

# **Recommendations**

**20<sup>th</sup> Meeting of Programme Advisory Committee  
for Nuclear Physics, 1–2 April 2004**

**Presentation to JINR Scientific Council  
3 June 2004**

**Neil Rowley**

# HEAVY-ION PHYSICS

## Activity with DRIBs

The PAC listened with great interest to the presentation on the recent developments in the DRIBS project and appreciated the information on first experiments to be started in its Phase I.

**Recommendation.** To maintain the attractiveness of the FLNR basic facilities in the future, the DRIBS project should be realized as quickly as possible involving also Phase II. To this aim the upgrade and modernization of the U400 accelerator should be treated with particular urgency.

# Preparation for and experiments at DRIBs-facility in 2004

Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Assembling and launching of DRIBs - systems at U400M

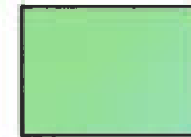
Assembling and testing of RI-beam lines, control systems at U400

$\gamma$  - rays at VASSILISSA

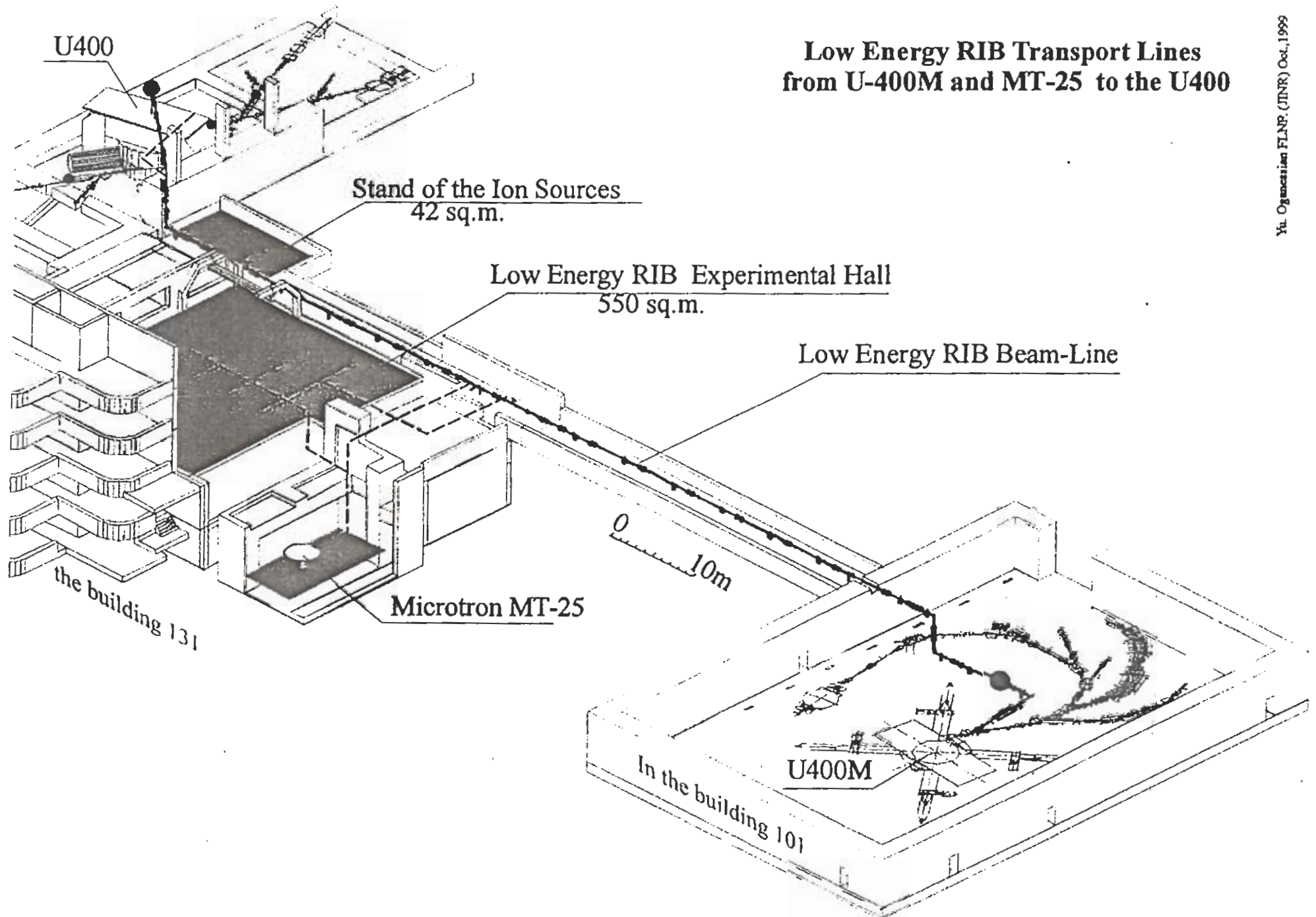
DRIBs adjustment

$^6\text{He}$  at CORSET

$^6\text{He}$  at MSP144

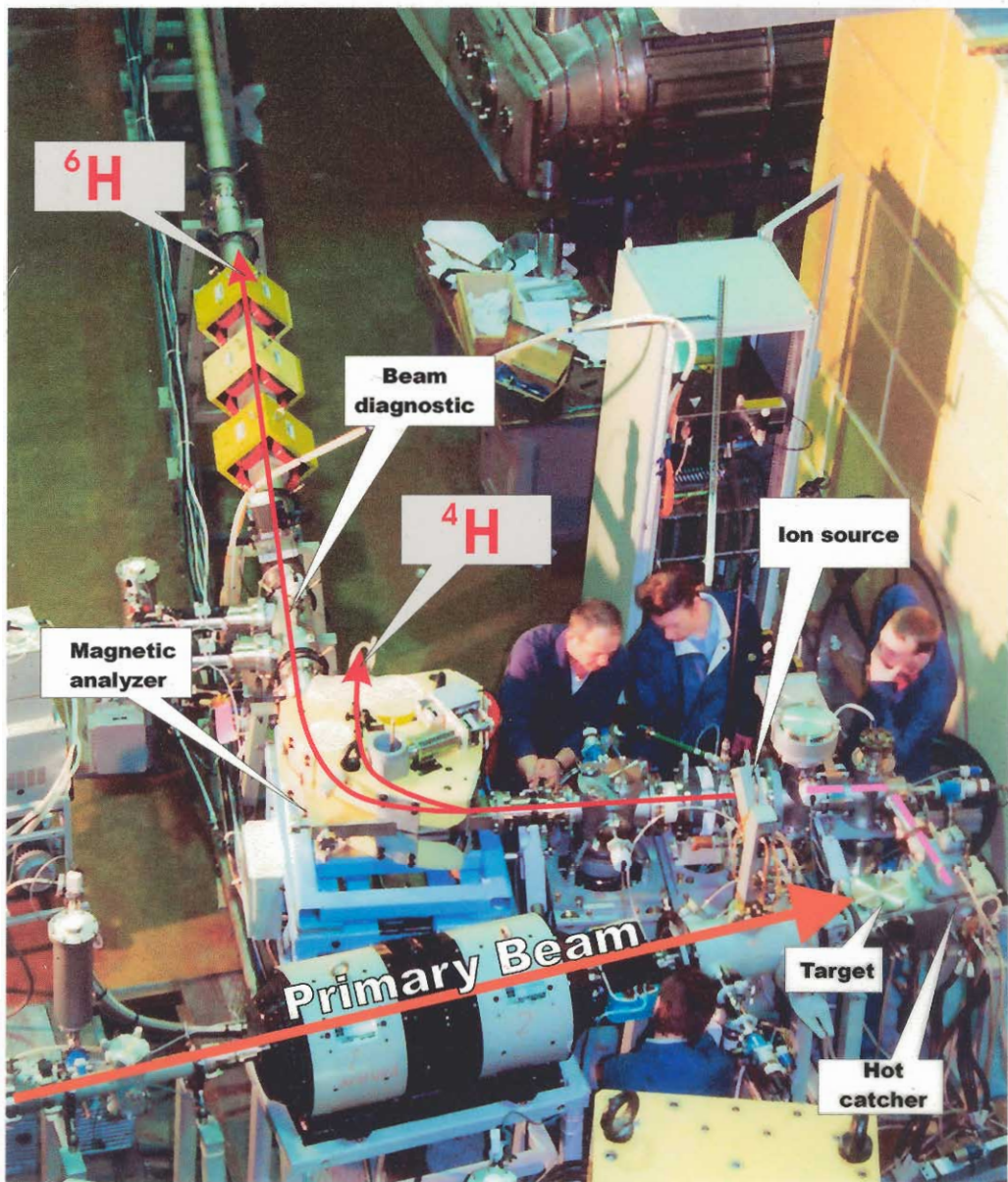


### Low Energy RIB Transport Lines from U-400M and MT-25 to the U400



# DRIBs - Project

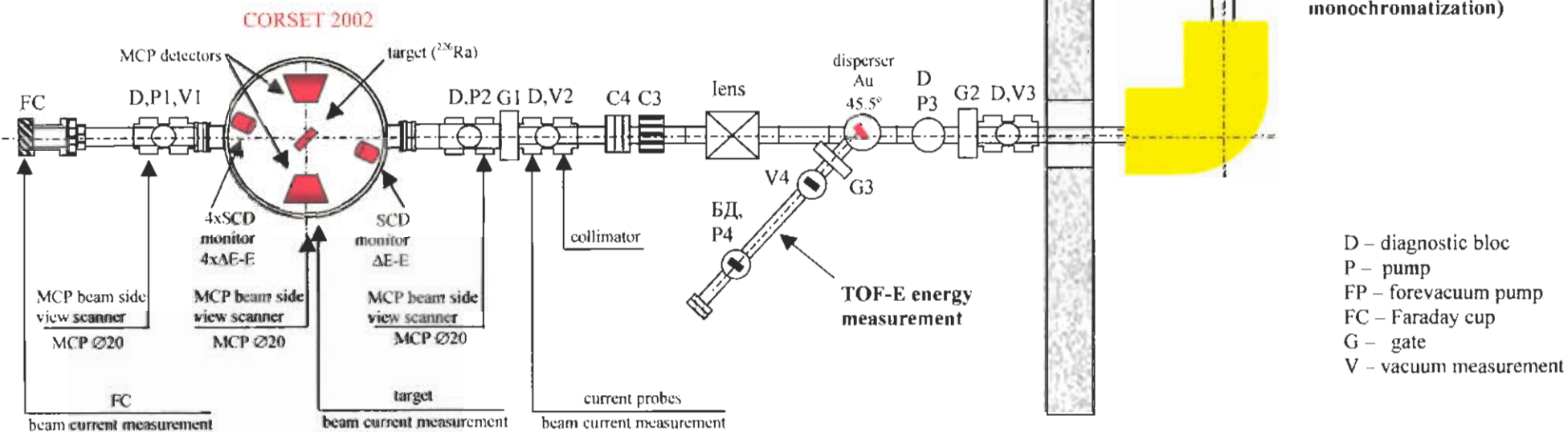
Transformation of the primary beam into a low energy radioactive ion beam



# Set up for measurement of fission-fusion processes on ${}^6\text{He}$ and ${}^8\text{He}$ ions beam

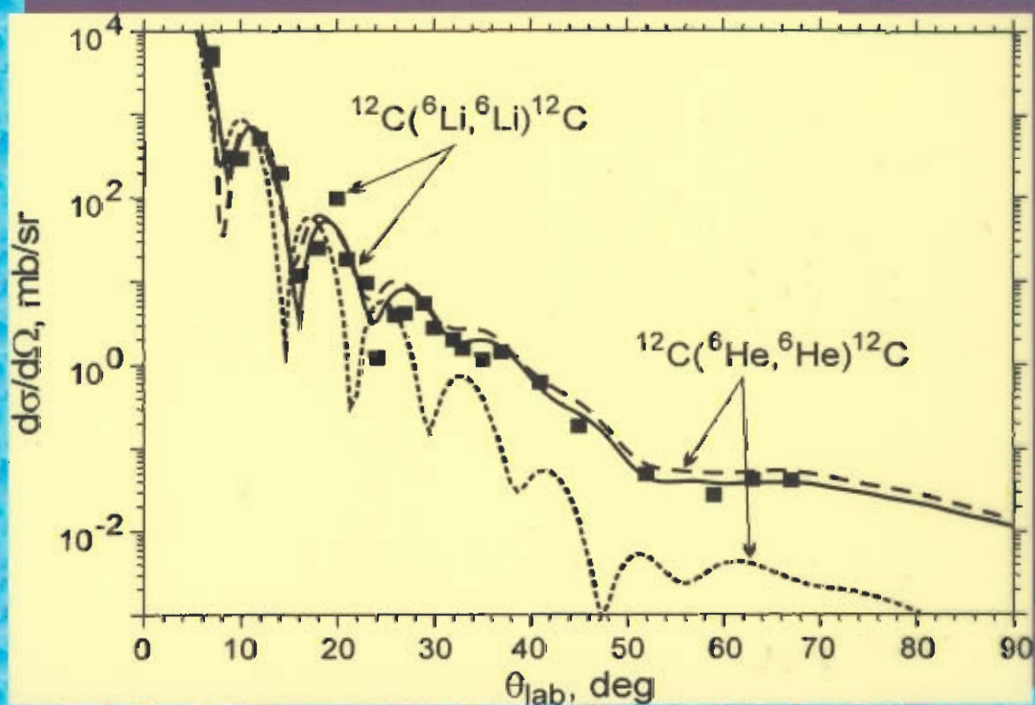
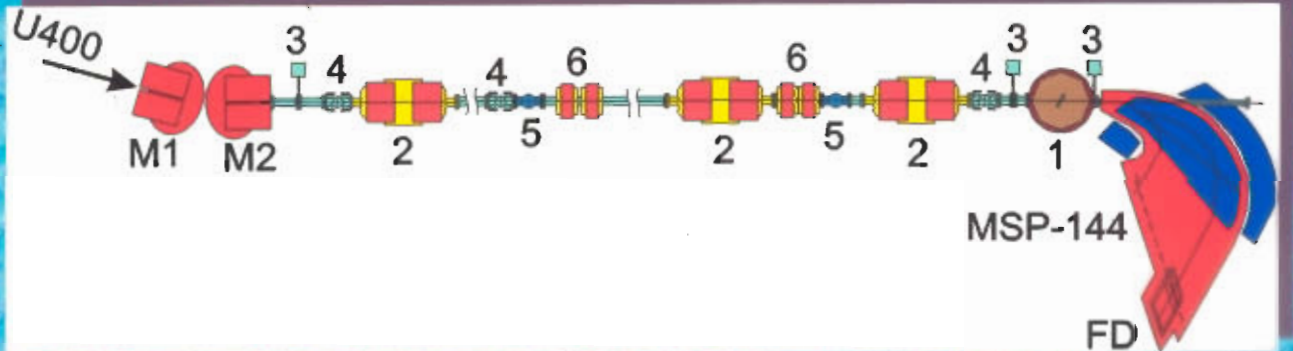
First Experiment  
 ${}^{226}\text{Ra} + {}^6\text{He}$

## Rejection line №8 (experimental cave)



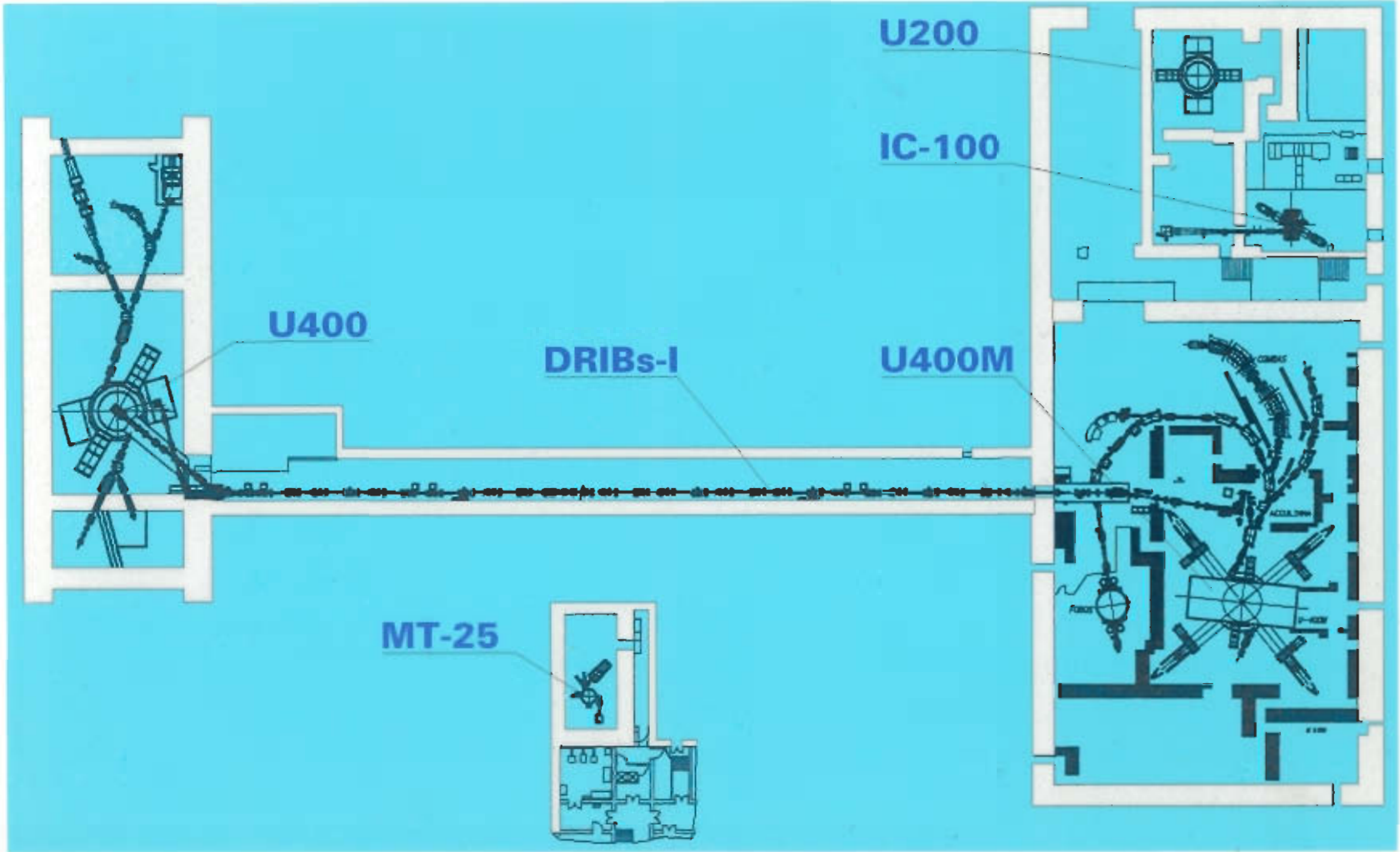
# Elastic and Inelastic Scattering of ${}^6\text{Li}$ & ${}^6\text{He}$ at 12 MeV/A

## Layout at DRIBs (MSP-144)



The differential cross sections of the elastic scattering  ${}^6\text{Li}+{}^{12}\text{C}$  and  ${}^6\text{He}+{}^{12}\text{C}$  at 63 MeV. Solid and long-dashed lines – calculations by the optical model, using the same set of parameters, for  ${}^6\text{Li}$  and  ${}^6\text{He}$ , respectively. Short-dashed line – cross section of the elastically scattered  ${}^6\text{He}$  calculated with the parameter  $R_1(\text{He})=1.2R_1(\text{Li})$ .

# FLEROVLAB CYCLOTRONES





# LOW- AND INTERMEDIATE-ENERGY PHYSICS

## DUBTO project

The PAC heard with interest a presentation of the first results with the DUBTO streamer chamber detector. In pion interactions with  $^4\text{He}$  nuclei, the production of secondary nucleons and nuclear fragments was observed and branching ratios of specific reaction channels reported, with charged-particle energies as low as 1 MeV. New software in connection with CCD techniques has so far allowed the efficient processing of about 3000 of the 25000 pion-helium interactions observed.

**Recommendation.** The PAC recommends continuation of the DUBTO experiment and looks forward to a report with more details about the physics that can be extracted from this work. The PAC also encourages more theoretical input into this project.

DUB TO

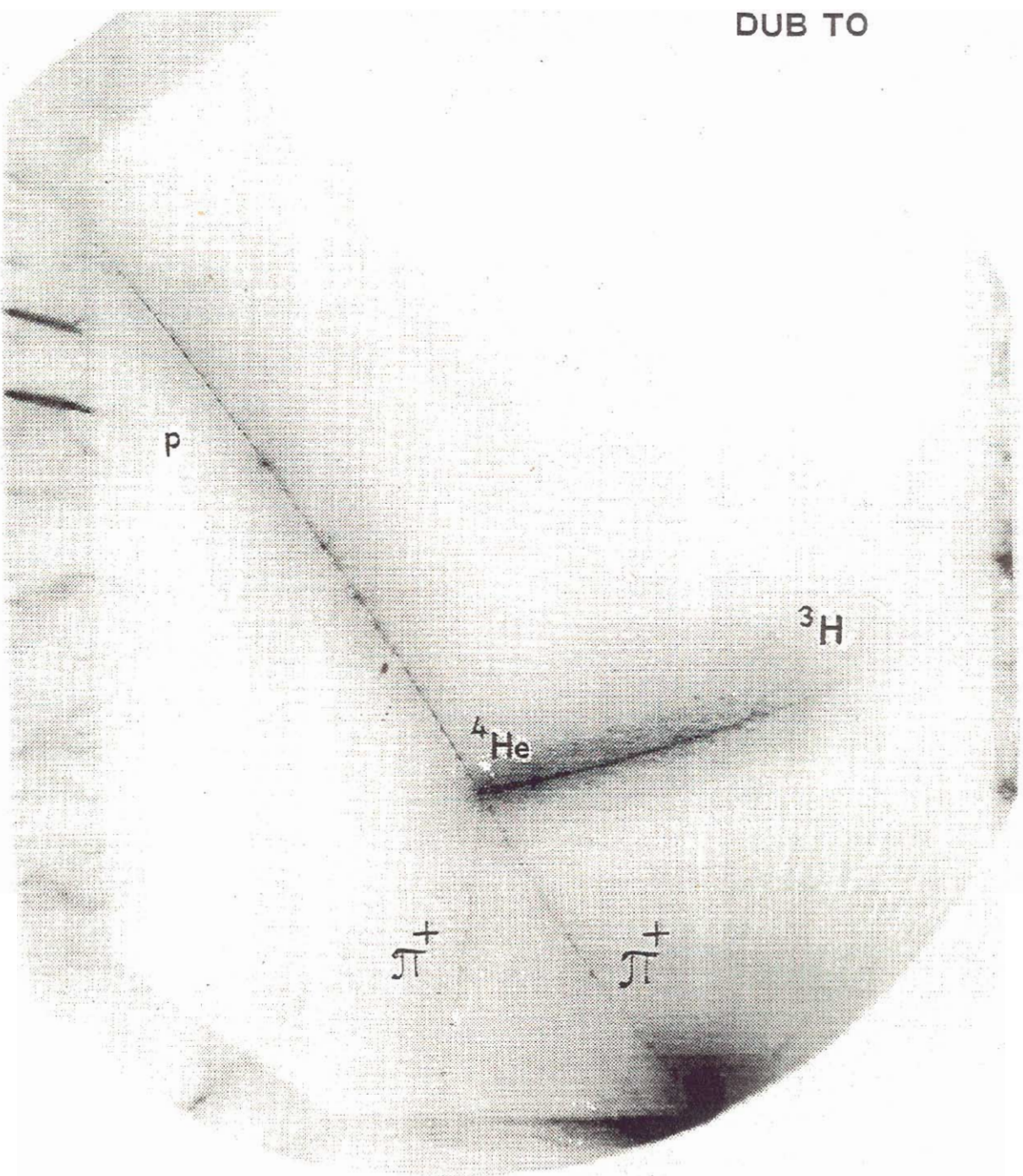
P

$^3\text{H}$

$^4\text{He}$

$\pi^+$

$\pi^+$



**Cross sections (mb) for two-prong  $\pi^{+4}\text{He}$  reactions  
(1480 evs):**

	1980: diff. ch. 120 MeV	1999: LADS 118 MeV	DUBTO Numb. events	2004: DUBTO 100 MeV
$\pi^{+4}\text{He} \rightarrow \pi^{+4}\text{He}$	$77 \pm 10$	—	374	$33.1 \pm 1.8$
$\rightarrow \pi^{+4}\text{He}\gamma$	—	—	305	$27.0 \pm 0.7$
$\rightarrow \pi^{+}\text{n}^3\text{He}$	$31 \pm 5$	—	454	$40.1 \pm 1.9$
$\rightarrow \pi^0\text{p}^3\text{He}$	$23 \pm 7$	$18.0 \pm 2$	347	$30.7 \pm 1.7$

**Number of three-prong  $\pi^{\pm 4}\text{He}$  events (2652 evs):**

	Reaction		events
$\pi^{+4}\text{He}$	$\rightarrow$	$\pi^{+}\text{p}^3\text{H}$	430
	$\rightarrow$	$\pi^{+}2\text{p}2\text{n}$	383
	$\rightarrow$	$3\text{pn}$	1617
$\pi^{-4}\text{He}$	$\rightarrow$	$\pi^{-}\text{p}^3\text{H}$	147
	$\rightarrow$	$\pi^{-}2\text{p}2\text{n}$	75

**Five-prong event ( $\pi^{+4}\text{He} \rightarrow \pi^{-}4\text{p}$ , DCX): 5 evs**

## LESI project

The PAC heard with interest the latest results of the LESI project on the measurement of fusion cross sections of very light nuclei. The S-factors obtained are of great interest in astrophysics and for the solar model, and are the first measurements in the energy range below 10 keV. They exploit a novel technique using very high intensity plasma pulses which may also give new information on the role of electron screening.

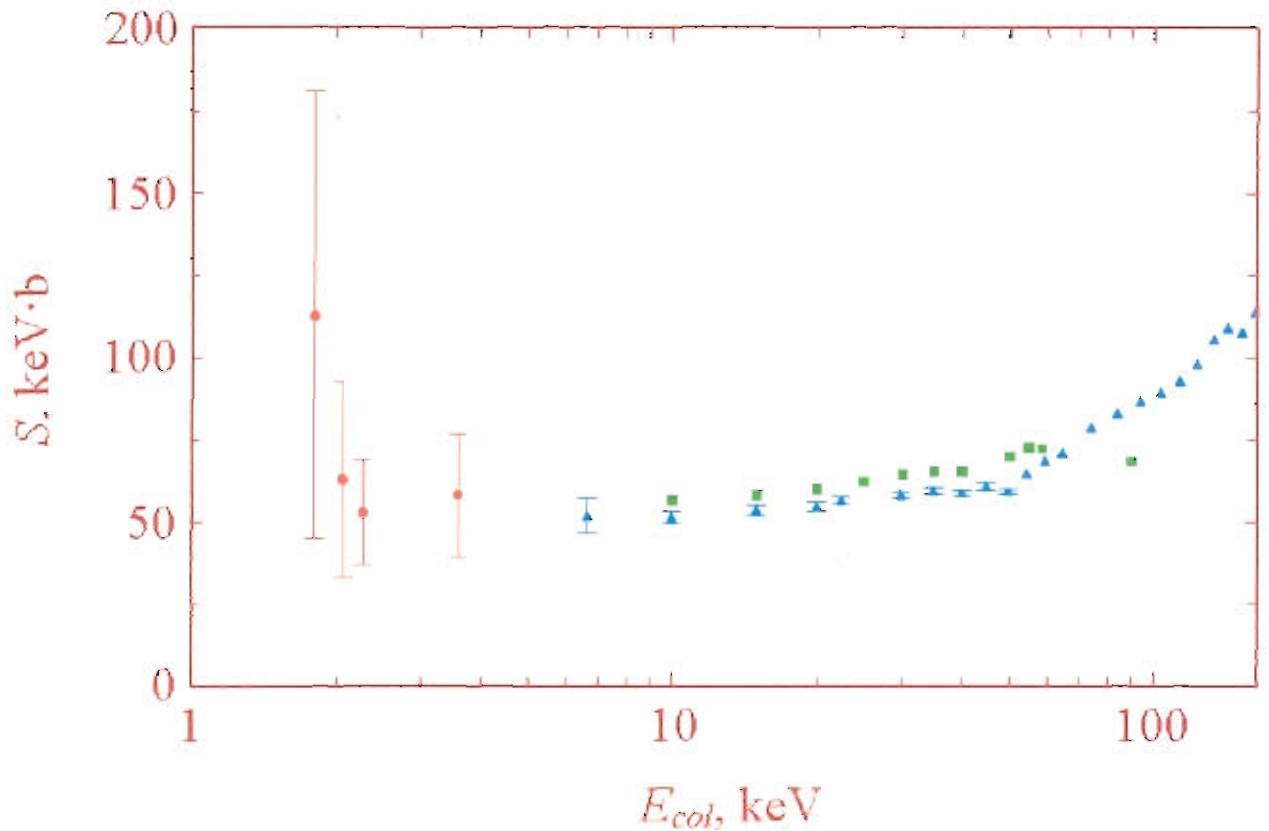
**Recommendation.** The PAC recommends continued support of this work.



## **Pulsed Power Generator MIG HCEI RAS (Tomsk, Russia)**

**(generator current  $I = 2.4$  MA, current pulse duration  $\tau \approx 80$  ns, power  $W \sim 2$  TW, energy storage  $E = 450$  kJ)**

**MIG consists: a pulsed inductive voltage adder of 26 stages, three forming water lines, spark gap switches, and a vacuum coaxial convolute from the forming water section to the Z-pinch load module**



# SAD PROJECT

The PAC welcomes the start-up of the project “Subcritical Assembly at Dubna” (project SAD), targeted on creating a facility for addressing important problems of modern nuclear energy production and waste transmutation.

**Recommendation.** The PAC supports the SAD project which is of considerable interest to JINR Member States and encourages closer collaboration and information exchange between SAD and other international transmutation projects.

# ISTC Project #2267 & JINR Project



## Project on Creation of **S**ubcritical **A**ssembly Driven by Proton Accelerator in **D**ubna

Leading Institution: **Joint Institute for Nuclear Research**

Financing Parties: **EC (Sweden, Germany France, Spain), JINR, Russia**

Timing: **Project started on November 2003**

**Physical Startup at 2006 – 2007**

Collaboration: **Russia (Institutes + ISTC projects ), France, Germany, Spain, Sweden, Czech Republic, Romania, Bulgaria, Poland, Belorussia,... (open for new participants)**



# NUCLEAR PHYSICS WITH NEUTRONS

## IREN project

The PAC heard a report on the theme “Construction of the IREN facility” (06-4-0993-94/2004). During the last four years essential progress has been achieved in spite of permanent underfinancing. However, it was again noticed with concern that the problem of continuing delay in the implementation of the IREN project is not yet solved. As new international neutron sources become available and compete with IREN, this might finally have an influence on its scientific impact if the delays accumulate further.

**Recommendation.** The Directorates of JINR and FLNP are asked to search for ways to accelerate the project including seeking external financing if this is the only possibility to ensure its timely implementation. A decision concerning extension of the project should be taken at the next session of the PAC, based on a solid new plan of investment.

# Construction of the IREN source

## Status&perspectives

- *But it is crucial for future of whole project an approval by JINR directorate of the realistic time-table with respective firm annual financing.*
- *The last point depends essentially from finding of new sources for support of the IREN project*
- *A detailed consideration of the most optimistic time-table presented at NP PAC session shows that even in the case of optimal financing a start-up of IREN source may be realized not earlier than by the end of 2006*

## **Nuclear physics research with neutrons**

The PAC was impressed by the presentation of the outstanding results obtained by FLNP on the theme “Nuclear physics with neutrons – fundamental and applied investigations” (06-4-1036-2001/2004).

**Recommendation.** The PAC recognizes the leadership of FLNP in this activity and supports a continuation of this first-priority theme for 2005-2007. An appropriate recommendation will be made at the next session of the PAC after presentation of a detailed scientific programme.

## Main Directions

- Experimental and methodical developments planned for *high resolution* neutron sources (IREN , nTOF, ORELA, KENS)
- Research focused on *high flux* neutron sources (IBR-2, HFR/ILL, JAGUAR, PSI, PIK)
- Applied Research
- Analytical Investigations at the IBR-2 Reactor, Project REGATA

# KaTRIn project

Development of Neutron Polarizer-Analyzer System for T-Invariance Experiment

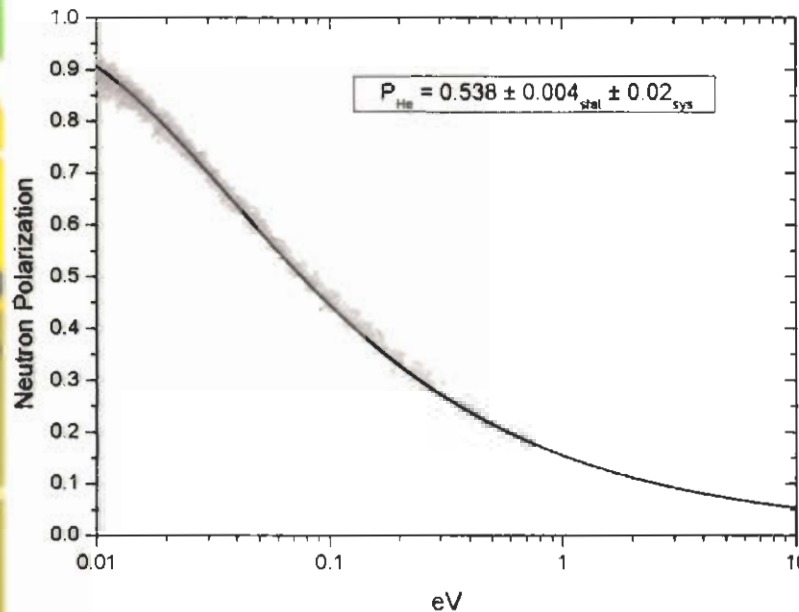
V.R. Skoy<sup>A1</sup>, Y. Masuda<sup>A2</sup>, S. Muto<sup>A3</sup>, T. Ino<sup>A3</sup>, G.N. Kim<sup>A4</sup>

A1 Frank Laboratory of Neutron Physics, JINR

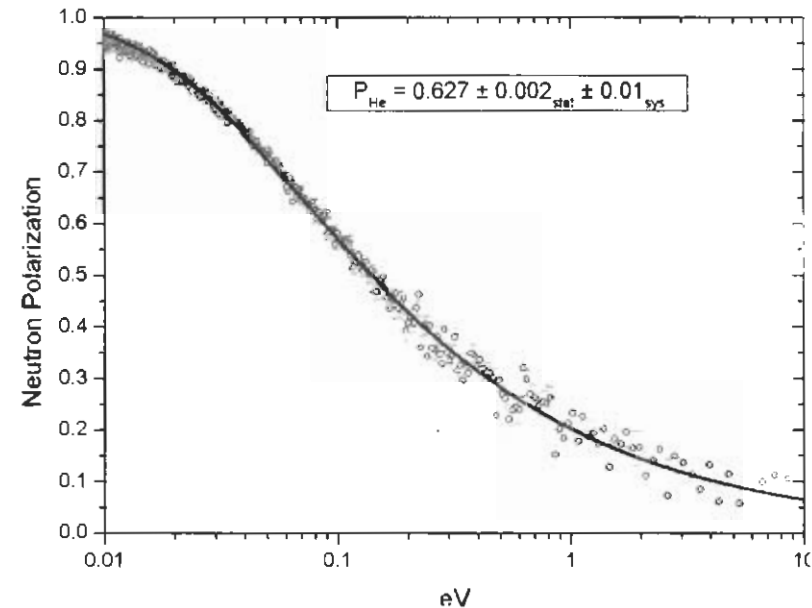
A2 IPNS, Tsukuba, Ibaraki, 305-0801, Japan

A3 IMSS Tsukuba, Ibaraki, 305-0801, Japan

A4 IHEP, Kyungpook National University, Korea

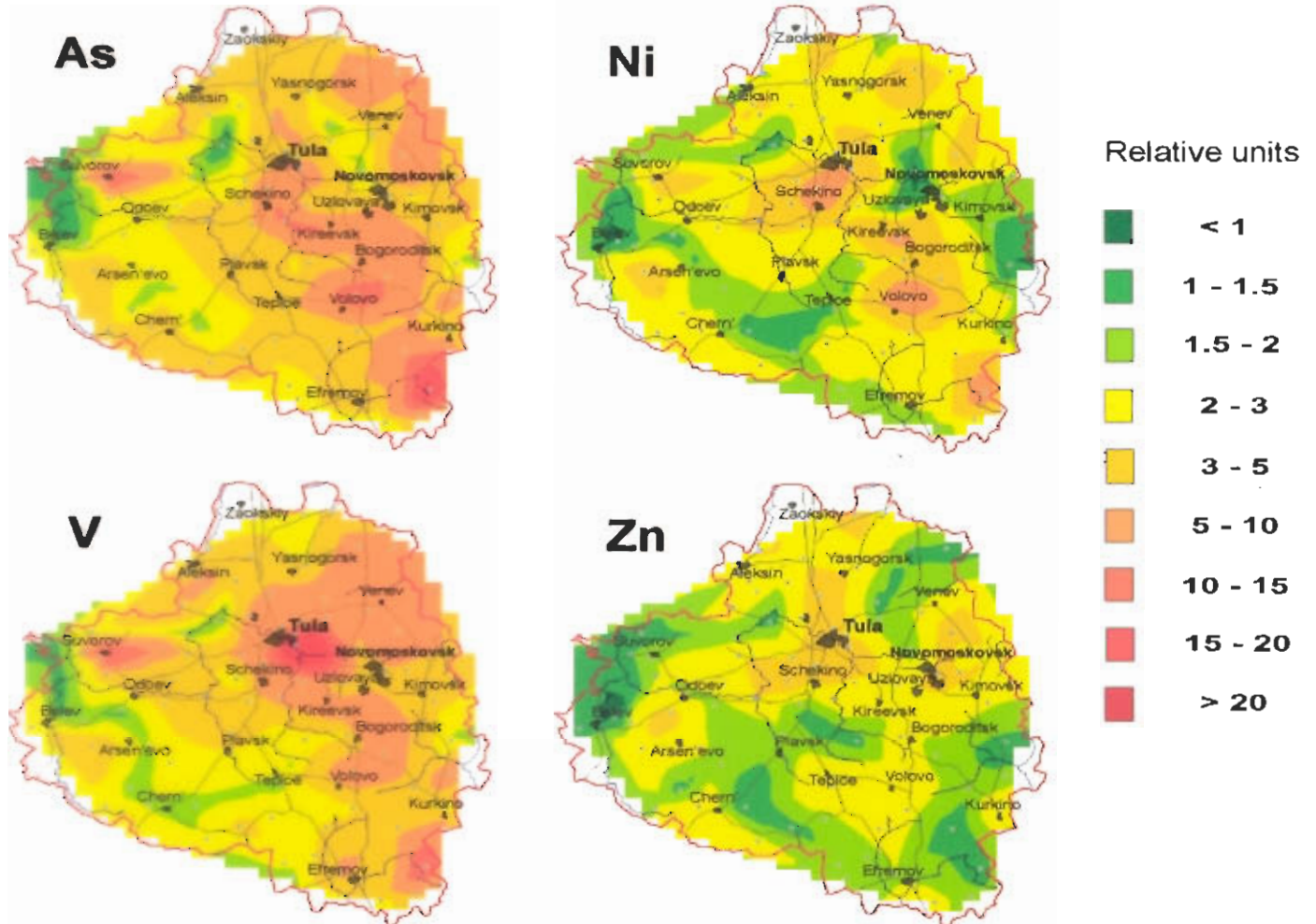


Neutron polarization with quartz cell



Neutron polarization with sapphire cell

# Analytical Investigations at the IBR-2 Reactor Project REGATA



consideration of the theme 06-4-1036-2001/2004