THE IBA-JINR C235-V3 CYCLOTRON DEVELOPMENT FOR DIMITROVGRAD HOSPITAL CENTER OF THE PROTON THERAPY

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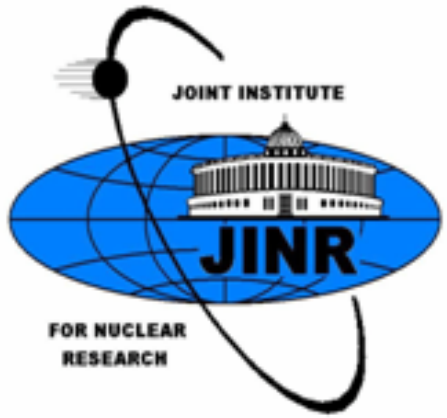
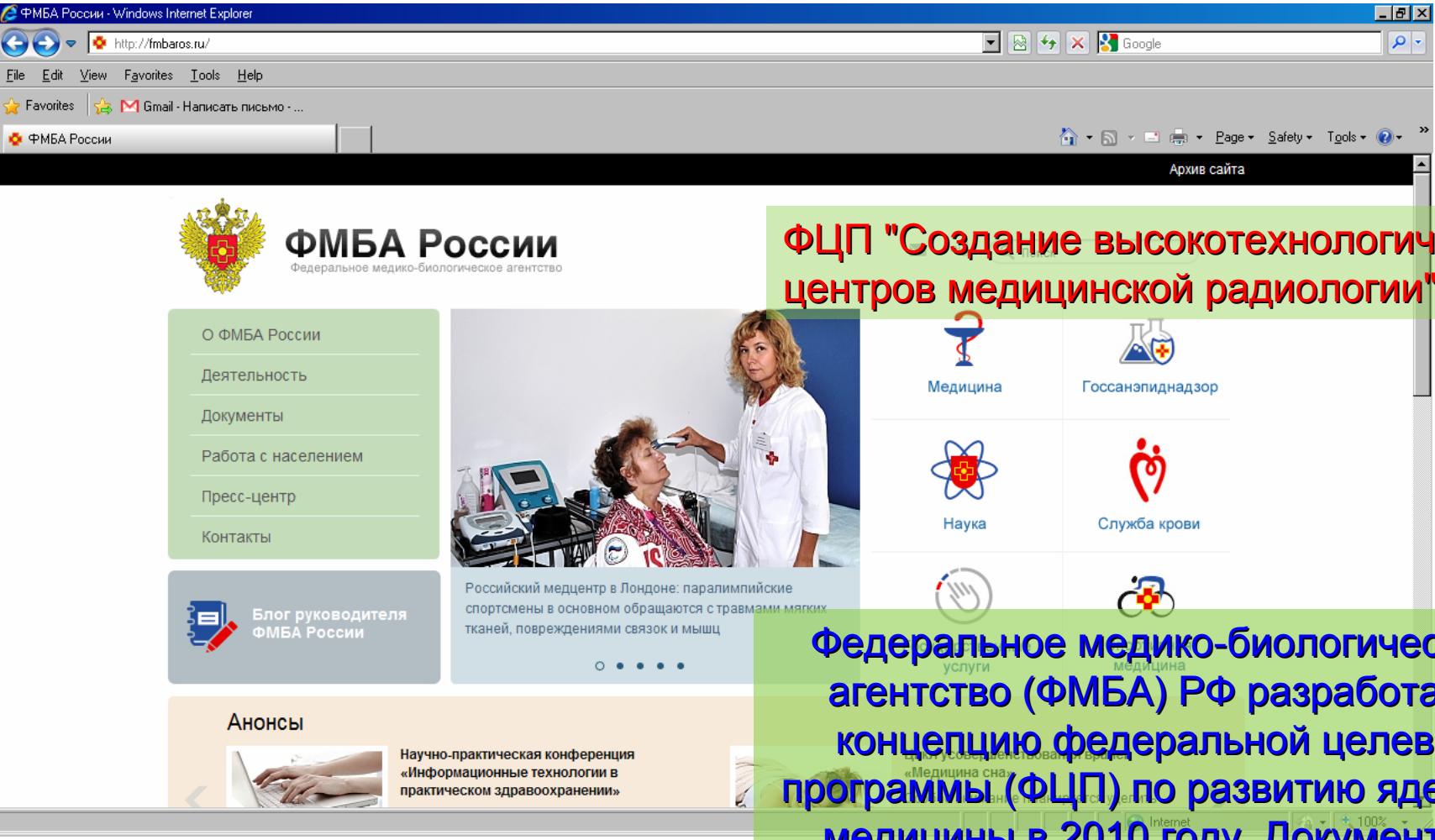
Joint Institute for Nuclear Research, Dubna

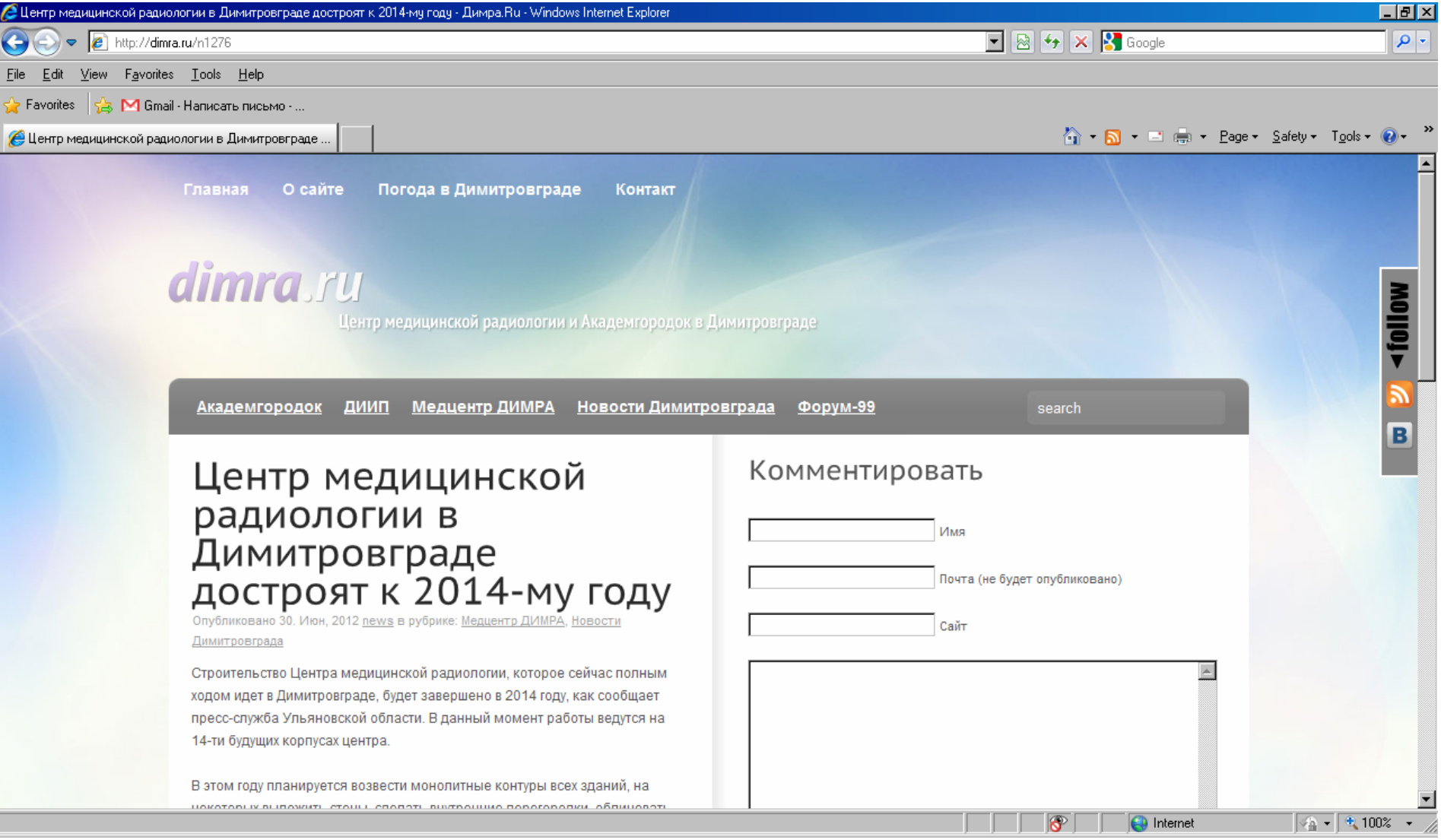


RuPAC-2012, 24-28 Sep, St. Petersburg



ФЦП "Создание высокотехнологичных центров медицинской радиологии"

Федеральное медико-биологическое агентство (ФМБА) РФ разработало концепцию федеральной целевой программы (ФЦП) по развитию ядерной медицины в 2010 году. Документом предусмотрено создание высокотехнологичных центров медицинской радиологии в Димитровграде, Обнинске и Томске до 2016 года.


Центр медицинской радиологии в Димитровграде достроят к 2014-му году - Димра.Ru - Windows Internet Explorer
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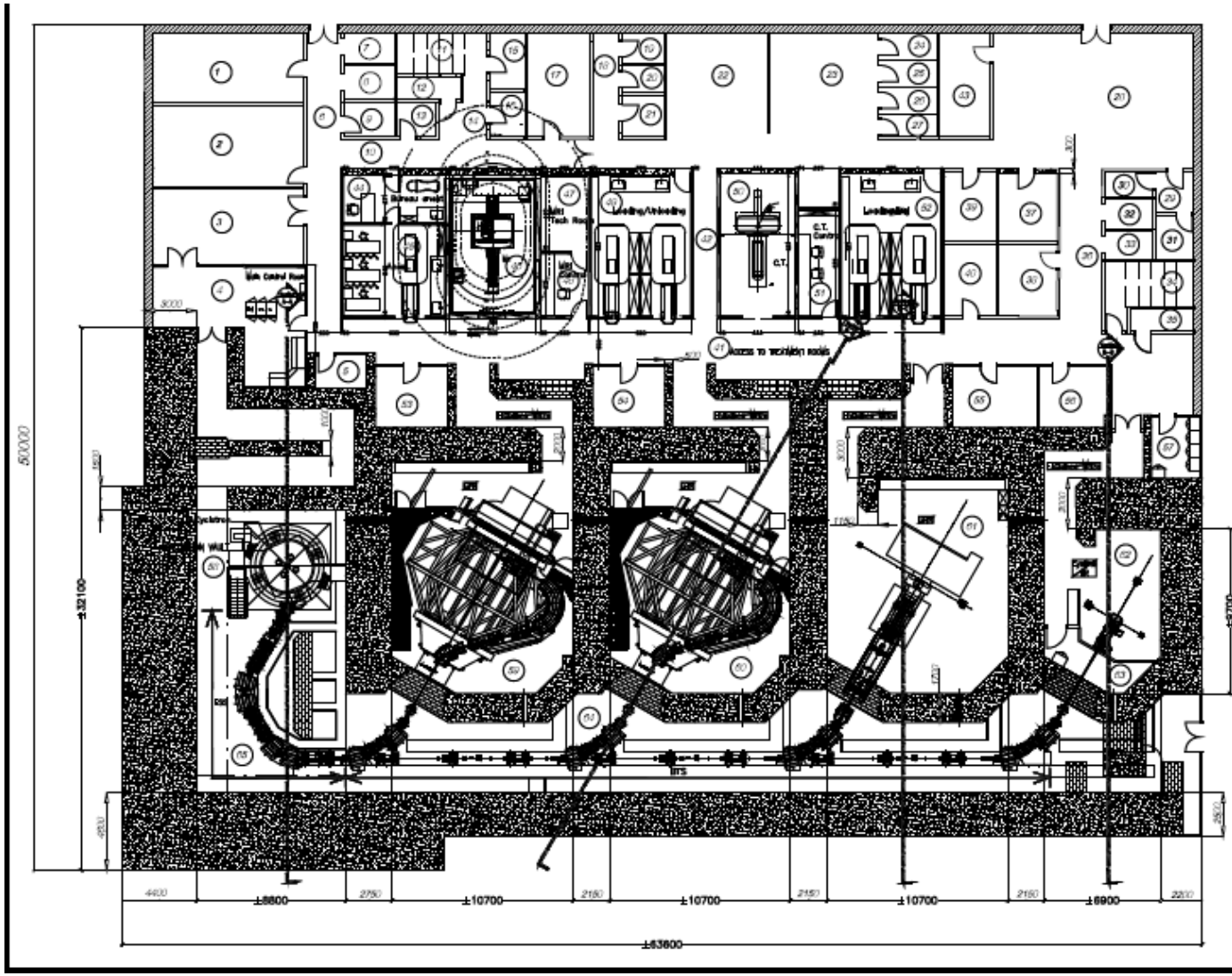
Опубликовано 30. Июн, 2012 news в рубрике: Медцентр ДИМРА, Новости Димитровграда
Строительство Центра медицинской радиологии, которое сейчас полным ходом идет в Димитровграде, будет завершено в 2014 году, как сообщает пресс-служба Ульяновской области. В данный момент работы ведутся на 14-ти будущих корпусах центра.
В этом году планируется возвести монолитные контуры всех зданий, на
Комментировать
Имя
Почта (не будет опубликовано)
Сайт
Internet
100%

Proton therapy center

Project of the Proton therapy center was developed by Federal Medico-Biological Agency in collaboration with JINR

Include:
2 gantry systems
Room with fixed beam
Eye treatment room
PATLOG system



22 IBA PT customers in the world

MGH, Boston

Skandion, Sweden

Beijing, China

ProCure 2, Chicago

ProCure 4, Seattle

MPRI, Indiana

NCC, Kashiwa, Japan

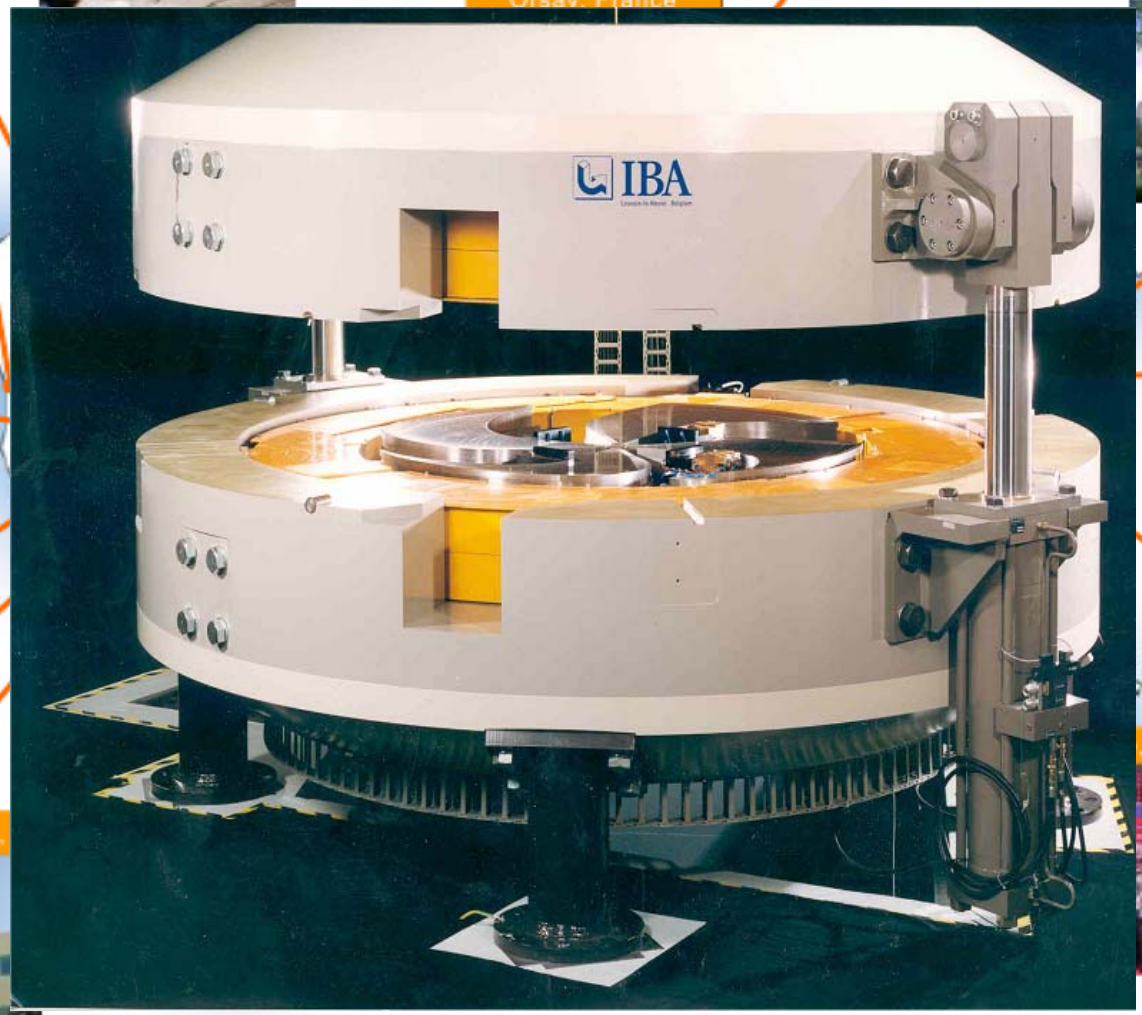
ProCure 1 Oklahoma City

KNCC, Ilsan, Korea

ProVision Knoxville, Tennessee

, China

UFPTI, Jacksonville,



C235 cyclotron parameters

Энергия ускоренных протонов, МэВ	232
Среднее магнитное поле, Т в центре на радиусе вывода	 1.7 2.15
Радиус вывода, м	1.08
Магнитное поле на радиусе вывода, Т в холме в долине	 3.09 0.98
Зазор, мм в долине в холме	 600 96-9
Периодичность структуры магнитного поля	4
Ампер-витки обмотки, кА	525
Потребляемая мощность обмотки магнита, кВт	190
Вес магнита, т	210
Количество дуантов	2
Напряжение на дуантах, кВ в центре на радиусе вывода	 55 120
Частоты бетатронных колебаний Q_r/Q_z	1-1.37/ 0-0.28

Experimental hall (Bld #5) preparation

- building floor reinforcement
- foundation under vault
- special plates inside the foundation for cyclotron feet
- technological pit

• Vault shielding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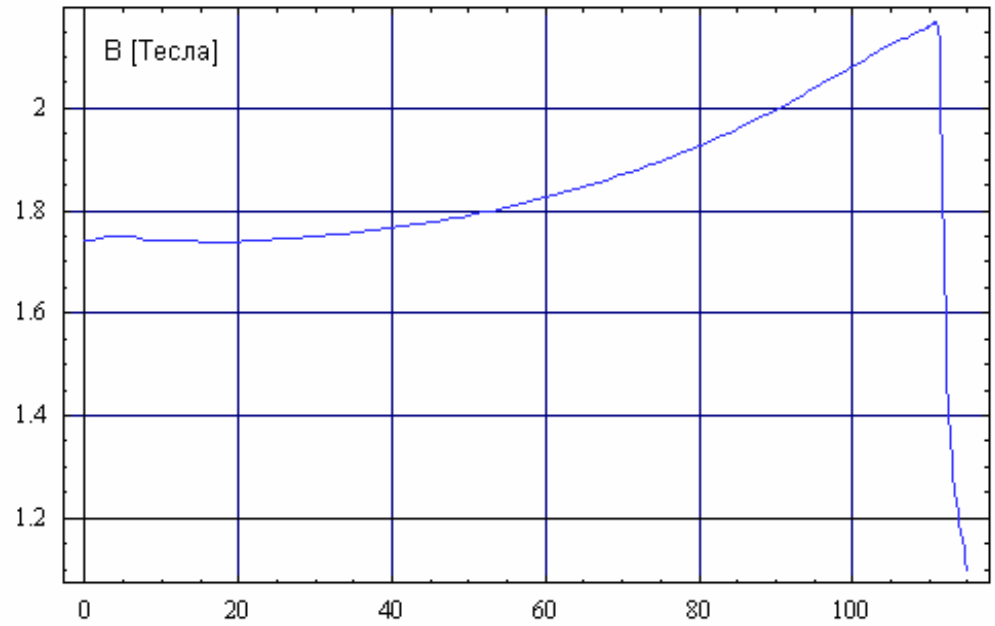
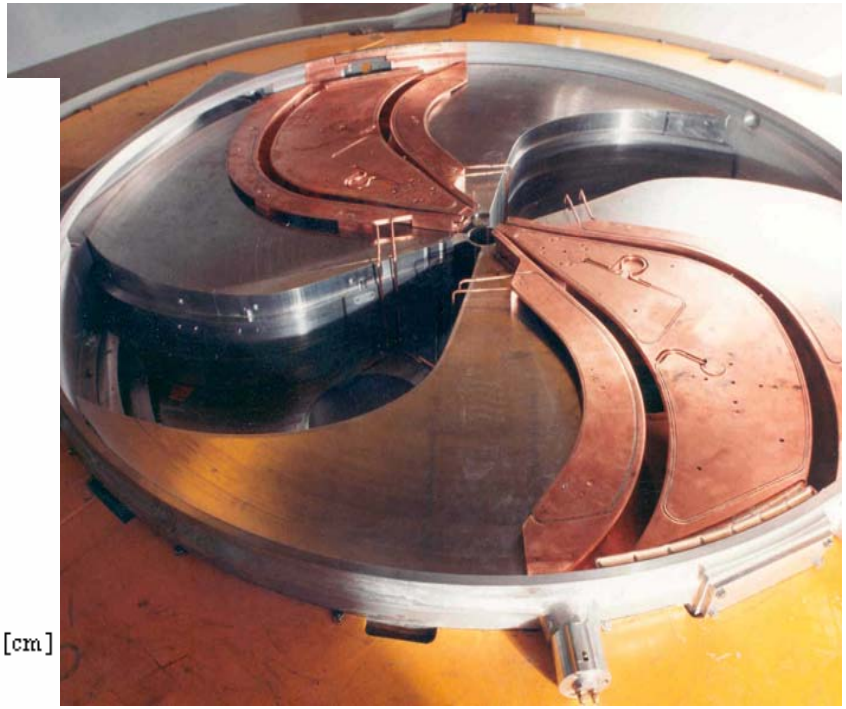
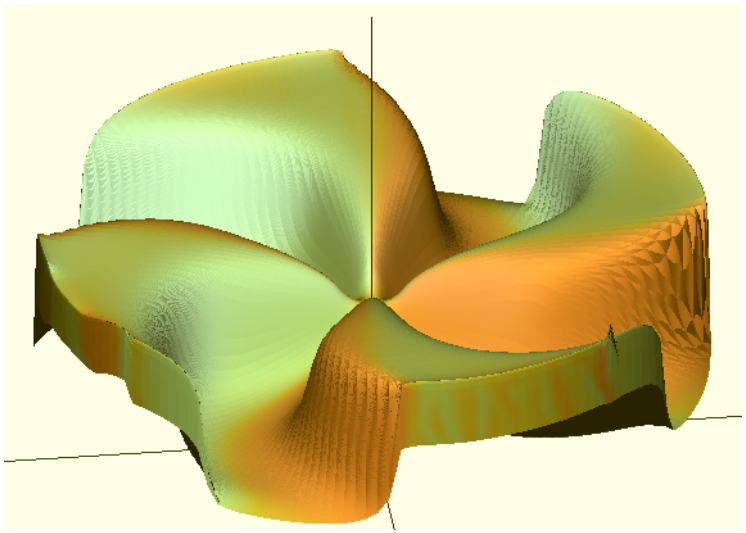
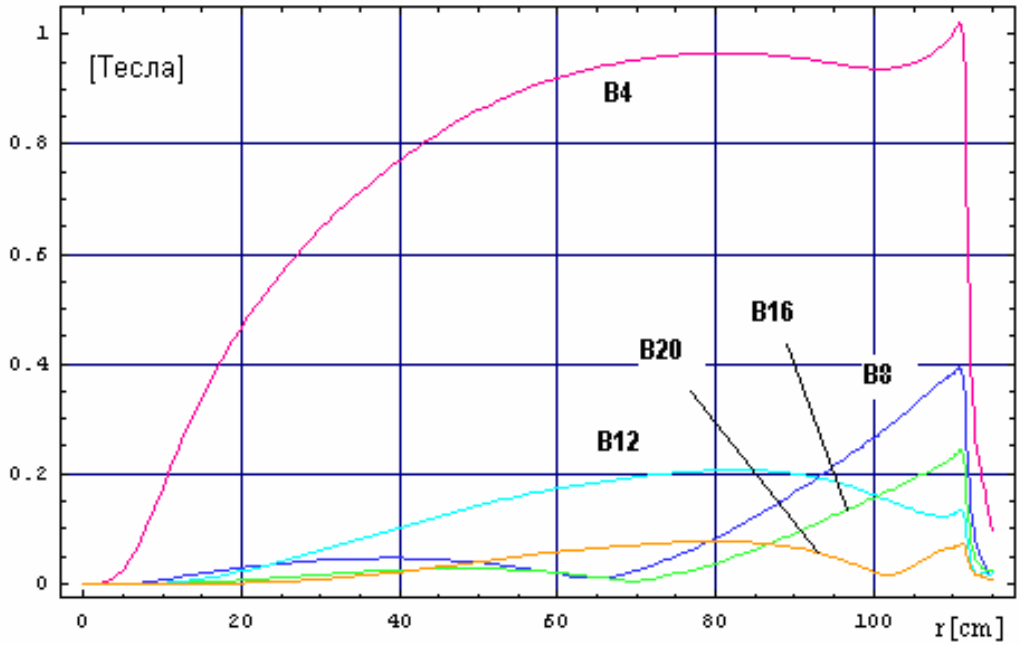
JINR experimental hall for medical accelerators assembling & testing

Cyclotron magnetic field sturcure





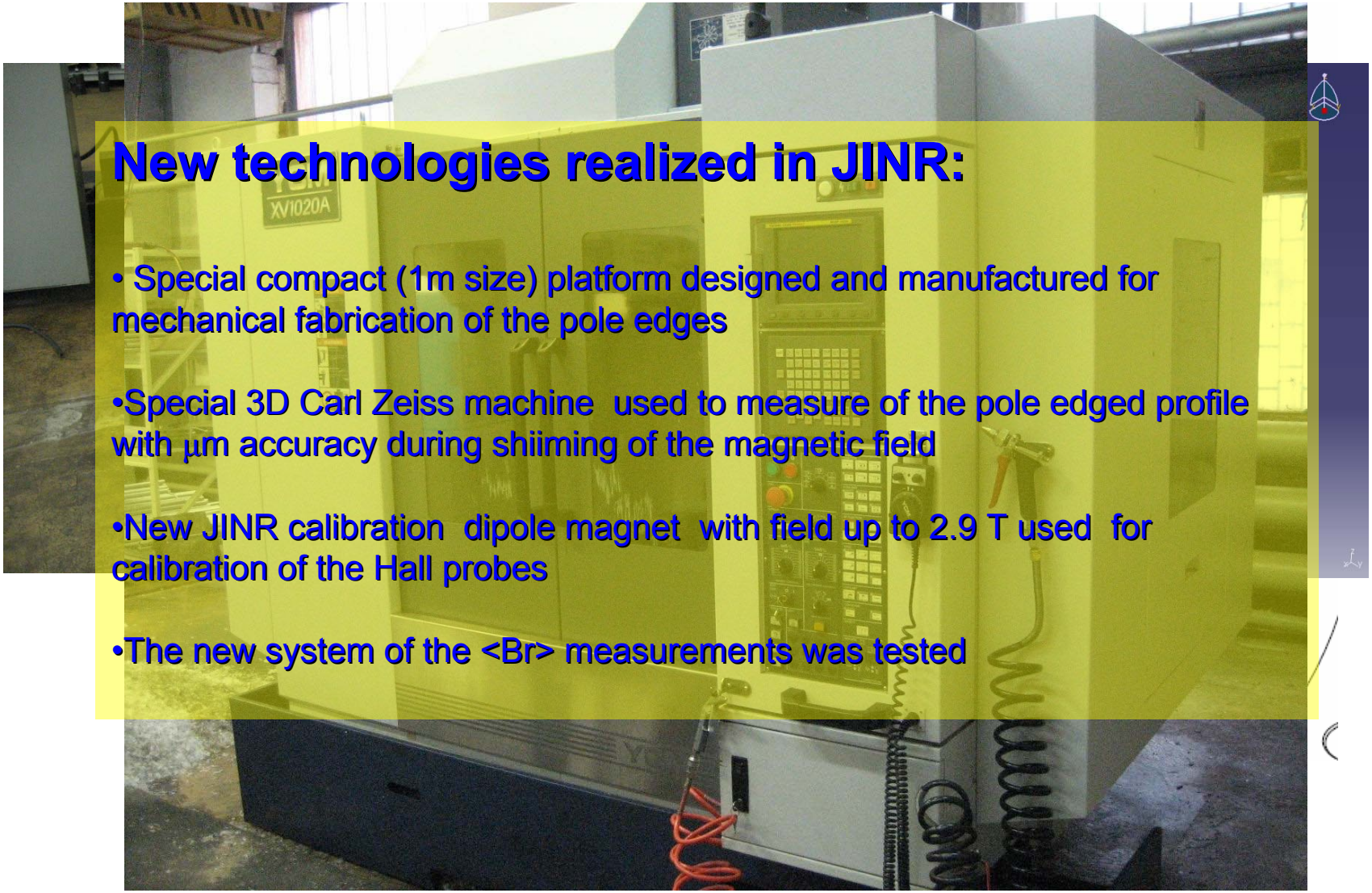




Magnetic field mapping system

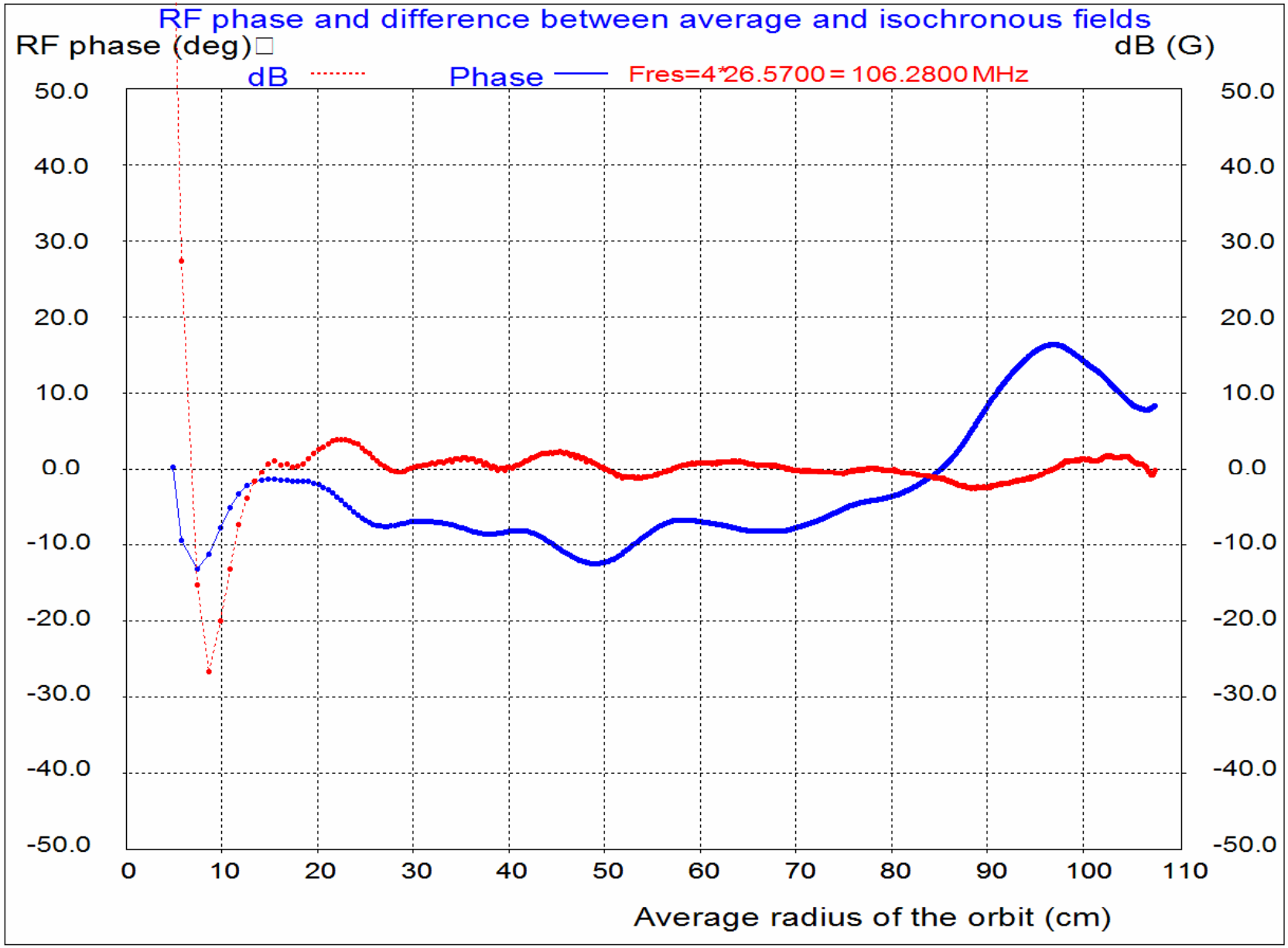
Br-mapping system

Calibration dipole magnet with field upto 2.9T

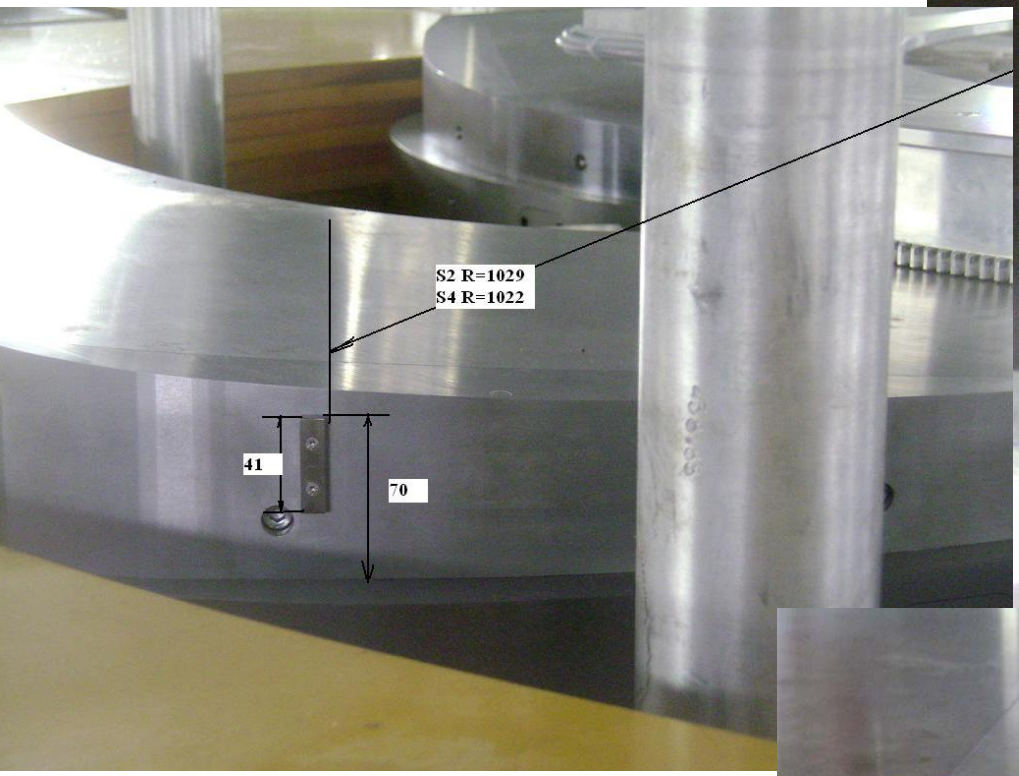


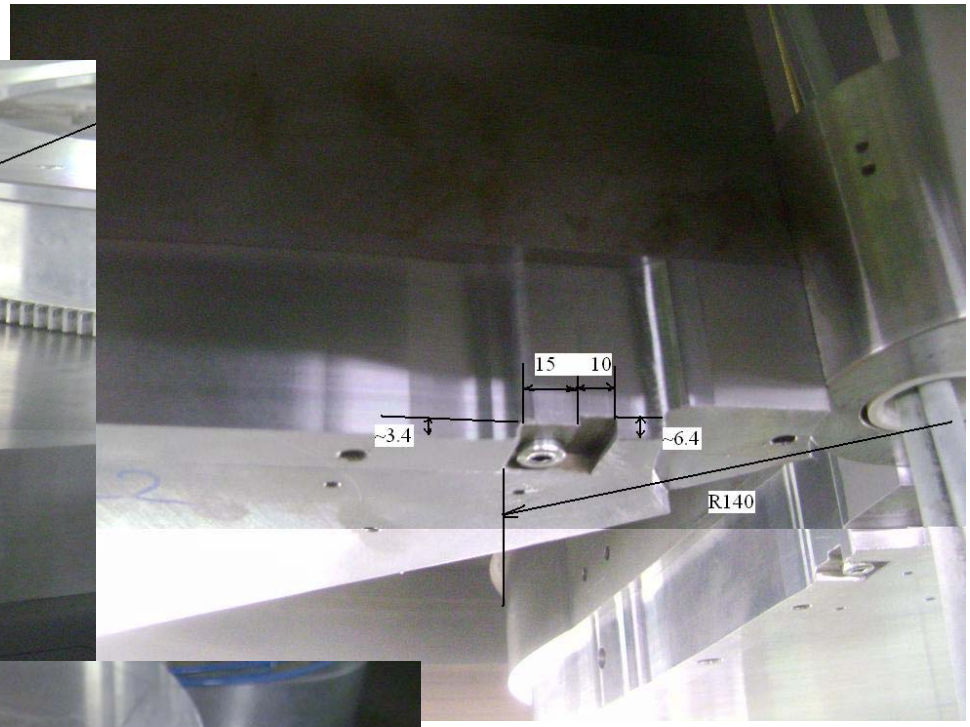
New technologies realized in JINR:

- Special compact (1m size) platform designed and manufactured for mechanical fabrication of the pole edges
- Special 3D Carl Zeiss machine used to measure of the pole edged profile with μm accuracy during shiiming of the magnetic field
- New JINR calibration dipole magnet with field up to 2.9 T used for calibration of the Hall probes
- The new system of the
 measurements was tested

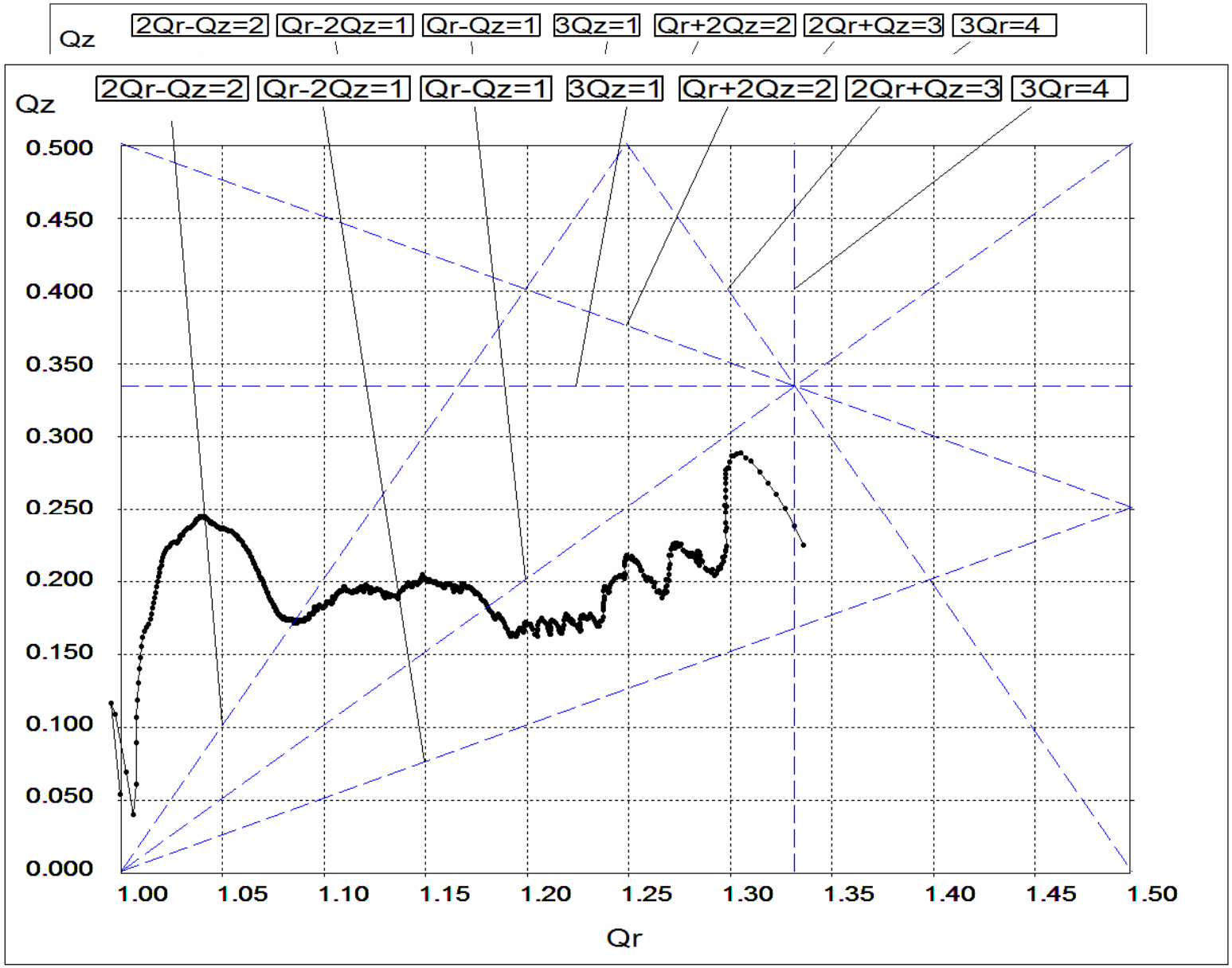


Финальная конфигурация магнитного поля


S2 R=1029
S4 R=1022
41
70

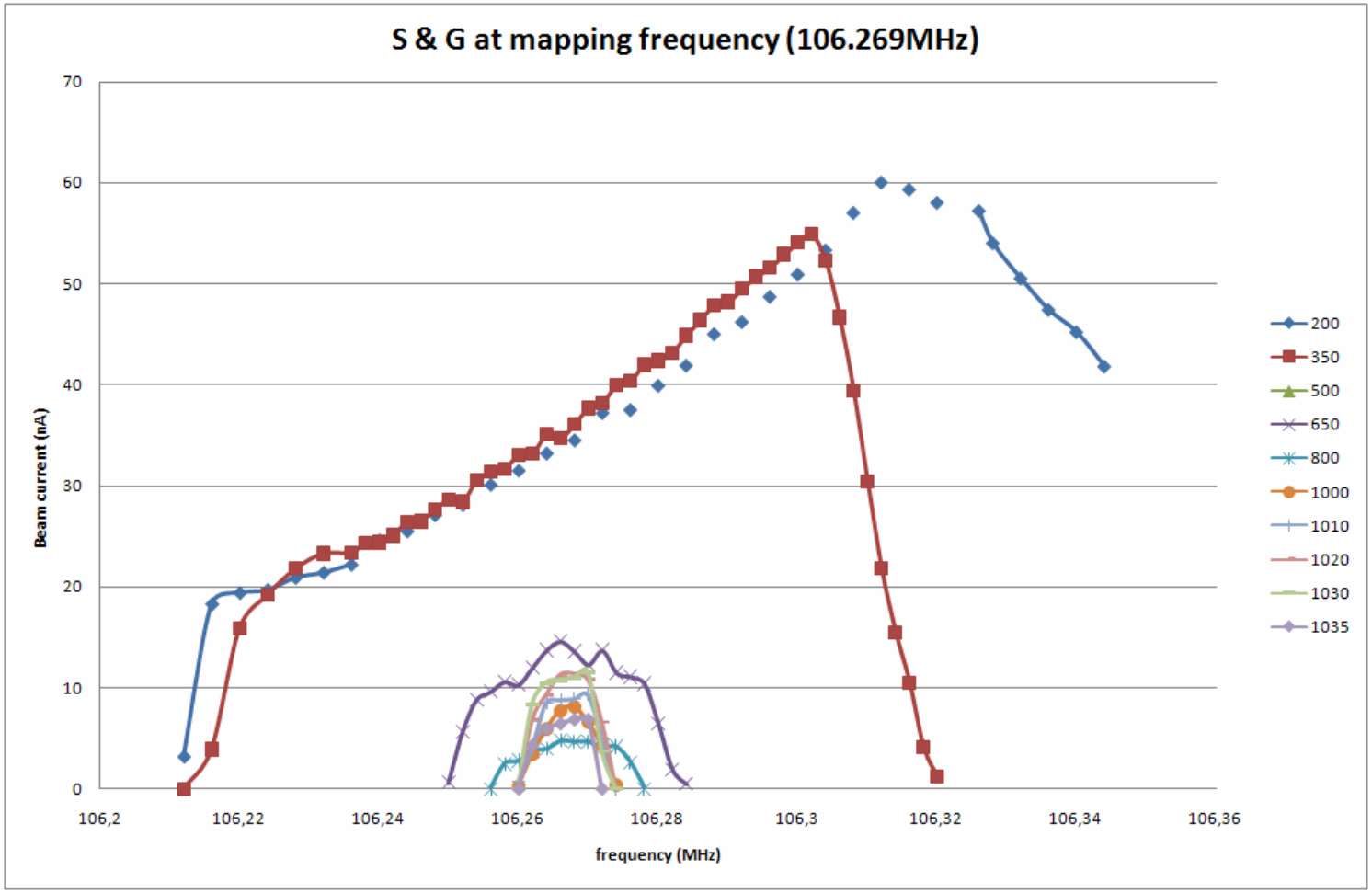

15
10
~3.4
~6.4
R140

Tune – diagram correction

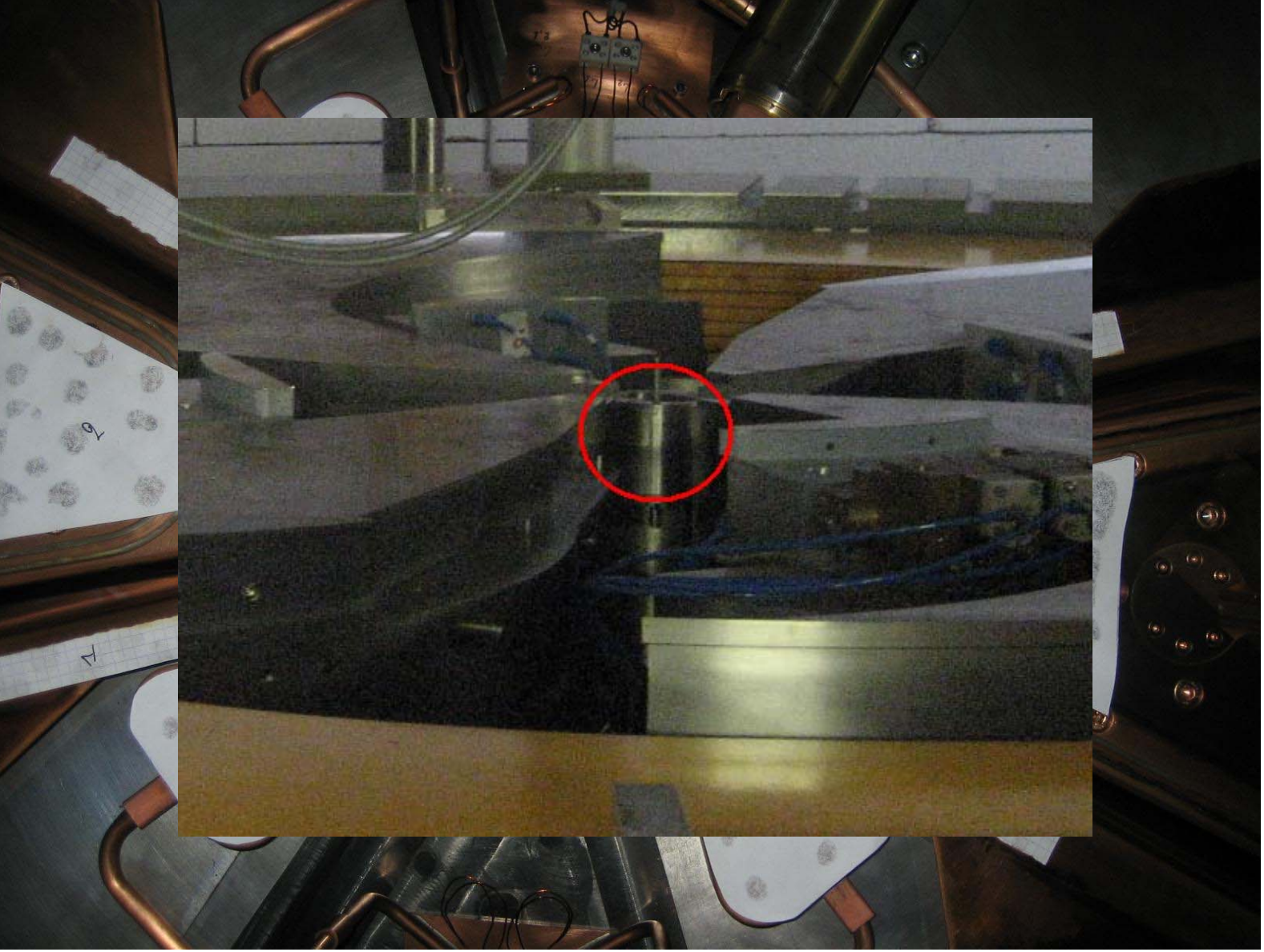


Beam tests

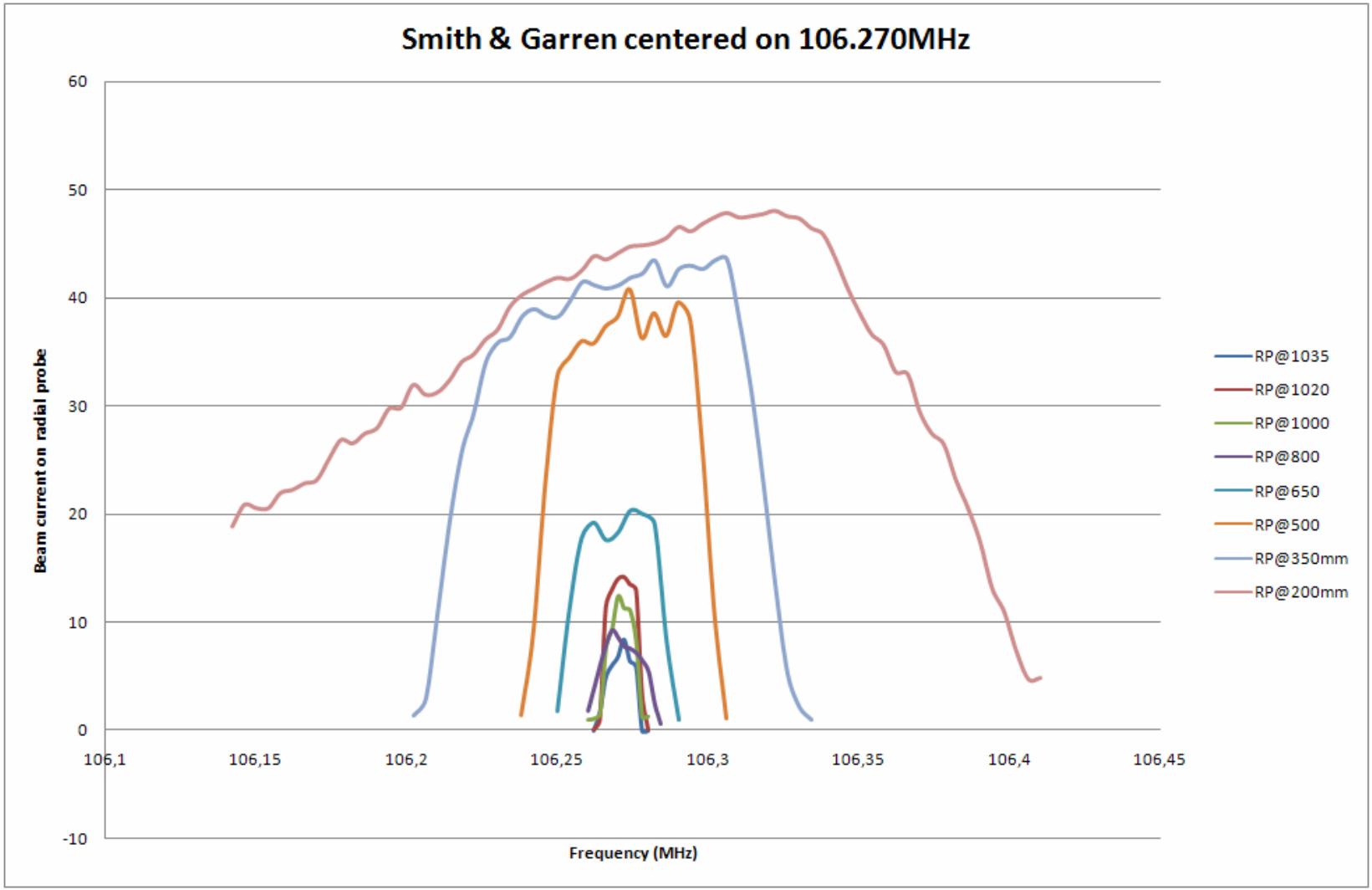
Isochronism test



Smith & Garren curves at initial configuration

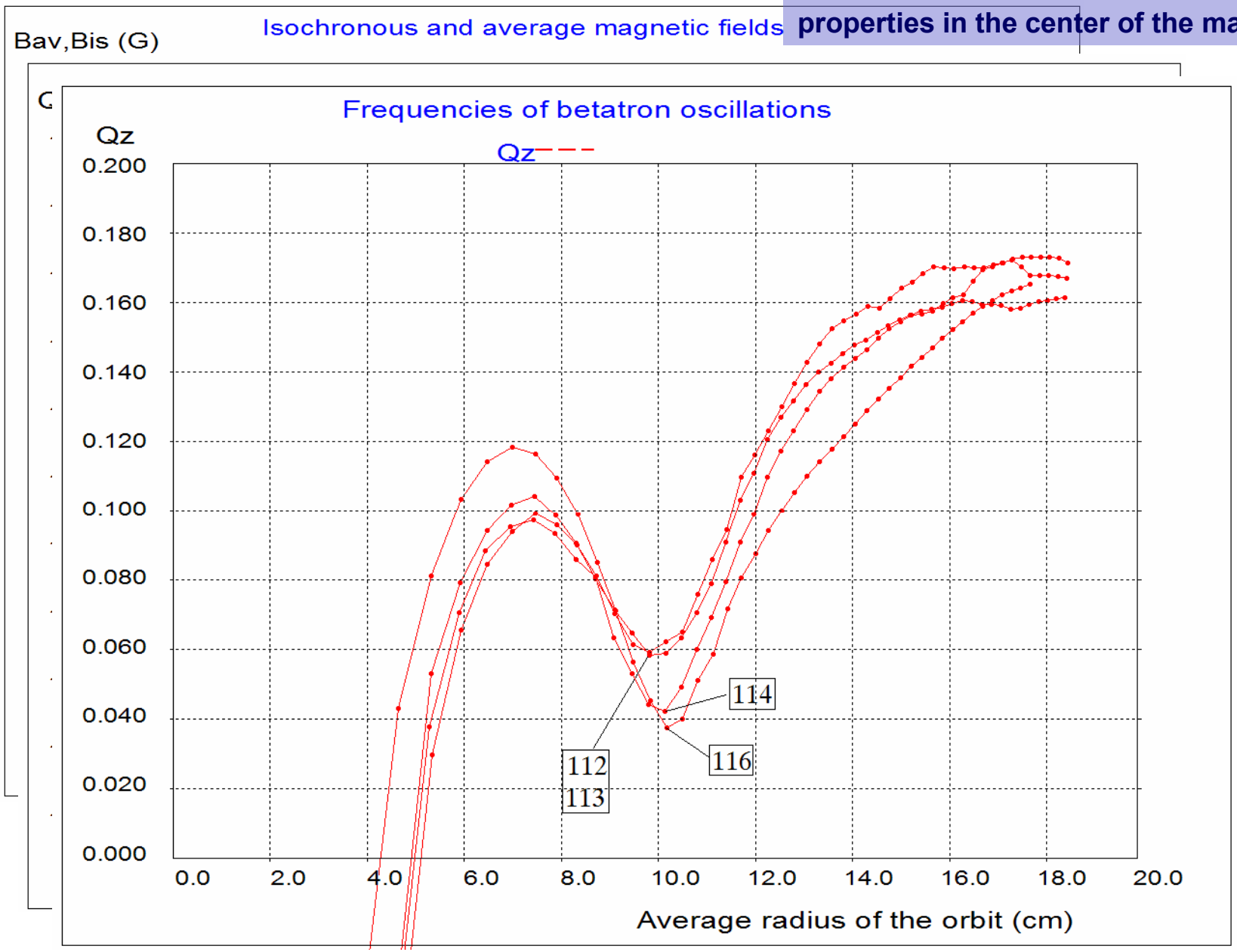


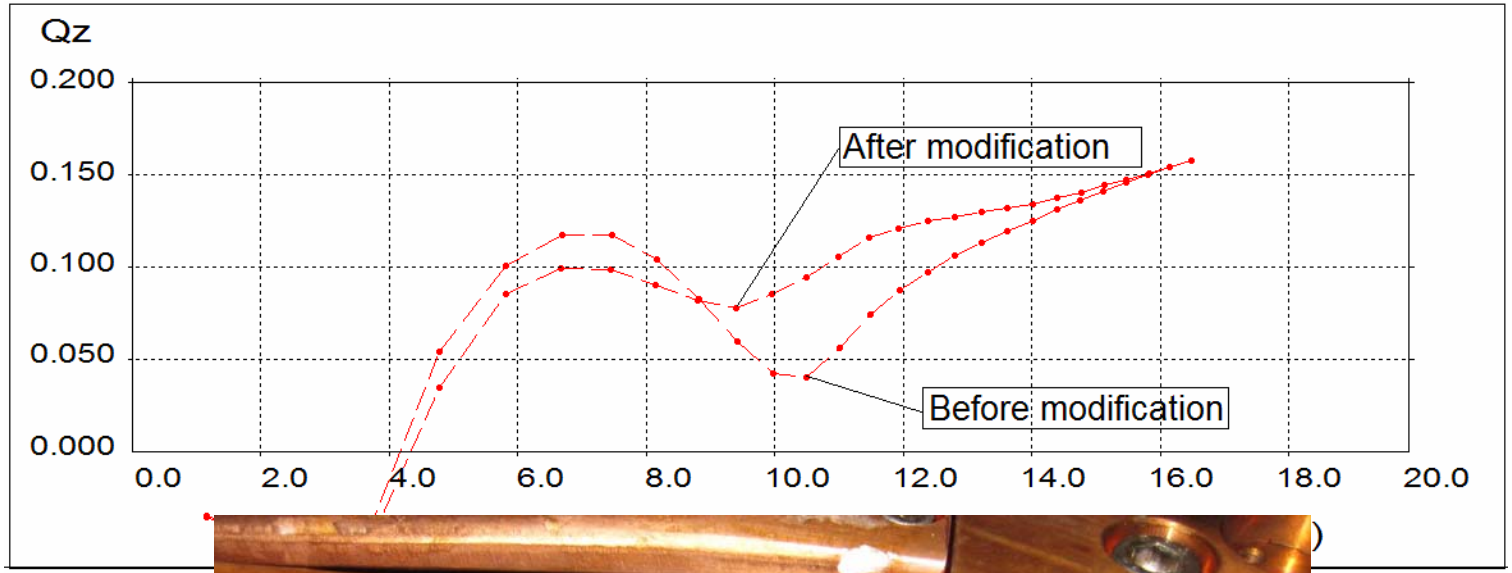
Vertical adjustment of the central plugs due to plane *z=0*

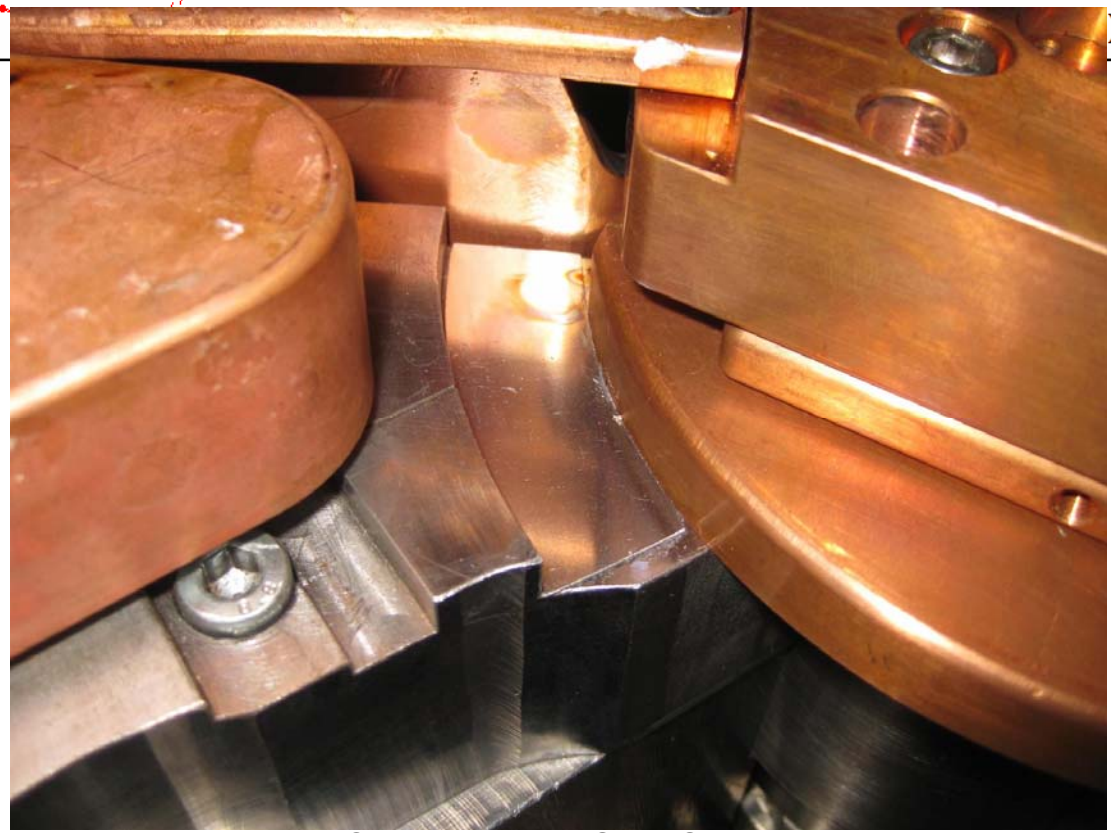


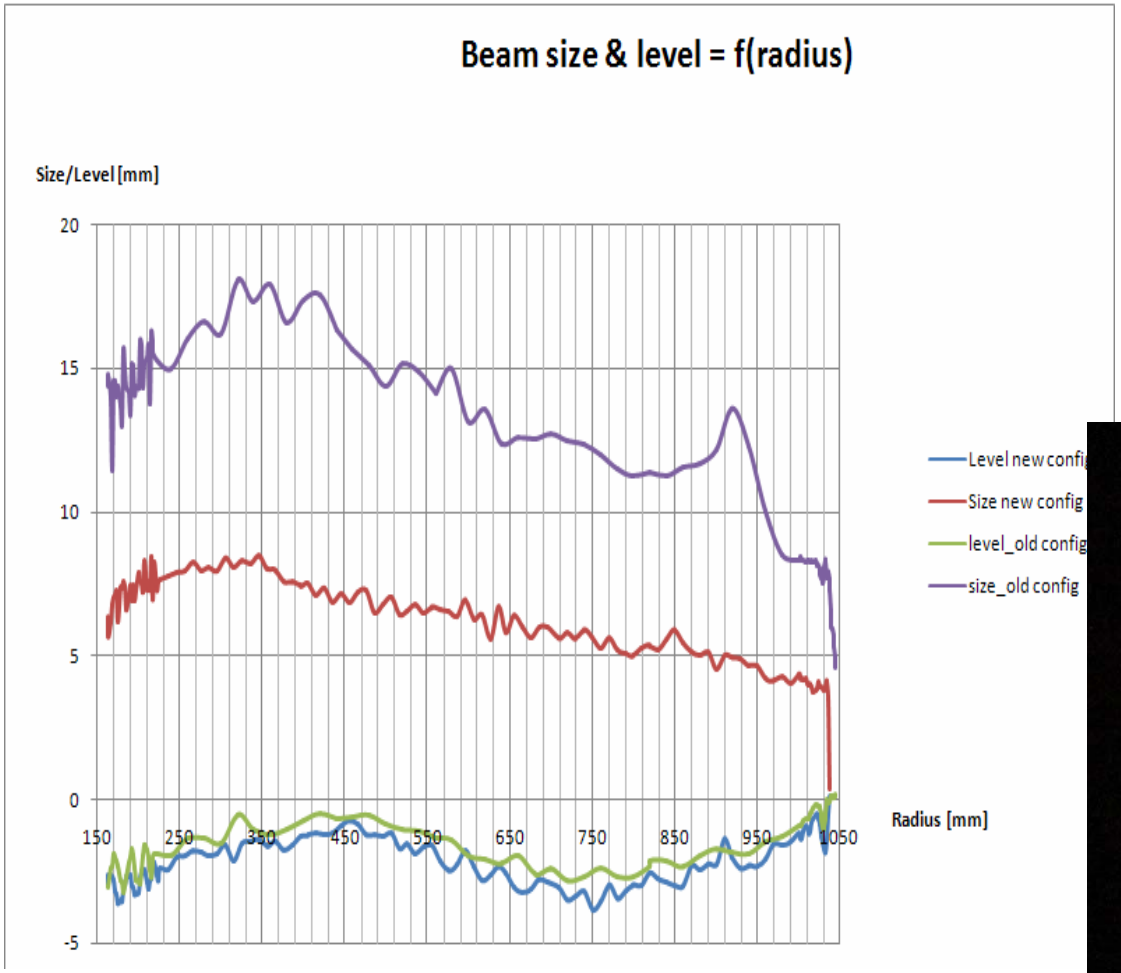
Smith & Garren curves at final configuration

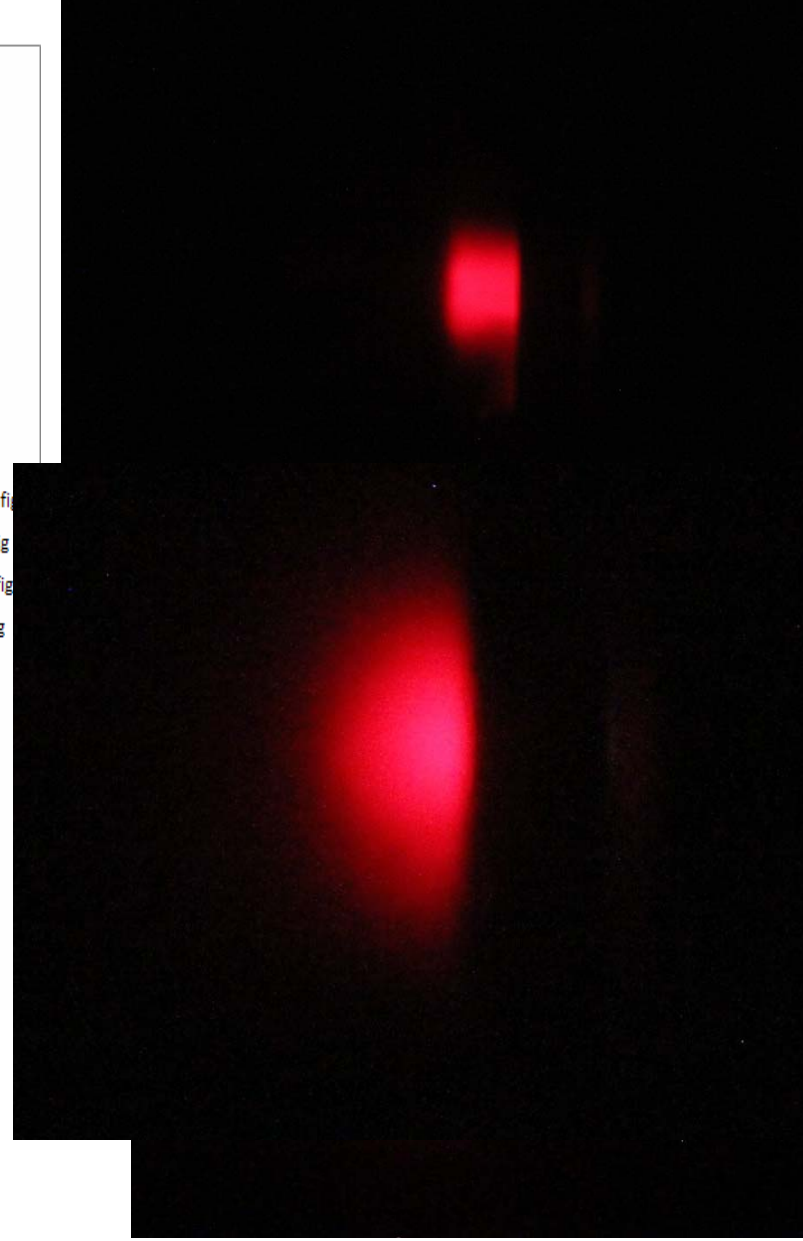
Correction of the vertical focusing properties in the center of the machine

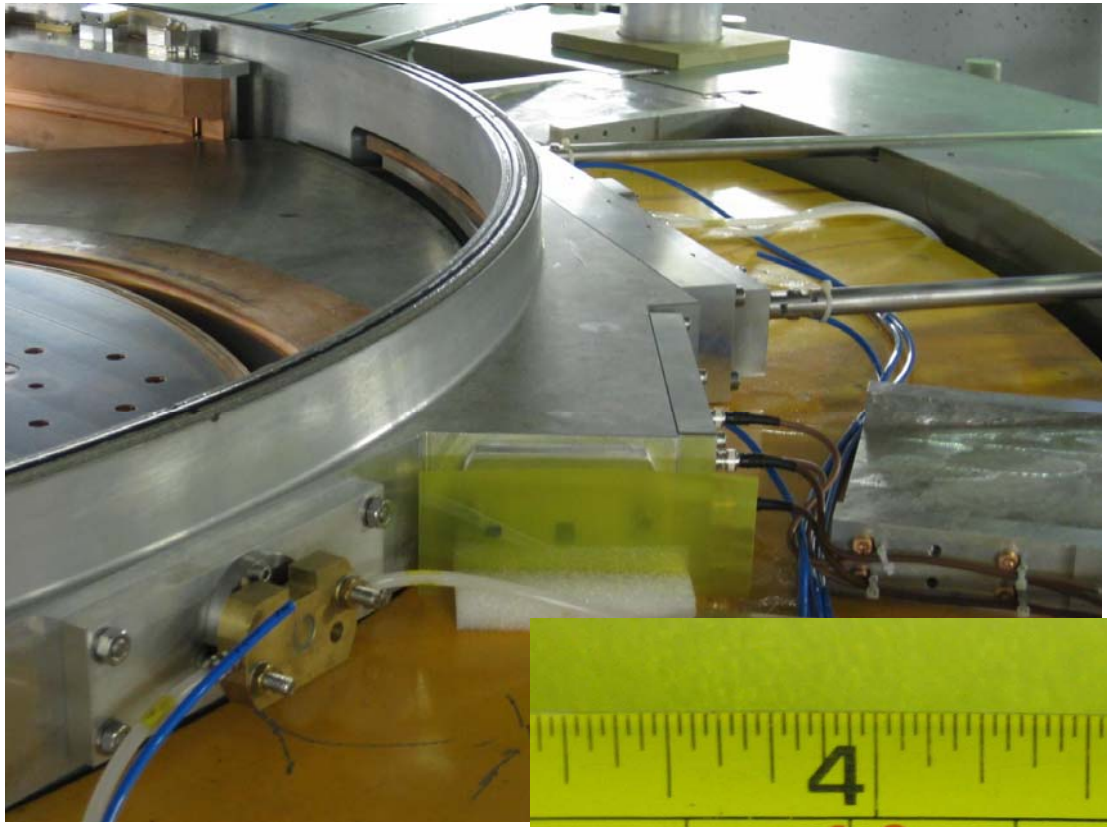


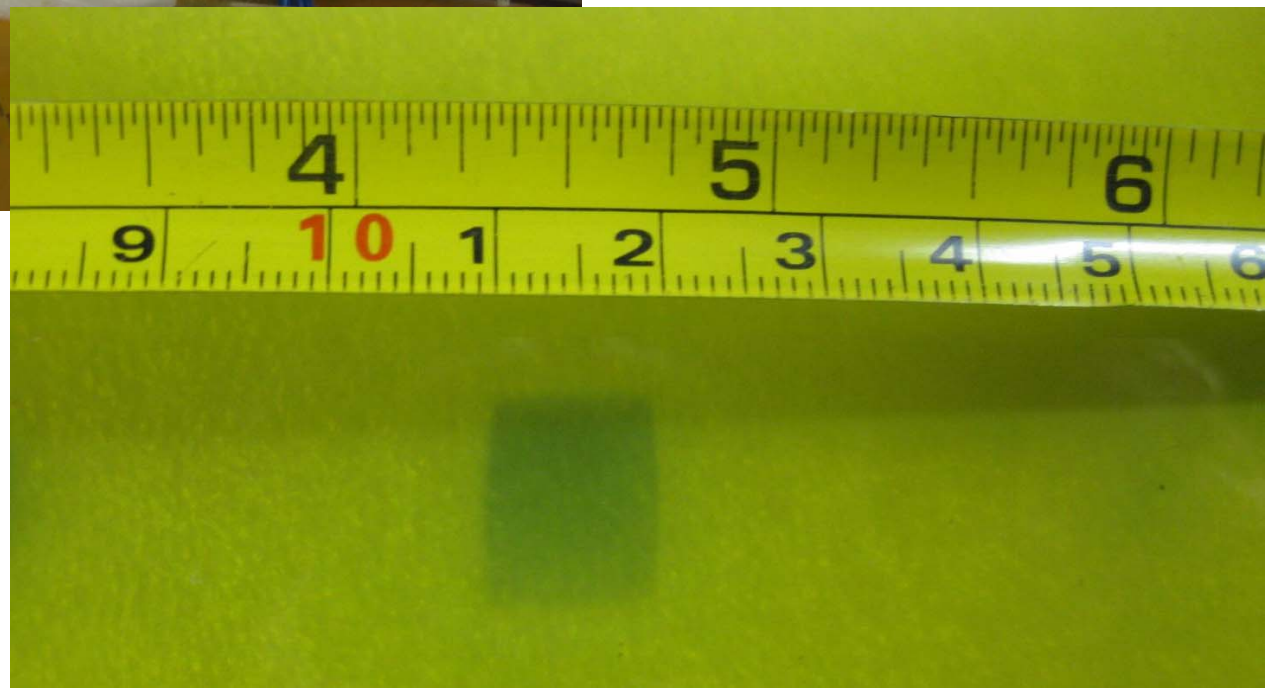

Qz
0.200
0.150
0.100
0.050
0.000
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
After modification
Before modification




Beam size & level = f(radius)
Size/Level [mm]
20
15
10
5
0
-5
150
250
350
450
550
650
750
850
950
1050
Radius [mm]
Level new config
Size new config
level_old config
size_old config






4
5
6
9
10
1
2
3
4
5
6

Beam test results C235-V3

•The PAP116 machine was finally isochronized, operating RF-frequency is 106.270 MHz, I_{mc}=760.7 A

•Beam leaves central region without essential vertical and phase losses.

•Transmission from r=300mm to 1030 is **72%** . Visual probe data show that likely the axial losses do not exist in this radial range.

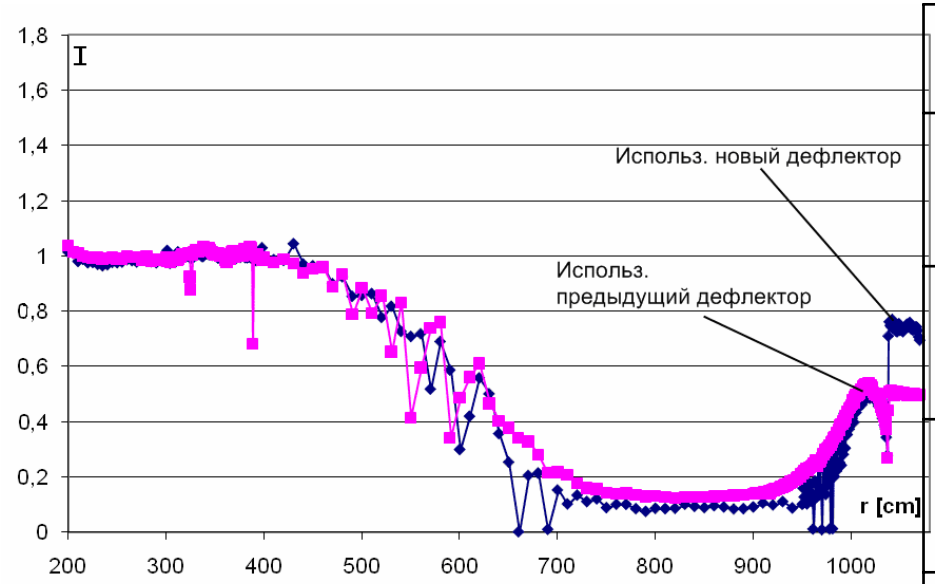
•Beam vertical motion in the cyclotron is in the acceptable limits ($\Delta Z_{beam} \leq 3$ mm).

•Extraction efficiency is **62%.**

•Total efficiency of PAP-116 machine is **45%**.

•Final tuning of the PAP-116 machine must be performed in Dimitrovgrad.

Modified cyclotron C235-V3

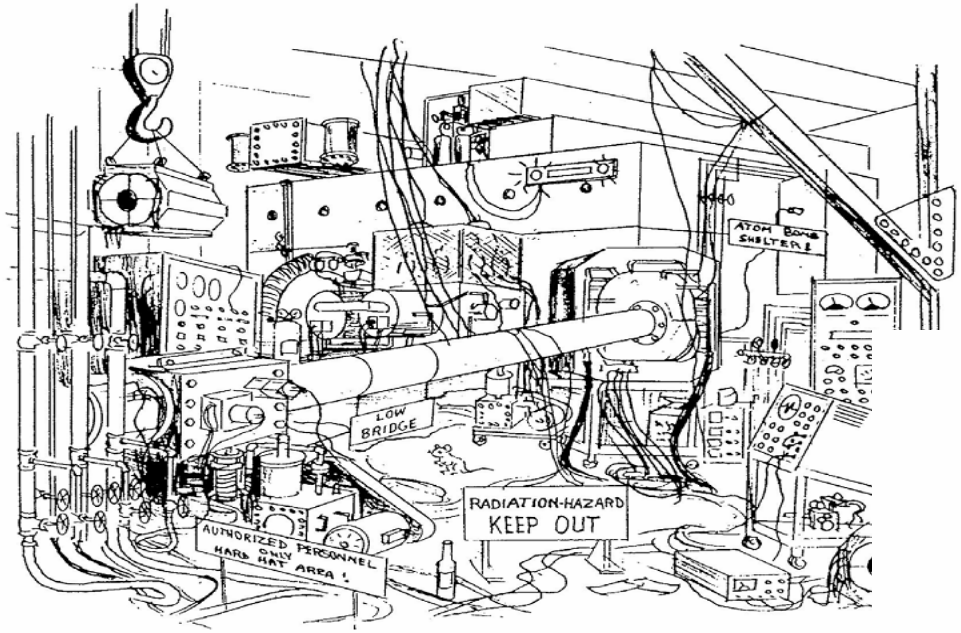


	C235	C235-V3
Vertical betatron frequency at R>80cm	Qz=0.25	Qz=0.45
Vertical coherent beam Displacement due to median plane effects	3-4mm	1-2mm
Possible beam losses at acceleration without installed diaphragms	50%	25%
Beam losses at extraction	50%	25%
Reduction of irradiation dose of cyclotron subsystems		2-3 times

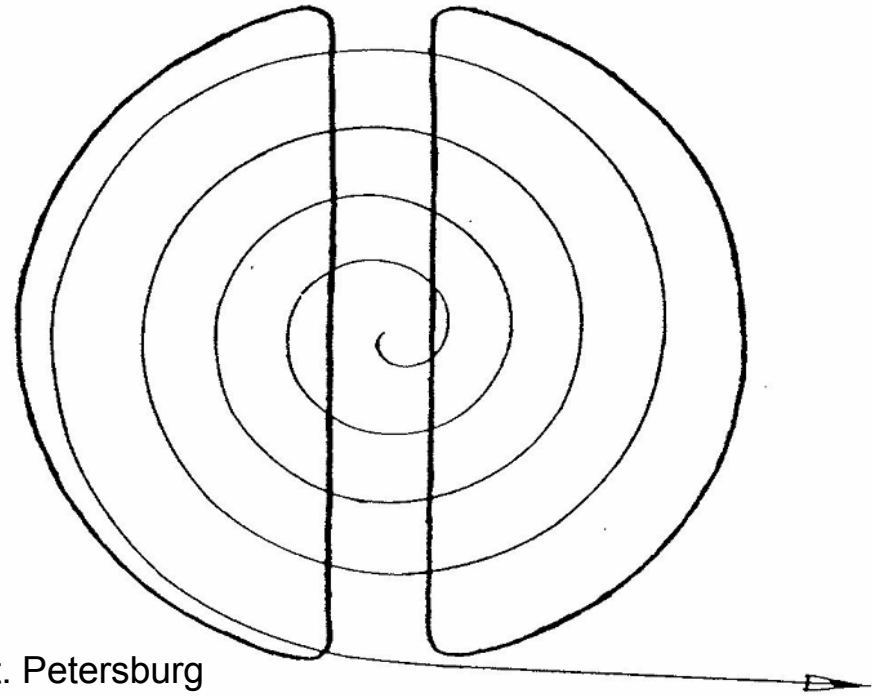
Extraction efficiency 50% -> 75% with new Extr. system

With finishing of this project in JINR the new milestone on JINR activity in applied researches is completed

The Cyclotron as seen by the **Visitor**

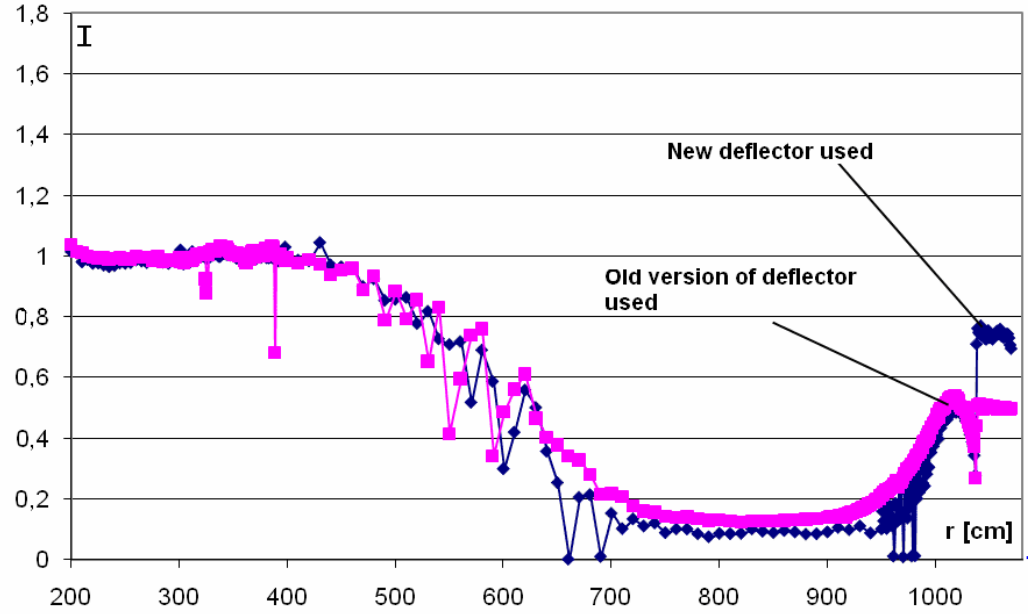


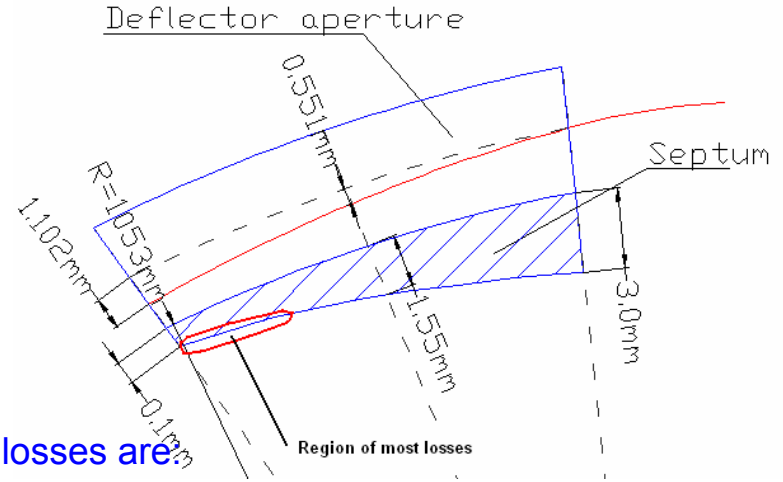
The Cyclotron as seen by the **scientist**



Спасибо за внимание

Efficiency of the extraction system





Beam losses are:

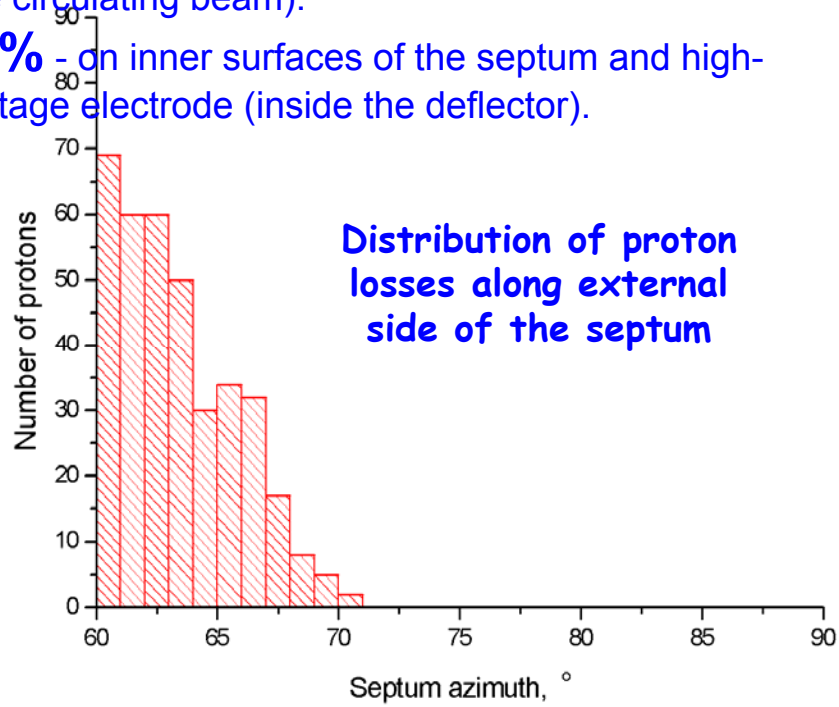
~10% - on the top of the septum

~25% - on outer surface of the septum (looking on the circulating beam).

~5% - on inner surfaces of the septum and high-voltage electrode (inside the deflector).

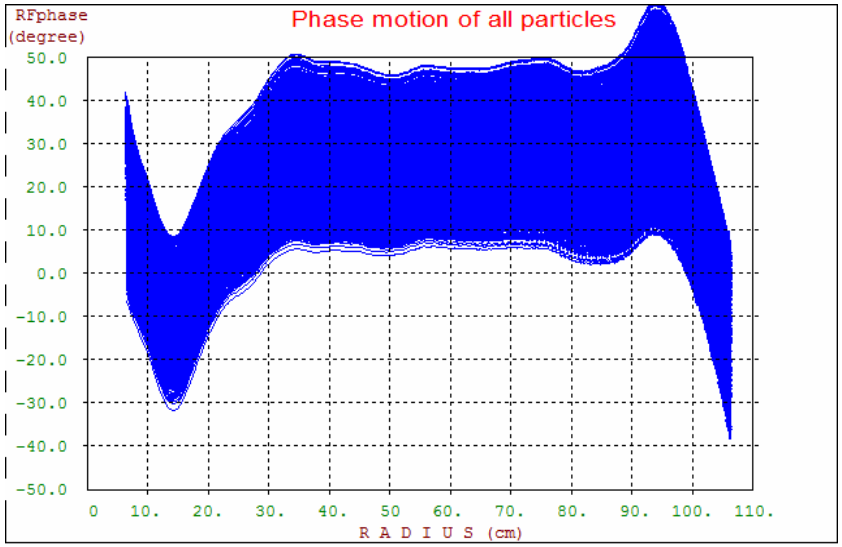
Simulations give that it is possible to ensure **80%** extraction efficiency.

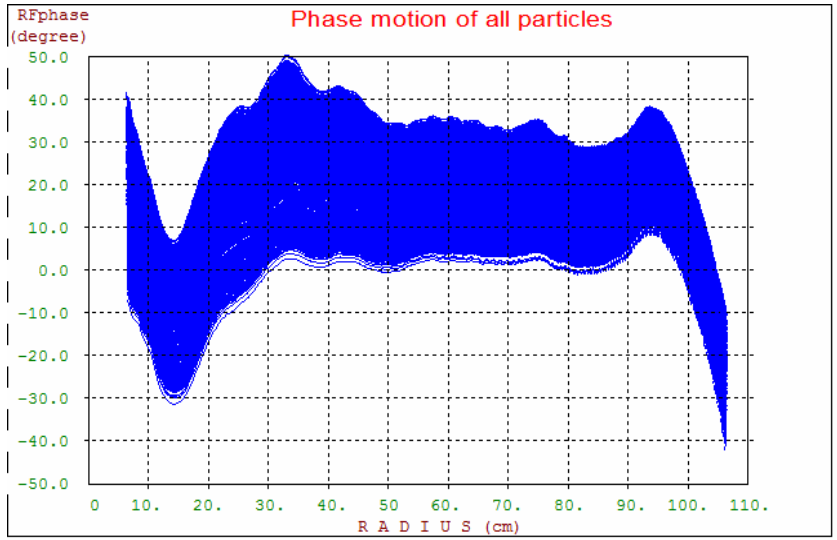
Deflector with a new geometry of the septum was manufactured and tested at one of the C235-cyclotrons. Extraction efficiency was increased from **50%** up to **77%**

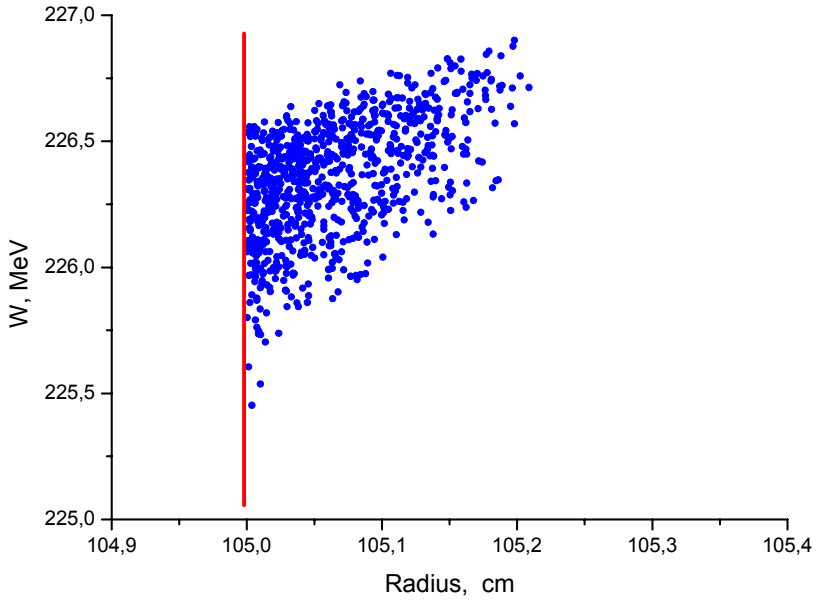


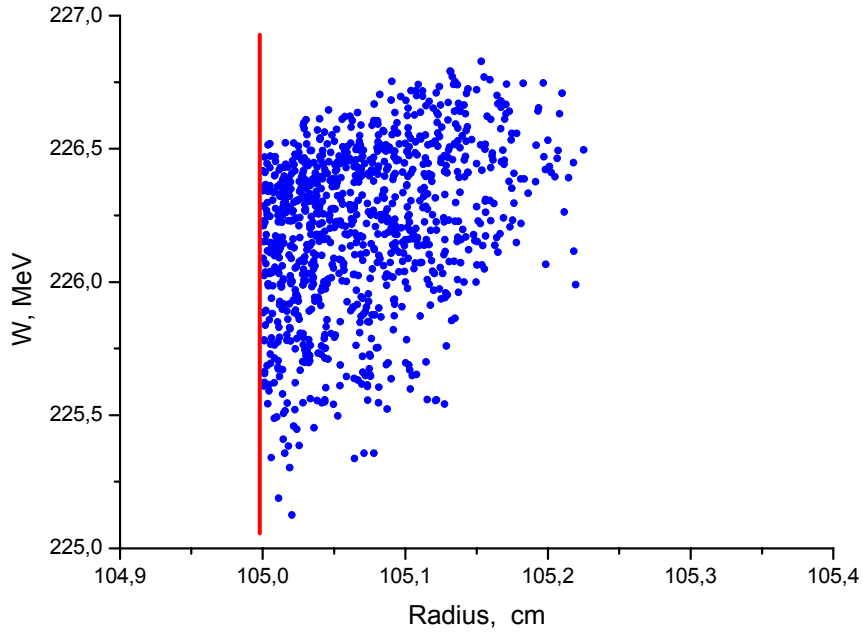
Distribution of proton losses along external side of the septum

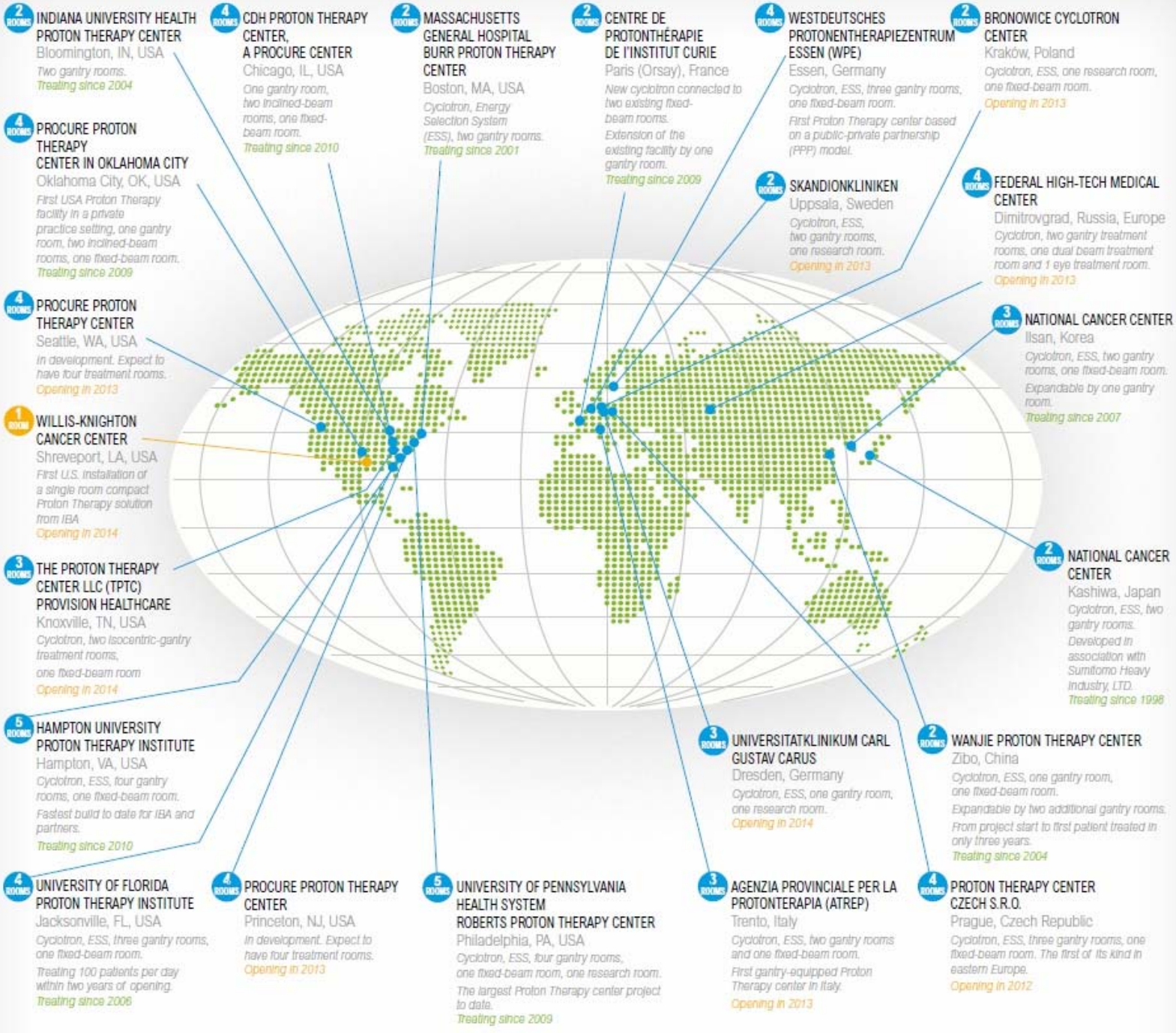
Учет влияния магнитной компоненты ВЧ-поля на движение пучка










2 ROOMS
INDIANA UNIVERSITY HEALTH PROTON THERAPY CENTER
Bloomington, IN, USA
Two gantry rooms.
Treating since 2004
4 ROOMS
CDH PROTON THERAPY CENTER, A PROCURE CENTER
Chicago, IL, USA
One gantry room, two inclined-beam rooms, one fixed-beam room.
Treating since 2010
2 ROOMS
MASSACHUSETTS GENERAL HOSPITAL BURR PROTON THERAPY CENTER
Boston, MA, USA
Cyclotron, Energy Selection System (ESS), two gantry rooms.
Treating since 2001
2 ROOMS
CENTRE DE PROTONTHÉRAPIE DE L'INSTITUT CURIE
Paris (Orsay), France
New cyclotron connected to two existing fixed-beam rooms.
Extension of the existing facility by one gantry room.
Treating since 2009
4 ROOMS
WESTDEUTSCHES PROTONENTHERAPIEZENTRUM ESSEN (WPE)
Essen, Germany
Cyclotron, ESS, three gantry rooms, one fixed-beam room.
First Proton Therapy center based on a public-private partnership (PPP) model.
2 ROOMS
BRONOWICE CYCLOTRON CENTER
Kraków, Poland
Cyclotron, ESS, one research room, one fixed-beam room.
Opening in 2013
4 ROOMS
PROCURE PROTON THERAPY CENTER IN OKLAHOMA CITY
Oklahoma City, OK, USA
First USA Proton Therapy facility in a private practice setting, one gantry room, two inclined-beam rooms, one fixed-beam room.
Treating since 2009
2 ROOMS
SKANDIONKLINIKEN
Uppsala, Sweden
Cyclotron, ESS, two gantry rooms, one research room.
Opening in 2013
4 ROOMS
FEDERAL HIGH-TECH MEDICAL CENTER
Dimitrovgrad, Russia, Europe
Cyclotron, two gantry treatment rooms, one dual beam treatment room and 1 eye treatment room.
Opening in 2013
4 ROOMS
PROCURE PROTON THERAPY CENTER
Seattle, WA, USA
In development. Expect to have four treatment rooms.
Opening in 2013
3 ROOMS
NATIONAL CANCER CENTER
Ilsan, Korea
Cyclotron, ESS, two gantry rooms, one fixed-beam room.
Expandable by one gantry room.
Treating since 2007
1 ROOM
WILLIS-KNIGHTON CANCER CENTER
Shreveport, LA, USA
First U.S. installation of a single room compact Proton Therapy solution from IBA
Opening in 2014
2 ROOMS
NATIONAL CANCER CENTER
Kashiwa, Japan
Cyclotron, ESS, two gantry rooms.
Developed in association with Sumitomo Heavy Industry, LTD.
Treating since 1998
3 ROOMS
THE PROTON THERAPY CENTER LLC (TPTC) PROVISION HEALTHCARE
Knoxville, TN, USA
Cyclotron, two isocentric-gantry treatment rooms, one fixed-beam room
Opening in 2014
5 ROOMS
HAMPTON UNIVERSITY PROTON THERAPY INSTITUTE
Hampton, VA, USA
Cyclotron, ESS, four gantry rooms, one fixed-beam room.
Fastest build to date for IBA and partners.
Treating since 2010
3 ROOMS
UNIVERSITATKLINIKUM CARL GUSTAV CARUS
Dresden, Germany
Cyclotron, ESS, one gantry room, one research room.
Opening in 2014
2 ROOMS
WANJIE PROTON THERAPY CENTER
Zibo, China
Cyclotron, ESS, one gantry room, one fixed-beam room.
Expandable by two additional gantry rooms.
From project start to first patient treated in only three years.
Treating since 2004
4 ROOMS
UNIVERSITY OF FLORIDA PROTON THERAPY INSTITUTE
Jacksonville, FL, USA
Cyclotron, ESS, three gantry rooms, one fixed-beam room.
Treating 100 patients per day within two years of opening.
Treating since 2006
4 ROOMS
PROCURE PROTON THERAPY CENTER
Princeton, NJ, USA
In development. Expect to have four treatment rooms.
Opening in 2013
5 ROOMS
UNIVERSITY OF PENNSYLVANIA HEALTH SYSTEM ROBERTS PROTON THERAPY CENTER
Philadelphia, PA, USA
Cyclotron, ESS, four gantry rooms, one fixed-beam room, one research room.
The largest Proton Therapy center project to date.
Treating since 2009
3 ROOMS
AGENZIA PROVINCIALE PER LA PROTONTERAPIA (ATREP)
Trento, Italy
Cyclotron, ESS, two gantry rooms and one fixed-beam room.
First gantry-equipped Proton Therapy center in Italy.
Opening in 2013
4 ROOMS
PROTON THERAPY CENTER CZECH S.R.O.
Prague, Czech Republic
Cyclotron, ESS, three gantry rooms, one fixed-beam room. The first of its kind in eastern Europe.
Opening in 2012

Beam test results C235-V3

•The PAP116 machine was finally isochronized, operating RF-frequency is 106.270 MHz, I_{mc}=760.7 A

•Beam production from ions source (140V/100mA, 198A) is acceptable

•Beam leaves central region without essential vertical and phase losses.

•Transmission from r=300mm to 1030 is **72%** . Visual probe data show that likely the axial losses do not exist in this radial range.

•Beam vertical motion in the cyclotron is in the acceptable limits ($\Delta Z_{beam} \leq 3$ mm).

•Extraction efficiency is **62%.**

•Total efficiency of PAP-116 machine is **45%**.

•Final tuning of the PAP-116 machine must be performed in Dimitrovgrad.