PK-ISIS the new SC-ECRIS of Pantechnik

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(1) Pantechnik, (2) GANIL, (3) LPSC, (4) TIFR

Topics

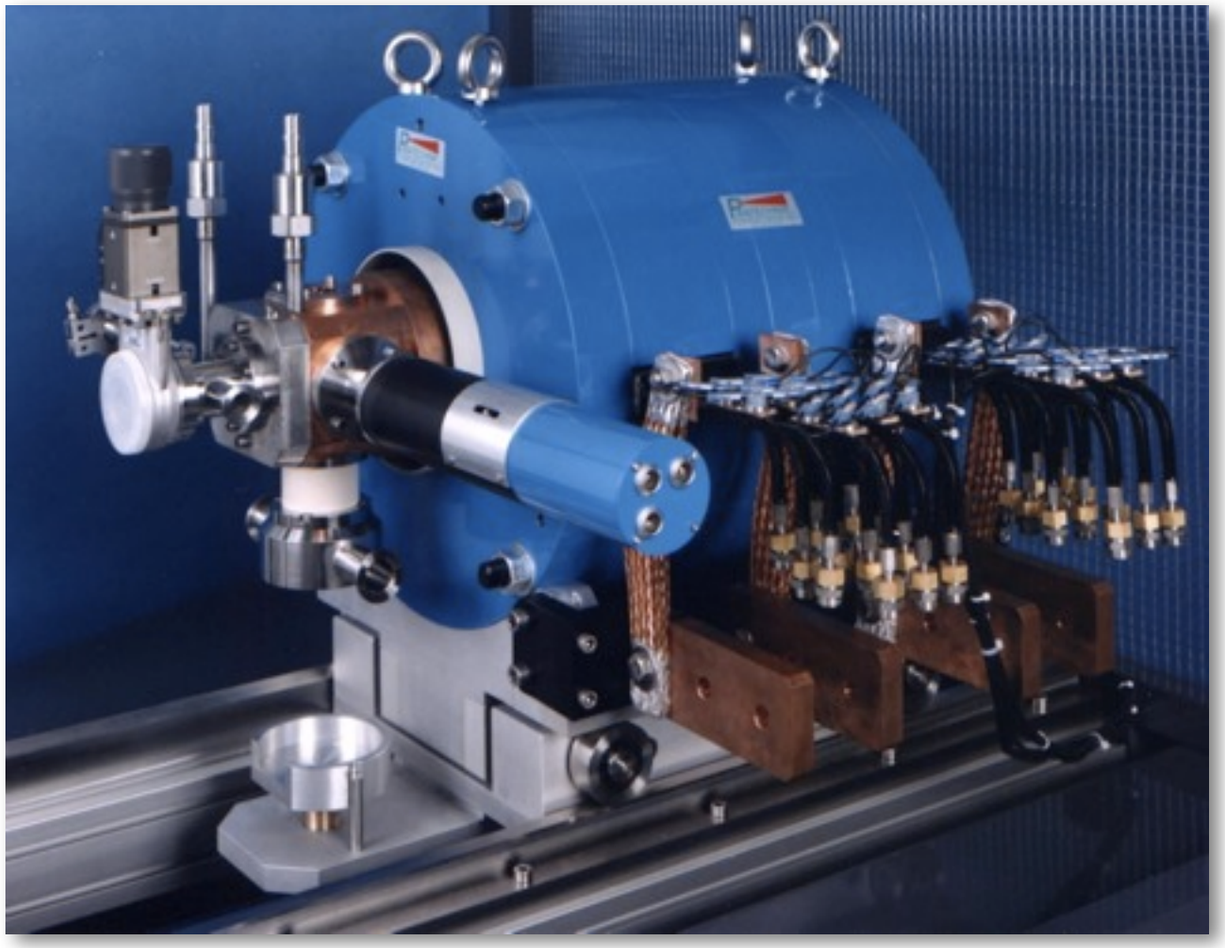
- Facts
- Frequency and Magnetic design of PK-ISIS
- Drawings
- Magnetic measurements
- X-rays
- Preliminary results
- Problems and solutions

Facts

- The first hybrid ECRIS with HTS coils was PK-Delis (following talk)

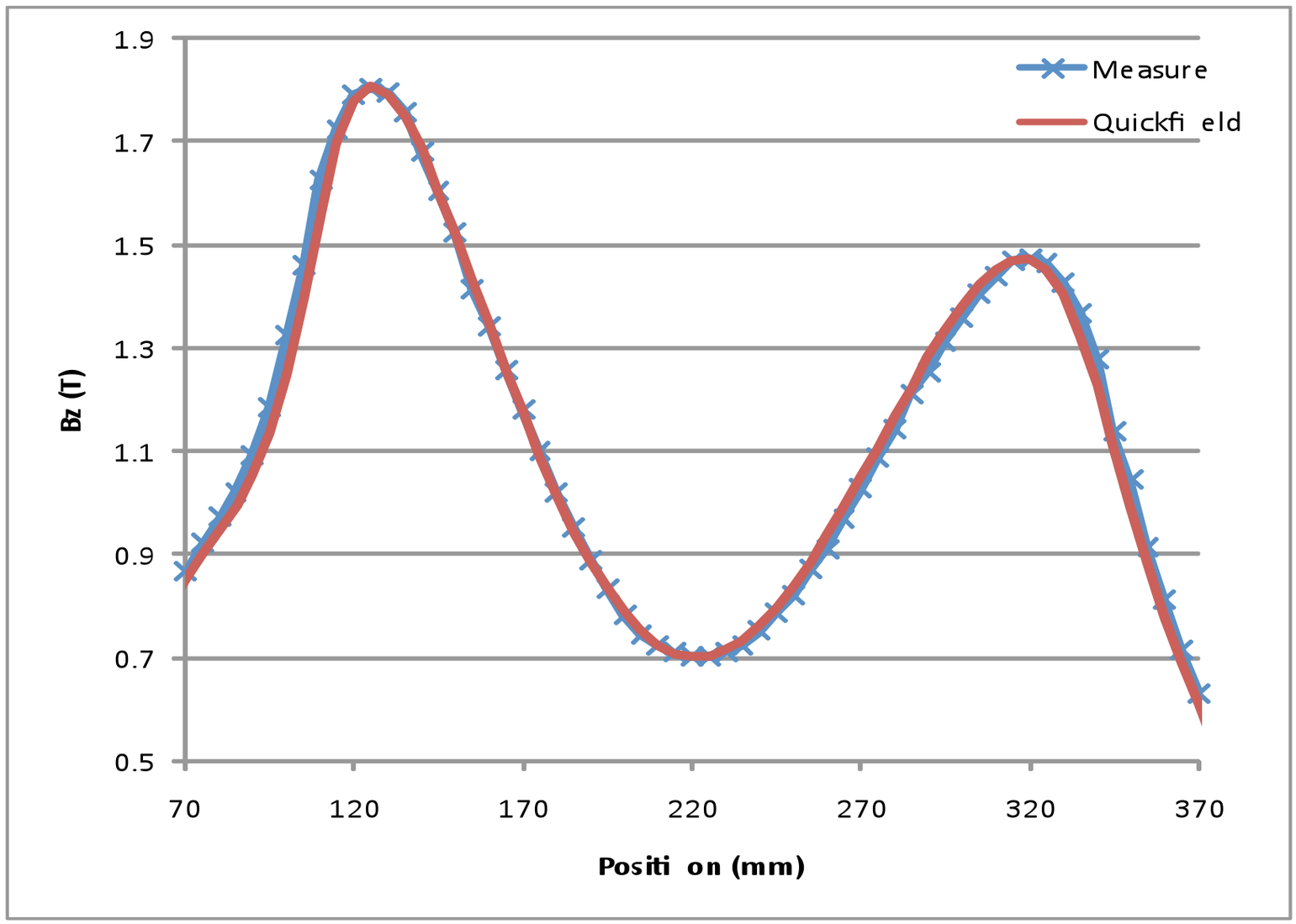
- It has the same geometry of Hypernanogan (Caprice ECR4-M)
- 18 GHz
- Low power consumption

working since 2003



Hypernaogan: 180 kW
PK-Delis: 15 kW

PK-Delis "max. field"



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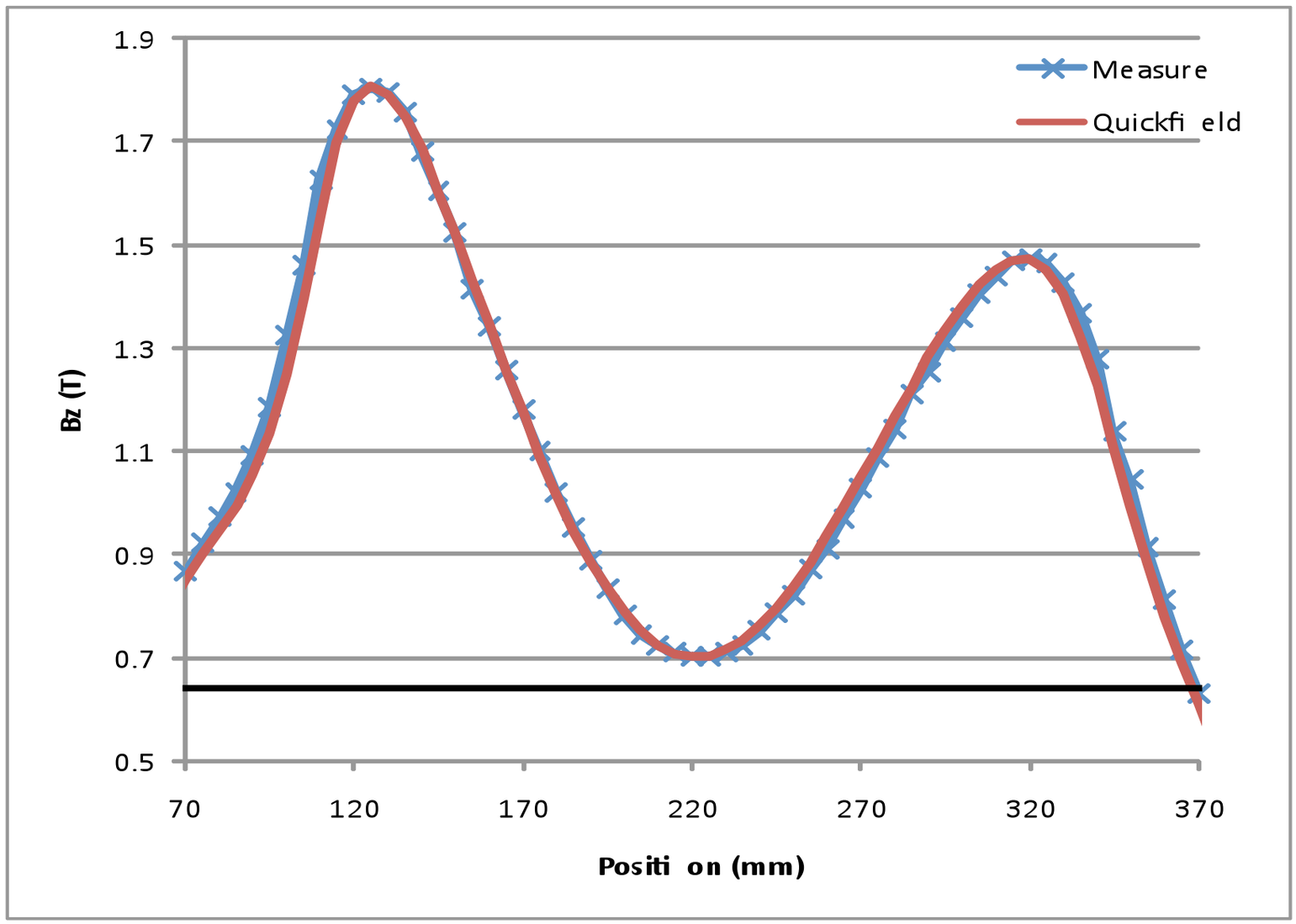
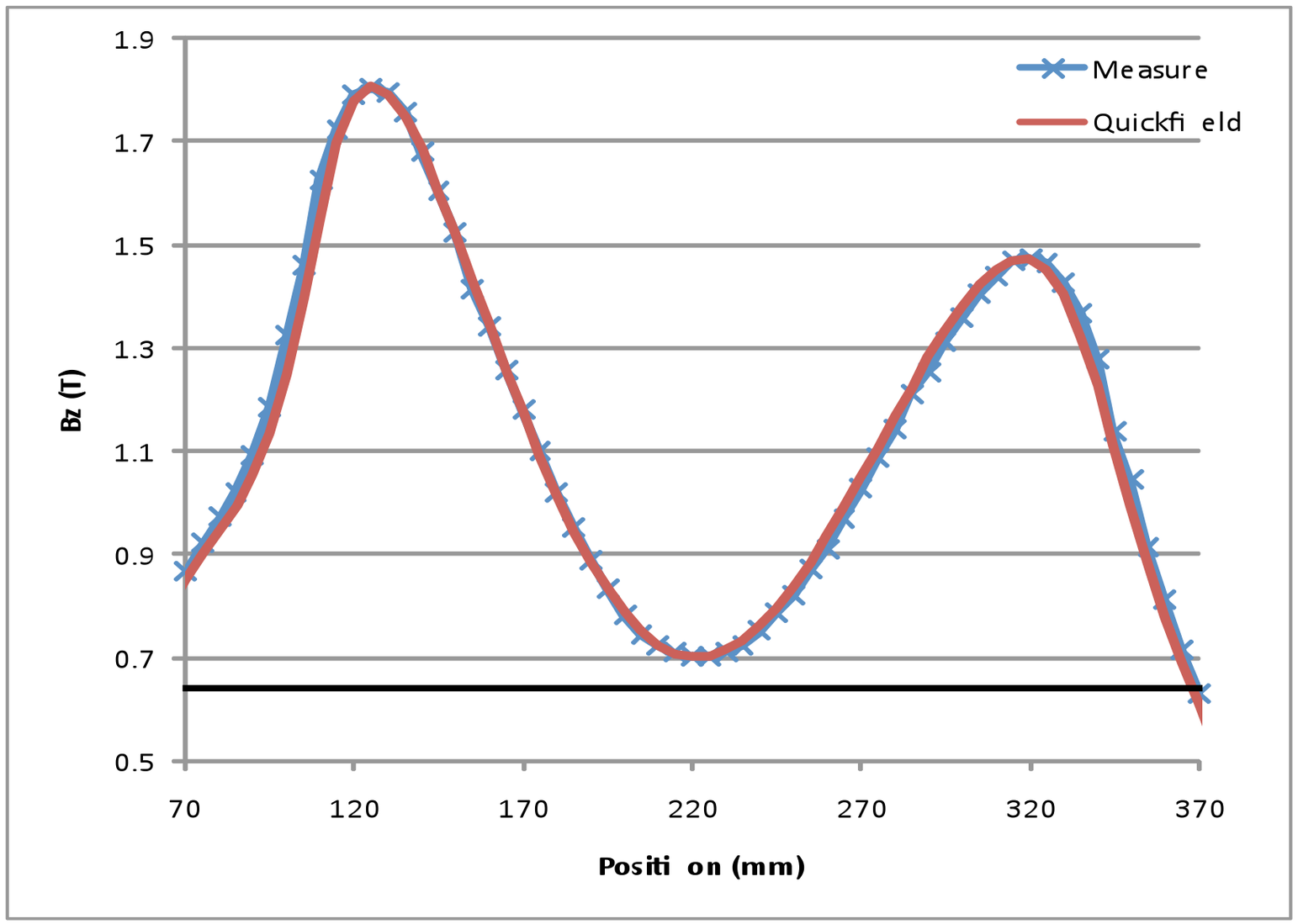


PK-Delis "max. field"



Real working: 1.5 T and 1.2 T

PK-Delis constraints

- Short distance between coils
- Absence of middle "magnetic tuning"
- Radial field limits

PK-ISIS design

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- Larger and longer chamber: 82 mm diameter with 440 mm distance between main coils

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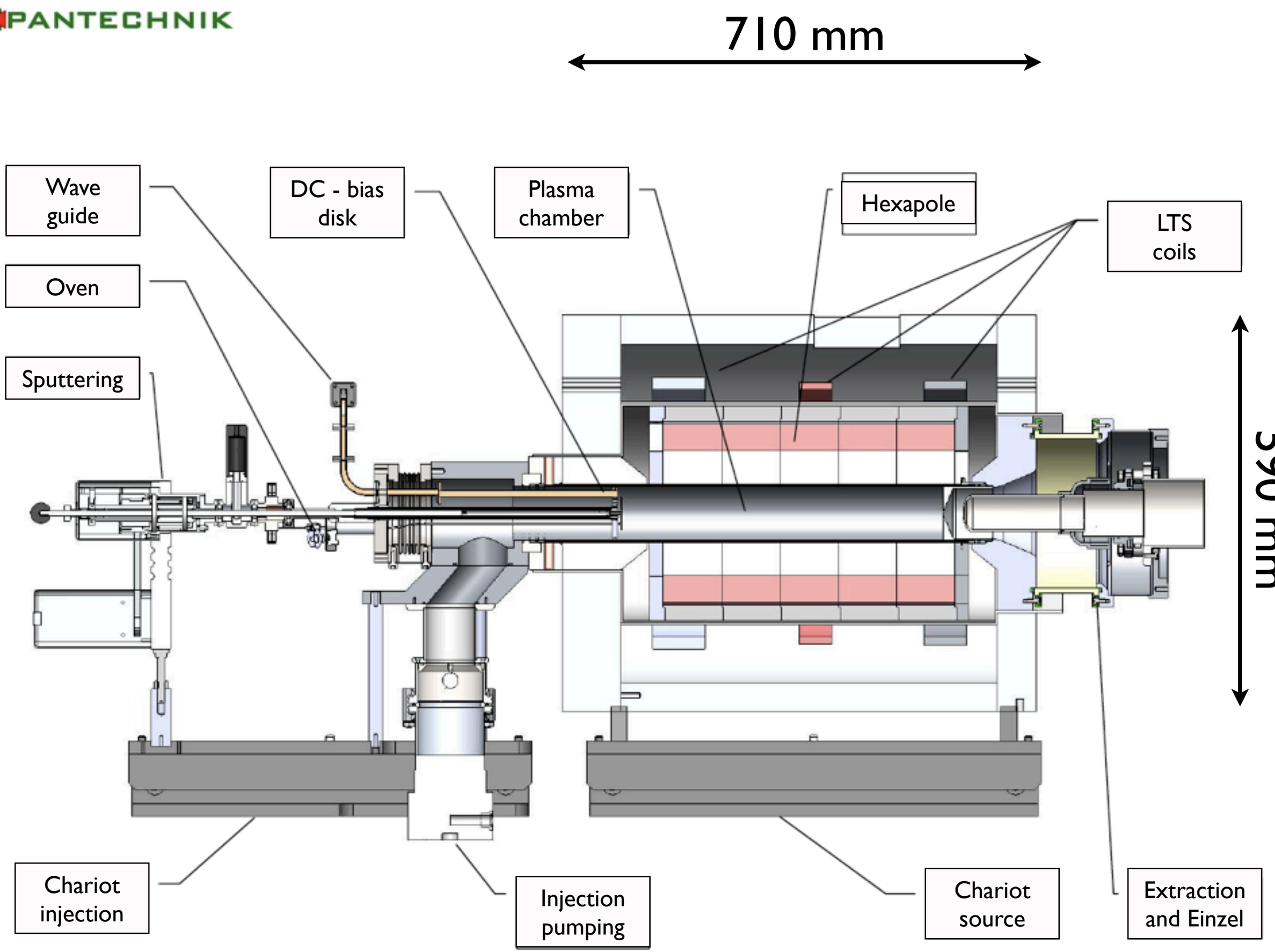
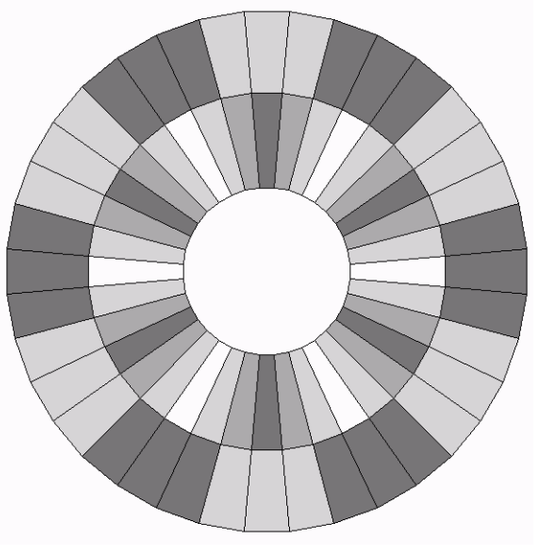
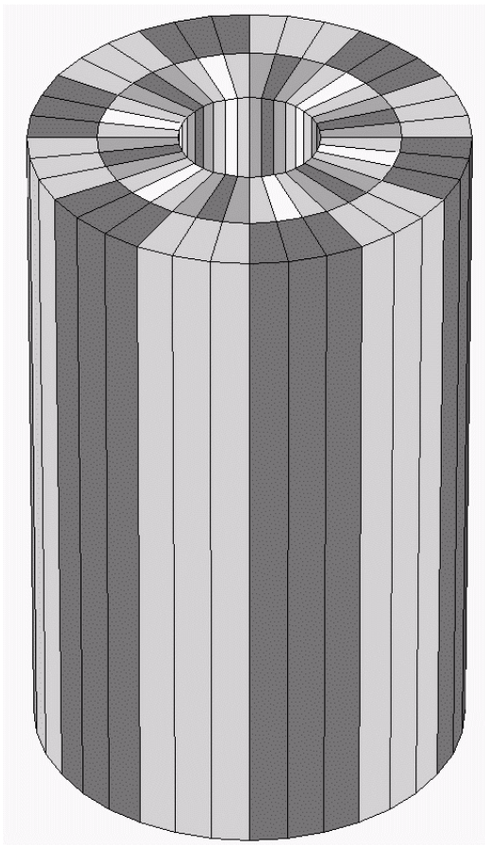
- This is not a research machine -RELIABILITY-


710 mm
590 mm
Wave guide
DC - bias disk
Plasma chamber
Hexapole
LTS coils
Oven
Sputtering
Chariot injection
Injection pumping
Chariot source
Extraction and Einzel

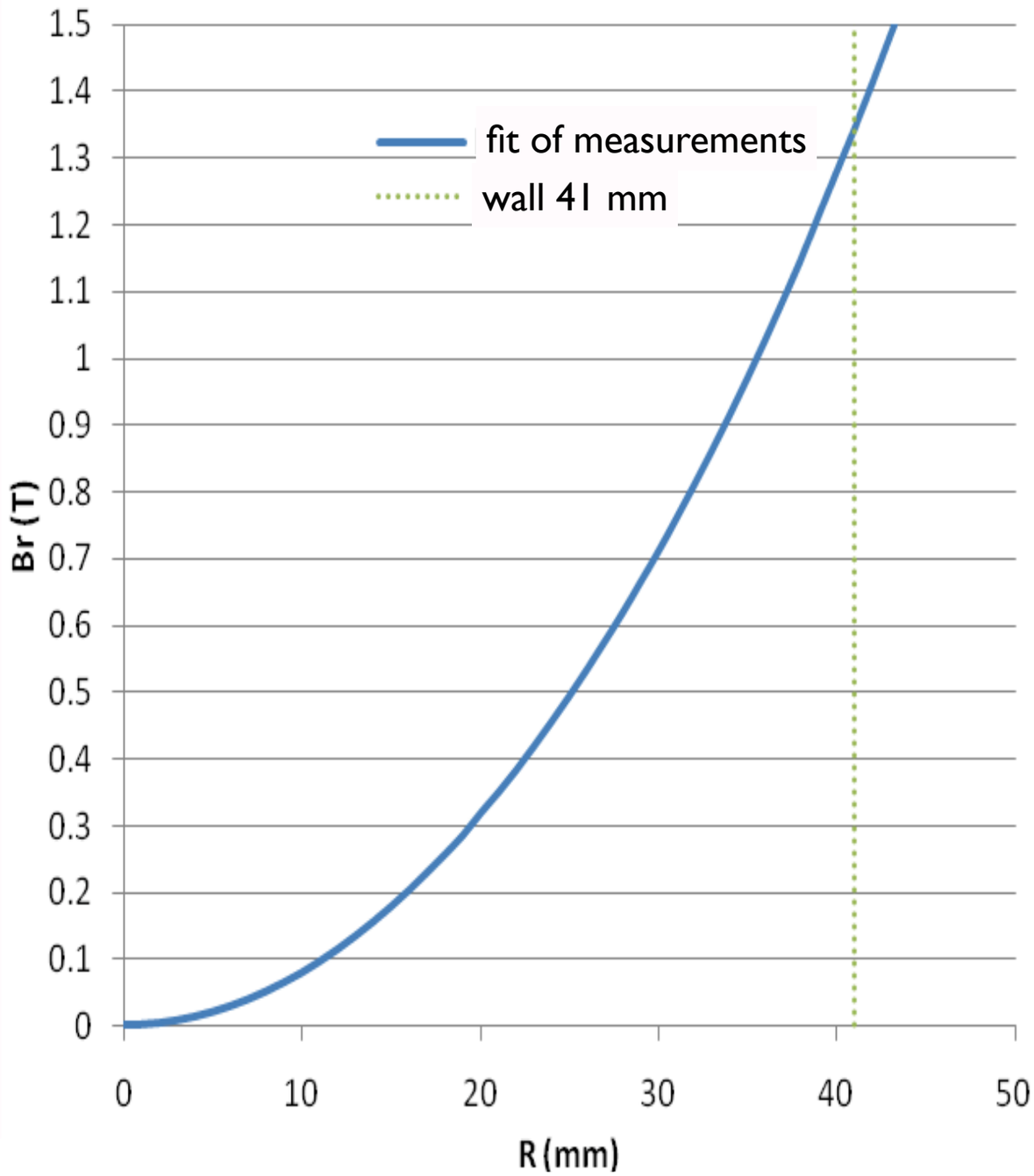
Hexapole

- HallBach 36 sectors of 10°
- Rint = 45 mm
- Rwall = 41 mm
- 2 shells
- IMPORTANT: Axial coils can be magnetized independently
- Length = 450 mm



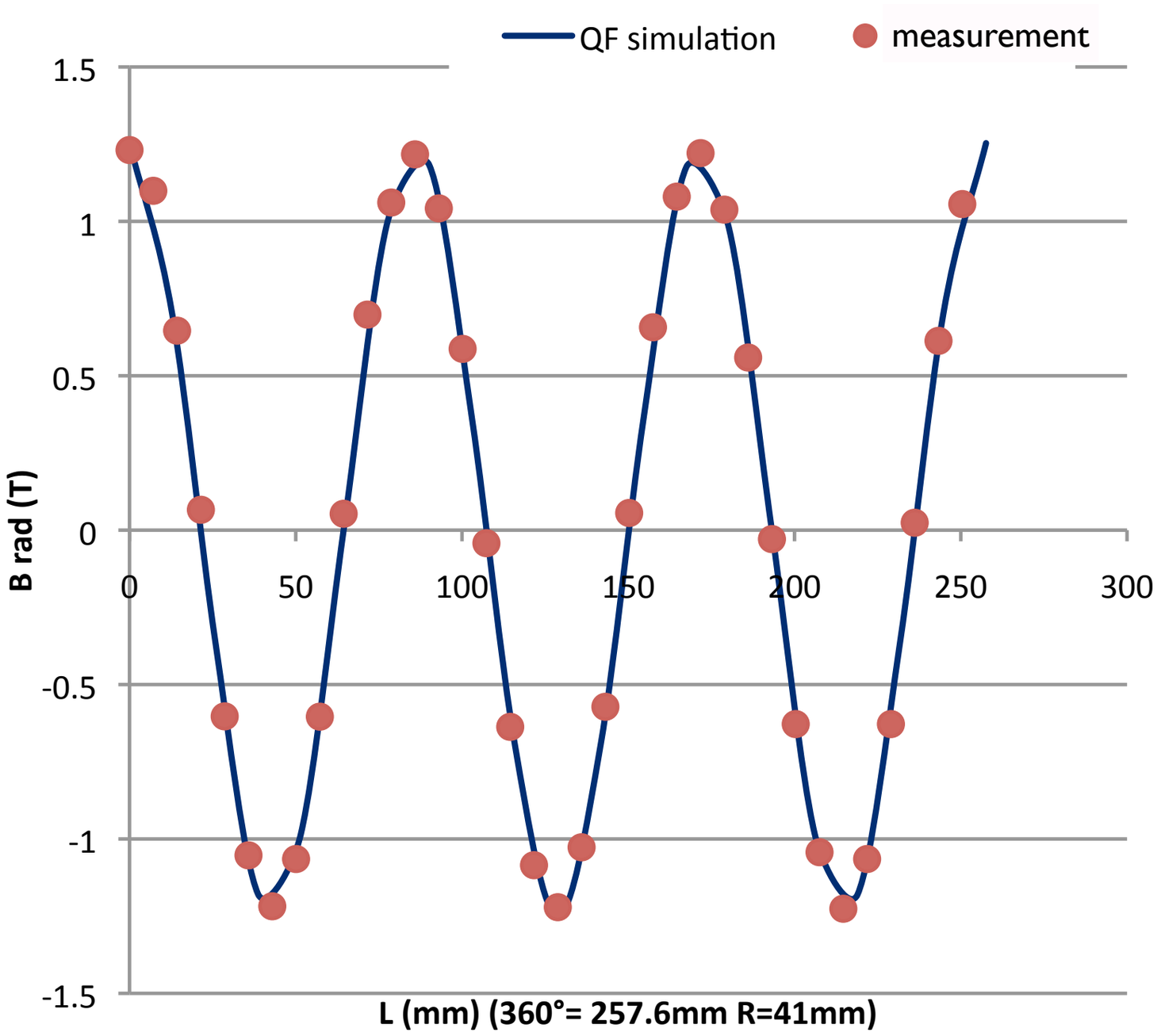


Hexapole



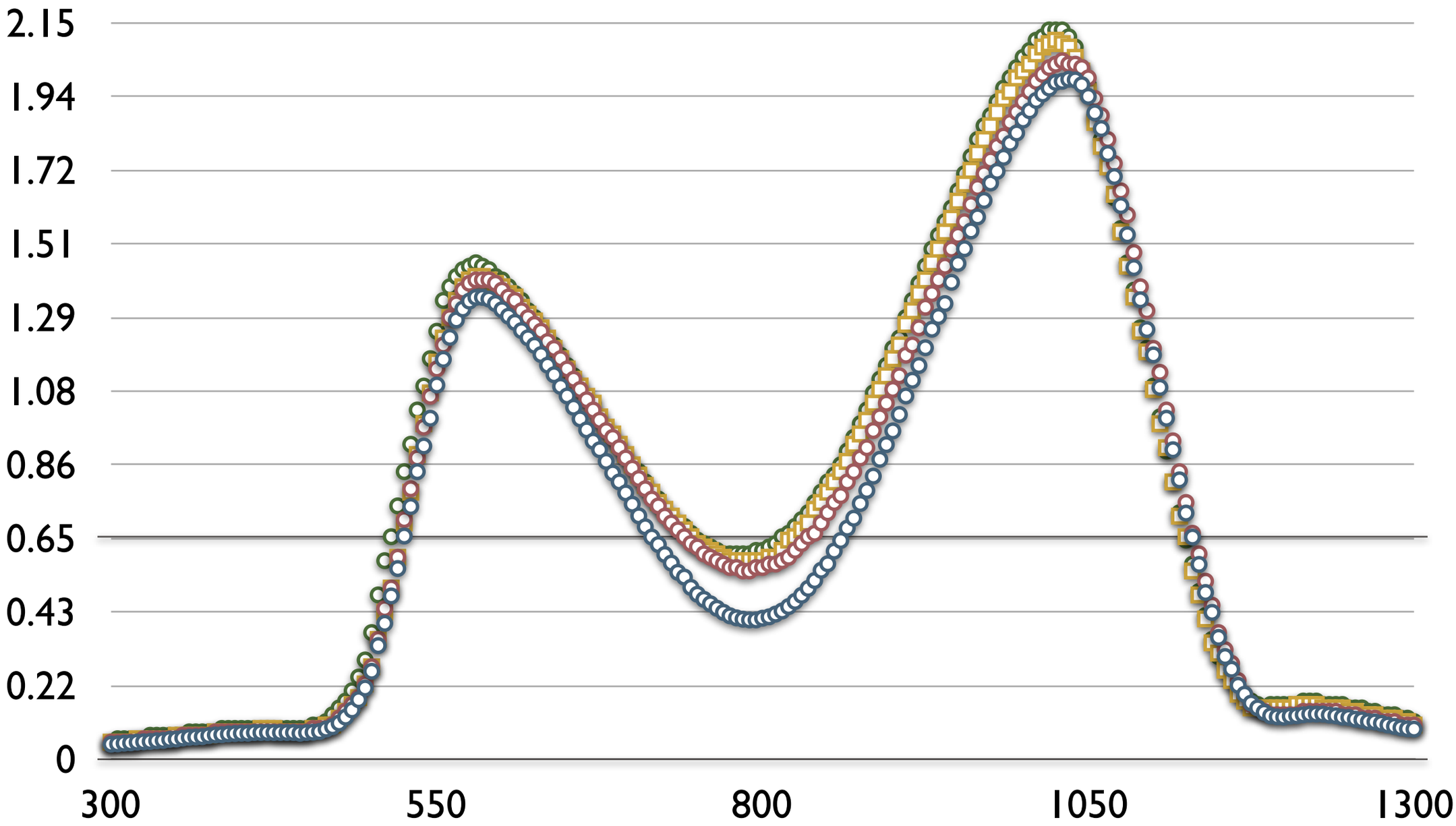
better than 1.3 T

Hexapole


QF simulation
measurement
1.5
1
0.5
0
-0.5
-1
-1.5
B rad (T)
0
50
100
150
200
250
300
L (mm) (360°= 257.6mm R=41mm)

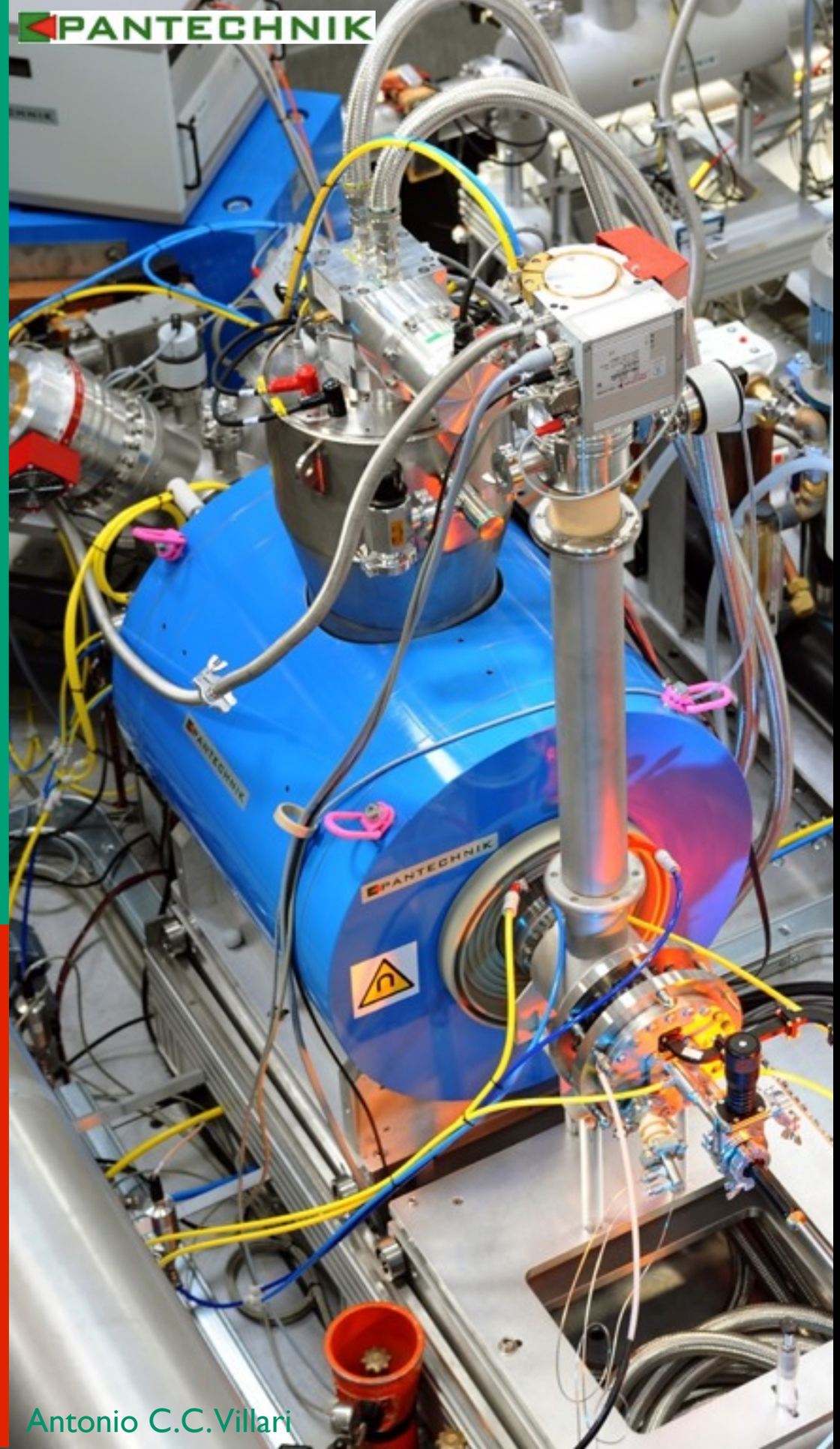
Axial field - measurement

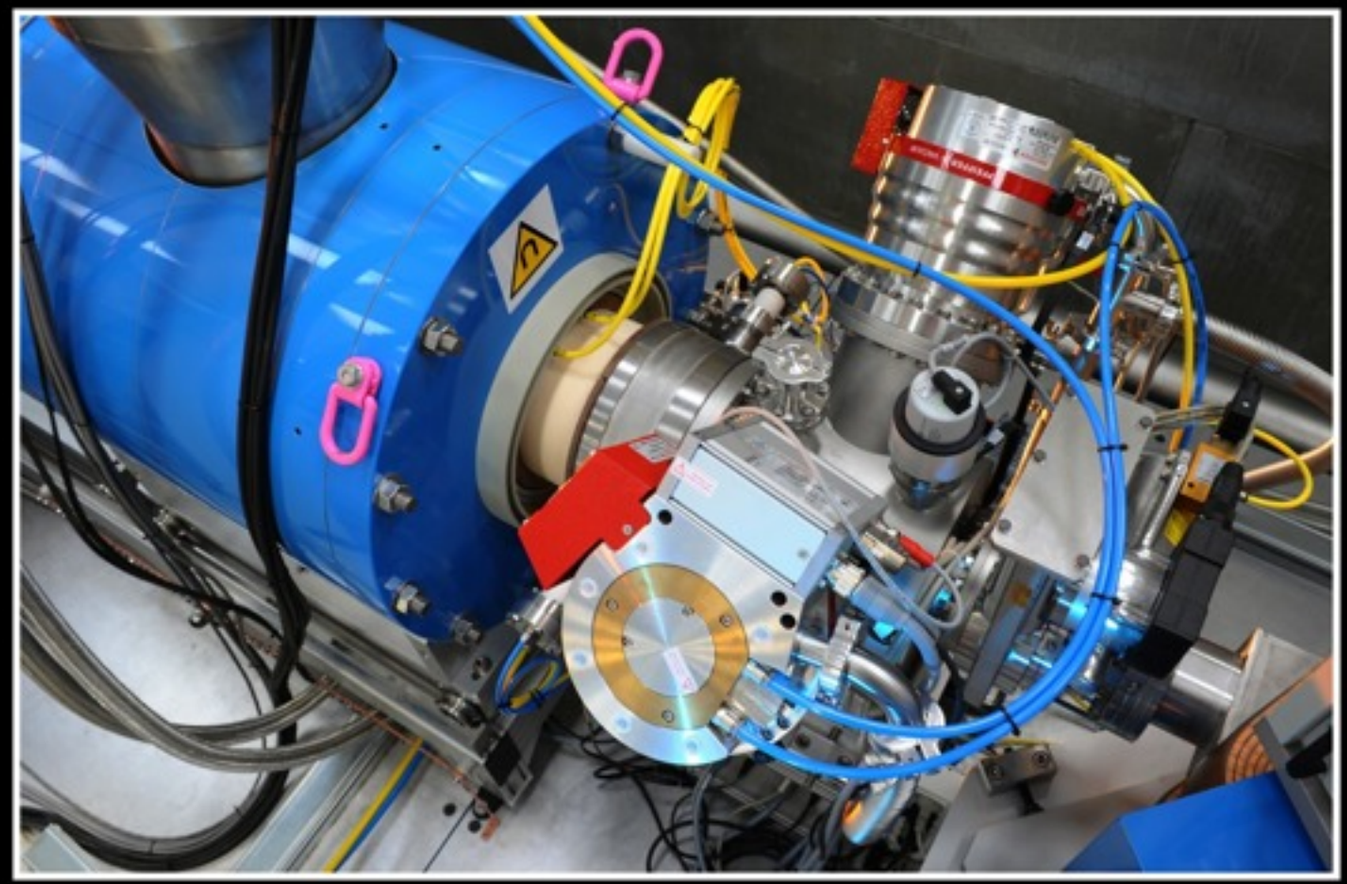
Axial field - measurement

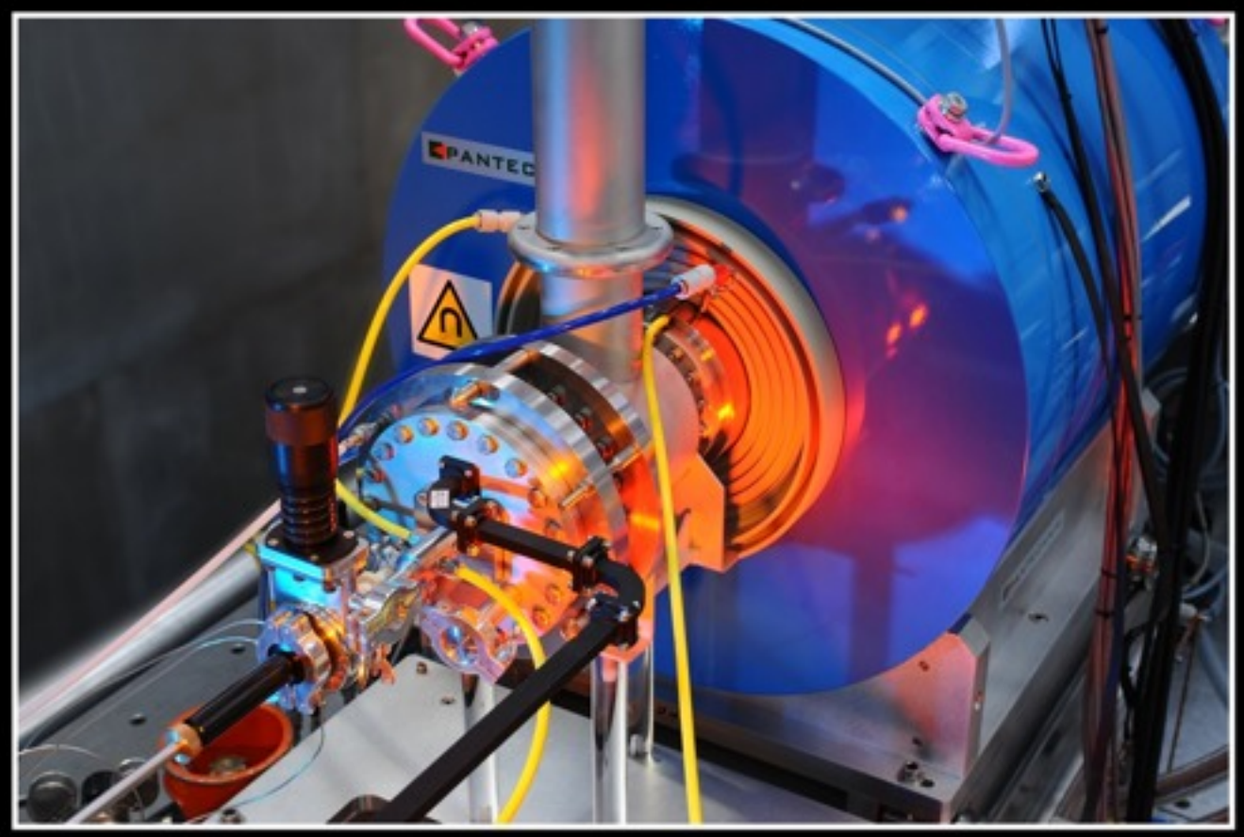


Coils: Nb - Ti - Cu

PANTECHNIK





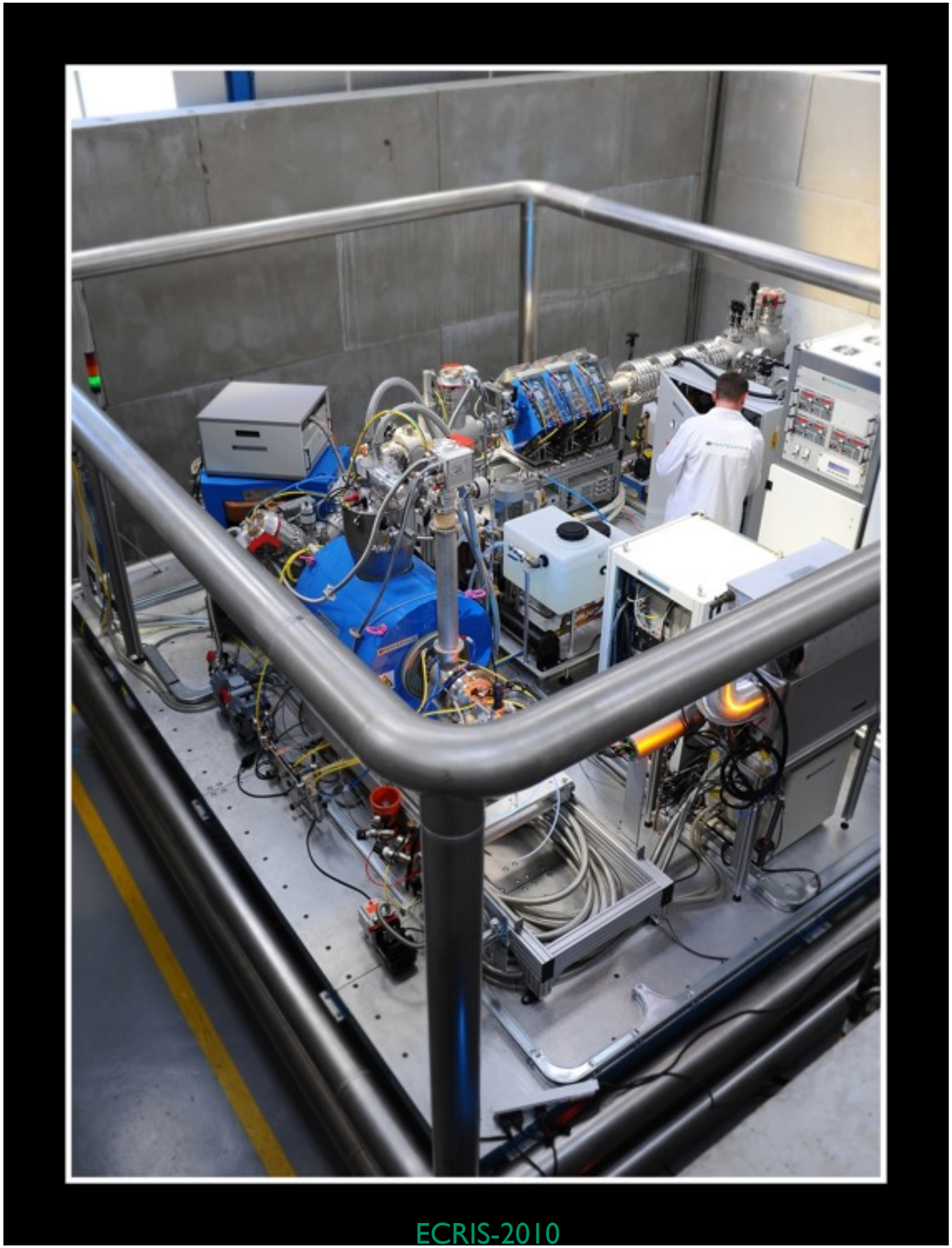


Antonio C.C.Villari

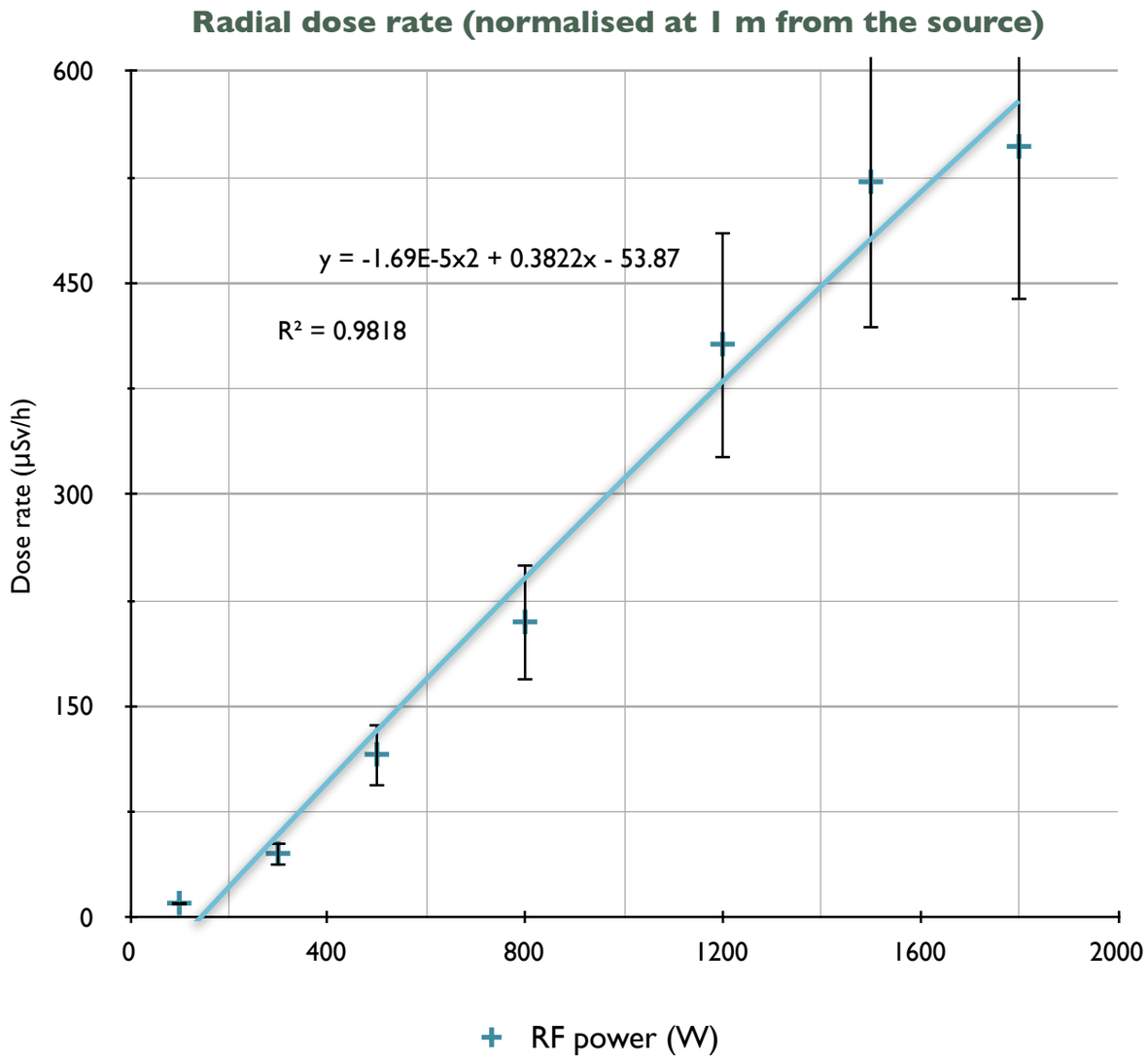
X-rays

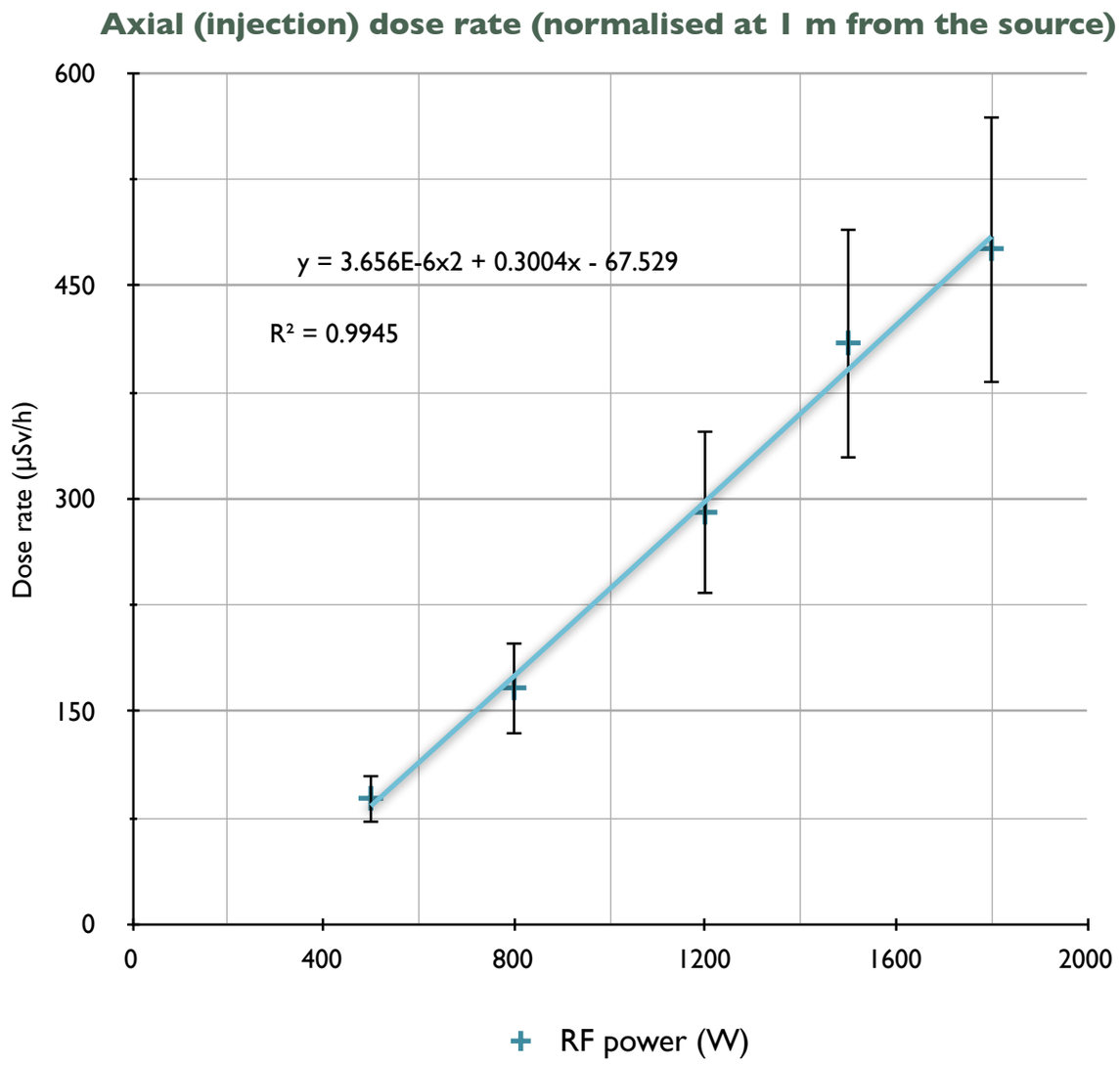
- The permanent magnet structure constitutes a "natural" shielding. The calculated power on the coils represent 0.15 W for full RF power.
- However, it was estimated that the X-rays dose rate created around PK-ISIS imposes special shielding.

PANTECHNIK



X-rays measurements





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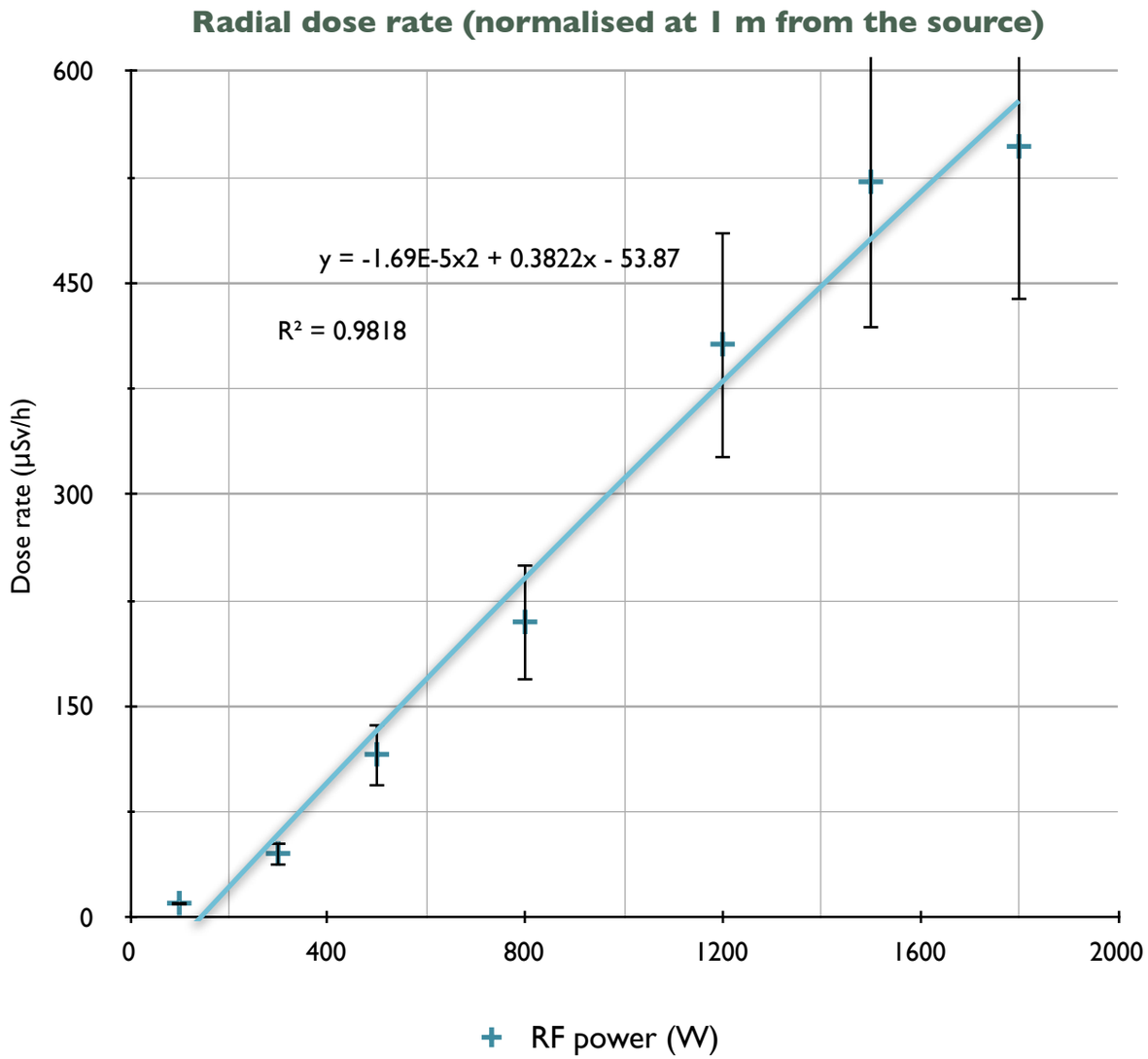
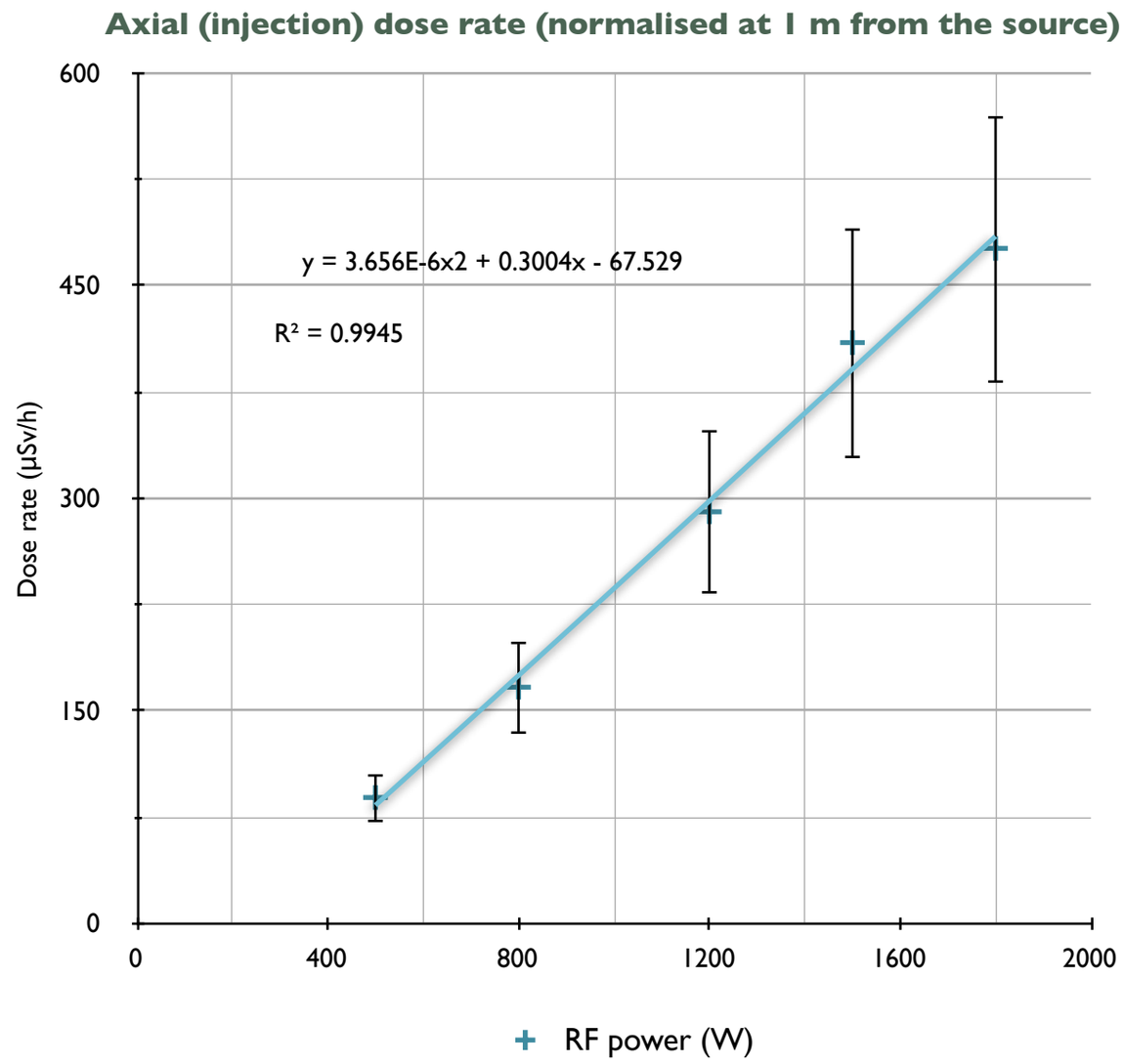
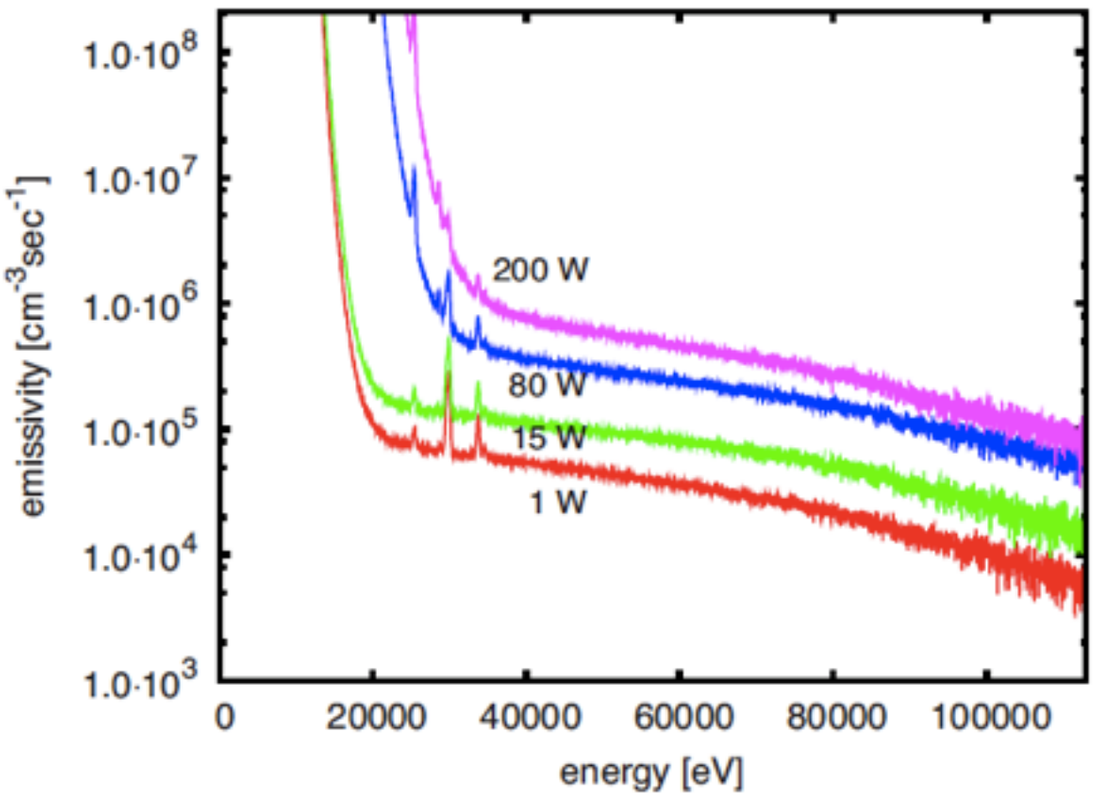


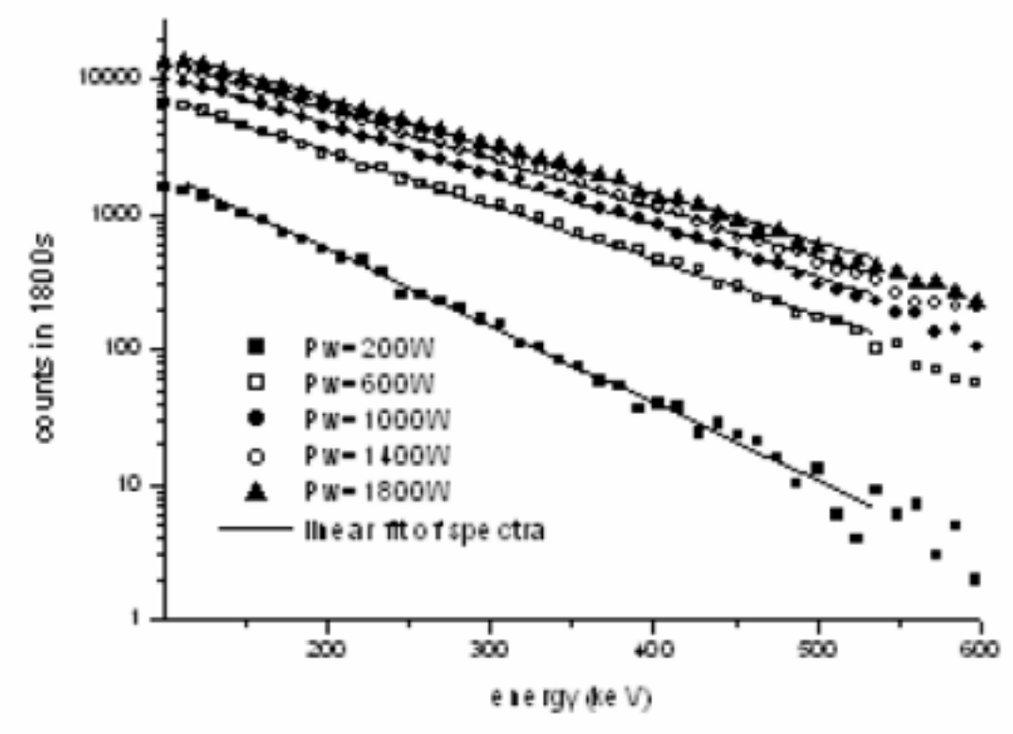


Outside the 400 mm concrete, the dose rate is < 0.5 µSv/h

Brehmsstrahlung



Supernanogan (14.5 GHz) X-rays
measured by
A. Gumberidze et al., RSI 81, 033303 (2010)



SECRAL (18.0 GHz) X-rays
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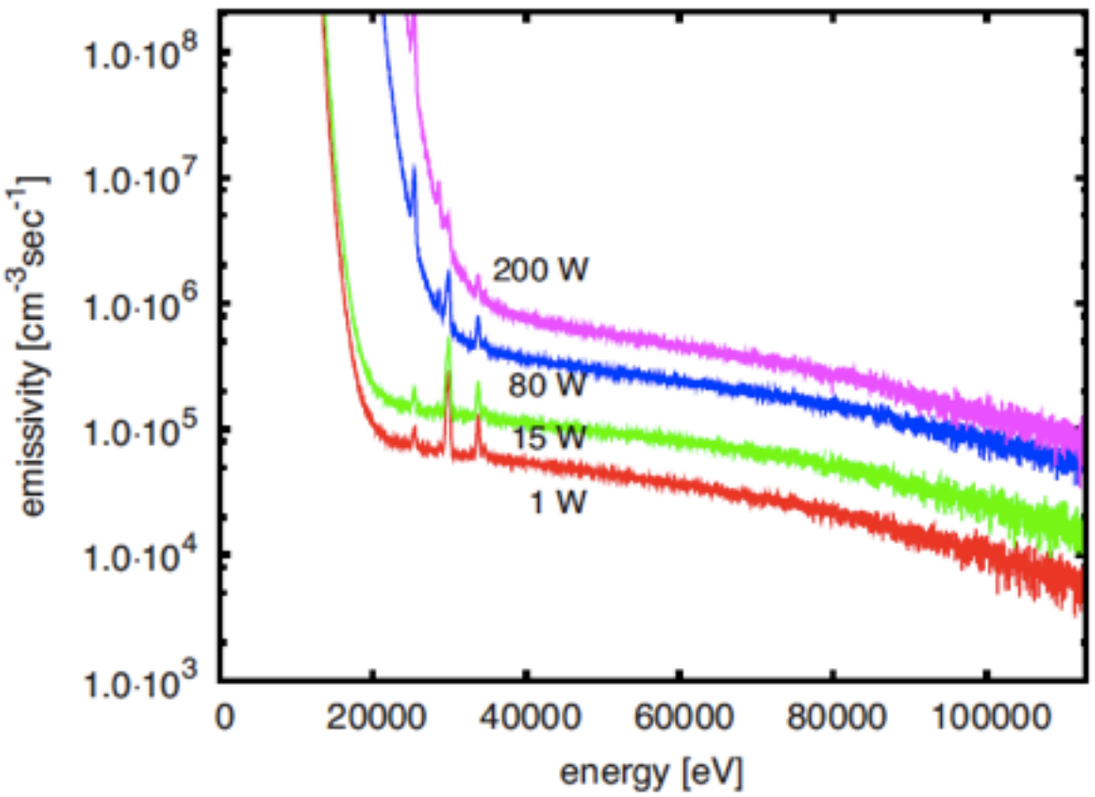
Huan-Yu Zhao et al., ECRIS 2006, Lanzhou - High Energy and Nuclear Physics - Chinese Edition

Brehmsstrahlung



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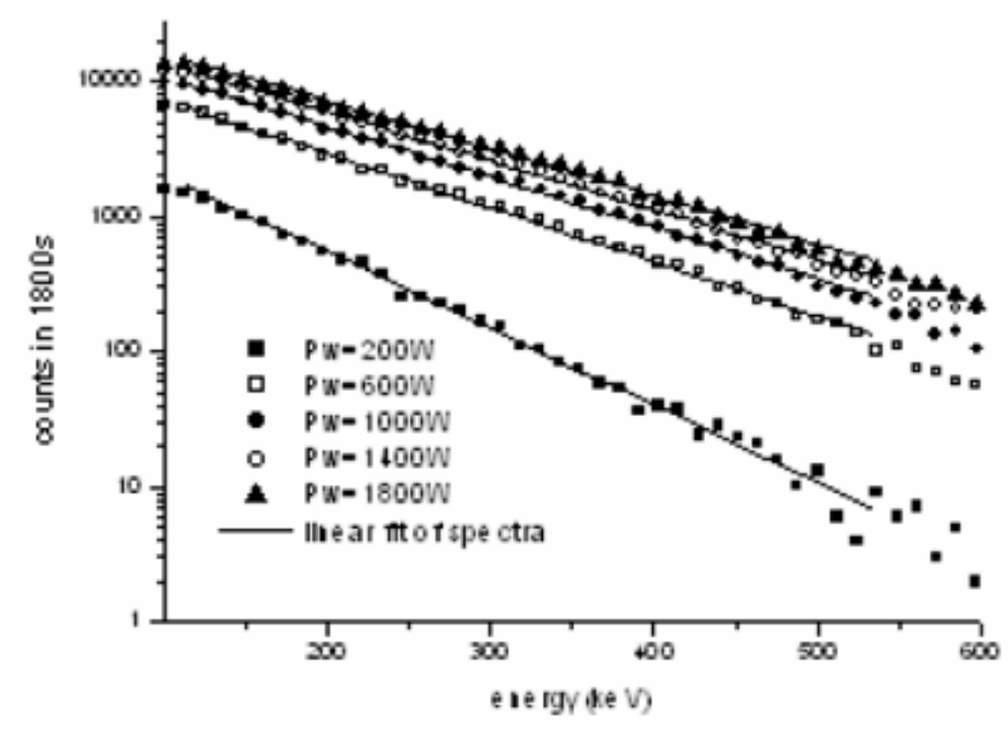

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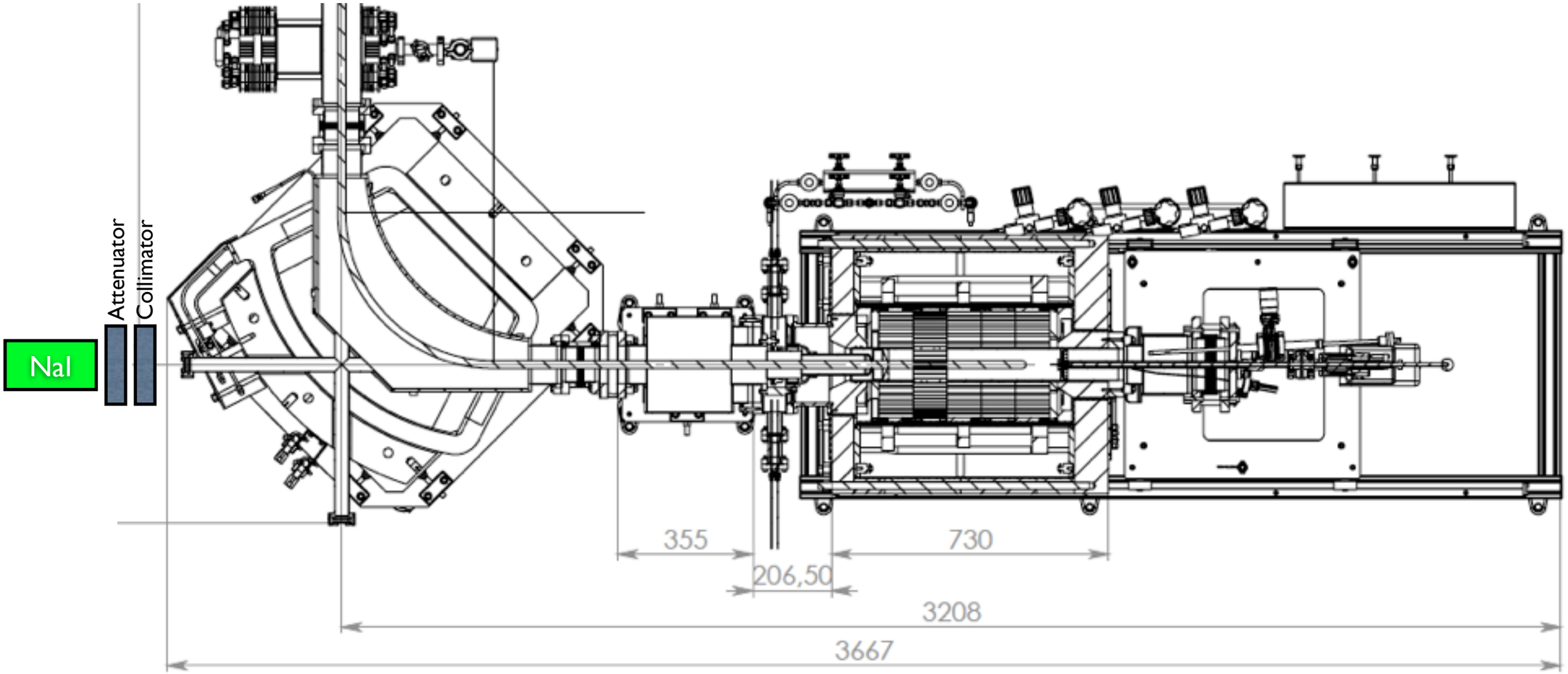
1st order approximation: $J(E) \propto \exp(-E/kTe)$

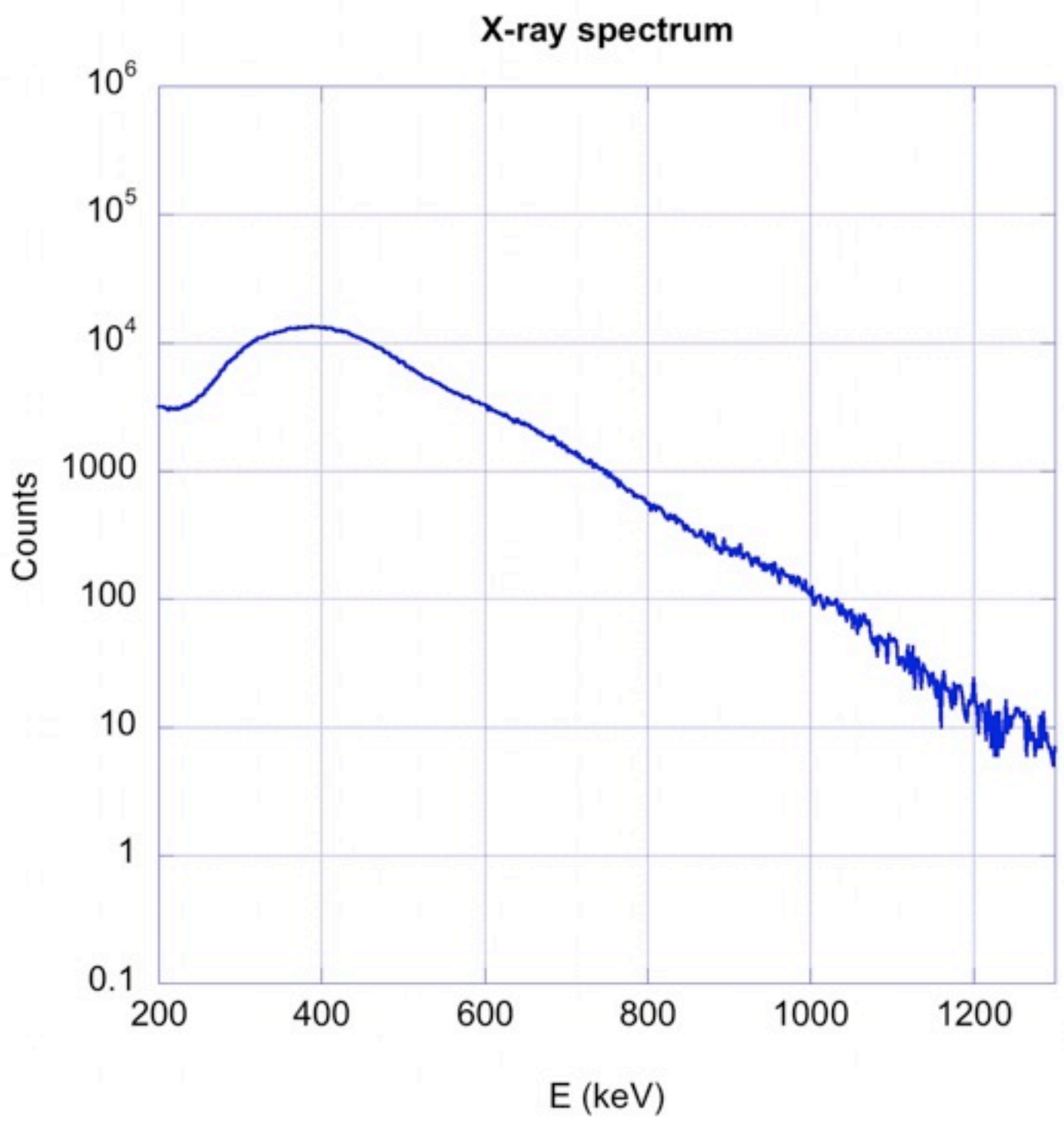
Measurement



PANTECHNIK

PRELIMINARY

Brehmsstrahlung



P = 1300 W
B inj = 1.85 T
B ext = 1.45 T

PANTECHNIK

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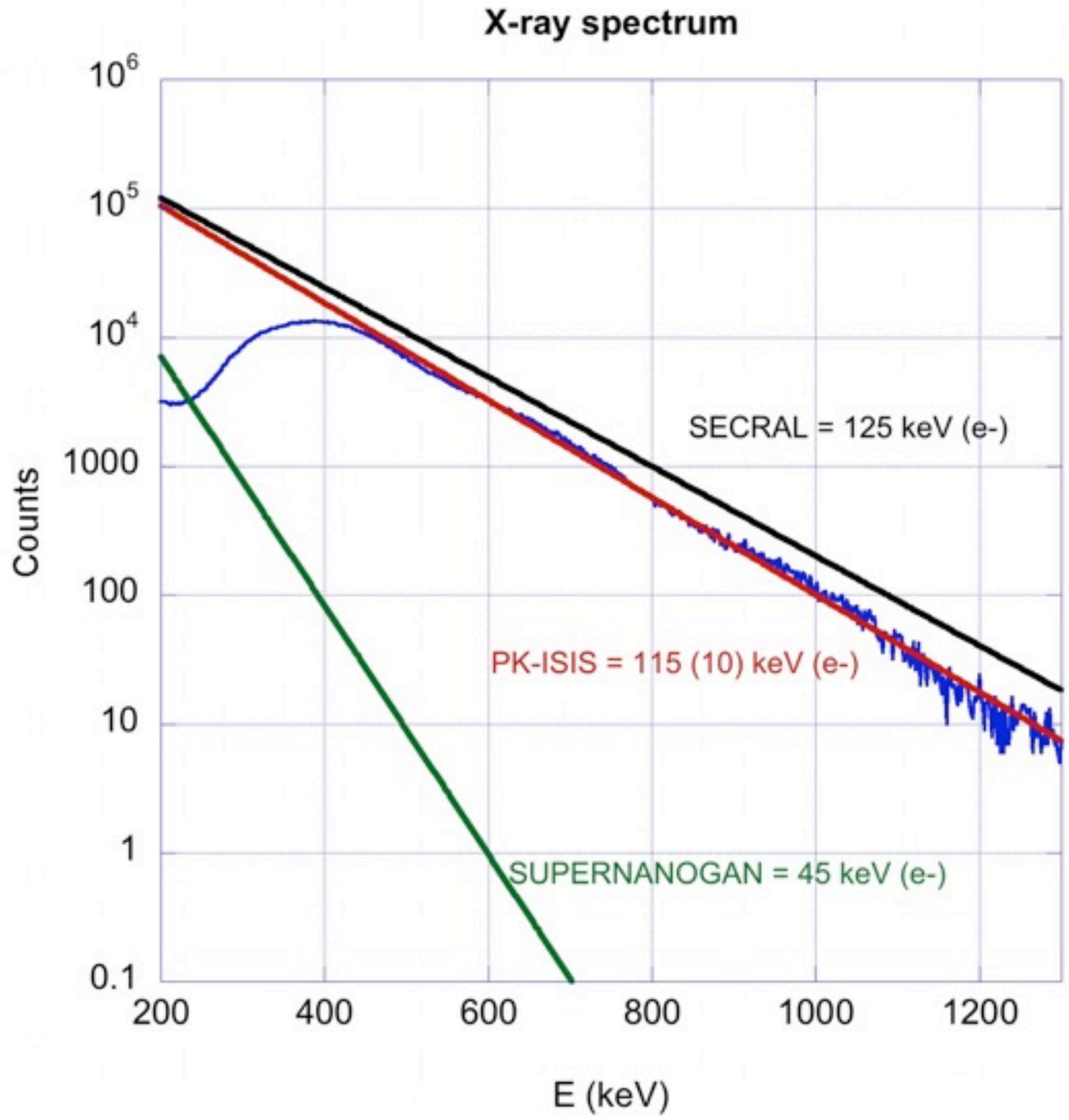

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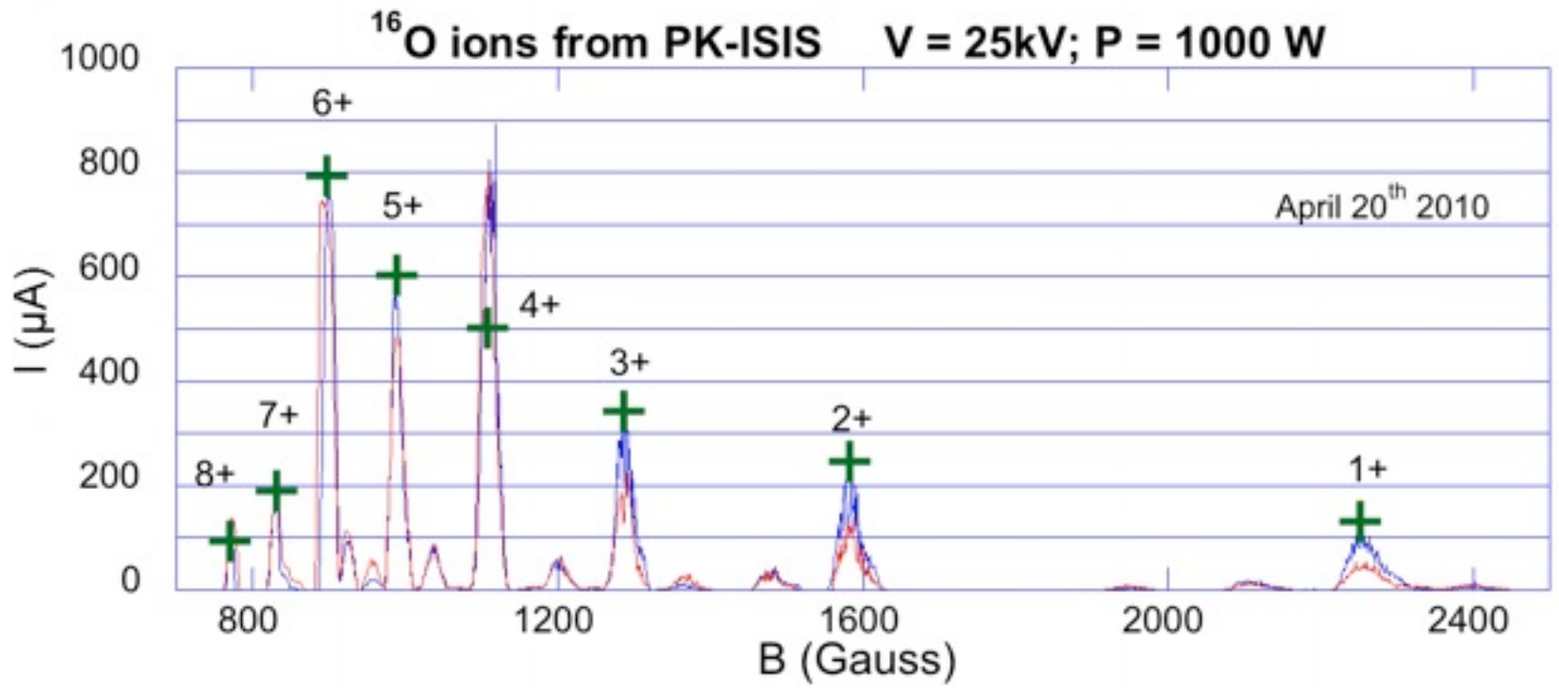
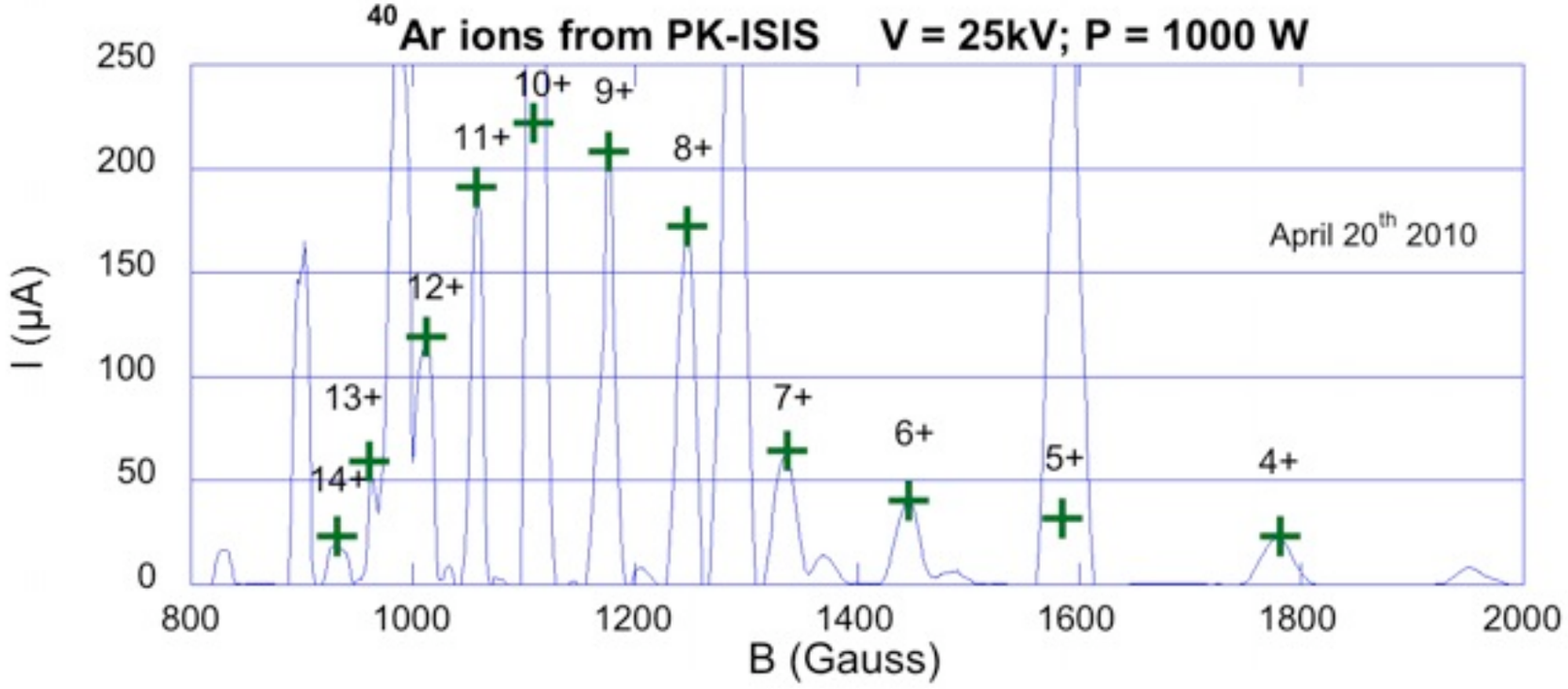
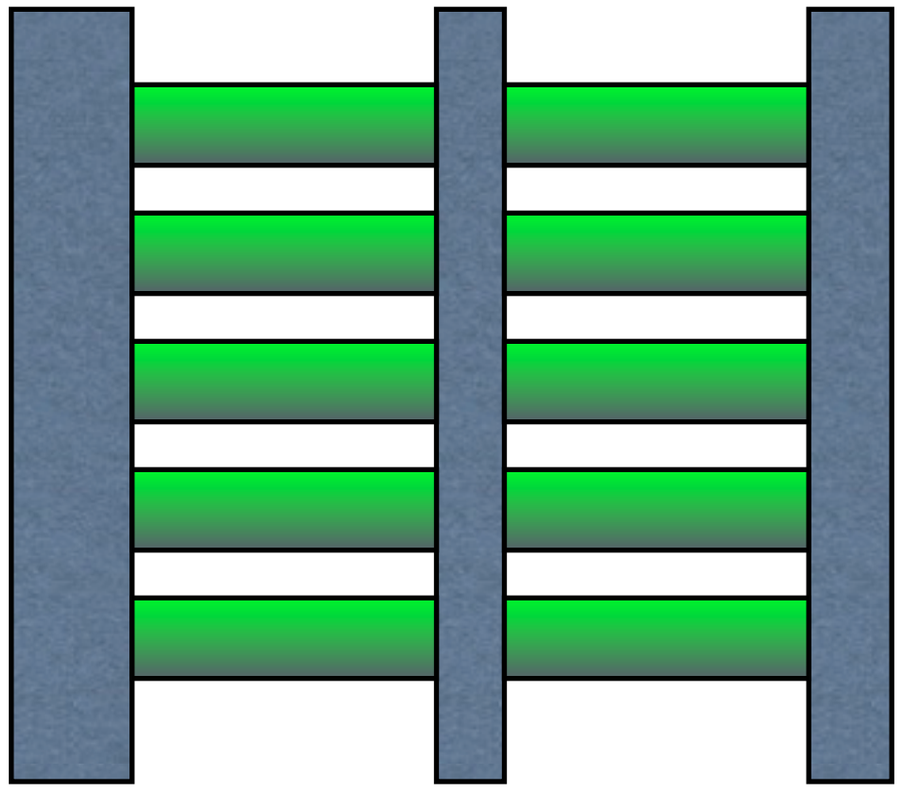
Ion source behavior





BUT, 2 accidents:

1- Missing O'ring
2- Disconnected strip after final coil trainning



As a consequence, Binj (max) = 1.85 T...

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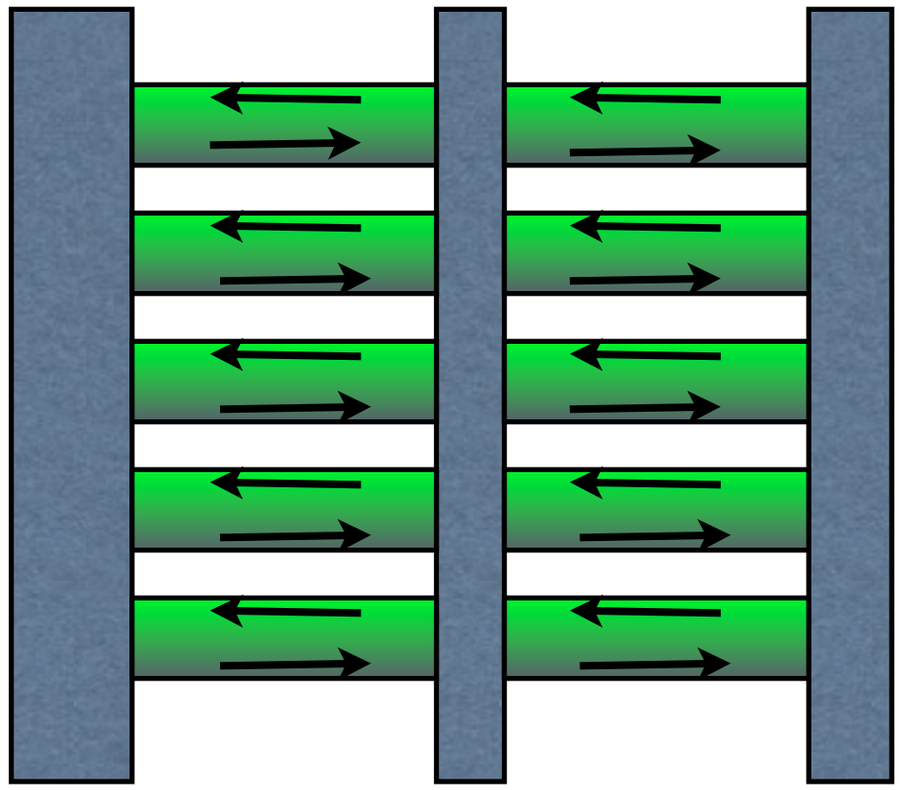

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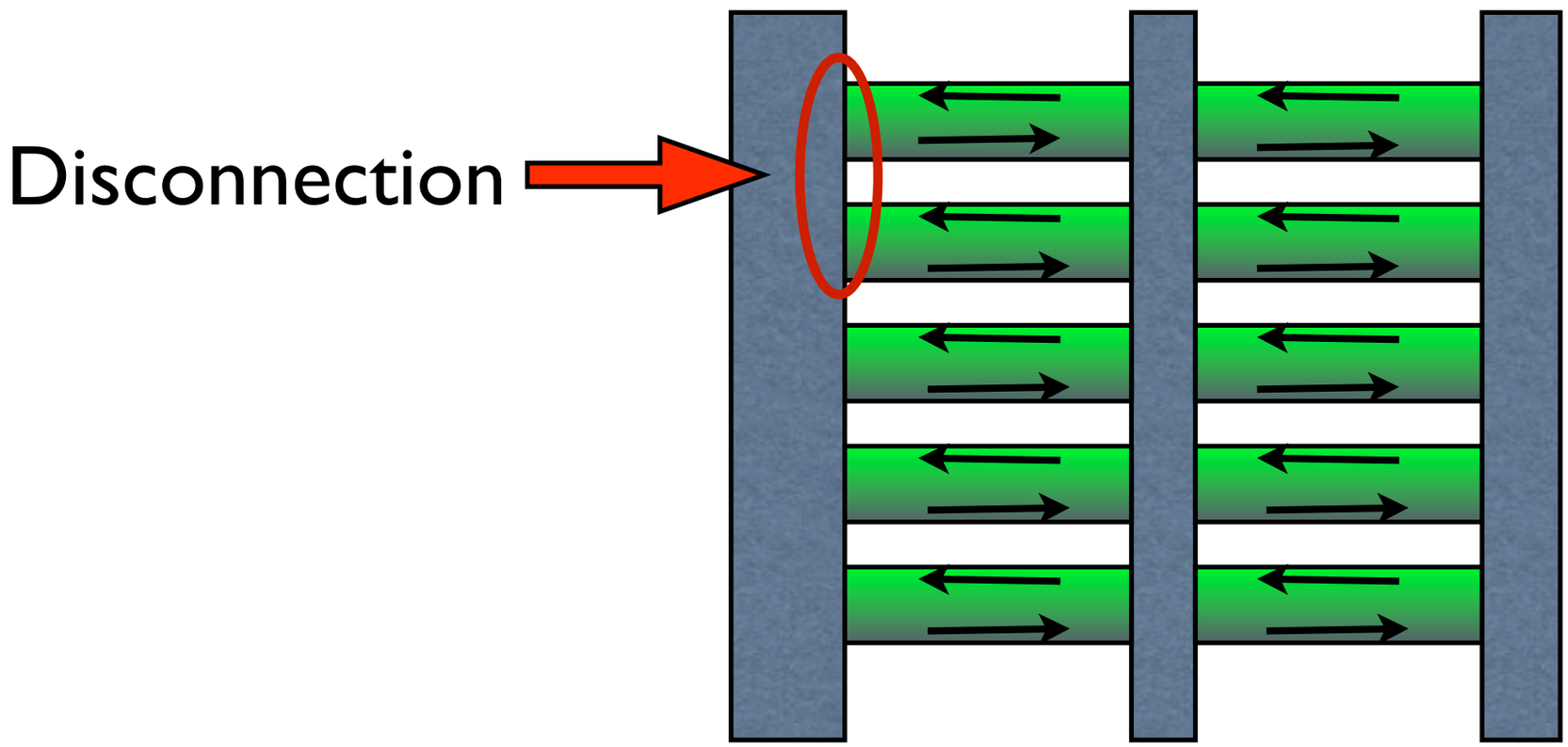

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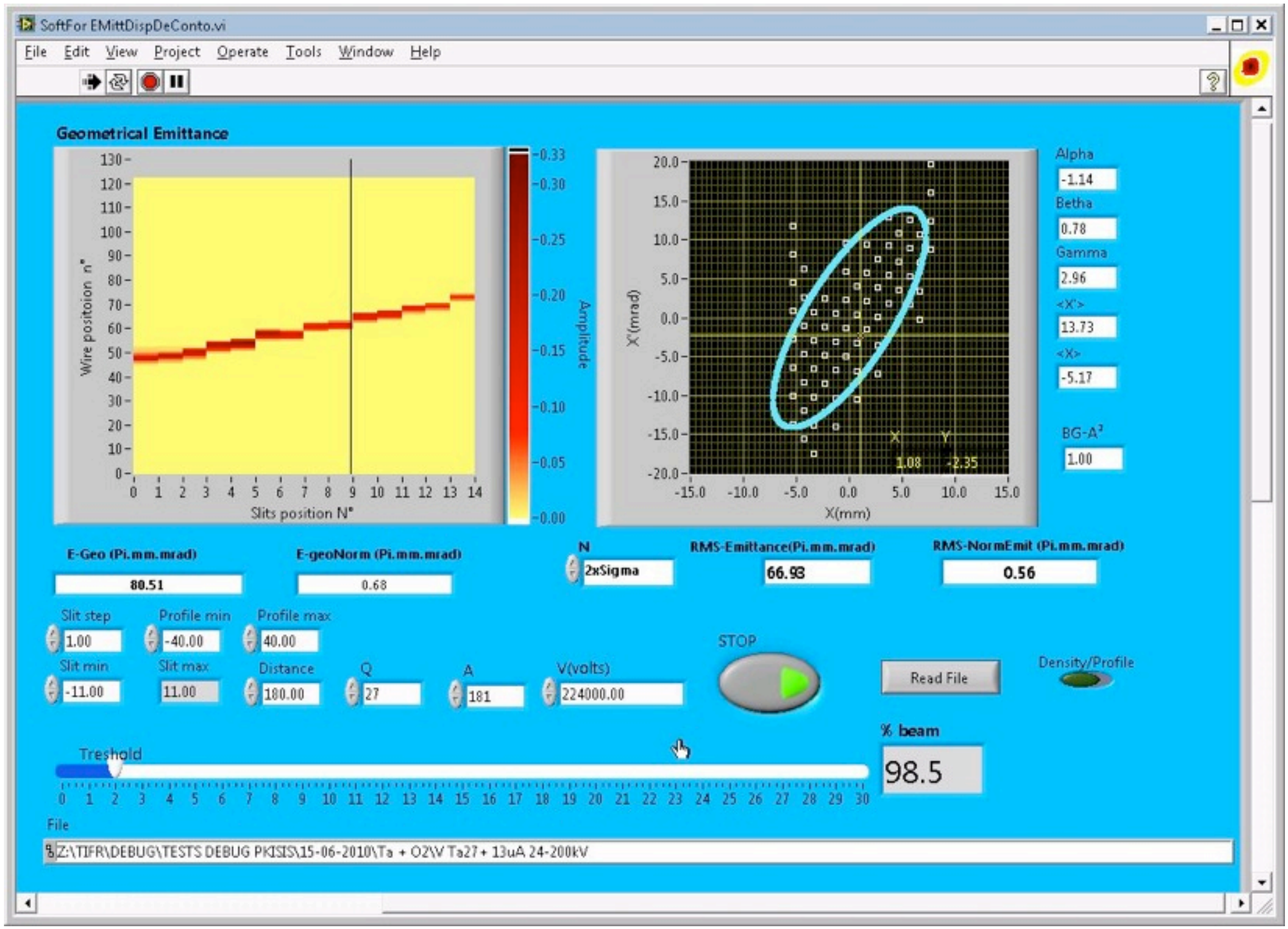
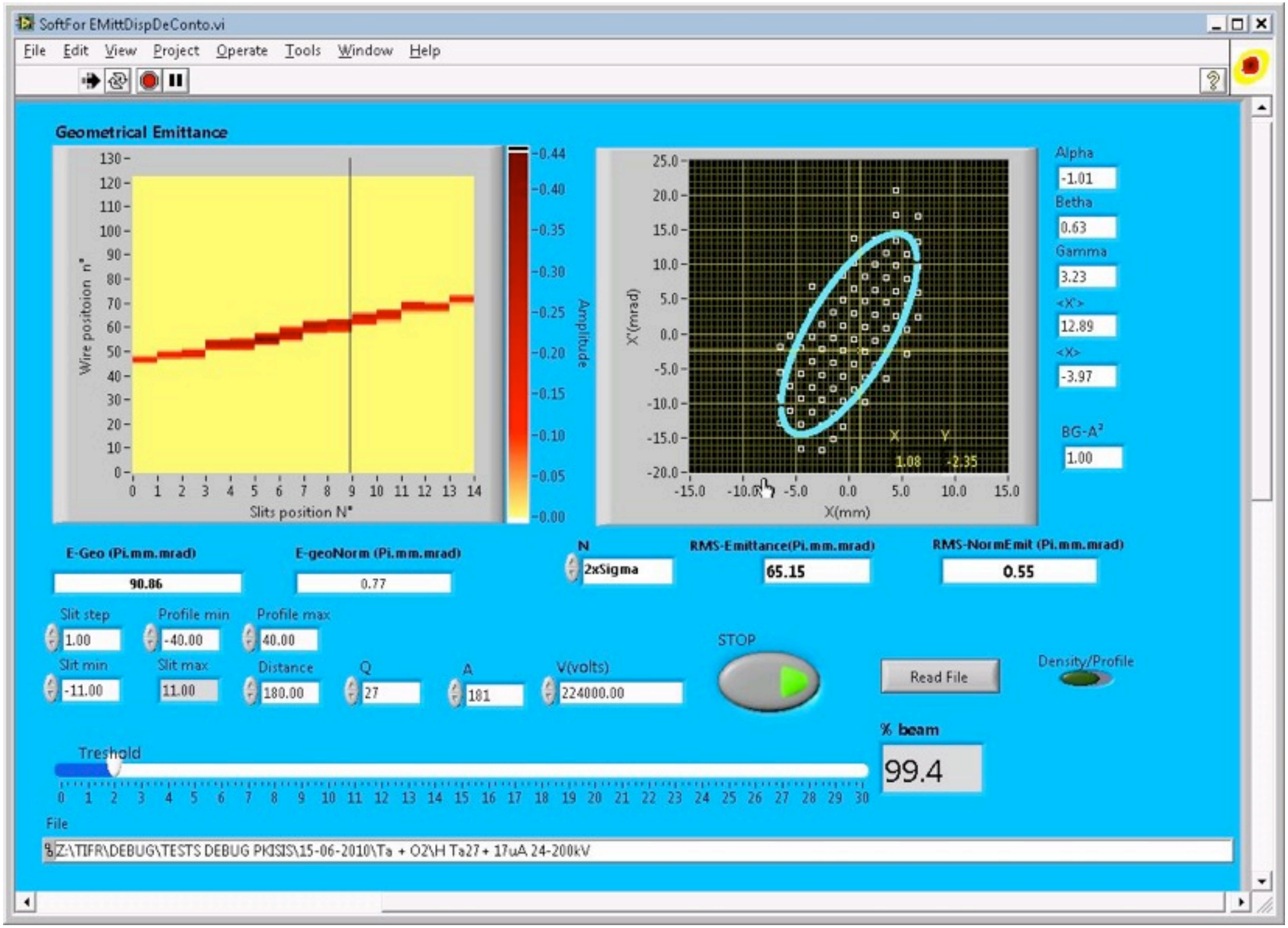
Results, so far

With B inj (max) = 1.85 T, Pmax = 1.4 kW

Ion	I (μA)
4He (2+)	2200
13C (6+)	45
16O (6+)	1100
16O (7+)	200
40Ar (12+)	150
40Ar (14+)	60
84Kr (17+)	85
129Xe (27+)	50
181Ta (30+)	13
208Pb (33+)	18


SoftFor EMittDispDeConto.vi
File Edit View Project Operate Tools Window Help
Geometrical Emittance
Wire positoion n°
Slits position N°
Amplitude
X'(mrad)
X(mm)
Alpha
-1.14
Betha
0.78
Gamma
2.96
<X'>
13.73
<X>
-5.17
BG-A²
1.00
E-Geo (Pi.mm.mrad)
80.51
E-geoNorm (Pi.mm.mrad)
0.68
N
2xSigma
RMS-Emittance(Pi.mm.mrad)
66.93
RMS-NormEmit (Pi.mm.mrad)
0.56
Slit step
1.00
Profile min
-40.00
Profile max
40.00
Slit min
-11.00
Slit max
11.00
Distance
180.00
Q
27
A
181
V(volts)
224000.00
STOP
Read File
Density/Profile
% beam
98.5
Treshold
File
Z:\TIFR\DEBUG\TESTS DEBUG PKISIS\15-06-2010\Ta + O2\V Ta27+ 13uA 24-200kV


SoftFor EMittDispDeConto.vi
File Edit View Project Operate Tools Window Help
Geometrical Emittance
Wire positoion n°
Slits position N°
Amplitude
X'(mrad)
X(mm)
1.08
-2.35
Alpha
-1.01
Betha
0.63
Gamma
3.23
<X'>
12.89
<X>
-3.97
BG-A²
1.00
E-Geo (Pi.mm.mrad)
90.86
E-geoNorm (Pi.mm.mrad)
0.77
N
2xSigma
RMS-Emittance(Pi.mm.mrad)
65.15
RMS-NormEmit (Pi.mm.mrad)
0.55
Slit step
1.00
Profile min
-40.00
Profile max
40.00
Slit min
-11.00
Slit max
11.00
Distance
180.00
Q
27
A
181
V(volts)
224000.00
STOP
Read File
Density/Profile
% beam
99.4
Treshold
File
Z:\TIFR\DEBUG\TESTS DEBUG PKISIS\15-06-2010\Ta + O2\H Ta27+ 17uA 24-200kV

Summary and to be done

- PK-ISIS is an easy-tuning source, powerful and with wide evolutive perspectives
- X-rays attest good confinement
- Intensities will improve with correction of cooling
- Check and eventually improve beam transport (65% measured - full extracted beam). 100% in the beam line.
- Cryostat is being repaired. The source will be re-tested in October during 3 weeks.
- Improvement of sputtering.
- Delivery

PANTECHNIK

Thank you