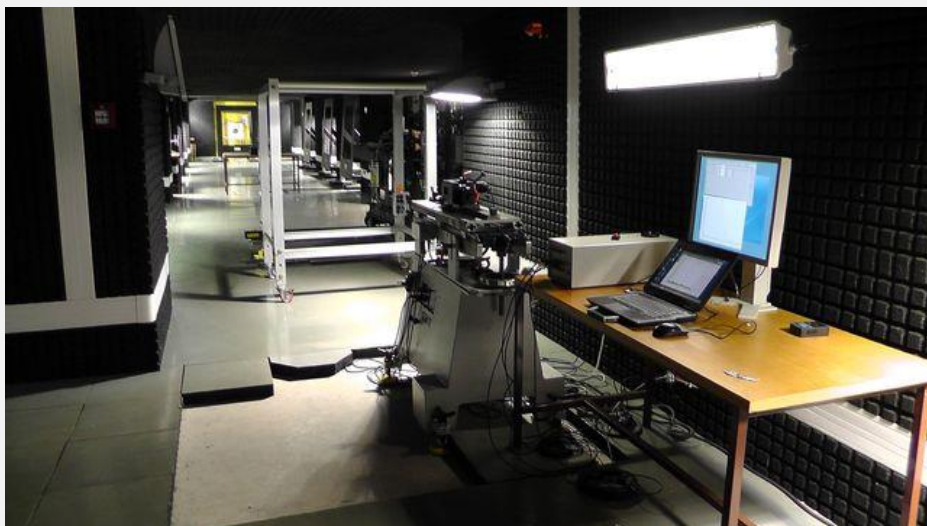




Education, Scientific and Expert Activities

Ballistic laboratory

Optical laboratory





Ballistic laboratory - purpose

- fundamental ballistic measurements on ballistic systems up to calibre 12.7 mm,
- special ballistic measurements,
- measurement of selected parameters of weapons.





Ballistic laboratory - equipment

- ballistic analyser Kistler 2519A,
- piezoelectric pressure transducers Kistler 6215,
- optical gates for measurement of projectile velocity Kistler 2521A,
- optical target system Kistler 2523A,
- ballistic Doppler radar Prototypa DRS-1,
- generator of quasi-static calibration pressure Kistler 6906,
- generator of dynamic verification pressure Kistler 6909,
- firing stand Prototypa STZA-12,
- universal breech Prototypa UZ-2002,
- high-speed camera IDT NX4,
- ballistic barrels,





Optical laboratory - purpose

- measurements of fundamental parameters of optical devices, both day-light and night vision systems,
- testing and assessment of laser devices.





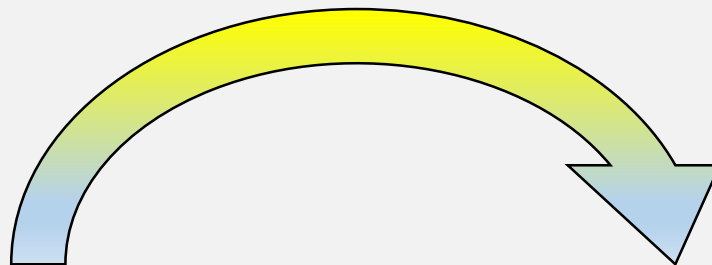
Optical laboratory - equipment

- system for measurement of optical transfer function Meopta,
- optical bench,
- holographic table,
- versatile collimator UKNP,
- system for check-up of night-vision devices NVG,
- spectrometers and spectrographs,
- models of absolutely dark bodies,
- thermo-camera FLIR,
- Hyperspectral camera Specim QE10V,
- high-speed camera Redlake HG100K,
- ...





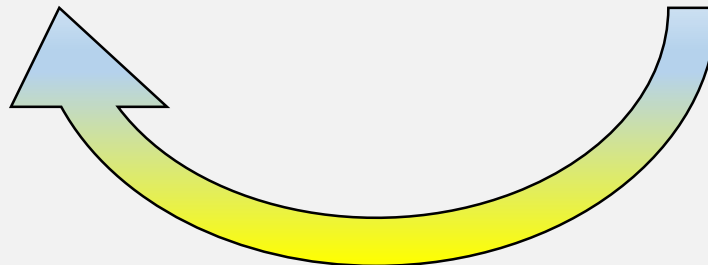
DEVELOPMENT IN SURVEILLANCE INSTRUMENTS



CAMOUFLAGE

SURVEILLANCE

DEVELOPMENT IN CAMOUFLAGE TECHNIQS





Mutual relationship between surveillance and camouflage defines significant requirements for:

- design of optical devices,
- design of methods of optical signal processing,
- design of camouflage means.

Fulfillment conditions

- to know the properties and characteristics of natural background,
- to be able to verify the physical properties of camouflage means,
- to verify the effectivity of camouflage means.





Most significant of SCI collaboration results

- Using of hyperspectral imaging for determination of properties and characteristics of natural background,
- Using of hyperspectral imaging for measurement of physical properties of camouflage surfaces,
- Camouflage effectivity testing.

Examples of publications

- Spectral Characterization of Natural Background in Virtue of Reconnaissance Possibilities,
- The possibilities of hyperspectral imaging for improving of validation of superficial quality of spectral features of camouflages surfaces.

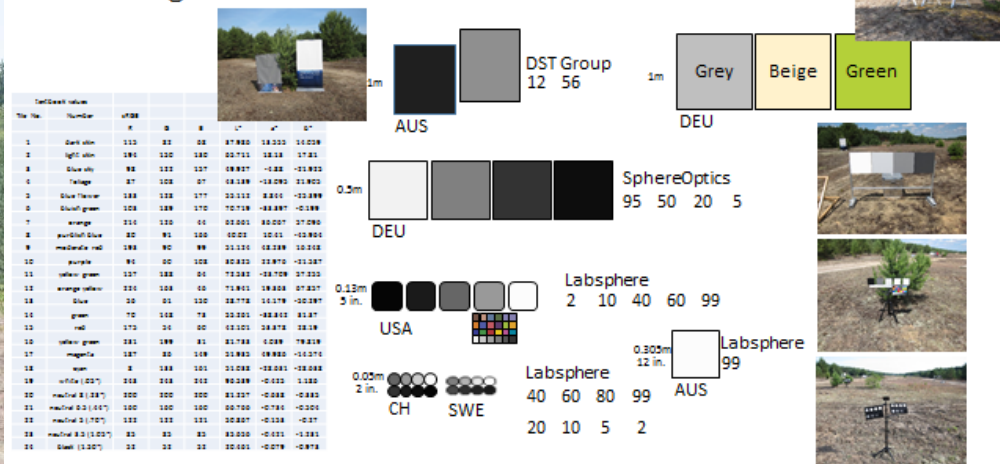




RACEK, František; BALÁŽ, Teodor. Spectral Characterization of Natural Background in Virtue of Reconnaissance Possibilities. In: International Conference on Military Technologies 2019 (ICMT'19). Brno: University of Defence, Brno, 2019.



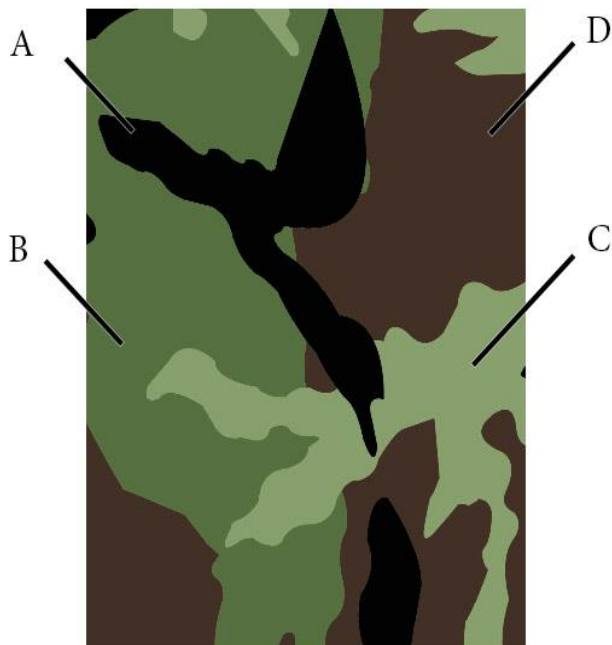
Calibration Array – 2017 06 21
Average Reflectance Values





RACEK, František; BALÁŽ, Teodor; KREJČÍ Jaroslav. The possibilities of hyperspectral imaging for improving of validation of superficial quality of spectral features of camouflages surfaces. FSS Conference, Prague, 2017.

CAMOUFLAGE SURFACE – quality validation



- measurement of spectral qualities of camouflage surfaces
- **Czech Defence Standard:**
 - lab. measurement
 - spot measurement

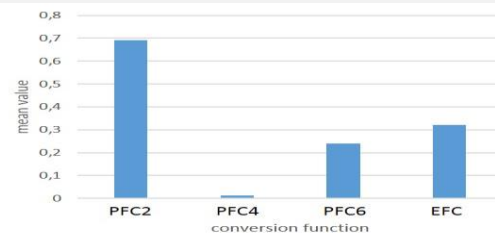
< 8%



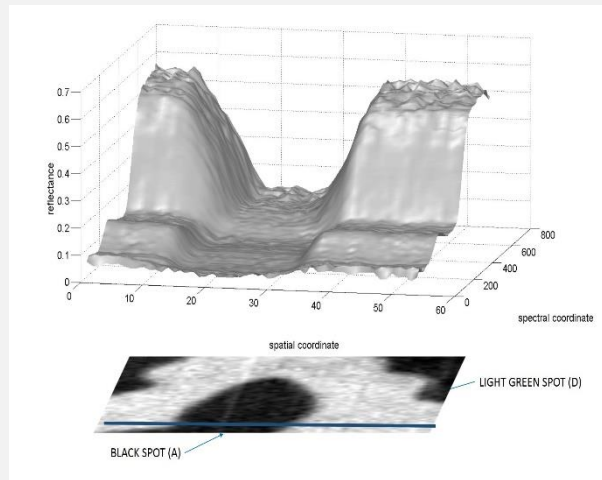
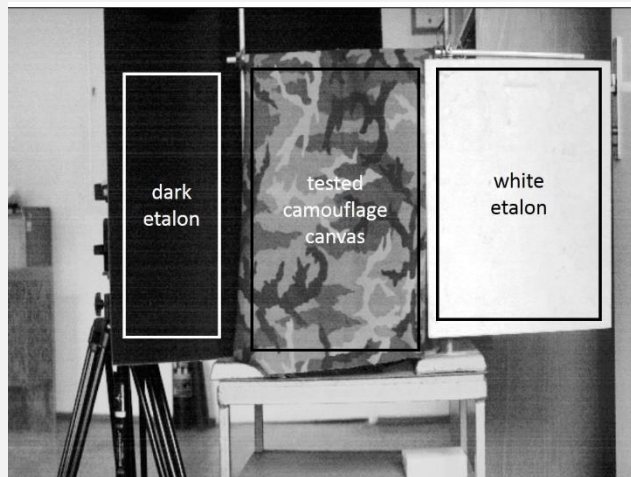
CAMOUFLAGE SURFACE – hyperspectral quality validation



$$S = \sum_{k=1}^K (r_e(k) - r_c(k))^2$$



	Spot A	Spot B	Spot C	Spot D	sum	mean
PFC2	0.306	0.1364	0.8305	1.496	2.7689	0.6922
PFC4	0.01817	0.01629	0.01354	0.005643	0.05364	0.01341
PFC6	0.02562	0.2641	0.1733	0.491	0.9540	0.2385
EFC	0.01834	0.2606	0.3128	0.6906	1.2823	0.3206



> 80%





Other examples of publications

Using of hyperspectral imaging for determination of properties and characteristics of natural background

- BÁRTA, Vojtěch; RACEK, František; KREJČÍ, Jaroslav. **NATO hyperspectral measurement of natural background**. In: *TARGET AND BACKGROUND SIGNATURES IV*. Bellingham, Washington USA: Society of Photo-Optical Instrumentation Engineers (SPIE), 2018, p. nestránkováno. ISSN 0277-786X. ISBN 978-1-5106-2172-5.
- BÁRTA, Vojtěch; RACEK, František. **Hyperspectral discrimination of camouflaged target**. In: *Target and Background Signatures III*. BELLINGHAM, WA 98227-0010 USA: SPIE-INT SOC OPTICAL ENGINEERING, 2017, p. "1043207-1"- "1043207-9". ISSN 0277-786X. ISBN 978-1-5106-1328-7.
- BÁRTA, Vojtěch; HANUŠ, Jan. **Collecting information for spectral boundaries determination**. In: *Target and Background Signatures IV*. Bellingham, Washington USA: SPIE-INT SOC OPTICAL ENGINEERING, 2018, p. nestránkováno. ISSN 0277-786X. ISBN 978-1-5106-2172-5.
- RACEK, František; BALÁŽ, Teodor; MELŠA, Pavel. **Ability of Utilization of PCA in Hyperspectral Anomaly Detection**. In: *International Conference on Military Technologies 2015 (ICMT'15)*. Brno: University of Defence, Brno, 2015, p. 19-22. ISBN 978-80-7231-976-3.
- RACEK, František; BÁRTA, Vojtěch. **Spectrally Based Method of Target Detection in Acquisition System of General Fire Control System**. In: *Conference Proceedings of ICMT'17*. Piscataway, NJ 08854-4141 USA: Institute of Electrical and Electronics Engineers Inc., 2017, p. 22-26. ISBN 978-1-5386-1988-9.
- RACEK, František; BALÁŽ, Teodor; MELŠA, Pavel. **Hyperspectral Data Conversion in the Case of Military Surveillance**. *Advances in Military Technology*, 2015, vol. 10, no. 1, p. 5-13. ISSN 1802-2308.
- RACEK, František; BALÁŽ, Teodor. **Spectral Angle Mapper as a Tool for Matching the Spectra in Hyperspectral Processing**. *Advances in Military Technology*, 2012, vol. 7, no. 2/2012, p. 65-76. ISSN 1802-2308.





Other examples of publications

Using of hyperspectral imaging for measurement of physical properties of camouflage surfaces

- RACEK, František; BALÁŽ, Teodor; JOBÁNEK, Adam. **Utilization of hyperspectral camera for determination of camouflage surfaces spectral characteristics homogeneity.** In: *SPIE Security + Defence*. Toulouse, France: SPIE Press, 2015, p. "96530K-1"- "96530K-13". ISSN 0277-786X. ISBN 9781628418637.
- RACEK, František; BALÁŽ, Teodor; KREJČÍ, Jaroslav; JOBÁNEK, Adam. **Selected issues connected with determination of requirements of spectral properties of camouflage patterns.** In: *Target and Background Signatures III*. BELLINGHAM, WA 98227-0010 USA: SPIE-INT SOC OPTICAL ENGINEERING, 2017, p. "1043205-1"- "1043205-12". ISSN 0277-786X. ISBN 978-1-5106-1328-7.
- RACEK, František; JOBÁNEK, Adam; BALÁŽ, Teodor; KREJČÍ, Jaroslav. **Pixelated Camouflage Patterns from the Perspective of Hyperspectral Imaging.** In: *Target and Background Signatures II*. Edinburgh: SPIE, 2016, p. nestránkováno. ISSN 0277-786X. ISBN 978-151060398-1.





Other examples of publications

Camouflage effectivity testing

- RACEK, František; BALÁŽ, Teodor; KREJČÍ, Jaroslav; JOBÁNEK, Adam. **Evaluation of validity of observer test for testing of camouflage patterns.** In: *Target and Background Signatures IV*. Bellingham, Washington, USA: Society of Photo-Optical Instrumentation Engineers (SPIE), 2018, p. nestránkováno. ISSN 0277-786X. ISBN 978-1-5106-2172-5.
- RACEK, František; KREJČÍ, Jaroslav. **Target Acquisition Performance as a Criterion of Camouflage Pattern Effectiveness.** In: *Conference Proceedings of ICMT'19*. Piscataway, NJ 08854-4141 USA: Institute of Electrical and Electronics Engineers Inc., 2019.





Result

- The experience and knowledge gained in collaboration with SCI are reflected in the preparation of students,
- The primary impact is on the teaching in subjects of Optical Devices of Weapons and Fire Control Systems,
- Most significantly, the SCI collaboration is reflected in independent scientific and creative work of DoWA and thus in the topics of students' final theses,
- The assumption of using knowledge in acquisition processes AČR.



