Large scale dosimetry based on EPR spectroscopy:
Evaluation of Q-band
EPR on tooth enamel mini-biopsies

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- Post-accident management of population

- Radiation epidemiology

- Emergency situation

	Capacity	Low dose assessment	Speed processing
Post-accident	+++	++	-
Epidemiology	+++	+++	-
Emergency	+ to ++++	+	+++

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Approximate duration (in days) between the time point of sample arrival to the laboratory and the completion of dose estimation for the purpose of triage.

Biodosimetric tool	Total time in days to analyse samples (excluding time of shipment)					
	1 sample 1 lab	50 samples 1 lab	100 samples 1 lab	100 samples 5 labs	1000 samples 1 lab	1000 samples 5 labs
Dic manual	2.5	6	9	5	65	16
Dic automated	2.5	3	4	3	19	6
MN automated	3.5	4	5	4	20	6
Gamma_H2AX	< 1	1	1	1	3	3

Overall capacity of MB partners in Dic and MN: 1100 samples per week

From Mutibiodose final report (www.multibiodose.eu)

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What about other proposed methods?

• Electronic components by TL/OSL (1000 samples in 2 weeks with 5 labs)[1]

• *EPR on touch screen of smartphone*

[1]From Mutibiodose final report (www.multibiodose.eu)

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What about EPR on tooth enamel?

- Sensitive material, high signal stability, signal specific to radiation, low variability, linear response

- Q-band EPR needs only 2-5 mg, easy and fast sampling with minimum detriment[1]

- Since 2011, ten expertises have already been performed using Q-band spectroscopy

[1]Romanyukha et al., 2007

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- With 2-5 mg samples, DL is 200-400 mGy

- Need for repetitive measurements to achieve sufficient accuracy (at least ten spectrum acquisitions): SD 1% at 10 Gy, 10% at 1 Gy and 50% at 0.2 Gy

Equation	y = a + b		
Adj. R-Squar	0,99215		
		Value	Standard Er
Signal intens	Intercept	-0,0021	0,00132
Signal intens	Slope	0,0121	5,4156E-4

- No sample preparation and no signal deconvolution required

- The time needed to record 1 spectrum is about 6 min (10 samples per day)
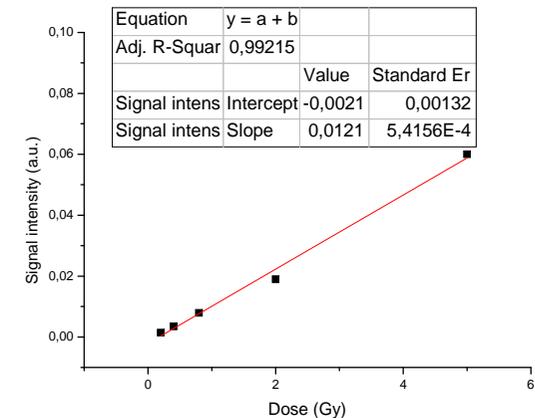
What would be the performance in triage mode (for example 1 measurement per sample)?

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Experimental evaluation of Q-band EPR in triage mode

Method:

Large size exercise simulating real conditions of triage (large number of sample to be measured in short delay)

Aims:

- To evaluate ability to identify the samples irradiated at high dose (> 2 Gy) with high level of confidence
- To evaluate ability to segregate samples irradiated from non irradiated (yes/no)
- To evaluate the rate of false negative and false positive according to dose threshold and the number of repetitive measurements needed to minimize false negative
- To determine the real capacity of samples measurements

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Experimental set-up of the exercise

- 60 samples of about 5 mg from 6 donors

- Random selection of samples for measurements

- Each selected sample measured 3 times with parameters selected to reduce analysis time (number of cumulative scans)

- Measurements were performed continuously during 7 hours

- Irradiation of samples to ^{60}Co at dose range of 0.2 - 3 Gy

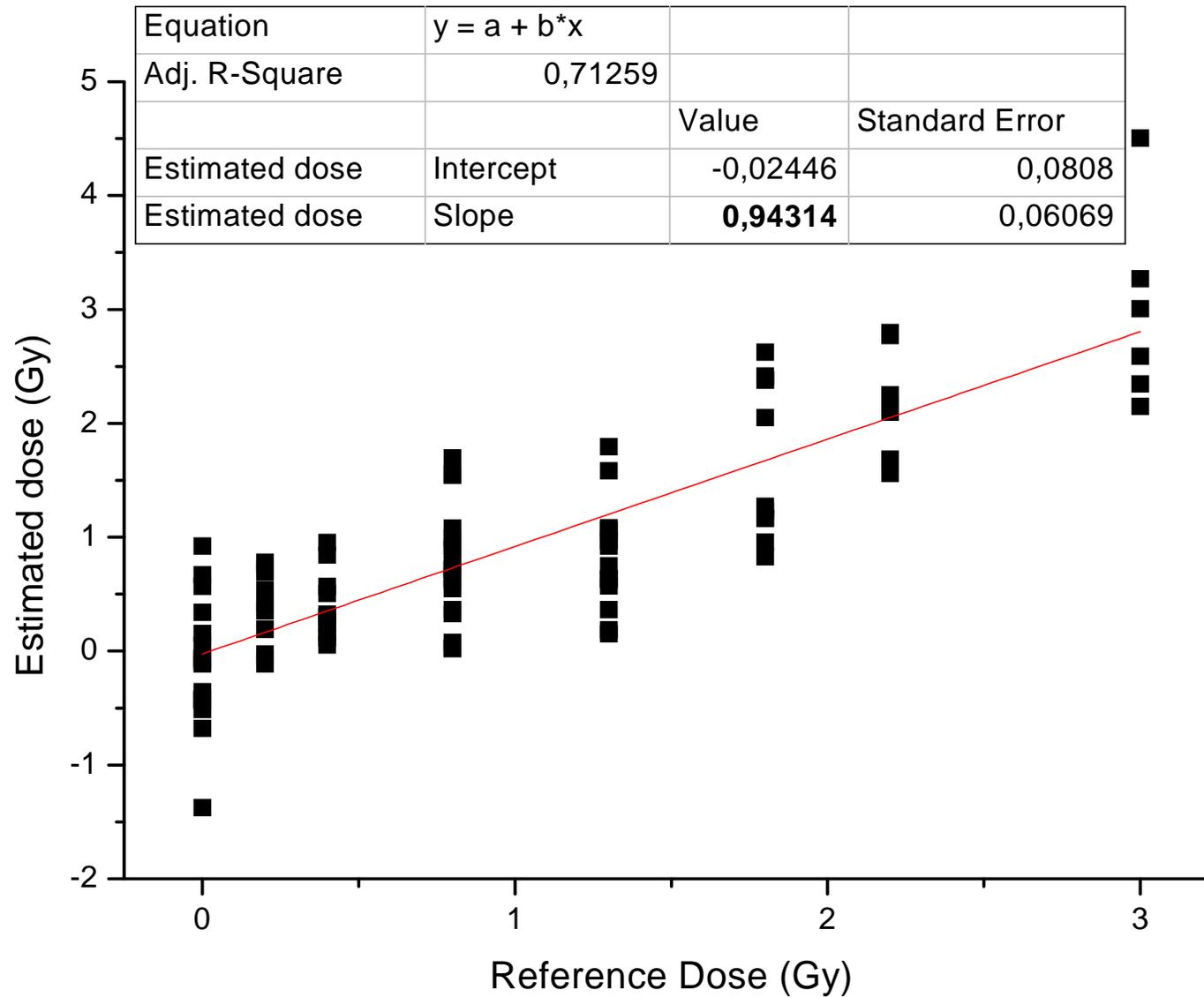| Dose (Gy)	0	0.2	0.4	0.8	1.3	1.8	2.2	3
% of samples	10	10	10	20	20	10	10	10

- **102 dose estimations were performed in 7 hours**

- **Optimization of recording parameters during the exercise (analysis time reduced by a factor of 2)**

- **After optimization 3-4 min per sample in average**
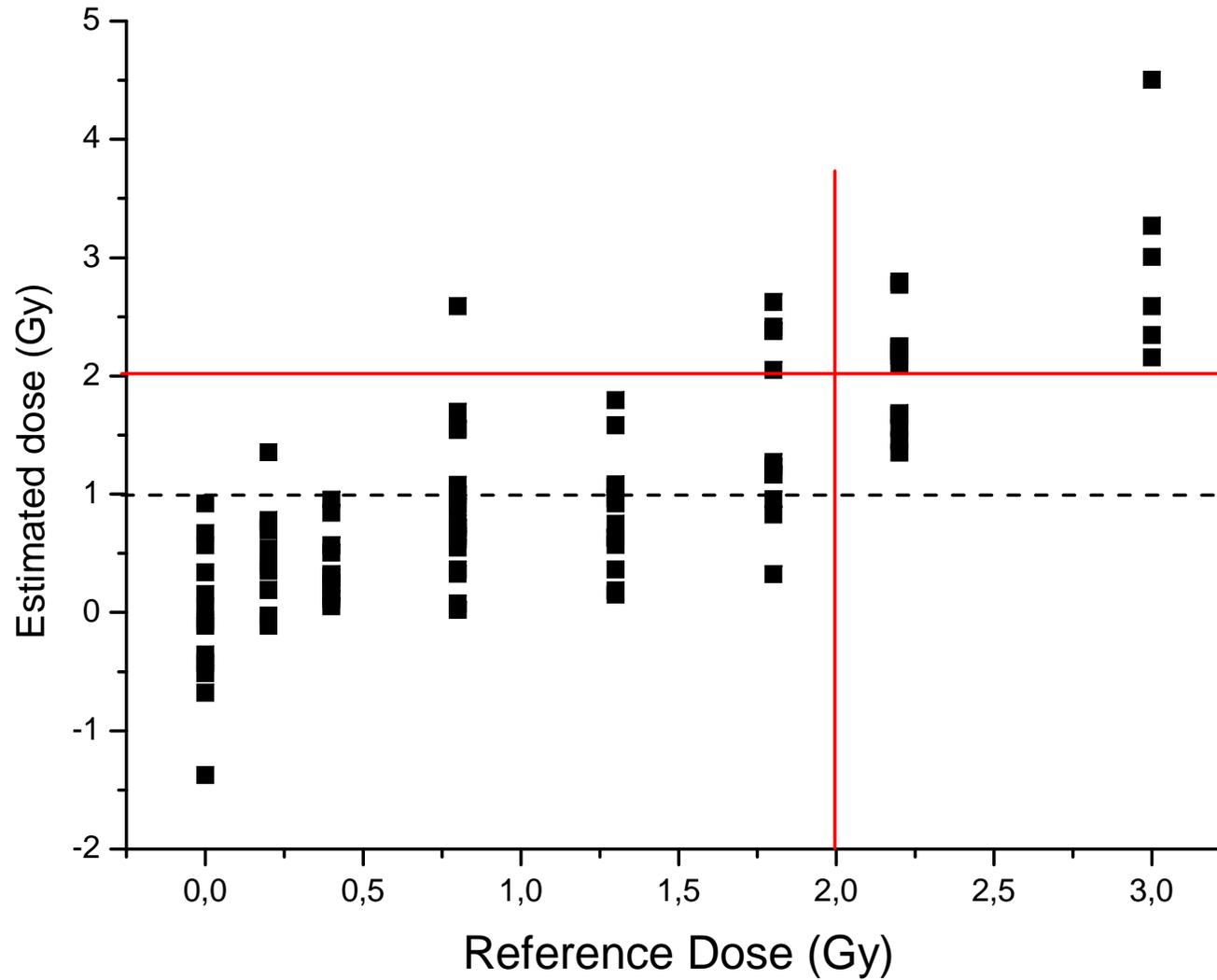
Capacity between 15-20 measurements per hour

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Equation	y = a + b*x		
Adj. R-Square	0,71259		
		Value	Standard Error
Estimated dose	Intercept	-0,02446	0,0808
Estimated dose	Slope	**0,94314**	0,06069

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Dose threshold	0.5 Gy		1 Gy		2 Gy	
Number of samples with dose above threshold	72		52		18	
number of meas.	1	3	1	3	1	3
False negative rate	6%	1%	8%	2%	4%	1%
False positive rate	11%	3%	5%	3%	6%	1%

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Conclusions

- **Q-band EPR on enamel biopsy presents some interesting characteristics for large scale dose evaluation**

- **With 1 spectrometer and 1 operator, the capacity of measurement is equivalent to network capacity**

- **However, very few EPR dosimetry labs have such equipment**

- **Large scale exercises are extremely useful**

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THANKS FOR YOUR ATTENTION