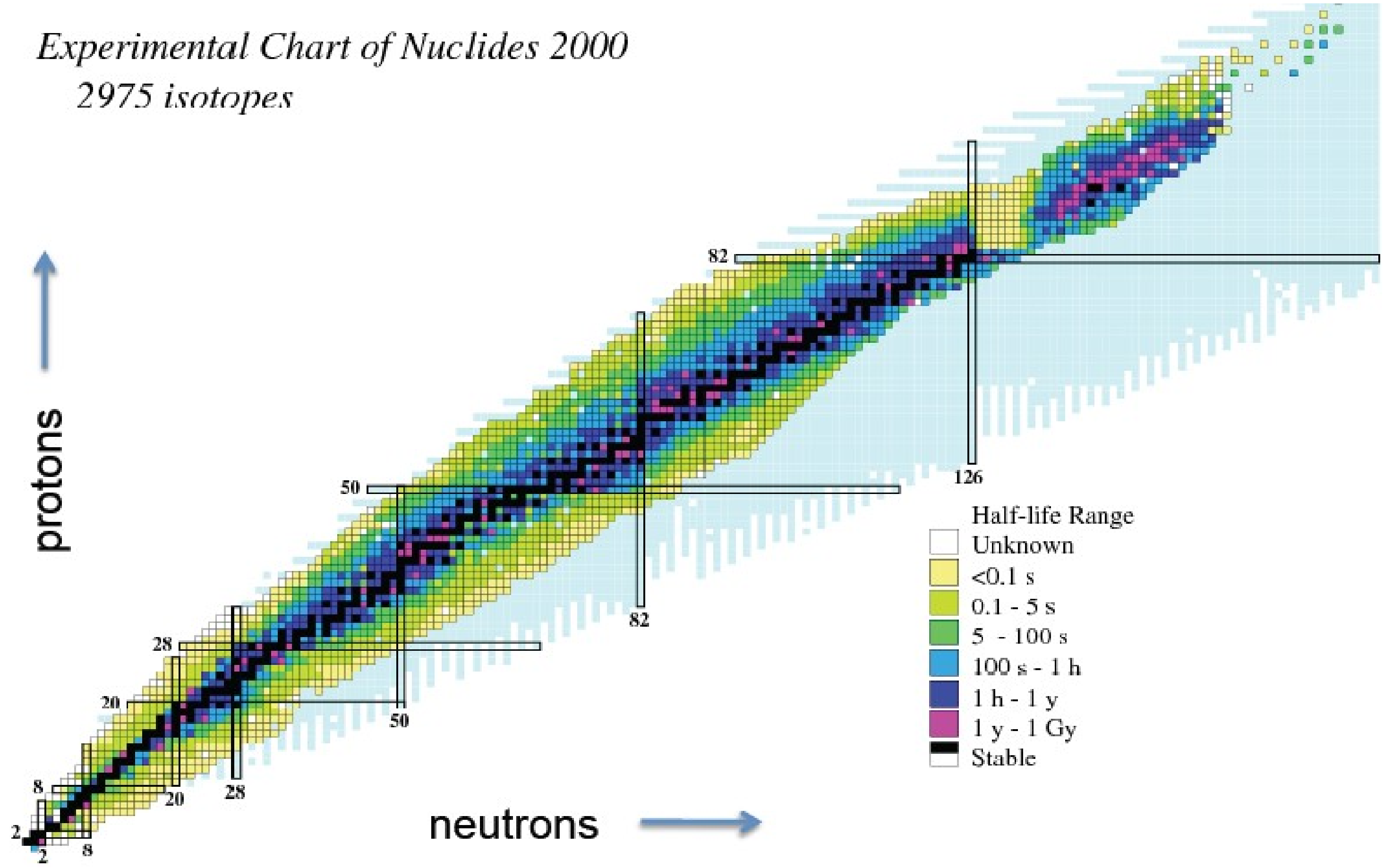
ЭКСПЕРИМЕНТ R3B

РЕАКЦИИ С РЕЛЯТИВИСТКИМИ РАДИОАКТИВНЫМИ ПУЧКАМИ

НА УСКОРИТЕЛЬНОМ КОМПЛЕКСЕ

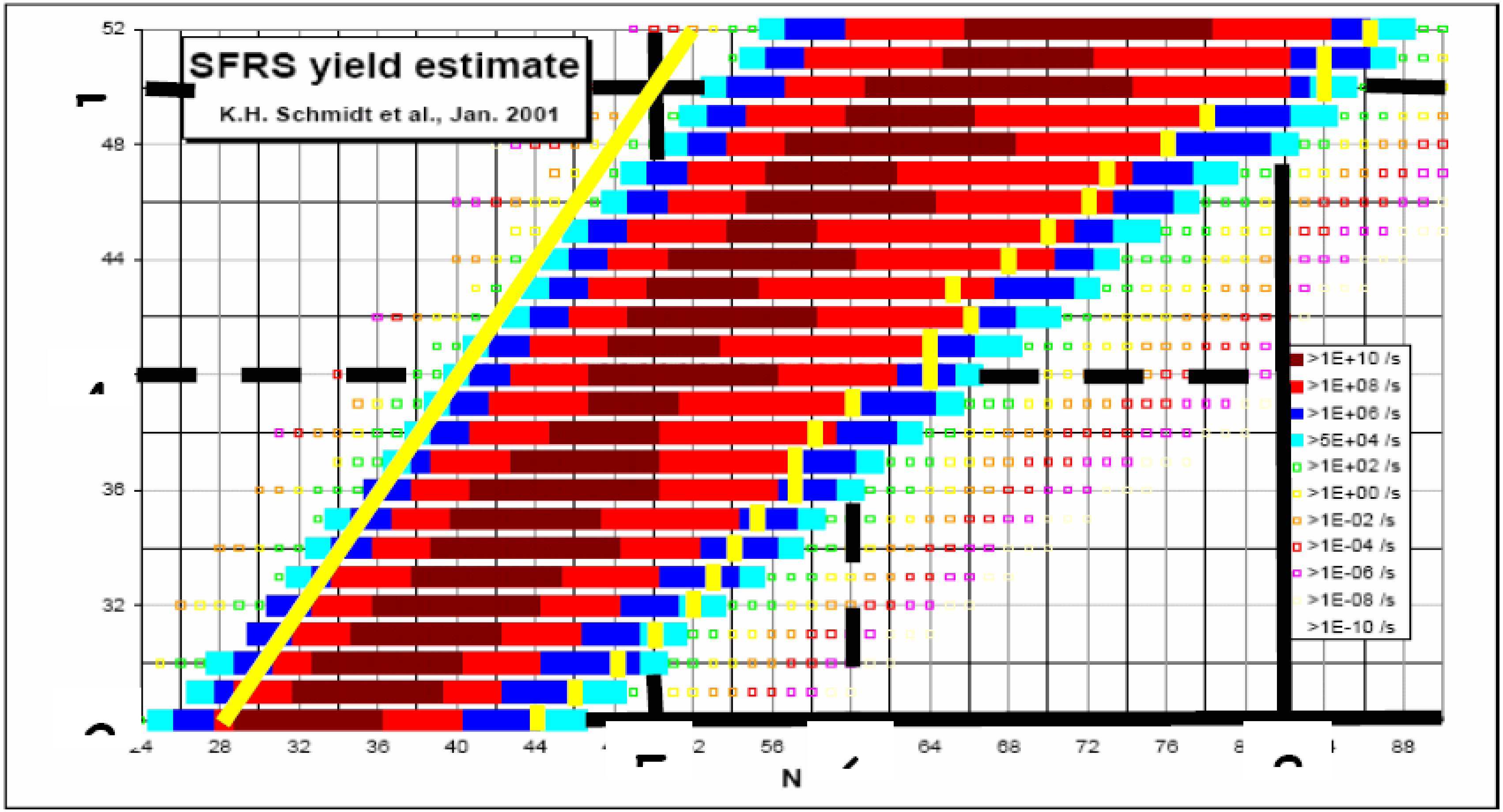
FAIR (GSI, DARMSTADT, GERMANY)

Е.М. МАЕВ


Experimental Chart of Nuclides 2000
2975 isotopes
protons
neutrons
Half-life Range
Unknown
<0.1 s
0.1 - 5 s
5 - 100 s
100 s - 1 h
1 h - 1 y
1 y - 1 Gy
Stable
2
8
20
28
50
82
126

GSI **FAIR**

RIB production Rates at FAIR



R3B

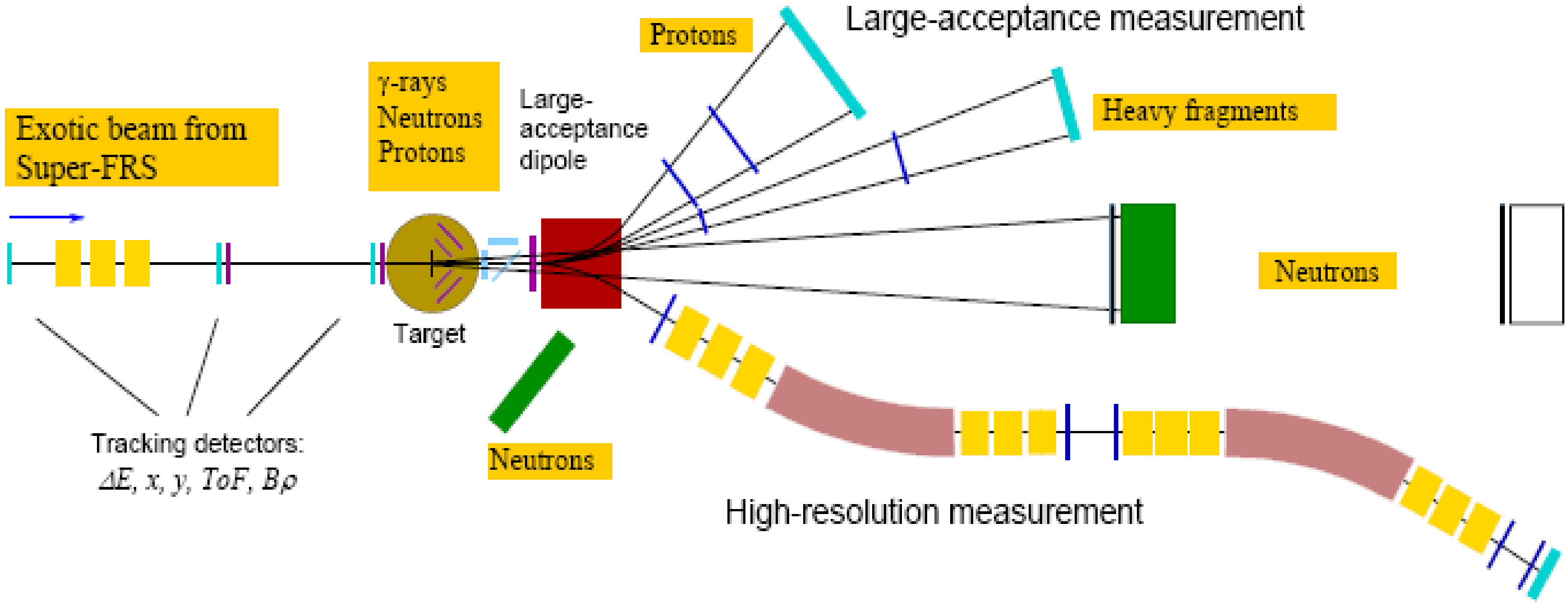


Figure 1: Schematic drawing of the experimental setup comprising γ-ray and target recoil detection, a large-acceptance dipole magnet, a high-resolution magnetic spectrometer, neutron and light-charged particle detectors, and a variety of heavy-ion detectors.

Russian participation:

Neutron detector, gamma spectrometer, active target.

Experiments with PNPI active targets

1.Diffraction scattering of high energy hadrons:

PNPI(Gatchina,1971-1974), IHEP(Serpuhov,1974-1977), CERN(1976-1980) and SACLEY(1980-1983).

2.Muon catalyzed pd, dd, dt, dHe3 fusion:

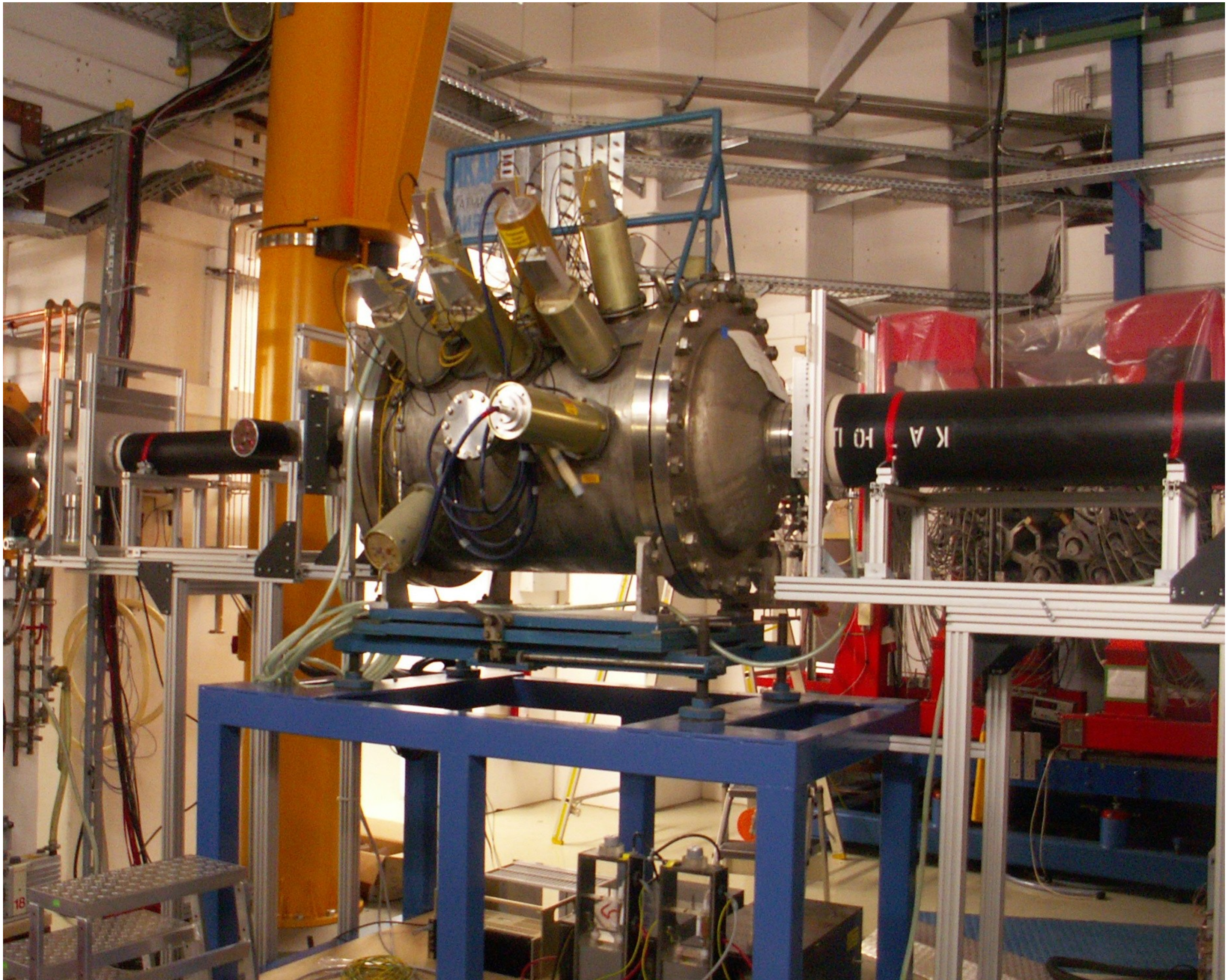
PNPI (1979-1989) and PSI (1989-1997).

3.Muon capture experiments at PSI:

Muon capture by He-3(1993), Muon capture by proton (1997-2007) and Muon capture by deuteron from 2008.

4.Proton diffraction scattering on nuclei (in inverse kine-matics) and nuclei matter distributions (GSI,from1993).

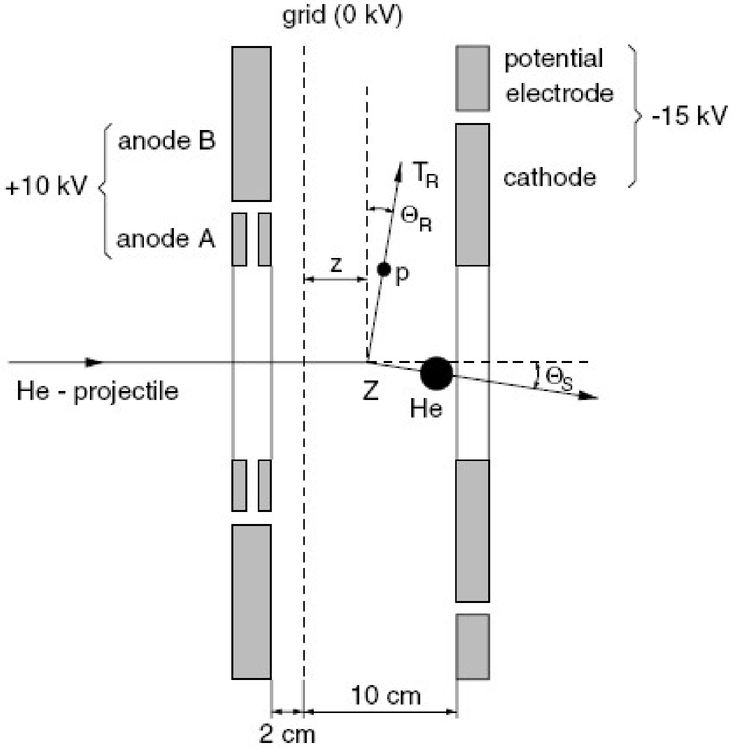
5. Nucleon polarizabilities (IKP-TUD,from 1999).

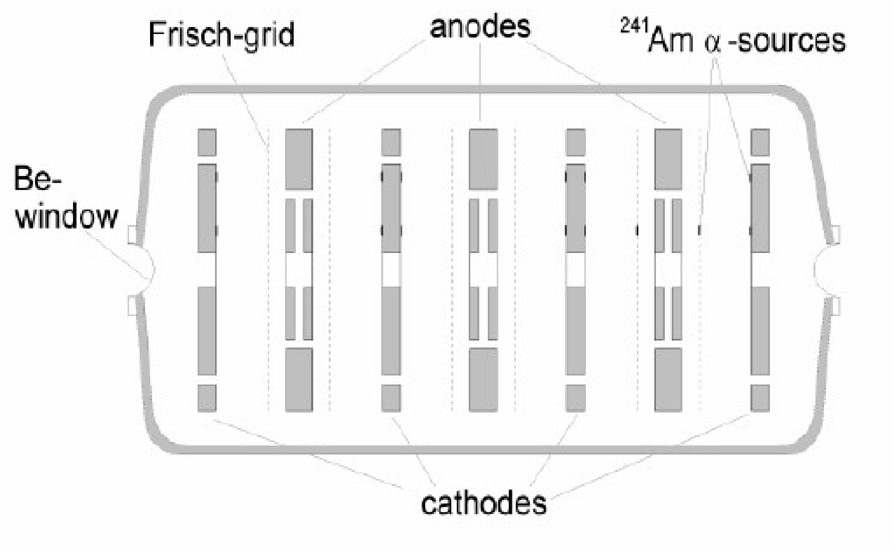


IKAR has been already used to study pHe, pLi, pBe, pB and pC elastic scattering

new IKAR can be used at FAIR for studies of small angular p-A and He-A elastic and inelastic scattering for heavier A

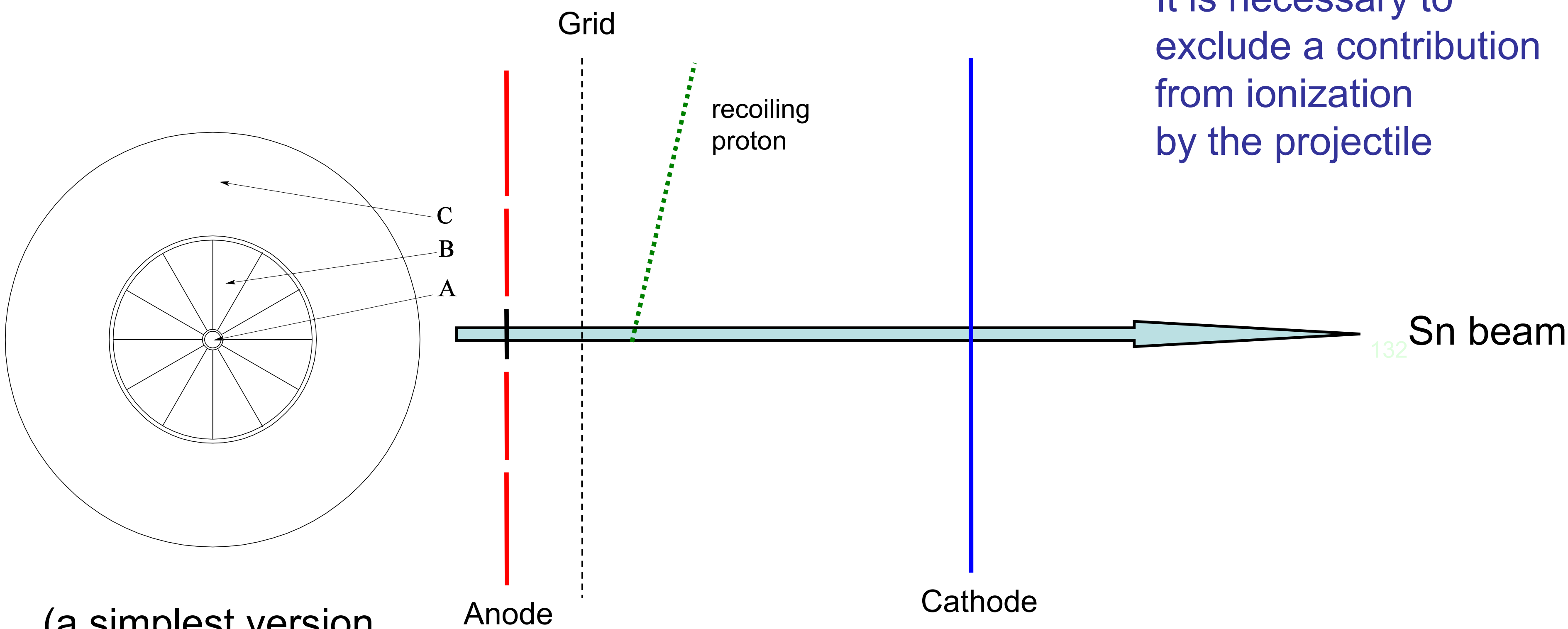
(studies at small momentum transfers)





New IKAR chamber

It is necessary to exclude a contribution from ionization by the projectile



(a simplest version of the anode)

A correction on the energy lost in the central dead region

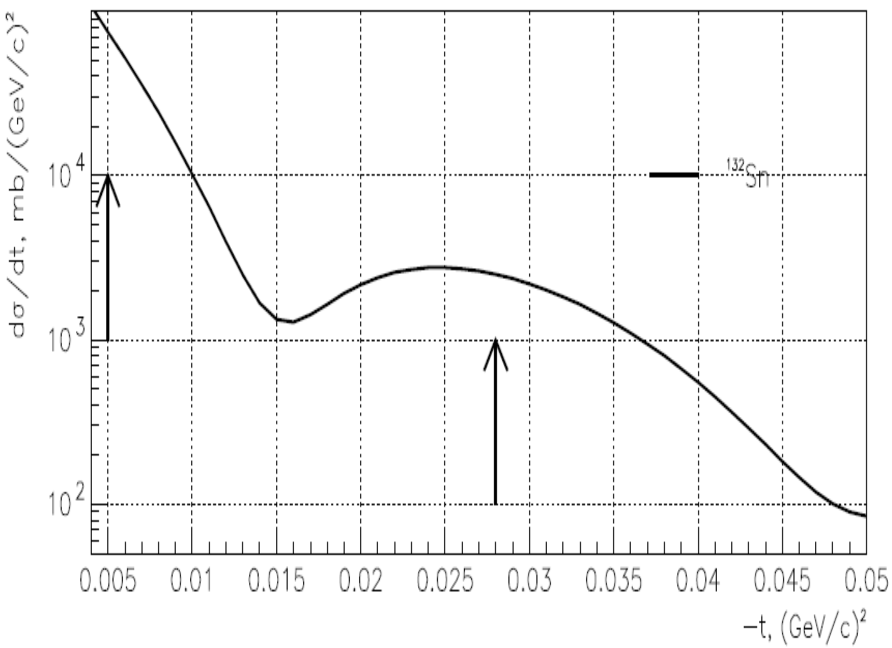
Farouk Aksouh

	Be 500 um	H2 50 cm	H2 1 m	P (bar)
ΔE	3.59	0.45	0.89	1
δE	0.1270	0.1338	0.14	
$\delta\vartheta$	0.4328	0.4439	0.4547	
ΔE	3.59	4.43	8.85	10
δE	0.1270	0.1834	0.2258	
$\delta\vartheta$	0.4328	0.5339	0.6195	
ΔE	3.59	8.85	17.7	20
δE	0.1270	0.2259	0.2925	
$\delta\vartheta$	0.4328	0.6195	0.7646	

ΔE [MeV/u]
δE [MeV/u]
δθ [mrad] - cumulative

Energy loss and straggling for a Sn132 beam at 700 MeV/u

Farouk Aksouh



Multiple Coulomb scattering of the projectile: $\delta\theta_s \sim Z/A \approx 0.5\text{-}0.8$ mrad.

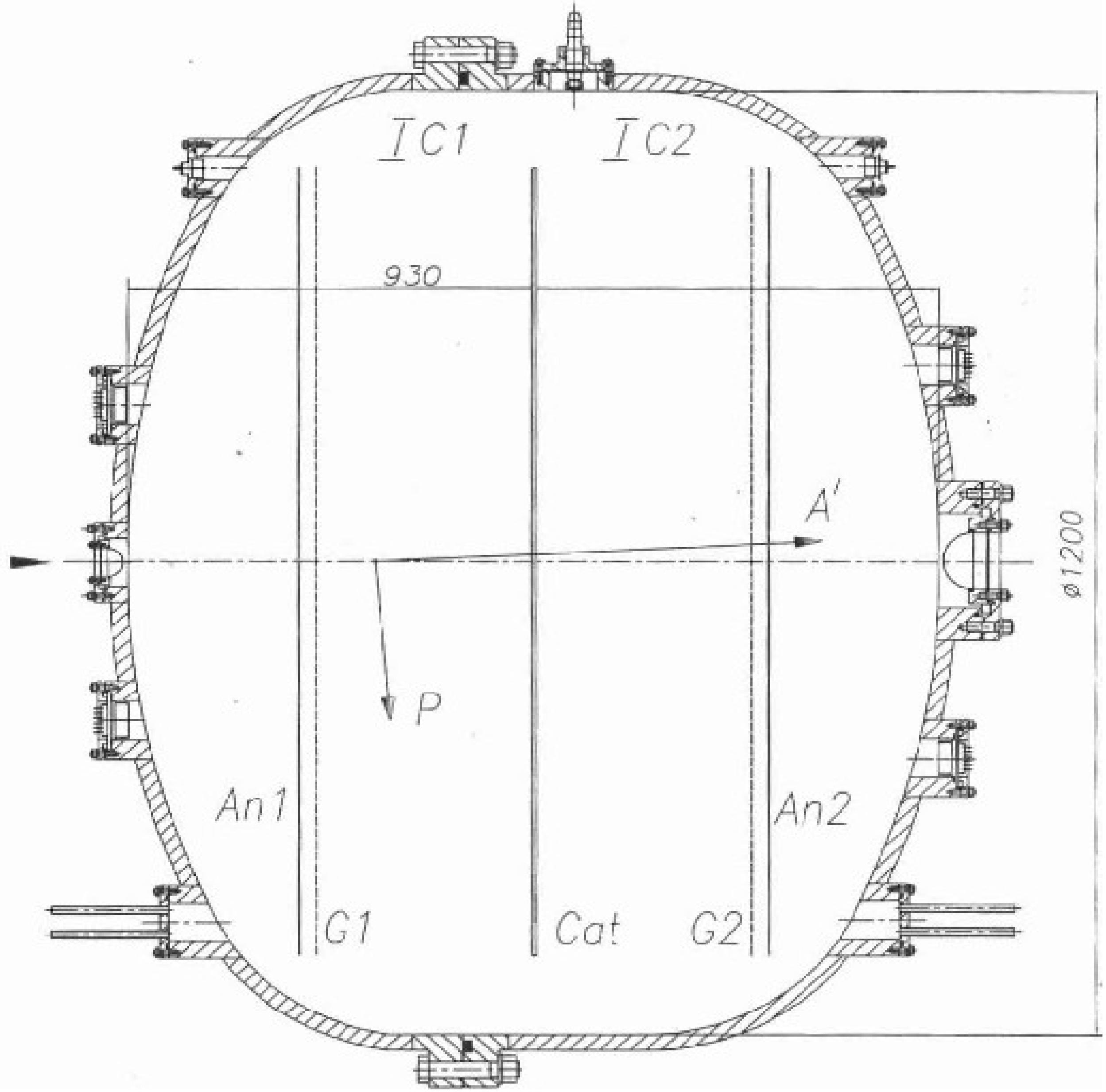
$\theta_s < 1$ mrad

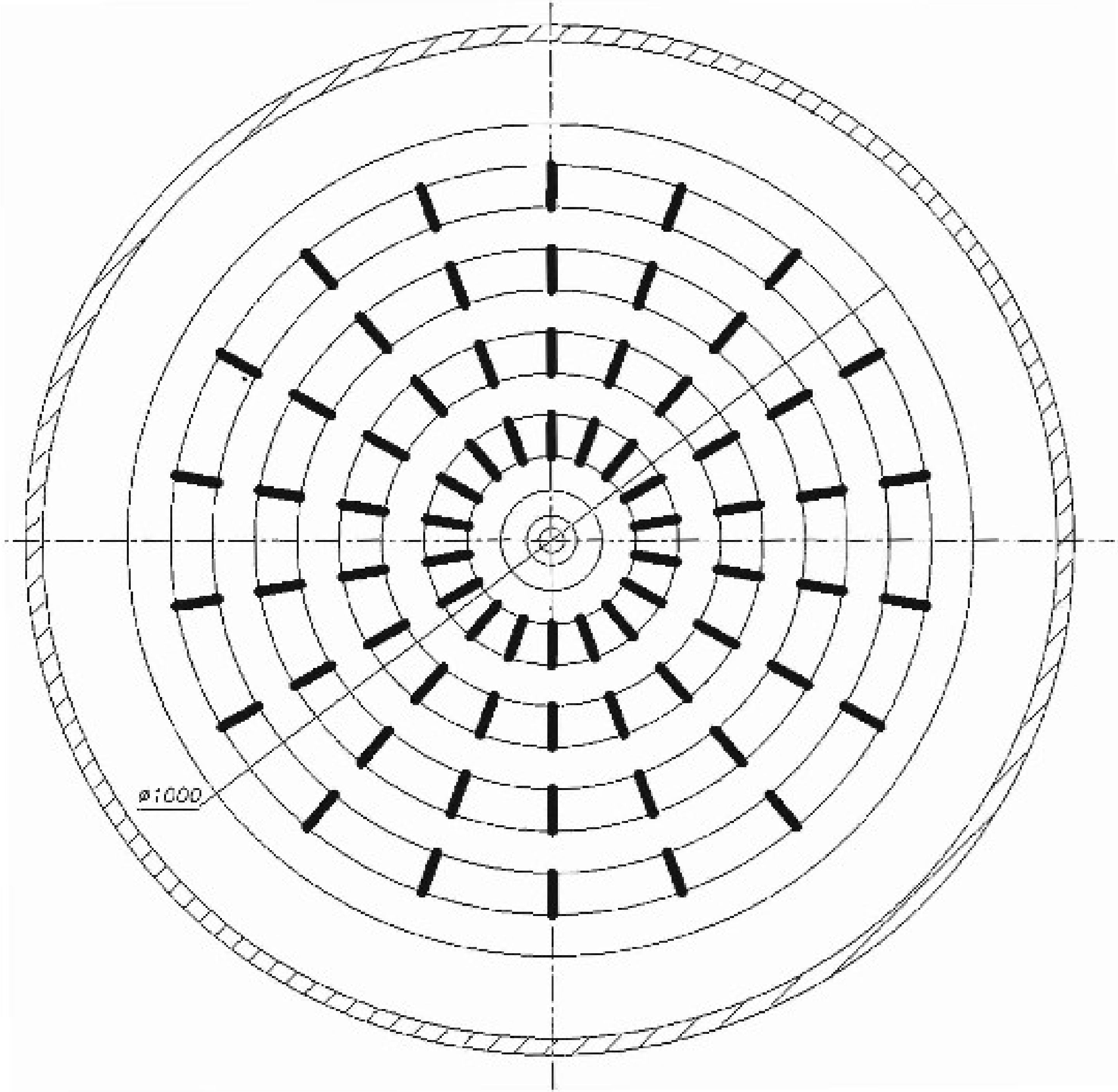
0.002 < t< 0.025 (GeV/c)2$_2$

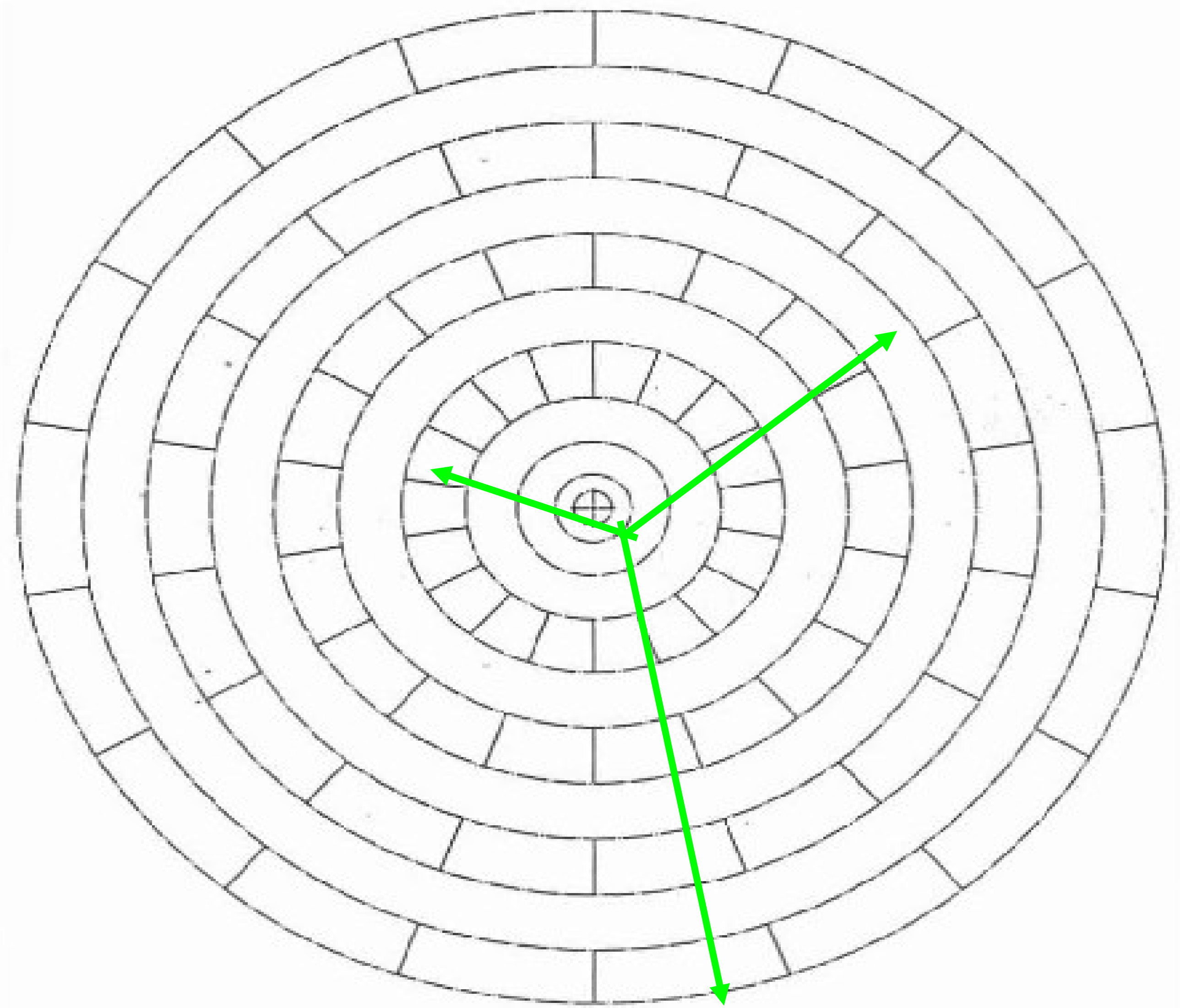
$E_p < 13$ MeV

$\sigma_{tot} \approx 600$ mb (in previous exp. – 60 mb)

Вариант 5




ø1000



Anodes of new IKAR

PNPI can fabricate a new IKAR setup with the relevant electronics

Main parameters of the new IKAR:

Anode and cathode diameter – 1.0 m, volume ~900 l,
pressure – from 1 bar up to 20 bar,
2 sections with the cathode-grid distance of 25 cm,
highly segmented anodes: 10 rings of 5 cm width,
divided on 20 segments in the azimuthal angle,
total number of anodes ~200 channels.

Thickness--- 4*10**22 n/cm2 (at 20 bar),
luminocity--- 2*10**27 n/cm2/s (5*10**4 n/s),
target gases---- H2,D2, He3, He4

(He,He') inelastic scattering

Active target from PSI muon capture experiment (MuCap).

PNPI TPC in coincidence with Gamma spectrometer (CALIFA).

GIANT RESONANCE

- Collective oscillations of all protons and all neutrons in a nucleus in phase (isoscalar) or out of phase (isovector).
- Characterized by multipolarity, spin and isospin.

	$\Delta S=0, \Delta T=0$	$\Delta S\ 0, \Delta T\ 1$	$\Delta S\ 0, \Delta T\ 1$	$\Delta S=1, \Delta T=1$	$\Delta S=1, \Delta T=1$
L 0: Monopole	ISGMR r^2Y_0	IAS τY_0	IVGMR $\tau r^2 Y_0$	GTR $\tau\sigma Y_0$	IVSGMR $\tau\sigma r^2 Y_0$
L 1: Dipole	ISGDR r^3Y_1		IVGDR $\tau r Y_1$		IVSGDR $\tau\sigma r Y_1$
L 2: Quadrupole	ISGQR r^2Y_2		IVGQR $\tau r^2 Y_2$		IVSGQR $\tau\sigma r^2 Y_2$

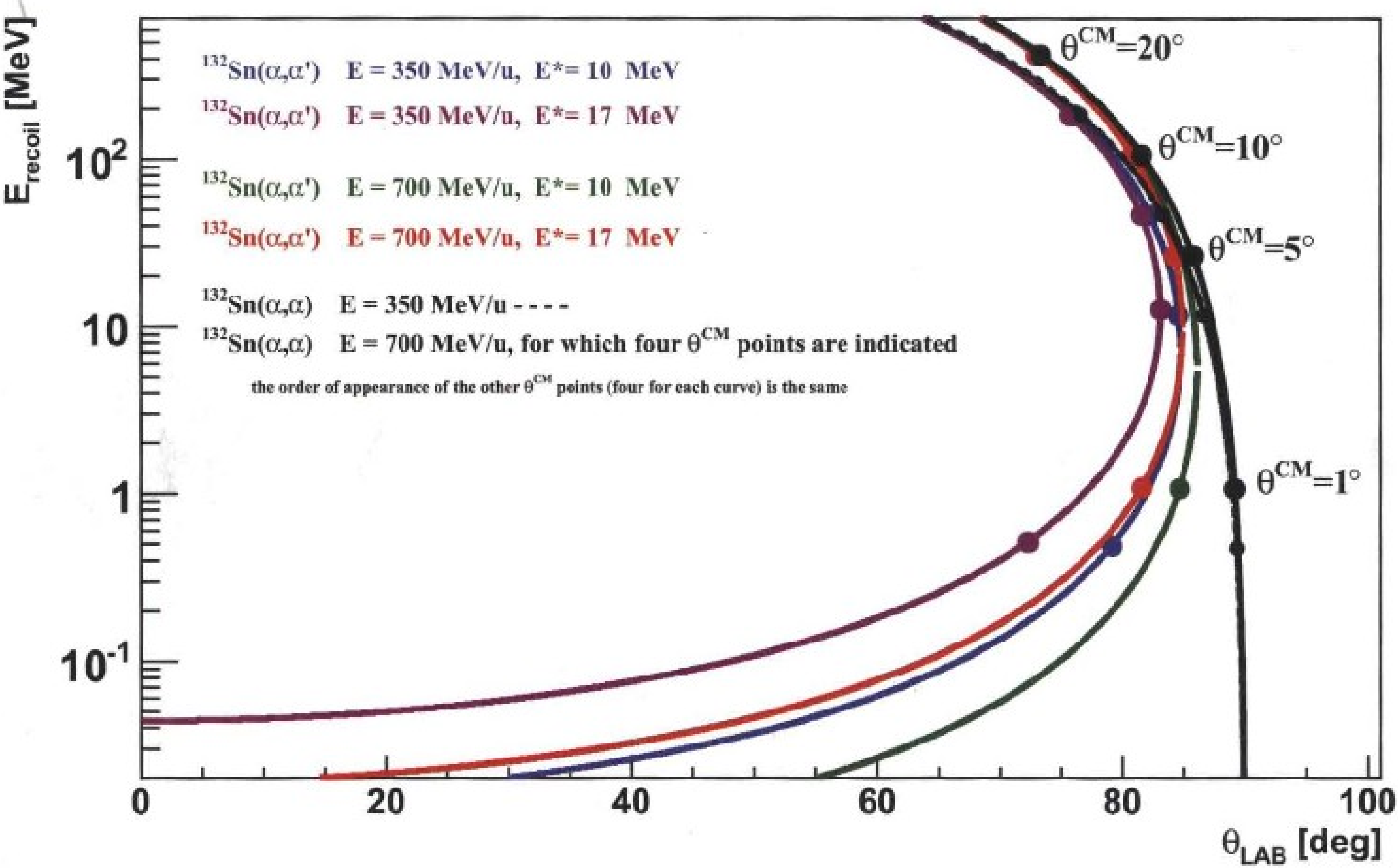
Why ISGDR (ISGMR) and how?

- Provides to determine experimentally the nucleus incompressibility.

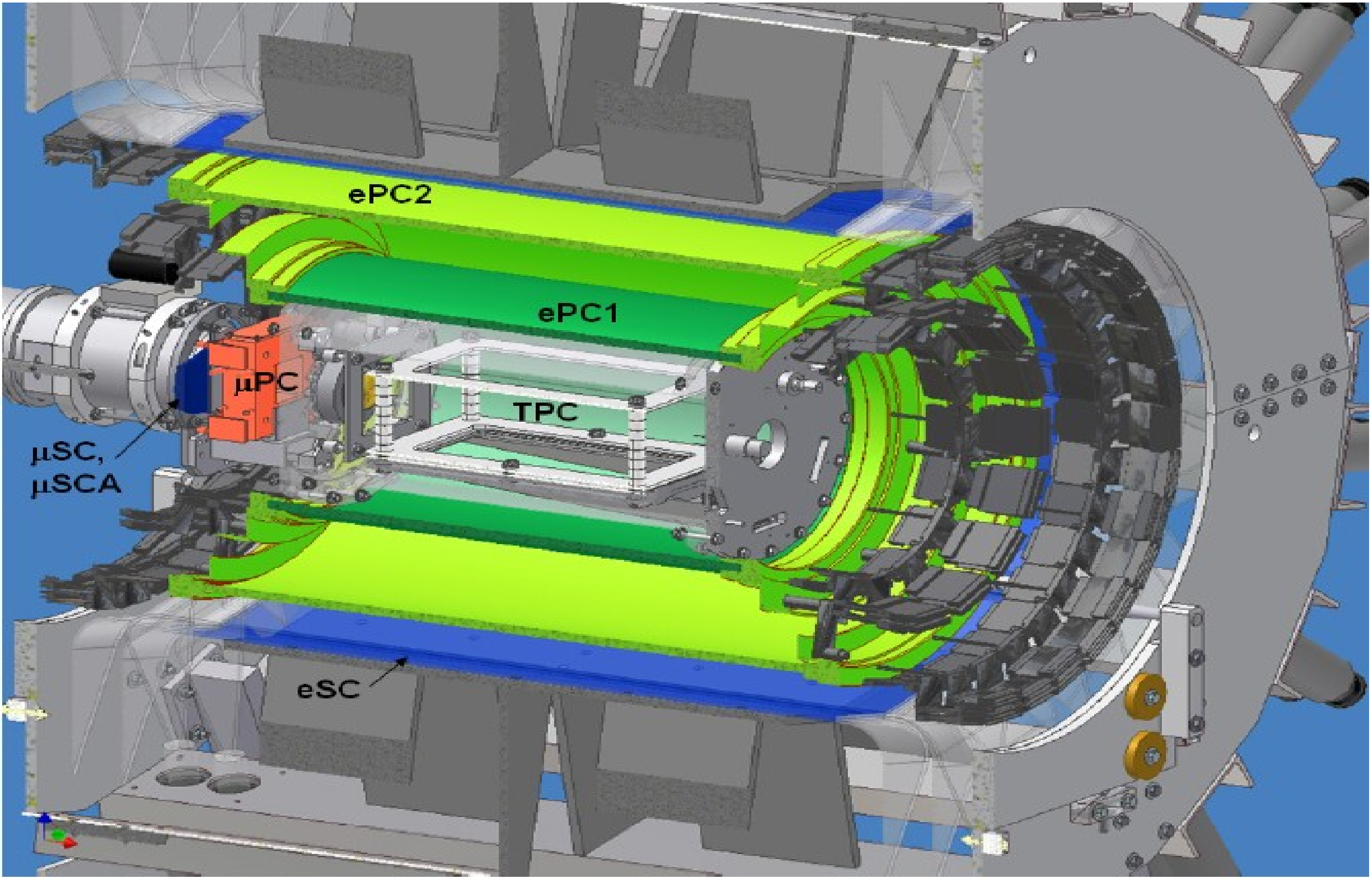
$$E_{ISGMR} = \hbar\sqrt{\frac{K_A}{m < r^2 >}}$$

$$E_{ISGDR} = \hbar\sqrt{\frac{7}{3}\frac{K_A + \frac{27}{25}\varepsilon_F}{m < r^2 >}}$$

- The EoS of nuclear matter governs the supernovae explosions and formation of neutron



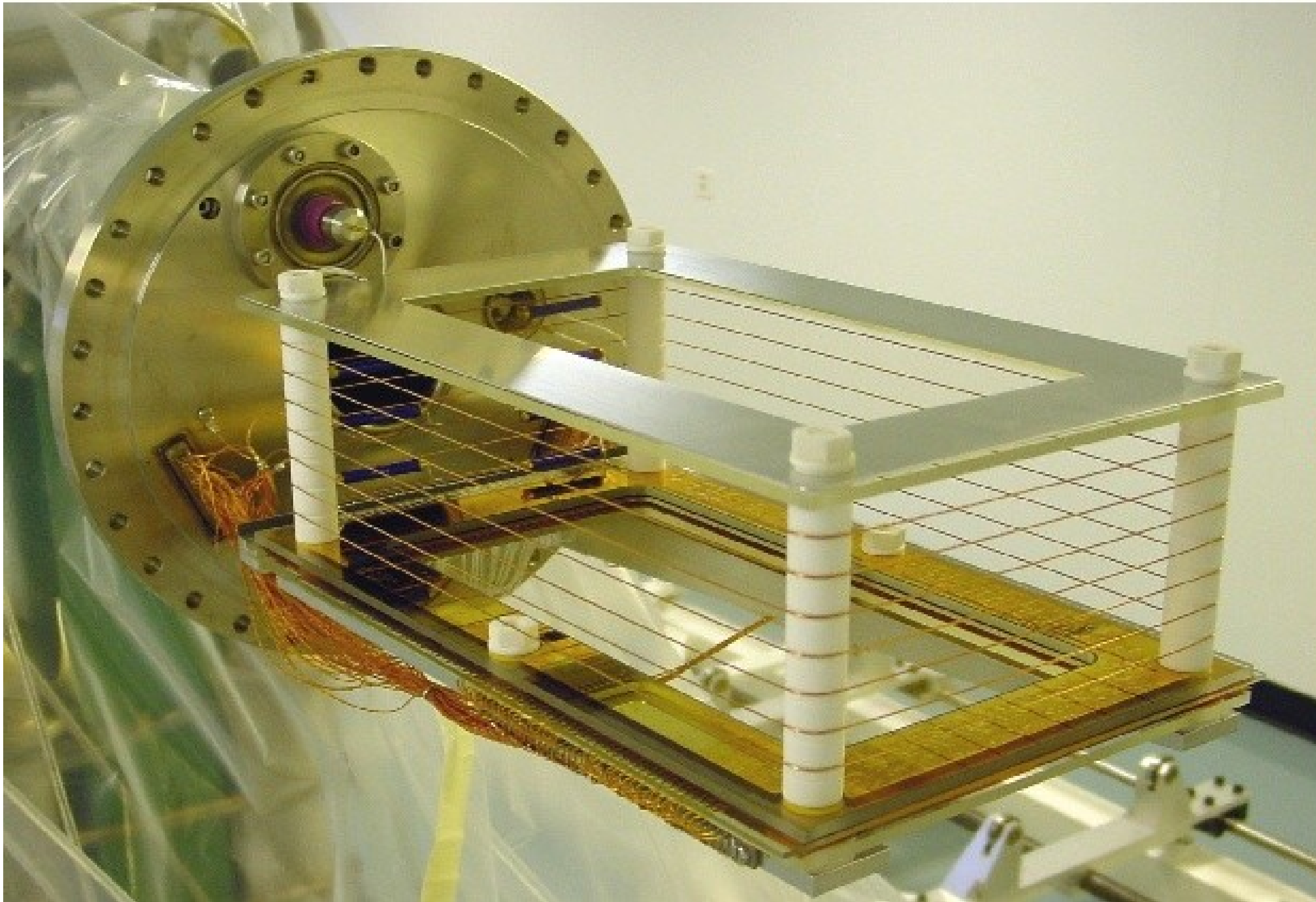
E_{recoil} [MeV]
10^2
10
1
10^{-1}
0
20
40
60
80
100
θ_{LAB} [deg]
^{132}Sn(α,α') E = 350 MeV/u, E*= 10 MeV
^{132}Sn(α,α') E = 350 MeV/u, E*= 17 MeV
^{132}Sn(α,α') E = 700 MeV/u, E*= 10 MeV
^{132}Sn(α,α') E = 700 MeV/u, E*= 17 MeV
^{132}Sn(α,α) E = 350 MeV/u - - - -
^{132}Sn(α,α) E = 700 MeV/u, for which four θ^{CM} points are indicated
the order of appearance of the other θ^{CM} points (four for each curve) is the same
θ^{CM}=20°
θ^{CM}=10°
θ^{CM}=5°
θ^{CM}=1°



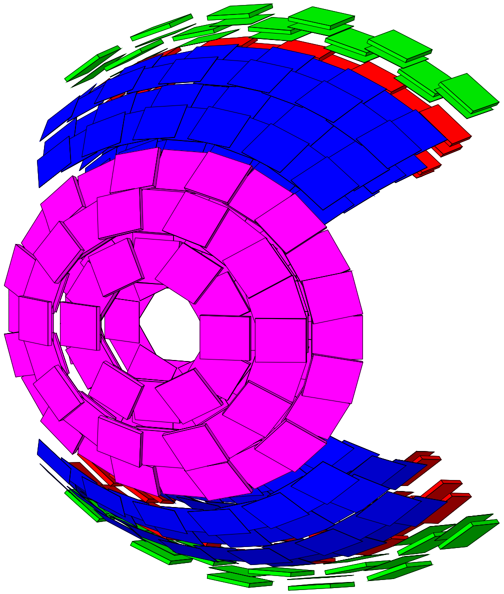
Cross-sectional diagram of the MuCap detector

the new Hydrogen TPC at PSI

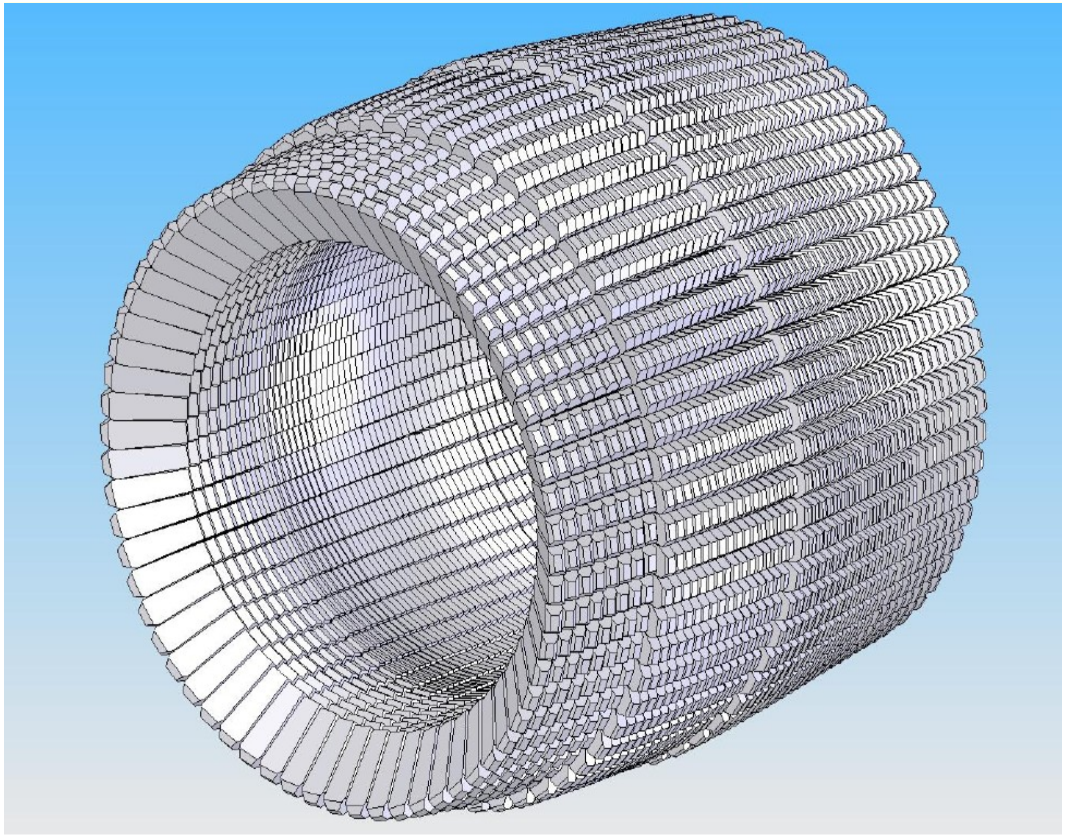
status report, Gatchina meeting June 14-17, 2004
by Malte Hildebrandt and Claude Petitjean



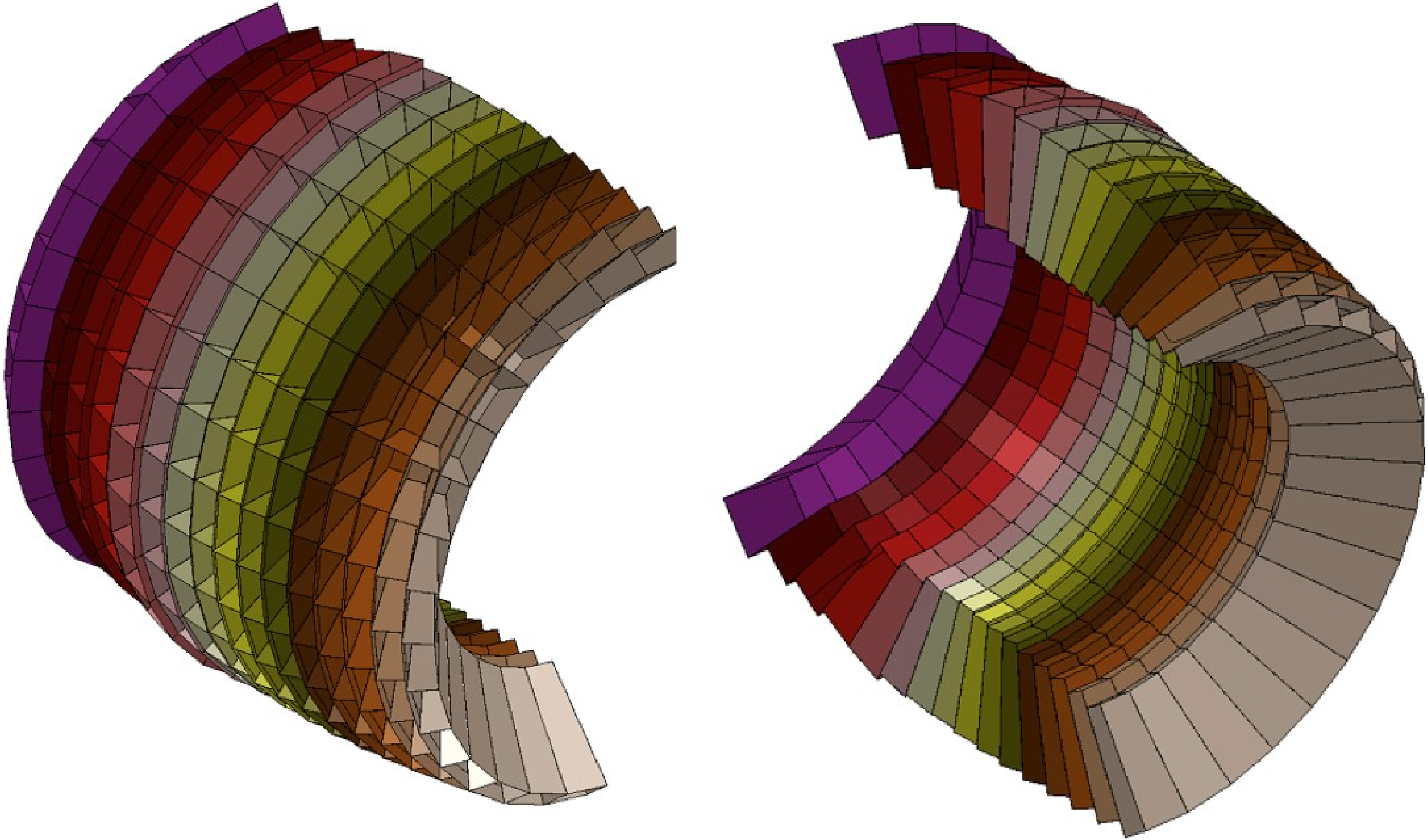
the TPC
at first
assembly
Oct 2002

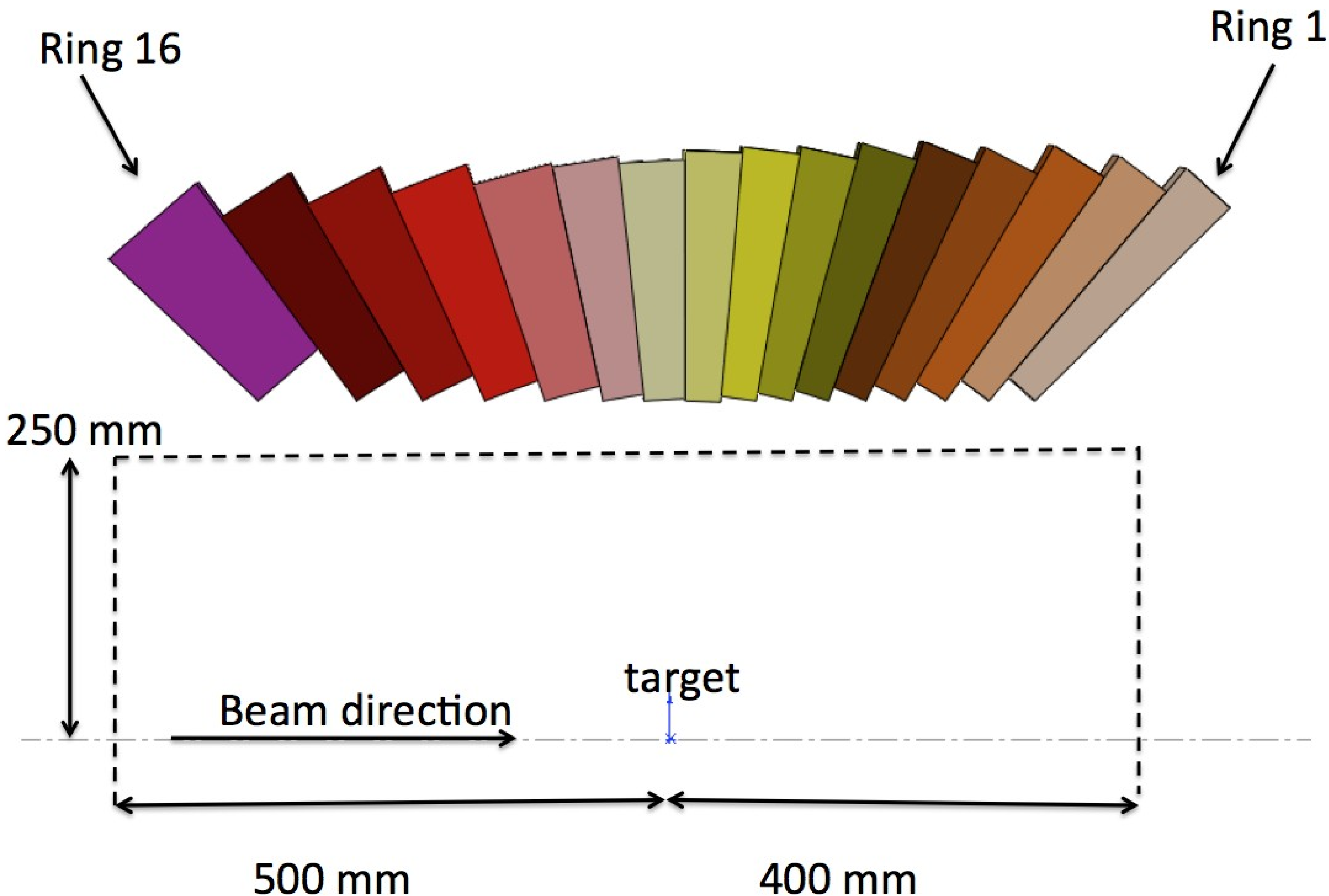


Particle-recoil
semiconductor detector



Gamma-detector




Ring 16
Ring 1
250 mm
target
Beam direction
500 mm
400 mm

Properties of an active targets - ionization chambers

1. Filling gas--H_2, D_2, He3, He4… at pressure 1-20 bar.
2. Registration of all charged particles (p,d,t, He3,He4) inside of an active target with the energy in the range of 1-15 MeV.
3. Energy resolution 20-30 keV(rms).
4. Efficiency of detection charge particles (T>1MeV) is ~100%.
5. Measurements of the interaction point inside of the gas volume with resolution of ~0.5 mm (rms).
6. Angular resolution ~5 mrad (rms) for recoil particles.
7. Avoiding the wall effects on the level of less than 0.1%.