PIK reactor
state of construction

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Recently Russian Government approved the decision of finalizing reactor PIK construction
on year 2012

Our government made an appropriation for the project in all the rest of PIK construction estimate sum

What for?

There are a number of research reactors in Russia and at first glance there should be no problems with performing of research and development works

Research Reactors
-Material test
-Beam

Research reactor boom in 60th. Beam researches got into the leading position in condensed material physics and demand for more neutron density increased.

HFBR	-	BNL
HFR	-	ILL
FRM II	-	MTU
BR-2	-	JINR

In USSR beam researches have world class.

Now it is neutron drought.

We have 4 reactors with flux $\leq 10^{14}$ n/cm$^2\cdot$sec where beam researches are done.

Now I am quite near to answer on "WHAT FOR? "

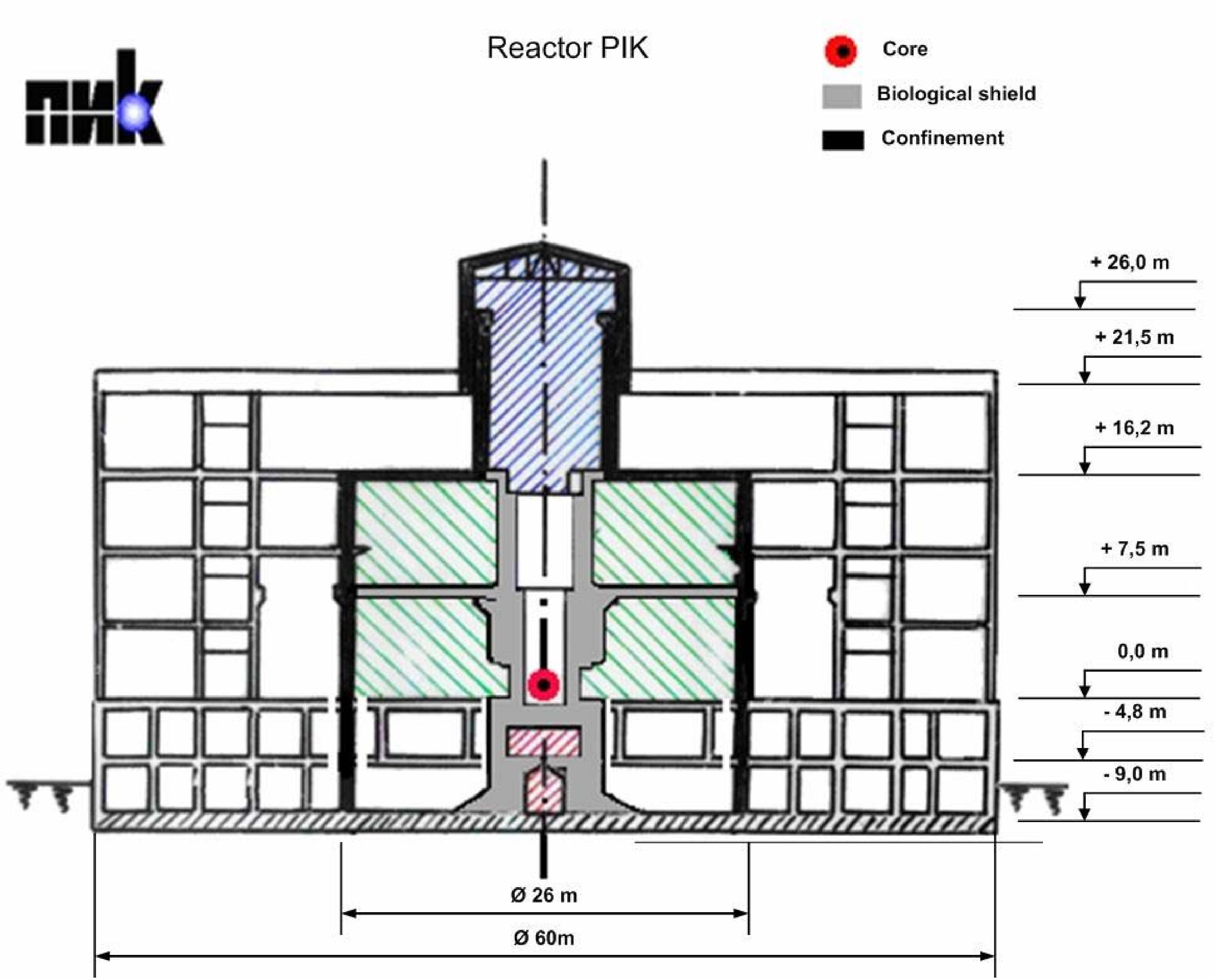
First answer - Country need in neutron beam research.

The second - to put an end to long lasting construction work.

The third - Economy arise and government can support science.

- Construction of reactor began in 1976.
- Building, cooling circuits control desk was completed at 1986.
- Chernobyl accident
- Revised “design 1991” led to significant changes in reactors systems and doubled initial cost.

PIK reactor state of construction.



From 1999 we proceed with installation of reactor systems according to new design.

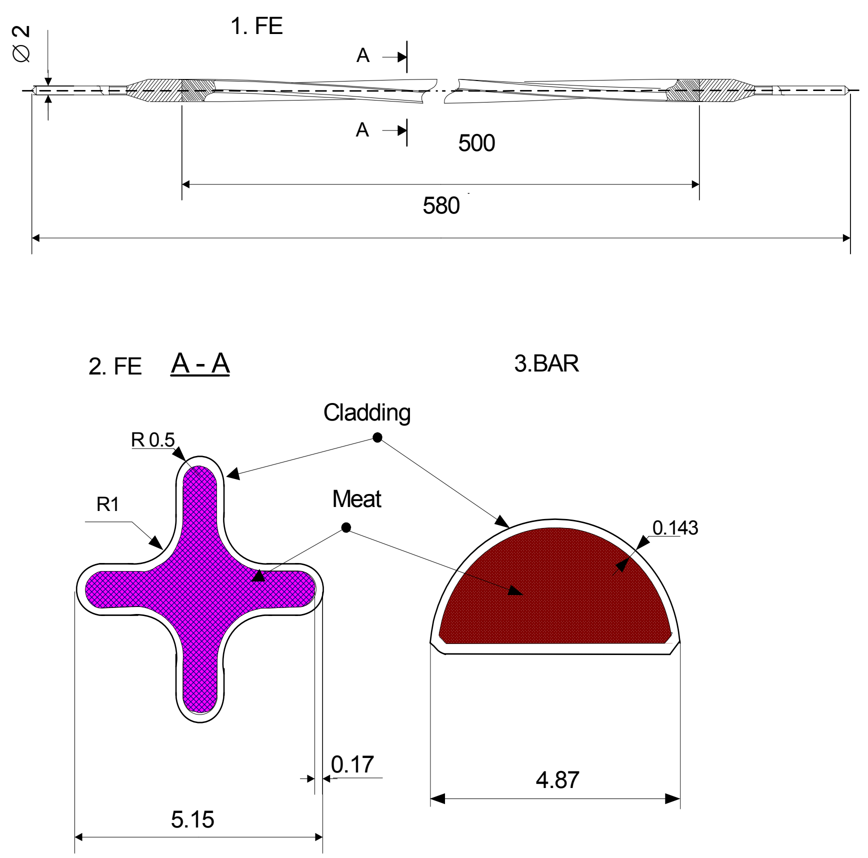
The size of financing was too small to complete construction in reasonable time.

Is the design out of date?

No.

Neutron-flux density in beams of PIK reactor hits record high.

Compact active core, cooled by light water and heavy-water reflector.



∅ 2
1. FE
A
A
500
580
2. FE
A - A
3.BAR
Cladding
R 0.5
R1
Meat
0.143
0.17
4.87
5.15

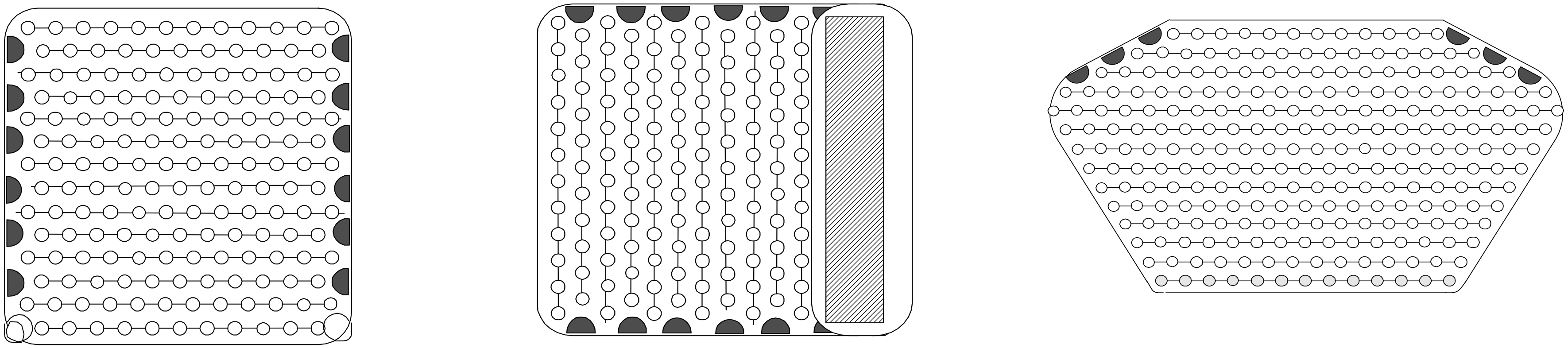
Fuel UO_2

Enrichment 90%

Uranium in the matrix 1.5 g/cm^3

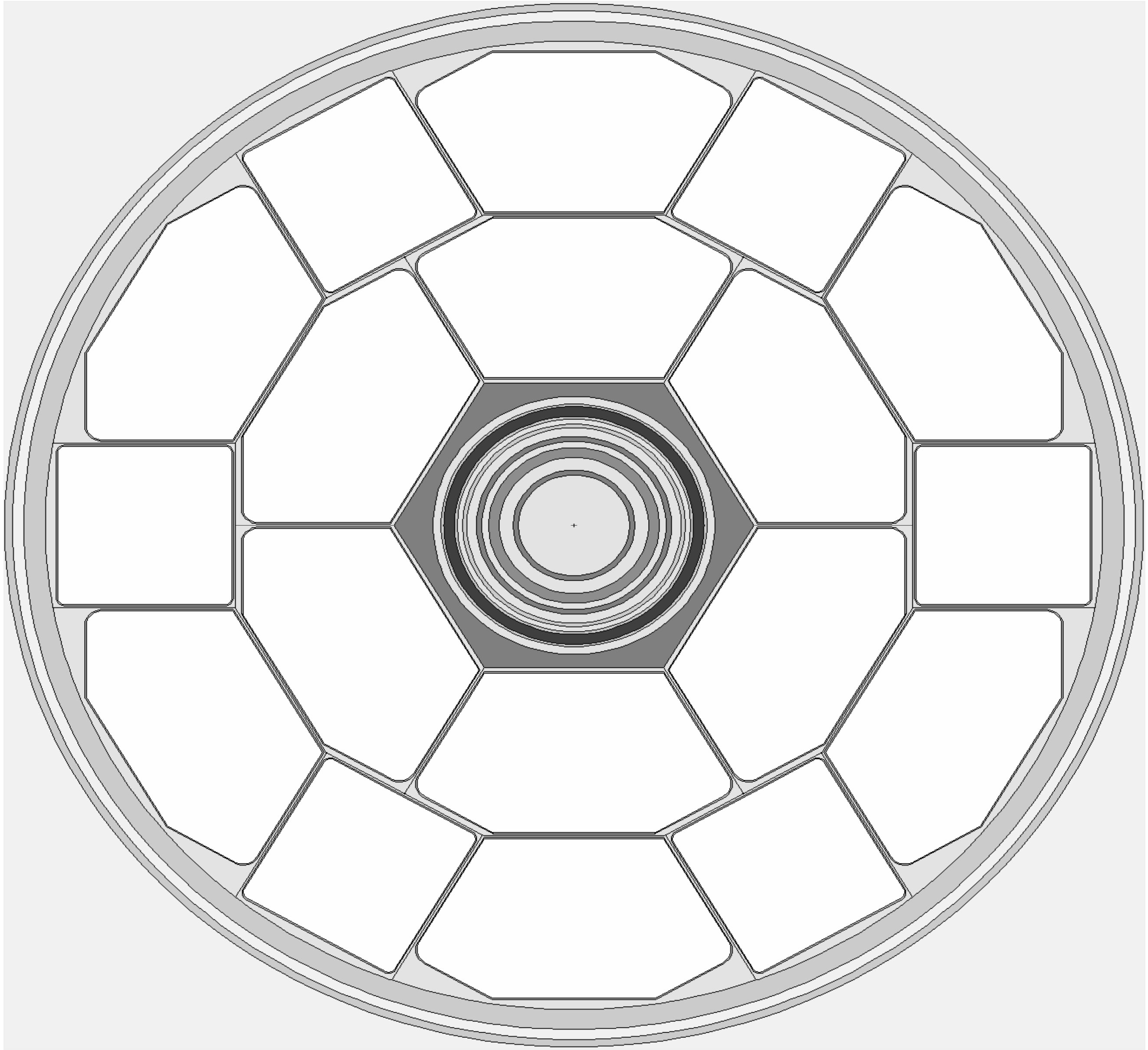
Stainless steel cladding 0.16 mm

Core fuel concentration ^{235}U – 600 g/l

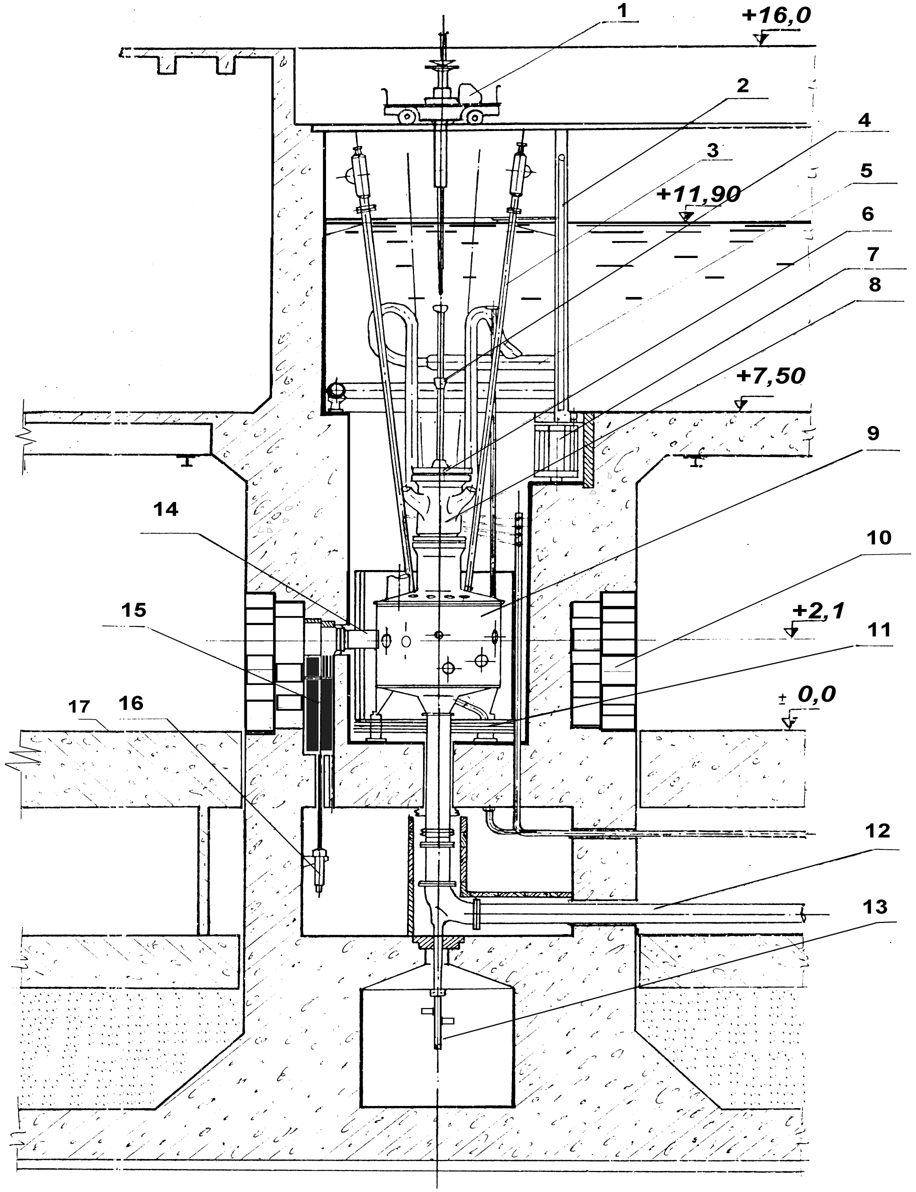


Fuel assemblies PIK

PIK reactor state of construction.



PIK reactor state of construction



Three characters:

Exchangeable experimental beam tubes

Exchangeable vessel

Dismountable biological shield

Power 100 MW

Maximal specific power 6 MW/l

Core volume 50 l

Core diameter 390 mm

Core height 500 mm

Reflector D2O

Diameter - 2.5 m

Height - 2 m

Cooling circuit

Coolant - H_2O

Pressure - 50 bar

Flow-rate - 2400 m^3/hour

Inlet/Outlet temperature - 50/95^{o}C

Central loop channel in the core

Thermal neutron flux

$5 \cdot 10^{15}$ n/cm^{2}s

Fast neutron flux (E>0.7 MeV)

$7 \cdot 10^{14}$ n/cm^{2}s

Cooling power 400 kW

Pressure range 1.5 ÷ 50 atm.

Horizontal channels– 10 units

Thermal neutron fluxes on bottoms

$(0.1 \div 1.2)\ 10^{15}\ n/cm^2s$

Thermal neutron fluxes at the outlet

$(0.2 \div 3)\ 10^{11}\ n/cm^2s$

Diameters 100 ÷ 250 mm

Inclined channels– 6 units

Thermal neutron fluxes on bottoms

$(0.2 \div 1) \cdot 10^{15}$ n/cm^{2}s

Fast flux (E>0.7 MeV) on bottom

channel № 5 $2 \cdot 10^{14}$ n/cm^{2}s

Channel diameters 90 – 140 mm

Vertical channels– **7** units

Thermal neutron fluxes on bottoms (1÷ 3) 10^{14} n/cm^{2}s

Channel diameters 60 mm

Cold neutron sources CNS –2 units

1. For the neutron guide hall.

Average flux value over CNS

$4 \cdot 10^{14}$ n/cm^{2}s

2. For the ultra-cold neutron.

Average flux value $1.2 \cdot 10^{15}$ n/cm^{2}s

Hot neutron source

Average thermal neutron flux value

$3 \cdot 10^{14}$ n/cm^{2}s

Wavelength at maximum 0,5Å

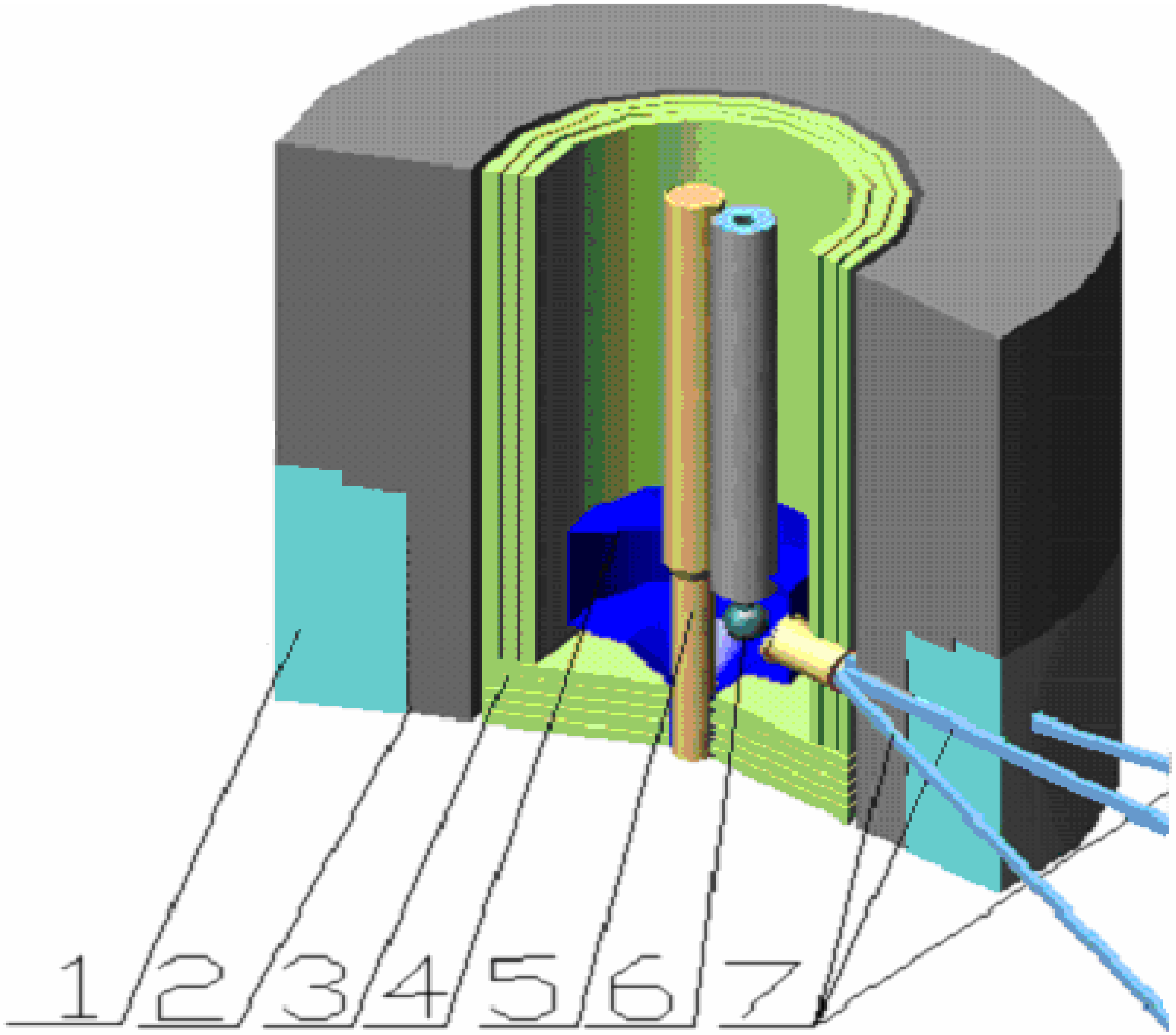
Flux at the outlet $3 \cdot 10^9$ n/cm^{2}s

Neutron guides – 7 units (with possible growth up to 9)

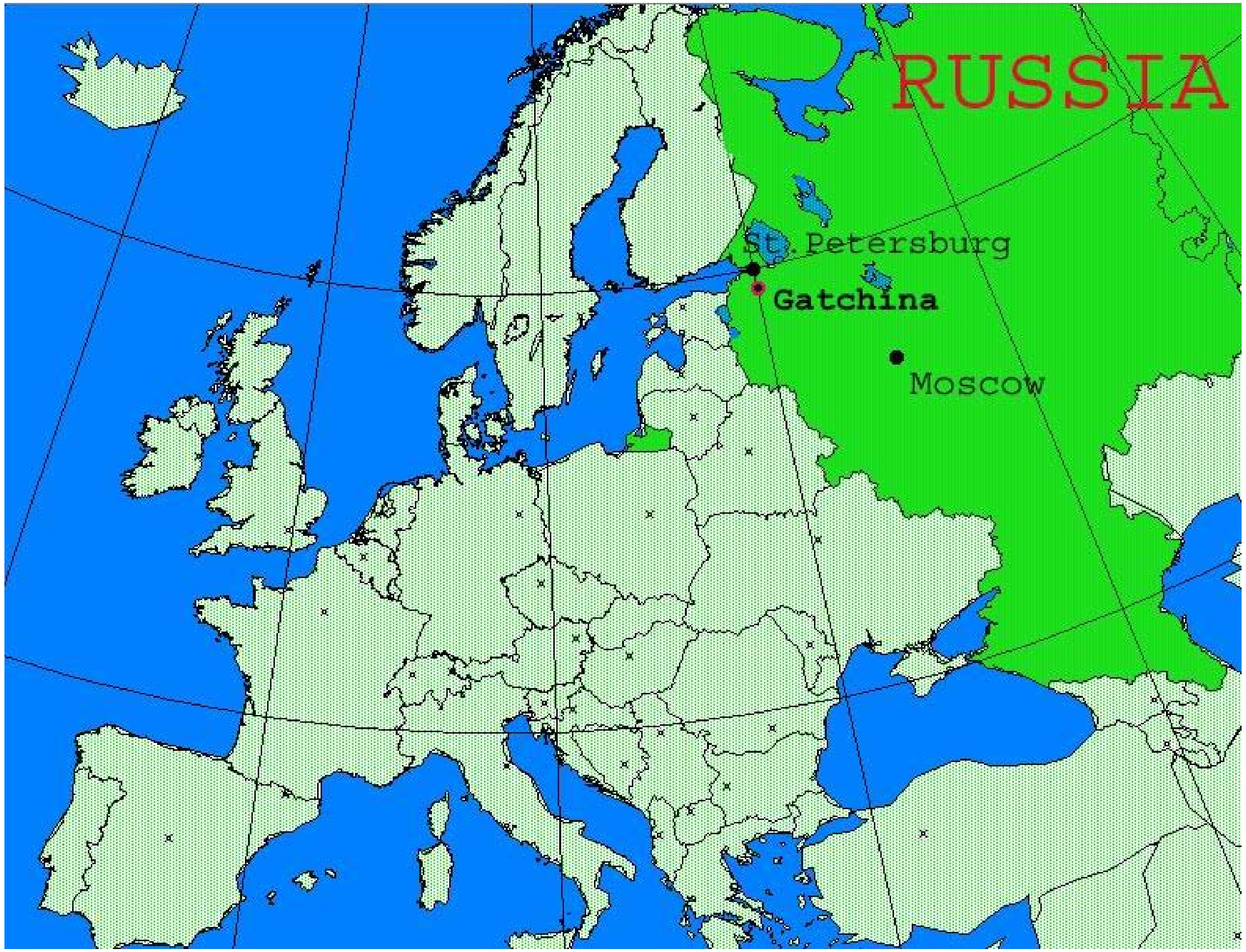
Wavelength λ = 1.0 ÷ 12 À

Outlet fluxes $(0.3 \div 1.5) \cdot 10^9$ n/cm^{2}s

PIK reactor state of construction.

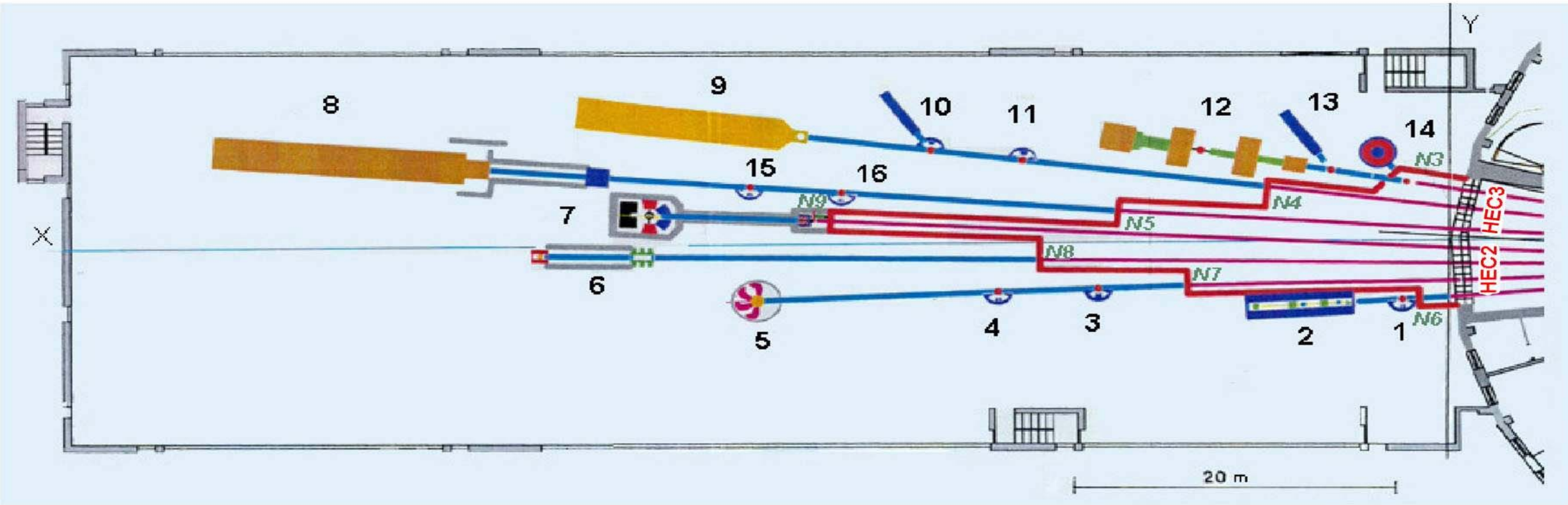


PIK reactor state of construction.

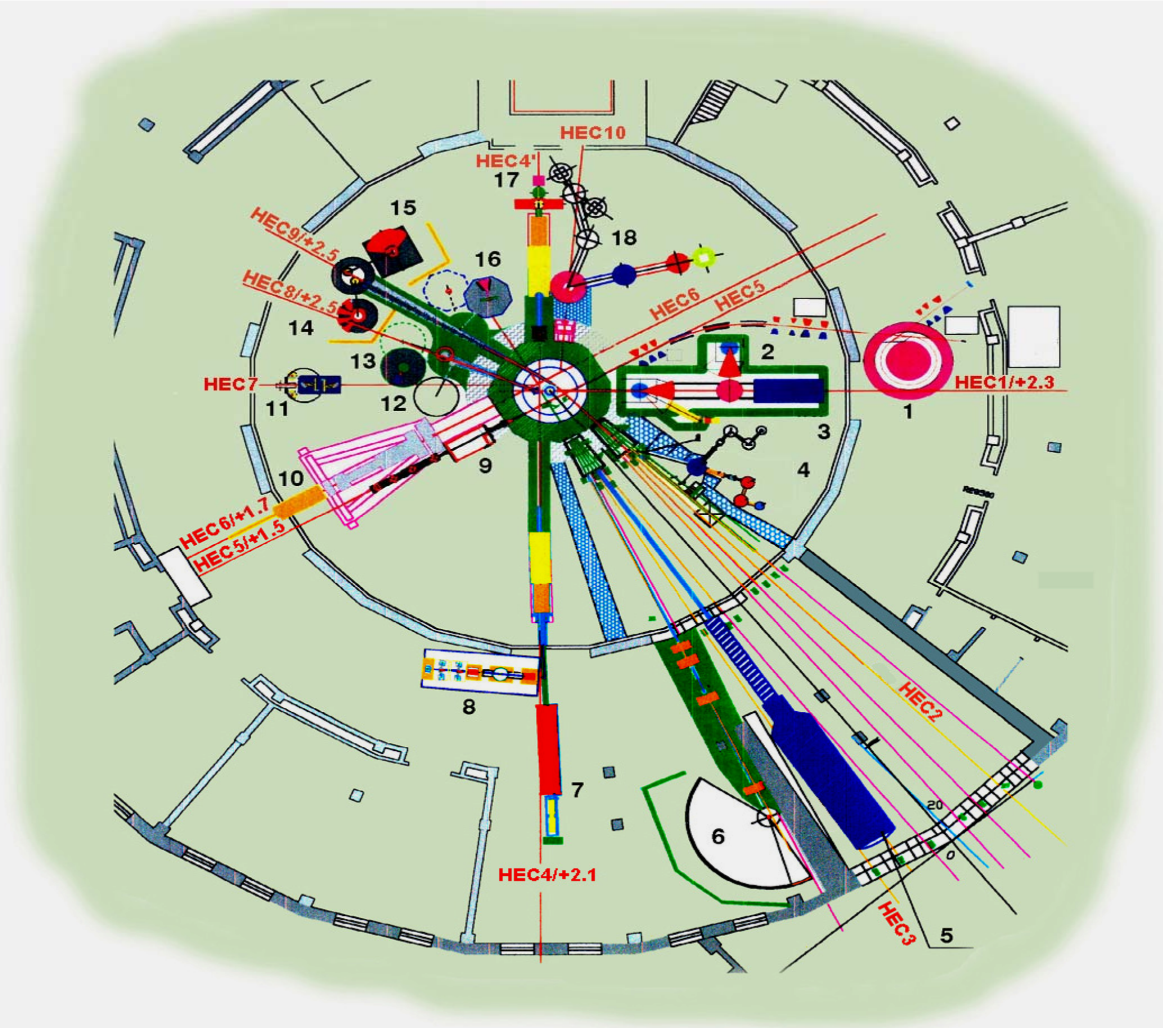


PIK reactor state of construction.

PLANNED PLACING OF FACILITIES IN NEUTRON GUIDE HALL

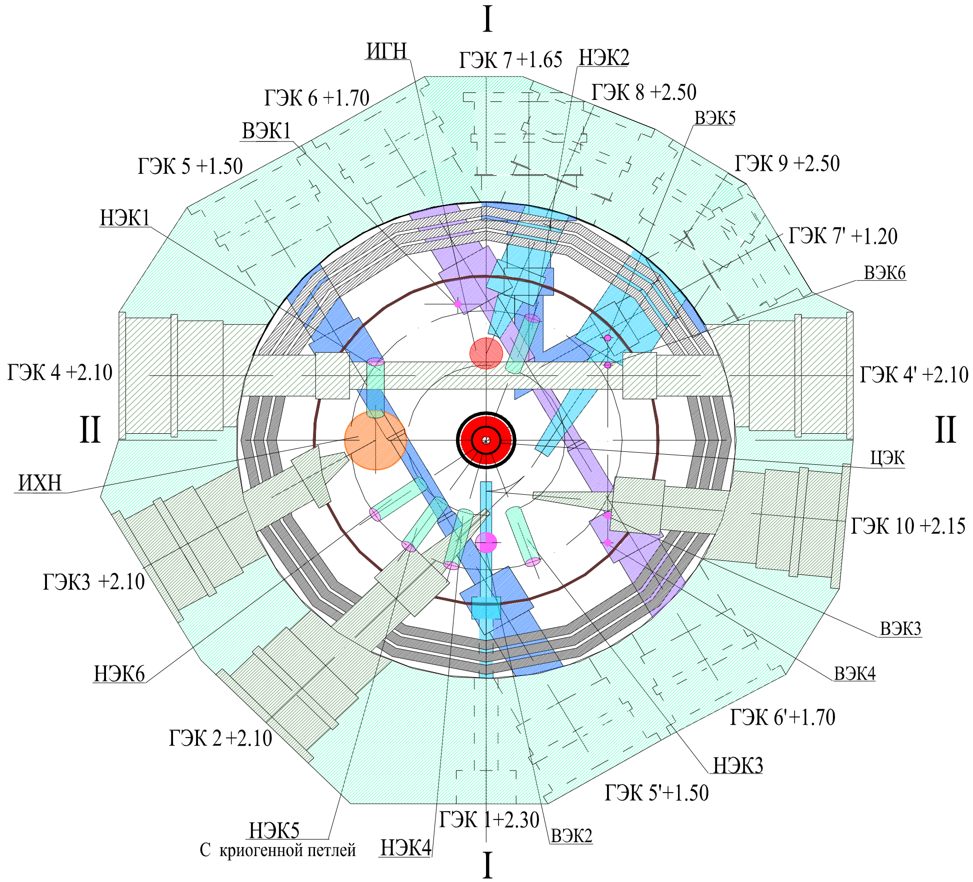


1. Vacant place
2. Test reflectometer
3. Vacant place
4. Vacant place
5. Correlation diffractometer
6. Set up using polarized neutrons for basic physics researches
7. Fourier diffractometer
8. Small angle scattering diffractometer
9. Small angle scattering spectrometer
10. Horizontal plane reflectometer
11. Vacant place
12. Modulation spin echo spectrometer
13. Texturometer
14. 70-counters powder diffractometer
15. Biaxial diffractometer for testing of monochromators
16. Vacant place



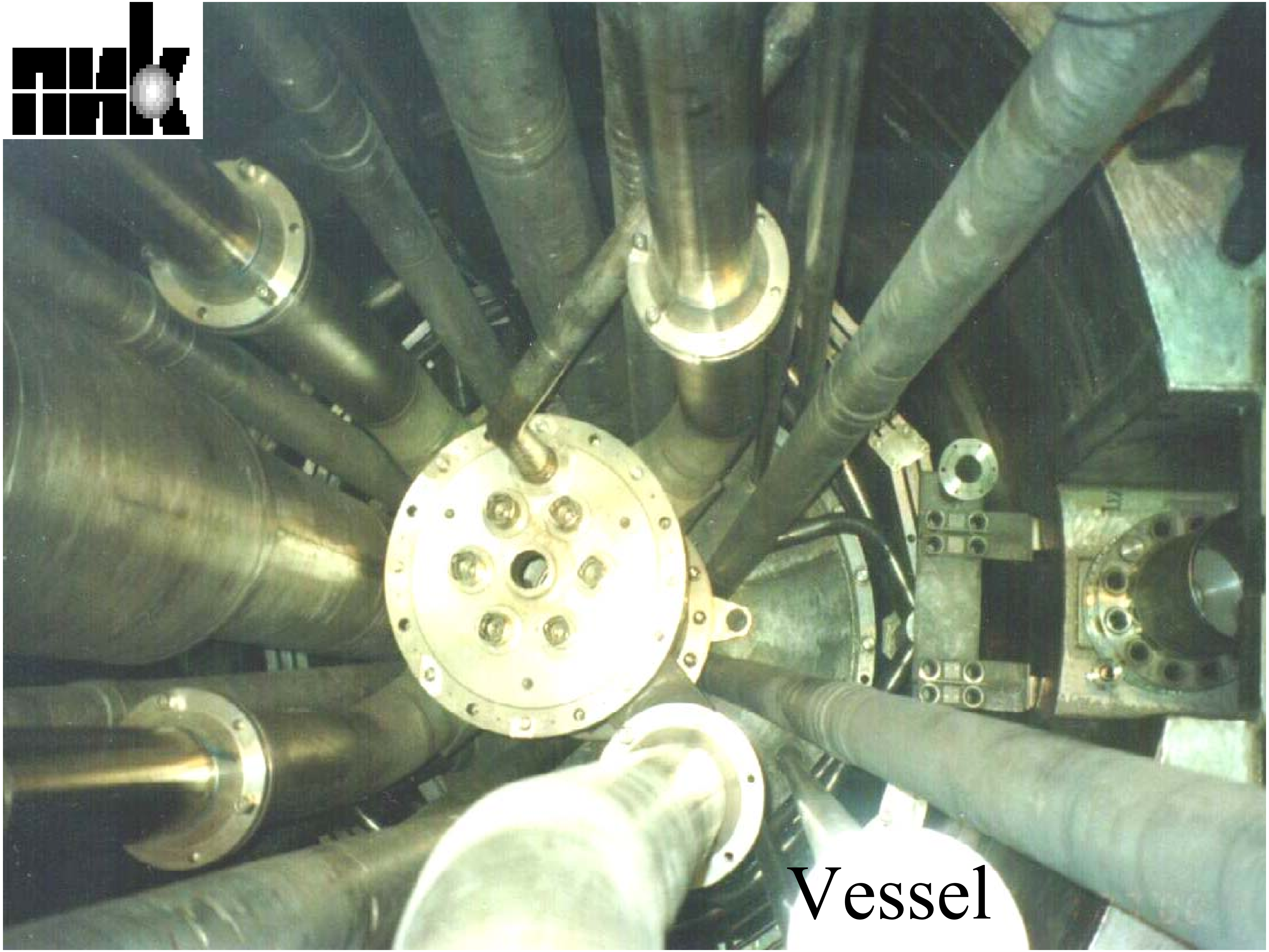
Planned installation in main hall

ПИК



I
ИГН
ГЭК 7 +1.65
НЭК2
ГЭК 6 +1.70
ГЭК 8 +2.50
ВЭК5
ВЭК1
ГЭК 5 +1.50
ГЭК 9 +2.50
НЭК1
ГЭК 7' +1.20
ВЭК6
ГЭК 4 +2.10
ГЭК 4' +2.10
II
II
ЦЭК
ИХН
ГЭК 10 +2.15
ГЭК3 +2.10
ВЭК3
НЭК6
ВЭК4
ГЭК 6'+1.70
ГЭК 2 +2.10
НЭК3
ГЭК 5'+1.50
ГЭК 1+2.30
НЭК5
С криогенной петлей
НЭК4
ВЭК2
I

Vessel

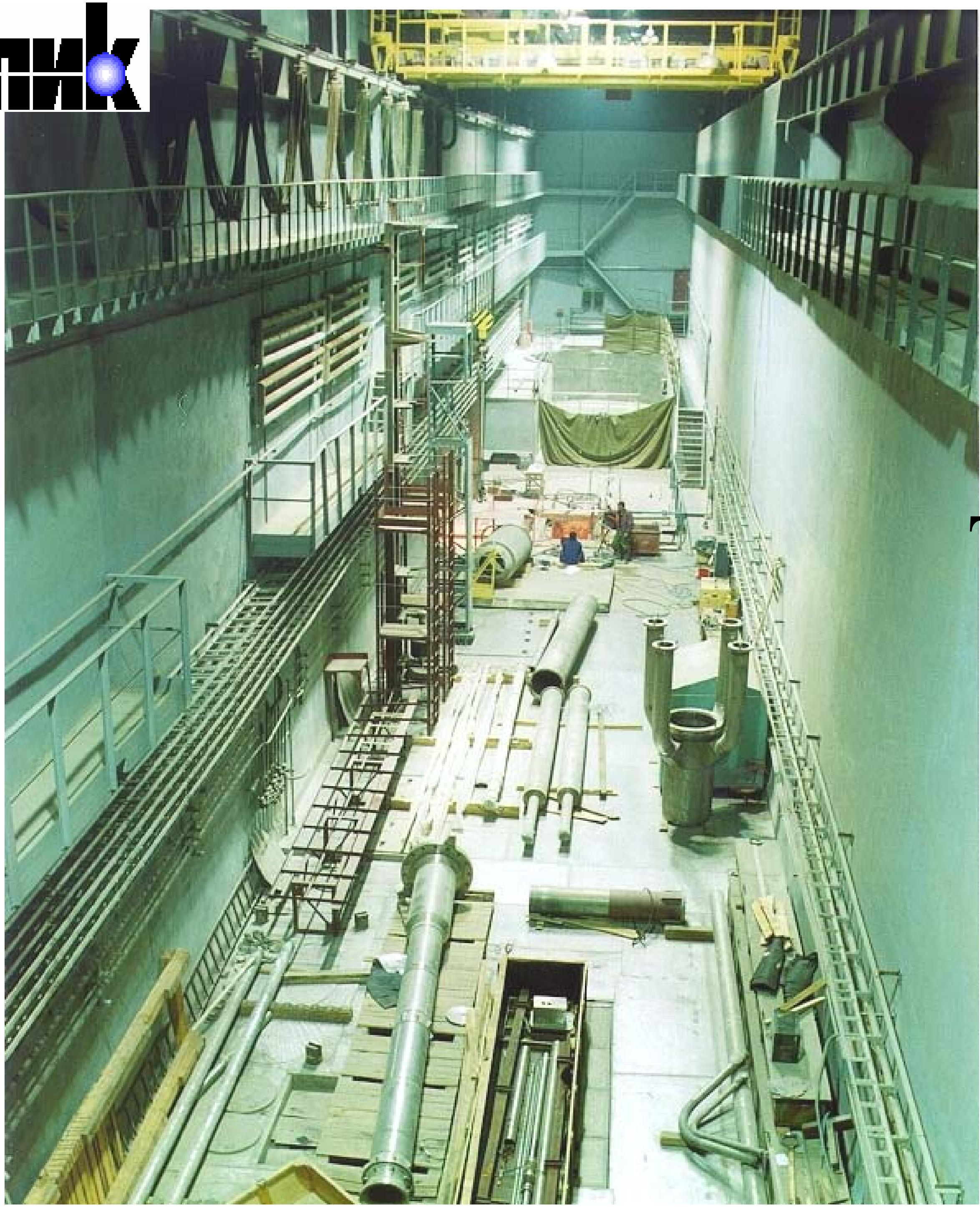

Vessel

Heavy water cooling station.

Air control station.

Main hall.

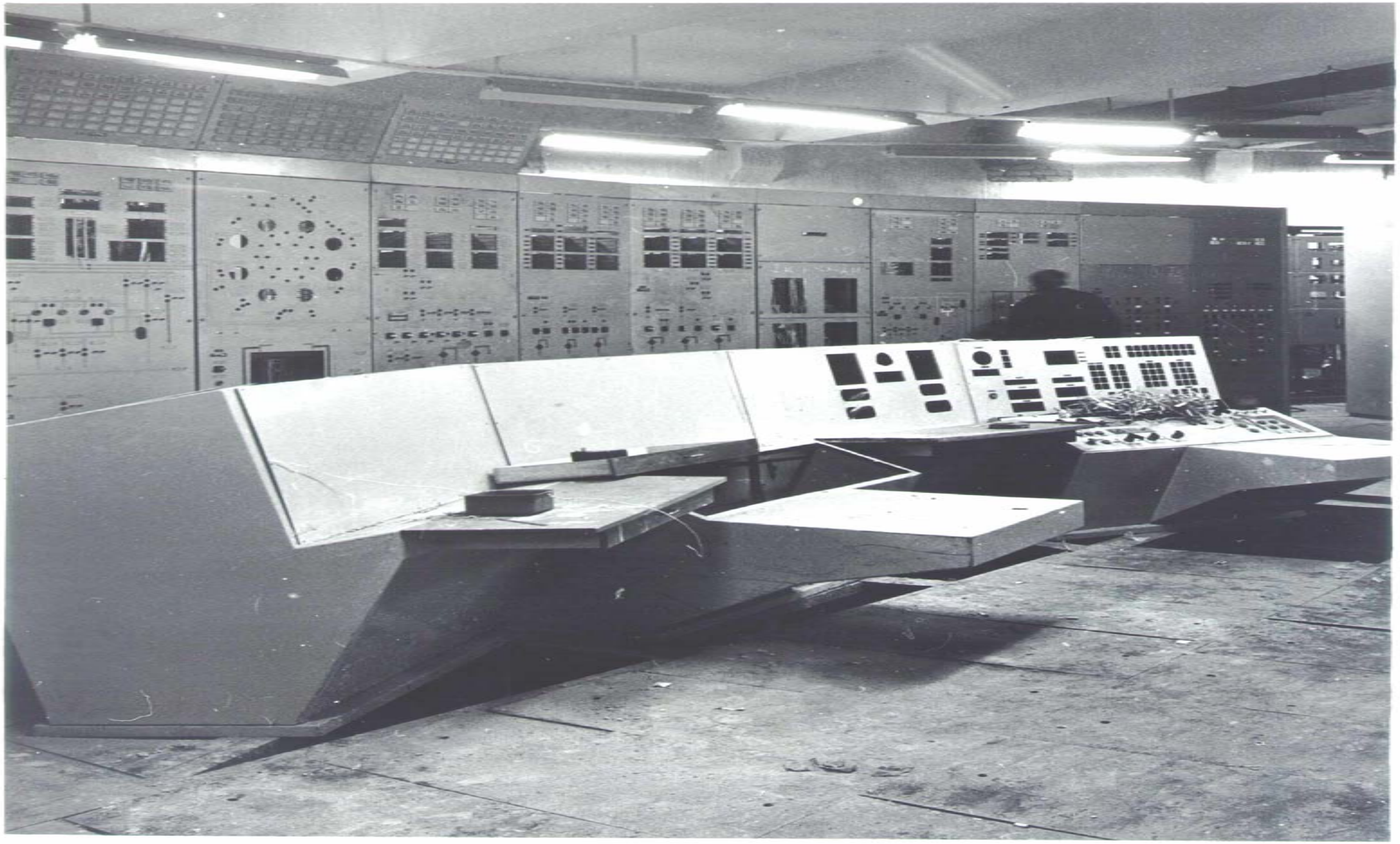
кого зала



Technological hall.

Control panel.

Фот Year 1986 о - пульт 1986

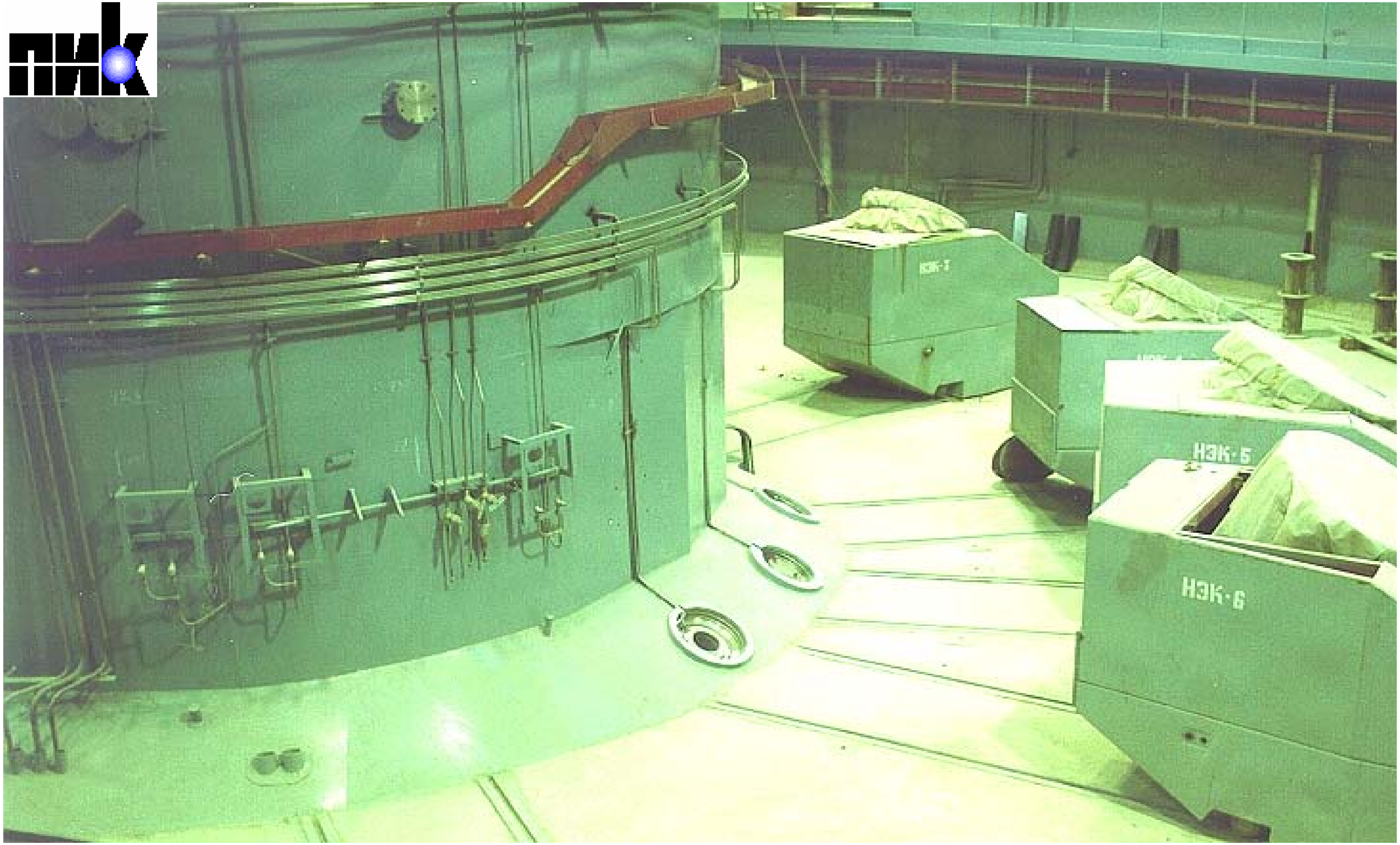


Октябрь I988г.

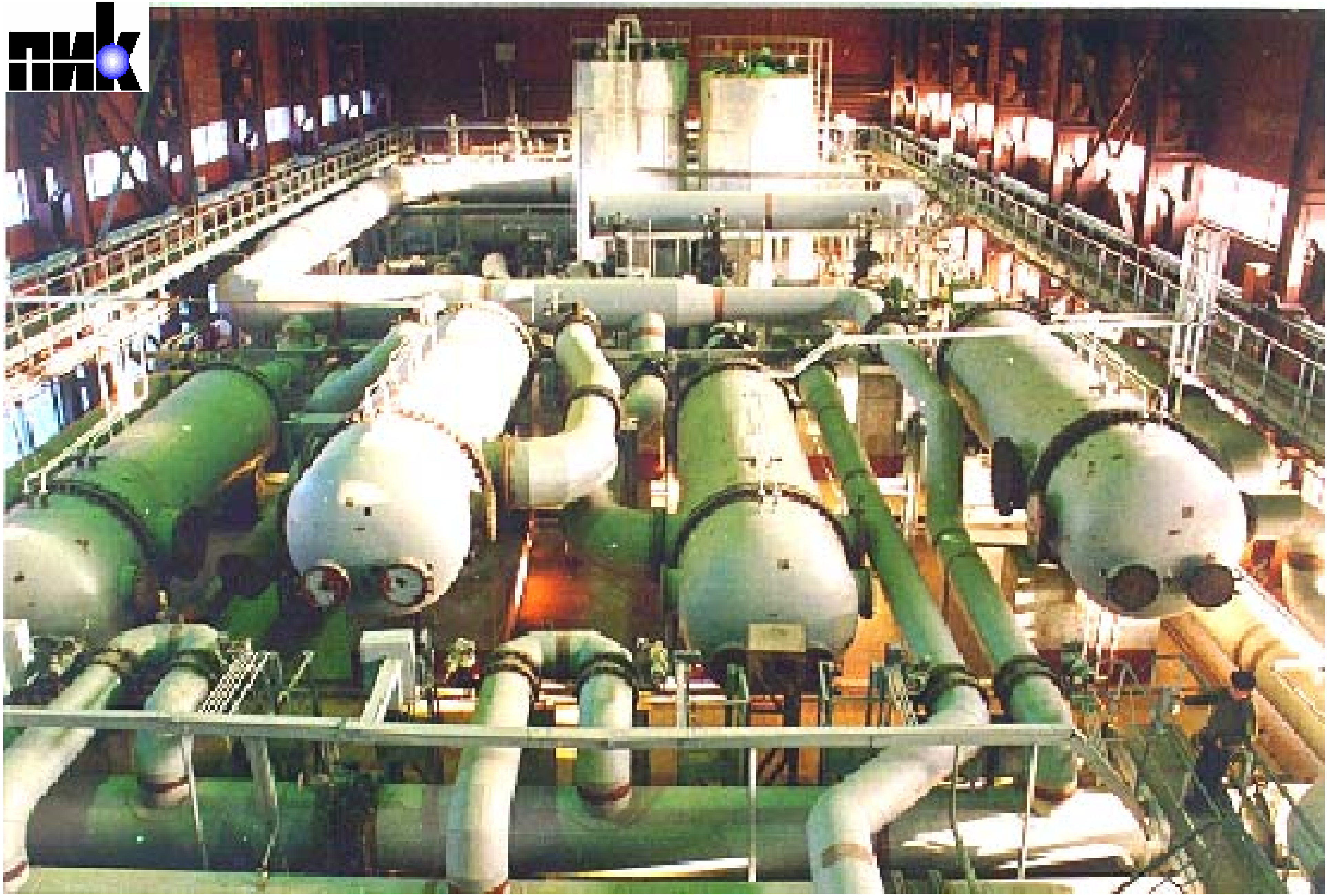
Блок IOOA. Пульт реактора

Монтаж остановлен в I986 году.

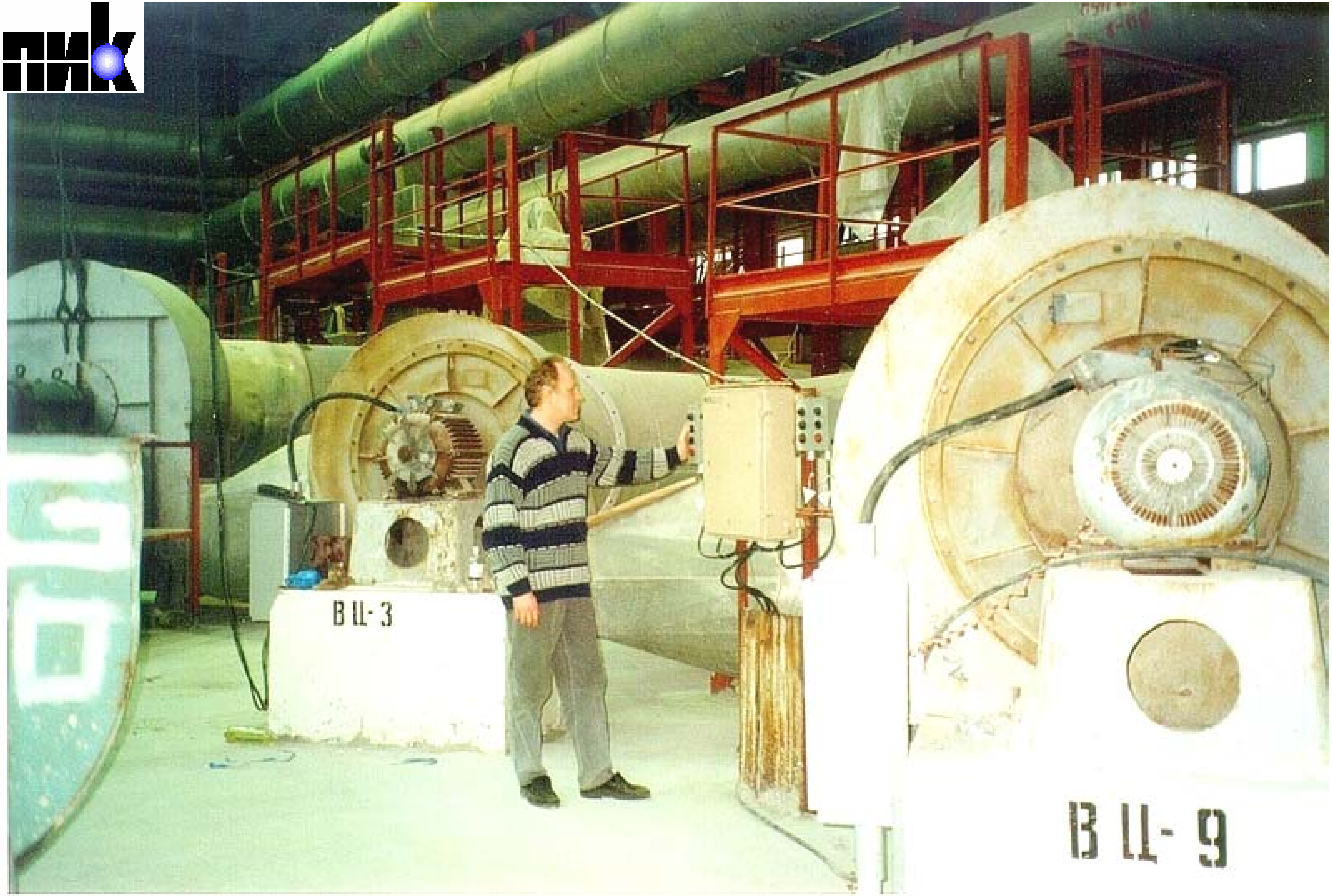
Корректировка проекта СУЗ не имеет установленных сроков.



Inclined channels hall.



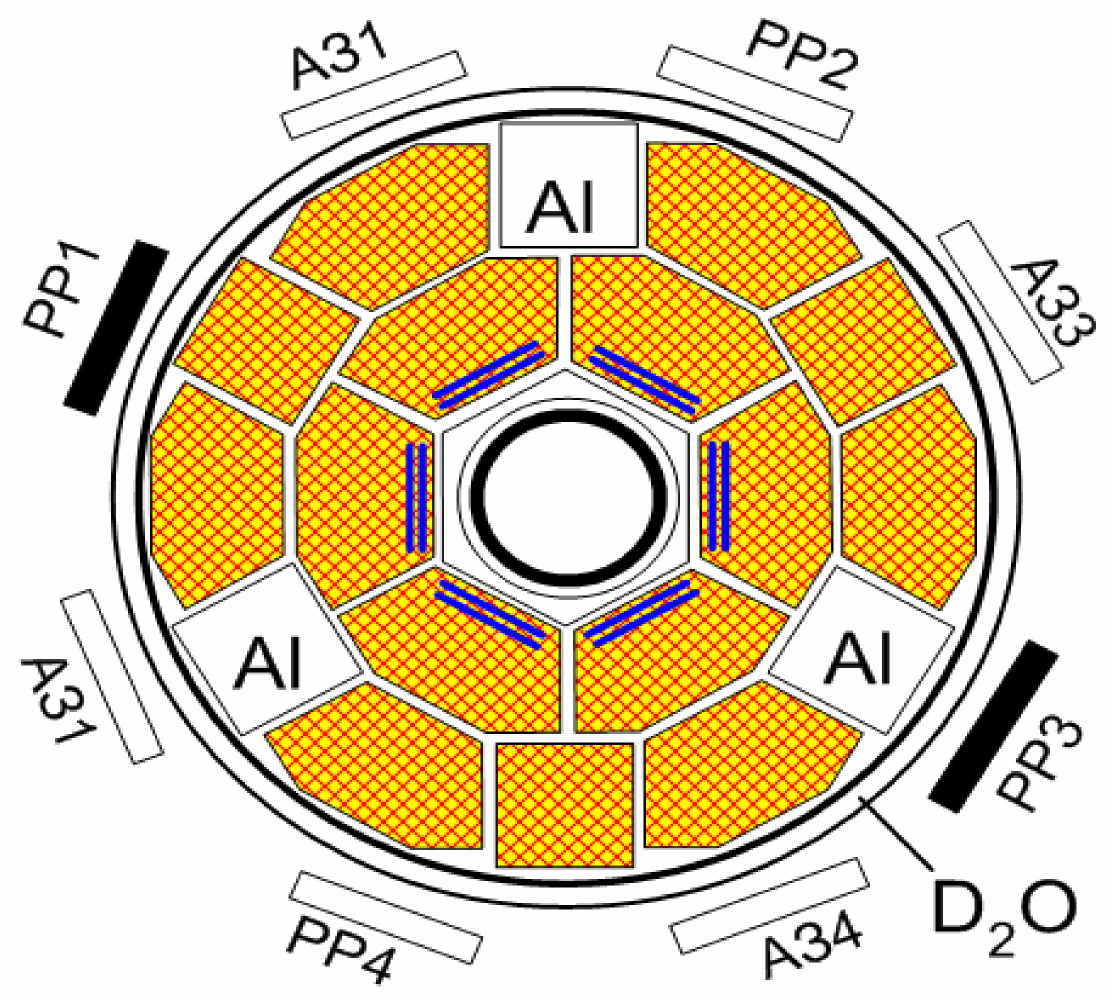
Secondary heat exchangers.



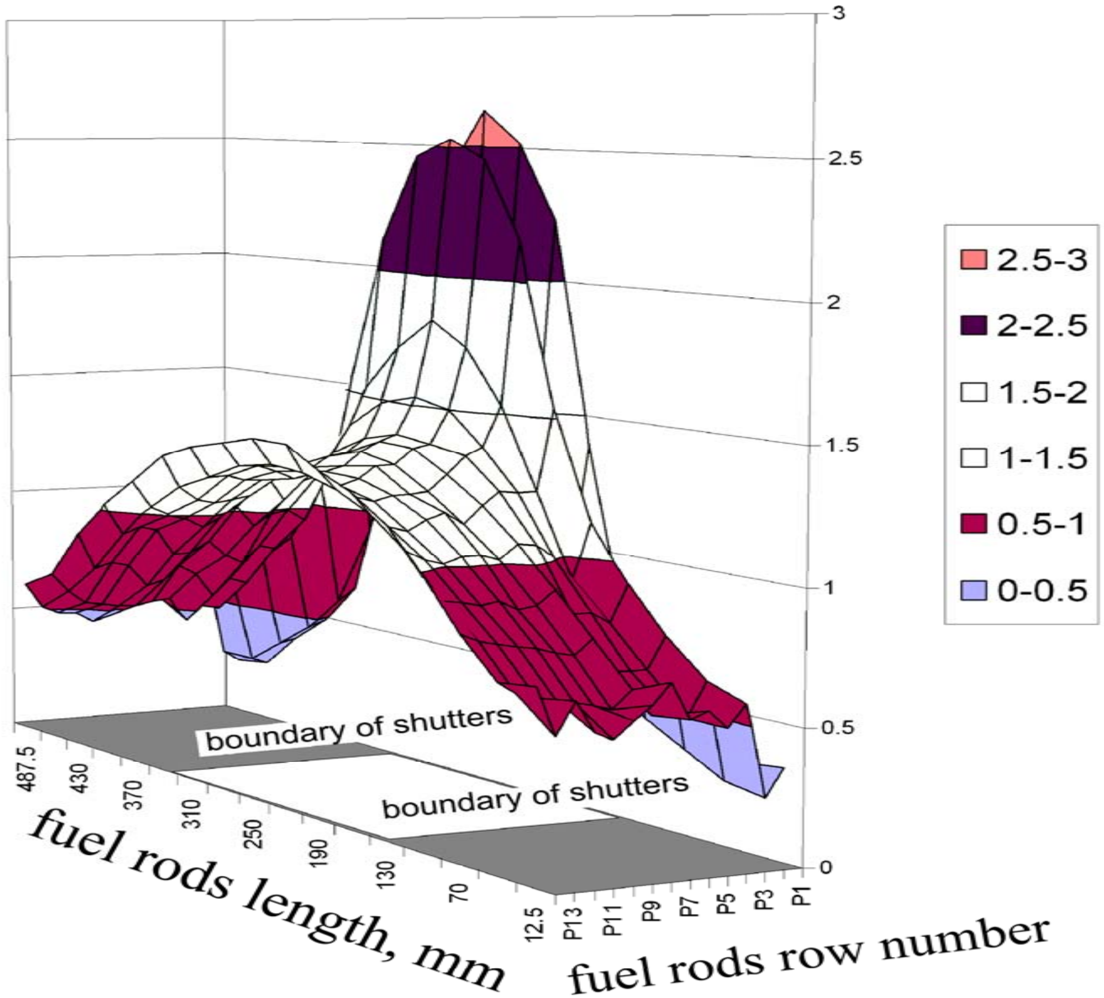
Air ventilation station

Preparation for the first reactor PIK criticality was done on a critical facility “Physical model of PIK reactor” it repeats core area, reflector and all the channels.

PIK reactor state of construction.


A31
PP2
PP1
Al
A33
Al
Al
A31
PP3
D2O
PP4
A34

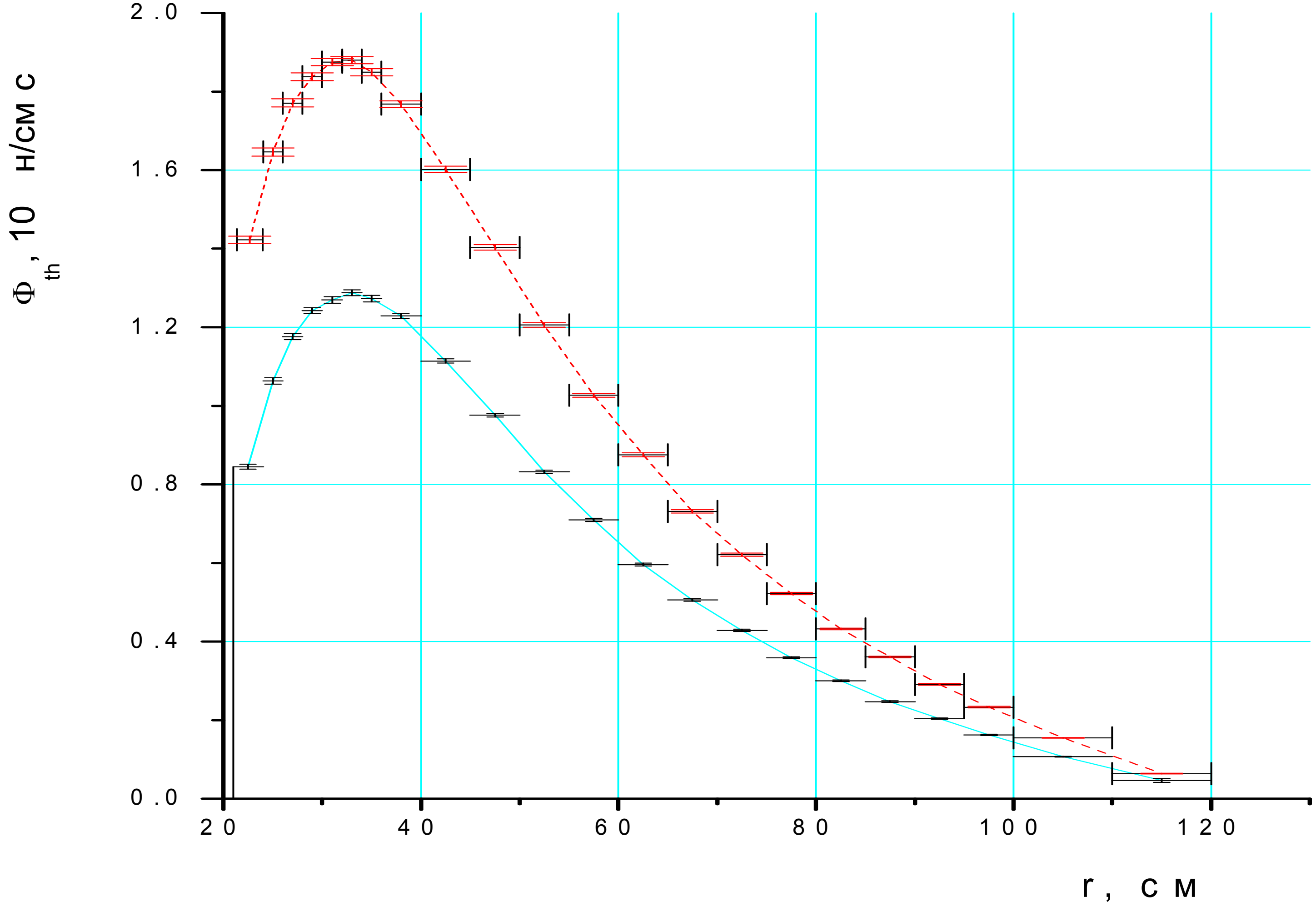
K_V is not equal to $Kr \cdot Kz$


3
2.5
2
1.5
1
0.5
0
2.5-3
2-2.5
1.5-2
1-1.5
0.5-1
0-0.5
boundary of shutters
boundary of shutters
487.5
430
370
310
250
190
130
70
12.5
P13
P11
P9
P7
P5
P3
P1
fuel rods length, mm
fuel rods row number

K_V=2.5±0.2 in 3rd layer of fuel rods is lower then K_V =3.3±0.3 for the full core.

Increase of average specific power is 12 %.

In future it is necessary to replace steel material of vessel with aluminum alloy and beryllium bronze material of matrix in fuel rods with aluminum also.


2.0
1.6
1.2
0.8
0.4
0.0
20
40
60
80
100
120
r, см
Φ_{th}, 10^{15} н/см^2 с

Full-scale implementation of PIK Project will cope with the all demands in Russia.

It is to be considered as arrangement of Grenoble type international neutron centre

PNPI sports center

PNPI Hotel

Living rooms

ПИК

The reporter acknowledges gratefully all his co-authors and co-designers mentioned in full manuscript references