

**National Science Center**  
**“Kharkov Institute of Physics and Technology”**

# **Current Situation and Future Revival**

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**Kharkiv, Ukraine**

**DESY, 15 July 2022**

# **NSC KIPT**

**(previously Ukrainian Physical-Technical Institute - UFTI)**  
**(staff about 2000 pers. in 2022)**

## **incorporates:**

- Institute of solid-state physics, materials science and technologies
- Institute of high-energy physics and nuclear physics
- Institute of plasma electronics and new methods of acceleration
- Institute of plasma physics
- Akhiezer Institute for theoretical physics
- Separate departments:
  - The Science and Technical Establishment "Nuclear Fuel Cycle" (NFC STE)
  - The Science and Production Establishment "Renewable Energy Sources and Sustainable Technologies" (SPE RESST)
  - "Accelerator" Science and Research Establishment
  - Accelerator Driven System and Neutron Source

# Institute of solid-state physics, materials science and technologies

- behavior of materials under irradiation
- life extension of nuclear power plants
- radioactive waste disposal problem
- simulation of radiation defects
- pure and ultrapure metals
- plasma methods of layering to solids to increase their hardness
- carbon-carbon composite heat resistant materials
- and etc.

# Institute of high-energy physics and nuclear physics + department “Accelerator”

- photo- and electronuclear reactions
- reactions with giant resonance in nuclei
- polarization effects in nuclear physics
- interaction of high energy electrons with matter
- coherent processes at high energies and channeling
- behavior of detector systems under irradiation
- physics of accelerators and particle beams



# The First in Europe 2 GeV Electron Accelerator was built in UFTI in 1965

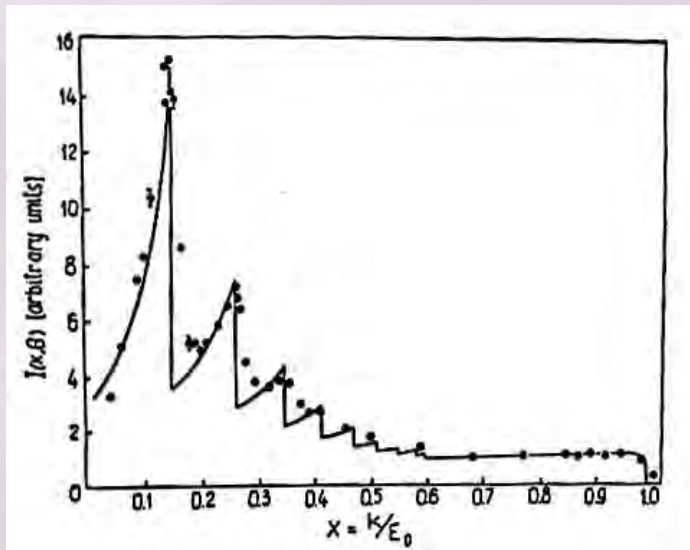


2 GeV electron accelerator (linac)  
(LUE-2000), KIPT, 1965.

In postwar years various acceleration installations were built at UFTI-KIPT for researches both in nuclear physics and physics of elementary particles and for applied, e.g., material science purposes.

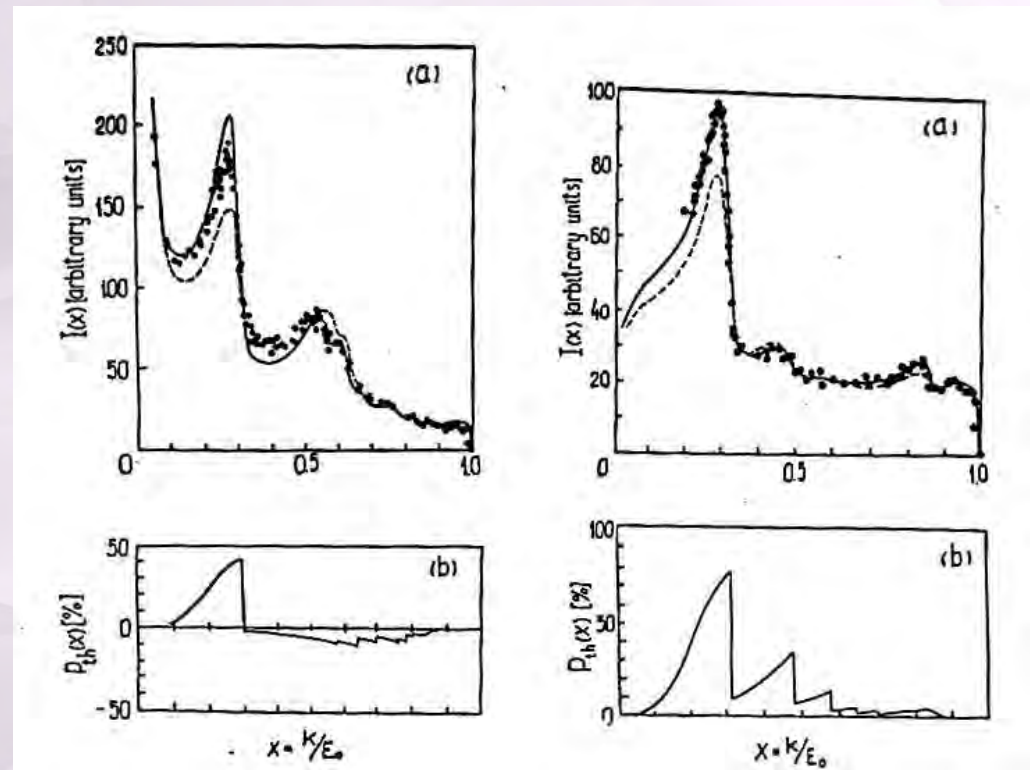
# Experiment $\varepsilon \sim 1 - 5 \text{ GeV}$ (1962 - 1965)

Frascati, DESY, Kharkov, Protvino, Tomsk, Yerevan, SLAC, ...



Frascati

$\varepsilon = 1 \text{ GeV}$ ,  $\theta = 4,6 \text{ mrad}$

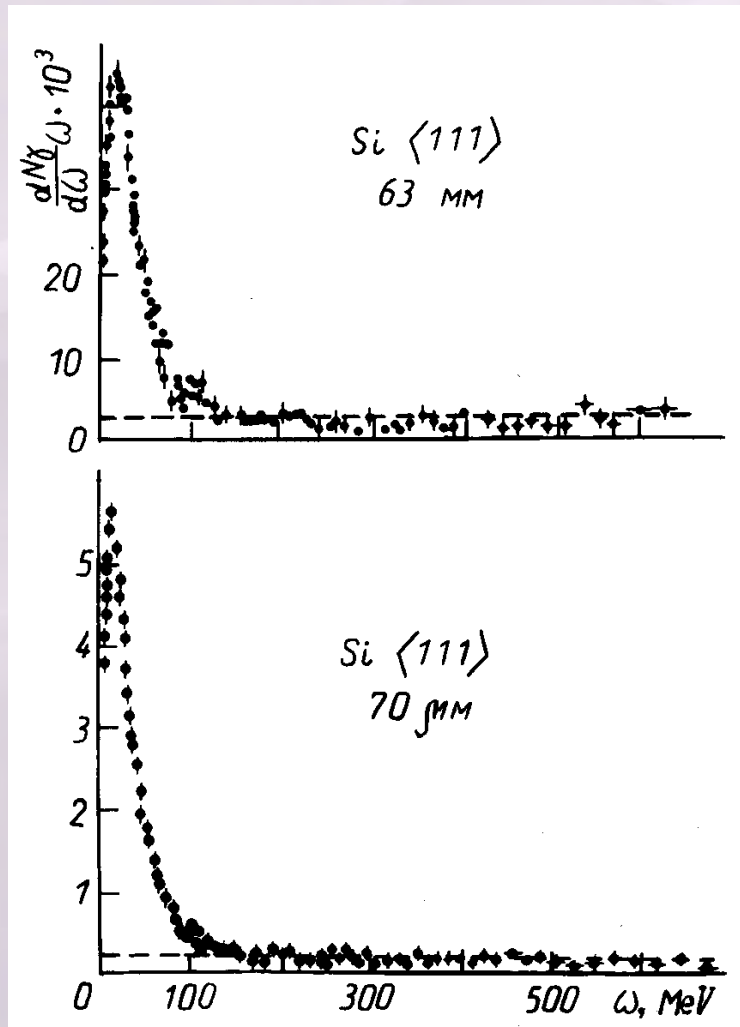


DESY

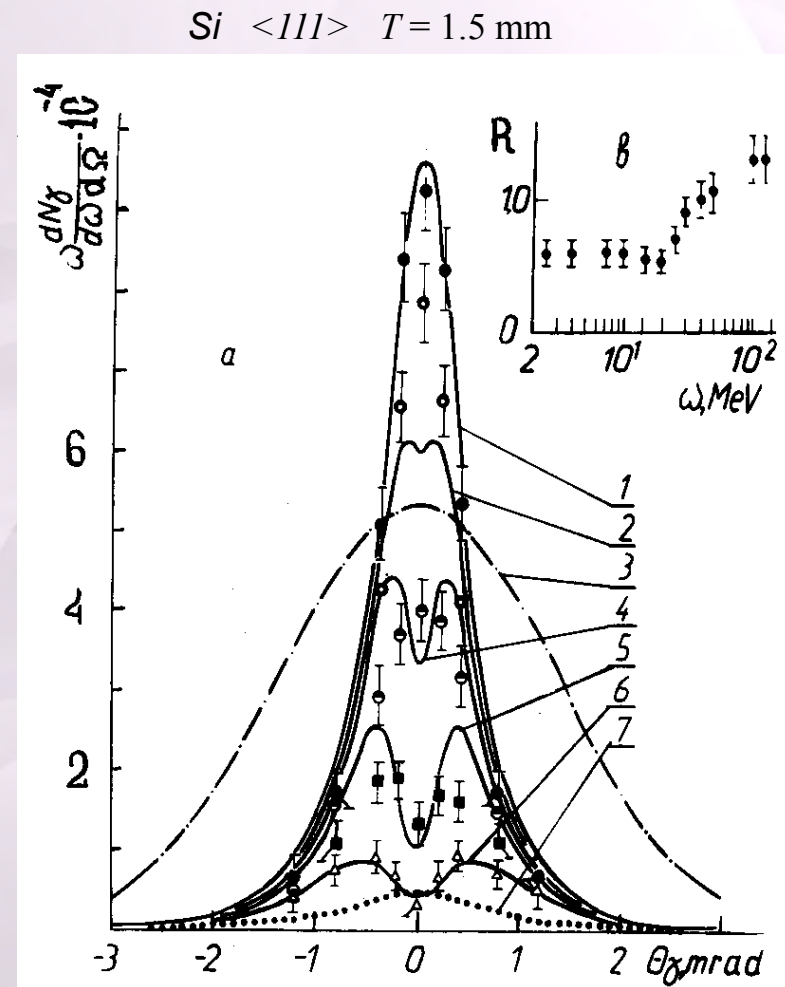
$\varepsilon = 4,8 \text{ GeV}$ ,  $\theta = 3,4 \text{ mrad}$

# Kharkov theory and experiment at 1.2 GeV

A. Antipenko et al., Phys.Lett. A158 (1991) 176.



Radiation spectra



Angular distributions for different  $h\omega$

# Institute of plasma physics + Institute of plasma electronics and new methods of acceleration

- thermonuclear research
- stellarator physics
- participation in Euroatom, EUROFUSION program
- interaction of intense plasma flows with the surface
- technological work with ozonators
- plasma acceleration methods
- exposure to radiation on electronic devices



## Kurchatov and fusion studies in Kharkiv



In the mid-1950s, Kurchatov was actively involved in the problem of controlled thermonuclear fusion. In 1956, he visited the Harwell British Nuclear Center with a group of Soviet scientists and proposed international cooperation of scientists in this field.

Harwell, April 21, 1956. In the foreground, from left to right: J. Cockcroft, I. V. Kurchatov, N. S. Khrushchev, N. A. Bulganin.



I.V. Kurchatov and K.D. Sinelnikov

Since 1956, a new era began at the institute: the famous Kurchatov involved the institute of his friend and colleague Sinelnikov to participate in solving a global problem - providing humanity with energy. Task: to begin research in the field of plasma physics with the aim of implementing a controlled thermonuclear reaction ." From the memoirs of V. T. Tolok.

# Akhiezer Institute for theoretical physics

- quantum field theory and statistical physics
- solid state physics, material science problems
- particle physics
- interaction of high-energy particles with matter
  - coherent processes in crystals
  - electromagnetic processes with half-bare electrons
  - dynamics and kinetics of beams in crystals
  - dynamical chaos and anomalous diffusion phenomena

## Pioneers of Supersymmetry at KIPT



Acad. D. Volkov (1925-1996)

In 1972 D.Volkov and V.Akulov tried to associate the massless fermion - appearing due to spontaneous supersymmetry breaking - with the neutrino.

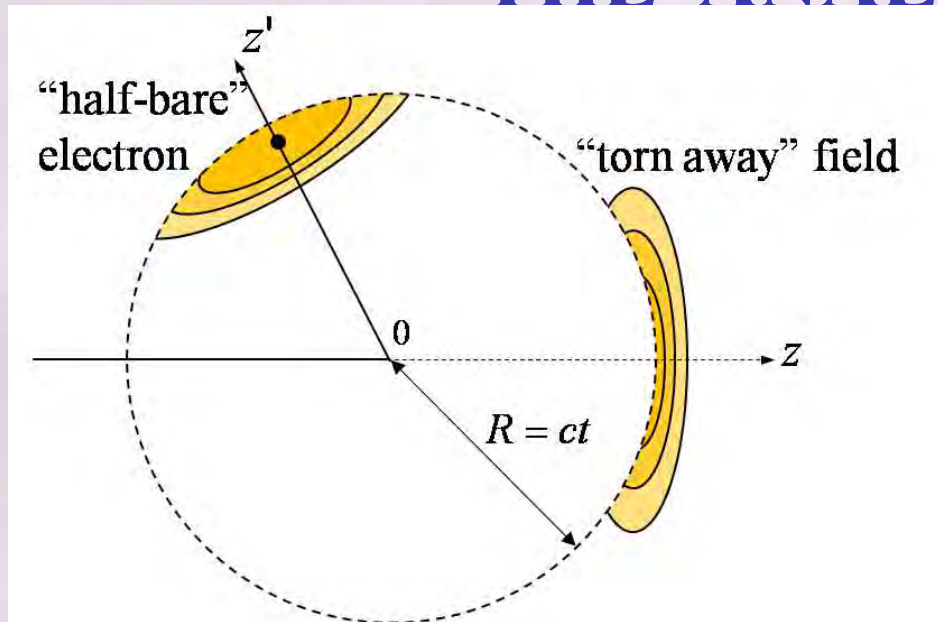
Within a year, D.Volkov and V.Soroka gauged the super-Poincaré group, which led to elements of supergravity. They suggested that a spin  $3/2$  graviton's superpartner becomes massive on "eating" the Goldstino that Akulov and Volkov had discussed earlier.

The existence of this "super-Higgs mechanism" in full-blown supergravity was later established in the West.

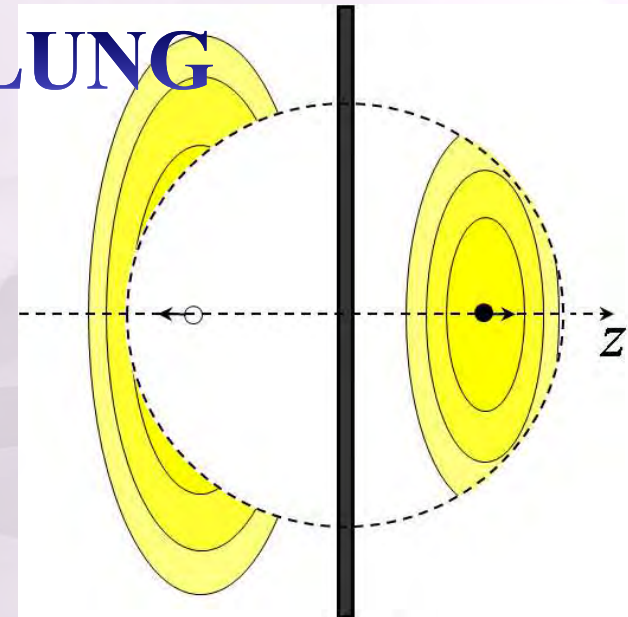


# Transition radiation by "half-bare" electron

## THE ANALOGY IN BREMSSTRAHLUNG



Bremsstrahlung



Transition radiation

The total field for  $t > 0$  :

$$\varphi(\vec{r}, t) = \theta(r - t)\varphi_{\vec{v}}(\vec{r}, t) + \theta(t - r)\varphi_{\vec{v}'}(\vec{r}, t)$$

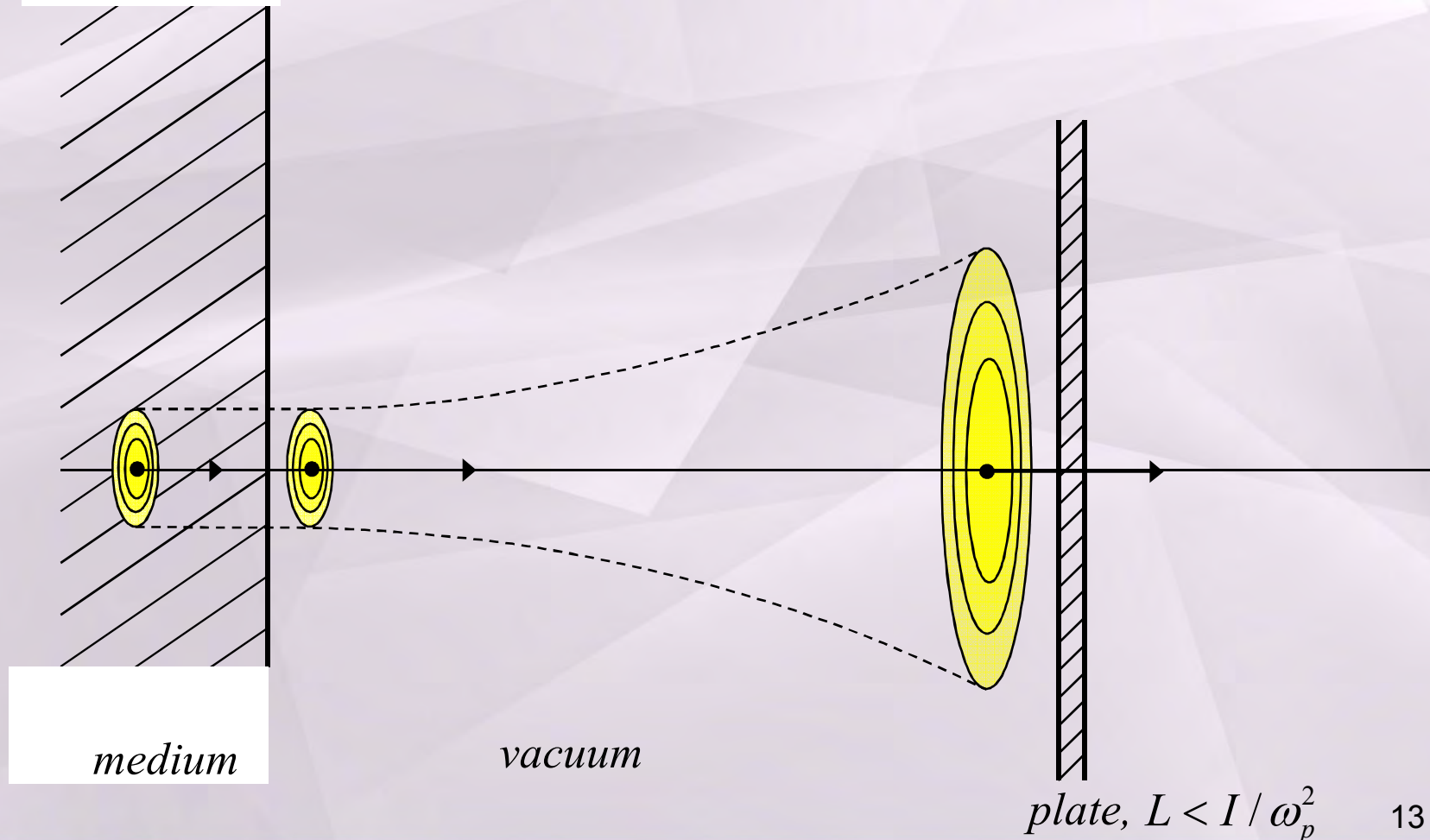
A. Akhiezer, N. Shul'ga *High Energy Electrodynamics in Matter*, 1996

N. Shul'ga, V. Syshchenko, S. Shul'ga // *Phys. Lett. A*374 (2009) 331



# IONIZATION ENERGY LOSSES BY HALF-BARE ELECTRON

N. Shul'ga, S. Trofymenko, Phys. Lett. A 376 (2012) 3572



# Suppression of radiation by relativistic electrons in a thin layer of matter (TSF effect)

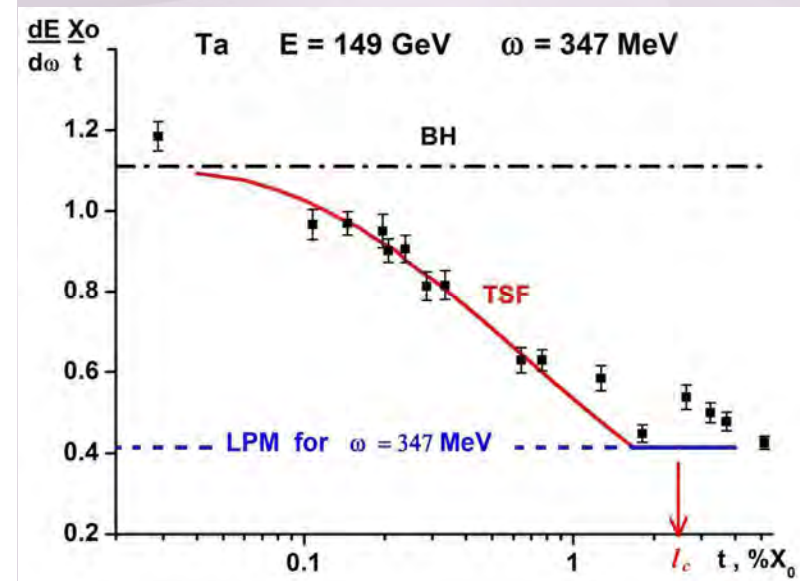
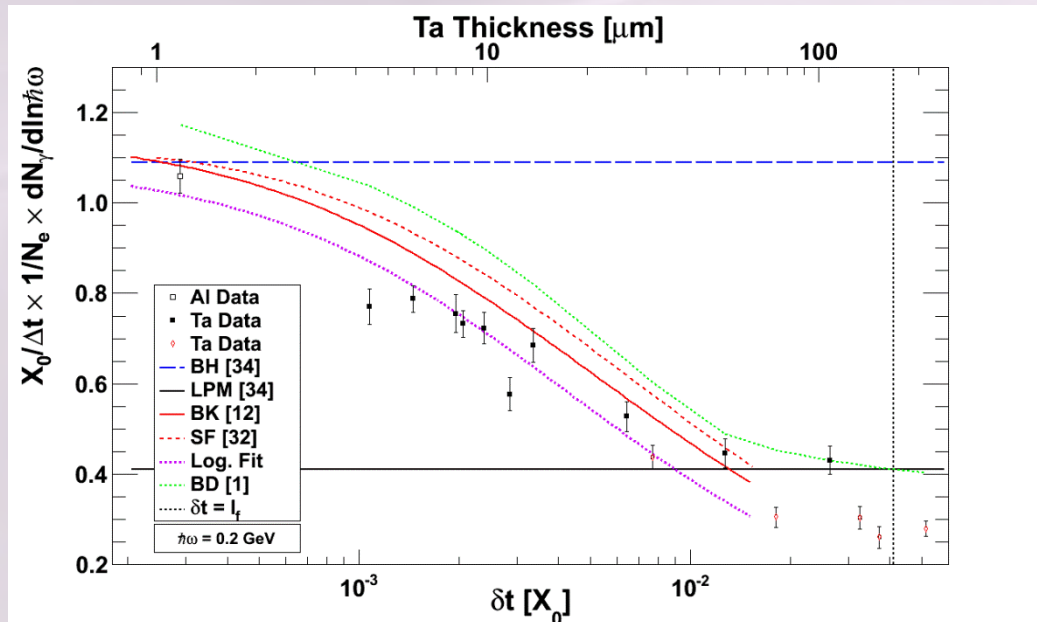
Predicted at KIPT - **1978** - *N.F.Shul'ga, S.P.Fomin, JETP Letters, 27(1978)126.*

Confirmed at CERN - **2009** - *H.D.Thomsen et al., Physics Letters B 672 (2009) 323.*

*H.D.Thomsen et al., Physical Review D 81 (2010) 052003.*

**CERN NA63 SPS  $E = 149$  GeV**

A.S.Fomin, S.P.Fomin, N.F.Shul'ga  
*Nuovo Cimento (2011)*



**U. Uggerhoj : ... we have seen the half-bare electron !**

# Renunciation of the nuclear status of Ukraine



Budapest, December 5, 1994. The memorandum is signed by: B. Yeltsin (Russia), V. Clinton (USA), L. Kuchma (Ukraine) and J. Major (Great Britain)



Dismantling and destruction of missile silos

In January 1994, the presidents of Ukraine, the United States and Russia signed an agreement on ways of nuclear disarmament in Ukraine. The UK has also joined in. At that time, Ukraine had the third largest nuclear arsenal.

NSC KIPT specialists advised the country's leadership on these issues.



# Transfer of highly enriched uranium from NSC KIPT



## Transfer of enriched uranium from KIPT

- 2010: Ukraine announces its readiness to completely eliminate its stocks of highly enriched uranium by 2012. The United States intends to transfer a source of neutrons to Ukraine if the latter refuses highly enriched uranium. This installation will be received by the NSC “Kharkov Institute of Physics and Technology”.
- December 2012: The last batch of highly enriched uranium is shipped from Ukraine to Russia.



## “Neutron Source” at NSC KIPT



Building of the installation "Neutron Source"

Cooperation between Ukraine and the United States on the construction of the neutron source nuclear research facility began in 2010. The feasibility study for the construction of the plant was approved in 2012, the project - in May 2013, after which construction began. The creation of the installation was financed by the US government (more than 90 million dollars) in exchange for the removal of all highly enriched uranium reserves from the territory of Ukraine.

## “Neutron Source” at NSC KIPT



Visit of the President of Ukraine and US Ambassador to NSC KIPT, 2016

- Physical launch was 23.08.2021
- Trial operation since and presently



# 06 March 2022

The "Neutron Source" YPU was fired upon

- the installation is switched to long-term shutdown mode
- the construction of the substation was completely destroyed
- the paneling is damaged in some places



## The war with Russian occupants started 24.02.2022



Since that time the building of the “Neutron Source” with the subcritical reactor was hit multiple times

Fresh result of the rocket hit of the neutron source (26 June 2022)



26 March 2022

Another shelling of the territory



ХАРКІВСЬКА  
ОБЛАСНА  
ПРОКУРАТУРА

ХАРКІВСЬКА  
ОБЛАСНА  
ПРОКУРАТУРА

## Damage to the social infrastructure

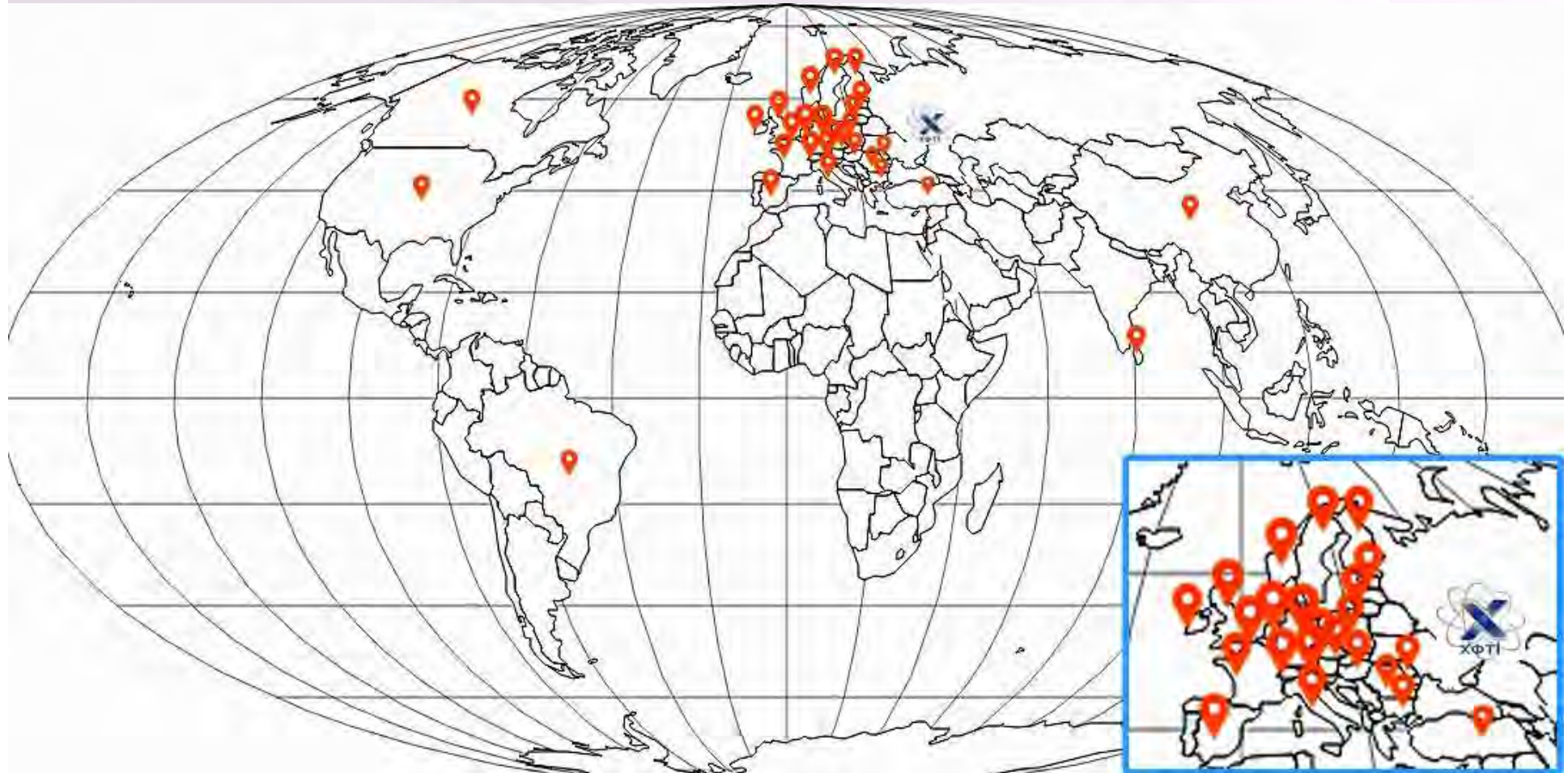


Departmental dormitories and personal apartments of employees were damaged





# Evacuation of NSC KIPT employees around the world



Thirty countries sheltered our employees



# Evacuation of NSC KIPT employees around the world



# Future for NSC KIPT

**NSC KIPT continues the fundamental and applied research in a number of directions that are in demand both in Ukraine and globally, such as**

- **nuclear energy,**
- **radiation materials science,**
- **solid state physics,**
- **plasma physics,**
- **nuclear physics,**
- **high energy physics,**
- **theoretical physics,**
- **nuclear medicine, etc.**

**We collaborate closely with many international science centers in these areas such as CERN, Euro Atom, Argonne National Laboratory, etc.**

**Also, based on the “Neutron Source” the NSC KIPT plans to create under auspices of IAEA the International Center “Nuclear Physics and Medicine”**

***Thank you for  
your attention !***