



1st ENV-54 MetroDecom Workshop, Třebíč

Workshop for stakeholders

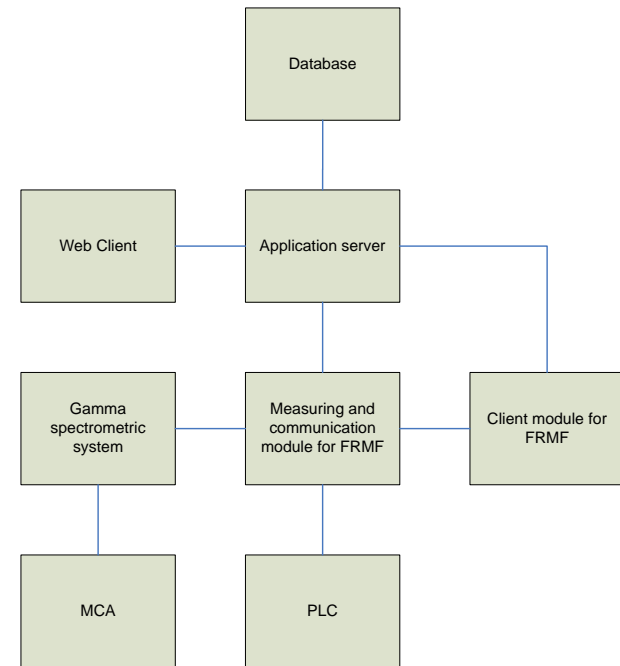
Name Lukáš SKÁLA, Tomáš GRÍSA

Date 25. 11. 2015



FRMF – software components

- **Measurement and analysis module** – measurement, communication with HW (MCA, PLC etc.), spectra acquisition and analysis
- **Operator module with GUI** – control and visualization, interface for users
- **Database** – data storage
- **Application server** – interface for other parts of system and external systems, web based application

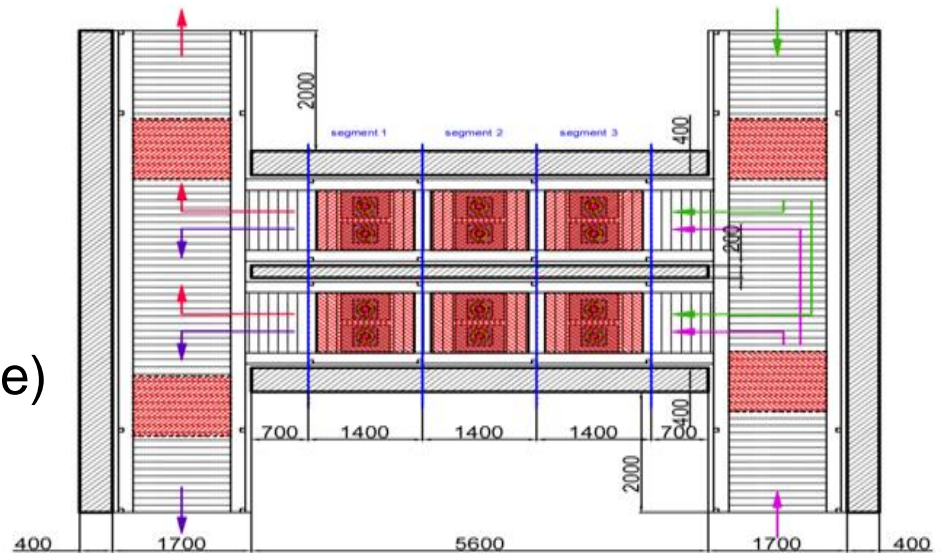


FRMF – software components

- **Software for HW control is versatile**
- Geometry with more „measuring tunnels“

- **Throughput**

- Each box – approx. 400l
- One box – 10 min
(measuring time + handling time)
- approx. 2400 l/h (one box)
- approx. 4800 l/h
(low density material – two boxes)



FRMF – operator module

The screenshot displays the FRMF Client software interface. At the top, there is a menu bar with options: Login, Logout, Refresh, Start, Stop, Return, Init, Print label, Close, Layout, and Zeroing balances. Below the menu bar, there are tabs for Measurement, Current spectra, Log, and About.

The main interface is divided into several sections:

- Measurement type:** Includes buttons for Material meas., Bkg meas., Stab. check, and Bkg check.
- Parameters of measurement:** Contains input fields for Material, Geometry (Position 1-3), Meas. time [s] (120), Mass [kg] (0), Description, Object, Box type, Filling [%], Batch (100), and checkboxes for Move box in, Return container, Close the door, Neutrons, and Print label.
- Status:** Displays current measured position, curr. time of position meas. [s], Mass [kg], Filling [%], Density [g/cm³], Measurement type, Bar code, Object, Material, and Temp. [°C].
- Finished measurement:** Shows Measurement details (Measurement type, Bar code, Object, Meas. date, Meas. number, Material, Filling [%], Meas. time [s], Mass [kg], Density [g/cm³]) and Result of measurement.
- Homogeneity:** Features a 3D schematic of three measurement positions (labeled 1, 2, 3) and a table with columns: Difference, Position I, Position J, Detector I, Detector J, and K.
- Object measurement protocol:** A large empty area for protocol details.
- Measurement progress:** Includes tabs for Detectors status HPGE and Detectors status Neutron, and a 3D schematic of the measurement setup.
- Table:** A table with columns: Type, Nuclide, Activity [Bq/g], MDA [Bq/q], Activity [Bq], MDA [Bq], and Unce.

At the bottom, the status bar shows: Server: 127.0.0.1:10000, Connected: YES, Logged in: N/A.

Algorithms

I. Input parameters (entered by user)

- Measurement geometry (1, 2 or 3 positions)
- Measurement time
- Material type (steel, aluminum, plastic ...)
- Box type
- Filling of box in percent (level)
- Note, description or batch ID

II. Weighing

- Reading gross weight on input conveyor
- Calculating net weight and density of material

Algorithms

Measurement type: Material meas.

Material meas.

Bkg meas.

Stab. check

Bkg check

Parameters of measurement

Material:	<input type="text" value="Steel"/>	Object:	<input type="text"/>	<input style="border: none;" type="button" value="..."/>
Geometry:	<input type="text" value="Position 1-3"/>	Box type:	<input type="text" value="box-normální"/>	
Meas. time [s]:	<input type="text" value="120"/>	Filling [%]:	<input type="text"/>	<input style="border: none;" type="button" value="..."/>
<input type="checkbox"/> Mass [kg]:	<input type="text" value="0"/>	Batch:	<input type="text" value="100"/>	
Description:	<input type="text"/>			<input type="checkbox"/> Neutrons
<input checked="" type="checkbox"/> Move box in	<input type="checkbox"/> Return container	<input checked="" type="checkbox"/> Close the door		<input type="checkbox"/> Print label

Status: Spectrum acquisition

Current measured position: **2**

Curr. time of position meas. [s]: **1.0**



Mass [kg]: **340.0**

Filling [%]: **100**

Density [g/cm³]: **1.10**

Measurement type: **Material meas.**

Bar code: **N/A**

Object: **926**

Material: **Steel**

Temp. [°C]: **0.0**

Algorithms

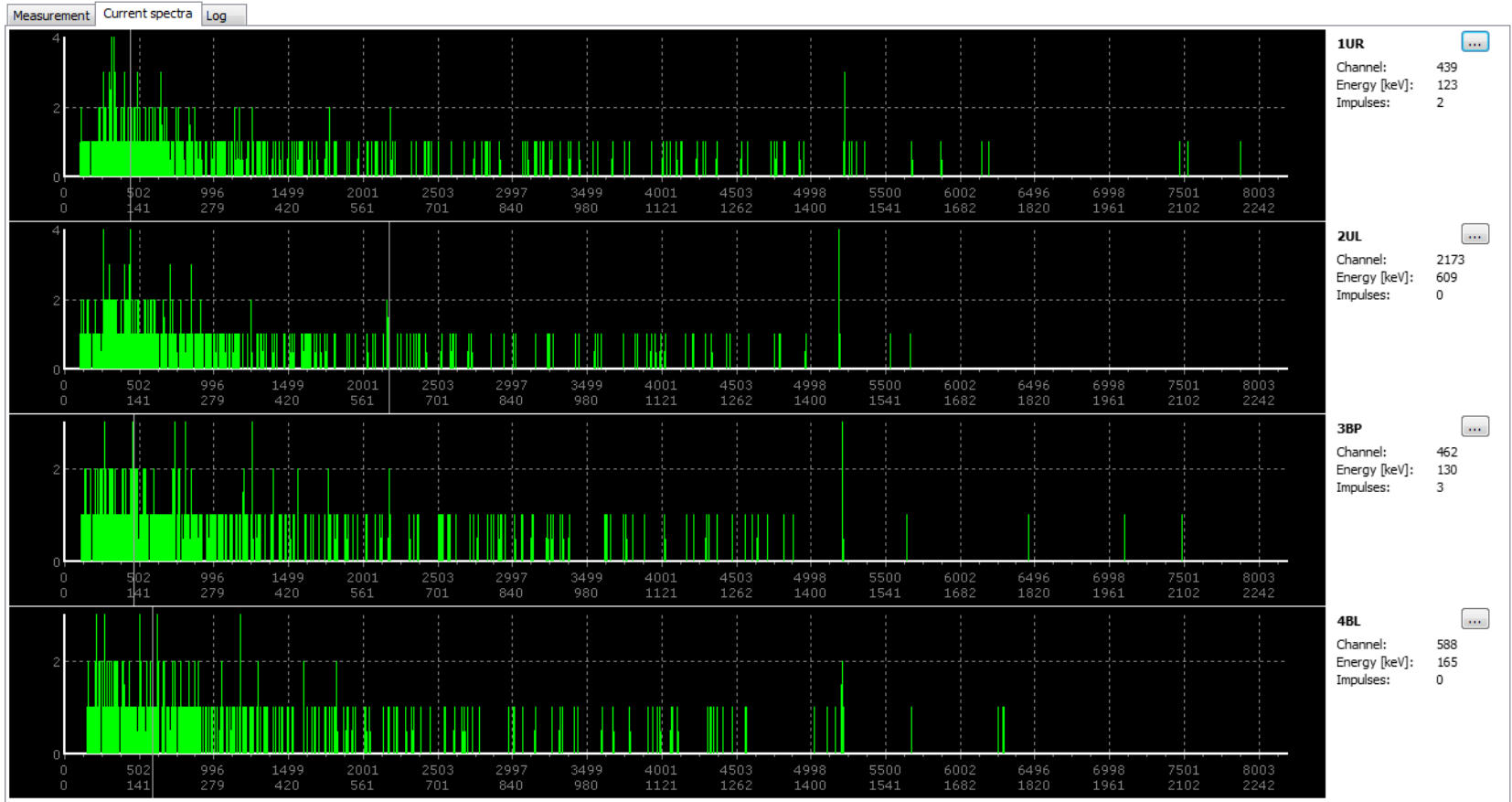
III. Spectra acquisition

- HV check
- Detector temperature check
- 4 detectors x 3 positions = 12 spectra files
- All spectra are saved

IV. Searching for hot-spots

- Each spc. divided to regions and CPS_{corr} values are calculated
- CPS values for same regions are compared
- Hot-spot identified when difference > limit

Algorithms



Algorithms

V. Sum spectrum

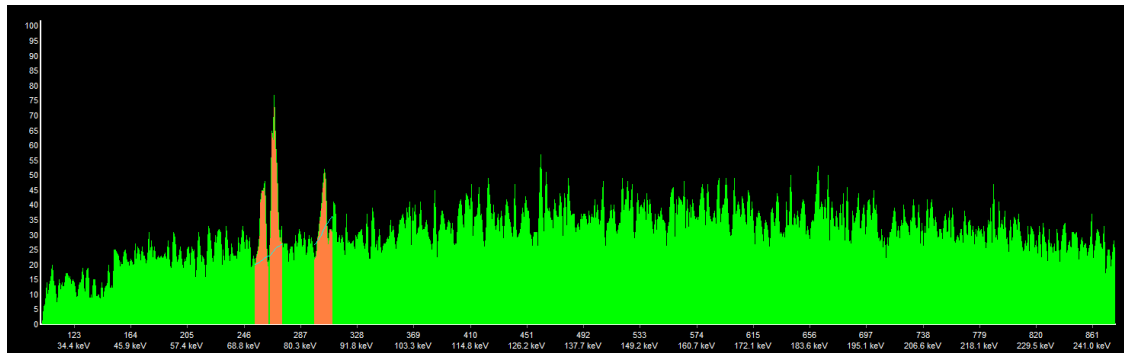
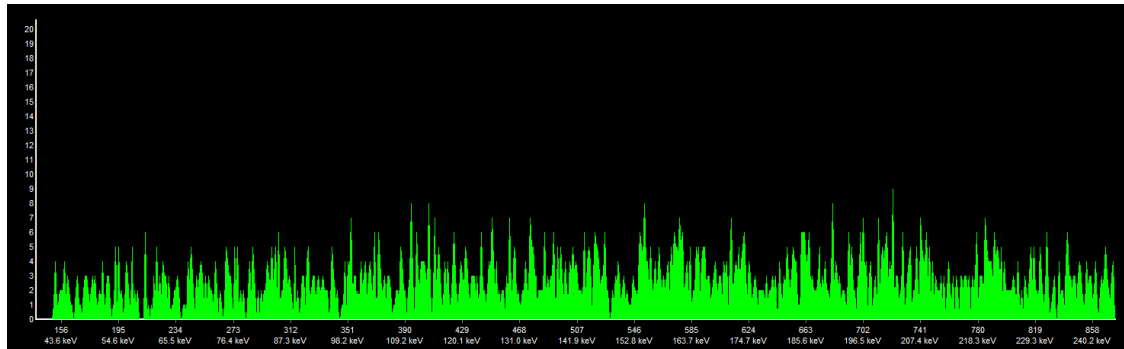
- Done only for homogeneous material (for lower MDA)
- If hot-spots found all spectra are analyzed individually

VI. Efficiency calibration (sum or individual spectrum)

- Eff. file used for actual material, density, filling, container type and geometry (1-3 positions)

Algorithms

Single spectrum



Sum spectrum of 12 individual spectra

Algorithms

VII. Analysis of spectrum

- Limited nuclide library, based on ROI analysis (expected nuclides)
- Wide nuclide library, based on peak search
- Activity/MDA calculated
- Raw reports generated
- Results are combined together (greater value selected)

VIII. Scale factors

- Read from customer DB
- Hard-to measure nuclides are calculated and added to results

Algorithms

IX. Release coefficient calculation

- Comparison with limits

X. Reporting and displaying results to user

XI. Saving to DB

- All data and files are saved to DB using WS (Web Services)

Algorithms

Finished measurement



Measurement

Measurement type: **Material meas.** Meas. number: **889** Mass [kg]: **340.0**
Bar code: Material: **Steel** Density [g/cm3]: **1.1**
Object: **926** Filling [%]: **100**
Meas. date: **24.11.2015 09:42** Meas. time [s]: **30**

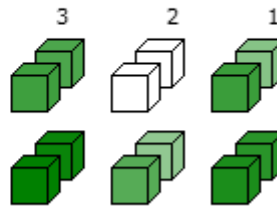
Result of measurement

Material is acceptable for free release, Kw = 0,220

Homogeneity

Homogenous distribution:

YES



Difference ---
Position I ---
Position J ---
Detector I ---
Detector J ---
K ---

Material measurement protocol


FRMF

Print: 2014-10-24 14:26

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Material measurement protocol

Declared values		
Batch No.: 1109/2013	Package type: box	Material type: Steel
Measurement device: FRMF	Measured by: Jindra Votava	
Note:		

Measurement		
Meas. number:  *541*	Date and time: 2014-01-29 16:33	Measurement time: 540 s
Material weight: 190,5 kg	Homogenous distribution: YES	Filling: 60 %

Weight activity								
Nuclide	Type*	Average weight activity		MDA [Bq]	Nuclide activity		Limit [Bq/kg]	Kw
		[Bq/kg]	Uncertainty [%]		[Bq]	Uncertainty [%]		
Ni-63	C	4,037E-03	8,1					
Ni-59	C	5,981E-01	8,1					
Sr-90	C	5,981E-04	8,1				3000,0	< 0,001
MN-54	M			2,118E+02		1,5	300,0	0,004
CO-57	M			4,355E+02		1,5	3000,0	0,001
CO-58	M			1,743E+02		1,5	300,0	0,003
CO-60	M	3,125E+00	8,7		5,954E+02	8,7	300,0	0,011
ZN-65	M			3,573E+02		1,5	300,0	0,006
AG-108m	M			1,983E+02		2,8	300,0	0,004
SB-125	M			6,620E+02		1,5	3000,0	0,001
BA-133	M			3,640E+02		1,5	3000,0	0,001
CS-137	M	6,878E+00	8,1		1,310E+03	8,1	300,0	0,025
EU-152	M			6,999E+02		1,5	300,0	0,012
AM-241	M			4,545E+03		1,5	300,0	0,081
Σ		1,061E+01		7,648E+03	1,906E+03			0,149

Kw= 0,149

* M - measured values, C - calculated values

Segregation array

- **5l plastic scintillation detectors, type NuDET SPD.1000.100.50**
- **Signal from each detector is processed by Single Channel Analyzer**
 - Four independent so-called ranges of interest (ROIs).
 - ROIs are determined by LLD (lower level discriminator) and ULD (upper level discriminator).
 - ROI represents a specific energy range.
 - From each detector, counts per second (CPS) are obtained for each ROI (total CPS for appropriate energy range).
 - Evaluation procedure is then based on various operations with these ROIs.

Segregation array

- Each ROI can be evaluated independently (better signal-noise ratio for certain nuclides).
- Impulses from ROIs and detectors can be also summed (to increase minimum detectable activity).
- Measured values are compared to limit values calculated based on the background radiation and its statistical properties.
- Background is automatically updated when no box is present in the measurement chamber.
- Level of background counts is also tested for defined threshold.
- Furthermore, various energy windowing algorithms can be used
 - Calculation of ratios between ROIs.

Web based application

The screenshot displays the RAOS web-based application interface. The main window is titled "RAOS" and contains several panels:

- Left Panel:** A sidebar with the RAOS logo and search filters for "Registration date from:" and "Measurement date from:". Below this is a table of "Objects" with columns for Code and Creation date.
- Main Table:** A large table with columns for Code, Creation date, and other data. The table is paginated, showing "Page 1 of 3" and "View 1 - 100 of 252".
- Files to download:** A list of files for download, including "SPECTRUM box_id300_pos1_det1.gpsc" through "REPORT box_id300.rpt".
- Spectrum viewer:** A graph showing a spectrum plot with a y-axis from 0 to 90 and an x-axis from 0 to 9500. The plot shows a noisy baseline with several distinct peaks, notably around 4000 and 4500.
- Right Panel:** A panel with a "Limit name" field, a "Homogeneous" button, and a table of "Kw" values. The table shows values like 2.472, 0.3175, 2.0621, etc. It is paginated "View 1 - 10 of 10".
- Bottom Panel:** A table with columns for ID, Name, Unit, and other data. It is paginated "Page 1 of 1" and "View 1 - 14 of 14".

The interface includes navigation buttons, a search bar, and a user login/logout option at the bottom right.