Design and simulation of Super Big Bite spectrometer magnet using MERMAID-3D

Stepan Mikhailov
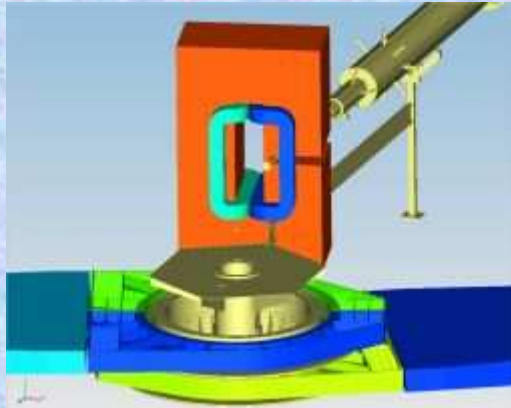
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(**Jefferson Lab, Newport News, USA**)

SuperBigBite exterimental program

• **http://hallaweb.jlab.org/12GeV/SuperBigBite/**

Experiment E02-013, approved by PAC21, will measure the neutron electric form factor at Q^2 up to 3.4 $(GeV/c)^2$, which is twice that achieved to date. The main features of the new experiment will be the use of the electron spectrometer BigBite, a large array of neutron detectors, and a polarized $^3\vec{He}$ target. We present the parameters and optimization of the experimental setup. A concept of an experiment for G_E^n where precision G_E^p data is used for calibration of the systematics of a Rosenbluth type measurement is also discussed.

1. Introduction

Elastic electron scattering, which in the one-photon approximation is characterized by two form factors, is the simplest exclusive reaction on the nucleon. It provides important ingredients to our knowledge of nucleon structure. There are well-founded predictions of pQCD for the Q^2 dependence of the form factors and their ratio in the limit of large momentum transfer [1]. Predictions of a fundamental theory always attract substantial attention from experimentalists. Recent surprising results on G_E^p show that the ratio G_E^p/G_M^p declines sharply as Q^2 increases, and therefore pQCD is not applicable up to 10 $(GeV/c)^2$. According to [2,3] the electric and magnetic form factors behave differently, starting at $Q^2 \approx 1$ $(GeV/c)^2$. The same mechanisms causing this deviation should also be present in the neutron. It is an intriguing question, how the ratio G_E^n/G_M^n develops in this Q^2 regime, where confinement plays an important role.

• **A vigorous nuclear physics experimental program**

• **QCD is challenged**

Stepan Mikhailov
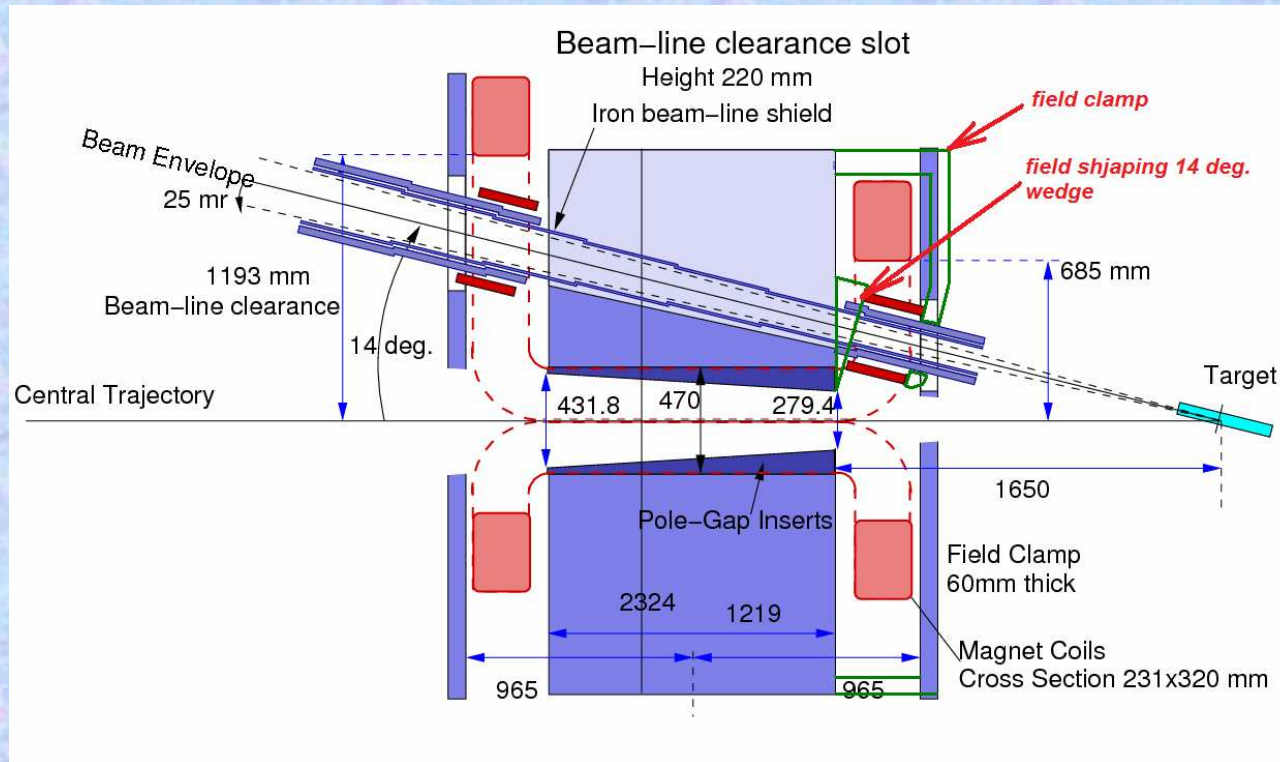**May 6, 2009**

SBS Layout
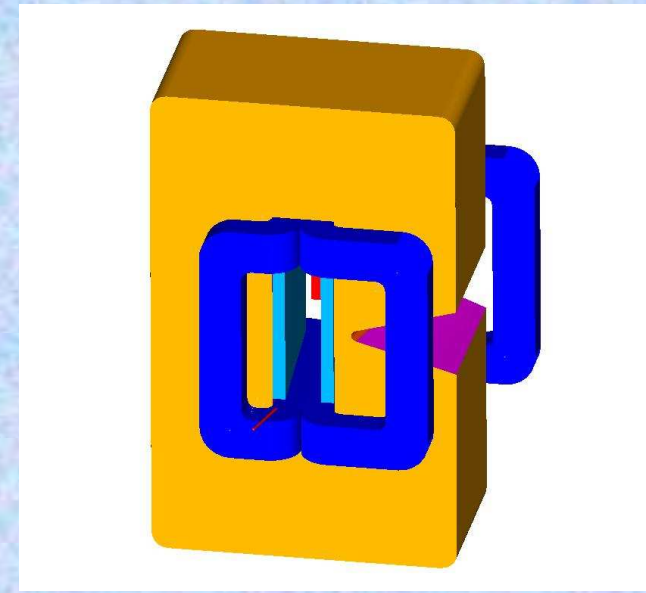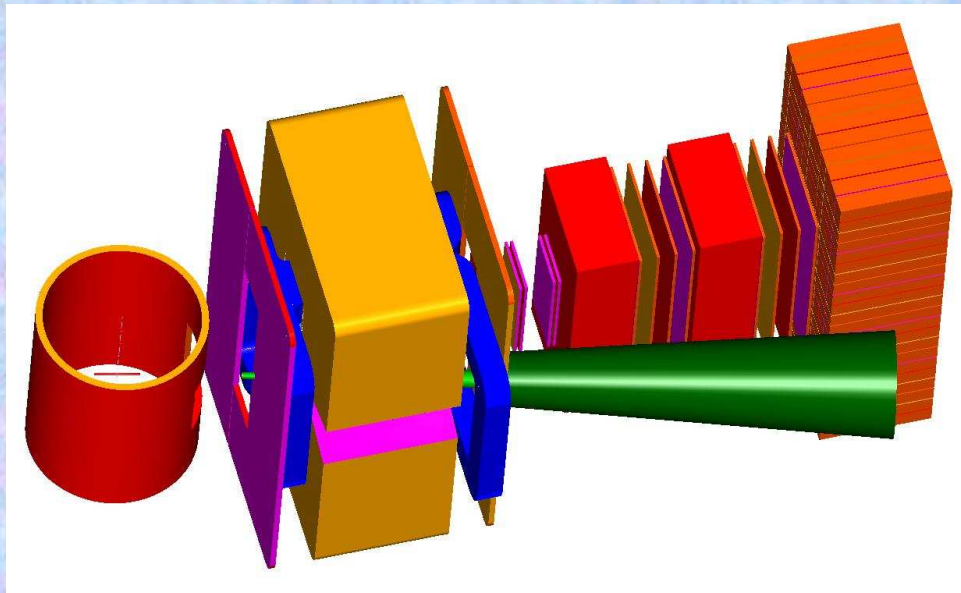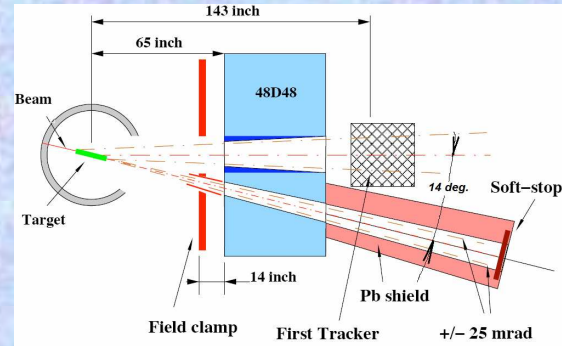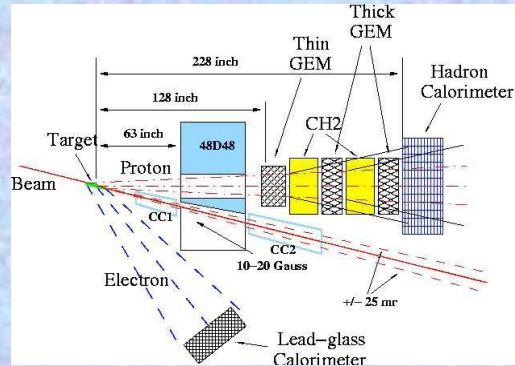
The 48D48 magnet at BNL

- The main component of SBS is the 48D48 dipole, which was previously used at Brookhaven's AGS accelerator 100 tons, 18.5" x 48" x 48" field volume
- No stray field allowed: both the target and the outgoing beamline are supposed to be shielded from the SBS fields

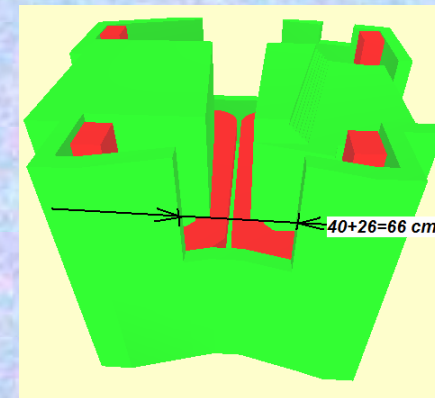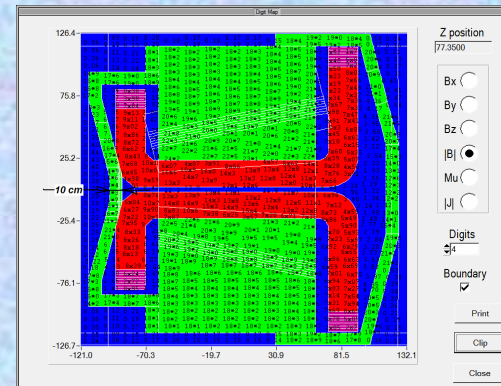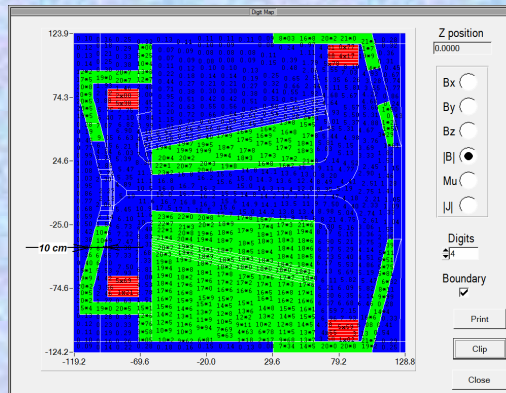# Proposed SBS front concept solution

- The field integral along the central trajectory : > 2.0 T*m (2.0-3.0)

- The filed transversal to the beam line (14 ° line) B_t should be as low as possible to eliminate the backbround

Design iterations….

- **encapsulated field concept:**

A:

The field clamps and flux return are saturated…

B:
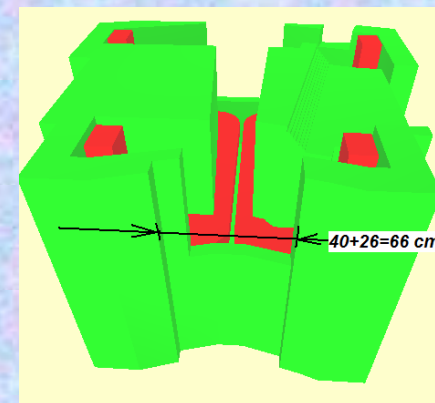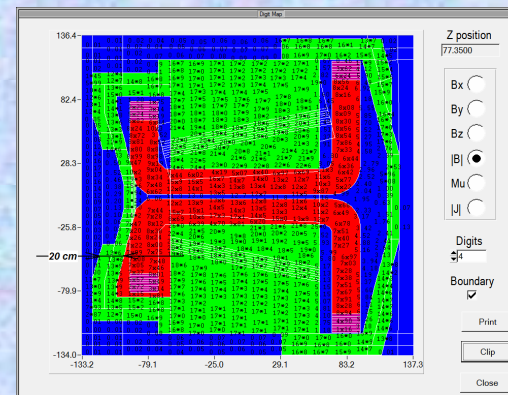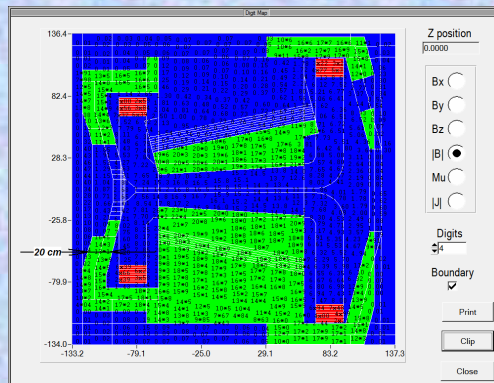
The field clamps and flux return are saturated…

Design iterations….

- **open clamp concept:**

C00:
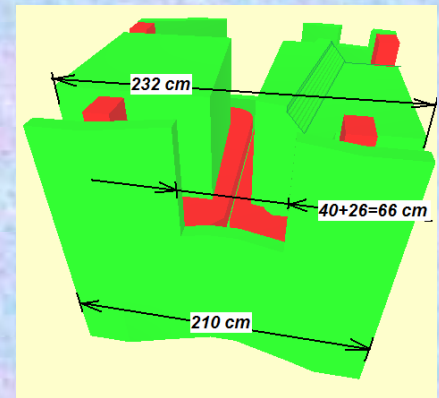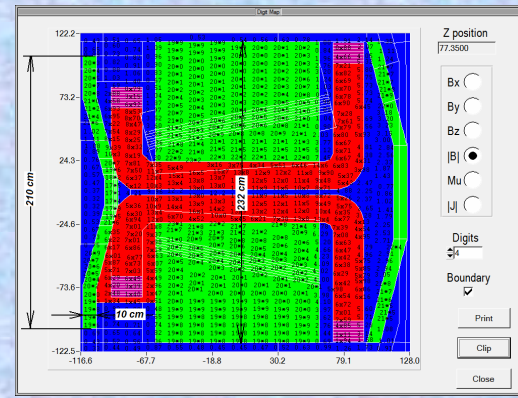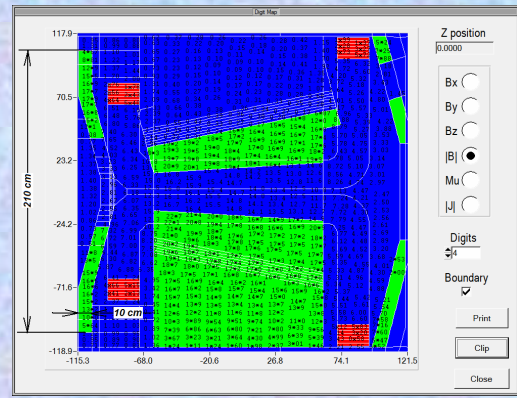
The field clamps and flux return are still saturated…

C03:
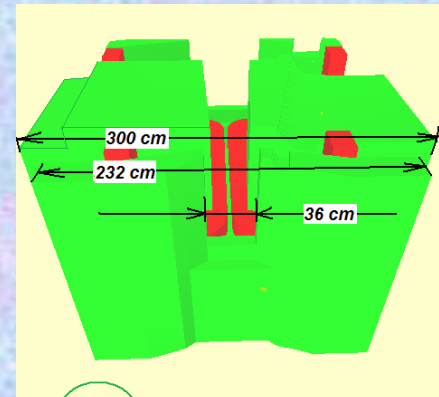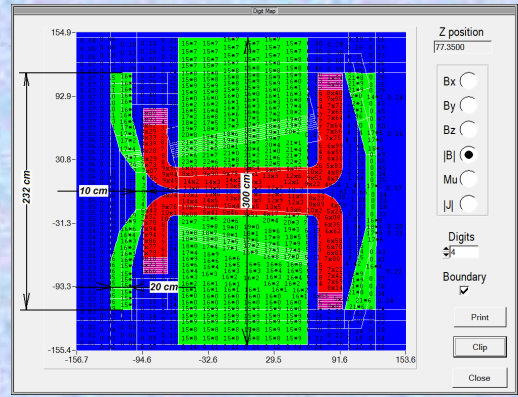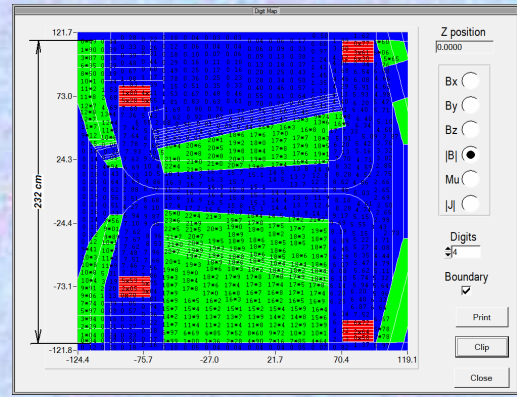
The field clamps and flux return are not saturated
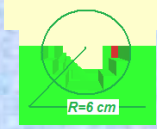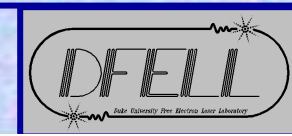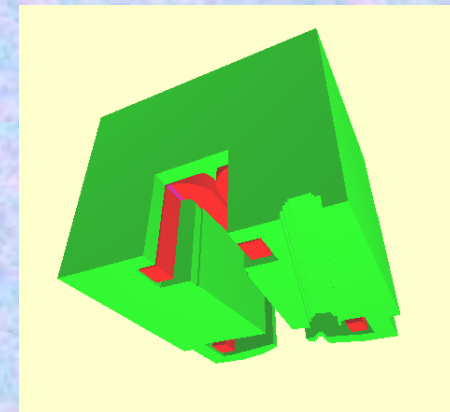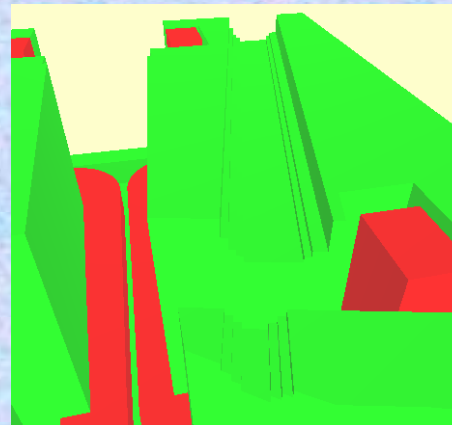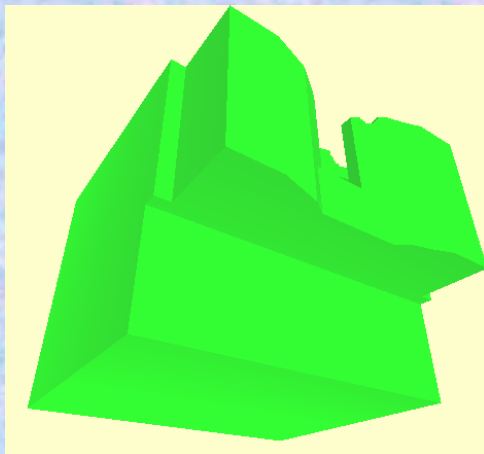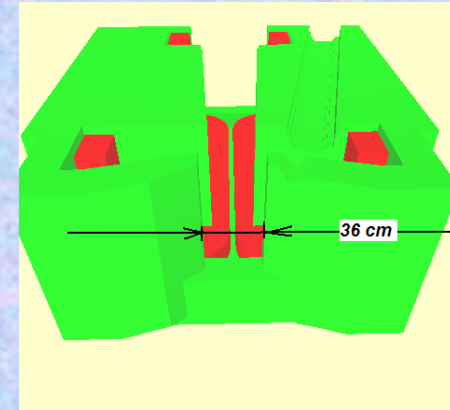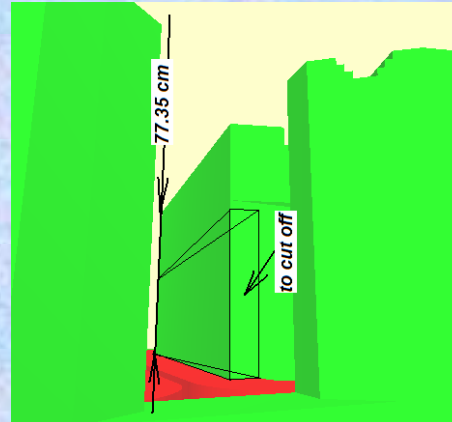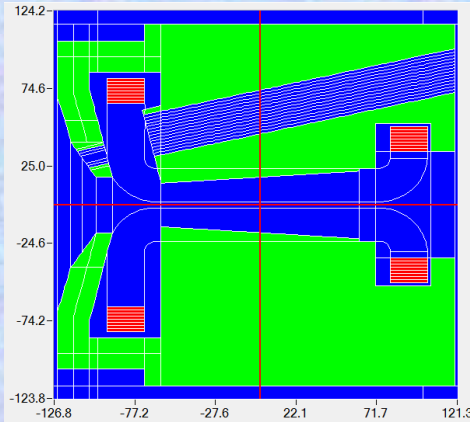
Entrance hole

Design iterations….

- **back to the encapsulated concept :**

D00:

The field clamps and flux return are not saturated

Entrance hole
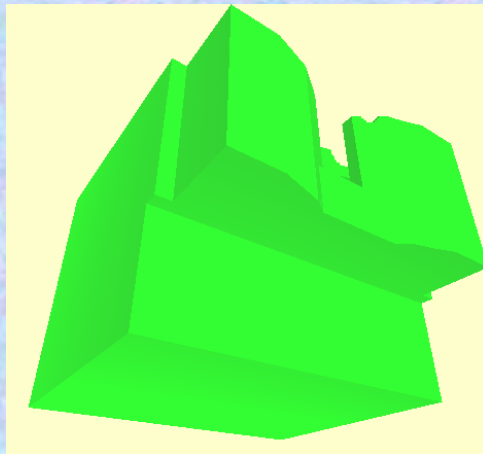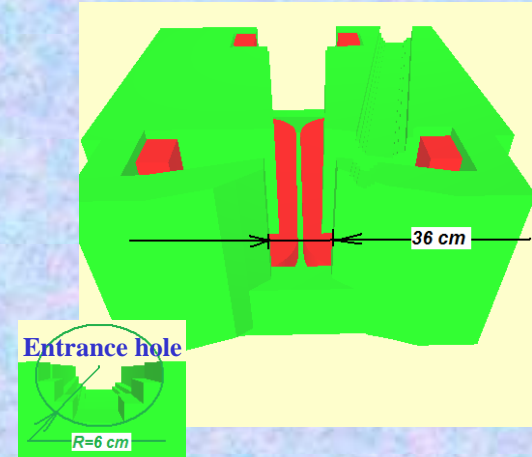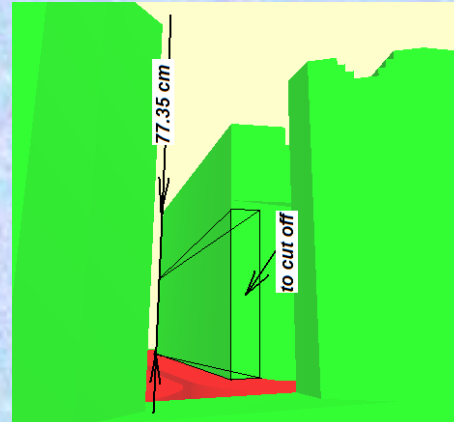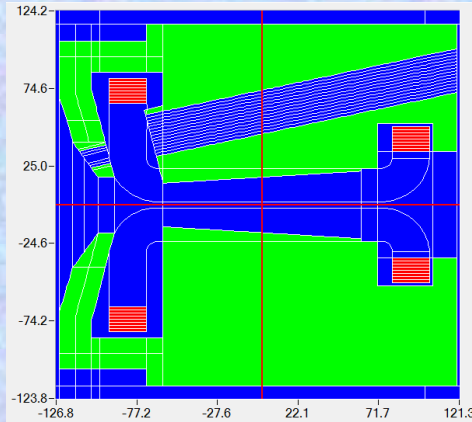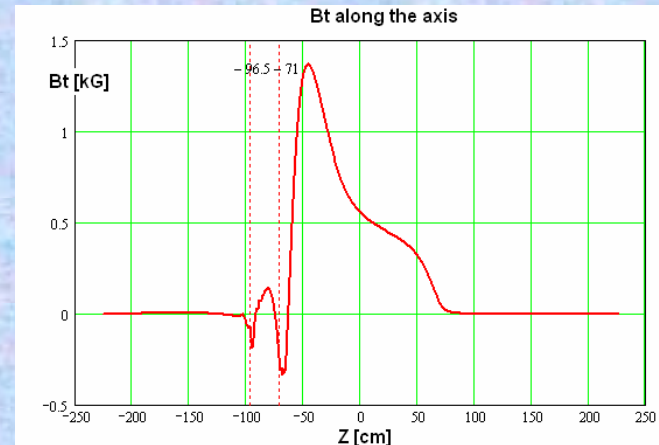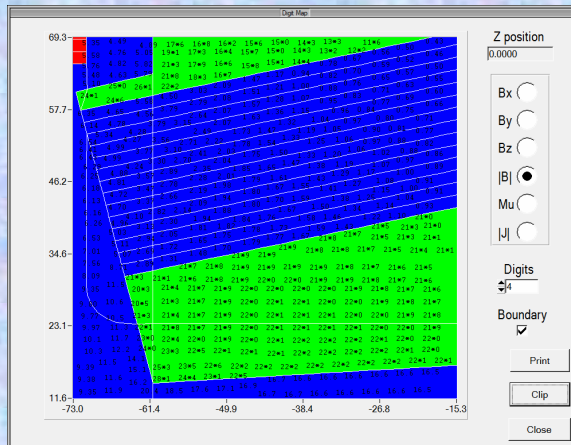
Design iterations….

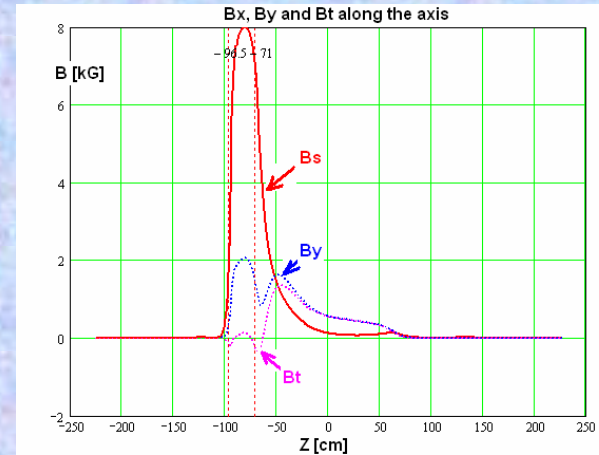- **back to the encapsulated concept :**

D00:

77.35 cm

to cut off

Entrance hole

R=6 cm

36 cm

The field clamps and flux return are not saturated
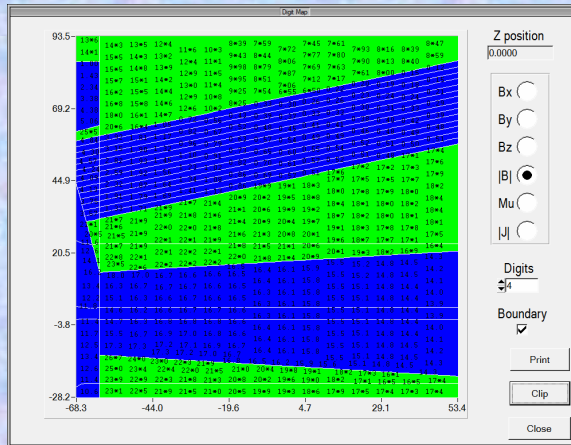
Exit hole

Design iterations….

- **back to the encapsulated concept :**

D00:

B_t field at the entrance to the beam opening is ~1.5 kG – too much!

And inside the opening (the beam hole) - ~0.5 kG – way too much!

Stepan Mikhailov
May 6, 2009
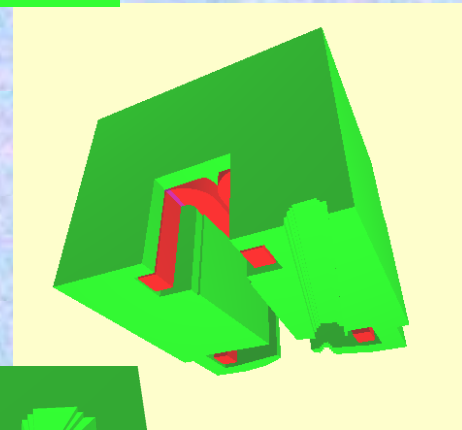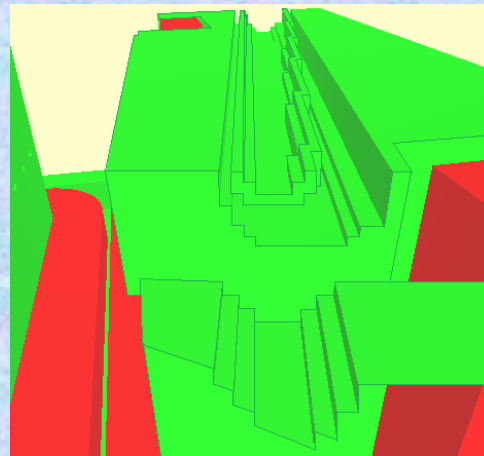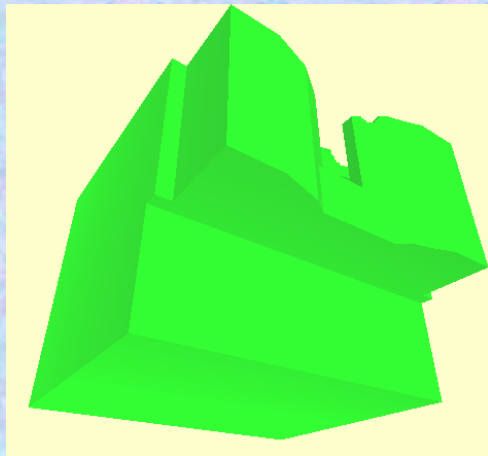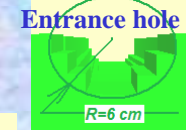
Magnet design workshop at PAC 2009

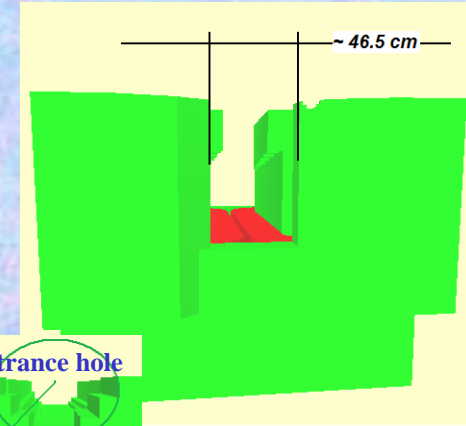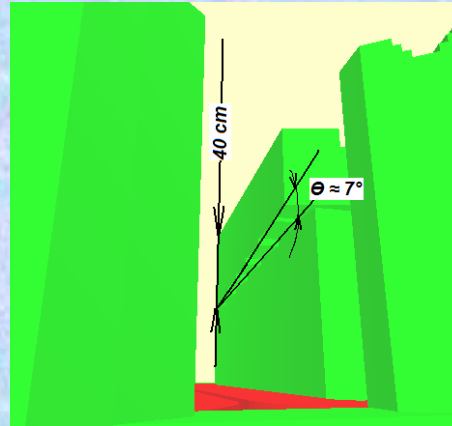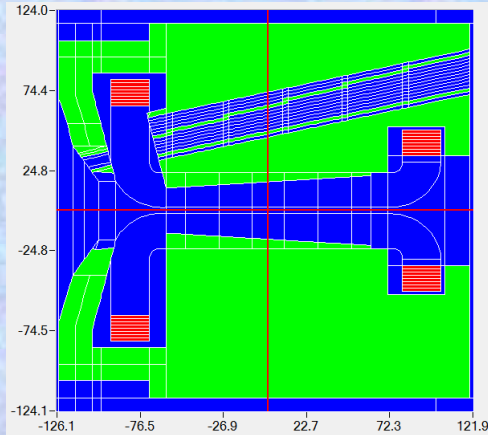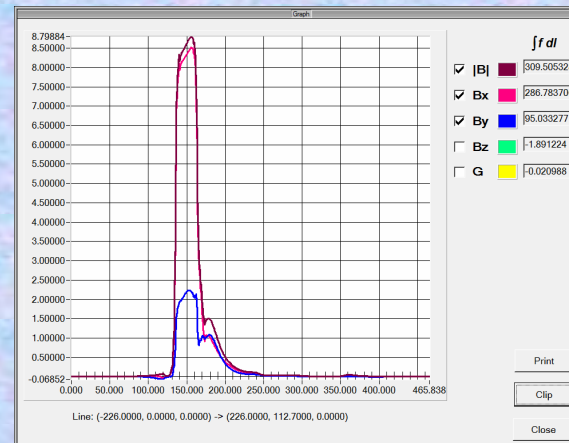# Design iterations….

- **back to the encapsulated concept :**

D04:

The field clamps and flux return are not saturated

Entrance hole

R=6 cm

Exit hole

~46.5 cm

40 cm

θ ≈ 7°

Design iterations….

- **back to the encapsulated concept :**
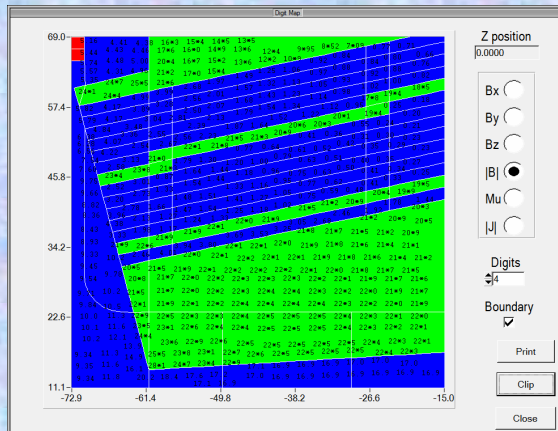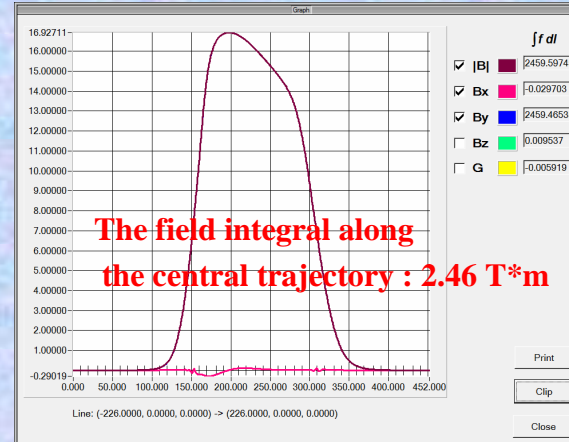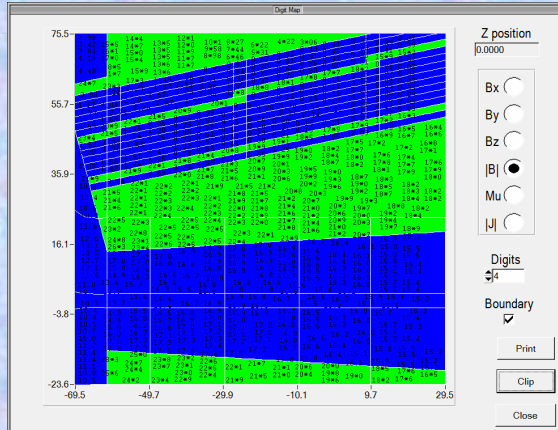
D04:

The field integral along
the central trajectory : 2.46 T*m

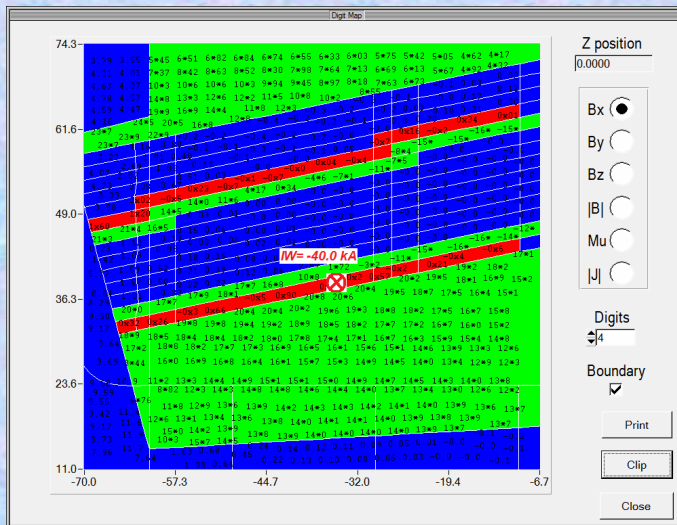B_t **field at the entrance to the beam opening is ~2.0 kG – way too much!**

Design iterations….

- **encapsulated concept : D73_40:**

Bt **field at the entrance to the beam opening is ~0.25 kG**
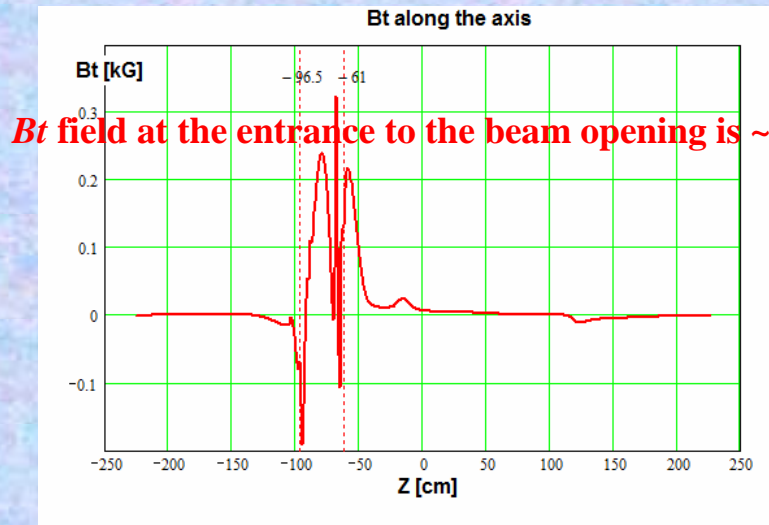
Design iterations....

- **encapsulated concept :** **D83_00_05&35:**

Exit pipe

36.0 cm

Entrance hole

R=6 cm

Bt **field at the entrance to the beam opening is ~0.25 kG**

Bt along the axis

Design iterations….

- **encapsulated concept : D83_NN_NN&NN:**
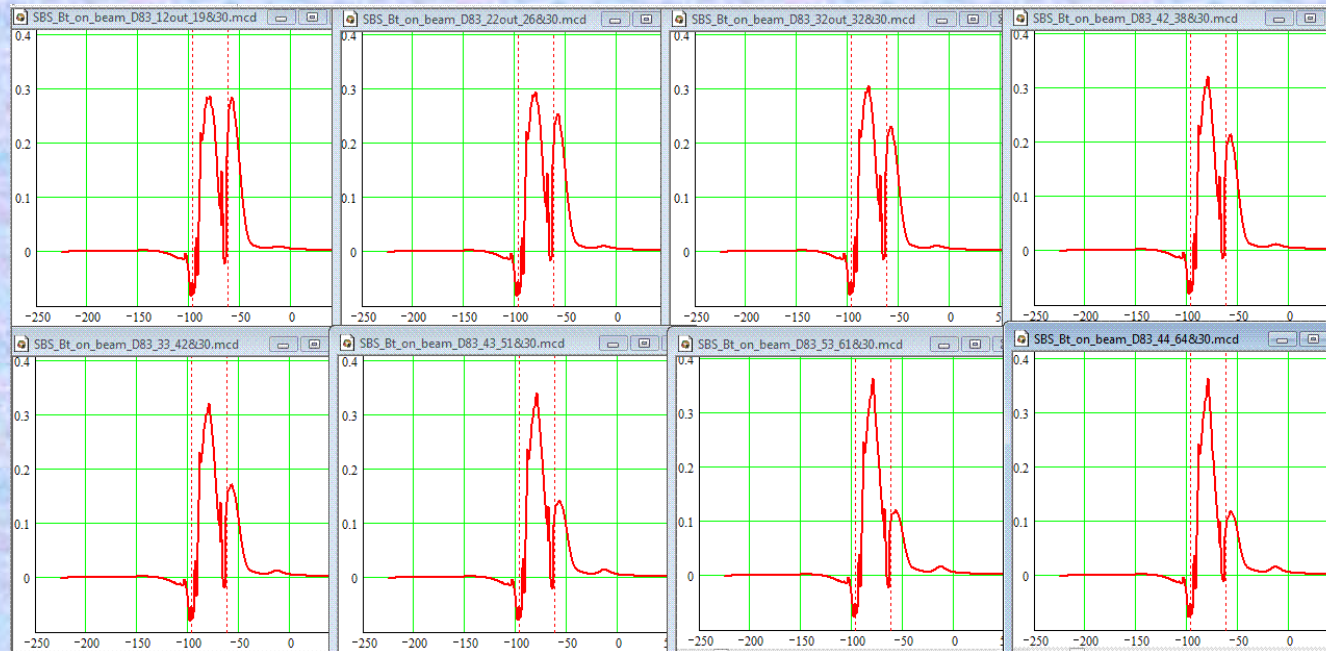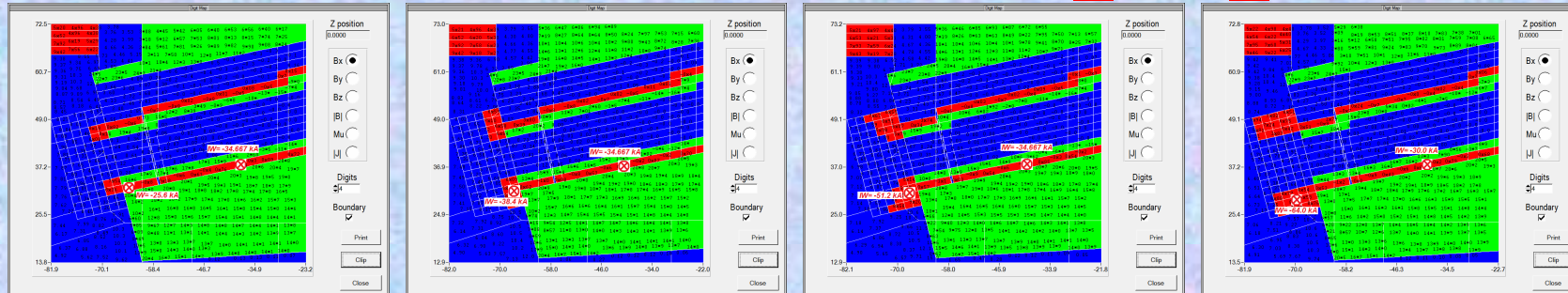
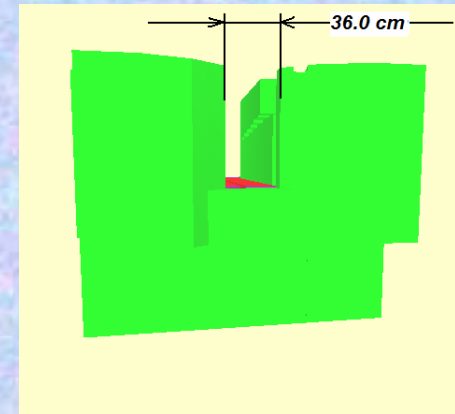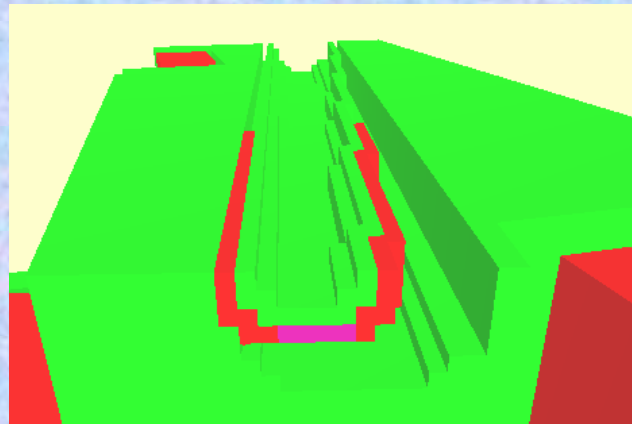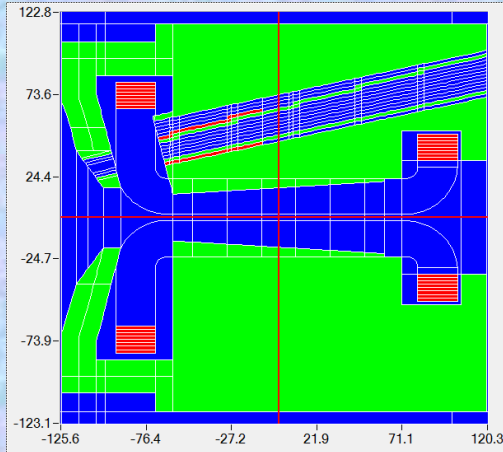*Bt* **field at the entrance to the beam opening is ~0.2-0.35 kG**

Stepan Mikhailov
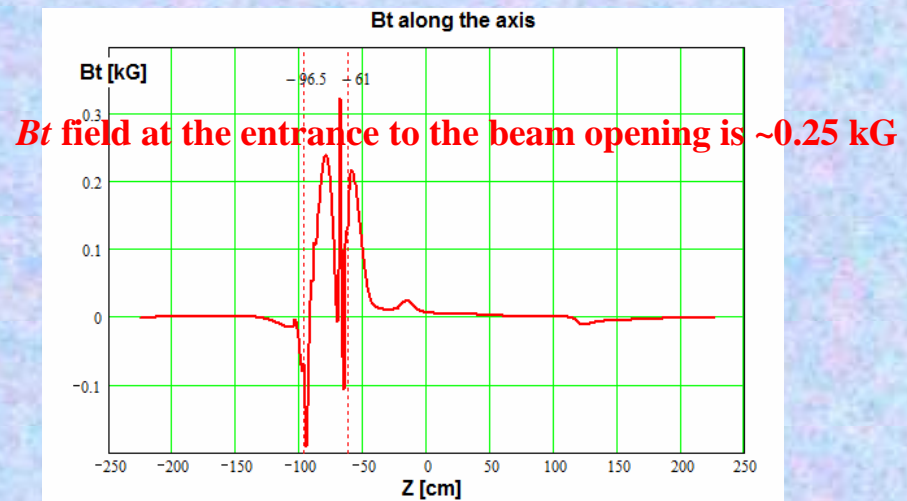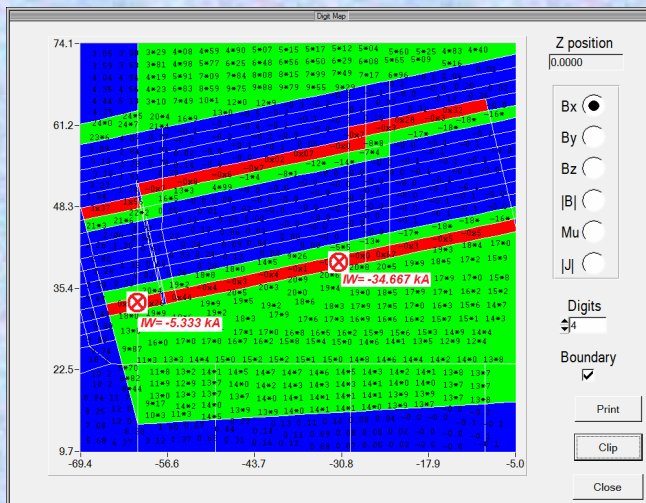**May 6, 2009**

Magnet design workshop at PAC 2009

Design iterations….

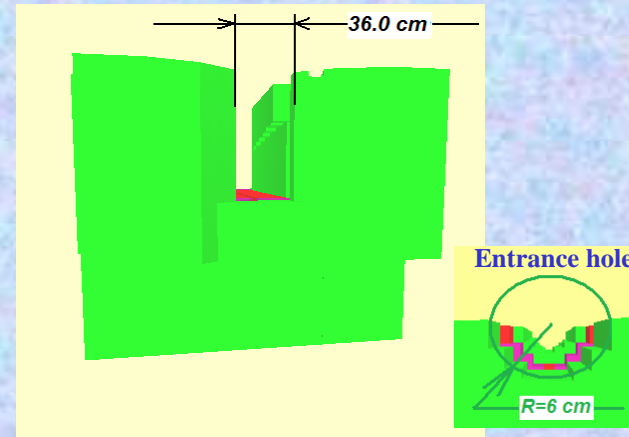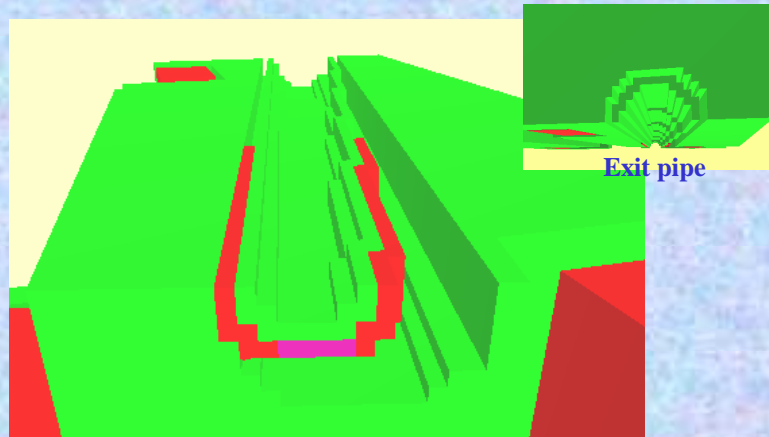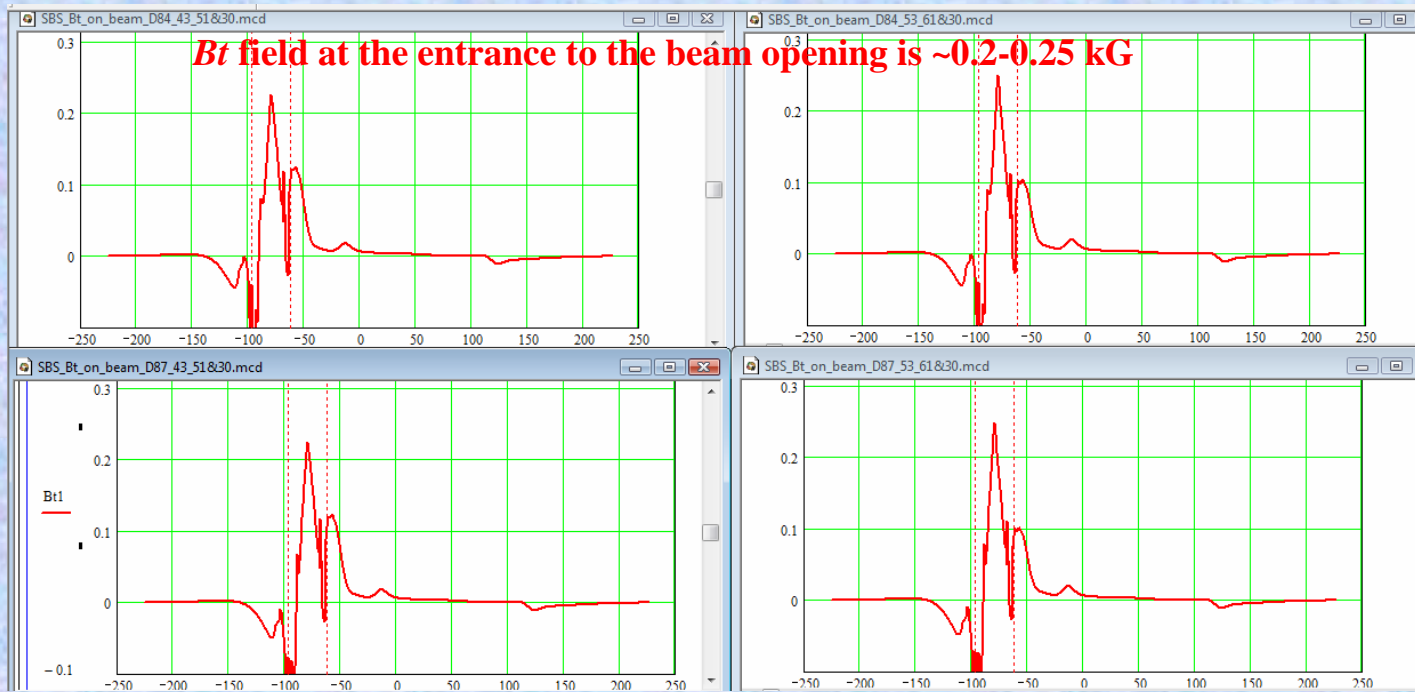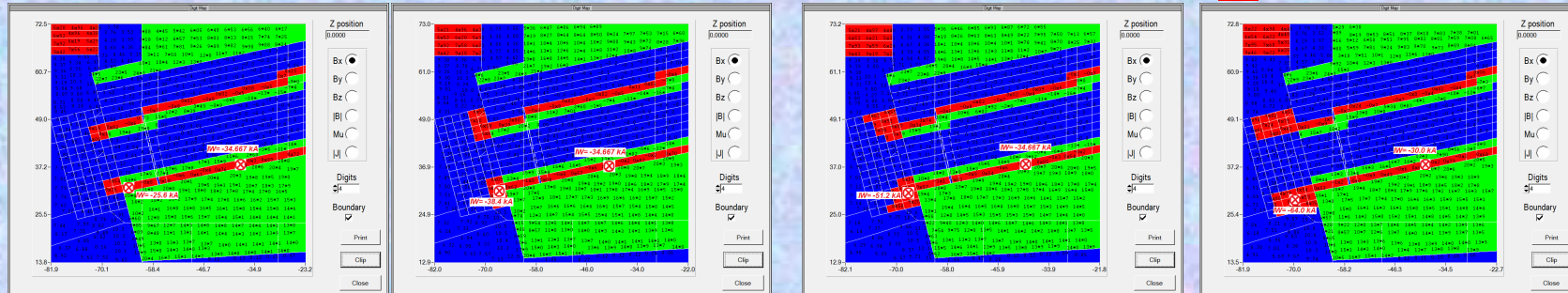- **encapsulated concept : D84&87_...... :**

Bt field at the entrance to the beam opening is ~0.2-0.25 kG

Summary of magnetic simulations of SBS magnet with MERMAID 3D:

- ## 54 versions/runs done!!
- ### Mesh of $\sim 10^7$ nodes;
- ### 25-45 min per version/run – all dramatically non-linear!
- ### To be continued …