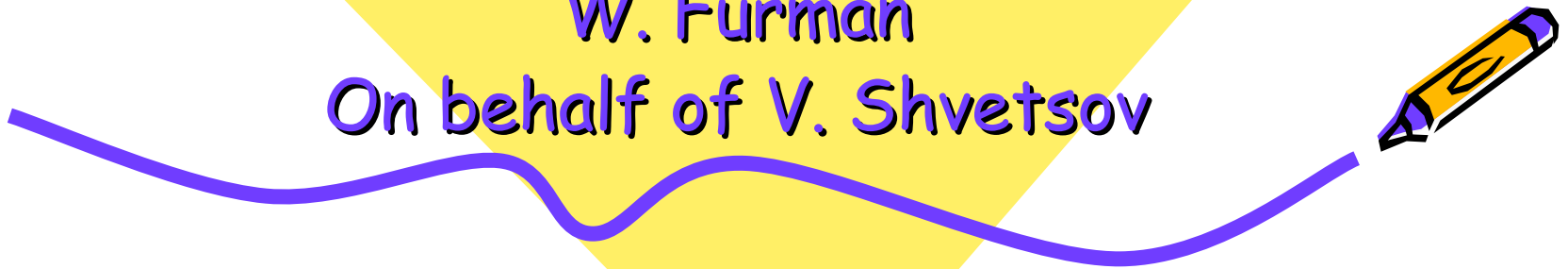




SAD Project Status & Perspectives

W. Furman

On behalf of V. Shvetsov



ISTC CEG meeting Jan 22-23, 2007, Brussels

SAD Project Objectives



- Coupling all major components of ADS;
- Core design, safety assessment, licensing;
- k_{eff} control and monitoring;
- Shielding from high energy neutrons;
- Experiments on core neutronics, reactivity feedbacks, transmutation reaction rates



Experimental Program



- **Qualification of subcriticality monitoring, experiments with PNG;**
- **Validation of the core power/beam current ratio;**
- **Tests and calibrations of the actual spallation target;**
- **Post-irradiation and on-line spallation products yields investigation;**
- **Transmutation reactions rates, integral cross sections and spectral indices measurements;**
- **Interpretation and validation of experimental data, codes validation, benchmarking;**

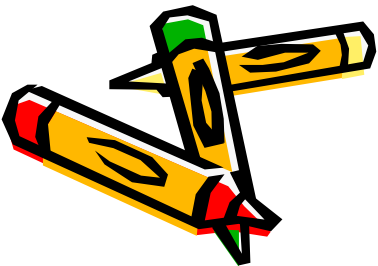


Participating Organizations

ISTC project #2267 was started at Nov 2003

- **JINR - leading organization, scientific supervisor;**
- **GSPI - the general designer;**
- **NIKIET – subcritical blanket and target designer;**
- **VNIINM - the developer of a fuel element;**
- **IA “Mayak” - manufacturer of the fuel;**

**ISTC project #2267 was
completed at Feb. 2006**



Foreign Collaborators



- ✿ **Forschungszentrum Karlsruhe - FZK, Institut für Reaktorsicherheit, Dr. Cornelis Broeders;**
- ✿ **Kungliga Tekniska Högskolan - KTH, Nuclear and Reactor Physics, Prof. Waclaw Gudowski;**
- ✿ **Centro de Investigaciones Energéticas Medioambientales y Technologies - CIEMAT , Dr. Enrique Miguel Gonzalez Romero;**
- ✿ **Commissariat a l'Energie Atomique - CEA, Cadarache, Dr. Frederic Mellier;**



Subcritical Blanket/ neutronics

Calculated K_{eff}	0.9515
Neutron lifetime	$2.4 \cdot 10^{-5}$ s
Fission power	27.6 kW
Averaged neutron flux	$1.7 \cdot 10^{12}$ 1/(cm²·s)
Peak factor of heat generation (height)	1.21

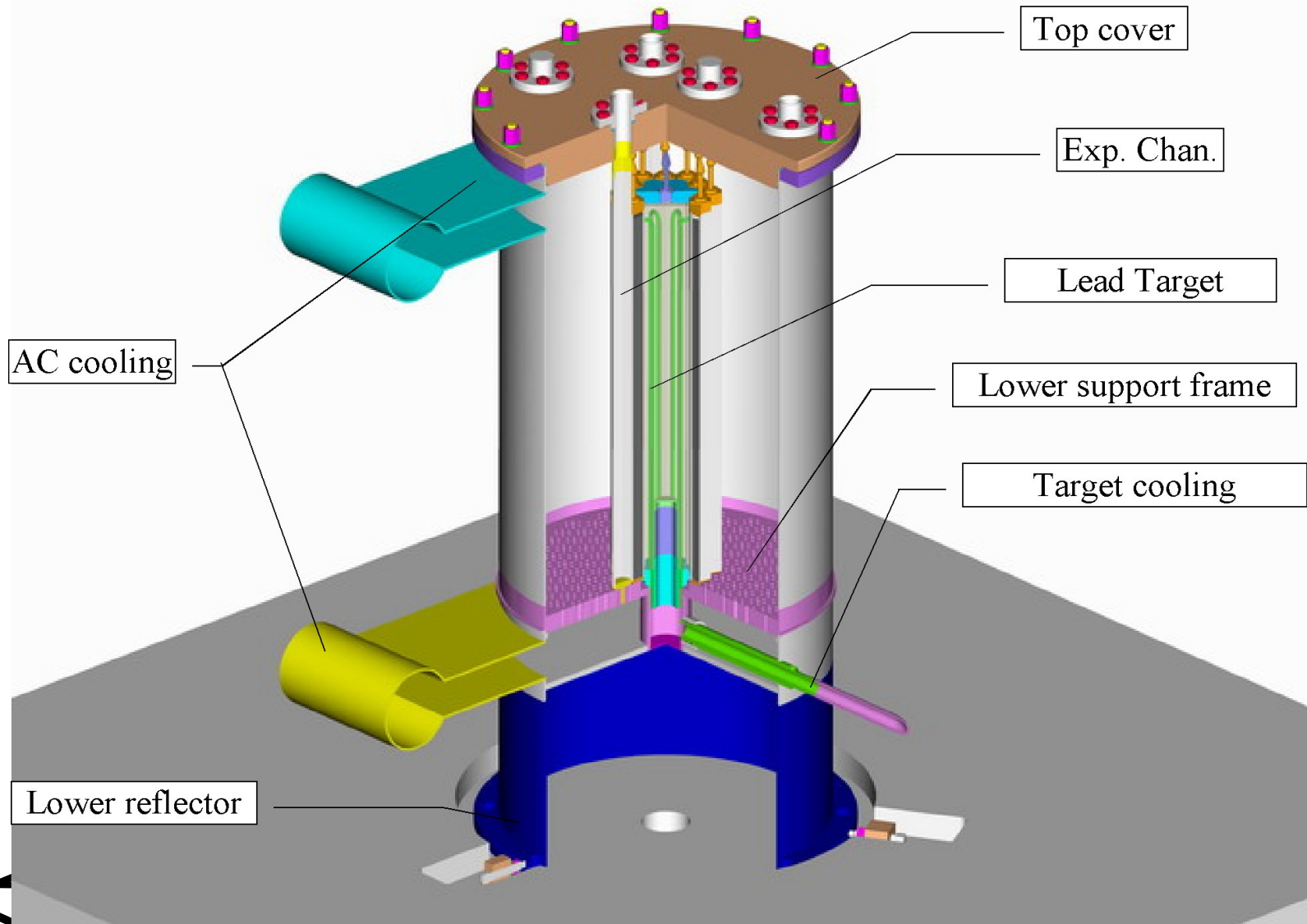
Heat generation in SAD parts:

Fuel	25.96 kW
Target (neutron and photon from fissions)	97.3 W
Core cladding	204.3 W
Side Pb reflector	565.4 W
B ₄ C	204.6 W
Concrete	771.1 W
Pu decay	~250 W

Fuel

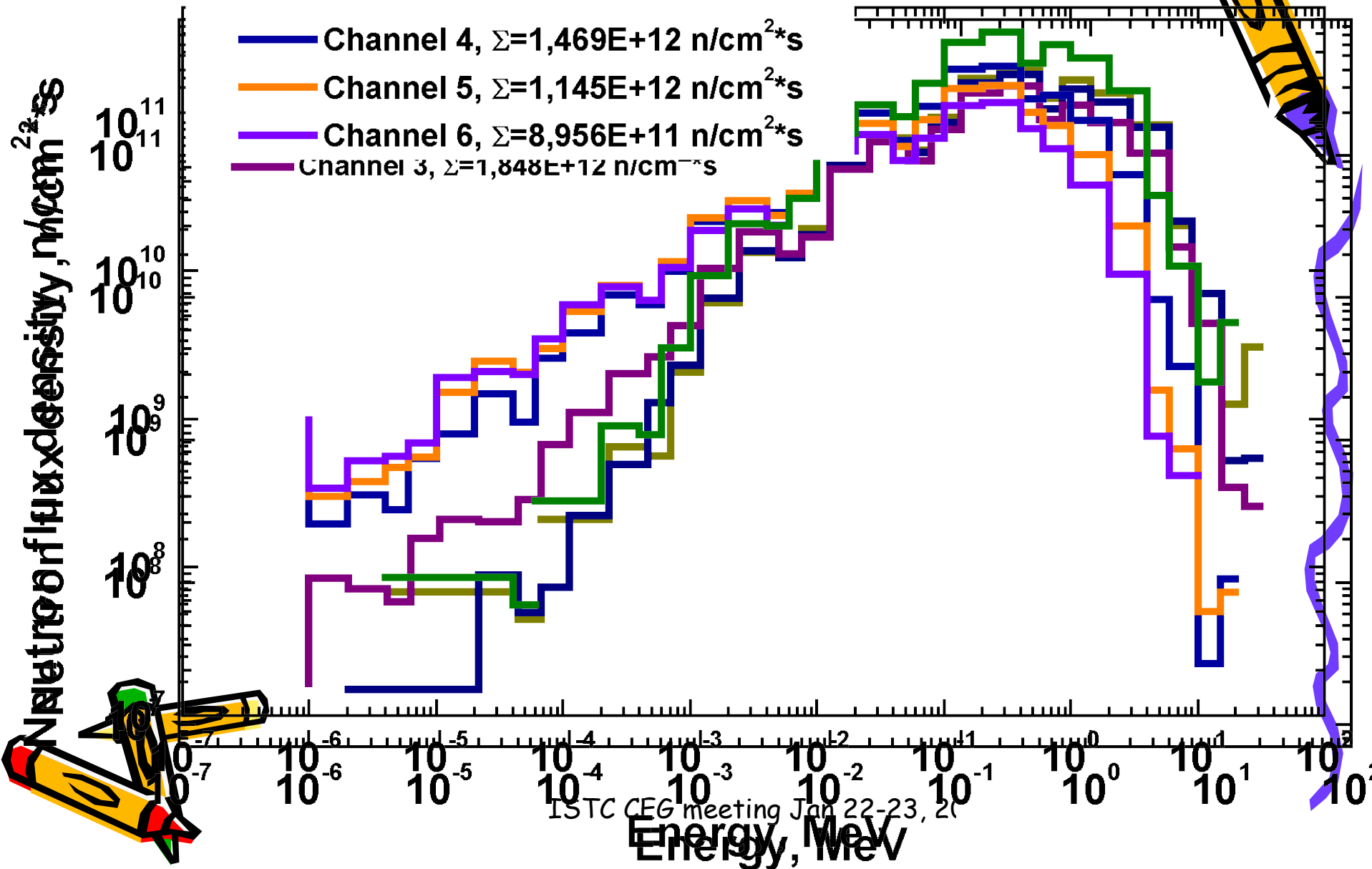
Max power density	18 W/cm³
Max flux of fast neutrons (E > 0,1 MeV)	$2.4 \cdot 10^{12}$ 1/(cm ² ·s)
Max fluence of fast neutrons (10000 hours)	$8.0 \cdot 10^{19}$ 1/cm²

Subcritical Blanket/design

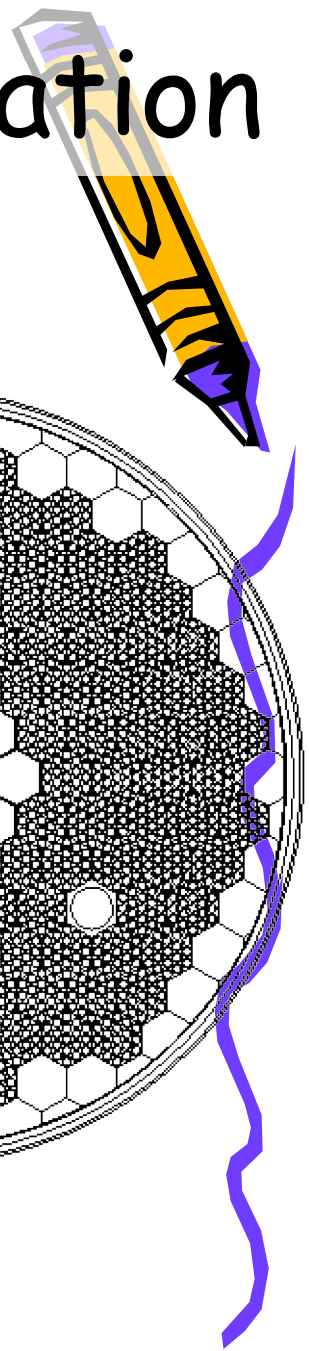


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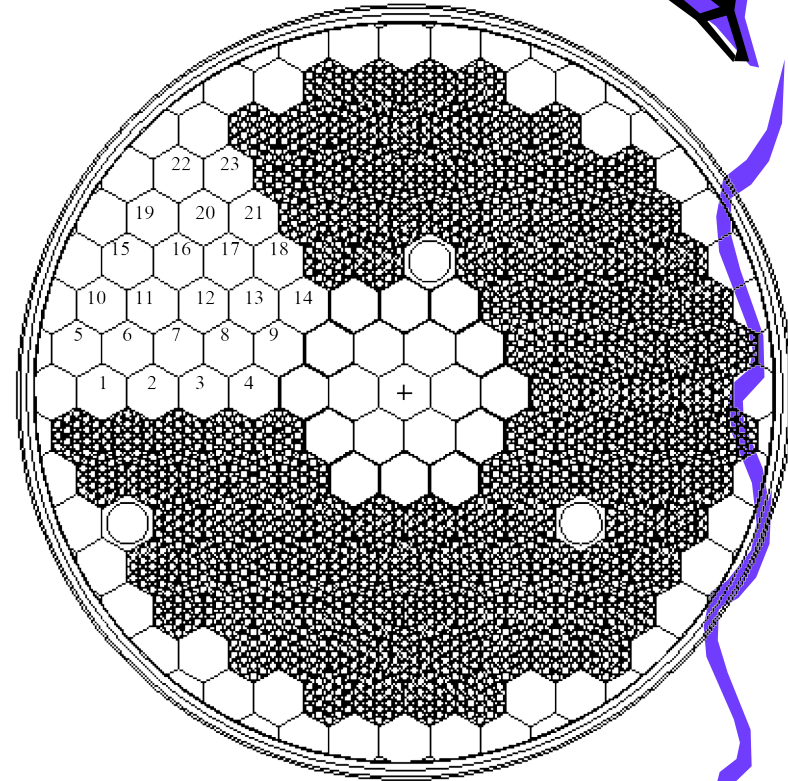
Subcritical Blanket/calculations



Subcritical Blanket Configuration



Number of cells for FAs	141
Number of loaded FAs	134
Number of loaded Pb prisms	7
fuel loading ($\text{UO}_2\text{-PuO}_2$)	396,9 kg
density of fuel	10,2 g/cm ³
PuO ₂ content in fuel	29,5 % (w.)
U enrichment	0,7 % (²³⁵ U)
Height of fuel	58 cm



Target/neutronics

Proton beam

Energy 660 MeV

Beam power 1 kW

Target

neutron generation 12.95 n/p

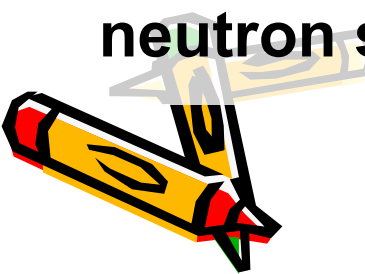
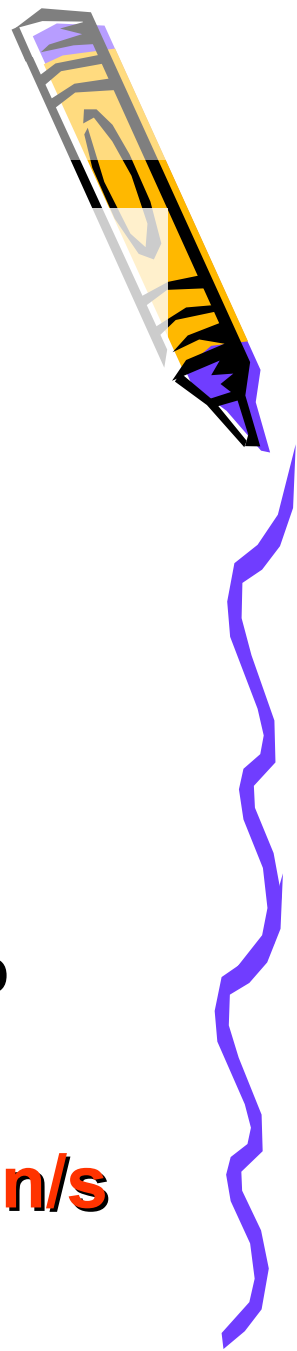
total neutron leakage from target 12.73 n/p

side neutron leakage from target 12.22 n/p

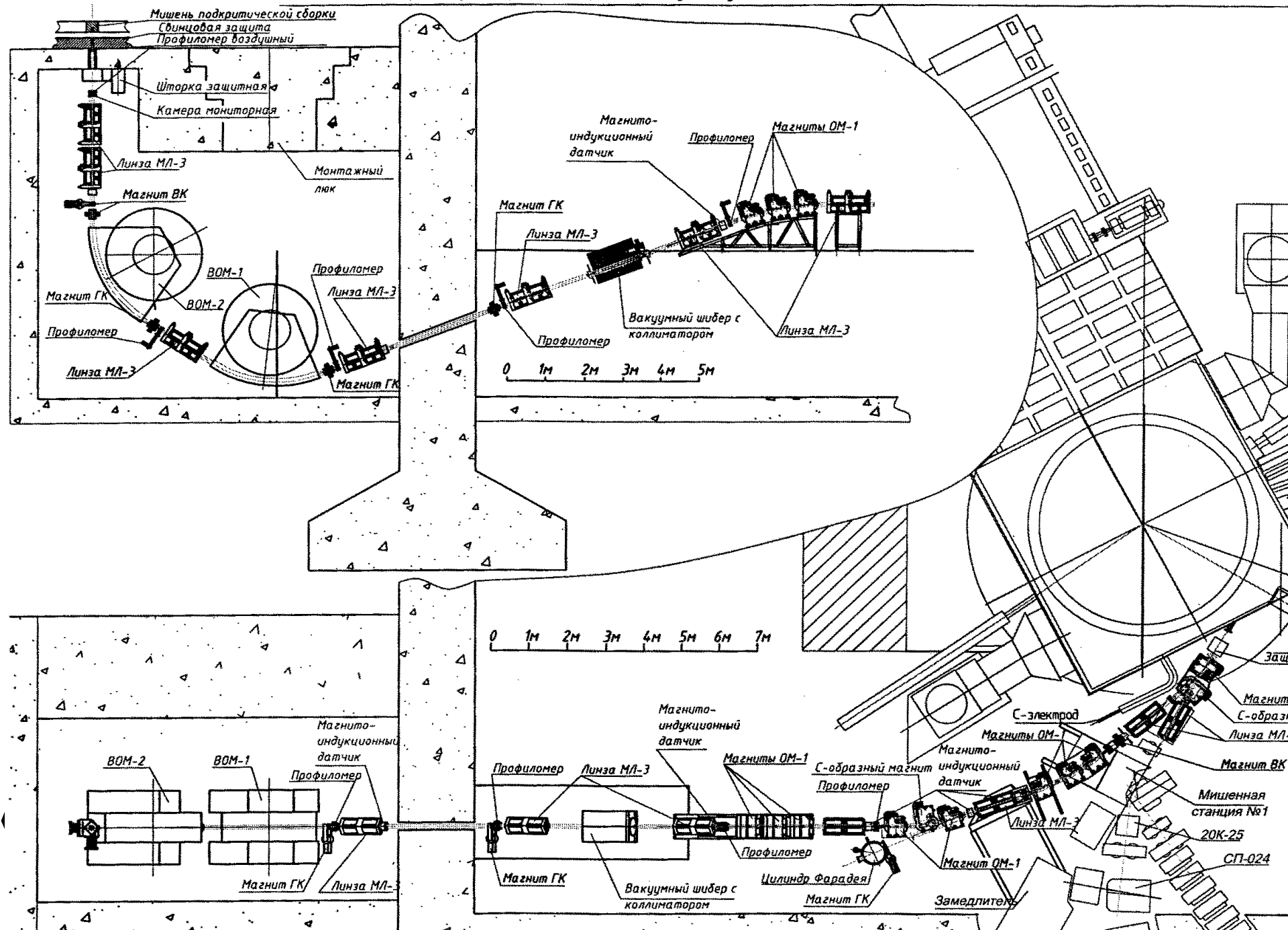
total energy of leakage neutrons 103.2 MeV/p

total heat generation 840 W

neutron source for blanket **$1.143 \cdot 10^{14}$ n/s**



Тракт транспортировки протонного пучка к установке SAD



Phasotron status

Fire accident in April 2005

Current status:

- All accelerator equipment restored
- Medical beam line restored
- In January 2007 cycle for proton therapy was conducted



ISTC CEG meeting Jan 22-23, 2007

Fuel





ФЕДЕРАЛЬНОЕ АГЕНТСТВО
ПО АТОМНОЙ ЭНЕРГИИ
ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ
УНИТАРНОЕ ПРЕДПРИЯТИЕ
"ПРОИЗВОДИТЕЛЬНОЕ
ОБЪЕДИНЕНИЕ
"МАЯК"

ул. Ленина, д.31, г. Озерск, Челябинская обл., 456
тел. (35130) 2 50 11, факс (35130) 2 38 26,
e-mail: mayak@po-mayak.ru
ОКПО 07622740, ОГРН 1027401177209,
ИНН/КПП 7422000795/742150001

Комиссия решила:

1. Принять представленные результаты по изготовлению опытной партии таблеток.
2. ОИЯИ представить полученные экспериментальные данные (масса и высота топливного столба) Главному конструктору установки SAD для уточнения параметров установки.
3. Полученные результаты использовать при разработке РКД на твэл.
4. ПО "Маяк" провести дополнительные исследования с таблетками

ления топливных таблеток 311.307.001

боте «Отработка режимов изготовлен
ой установки SAD в производственн

таблеток опытной партии представлены

Parameter according to specifications 311.307.001	Design value	Results						
		Numbers of agglomeration sample						
		15/20	16	18	20/1	21	22/30	23/2
Mass share of U and Pu sum, %, not less	87.6	87.90	88.14	87.96	87.90	88.28	88.30	88.20
Pu mass share to U and Pu sum, %	30±0.3	30.18	29.82	30.04	30.13	29.81	30.08	30.11
Oxygen ratio	1.98 ^{+0.01} _{-0.02}	1.99	1.99	1.99	1.99	1.97	1.99	1.98 — 1.99
Density, g/sm ³	10.2 – 10.6	10.39 10.43	10.22 10.30	10.36 10.41	10.22 10.25	10.25 10.33	10.23 10.33	10.25 10.29
Fuel column height, mm	580±10	580	586	578	580	580	586	580
Fuel column weight, g	160±3	154.6	157.1	155.7	153.6	152.6	155.6	154.0
Impurities mass share, %, not more	0.005 – 0.03	Less than design value for all elements						
Geometry Diameter, mm Height, mm	5.95 ^{-0.15} 7 – 9	Within limits for all pellets						

Fuel: what happened since Jan 2006

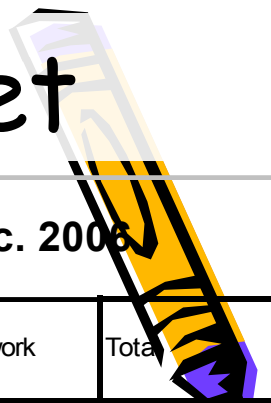


- Experimental batch of the fuel pellets was reexamined, recommendations were made for pellets control techniques.
- 600 kg of UO_2 were delivered in April 2006 to "Mayak" and ceramics properties of the material were tested
- Working design for test fuel elements and fuel assemblies was completed

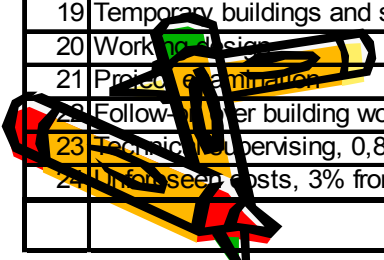


Financing issues: SAD budget

SAD Cost Assessment (full costs), Russian kroubles extrapolated to Dec. 2006



	Equipment, work	Building work (BW)	Installation work (IW)	Equipment procurement & manufacturing	Other work	Total
1	Multiplying blanket, including working design and automatic control system		7 281,60	66 954,07	38 814,86	113 050,53
2	Beam transport line		2 460,00	27 338,60		29 798,60
3	Building construction	115 128,00				115 128,00
4	Fuel temporary storage equipment (doors, containers etc.)		2 137,99	29 005,86		31 143,85
5	Blanket and target cooling system		4 103,28	16 789,50		20 892,78
6	Air flow system for radiation control system		110,70	553,50		664,20
7	Detection system for nonhermetic FE		147,60	4 858,50	1 230,00	6 236,10
8	Fuel elements manufacturing and delivery		0,00	51 931,22	0,00	51 931,22
9	Physical security system		17 718,15	22 715,64	9 539,88	49 973,67
10	FE storage room equipping, FA production line creation		24,60	2 214,00		2 238,60
11	Radiation control system		412,05	20 295,00		20 707,05
12	Hoisting devices		467,40	5 043,00		5 510,40
13	Geodesical support			1 414,50	2 191,86	3 606,36
14	Special television			2 428,02		2 428,02
15	Auxiliary systems (water supply, sewer, heating, ventilation, electricity, communication and signalling)	2 113,14	5 248,41	11 869,50		19 231,05
16	Land improvement	487,08				487,08
	Subtotal:	117 728,22	40 111,78	263 410,90	51 776,60	473 027,50
17	Rise in the cost of the installation work in winter time, 1,5% from BW and IW	1 765,92	601,68			2 367,60
18	Premium for the commissioning				2 367,60	2 367,60
19	Temporary buildings and structures, 1,8% from BW and IW	2 119,11	722,01		0,00	2 841,12
20	Work on design				32 841,00	32 841,00
21	Project administration				1 313,64	1 313,64
22	Follow-up for building works - 0,2% from subtotal				946,05	946,05
23	Technical supervising, 0,8% from subtotal				3 784,22	3 784,22
24	Unforeseen costs, 3% from subtotal				1 553,30	1 553,30
	Total:	125 145,10	42 638,82	271 313,22	94 582,42	533 679,56



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Financing issues: SC meeting Sept. 2005

Statement of

Joint Institute for Nuclear Research (JINR)

on the scientific working programme of the Sub-critical Assembly Dubna (SAD) project, in close co-operation with the Domain DM2 ECATS activities of the European sponsored integrated project EUROTRANS.

The JINR representatives assume that the project can be realised providing that **JINR and DM2 ECATS of EUROTRANS fund SAD project at the level 1/3 each** under the condition that another 1/3 of the necessary funding will be provided by ISTC. At present time JINR is ready to take responsibility on 1.2 M Euro funding, having in mind that the rest of the funds necessary to cover 1/3 of the project cost will be covered by a collaboration that will be created in Russia.

Cost split for the SAD project funding numbers are in M Euro

Year	ECATS	ISTC	JINR	
			Budget	Collaboration
2006	1.7 + 0.6 (in kind contribution)	0.8	0.1	*
2007		1.5	0.1	*
2008		0.4	0.5	*
2009				0.5

* Numbers to be clarified after creation of the collaboration

ISTC CEG meeting Jan 22-23, 20

Minutes of the JINR-AFK-ISTC-EUROTRANS Meeting

on May 23-24 2006
at AFK Headquarters Moscow Russia



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Denis Muratov summarized the AFK Sistema position: The involvement of AFK Sistema in 'SAD/XT-ADS' allows for the engagement in a unique project which realizes the first-ever experimental coupling of a proton accelerator, a spallation target and a sub-critical blanket, and the extension to the commercial development of this technology.

'SAD/XT-ADS' is considered to be a two step project:

- Step one: realization of the SAD installation at JINR Dubna with physical start-up by 2009 (first protons on target and core) as a proof of principle experiment.
- Step two: realization of a semi-industrial demonstrator facility for nuclear waste transmutation (XT-ADS). Its design and construction is on a time schedule between 5 and 10 years from now.

The involvement of AFK Sistema is conditioned on the setting up of a business plan (including these two steps), which is approved by the funding organisations. This business plan shall be developed within two months from now.



Financing issues: ISTC - EUROTRANS - JINR - AFK meeting May 2006

Minutes of the JINR-AFK-ISTC-EUROTRANS Meeting

on May 23-24 2006
at AFK Headquarters Moscow Russia



SAD Cost Assessment:

Moscow, Russian Federation
May 24, 2006

Elenis Muratov
AFK Sistema

Valery Shvetsov
JINR

Lev Tocheny
ISTC

Joachim U. Knebel
EUROTRANS

plan, for communications, and the preparation of the project proposals.

All participants to the meeting agree to increase the funding capabilities.



Interaction with RosAtom

- Official letter from JINR Director to the Chairman of Scientific-Technical Council #3 of RosAtom with SAD application was sent in the end of 2005. No answer.
- SAD report at the Scientific-Technical Council of NIKIET - Nov. 2006. Positive resolution, recommendation for JINR and NIKIET to apply to RosAtom administration with request to define Agency position on SAD project. In progress.



Conclusion



- SAD technical project is ready licensing and practical implementation
- Fuel technology developed, materials are at "Mayak"
- Phasotron accelerator successfully restored
- We have (still) at least one Russian coinvestor - AFK "Sistema" ready to support near 30% of the project cost
- This support depends crucially from RosAtom (even non financial) approval of that coinvesting

So the future of the SAD project now is in hands of RosAtom and European partners

ISTC CEG meeting Jan 22-23, 20

