^{175}Lu in PET DETECTORS - IMPACT ON MEDICAL IMAGE AND LEGAL REMEDIATION ISSUES

Vera Artiko[1,2],, Jelena Petrovic[1,2], VojislavAntic[1]
[1]University Clinical Center of Serbia, Belgrade, Serbia
[2]Faculty of Medicine, Belgrade, Serbia

Introduction

- The current PET devices contain scintillation crystals based on lutetium – LSO or LYSO
- Lutetium is found in the monazite sand ores [(Ce, La, etc.)PO_4] or in carbonate-fluoride minerals [(Ce, La, etc.)$(CO_3)F$]
- Naturally occuring lutetium is composed of one stable isotope ^{175}Lu and one long-lived radioisotope ^{176}Lu (abundance 2,6%; $T_{1/2}=(3{,}56\pm0.07)\times10^{10}$ years, with *β- decay* (E_{max}=596 keV), followed by three simultaneous γ-ray emissions (energies: 88, 202 and 307 keV)).
- Taking into account long half-life, lutetium natural radioactivity could be considered as constant: 52,61±0.36 Bq/g

Figure 1. Lutetium was discovered with ytterbium in 1907., at the same time by Georges Urbain, Baron Carl Auer von Welsbach and Charles James.

Objective

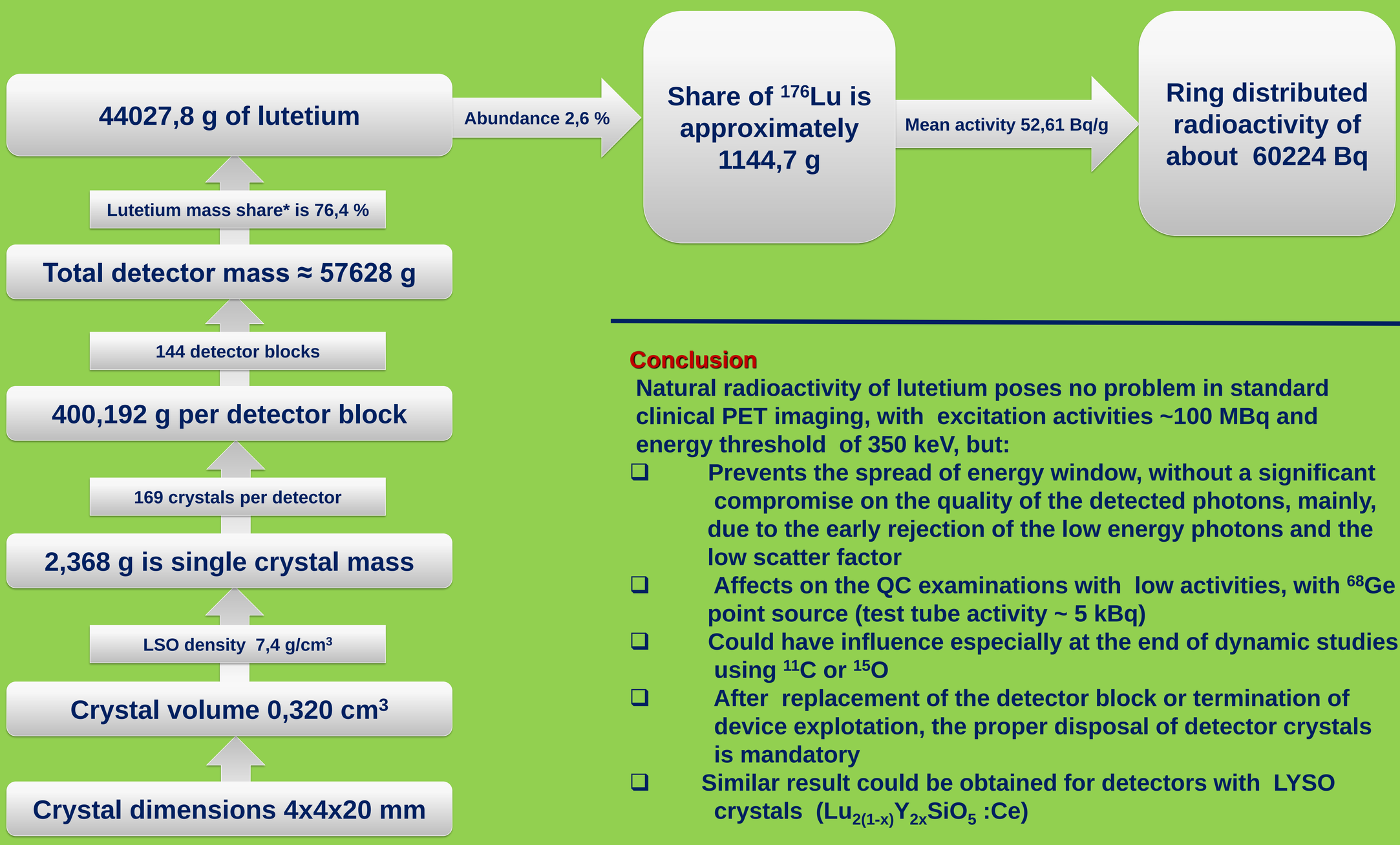
The objective of this work was to estimate the amount of radioactive lutetium in PET-CT device from University Clinical Centre of Serbia (with LSO detectors), with relevant discusion about:

- potential impact of ^{176}Lu natural radioactivity on the diagnostic information;
- Importance of remediation, to protect enviroment

Methods

Based on the dimensions of the LSO (Lu_2SiO_5:Ce) crystals, LSO density, mass share and the total number of crystals, it was estimated the contribution of radioisotope ^{176}Lu in the overall mass, and the associated radioactivity.

Results



* -The impact of cerium in the mass share is neglected (below 0,1%)

Conclusion

Natural radioactivity of lutetium poses no problem in standard clinical PET imaging, with excitation activities ~100 MBq and energy threshold of 350 keV, but:

- Prevents the spread of energy window, without a significant compromise on the quality of the detected photons, mainly, due to the early rejection of the low energy photons and the low scatter factor
- Affects on the QC examinations with low activities, with ^{68}Ge point source (test tube activity ~ 5 kBq)
- Could have influence especially at the end of dynamic studies using ^{11}C or ^{15}O
- After replacement of the detector block or termination of device explotation, the proper disposal of detector crystals is mandatory
- Similar result could be obtained for detectors with LYSO crystals ($Lu_{2(1-x)}Y_{2x}SiO_5$:Ce)

International Conference on the Safety of Radioactive Waste Management, Decommissioning, Environmental Protection and Remediation: Ensuring Safety and Enabling Sustainability , Vienna, Austria, 6 to 10 November 2023