



The Application Of Nuclear Physics In Medicine

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ABSTRACT

This article comprehensively covers the application of nuclear physics in the field of medicine. It analyzes the fundamental principles of nuclear medicine, radioactive isotopes, and the interaction of ionizing radiation with matter and biological tissues. In the field of diagnostics, SPECT and PET technologies, along with the role of radiopharmaceuticals, are reviewed in detail. In the therapy section, methods of external beam radiation (proton therapy), brachytherapy, and radionuclide therapy are described based on their scientific foundations.

Keywords:

nuclear physics, nuclear medicine, radioactive isotopes, SPECT, PET, proton therapy, radionuclide therapy, ^{99m}Tc , brachytherapy, dosimetry, cancer diagnostics, nuclear medicine in Uzbekistan.

Introduction. Kernel physics -atomic nuclei structure, properties and each other effects learner physics important department. It is the 20th century second in the middle medicine fundamentally changed. Today on the day **core medicine** (nuclear medicine) diseases detection (diagnosis) and radioactive in therapy isotopes, nucleus radiation and their substance with each other from the influence wide uses. These methods simple X-ray or from ultrasound different dead, organs not only structure, but function (how It also shows how it works).

Core medicine History In 1934, Frédéric and Irène Joliot- Curies by artificial radioactivity discovery to be with begins. George de Hevesy isotopes using metabolic processes learned. Second world from the war then technologies developed, millions people his life save to stay help gave. Present at the time in the world every year ten millions core medicine procedures is held.

Core radiation ionizing (alpha, beta, gamma, neutron, proton) and non-ionizing to types divided into. In medicine mainly ionizer

rays is used because they cell inside water molecules ionize, free radicals harvest does and DNA chains destroys. Cancer cells healthy to cells than to radiate more sensitive will be.

Dose measurement (dosimetry) is very important. Units: Gray (Gy) — absorbed dose, Sievert (Sv) — equivalent dose. To the patient given the dose is minimal but effective to be Need. Employees lead protection and from dosimeters uses.

(Nucleus medicine or nuclear medicine) modern medicine important from the fields one radioactive isotopes, nucleus radiation and their substance with mutual from the influence It mainly uses **diagnostics** (diagnosis) and for **treatment** (therapy) is used.

1. Diagnosis to put

Radioactive substances (radiopharmaceuticals) into the body is introduced (drop , breath) to take or swallowing via). They known to the organs it is planned and releasing radiation (most often gamma rays) special using devices (gamma camera, SPECT, PET) record These methods are

of organs function (how (shows how it works), simple X-ray and only structure shows.

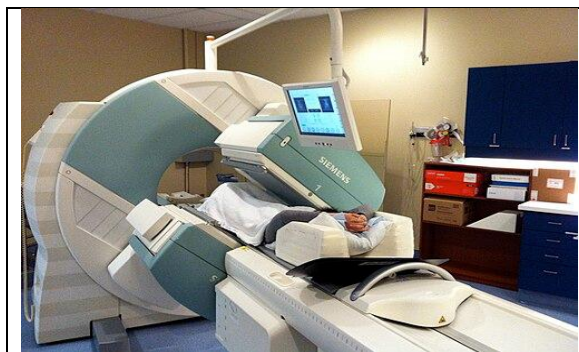
Single-photon emission computer tomography (SPECT or less scattered SPET) from gamma rays used without nuclear medicine tomographic to describe This is a gamma camera (i.e. scintigraphy) traditional nuclear medical planar imaging very it looks like, but real 3D data presented to reach capable. This information usually patient through incision pieces as presented is possible, but necessary when free formatting or management possible.

Radioligand radioactive biochemical a substance, especially a radioactive one labeled ligand. Radioligands diagnostics for or body receptors systems study for and to cancer anti-radioligand therapy for is used.

SPECT scan analysis 3D model image every one in place biological activity level

control The radionuclide emission illustrated of the regions in the capillaries blood of the flow amount shows. Simple X - ray 3D 2- dimensional structure appearance happened like a gamma camera by taken The image is also a 3- dimensional representation of the radionuclide. 2- dimensional distribution It looks like.

SPECT imaging one how many from the corners one How many 2 - dimensional to take images (also called projections) gamma camera for using done is increased. Then computer tomographic reconstruction algorithm one how many to projections application for used, this is 3-dimensional information set gives. Later this information set magnetic resonance imaging tomography (MRI), X-ray computer tomography and other tomographic from methods to those taken similar body every how chosen arrow along thin pieces show for manipulation to be done possible.



SPECT machine whole body bone examines the patient car along slipping passing table on lies, one double gamma camera and his/her around turns.

SPECT images to take gamma camera for patient around is rotated. Projections rotation in the process, usually every 3-6° at points is taken. Many optimal reconstruction in cases to take for full 360° quality rotation is used. Each projection to take for departing The time is also variable, but 15-20 seconds is typical. This is a general scan It takes 15-20 minutes.

Myocardium perfusion see

Myocardium perfusion imaging (MPI) of the heart ischemic disease diagnosis for used functional heart image to take one is the form of. Main principle is that under stress sick myocardium simple to the myocardium than less blood flow harvest MPI cardiac stress test one how many of the types is one.

From stress after SPECT image performed radiopharmaceutical spread and that's why for

myocardium various to the regions relatively blood flow Diagnosing stress images usually stressful from images before vacation taken during taken other images set with compare through done is increased.

Functional brain image

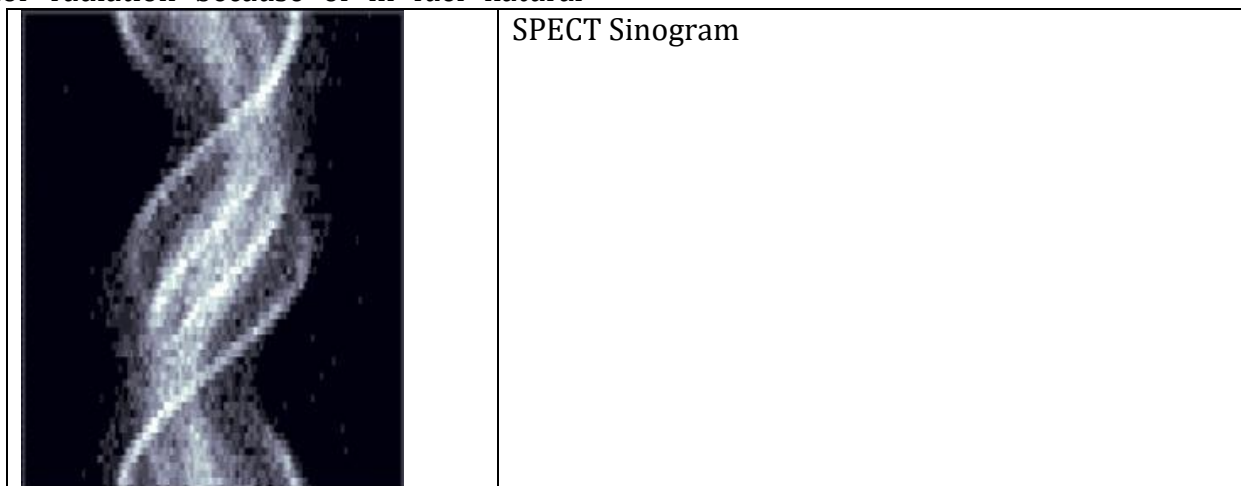
Usually, functional brain in view The gamma-emitting tracer used is Technetium (^{99m}Tc) exametazime. Tc is metastable core isomer is a gamma camera by detectable gamma rays She will be examined. Attachment her brain blood to the flow proportional accordingly brain tissues by acceptance to be done opportunity gives and own in turn brain blood flow nuclear gamma camera with to evaluate opportunity gives.

Core in technology application

Core energy SPECT method in the field irradiated core in fuels radioisotopes image in

distribution usage possible. Nuclear neutrons from fuel (e.g., uranium) with nuclear in the reactor radiation because of in fuel natural

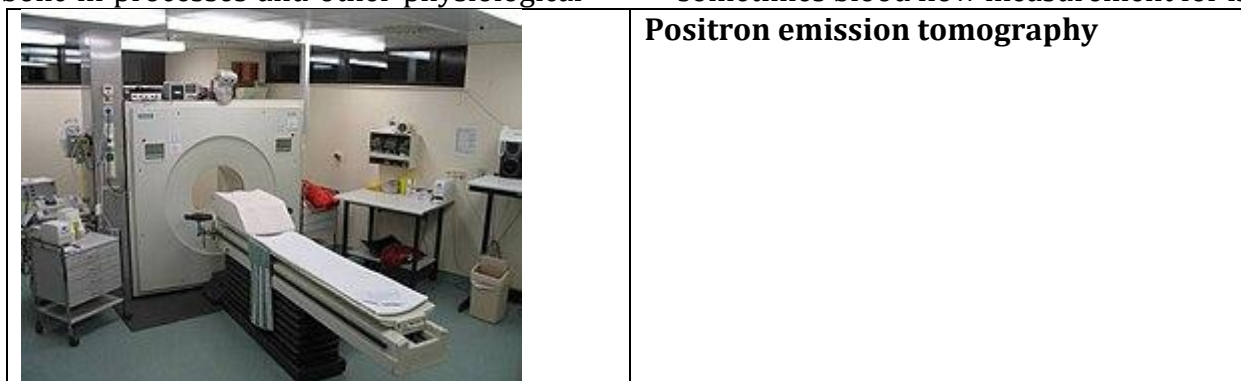
accordingly wide gamma-ray emitter radionuclides harvest will be.



Again restored images usually 64x64 or 128x128 pixels to the dimensions of has, pixel The size of the beads is 3-6 mm. Obtained projections number approximately taken of images to the width equal to be for is selected. In general reconstruction made images resolution lower will be, flat to the images than high to the noise has and to artifacts sensitive will be.

in operation changes see and measurement for known as radiotracers radioactive from substances used functional to describe method blood flow, regional chemical composition and absorption. In the body targeted to the process depending on, different kind to describe goals for various trackers For example, ¹⁸F-FDG (fluorodeoxyglucose) usually cancer disease determination for used, NaF ¹⁸F bone formation determination for wide is used and oxygen-15 sometimes blood flow measurement for is used.

Positron emission tomography (PET) metabolic in processes and other physiological



PET wide widespread to describe technique, nuclear in medicine applicable medical scintigraphy Radiopharmaceuticals - the drug attached radioisotope - to the body seeker as Radiopharmaceuticals beta plus to break up when encountered, positron will be

issued and positron simple electronic with when they collide, two particle no become goes and gamma These gamma rays are emitted. X-ray image to take such as three size the image harvest to do gamma cameras for by is determined.

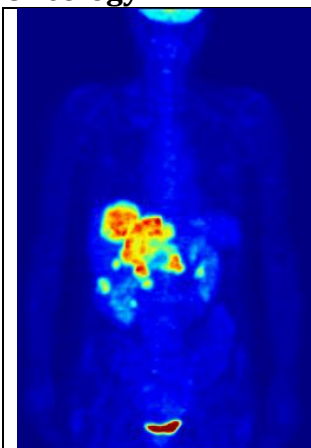


PET/CT system with 16 -slice CT

PET clinic previous and clinical under the circumstances applicable medical and research is a tool. in describing and clinical oncology in the field metastases in search and various kind dementias brought releasing some diffuse brain diseases clinical in diagnosis wide PET is used in simple human brain, heart activity about our knowledge study and improve and medicine tools working exit support for valuable research PET is a means of used without from the clinic

previous It is also used in research. This time passing with one kind in topics repetitive research transfer opportunity gives, in which subjects own control to act as possible and known one research for necessary was animals number noticeable at the level reduces. This approach research of the results statistic quality increase with together necessary sample size to reduce opportunity gives.

Oncology

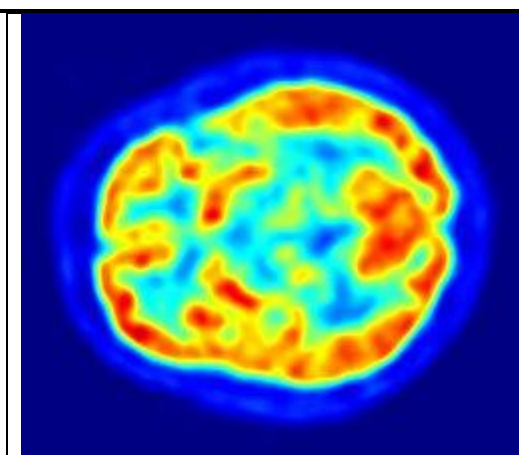


Using ¹⁸F – FDG (fluorodeoxyglucose) whole PET scan of the body. Normal brain and kidneys labeled and from FDG decay come came out radioactive urine urine in the bladder It seems. From this outside, in the liver fat intestine from cancer big metastatic tumor mass it seems.

¹⁸F- PET scan with fluorodeoxyglucose tracer clinical in oncology wide Fluorodeoxyglucose is used. glucose similar is, it is glucose usable cells by acceptance will be done and hexokinase by phosphoresced (its mitochondrial shape fast growing in malignant tumors noticeable at the level rises). Radioactive glucose molecule metabolic PET scan to use opportunity gives. Illustrated fluorodeoxyglucose of the seeker concentration of tissues metabolic activity

shows, because it is regional glucose to be mastered suitable comes. ¹⁸F- fluorodeoxyglucose cancer to other body parts spread probability study for used (cancer metastases). Cancer metastasis determination for this ¹⁸F- fluorodeoxyglucose PET scans standard medical in aid the most wide widespread (current) 90% of scans organization does). Same this seeker dementia types diagnosis also use for possible .

Neurology



Human PET scan of the brain

PET imaging with oxygen-15 indirectly to the brain blood flow This is a measure of in a way radioactivity signal increase blood of the flow from the increase evidence gives, this and brain activity increase with I think it depends. 2 minutes half decomposition period because of ^{15}O Oh straight away medical from the cyclotron transfer this is necessary very difficult

^{18}F - fluorodeoxyglucose PET imaging with brain usually glucose fast consumption to do from the fact uses. The brain standard ^{18}F - fluorodeoxyglucose PET regional glucose consumption measures and neuropathological in diagnosis application possible.

Alzheimer's disease such as brain pathologies in tandem glucose and of oxygen brain metabolism noticeable at the level reduces. Therefore for brain ^{18}F - Alzheimer's from fluorodeoxyglucose PET disease other dementia from the processes successful separation, also Alzheimer's of the disease early diagnosis to put also use for This is possible. goals for ^{18}F - fluorodeoxyglucose PET advantage his much wider is the existence.

Cardiology

Cardiology, atherosclerosis and blood vein diseases study: ^{18}F - fluorodeoxyglucose PET sleep in the state myocardium to determine help However , this role for PET vs. SPECT economic efficiency uncertain. ^{18}F - fluorodeoxyglucose stroke danger was patients determination for PET imaging of atherosclerosis It can also be transferred. It can also cause atherosclerosis. against new treatment methods to check help gives.

Infectious diseases

Clinical PET infection in terms of with related inflammation reaction determination for

fluorodeoxyglucose using bacterial infections to describe for wide In vivo bacterial infections to describe for three different PET contrast agent working produced: ^{18}F maltose, ^{18}F maltohexose and ^{18}F 2-fluorodeoxy sorbitol (FDS). FDS only Enterobacteriaceae goal as of the sheep additional to the advantages has.

2. Treatment

Core radiation (gamma, beta, proton, neutron) is harmful cells (mainly cancer cells) no to do for used. Healthy minimal damage to cells an attempt is made to convey.

External radiation (Teletherapy) – this oncological diseases treatment method be, in this special equipment (for example, linear accelerator (patient) from the body known one in the distance standing, shining source directly The tumor (stem) is located to the field directs. Linear accelerators using high energetic rays (X-rays) rays, electrons, protons) are used. **Proton therapy** - the most modern method, because protons known in depth energy maximum releases and healthy to the tissues less impact does.

Home features and Advantages:

Local impact: Radiation rays clear oh my god to the tissue will be focused and his surrounding healthy minimal damage to cells to deliver help gives.

Painlessness: Process no how pain does not bring, X-ray to the inspection like goes and usually one how many minute continue will reach.

Sessions division: Treatment course usually one how many week during every day transferable short from sessions consists of It

will be healthy . of tissues to recovery opportunity gives.

This treatment progressive from technologies used without of tumors no to make, to reduce or cancer with related pain signs alleviation for wide is applied.

Internal Radiation (Brachytherapy): Radioactive sources (e.g. Iridium-192, Cesium-137) directly to the tumor close will be placed.

Brachytherapy - cancer disease treatment for used radiation type. It is cancer cells to kill and tumors reduce for ionizer called radiation energy of the type uses.

Machine by working issued high energetic X-ray rays from the body outside on the wire directed external light different from therapy (EBT) as, brachytherapy radioactive the material straight away to the body placement own inside takes.

Brachytherapy whole in the body cancer diseases, that including prostate, uterus neck, head and neck, ovary, breast, gall bubble and grass paths, uterus and uterus neck, vagina, esophagus, bronchi, eye, brain and others such as in the organs cancers treatment for is used.

Brachytherapy is probably conformal radiation therapy the most good from the forms is one. Home advantage is that radiation source oh my god inside that was because of the tumor high dose radiation in the body to surrounding normal structures very minimal or insignificant in doses convey This is possible. approach healthy to the tissues damage convey the risk reduces and tumor no to do probability increases. Normal to tissues dose very minimal because of the radiation big one disposable doses no how disease-free delivery possible. So that radiation whole course very short time inside delivery to be given possible. Traditional external radiation therapy 6-8 weeks continue if so, brachytherapy one how many day inside whole radiation chair This gives patients time and other resources in terms of big benefit brings.

Brachytherapy types

Permanent brachytherapy:

Permanent In brachytherapy, also called seed implantation, the radioactive seeds with in advance filled needles is entered. Then needle

or device take discarded, radioactive seeds behind The seeds remain, in placement to the doctor help to give for X-ray rays, ultrasound or computer from tomography use possible. Seeds location check for from implantation then additional see tests transfer possible.

Temporary brachytherapy:

Temporary in brachytherapy radiation sources to place help to give for fluoroscopy, ultrasound or using CT on the wire catheter, needle or applicator such as delivery to give device will be placed. Delivery to give device vagina or uterus into a body cavity such as introduction possible (intracavitary brachytherapy) or applicators (usually needles or catheters) into body tissues (interstitial brachytherapy) insertion possible.

Treatment places

Oh my to the place and to the stage depending on, brachytherapy the only way to treat as or external radiotherapy or surgery with together usage possible.

Some early in tumors, for example, the head and neck cancer and prostate cancer, this radical surgery and external radiation to therapy is an alternative. Correct. chosen In some cases , it is very few side effects has was high treatment speed offer does.

Prostate brachytherapy

LDR and HDR brachytherapy organs with limited (early) prostate in cancer This is the only way to treat it . as or 4-5 weeks old external radiation from therapy then amplifier as done increase possible.

HDR temporary brachytherapy prostate gland very small plastic catheters placement and then this catheters through one row radiation treatments to transfer own inside takes. Then catheters easily will be issued and prostate in the gland radioactive substances Computer by controllable car one high radioactive iridium seed to catheters one after another Computer catheters every in one this one How much is the seed? time to stay control do received because of this, we prostate gland various in the regions radiation dose control do We will get it. We will get it. high dose we give possible and urine the urethra and right low dose of the intestine to take our provision possible. Conifers from the

beginning then dose change ability brachytherapy permanent seed to implants relatively main from the advantages is one.

Radionuclide Therapy: Radioactive substances drop through is entered and don't grow is collected.

Examples:

Iodine-131 - thyroid cancer and in hyperthyroidism.

Lutetium-177 (Lutathera) - neuroendocrine tumors for.

Bone Radium-223 or Samarium-153 in metastases .

Other Applications:

Medical equipment sterilization to make (gamma- rays with).

Radioisotopes using of drugs the impact to study

Security and dose

Ionizer radiation dangerous to be possible, therefore for **dosimetry** (dose measurement) and radiation security rules strict is performed. To the patient given the dose is minimal but effective will be. Employees special protection from the means uses.

Conclusion. The nucleus physics medicine revolution did: cancer early determine, define treatment and personal medical (theranostics) opportunity gave. In the future new isotopes, using AI image analysis and proton therapy expansion is expected. But security and ethics issues permanent under control to be need.

Core medicine of humanity the most great from the achievements one into millions life save remains and quality is improving.

References:

1. Core medicine – Uzbekistan national encyclopedia and Wikipedia information.
2. IAEA and World Nuclear Association reports.
3. Uzbekistan Atomic Energy Agency (Uzatom) materials.
4. Scientific articles: SPECT/PET technologies according to international comments.

5. https://uz.wikipedia.org/wiki/Positron_emission_tomografiyasi
6. Nasriddinov, KR, and RV Kasimjonov. "Use of Case Study Technology in Improving Practical Courses in Nuclear Physics." *Texas Journal of Engineering and Technology* 15 (2022): 142-146.
7. Nasriddinov, K. R., and RV Qosimjonov. "ORGANIZATION OF PRACTICAL TRAINING ON THE TOPIC OF CORE MODELS IN PEDAGOGICAL HIGHER EDUCATIONAL INSTITUTIONS." *Academic research in educational sciences* 3.11 (2022): 36-45.
8. Nasriddinov, KR, and RV Kasimjonov. "Methodology of Organizing Practical Training on the Subject of" Nuclear Models". *INTERNATIONAL JOURNAL OF INCLUSIVE AND SUSTAINABLE EDUCATION* 1.5 (2022): 160-163.
9. Nasriddinov, K.R., and RV Qosimjonov. "THE PLACE AND IMPORTANCE OF NON-STANDARD TESTS IN NUCLEAR PHYSICS." *Academic research in educational sciences* 3.6 (2022): 509-517.
10. Qosimjonov, R. V. " SOME ASPECTS OF INTERDISCIPLINARY INTEGRATION OF NATURAL SCIENCES IN NUCLEAR PHYSICS." *Academic research in educational sciences* 2.CSPI conference 3 (2021): 638-644.