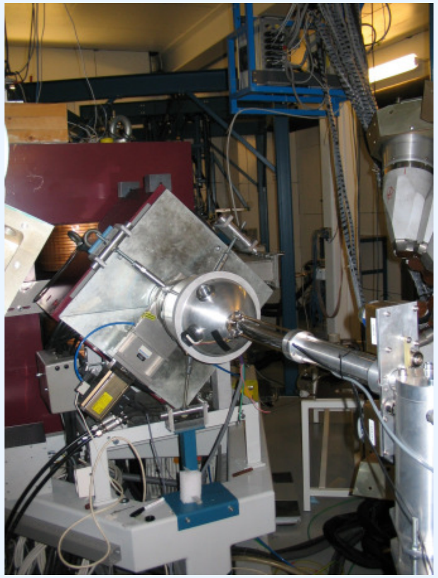
TASCA separator - Trans Actinide Separator and Chemistry Apparatus

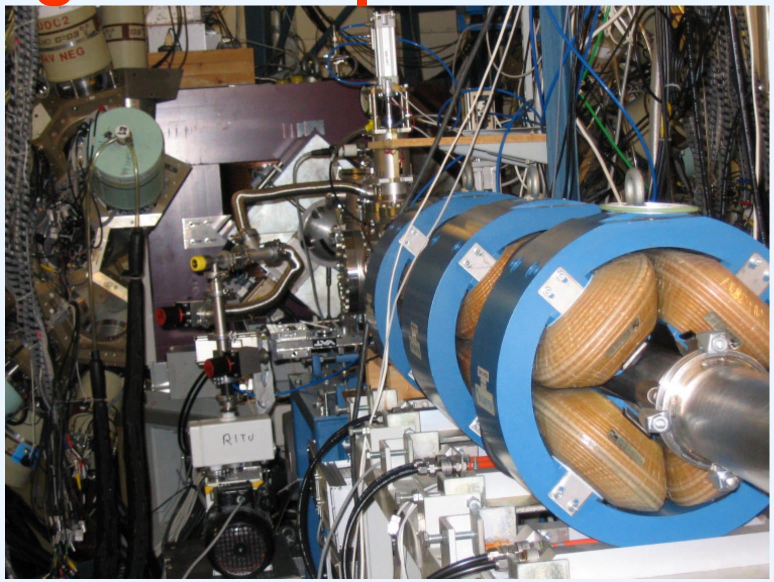
Comparison of separators

Separator	SASSY II	DGFRS	HECK	GARIS	RITU	BGS
Configuration	$D_vQ_hQ_v$	DQ_hQ_v	DQ_hQ_v	DQ_hQ_v	$Q_vDQ_hQ_v$	Q_vD_hD
Solid angle, msr	7	10	10	22	10	45
Bend. angle, deg	23	23	30	45	25	70
Bro, max, Tm	2.2	3.1	2.2	1.85	2.2	2.5
Length, m	4.0	4.3	3.8	4.8	4.7	4.7
Dispersion, cm/%	0.67	0.63	0.61	0.78	1.00	2.00

old NASE (HECK) sep.

working RITU separator





Problems to have high transmision

connected to the initial beam:

- Size of the beam
- Energy and Angular spread of the beam
- Energy and Angular spread of the beam in the target

connected to the products of reactions:

- Energy and angular spread of products in the target
- Energy and angular straggling of products in the target
- Energy and angular straggling of products in the gas
- Charge value and spread of charge states in the gas

connected to separator:

- Ion – optical scheme
- Vertical and horizontal acceptance of Dipole magnet
- Vertical and horizontal acceptance of Quadrupole magnets

Input parameters for TRANSPORT and GICO calculations

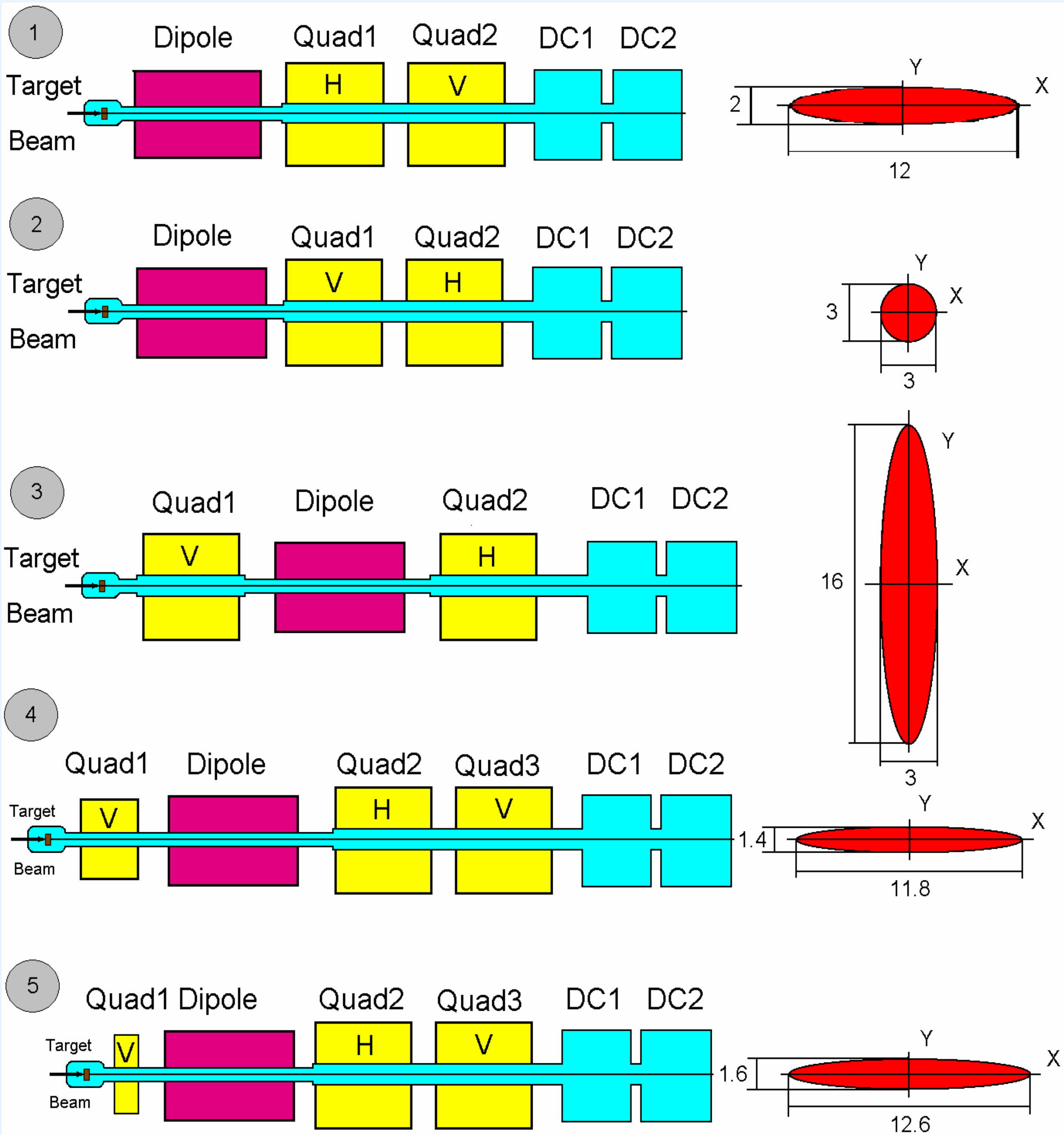
The studied test reaction is:

- ^{48}Ca(235 MeV) + ^{238}U(0.5 mg/cm^2) -> $^{286}112$ -> $^{283}112$ + 3n
- 54% of $^{283}112$ will appear within ±40 mrad
  (according to simulations of K.E.Gregorich)

Input parameters:

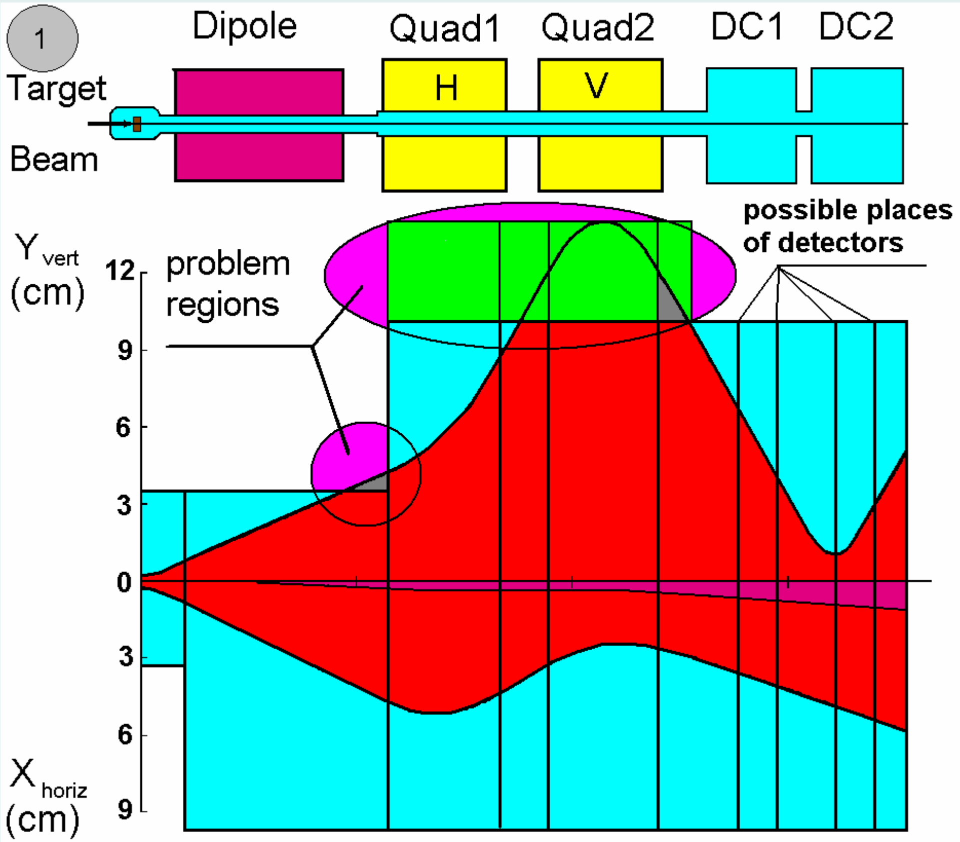
- Horizontal and vertical beam size - ± 2.5 mm
- Horizontal and vertical angle of the products - ± 40 mrad
- Momentum dispersion - ± 5% (92% of all $^{283}112$)
- Magnetic rigidity – 2.24 T*m

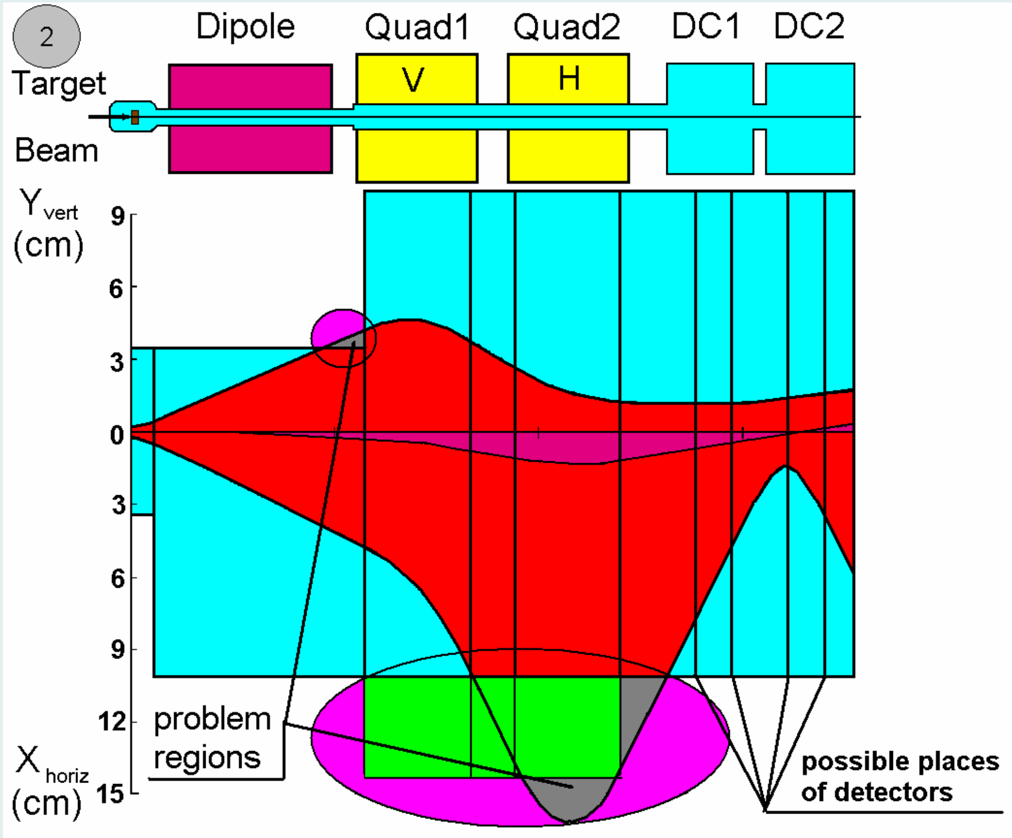
Summary data at the exit focus



		Transmission round	Transmission square
1	$S = 18\ (24)\ cm^2$	50%	54%
2	$S = 7\ (9)\ cm^2$	30%	36%
3	$S = 38\ (48)\ cm^2$	38%	40 %
4	$S = 13\ (17)\ cm^2$	48 %	50 %
5	$S = 16\ (20)\ cm^2$	51%	52%

Final decision: DQQ - configuration





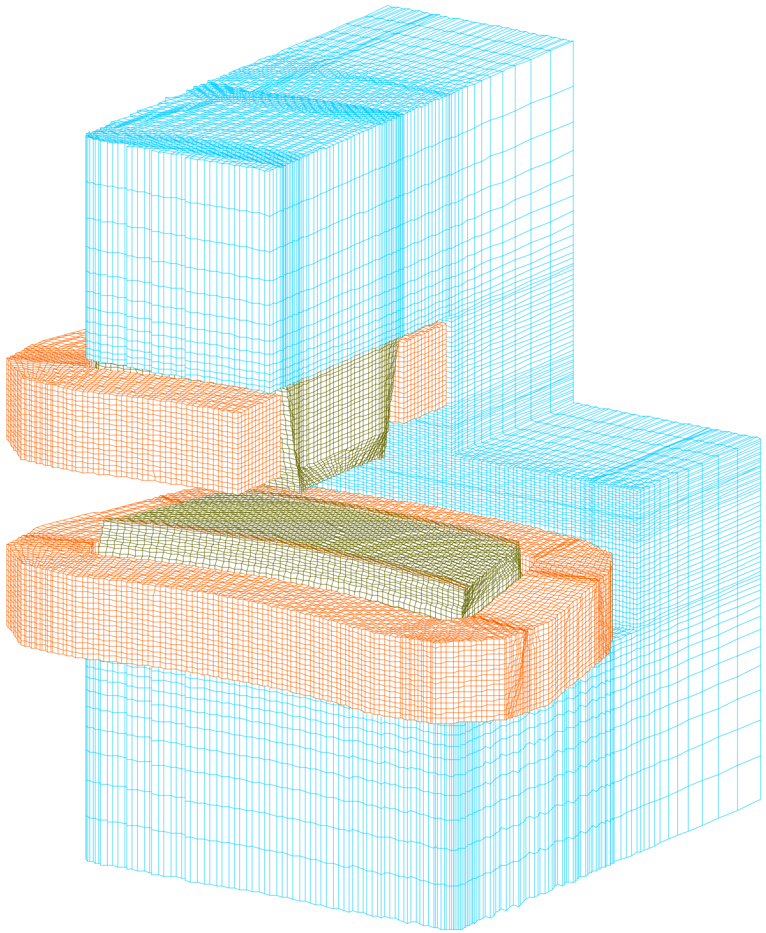
Where are the problems and how to solve them:

Magnet vacuum chamber **– increase vertical and horizontal aperture solution – calculate the magnet to skip shims (+10% in vertical aperture), new large vacuum chamber in vert. and horiz. sizes + RITU experience - large size chamber**

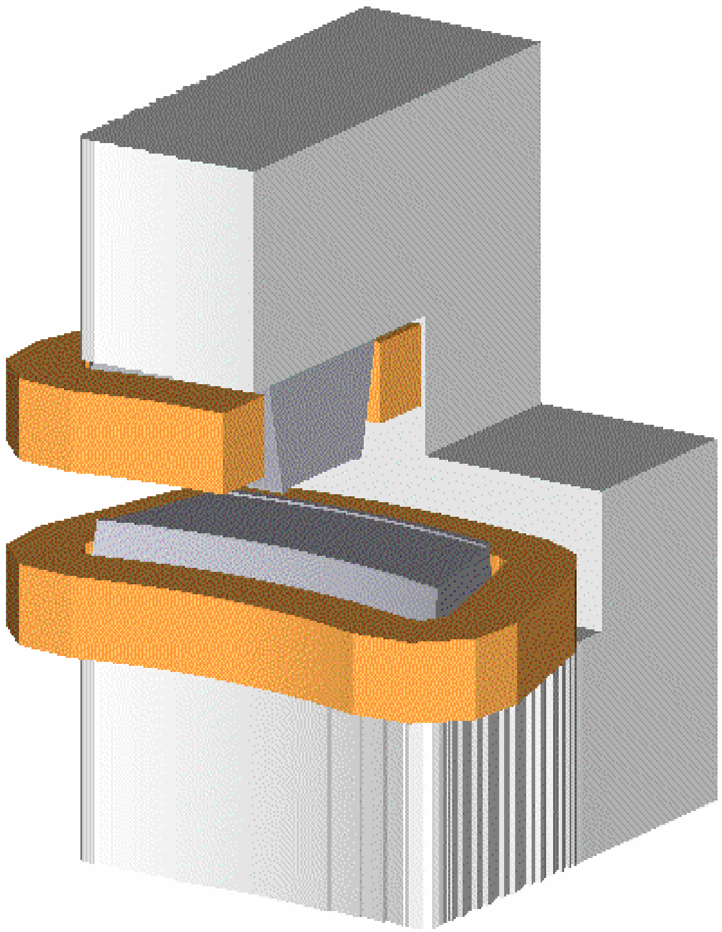
Quads vacuum chamber **- increase vertical and horizontal aperture. It was two options cheap square chamber and expensive butterfly-like vacuum chamber.**

New more powerful power supply for Bending magnet.

TASCA magnet



KOMPOT 3D mesh
(number of calculated points
128*63*59 = 475776)

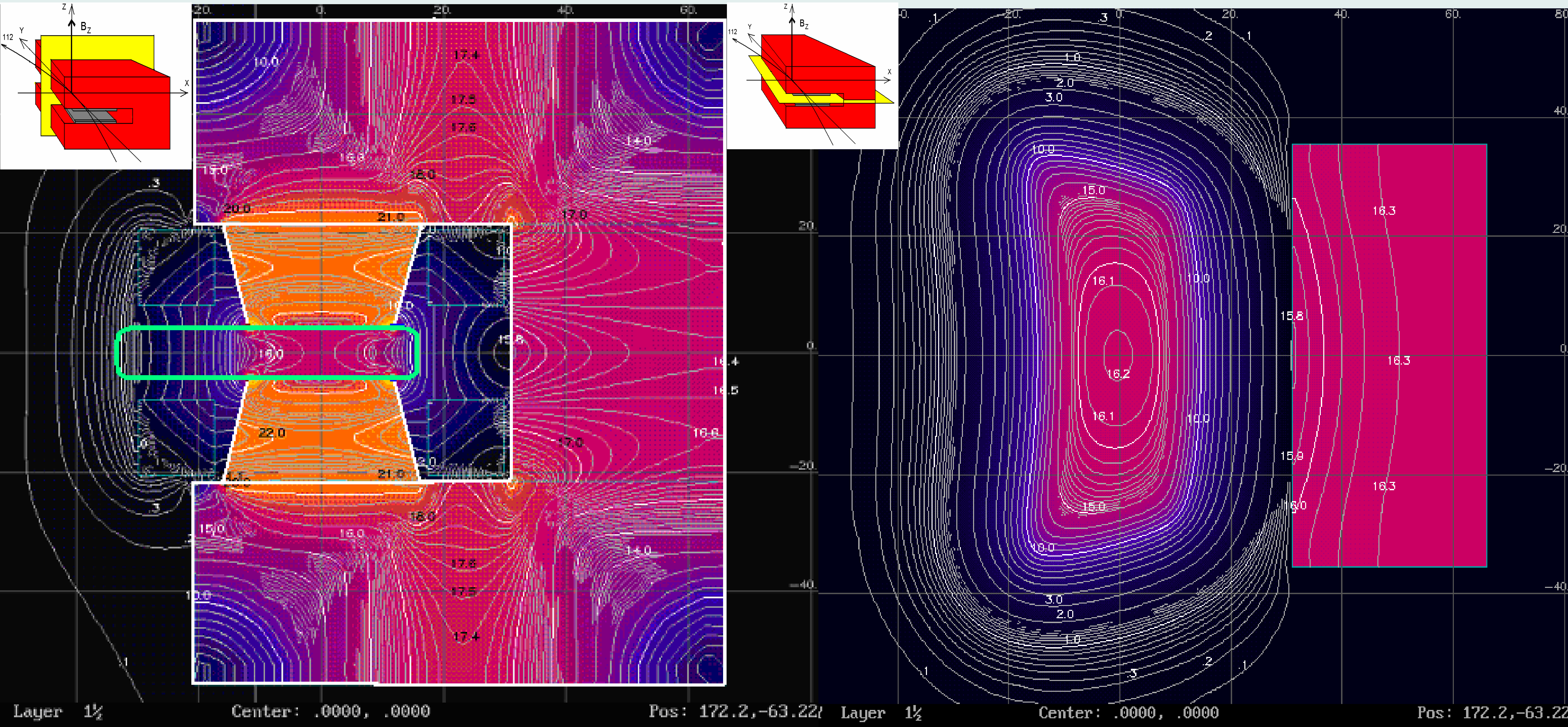


KOMPOT
computation model

The KOMPOT magnetic field distribution

Vertical Section   Horizontal Section

Distribution of B (in kGauss).Existing pole. I=700 A. B_{max}=1.635T=16.35kGauss

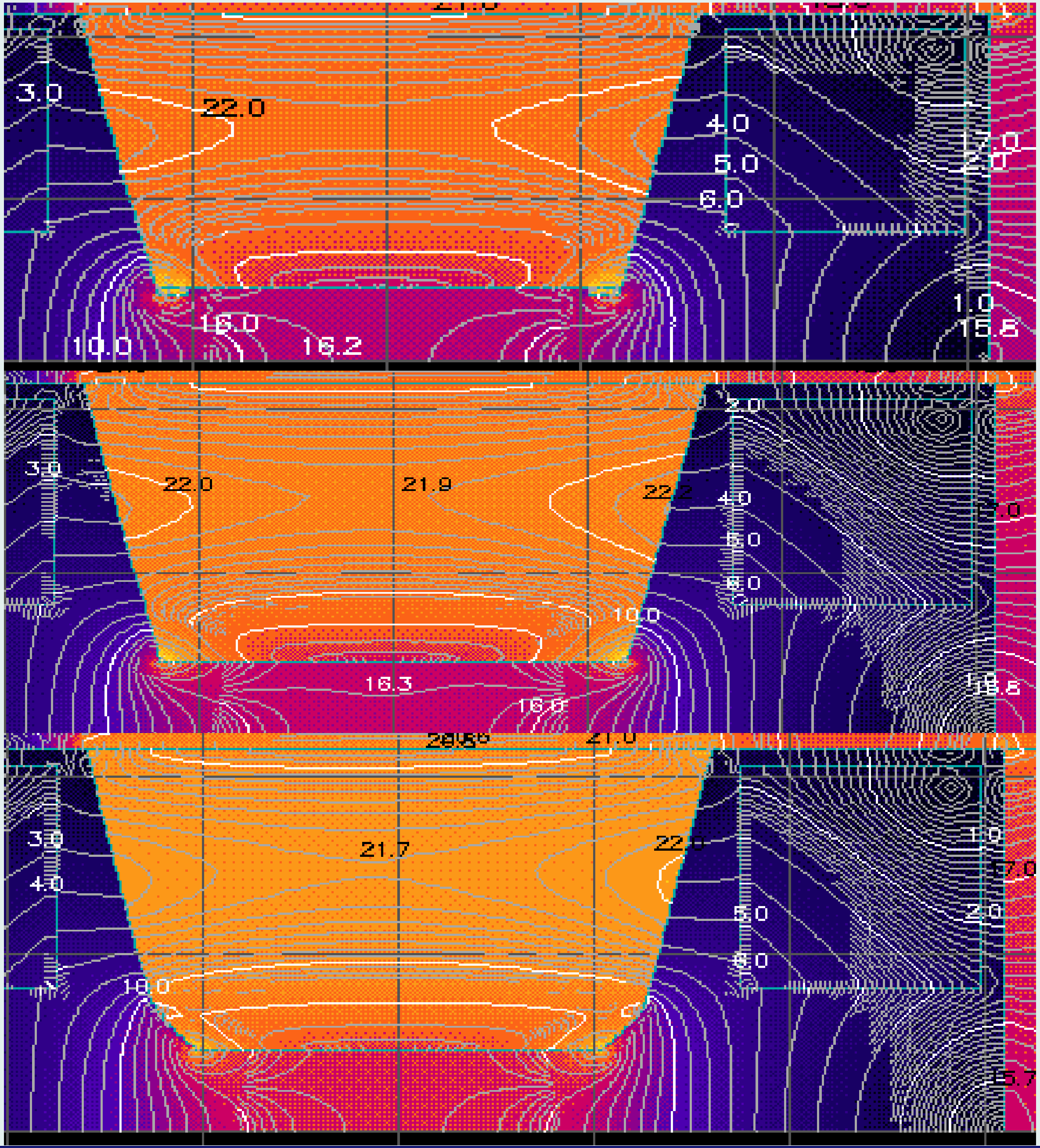


TASCA magnet (shims variations).

Distribution of Induction in the central vertical section.

Existing pole with shims.

I =700 A. $\mathbf{B}_{max}$ = 1.635 T = =16.35 kGauss



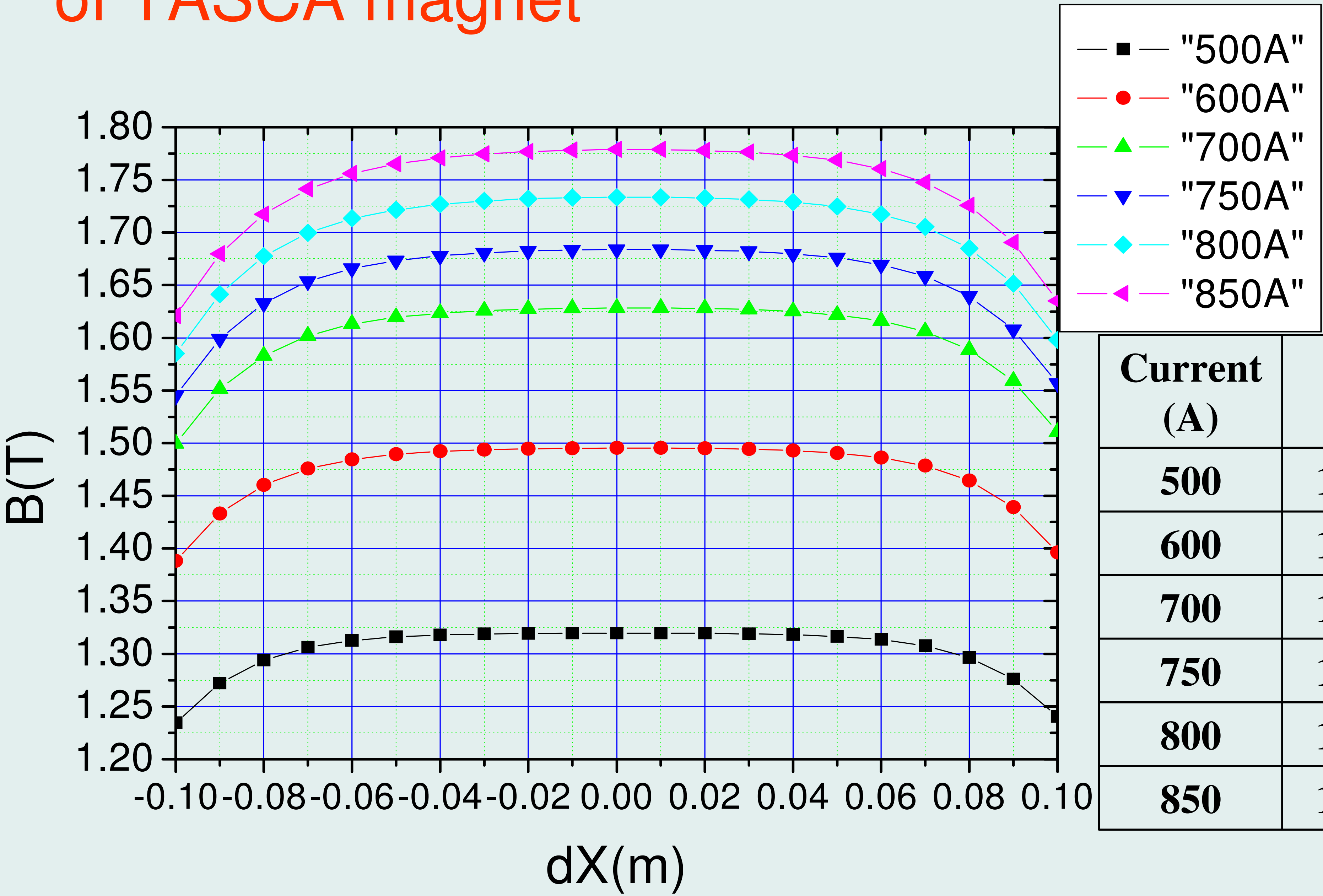
Existing pole without shims.

I = 700 A. $\mathbf{B}_{max}$ = 1.643 T = = 16.43 kGauss

Existing pole with anti-shims.

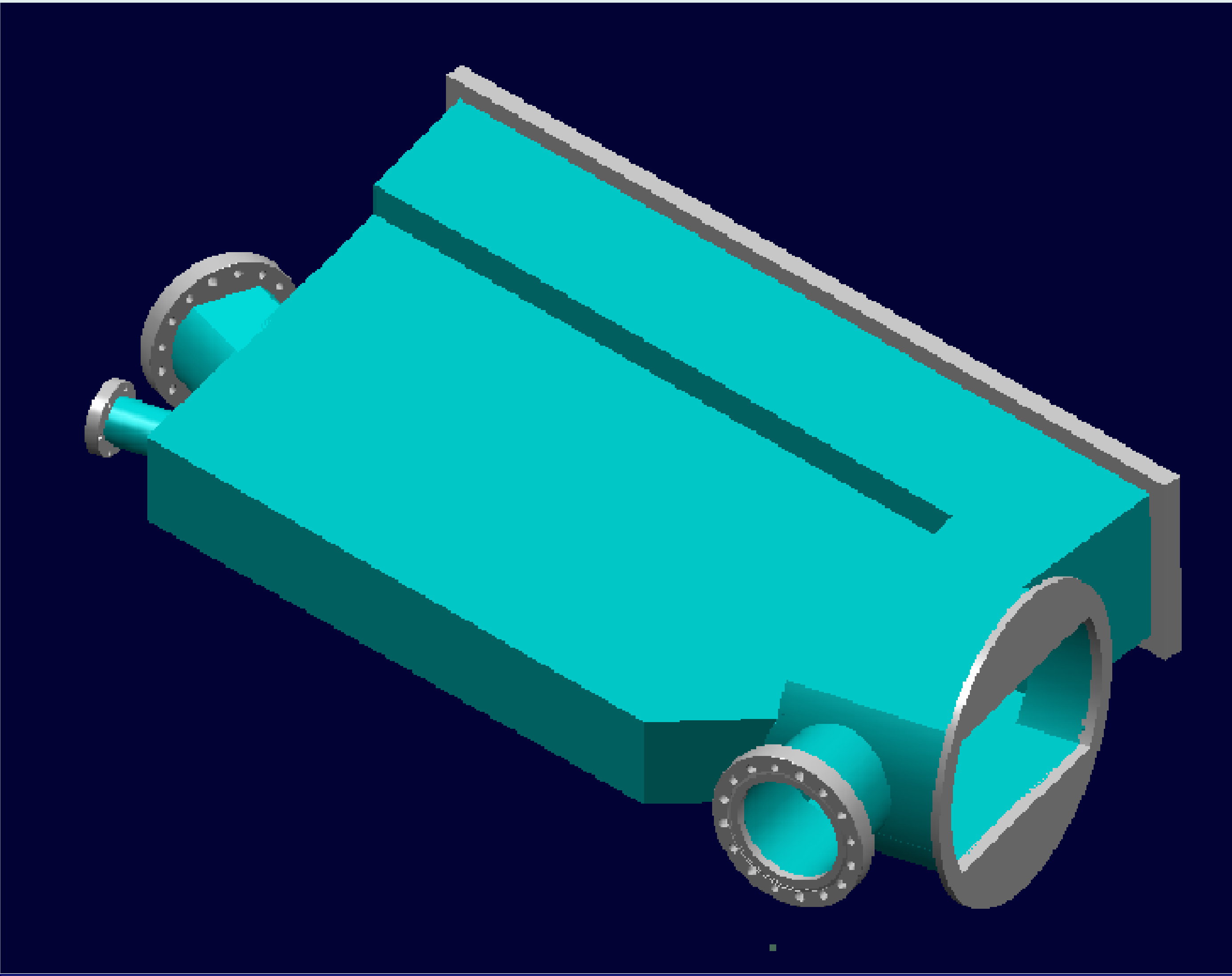
I = 700 A. $\mathbf{B}_{max}$ = 1.666 T = = 16.66 kGauss

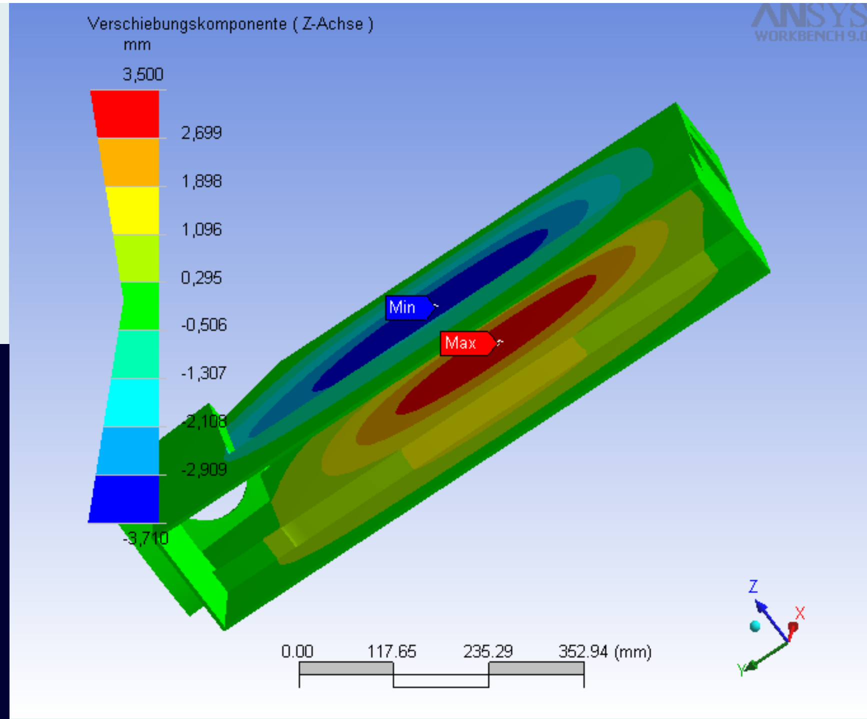
Magnetic field distributions in the central crossection of TASCA magnet

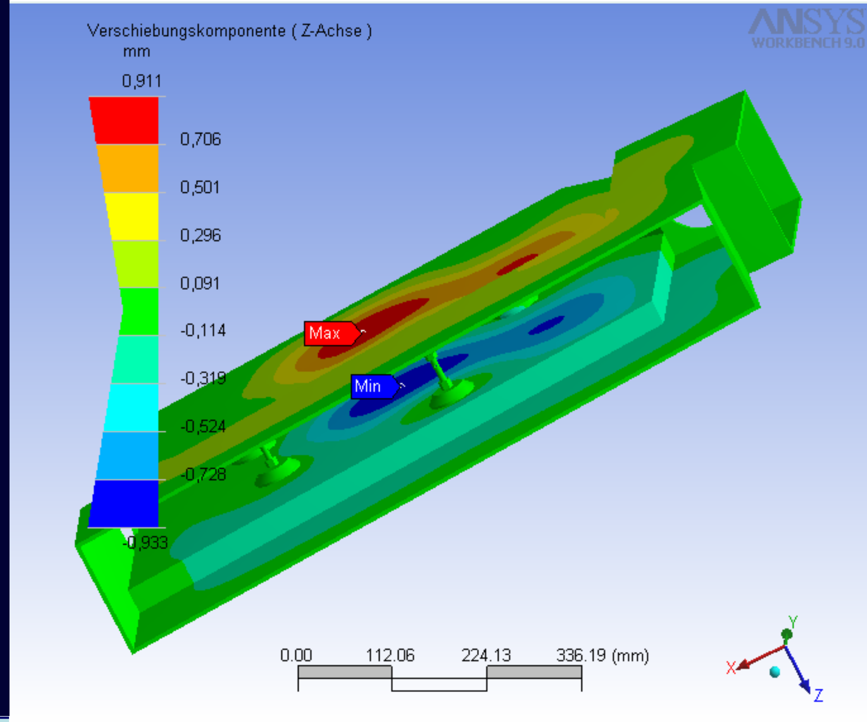


Current (A)	B (T)	Bρ (T m)
500	1.32	1.85
600	1.50	2.10
700	1.63	2.28
750	1.68	2.35
800	1.73	2.42
850	1.78	2.49

Dipole Magnet vacuum chamber design

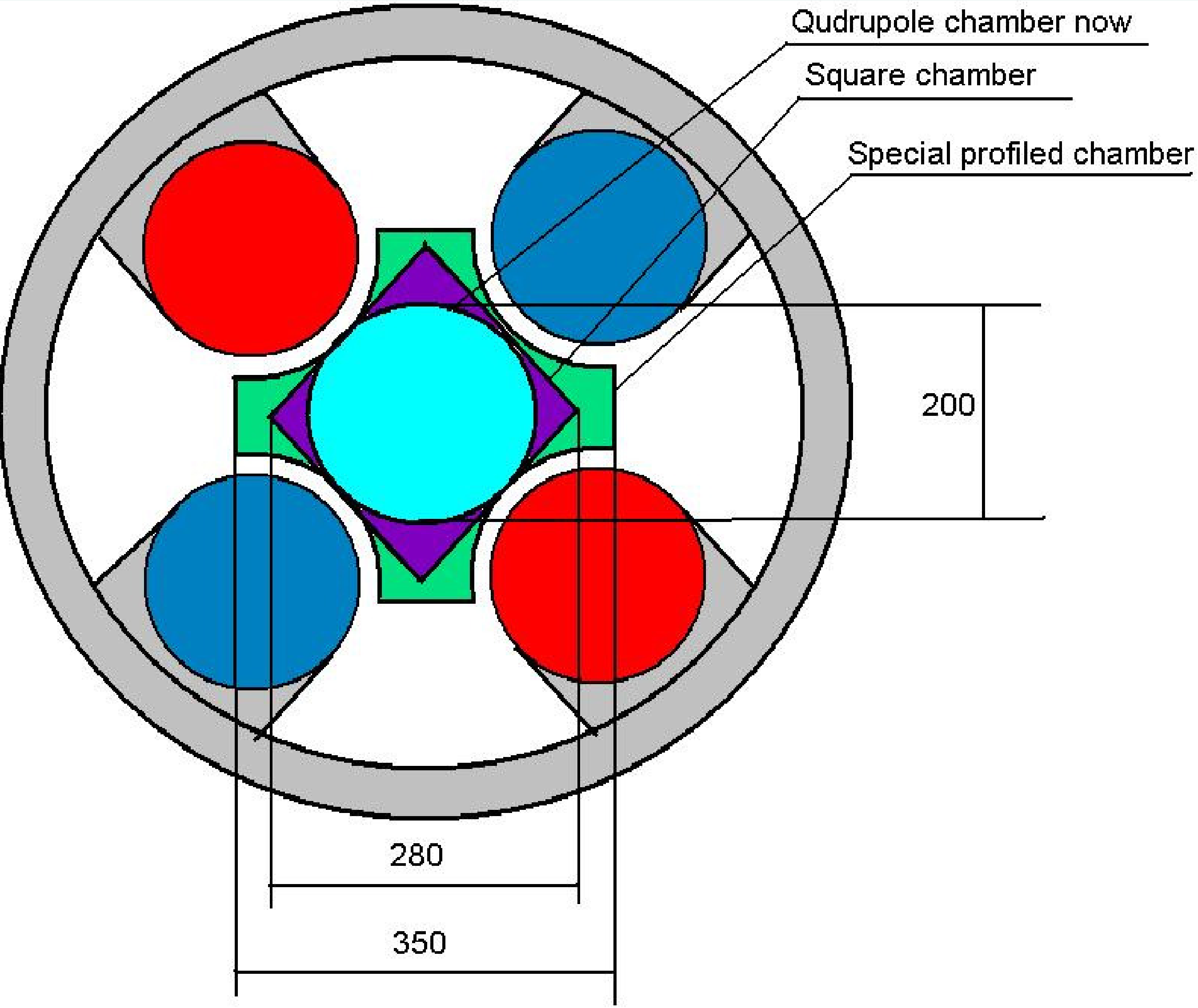


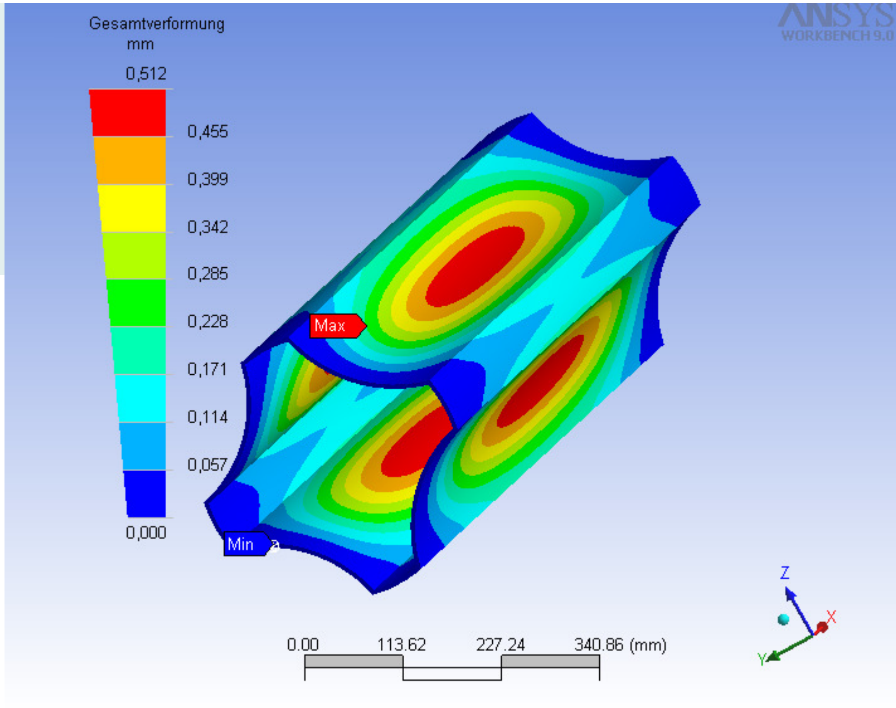


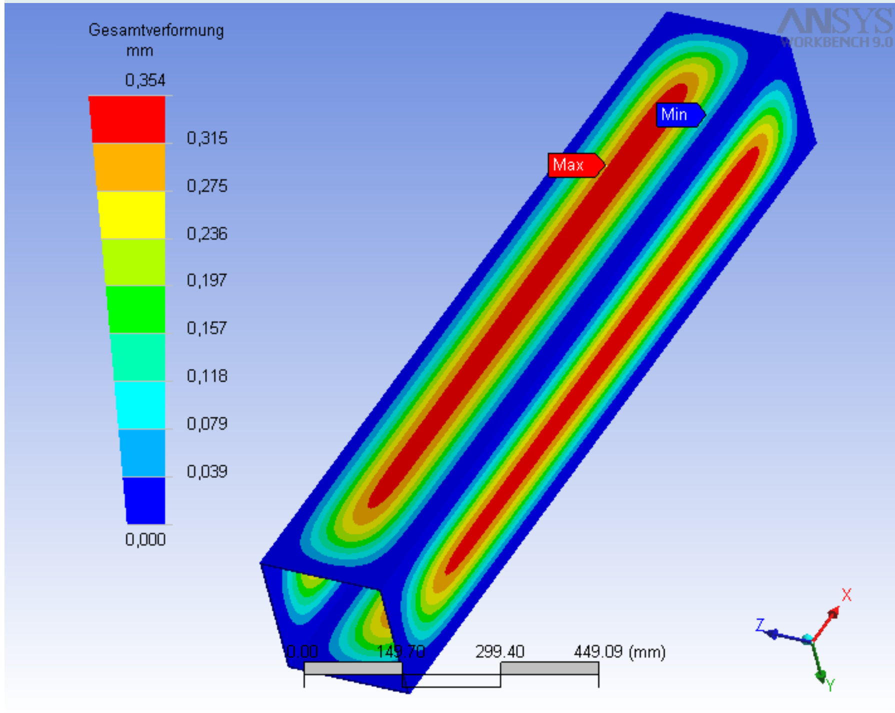


GSI Darmstadt TU München TASCA

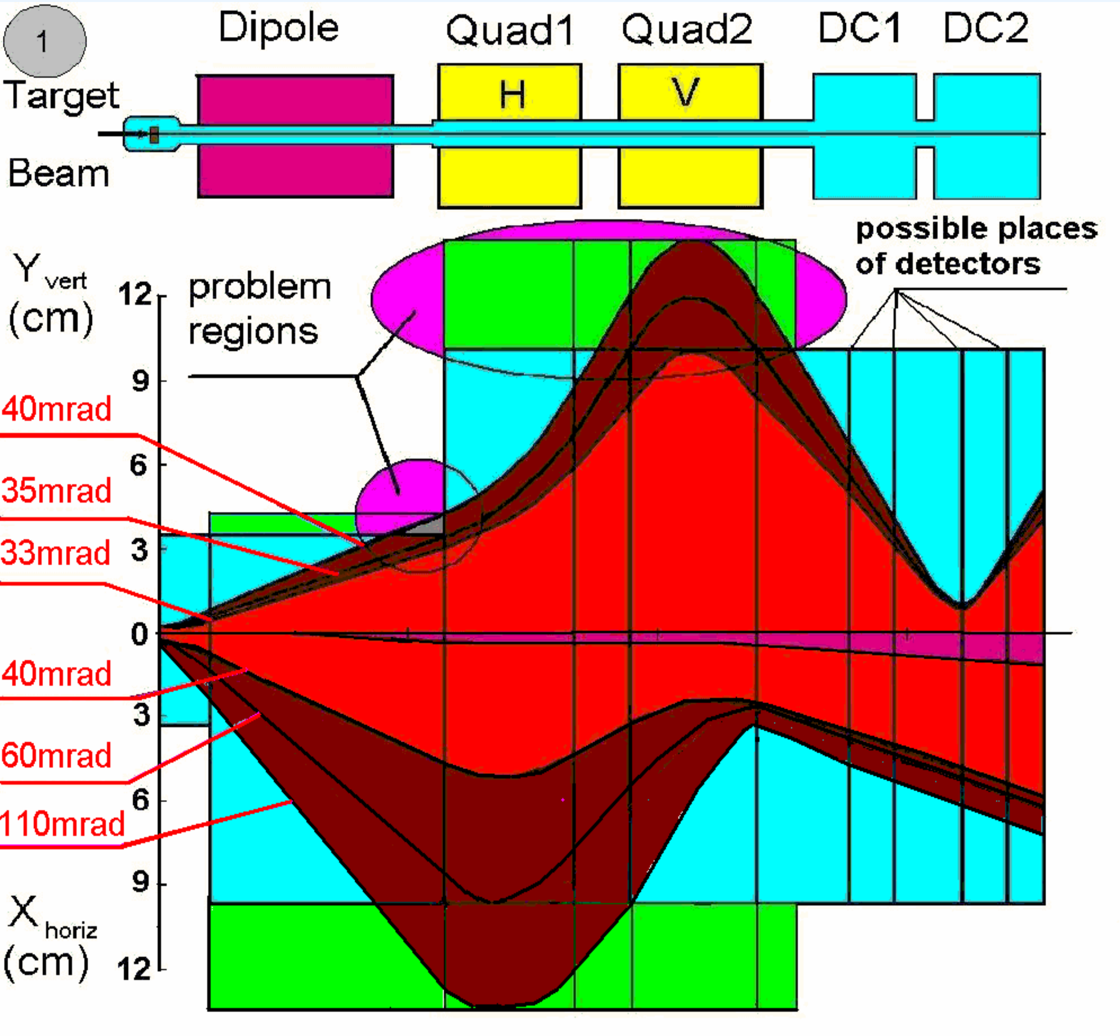
Quadrupole vacuum chamber design







DQ_hQ_v - configuration with new input parameters



Present set-up: Future TASCA

VARIABLE INPUT PARAMETERS:

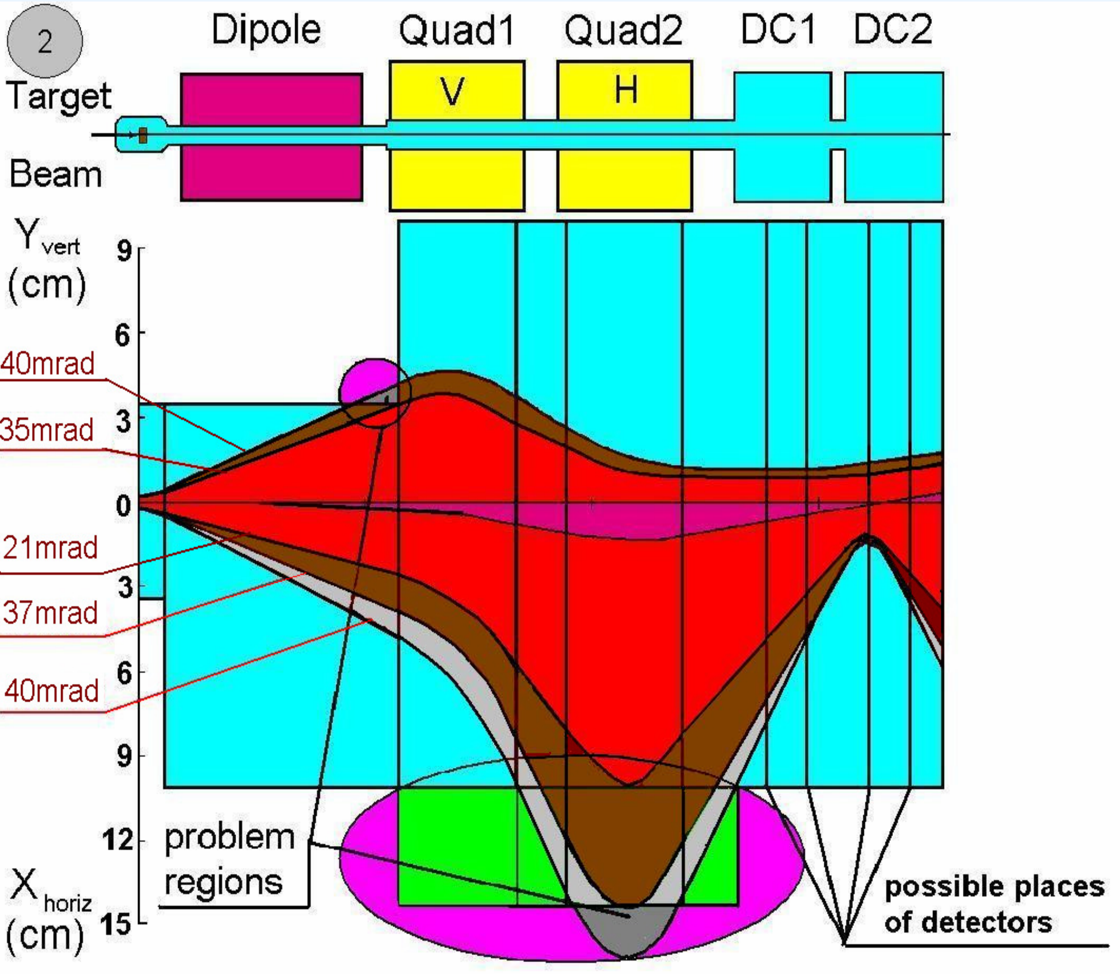
Present set-up		Future TASCA
x'= 60mrad	← Horiz. ang. accept. →	x'= 110mrad
y'= 33mrad	← Vert. ang. accept. →	y'= 40mrad
x'y'=45mrad	← Aver. ang. accept. →	x'y'=65mrad
SA= 6.4 msr	← Solid angle →	SA= 13.3msr

RESULTS OF CALCULATIONS:

Present set-up		Future TASCA
T' = 58%	← Ang. transmis. →	T' = 72%
T = 52%	← Total transmis. →	T = 65%
X = 12 cm	← Horiz. image size →	X = 14 cm
Y = 2.2 cm	← Vert. image size →	Y = 2.5 cm
S = 21 cm^2	← Image area →	S = 27 cm^2

RESULT:
New vacuum chambers (in dipole magnet and butterfly-like one in quads)
→ increase transmission by (minimum) 25%

DQ_vQ_h - configuration with new input parameters



Present set-up:		Future TASCA:

VARIABLE INPUT PARAMETERS:

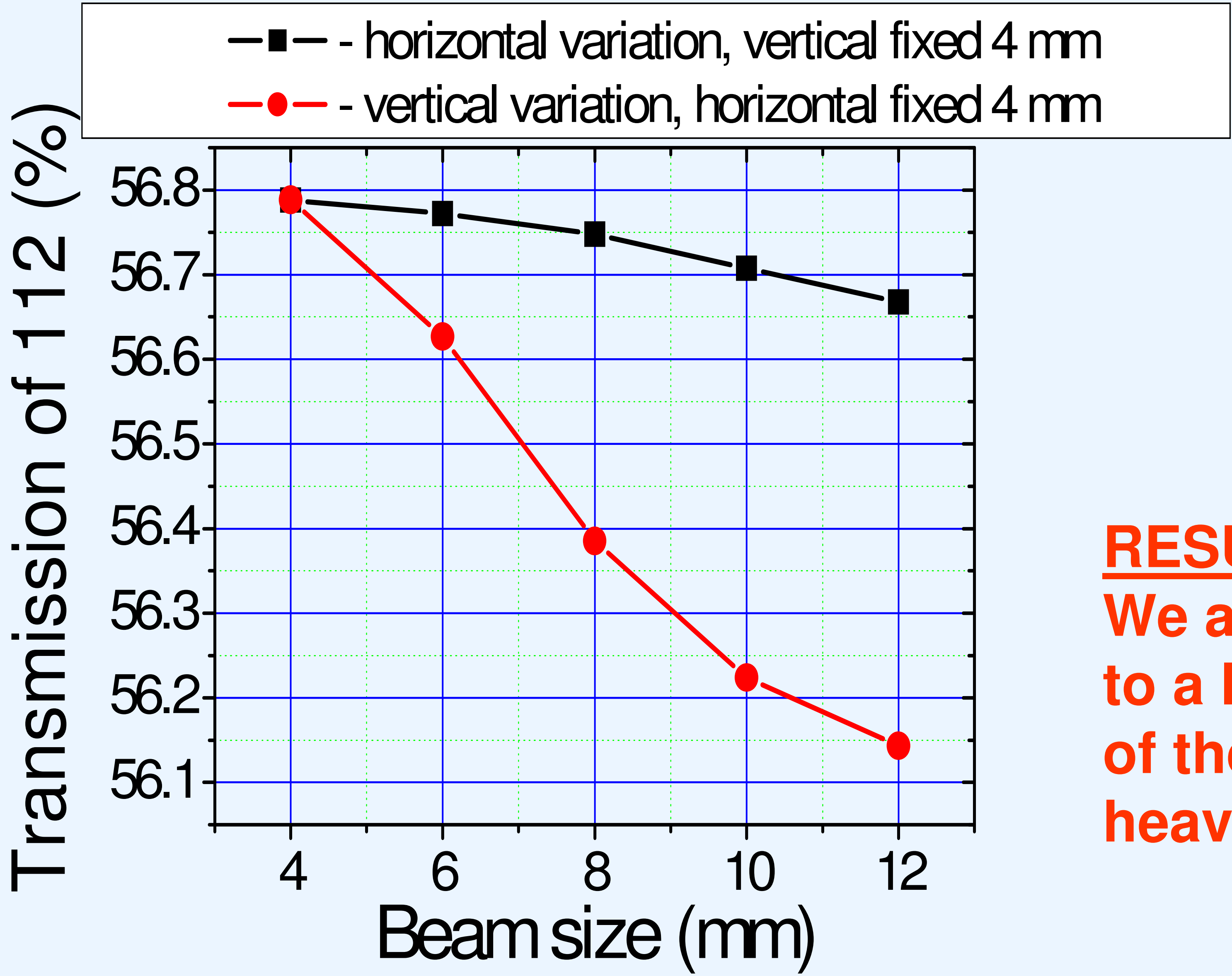
Present set-up		Future TASCA
x'= **21mrad**	← **Horiz. ang. accept.** →	x'= **34mrad**
y'= **33mrad**	← **Vert. ang. accept.** →	y'= **40mrad**
x'y'=**26mrad**	← **Aver. ang. accept.** →	x'y'=**37mrad**
SA= **2.6 msr**	← **Solid angle** →	SA= **4.3 msr**

RESULTS OF CALCULATIONS:

Present set-up		Future TASCA
T' = 33%	← **Ang. transmis.** →	**T' = 44%**
T = 30%	← **Total transmis.** →	**T = 40%**
X = 2.5 cm	← **Horiz. image size** →	**X = 3 cm**
Y = 2.5 cm	← **Vert. image size** →	**Y = 3 cm**
S = 5 cm²	← **Image area** →	**S = 7 cm²**

RESULT:
New vacuum chambers (in dipole magnet and butterfly-like one in quads)
→ increase transmission by (minimum) 25%

Beam spot size dependence of the 112 transmission



RESULT:

We are not sensitive to a large spot size of the primary heavy-ion beam

CONCLUSIONS:

- DQQ–configuration is the optimized configuration for TASCA
  – most efficient and most universal
- We increased the size of the vacuum chamber in the dipole magnet
- We increased the size of the vacuum chamber in the quadrupoles
  – butterfly-type with large acceptance
- This increased the transmission of 112 by at least 25%
- The TASCA dipole magnet with new power supply can operate
  up to magnetic rigidities of 2.5 Tm

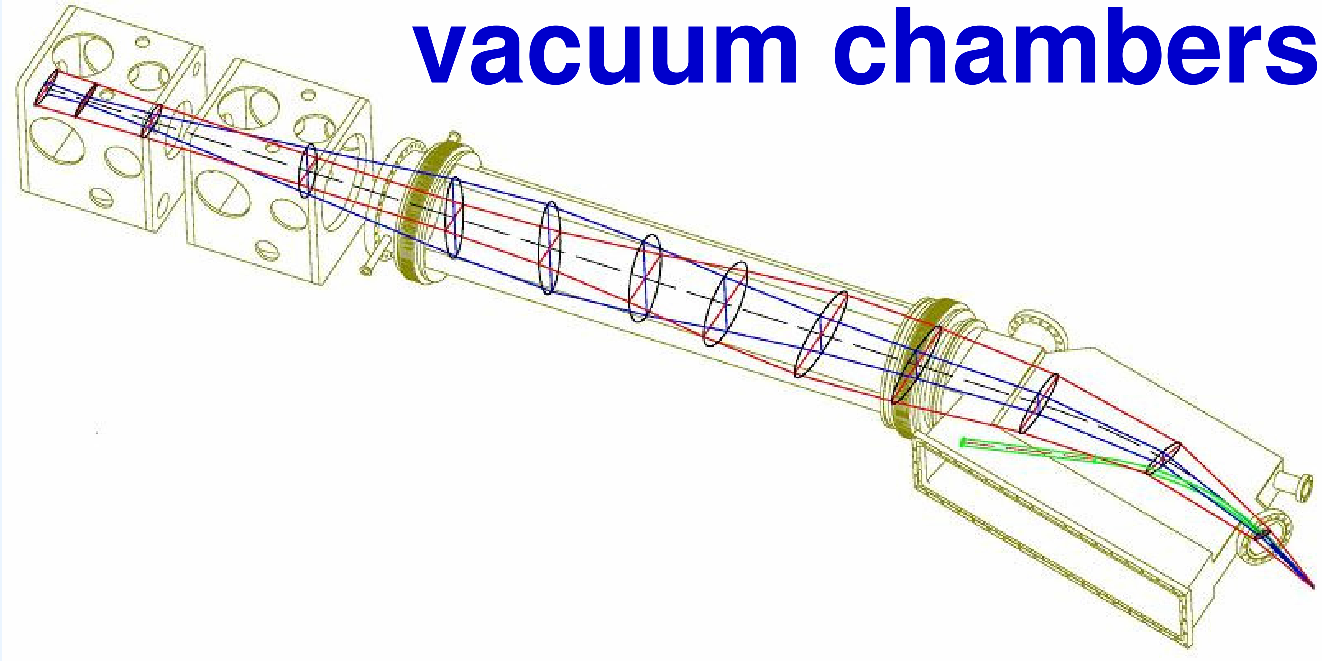
What are we have now:

- Dipole magnet and quadrupoles were tested
- Vacuum chambers for all magnets will come this month
- Two detector chambers are in the cave
- All power supplies for Dipole magnet, Q_1 and Q_2
- Vacuum pumps and equipment
- Computers and parts of control system

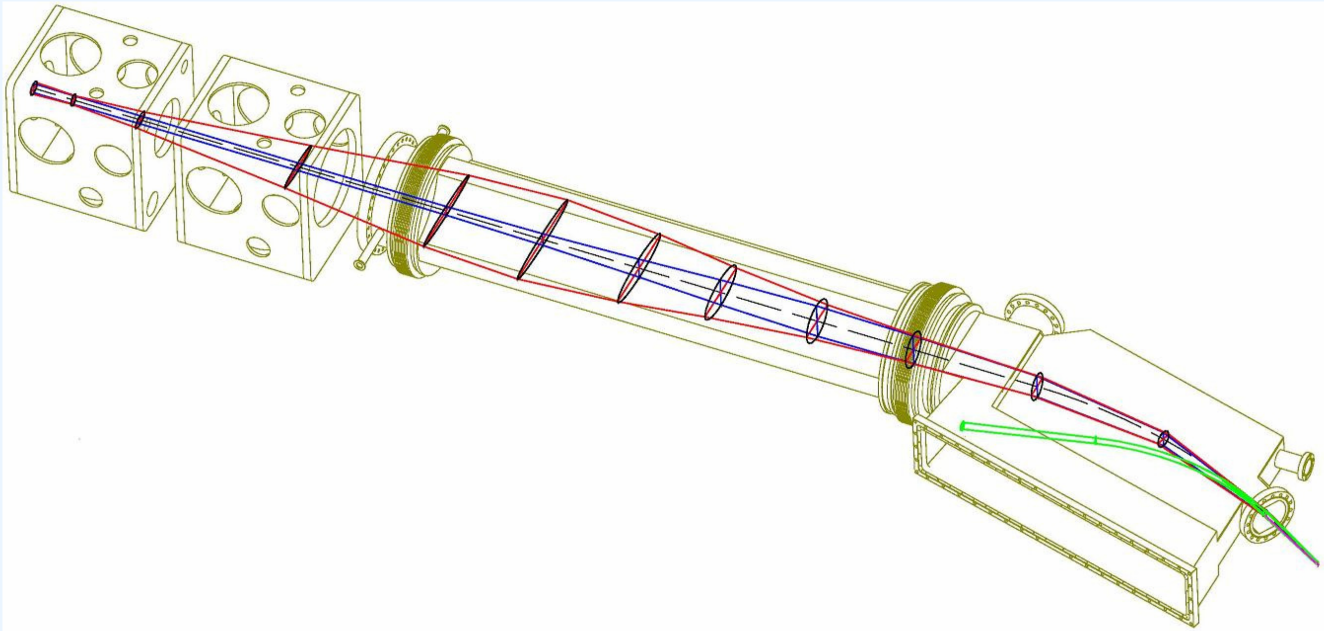
Our future plans:

- Monte-Carlo simulations of transmission with higher accuracy are still actual
- Current year – continue to constructing TASCA separator based on existing components and new vacuum chambers
- Vacuum system constructing
- Writing Control system
- Following two years - testing TASCA separator

Recoils beam shape in TASCA



DQ_hQ_v-configuration



DQ_vQ_h-configuration

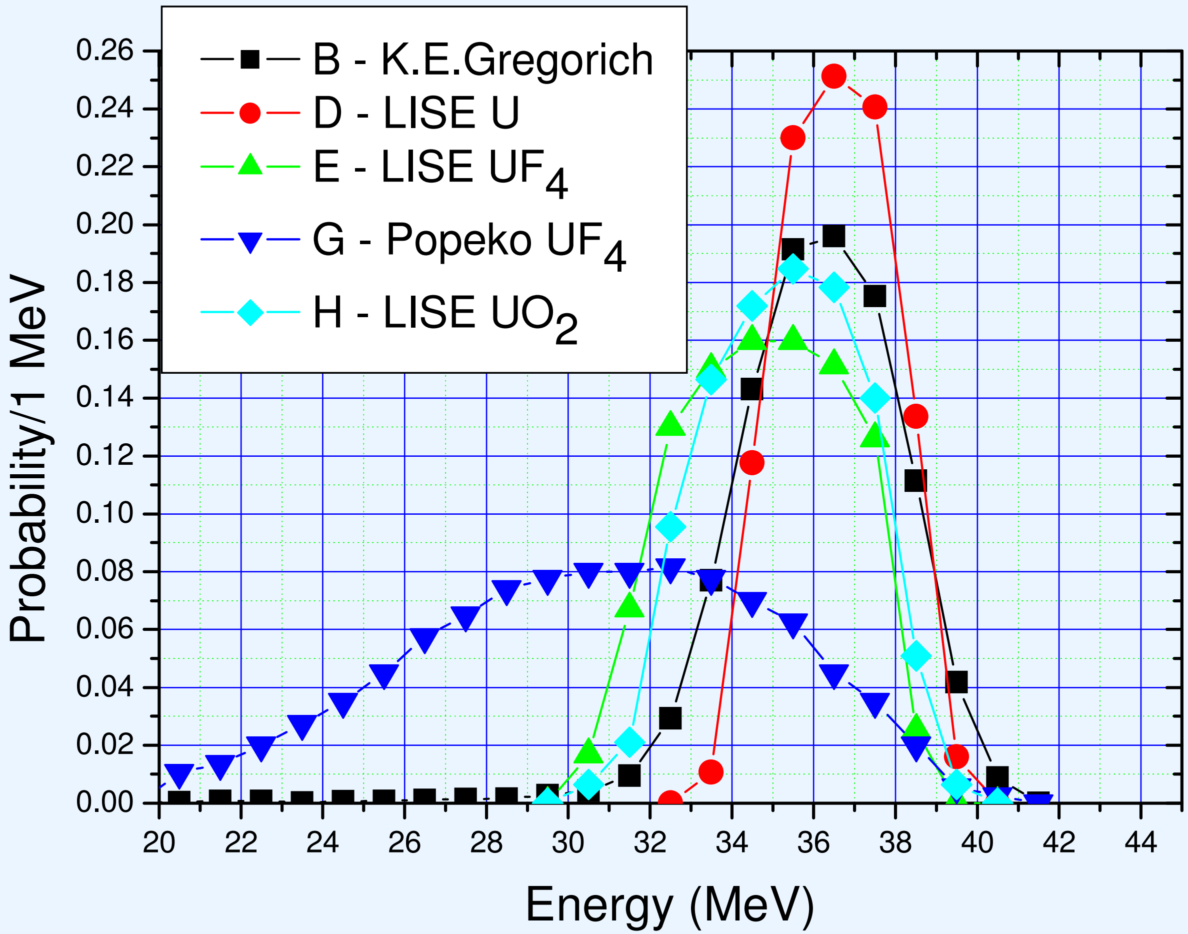
Energy distribution of products from a target

The studied reaction is:

$^{48}Ca(235\ MeV)+^{238}U(0.5\ mg/cm^2) \to {}^{286}112 \to {}^{283}112 + 3n$

different target materials

	TKE_{112} (MeV)	FWHM (MeV)
UF_4 K.E.G.	36	5
U (LISE)	36.5	4
UF_4(LISE)	35	6
A.Popeko	31	12
UO_2(LISE)	35.5	6



Angular straggling of products in the target

The studied test reaction is:

$^{48}Ca(235\ MeV) + ^{238}U(0.5\ mg/cm^2) \rightarrow {}^{286}112 \rightarrow {}^{283}112 + 3n$

beam energy at the target center

	Peak Angle (mrad)	FWHM (mrad)
U (LISE)	22	40
UO_2(LISE)	23	40
UF_4(LISE)	24	40
UF_4 K.E.G.	25	60
A.Popeko	28	70