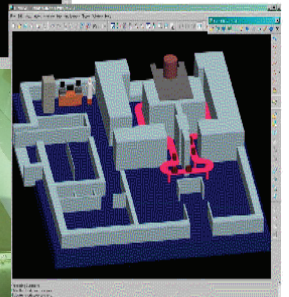
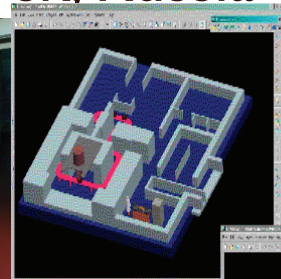
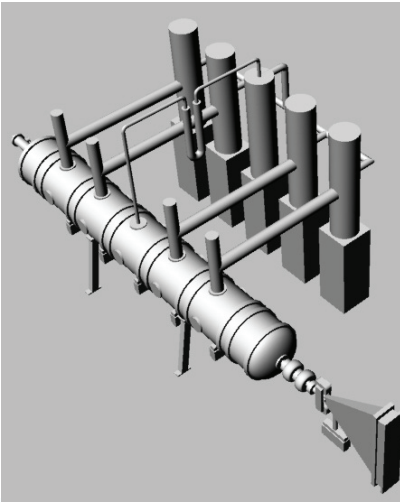


ELECTRON ACCELERATORS SERIES ILU AND PROSPECTS OF THEIR APPLICATION IN THE FOOD INDUSTRY

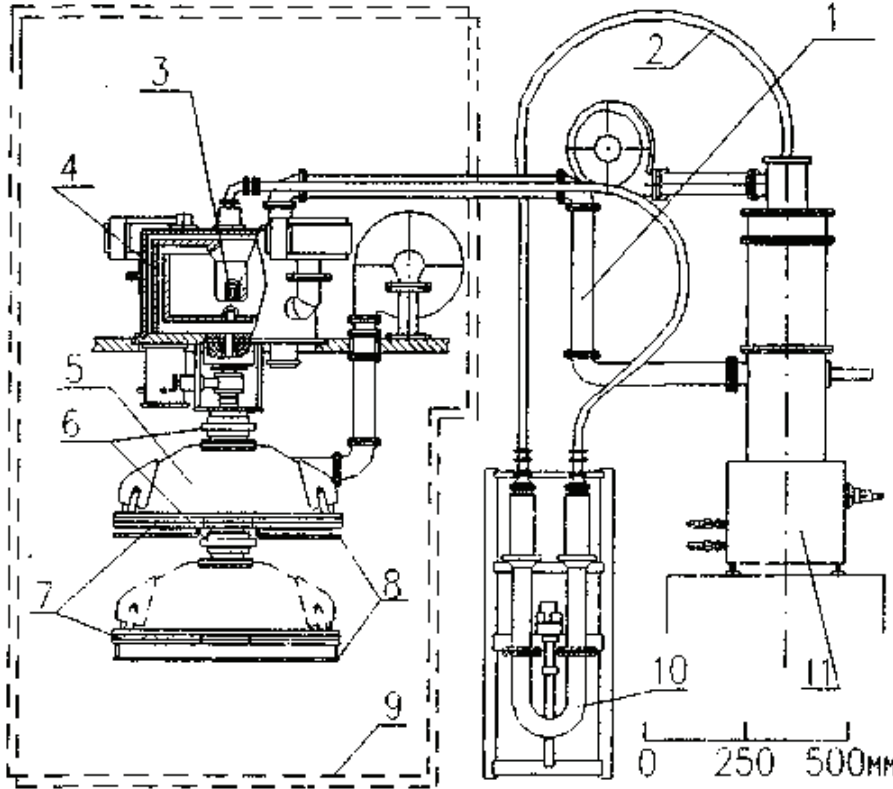
A.A. Bryazgin, V. Bezuglov, B.L. Faktorovich, E.N. Kokin, M.V. Korobeynikov, A.N. Lukin, V. E. Nekhaev, A. D. Panfilov, V.M. Radchenko, A.V. Sidorov, E. Shtarklev V. O. Tkachenko, L.A. Voronin, A. Vlasov, BINP, Novosibirsk, Russia



ILU Accelerators

Parameters	ILU-6	ILU- 8	ILU-10	ILU-14
Energy of electrons, MeV	1.2-2.5	0.6-1.0	3.0-5.0	7.0-10.0
Average beam power (max), kW	20	25	50	100
Average beam current (max), mA	20	30	10	10
Power consumption, kW	100	80	150	450
Accelerator weight, tons	2.2	0.6	2.9	5
Weight of local protection, t	-	76	-	-

ILU-8 in Local Shield



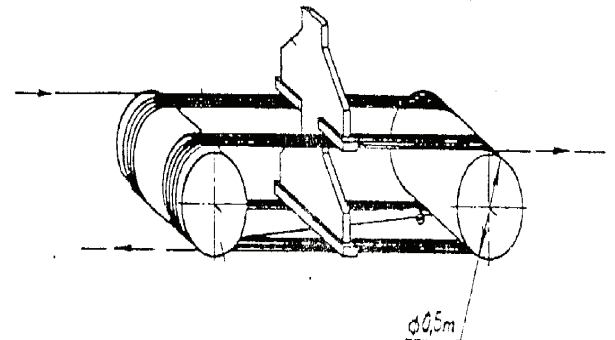
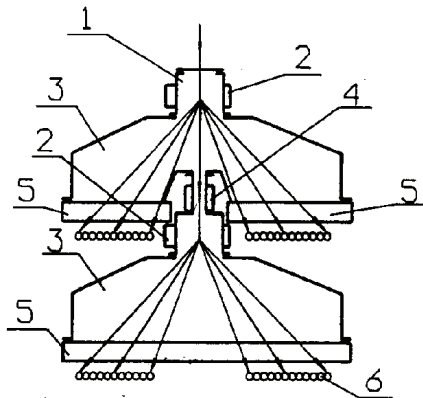
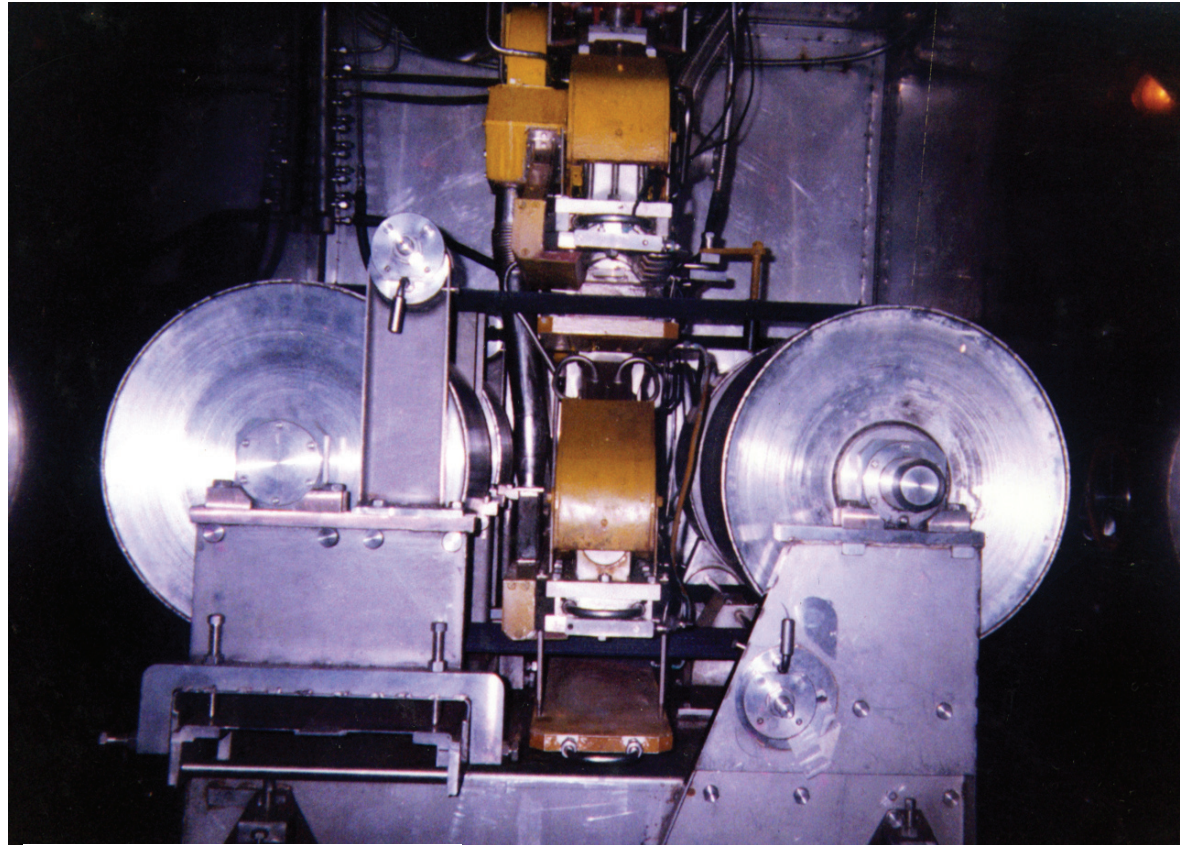
Main features of
ILU accelerators

- Compact
- Self-excitation
- No insulation and gas systems
- Pulse
- GI-50

- Energy 0.8-1 MeV
- Av. Current 0-20 mA
- Pulse current 0-500 mA
- Pulse duration 800 mks
- Pulse repetition 1-50 Hz
- RF frequency 175 MHz
- Dim D800x800 mm

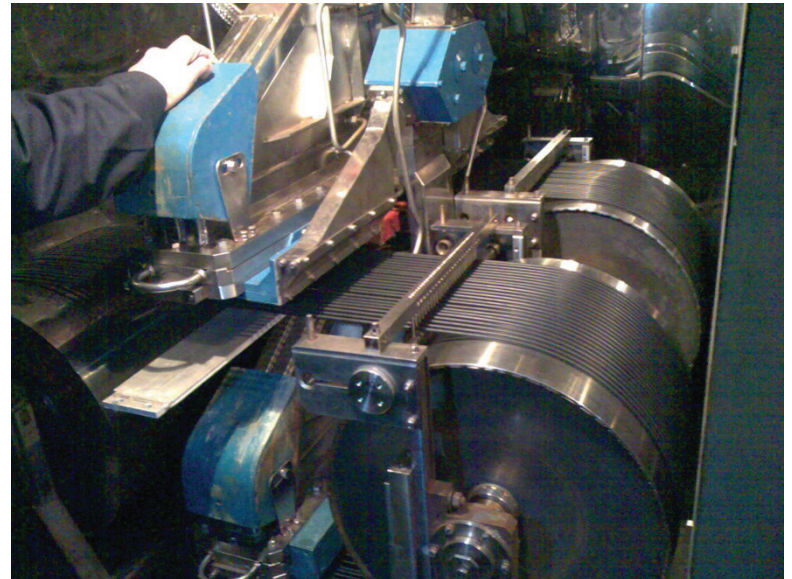
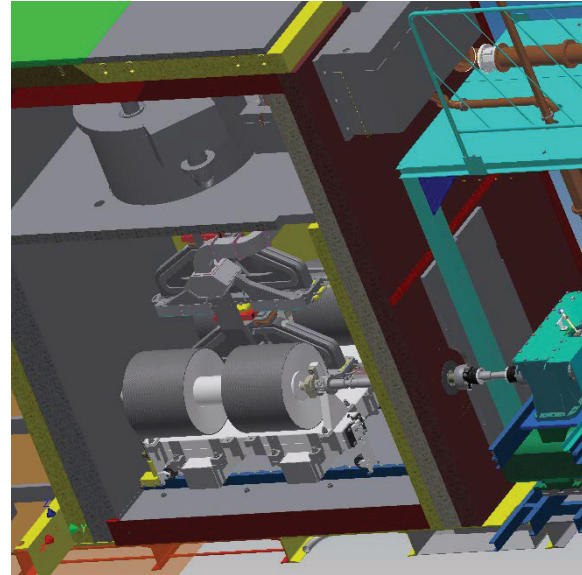
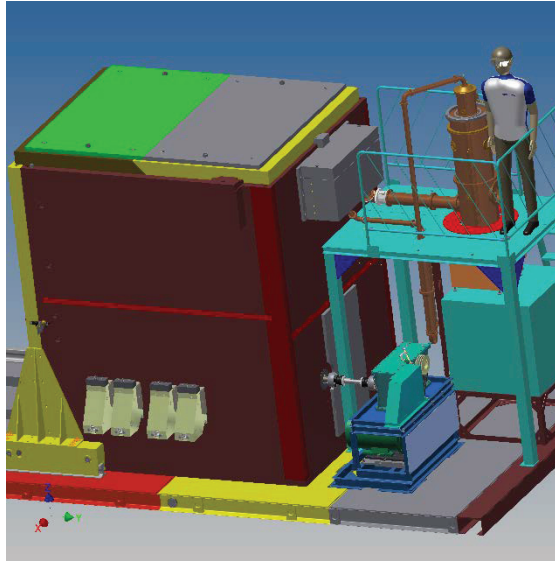
4-sided cable irradiation

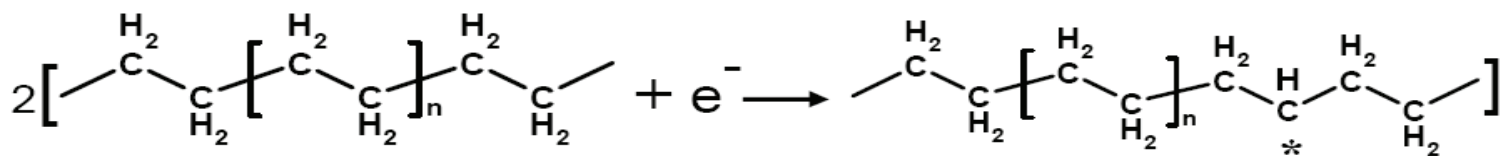
- Beam extraction device for 4-sided irradiation allows to increase beam usage efficiency comparing with 2 sided irradiation
- No cable twist



Accelerator ILU-8 in local shielding

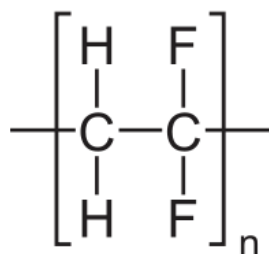
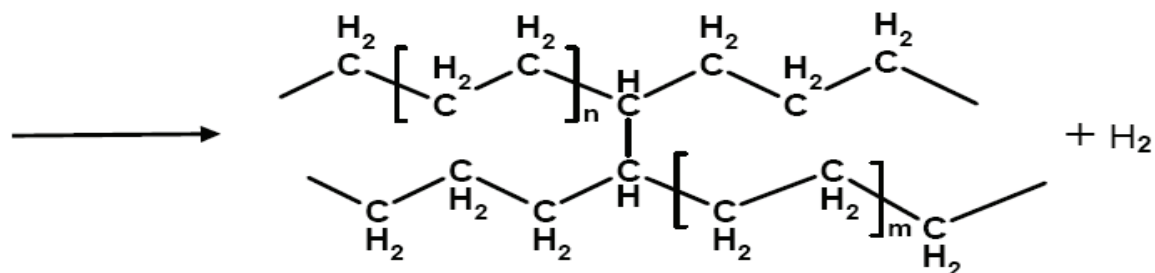
Russia, Cheboksary, 2010



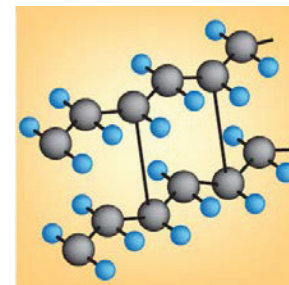


Polyethylene – amorphous region

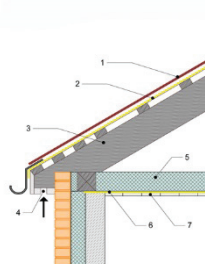
PE with reactive free radical



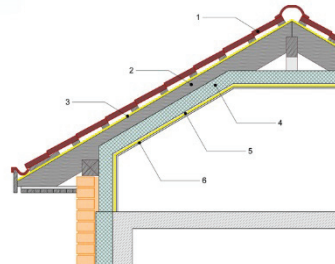
Поливинилиденфторид
Фторопласт 2
PVDF



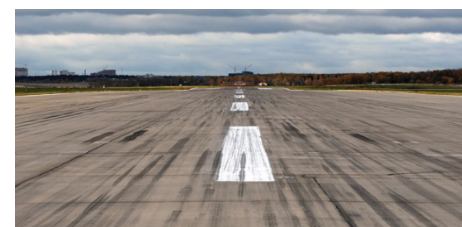
products made of foam, crosslinked accelerator ILU-8 in "RusFom" Khimki



1. Кровельное покрытие метал. черепица
2. Ветро-пылезащита Пенолон
3. Стропильная нога
4. Вентиляция
5. Утеплитель
6. Пароизоляция Пенолон
7. Подшивка потолка

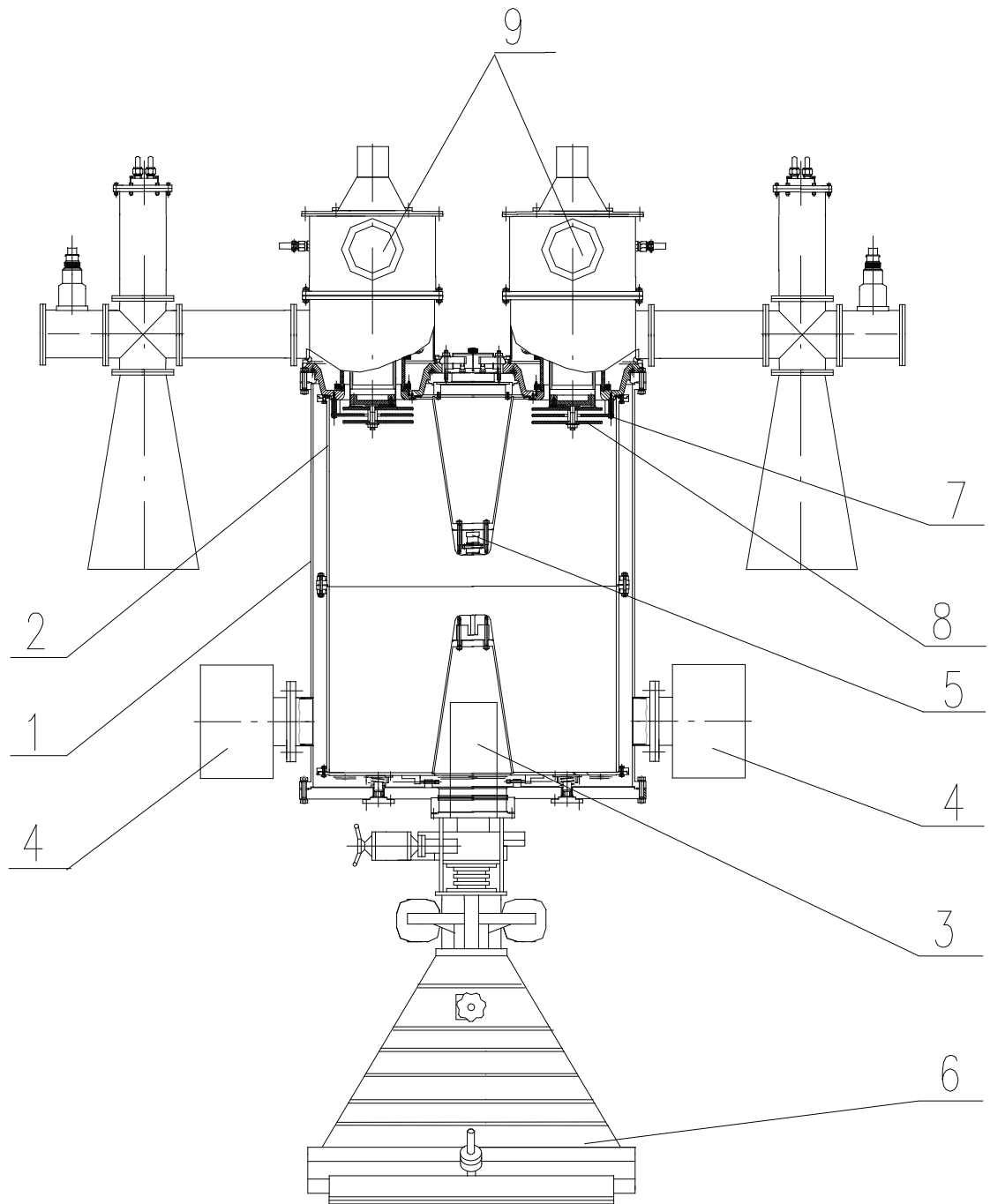


1. Кровельное покрытие
2. Стропильная нога
3. Ветро-пылезащита Пенолон
4. Утеплитель Пенолон блок
5. Пароизоляция Пенолон
6. Внутренняя обшивка мансарды



ILU-10

- Energy 4-5 MeV
- Av. Current 0-10 mA
- Pulse current 0-400 mA
- Pulse duration 500 mks
- Pulse repetition 1-50 Hz
- RF frequency 115 MHz
- Dim. D1280x1480 mm

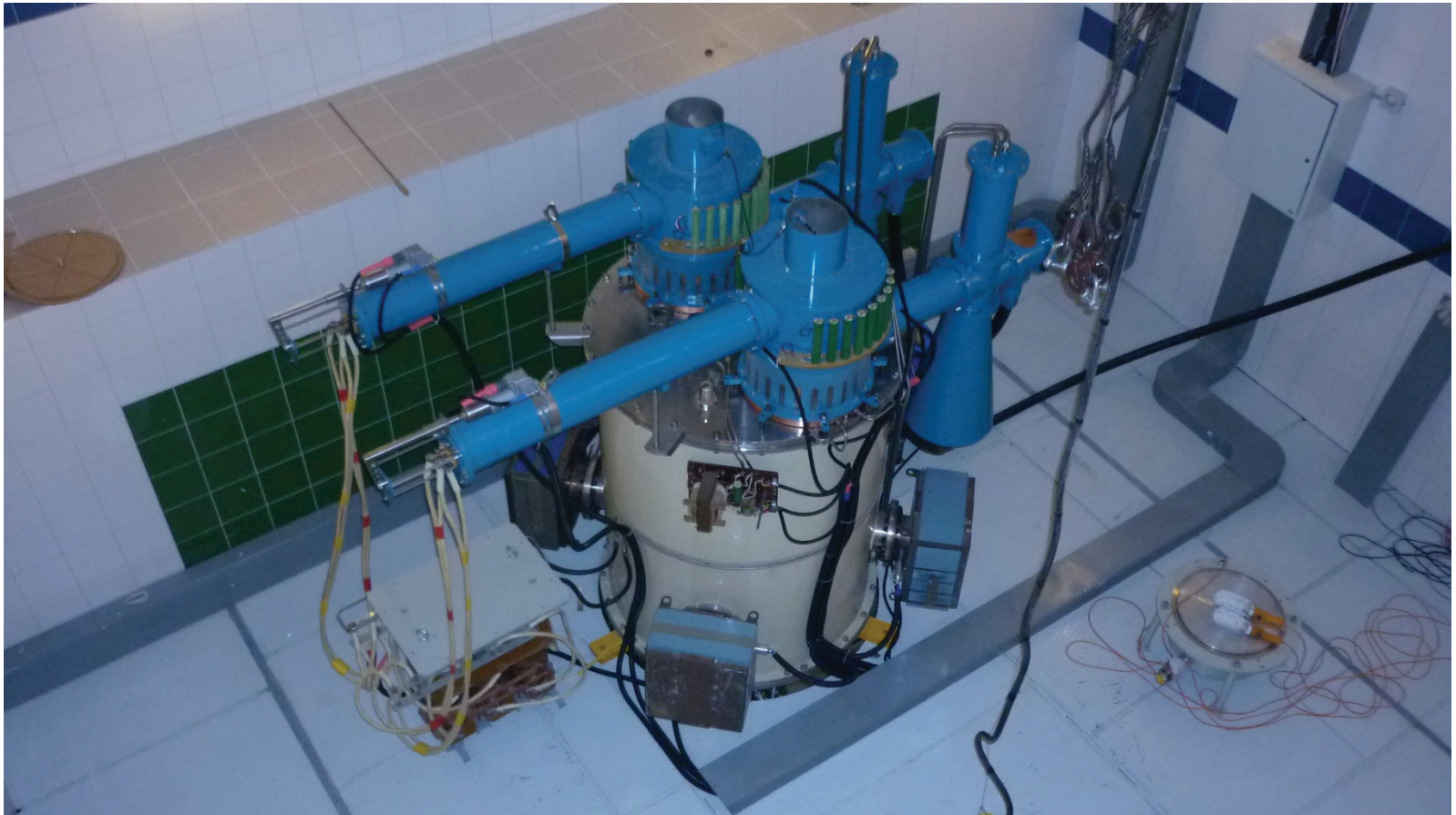


ILU-10 in Poland, RadPol SA, 2008

- Energy 5 MeV
- Beam power 50 kW
- Treatment of polymer pipes
- Treatment of cables
- Movable accelerator between two conveyors.



ILU-10 in Novosibirsk pharmaceutical plant 2013



ILU-10 in Novosibirsk pharmaceutical plant 2013



ILU-10 in Novosibirsk pharmaceutical plant 2013



ILU-10 in Novosibirsk pharmaceutical plant 2013



ILU-10 in Novosibirsk pharmaceutical plant 2013



Centre of radiation technologies in Budker Institute and NSU (started 2014)



Centre of radiation technologies in Budker Institute and NSU.



Centre of radiation technologies. Conveyor load zone.



Centre of radiation technologies. Labyrinth entrance.



Centre of radiation technologies. Control cabinet.



Irradiation service center. Track load-unload gateway.





Парк Ядерных Технологий



- Sterilization plant based on ILU-10 accelerator in Park of Nuclear Technology in Kazakhstan (2013)





Парк Ядерных Технологий

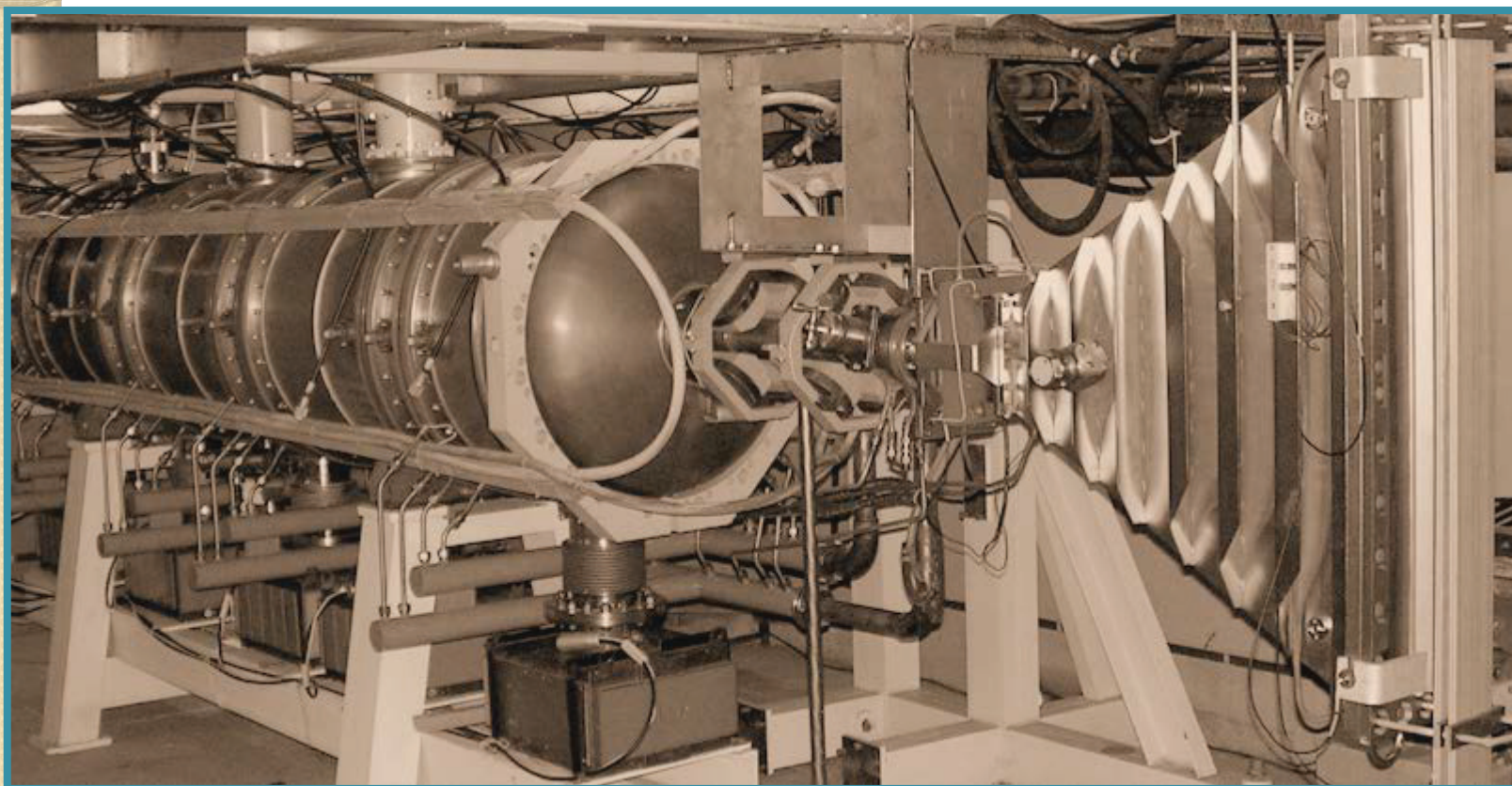


ILU-14

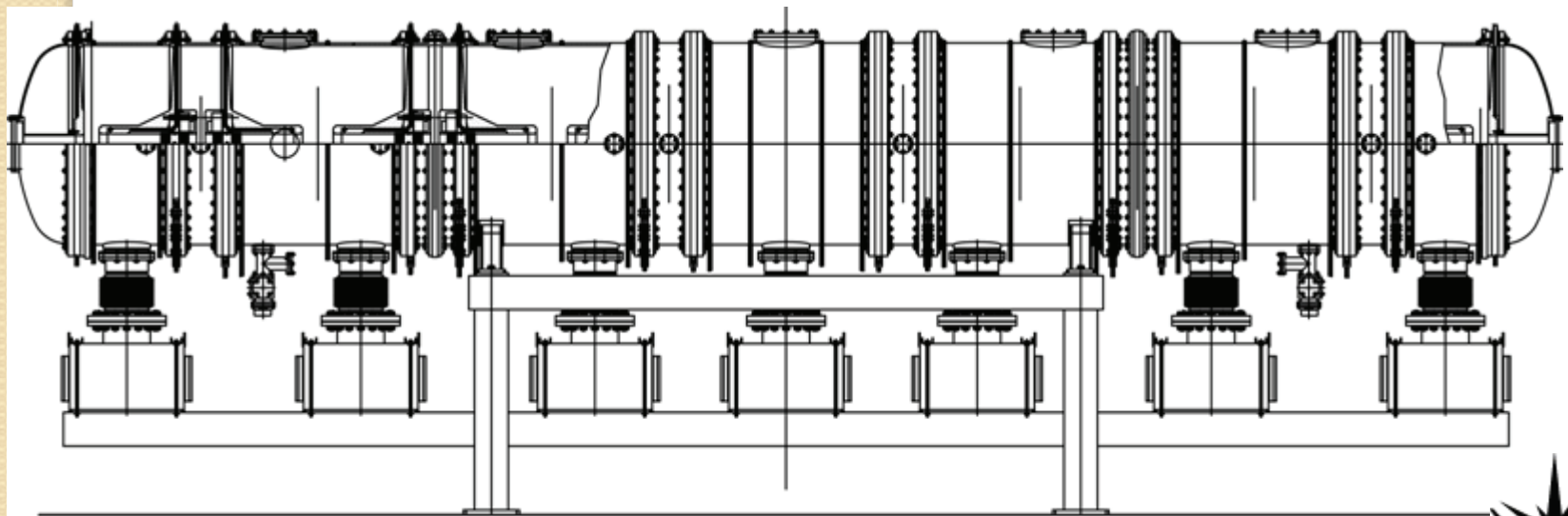
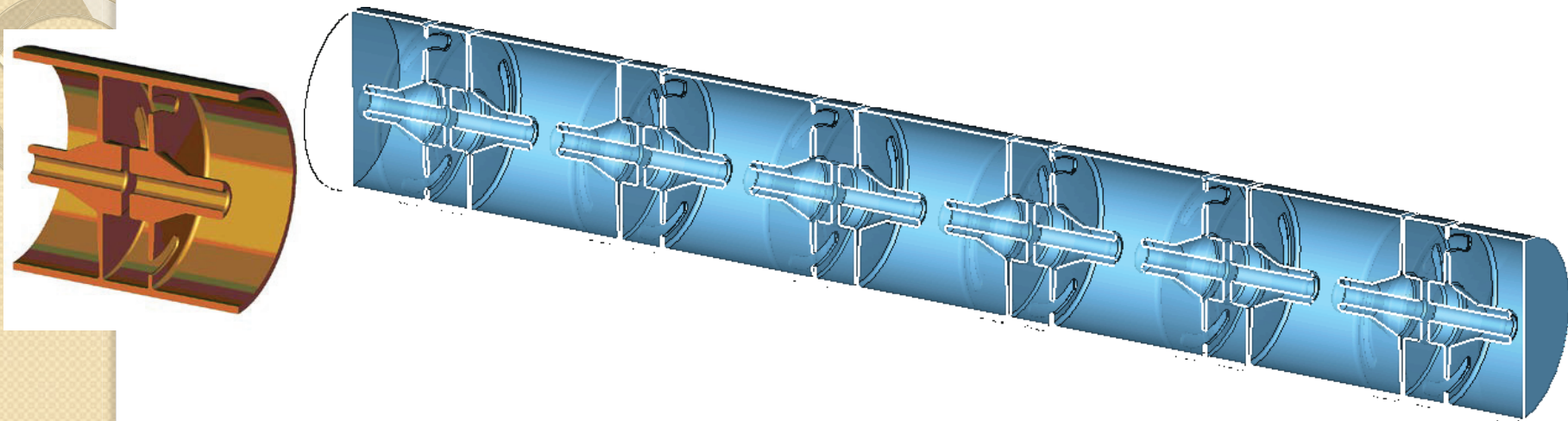
7,5-10 MeV, 100 kW

ILU-12

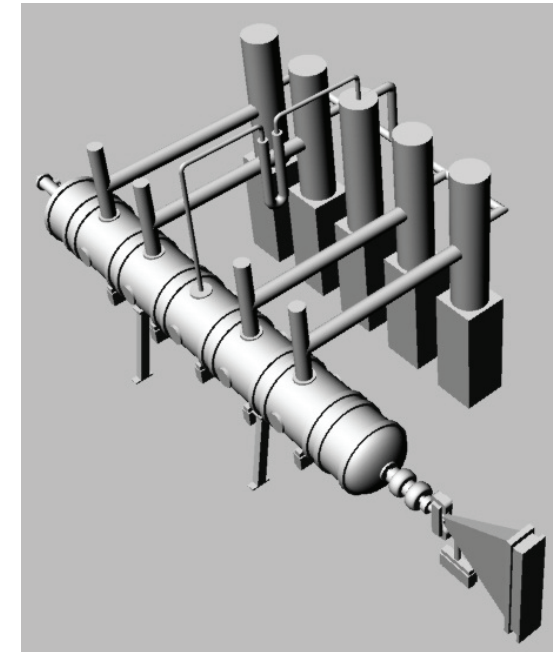
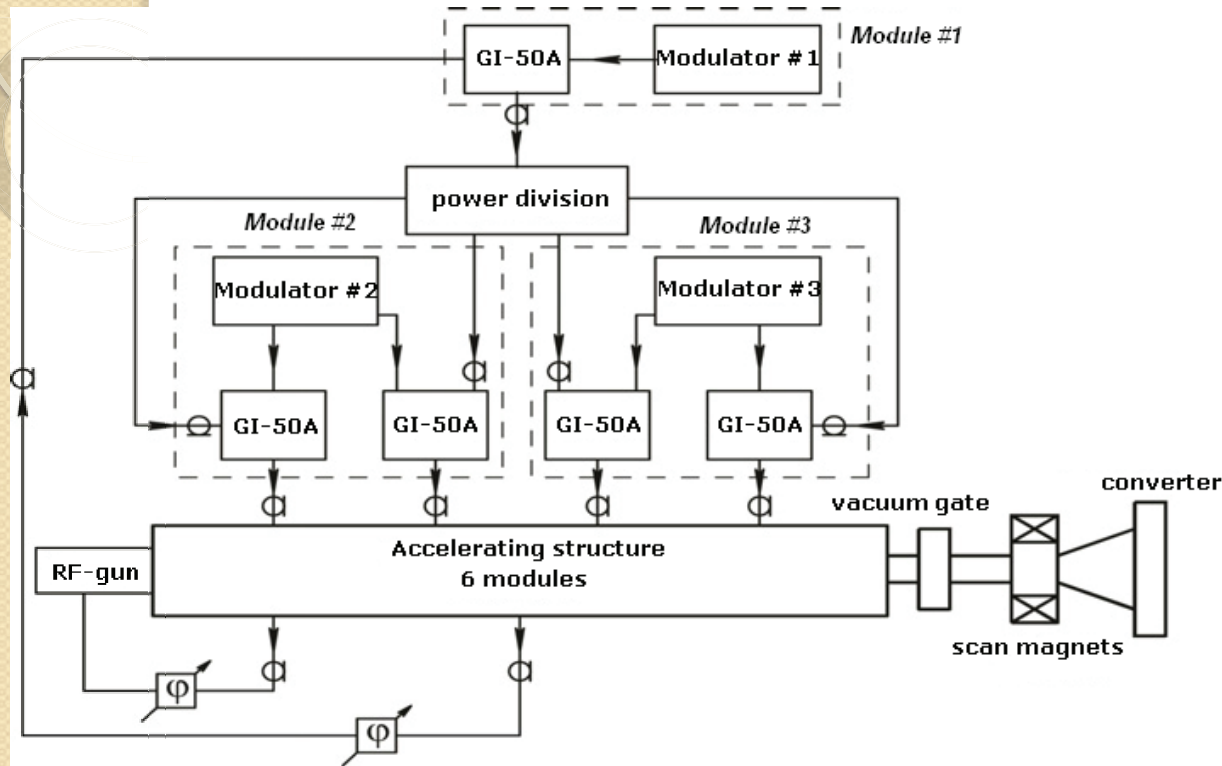
5-7,5 MeV, 60 kW



Accelerating structure



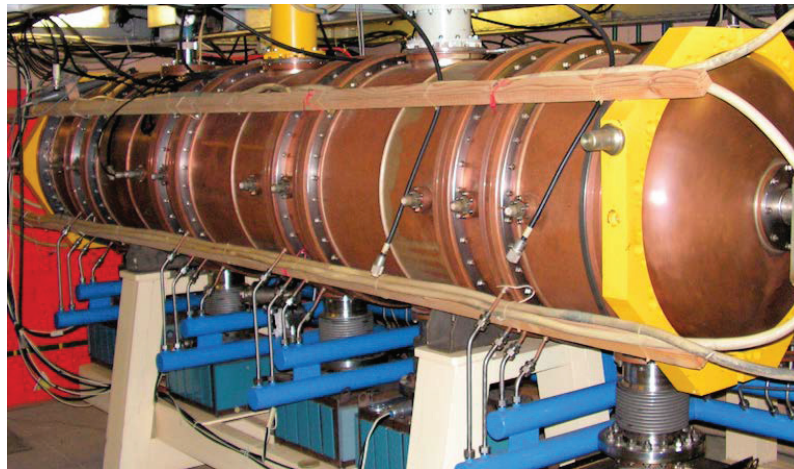
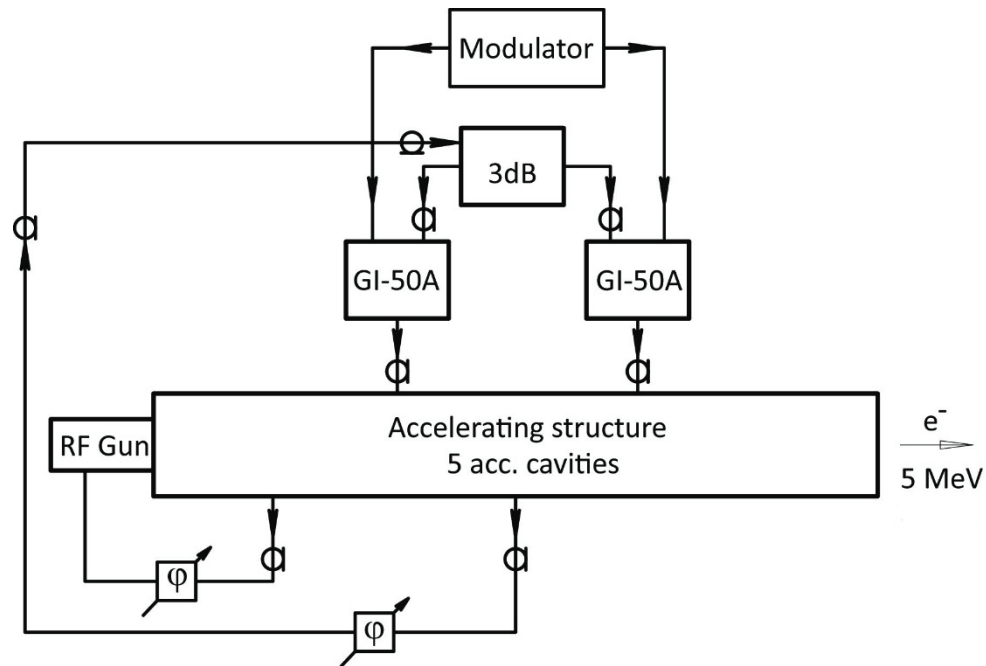
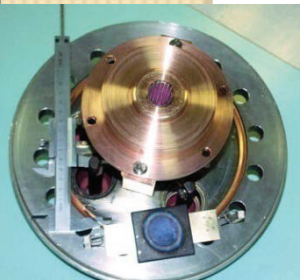
ILU-14 accelerator



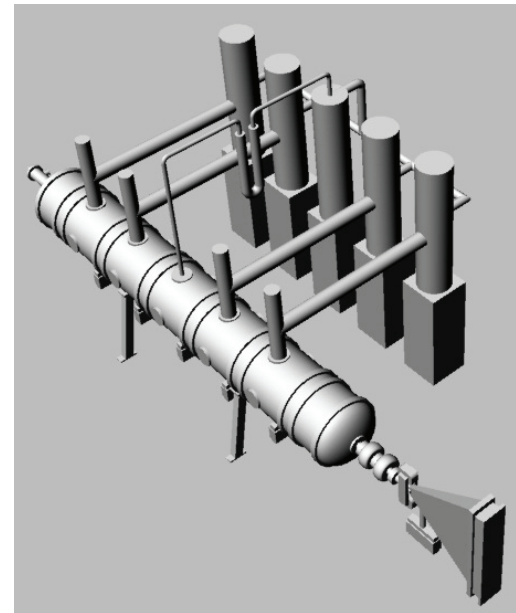
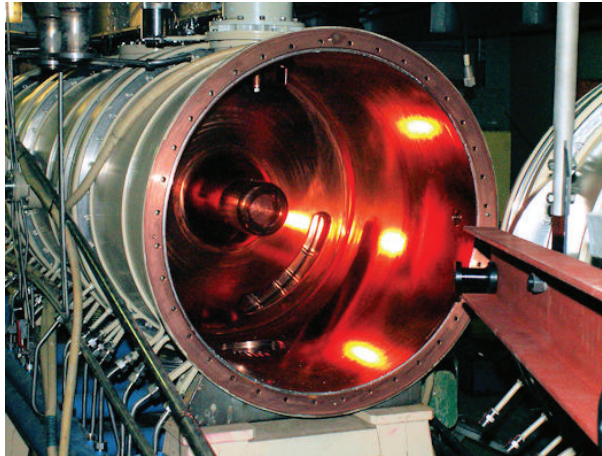
<i>Operating frequency, MHz</i>	<i>176</i>	<i>Full efficiency, %</i>	<i>26</i>
<i>Electron energy, MeV</i>	<i>7,5-10</i>	<i>Modulator pulse duration, μs</i>	<i>500</i>
<i>Average beam power, kW</i>	<i>100</i>	<i>Repetition rate, Hz</i>	<i>Up to 50</i>



5-7.5 MeV, 40-60 kW ILU-I2



ILU-14

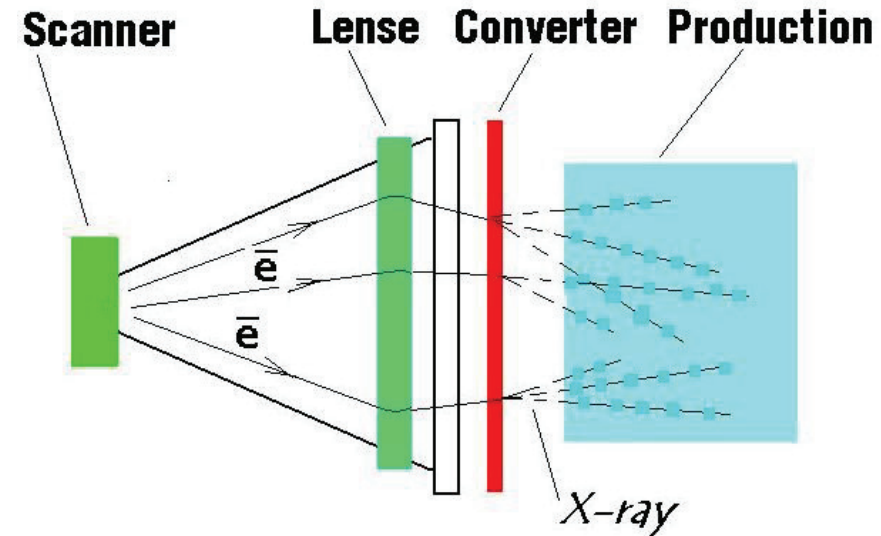
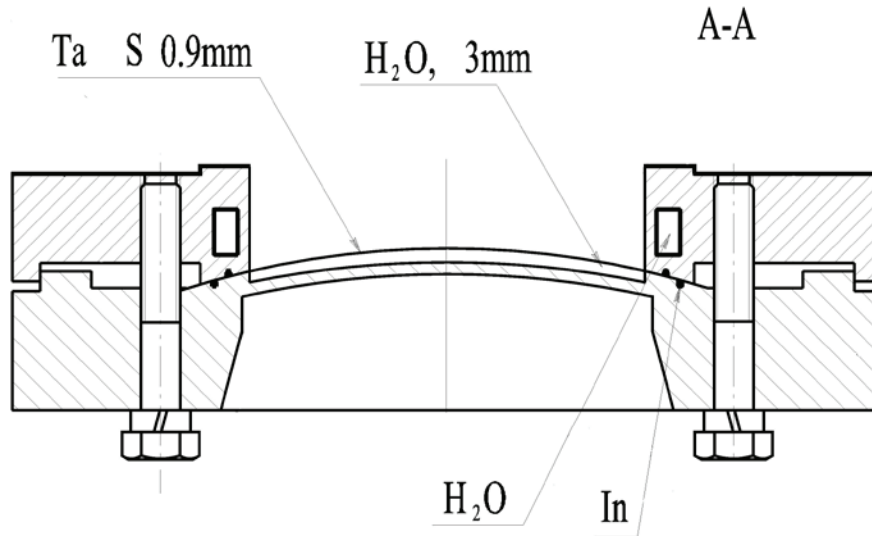


ILU-14 on pilot plant for irradiation medical waste.

Moscow. Start of operation in 2014.



X-ray converter

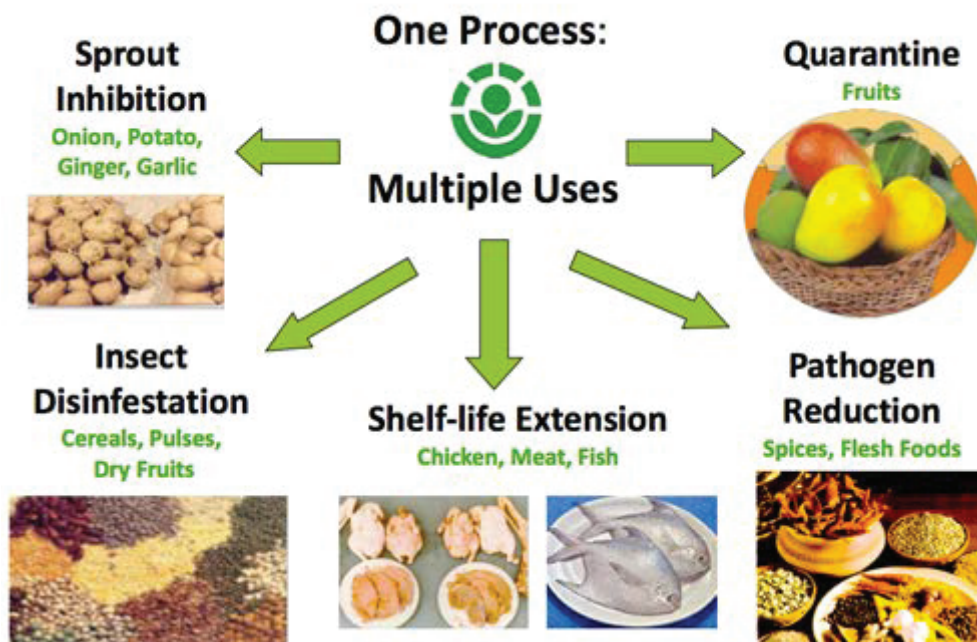


Conversion rate X-ray/Ebeam power

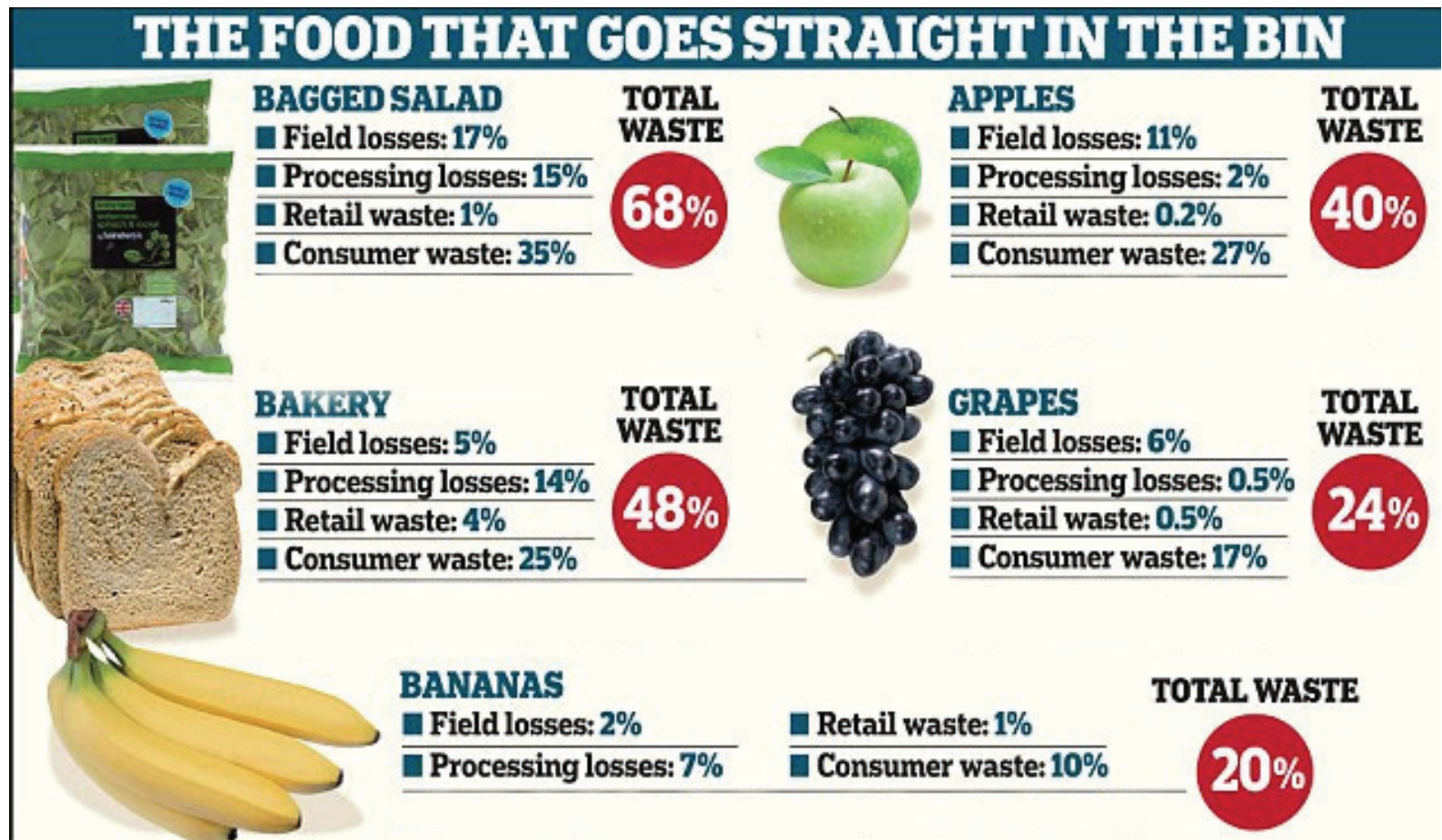
E(MeV)	Ta thickness	60 deg	360 deg
7.5	0.9	13,2%	16,9 %
5	0,7	8,3%	12%

Why irradiate food?

- Decreasing pathogenic microorganisms (Salmonella, E-Kohli et al.)
- Увеличение времени хранения продукта без использования химических консервантов.
- Уничтожение насекомых.

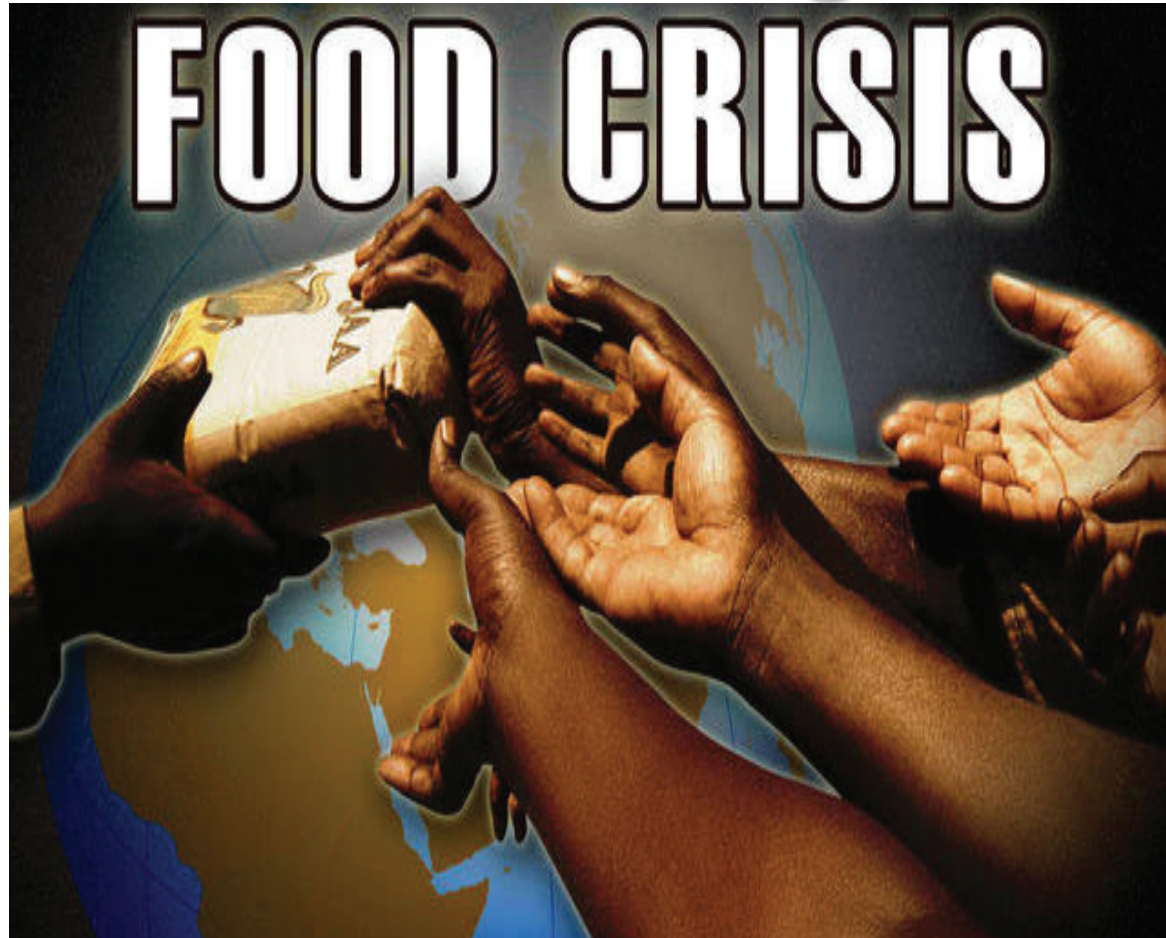


Product losses in TESCO supermarket chain in 2013.



Earth's population will exceed 9 billion by 2050.
Today about 40% of food is thrown.
In the USA
more than 50%.

WE are waiting for



Electron accelerators can reduce food losses

Newsweek

September 1, 1997 : \$2.95

SWINGING MOSCOW
WOMEN'S B-BALL ON THE LINE

Can This Meat Kill You?

THE **E. COLI** THREAT—
IT'S WORSE
THAN YOU THINK

BEEF CHUCK GROUND
(FAMILY PACK)

SAFE HANDLING INSTRUCTIONS

THIS PRODUCT WAS PREPARED FROM INSPECTED AND PASSED MEAT AND/OR POULTRY. SOME FOOD PRODUCTS MAY CONTAIN BACTERIA THAT COULD CAUSE ILLNESS IF THE PRODUCT IS MISHANDLED OR COOKED IMPROPERLY FOR YOUR PROTECTION. FOLLOW THESE SAFE HANDLING INSTRUCTIONS.



KEEP REFRIGERATED OR FROZEN.

THAW IN REFRIGERATOR OR MICROWAVE.

KEEP RAW MEAT AND POULTRY SEPARATE

FROM OTHER FOODS. WASH WORKING

SURFACES (INCLUDING CUTTING BOARDS),

UTENSILS AND HANDS AFTER TOUCHING

RAW MEAT OR POULTRY.



COOK

THOROUGHLY.

KEEP HOT FOODS

HOT REFRIGERATE

LEFTOVERS.

IMMEDIATELY OR

DISCARD.



0 200059 403283

PACKED ON

SEE BY

AUG 26

NET WT. 1.65

PRICE/POUNDS

\$3.28

TOTAL PRICE \$5.31



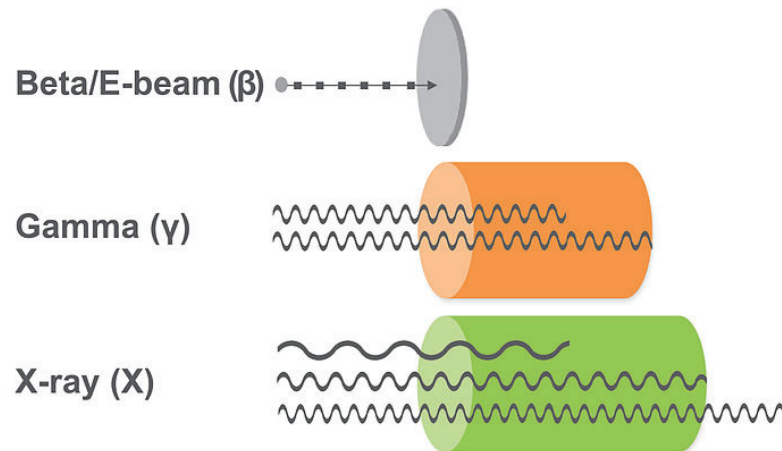
01134

0 706288 9

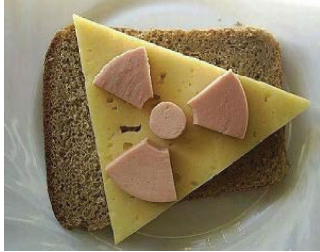
35

Food irradiation.

- The electron beam to 10 MeV
- Gamma rays:
X-ray (bremsstrahlung) to 5 MeV
X-ray in the US to 7.5 MeV



Is irradiated food safe?



- induced radioactivity.
- Long-lived free radicals.



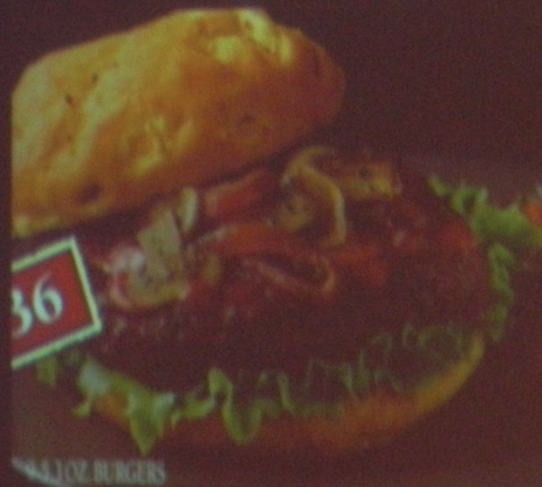
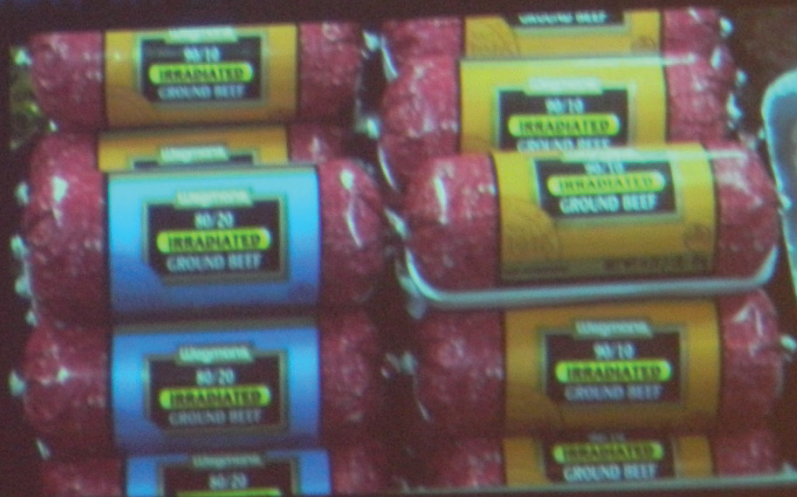
Is irradiated food safe?

- On the proposal of the Joint Committee of Experts of the three international organizations (FAO, IAEA and WHO) in 1970, it was decided to conduct additional studies of mutagenic properties of irradiated food. Studies carried out on a large scale for a number of years in the USA. A large program funded by 23 countries, was carried out in the framework of the international project in Karlsruhe (Germany) at the IAEA task.
- In 1980, a joint committee of experts (FAO, IAEA and WHO) reviewed data from the international research project on the toxicity of irradiated food and concluded that they are not more harmful than conventional foods containing small amounts subtly mutagens, irradiation at a dose of not more than 10 kGy.

Холодная электронная пастеризация



Current Meat Applications of Irradiation in the USA



Schwan's
GROUND CHUCK
Beef Burgers

Keep Frozen
Cook Thoroughly





Irradiation kills harmful bacteria to make your food safer



USDA

Blackberries



Control vs. Irradiated samples 41 days after storage at 0°C (32°F).

Control

0.50kGy



NON - IRRADIATED -

IRRADIATED - (0.2 M RAD)

STRAWBERRIES -

15 DAYS STORAGE 38°F (4°C)

Tomatoes



Control compared to tomatoes irradiated at 1.0 kGy at 10 days



Unirradiated Sample Irradiated Sample,
Dose : 500 Gy

Storage Temp : 20 – 25°C

Relative Humidity : 37% to 90%

Food for astronauts, military and strategic reserves.



Ha Noi Irradiation Center
(VINATOM) – Gamma
Irradiator, 1991

Project D Nang (VINATOM)
Gamma irradiator

Project Bin Thuan
Gamma irradiator

An Phu Co., Lt
Gamma Irradiator, 2005&06

Son So Corp.
EB converted to X-rays, 2003

VINAGAMMA (VINATOM)
Gamma and EB, 1999 & 2012

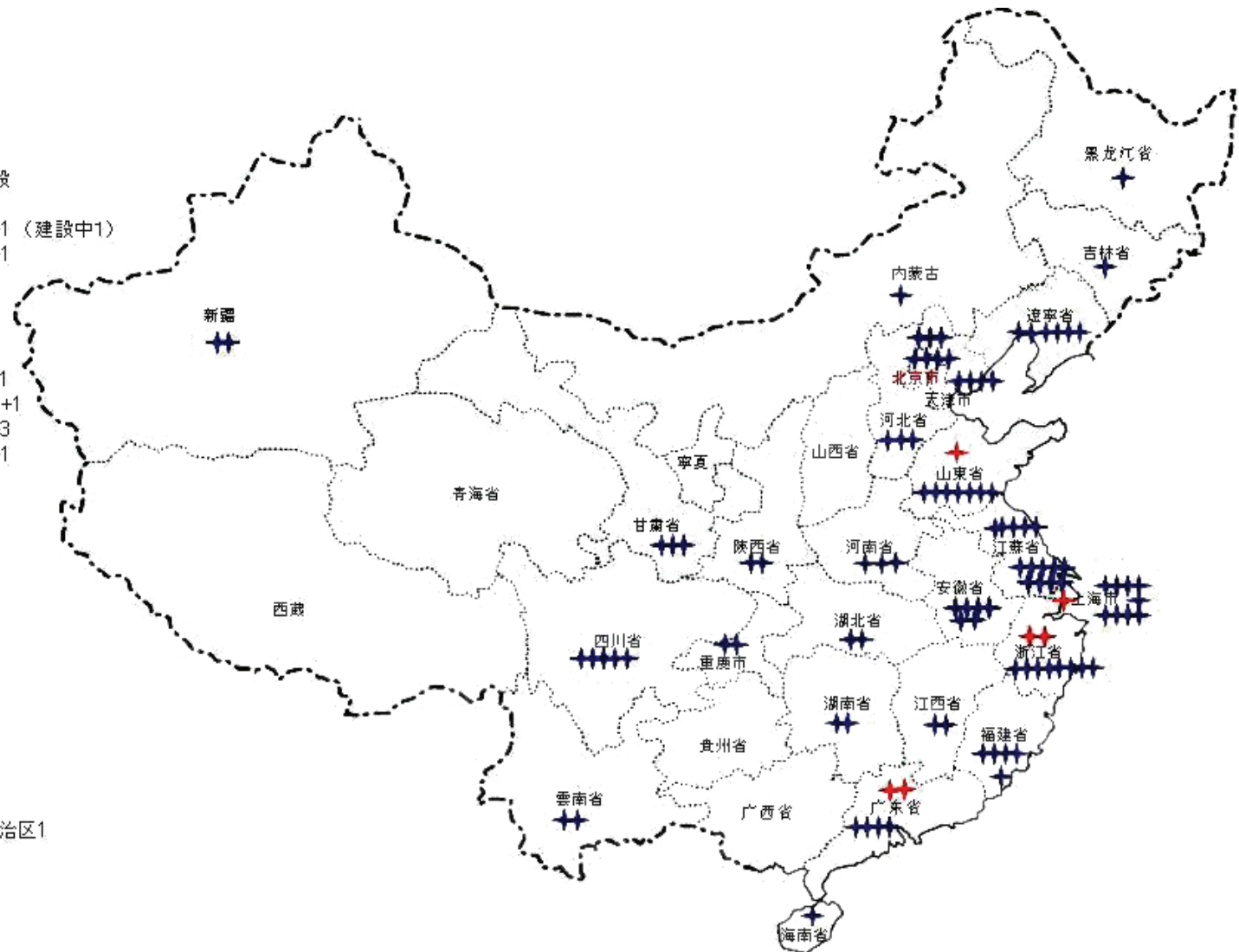
Thai Son Group
Gamma Irradiator, 2009



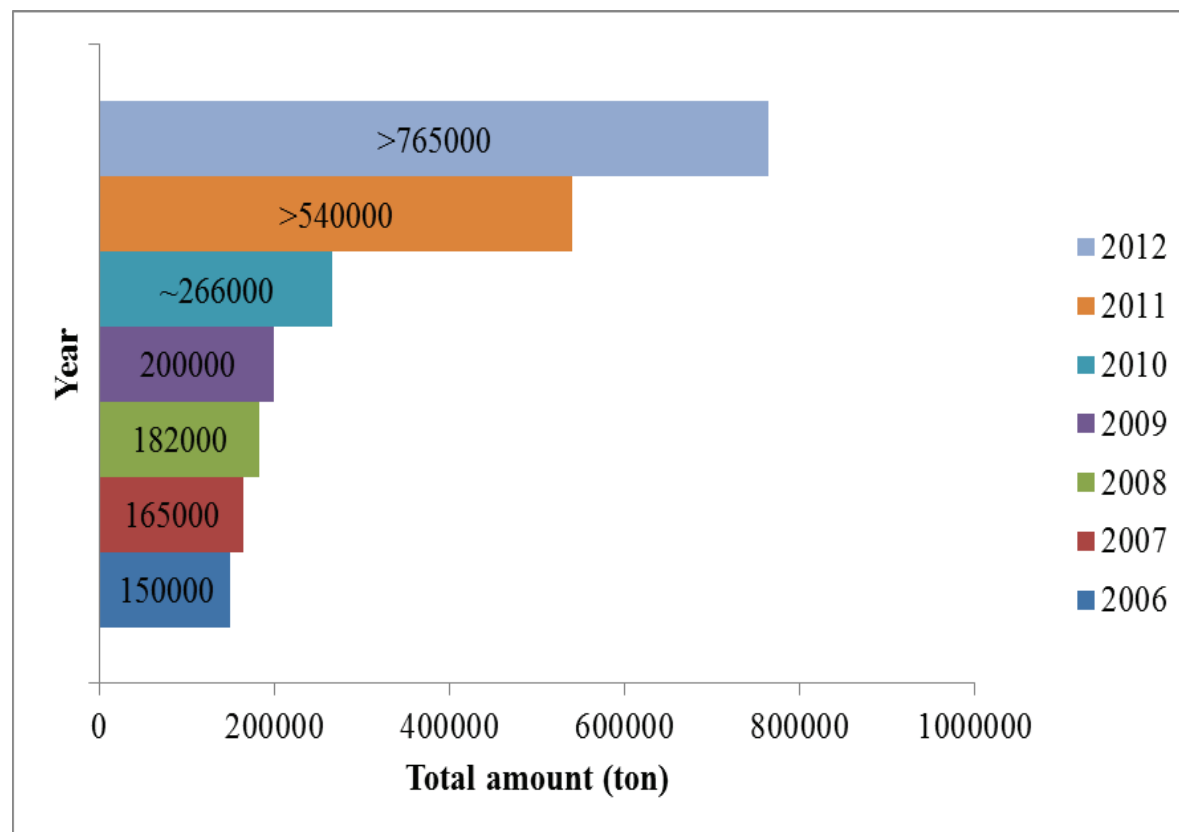
Over 80 facilities irradiate food across China

Co60 施設

北京市7
天津市3+1（建設中1）
上海市8+1
重慶市2
河北省3
遼寧省6
吉林省1
黑龍江省1
江蘇省1+1
浙江省5+3
安徽省5+1
福建省5
江西省2
山東省7
河南省3
湖北省2
湖南省2
广东省4
海南省1
四川省5
貴州省
雲南省2
陝西省2
甘肅省3
青海省
內蒙古自治區1
新疆1+1



Quantities of food irradiated in China



Major Uses and Countries

- Food irradiation increasing rapidly in Asia, and steadily in the USA, Central & South America
- But it is decreasing in the EU
 - EU-wide – only herbs and spices approved
 - Existing national regulations still in force until there is a final approved list for the EU
 - Approved list has been under consideration for 13 years



Problems of development and implementation of the regulatory framework of food irradiation in Russia, the CU and EurAsEC

Adopted in recent years, statutory intergovernmental

documentation:

- Technical Regulations (TR) of the Customs Union TR CU 021/2011 "On food safety". UTV. Decision of the Customs Union Commission on 09.12.2011, № 880
- Common sanitary and the epidemiological-Kie and hygiene requirements (ESEGТ) for goods subject to sanitary and epidemiological supervision (control). Chapter II
- Section I: Safety requirements and the nutritional value of foods. UTV. CU Commission Decision of 28.05.2010g. Number 299, taking into account decisions of the Eurasian Economic Commission and from 19.04.12 №34 from 15.01.13 №6

By TR - From section HACCP compliance (HACCP - Hazard Analysis and Critical Control Points), removed radiation treatment method

Appendix 5 TR stated:

prohibition radiation treatment following products:

- Poultry meat;
- Horsemeat;
- Meat of domestic rabbits;
- Egg powder, melange, and others. Dried egg products

In ESEGТ do not reflect the position of the possibility of radiation treatment (can be interpreted -no ban)

МЕЖГОСУДАРСТВЕННЫЙ СОВЕТ ПО СТАНДАРТИЗАЦИИ, МЕТРОЛОГИИ И СЕРТИФИКАЦИИ
(МГС)
INTERSTATE COUNCIL FOR STANDARDIZATION, METROLOGY AND CERTIFICATION
(ISC)

МЕЖГОСУДАРСТВЕННЫЙ
СТАНДАРТ

ГОСТ
ISO 14470—
2014

РАДИАЦИОННАЯ ОБРАБОТКА ПИЩЕВЫХ ПРОДУКТОВ

**Требования к разработке, валидации и повседневному контролю
процесса облучения пищевых продуктов ионизирующим
излучением**

(ISO 14470:2011, IDT)

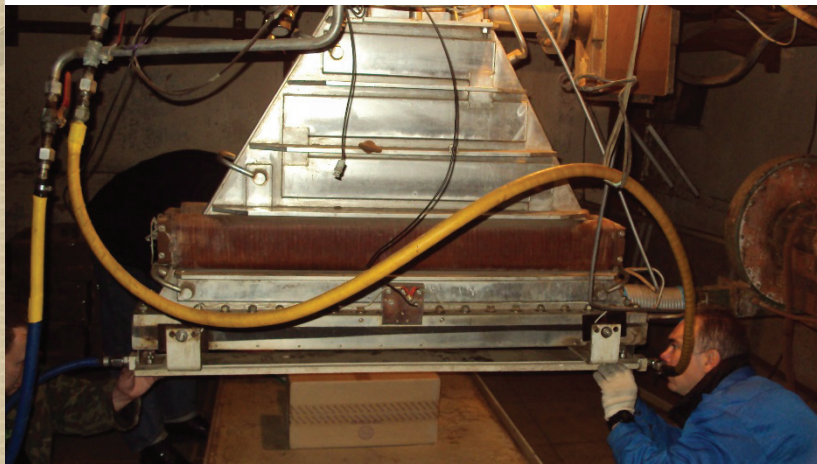
Издание официальное



Москва
Стандартинформ
2015



Irradiation of food samples 9-12.11.2015 Institute for Radiology and Agroecology (Obninsk) on the accelerator ILU-10 in 18 Bld. INP.



Irradiation of grain in Kazakhstan

ТОО «Казахский научно – исследовательский институт защиты и карантина растений»



«УТВЕРЖДАЮ»

Генеральный директор

ТОО «КазНИИЗ и КР»

А.О. Сагитов

2015 г.

ОТЧЕТ

по оценке эффективности действия ионизирующего излучения на насекомых-вредителей

ТОО «Казахский НИИ защиты и карантина растений» (далее - Институт) по заказу АО «Парк ядерных технологий» провел научно-исследовательскую



Парк
Ядерных
Технологий

обычно погибают быстрее взрослых вредителей и, как правило, не могут превратиться в следующую стадию развития.

Методика. Институт провел намеренное заражение муки и крупы амбарными вредителями по общепринятой методике. Степень зараженности исследуемых продуктов определялась по ГОСТ 13586.4-83.

Исследуемые продукты были заселены согласно вариантам опыта жуками по степени зараженности (I, II, III) в лаборатории Института при постоянной

контрольными образцами. Плодовитость через 7-20 суток во всех вариантах не отмечалась, т.е. составила 100%, а в контроле она составила от 7,6 до 12,3%. Через 30 суток все насекомые вымерли.

Таким образом, как видно из полученных данных, при радиационной обработке указанными дозами сокращается продолжительность жизненного цикла жука и его плодовитость.

Основываясь на полученных результатах, можно заключить, что обработка на ускорителе электронов ИЛУ-10 выбранными дозами оказалась эффективной* для уничтожения долгоносиков (*Sitophilus granarius* L.) и мучных хрущаков (*Tribolium confusum* Duv.) в исследуемых продуктах.

**обычно принимают дозу, при которой отмирают 50% особей.*

Зав. отделом защиты технических культур и леса, к.б.н.

Мухамадиев Н.С.

Старший научный сотрудник, к.с.-х.н.

Сарсенбаева Г.Б.

Младший научный сотрудник

Салпиев Р.К.

ILU accelerators for sterilization and pasteurization

Accelerator	appointment	Location	Year of commissioning
ILU-6	Sterilization of needles	Izhevsk, Axion	1994
ILU-10	Pasteurization	Chicago, SureBeam	2001
ILU-10	Sterilization	Novosibirsk, BINP	2001
ILU-6	raw materials Sterilization	Biisk, Evalar	2007
ILU-10, 2 шт.	The synthesis of pharmaceuticals, sterilization	Koltsovo, SPS	2013
ILU-10	Sterilization	Kazakhstan, Kurchatov, Nuclear Technology Park.	2013
ILU-10M	Pasteurization	India, MumbaiBARC.	2014
ILU-14	Decontamination of waste meditsinskikh	Moscow, Federal Medico-Biological Center	2014
ILU-10	Sterilization и исследования	Koltsovo, SPS	2014