GOETHE UNIVERSITÄT FRANKFURT AM MAIN

UCANS-1 Workshop 2010

Tsinghua University, Beijing

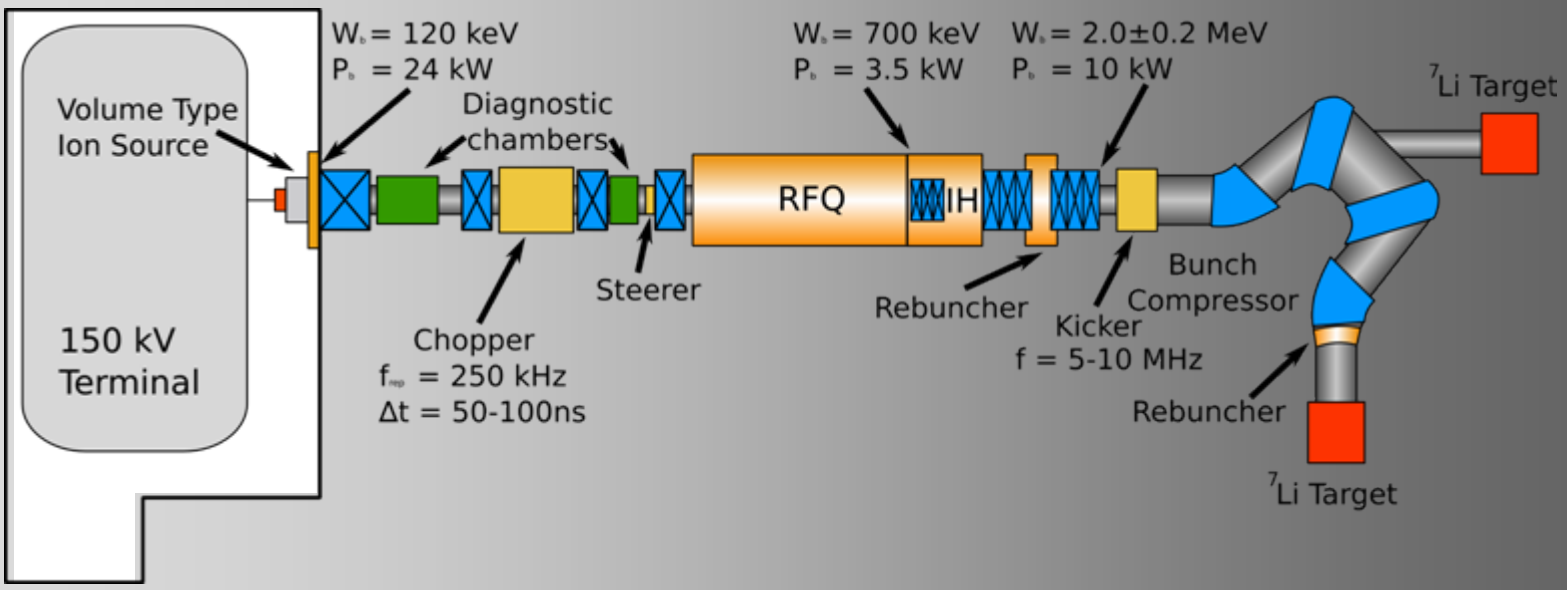
Frankfurt Neutron Source - FRANZ

Status und Perspective

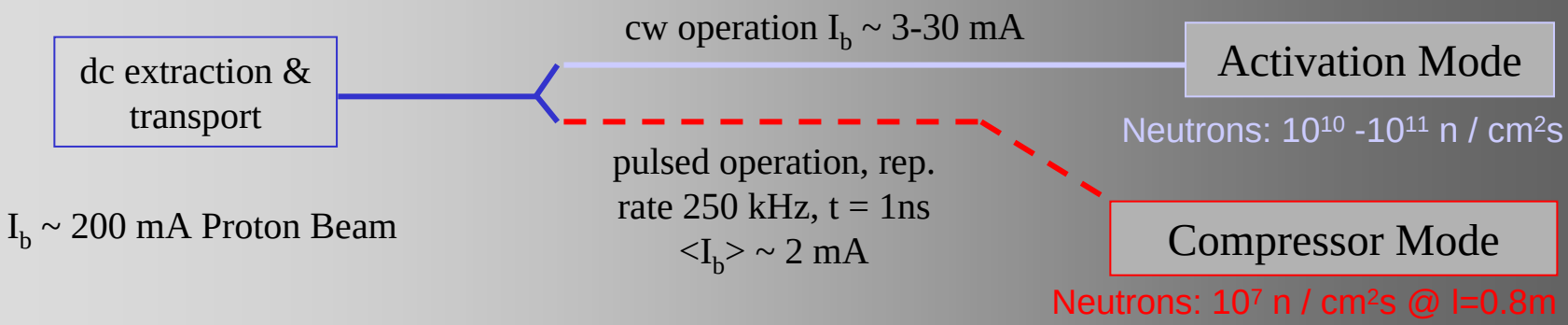
on behalf of the FRANZ community

Oliver Meusel

Overview


Volume Type
Ion Source
150 kV
Terminal
W = 120 keV
P = 24 kW
Diagnostic
chambers
Chopper
f = 250 kHz
Δt = 50-100ns
Steerer
W = 700 keV
P = 3.5 kW
RFQ
IH
Rebuncher
W = 2.0±0.2 MeV
P = 10 kW
Kicker
f = 5-10 MHz
Bunch
Compressor
Rebuncher
7Li Target
7Li Target

Overview



Accelerator Physics

Target Development

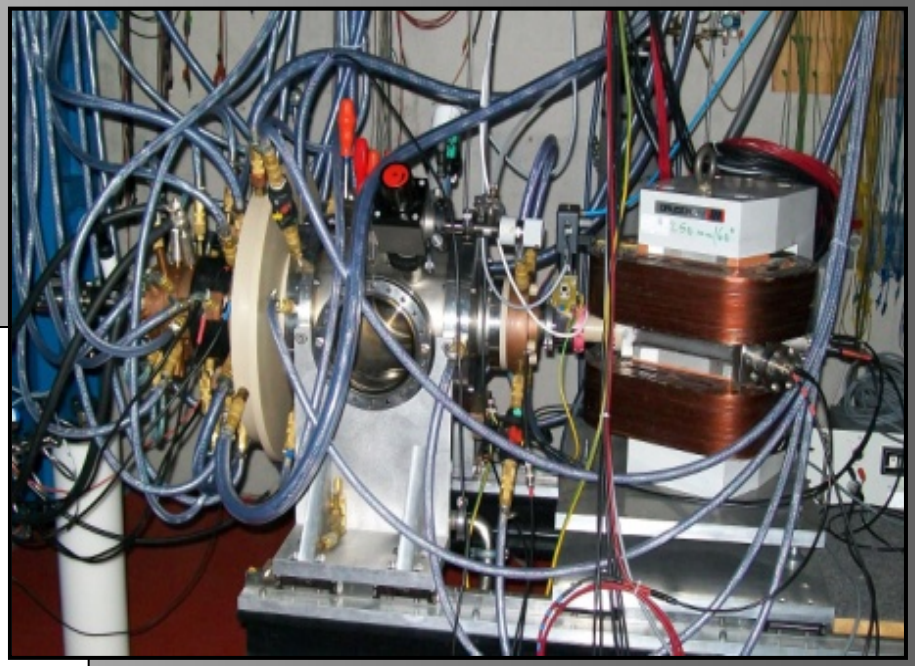
Neutron Physics

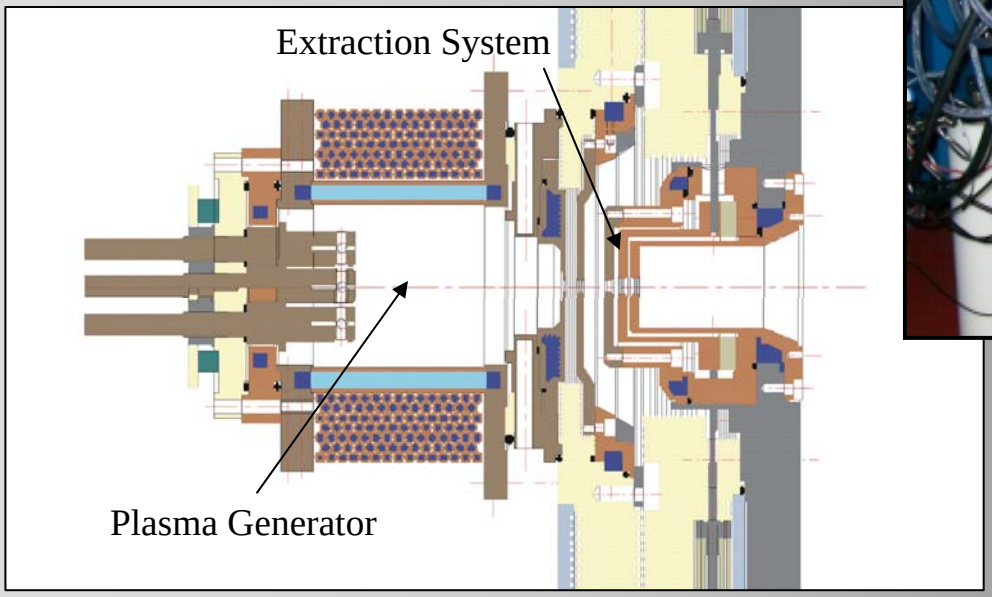
Ion Source Development & Design

I_p = 200 mA $\varepsilon_{rms,norm}$ = 0.07 π mm mrad

W = 120 keV dc-operation

P = 24 kW

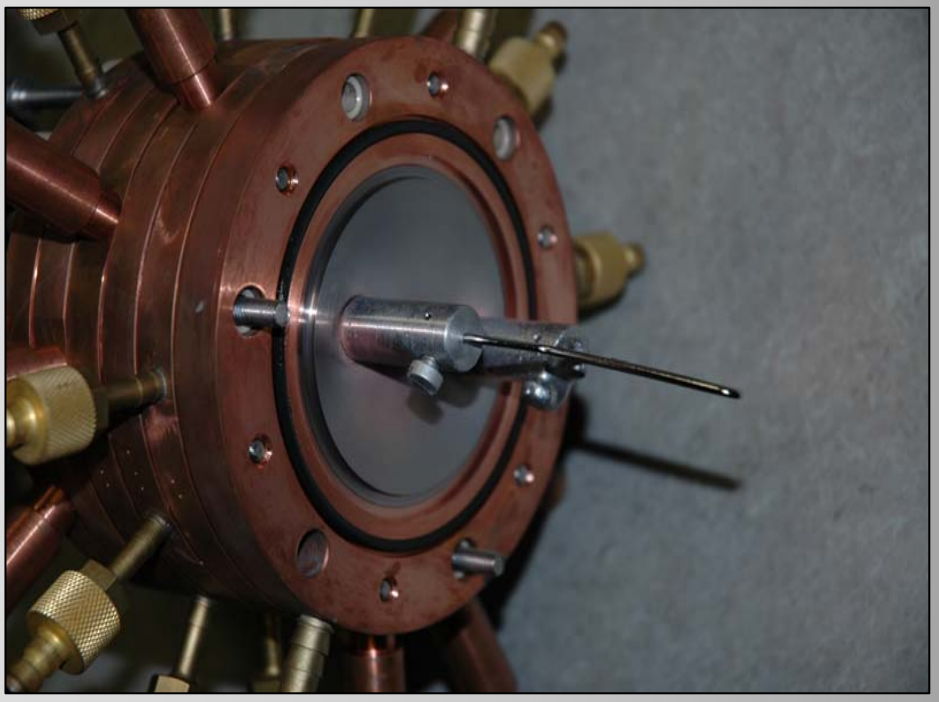




mechanical design of the proton source

K. Volk, W. Schweizer, R. Nörenberg

Plasma Generator & Extraction System

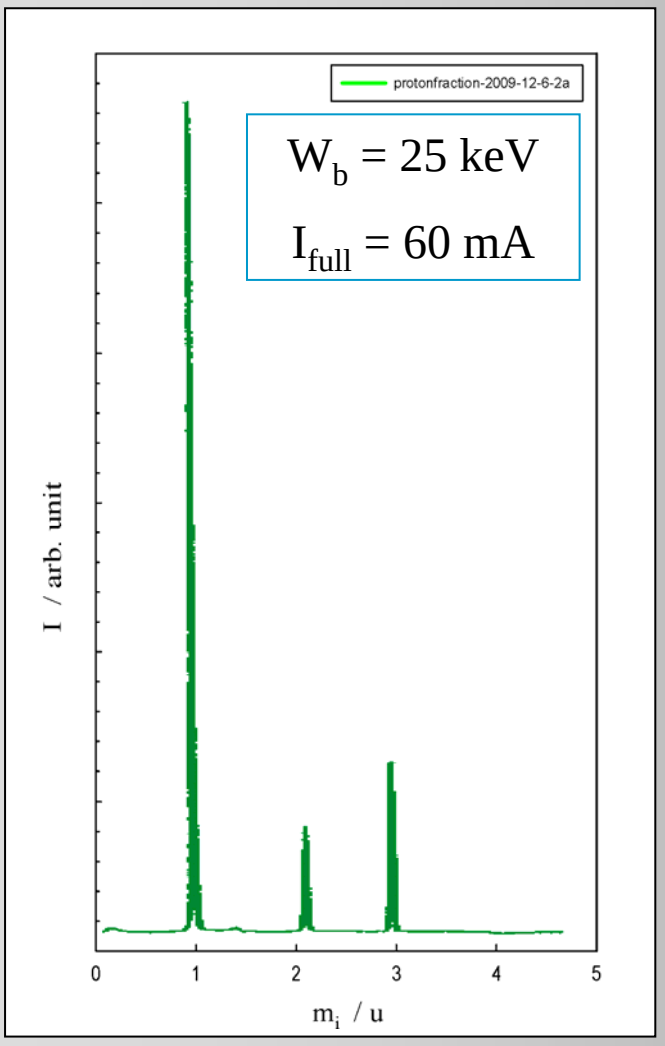


hot filament driven gas discharge

Experiments

- lifetime of the filament
- reliability of the source
- sparking
- power deposition in the extractor
- plasma vs. beam properties

Impact of Plasma Properties



I_p = 200 mA → N = $1{,}2 \cdot 10^{18}$ s^{-1}

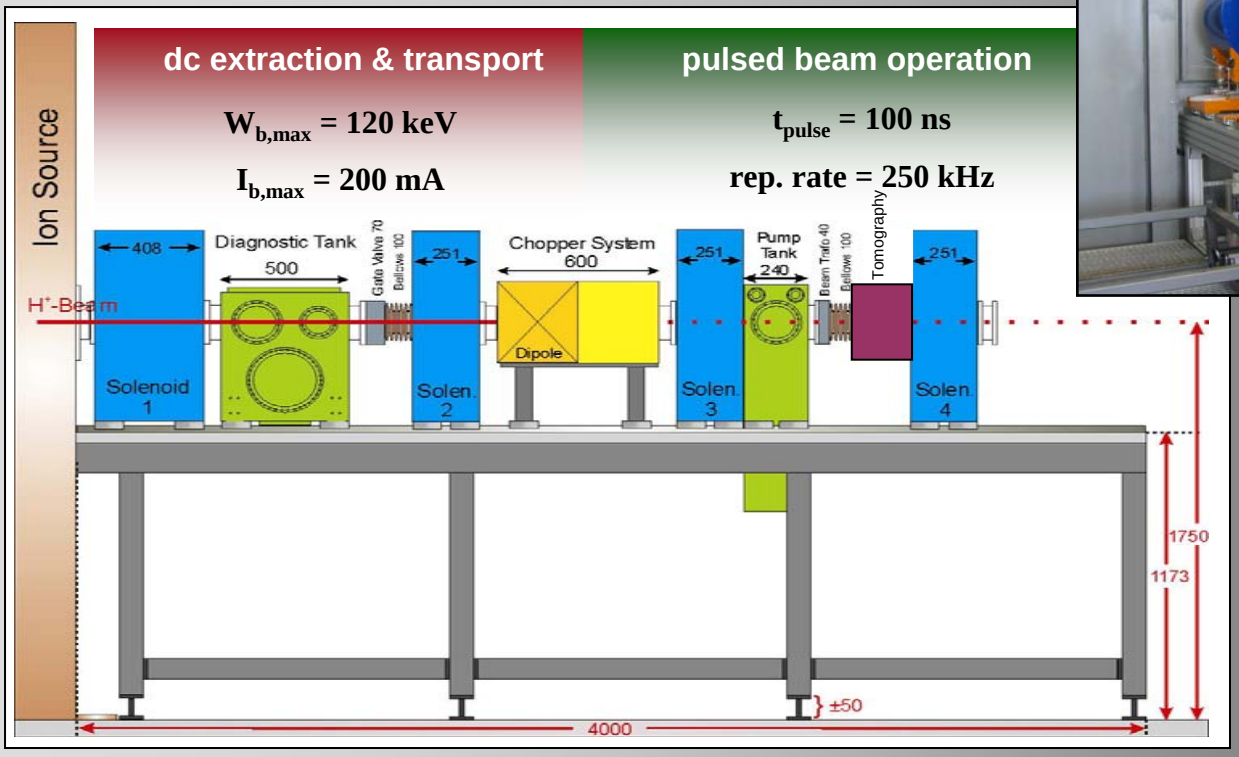
stady state assumption

$$\overbrace{\sum_1^p n_p \cdot \sigma_p}^{\text{Erzeugung}} \longleftrightarrow \overbrace{\sum_1^v n_v \cdot \sigma_v}^{\text{Vernichtung}} + \overbrace{[\text{Extraktion}]}^{\text{Störung}}$$
Gleichgewicht

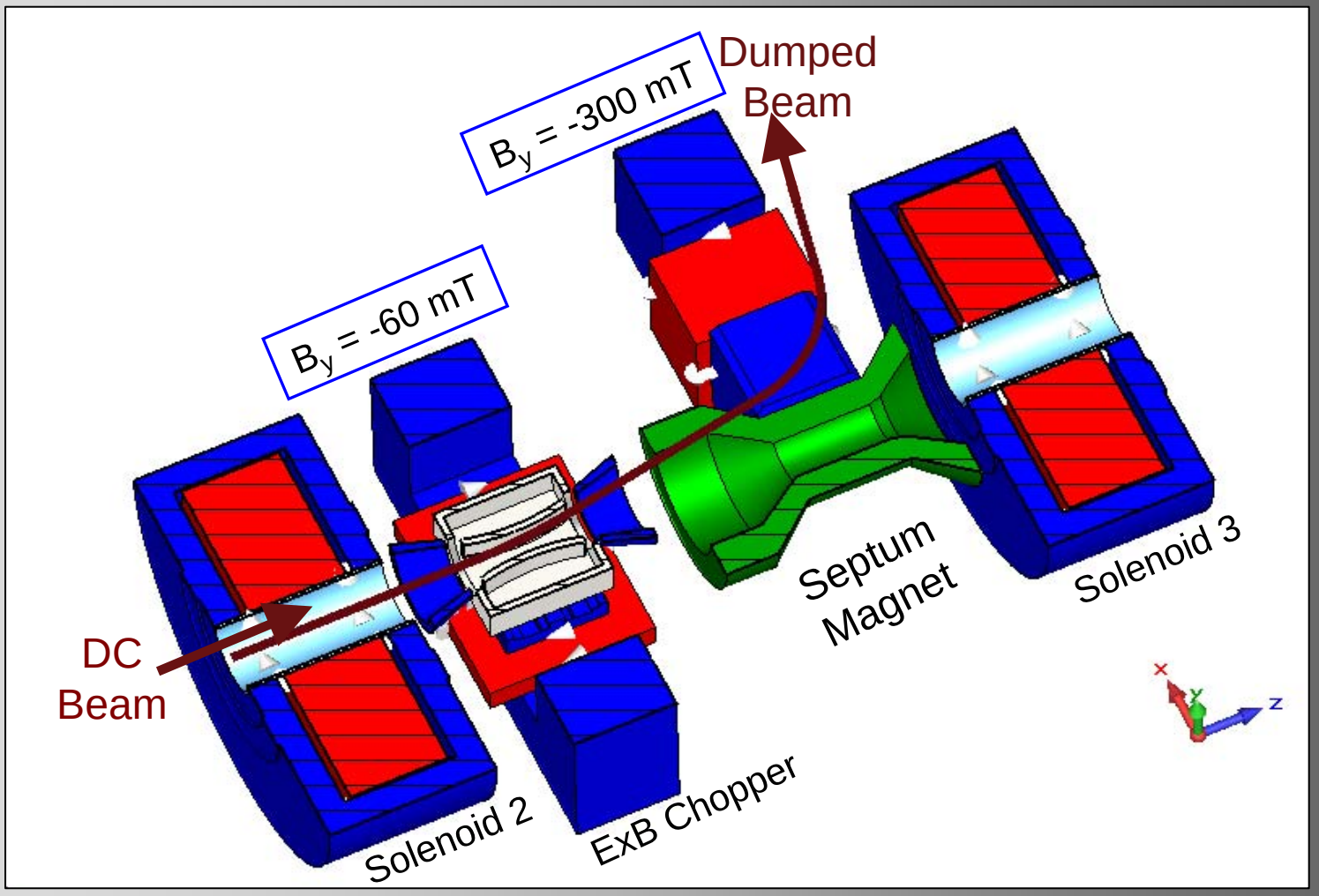
cold plasma: $T_i \sim 0{,}5$ eV & $T_e \sim 5$ eV

- small rms-Emittance
- production of protons via secondary reaction $H_2^* + e \rightarrow p + H + 2e$

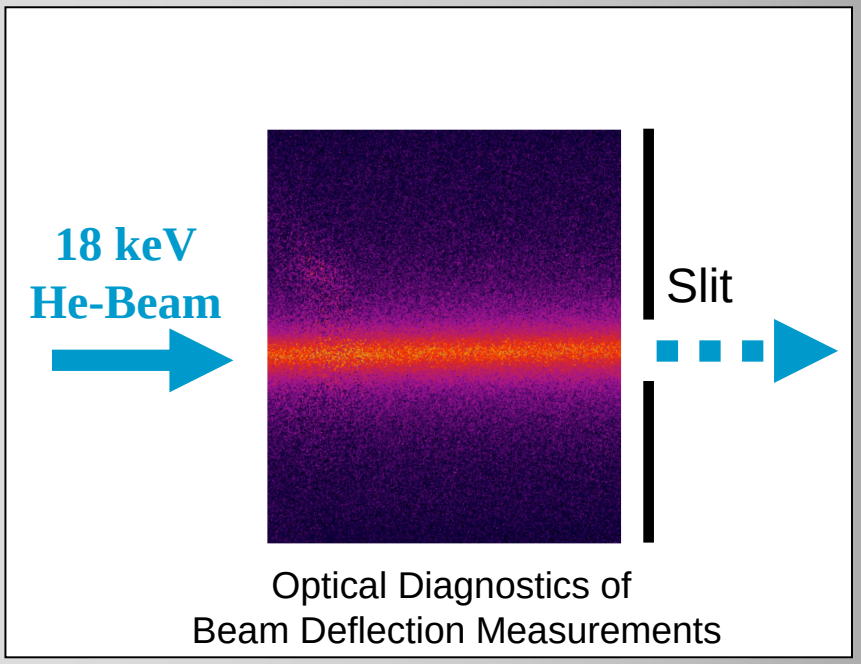
LEBT - 3 Sections - 4 Lenses



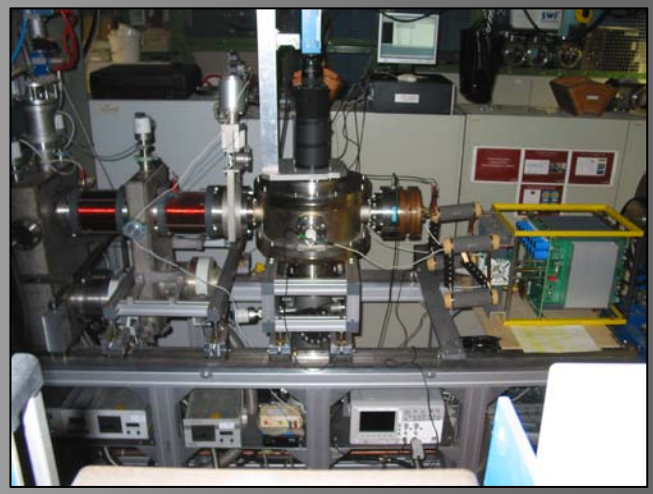
E x B - Chopper


B_y = -300 mT
Dumped Beam
B_y = -60 mT
DC Beam
Septum Magnet
Solenoid 3
Solenoid 2
ExB Chopper
x
y
z

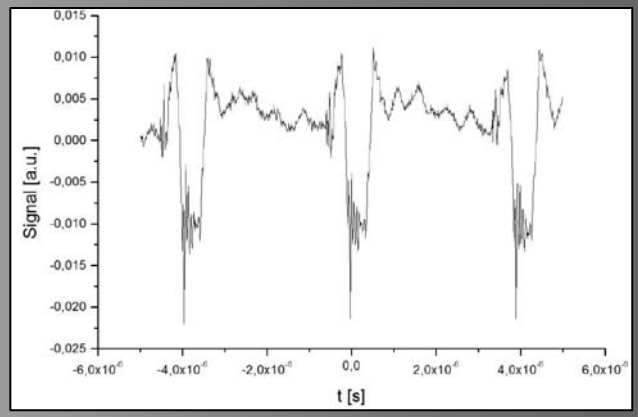
Pulser and Electric Deflector



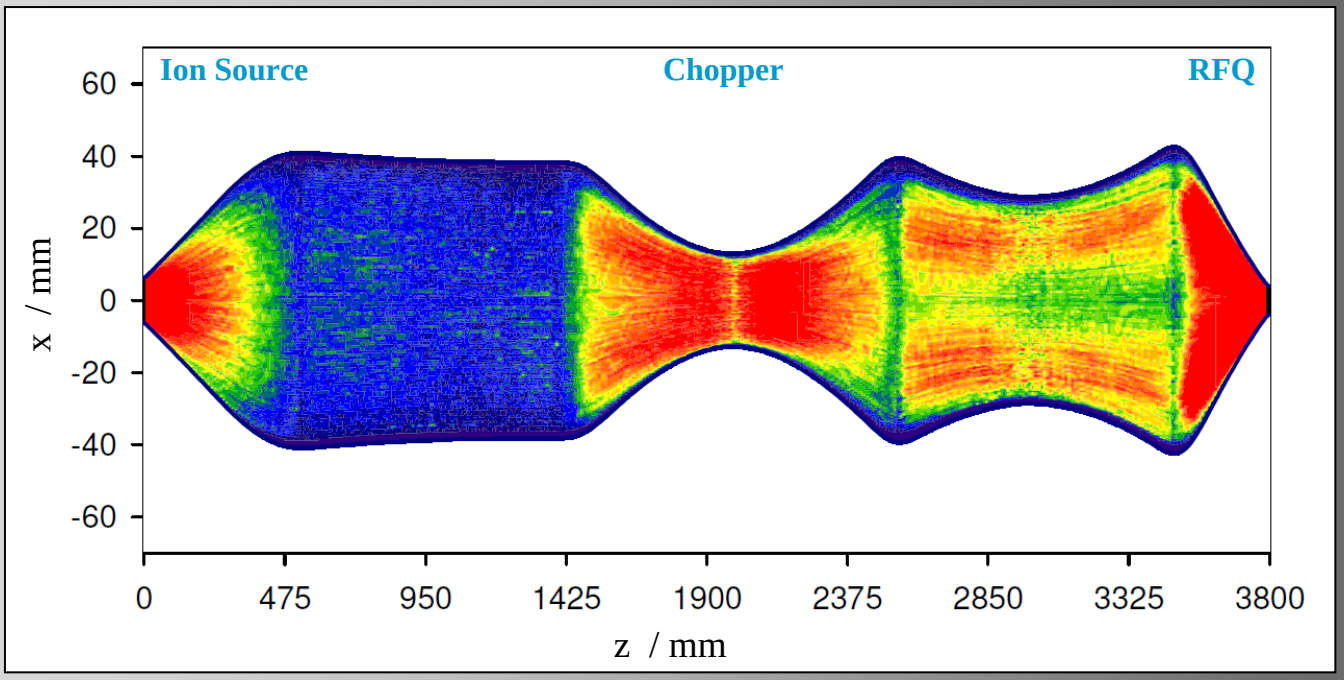
Optical Diagnostics of
Beam Deflection Measurements



t_{pulse} = 100 ns rep. rate = 250 kHz



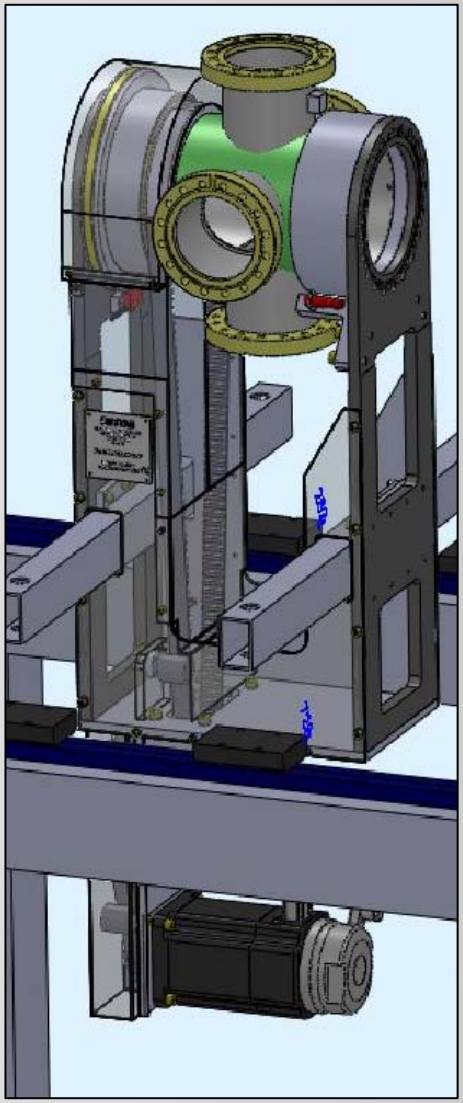
Emittance Growth due to Lens Abberations

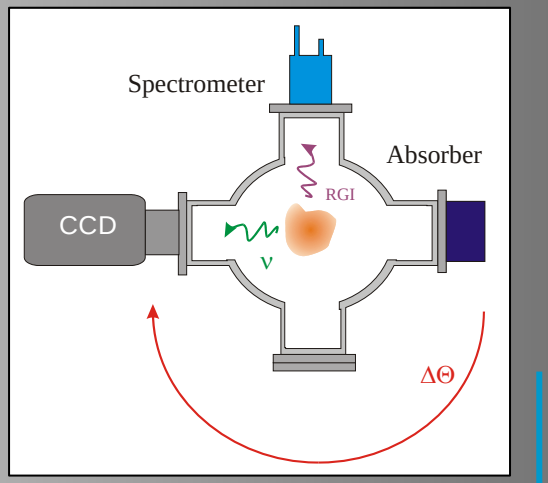


density distribution of transverse momentum $v_{t,px}$

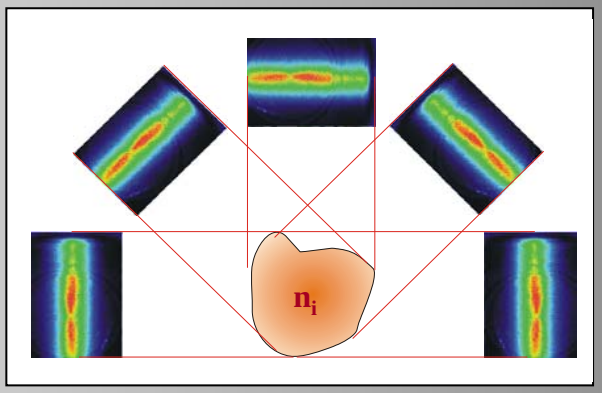
$$v_{t,px} = \int_{-y}^{+y} n_i \cdot \varepsilon_{rms,x} dy$$

Beam Diagnostics

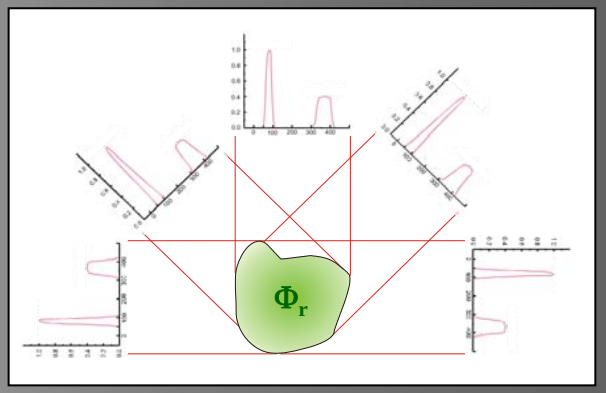




optical profiles

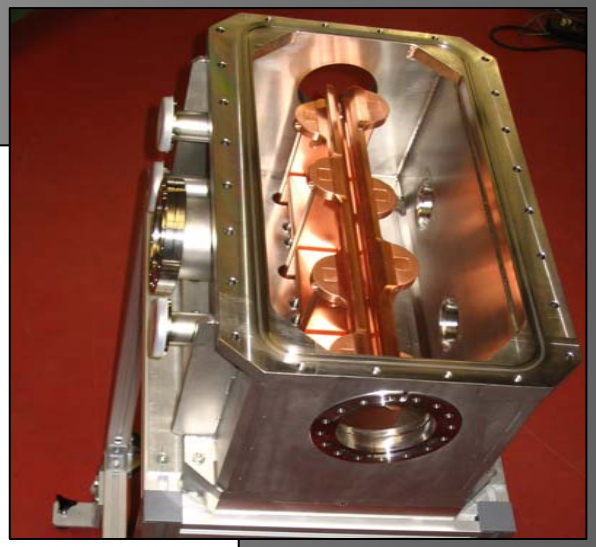


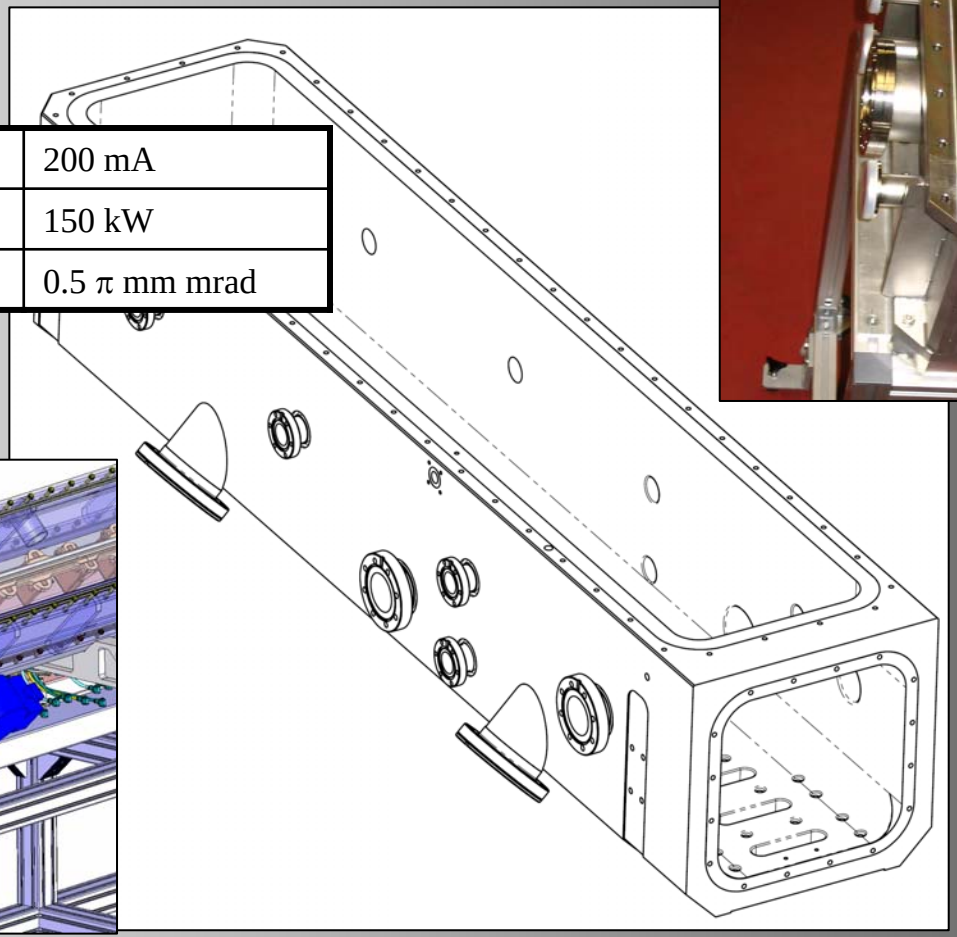
potential distribution

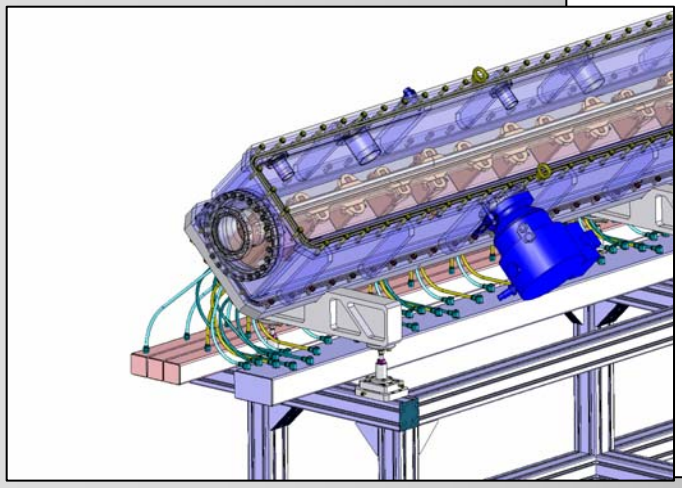


Radio Frequency Quadrupole - RFQ

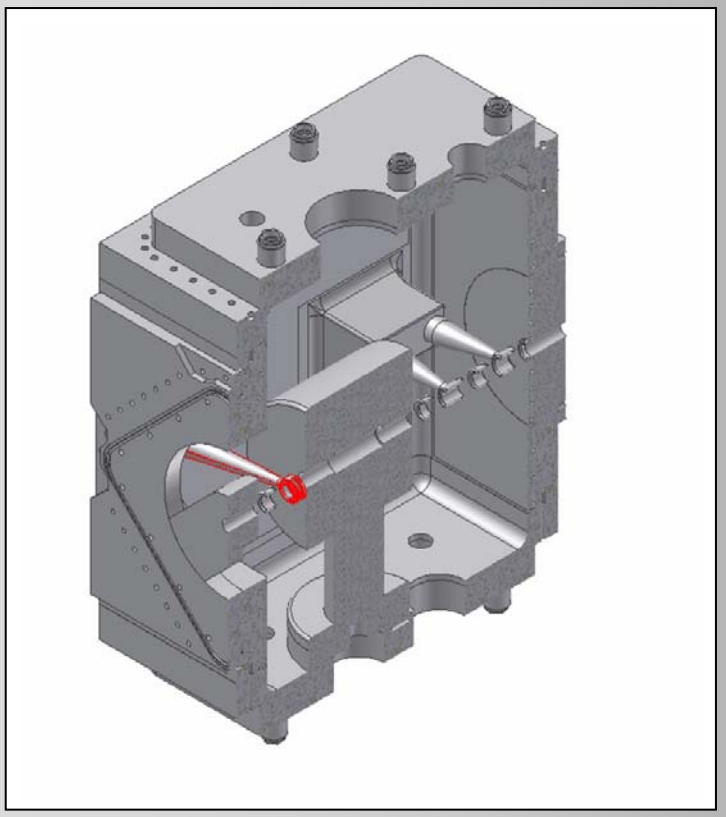
Max. Proton Current	200 mA
Exp. Power Consumption RFQ	150 kW
RFQ Acceptance (norm. rms)	0.5 π mm mrad



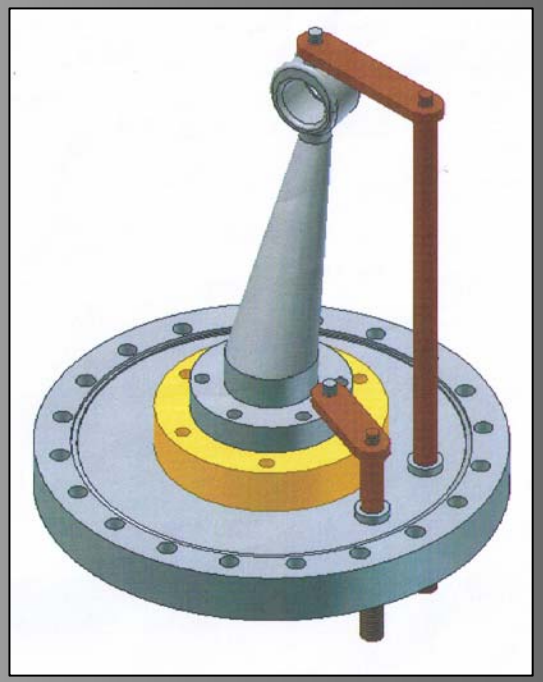




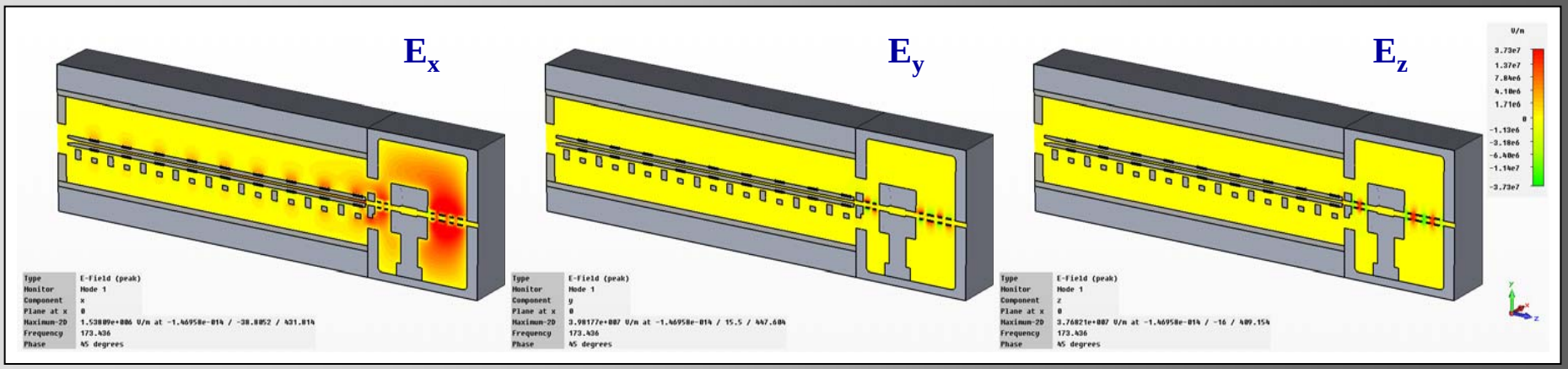
IH - Cavity

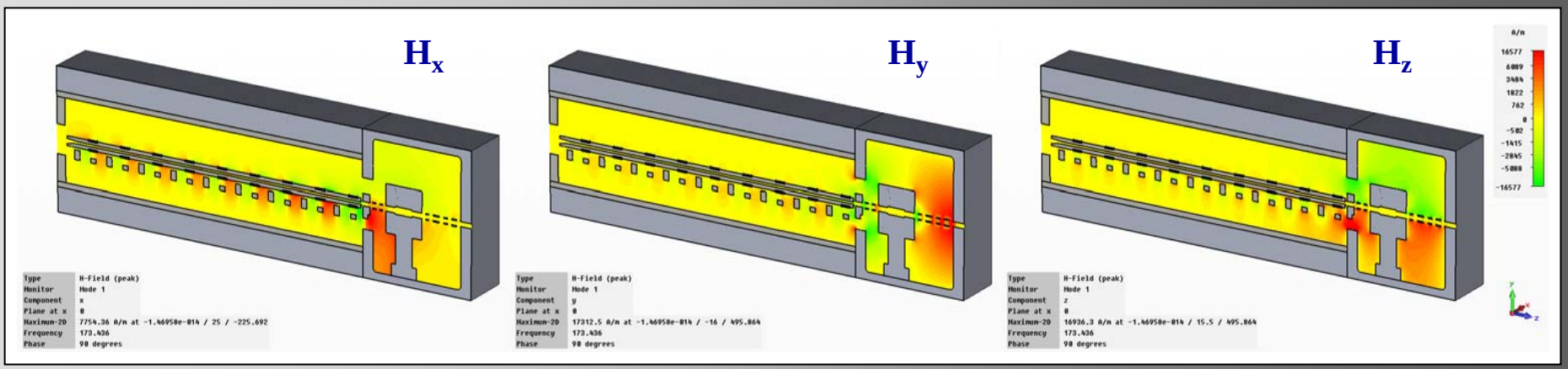


Max. Proton Current	200 mA
Exp. Power Consumption IH	54 kW
IH ε (out, norm. rms)	0.95 π mm mrad

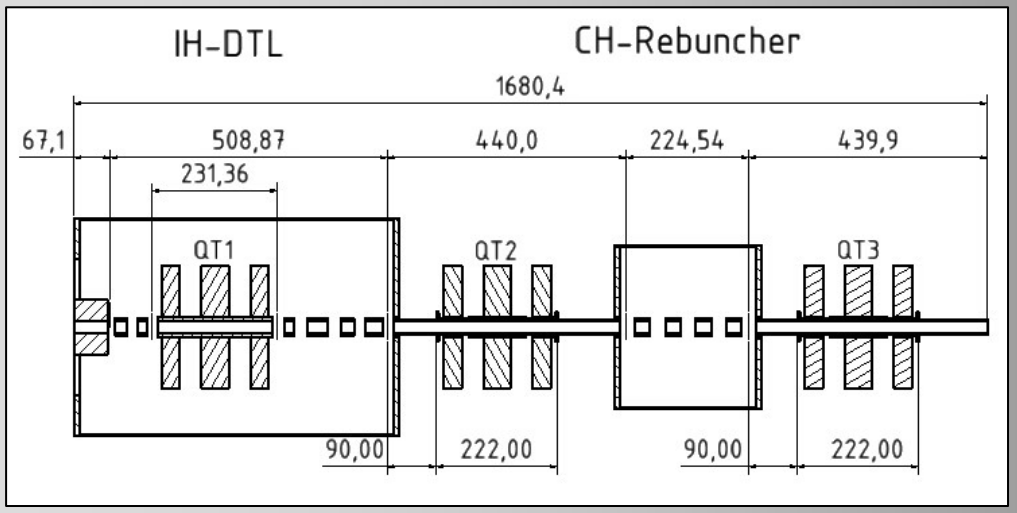


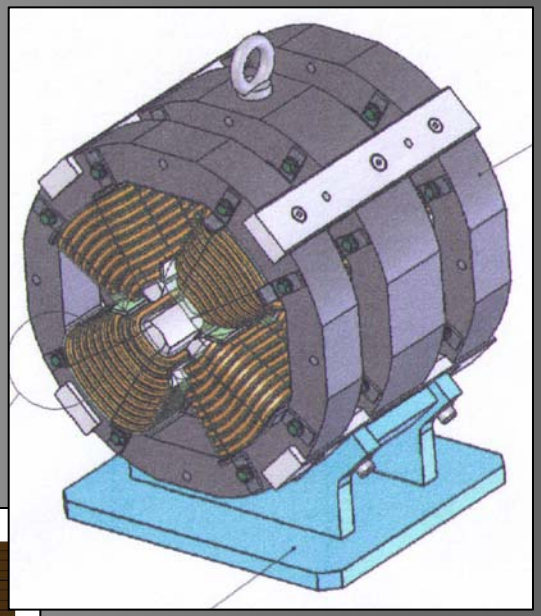
Coupled RFQ-IH Cavities

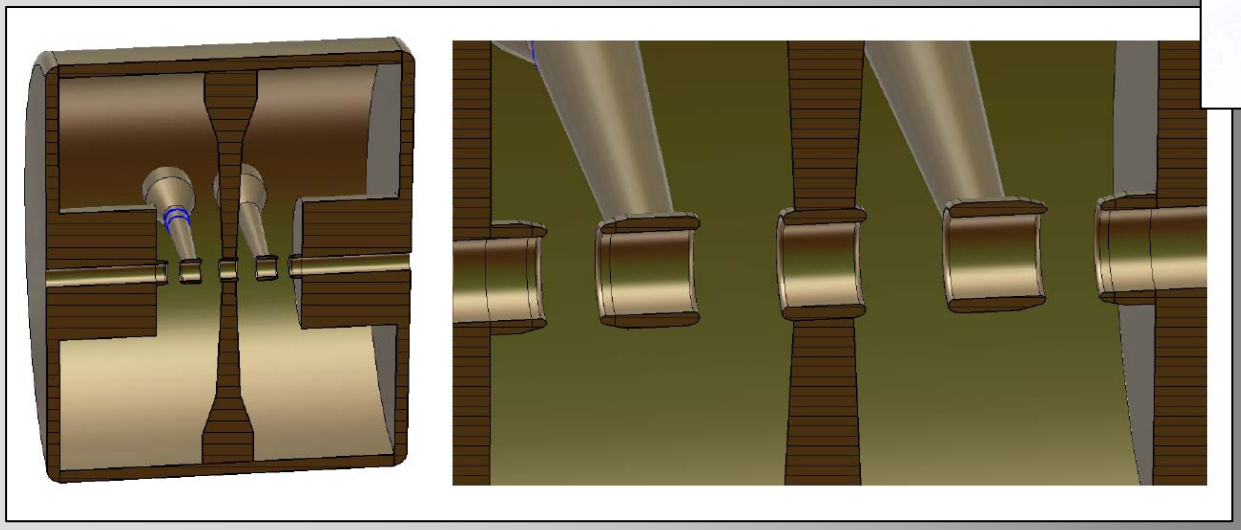




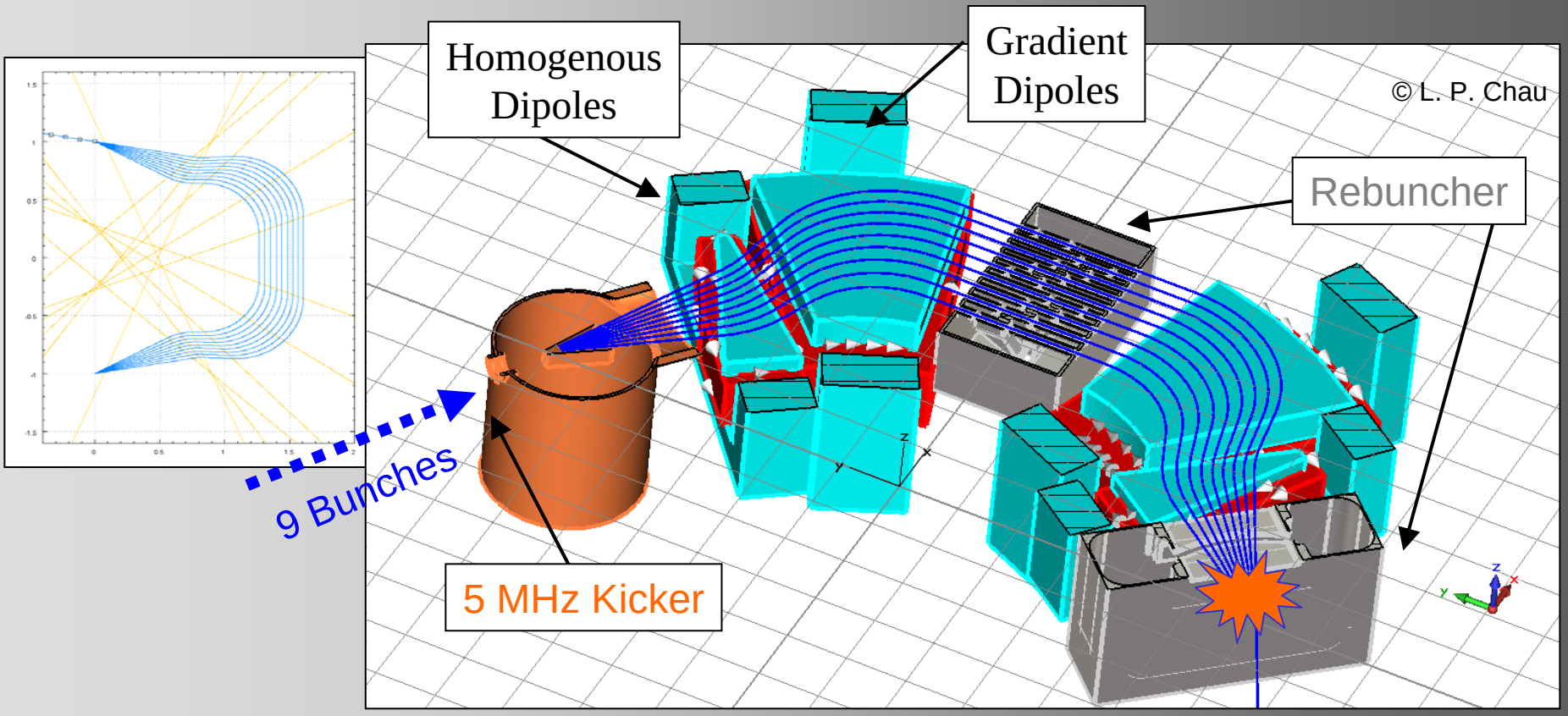
CH - Rebuncher Cavity





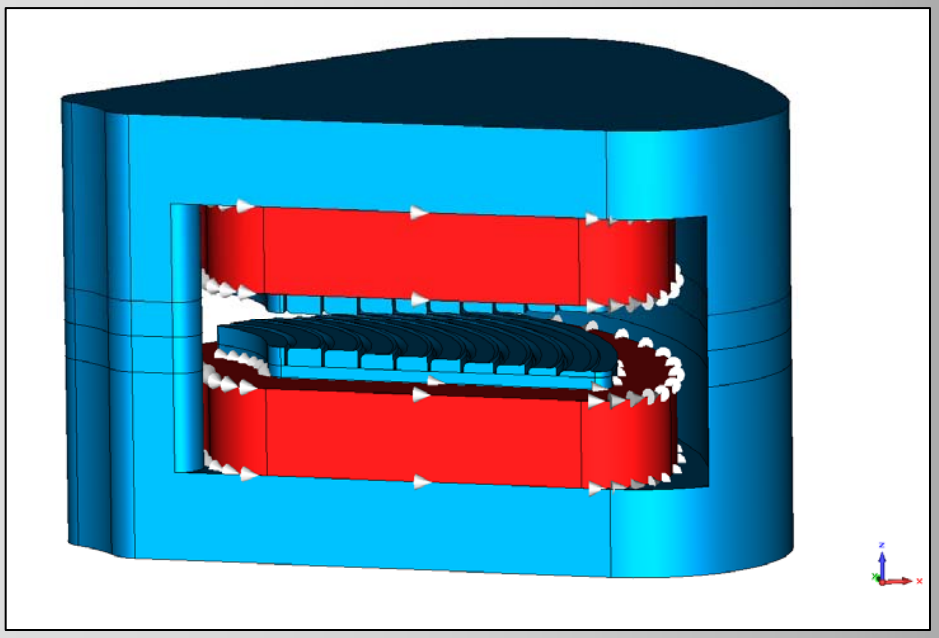


Towards Compression Ratio of $\eta = 48$

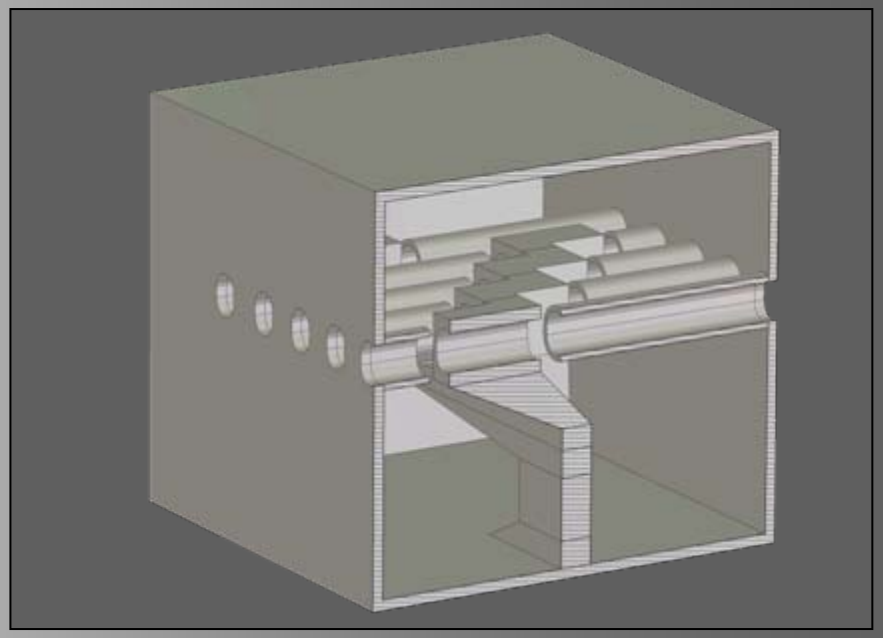


Design Study of Multi Track Devices

Duplex Gradient Dipole

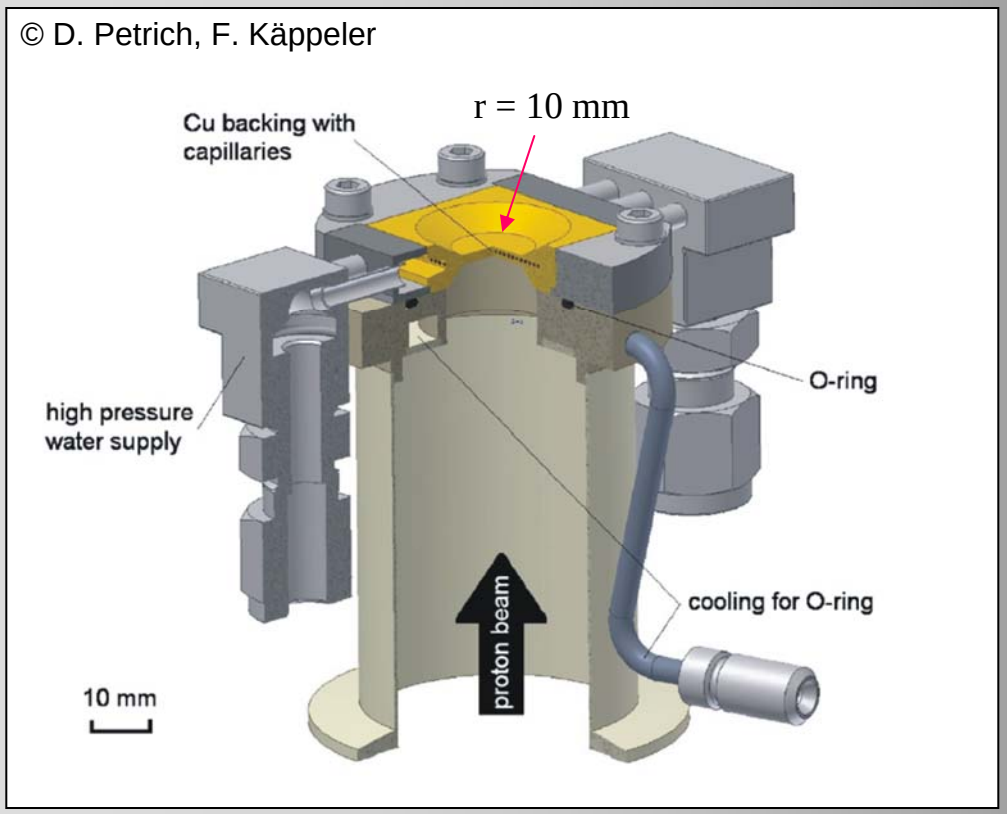


Syrinx Rebuncher

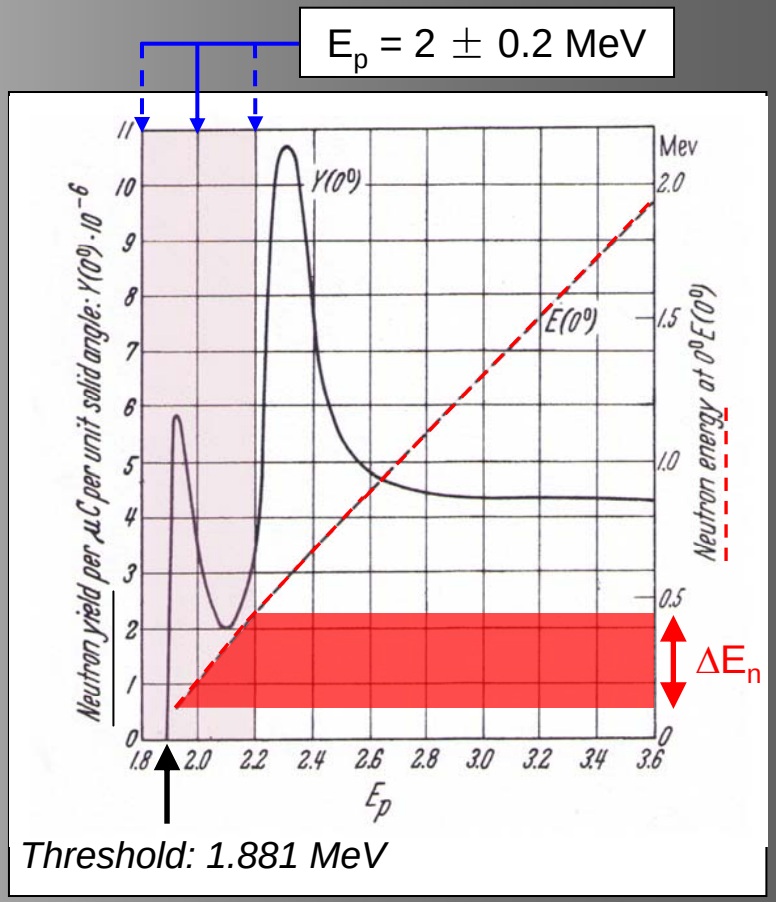


High Power Target

$$_1H^1 + _3Li^7 \rightarrow _4Be^7 + _0n^1 - 1{,}646\ \text{MeV}$$



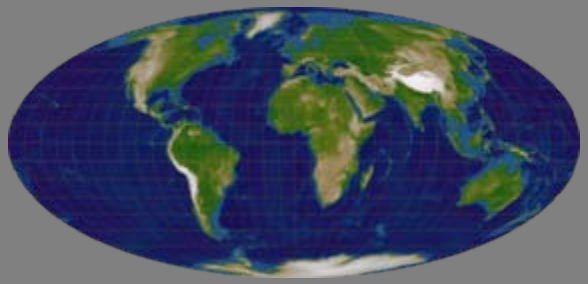
Target prototype development at Karlsruhe for beam power up to 6 kW.



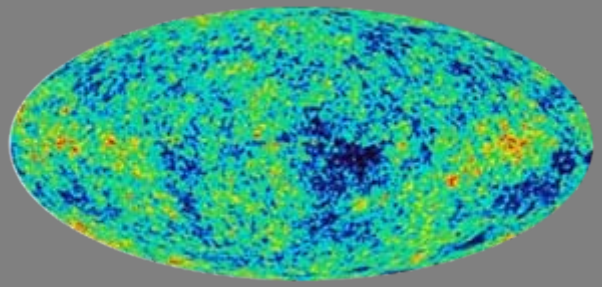
Neutron yield and maximum neutron energy in forward direction (0°).

Neutron Dynamics

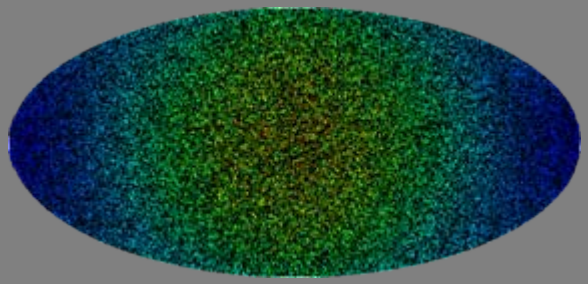
examples for Mollweide projection



World



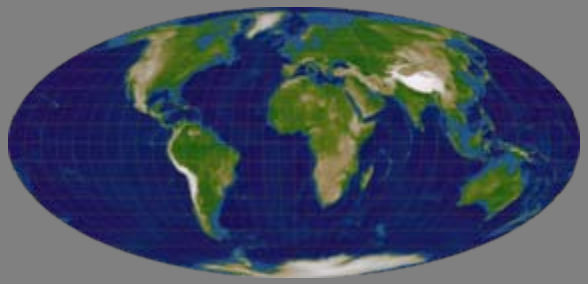
2,725 ± 0,002 K



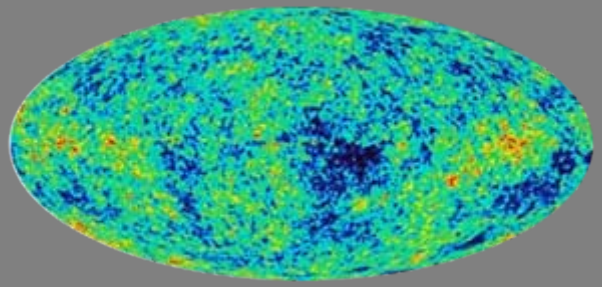
Neutron Distribution

Neutron Dynamics

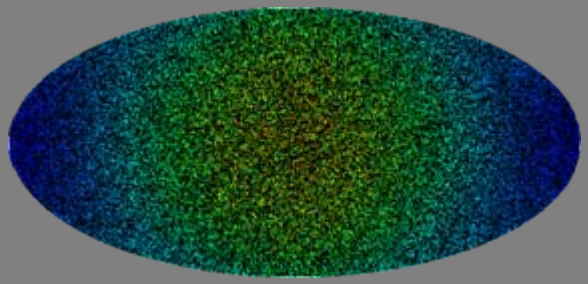
examples for Mollweide projection



World

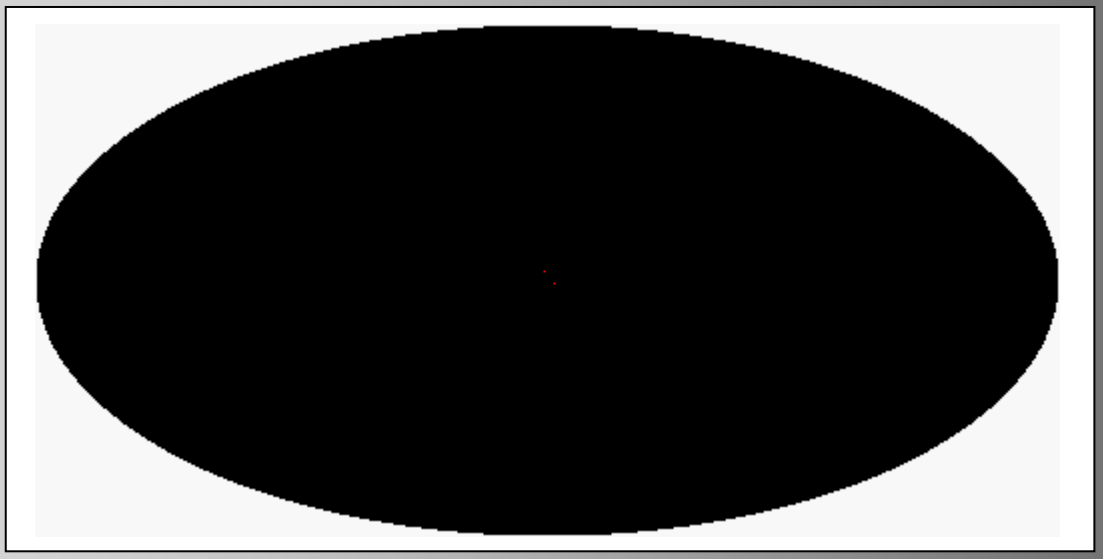


2,725 ± 0,002 K



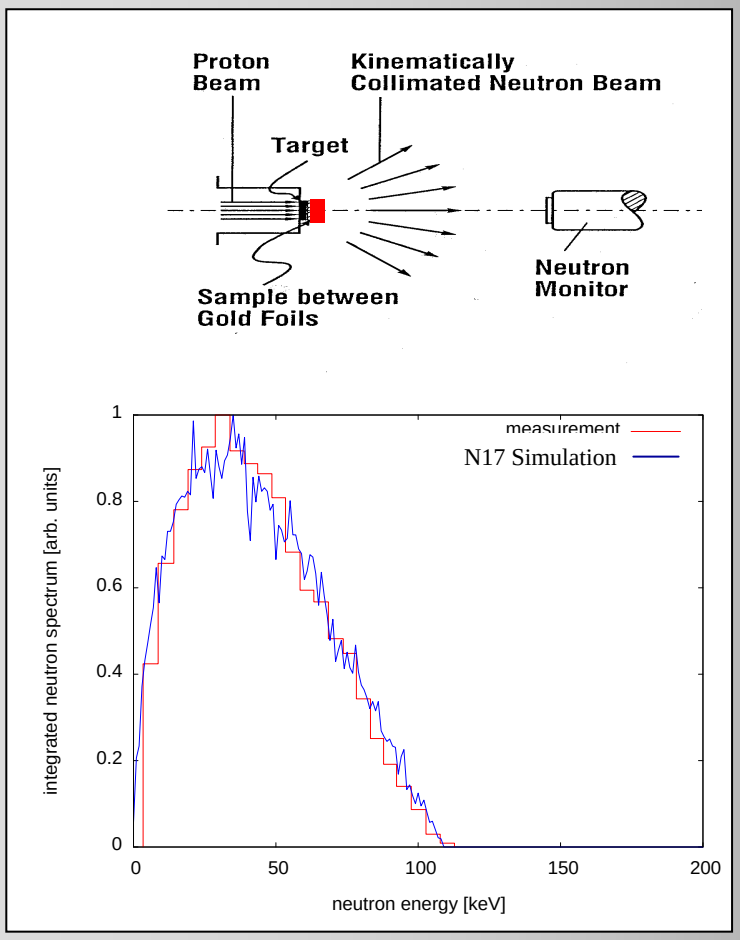
Neutron Distribution

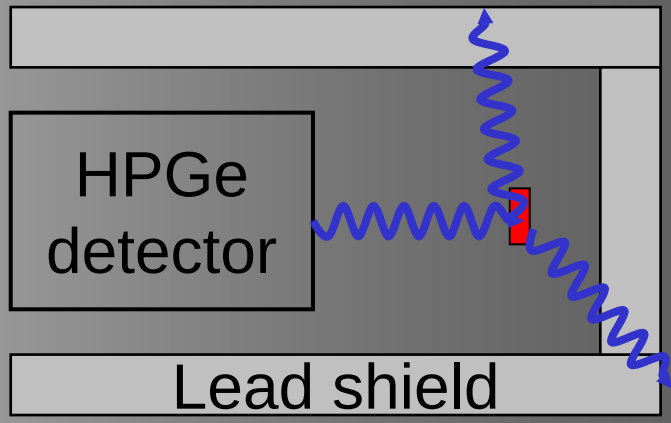
Neutron energy distribution as a function of E_p



Experiments

neutron caption reaction

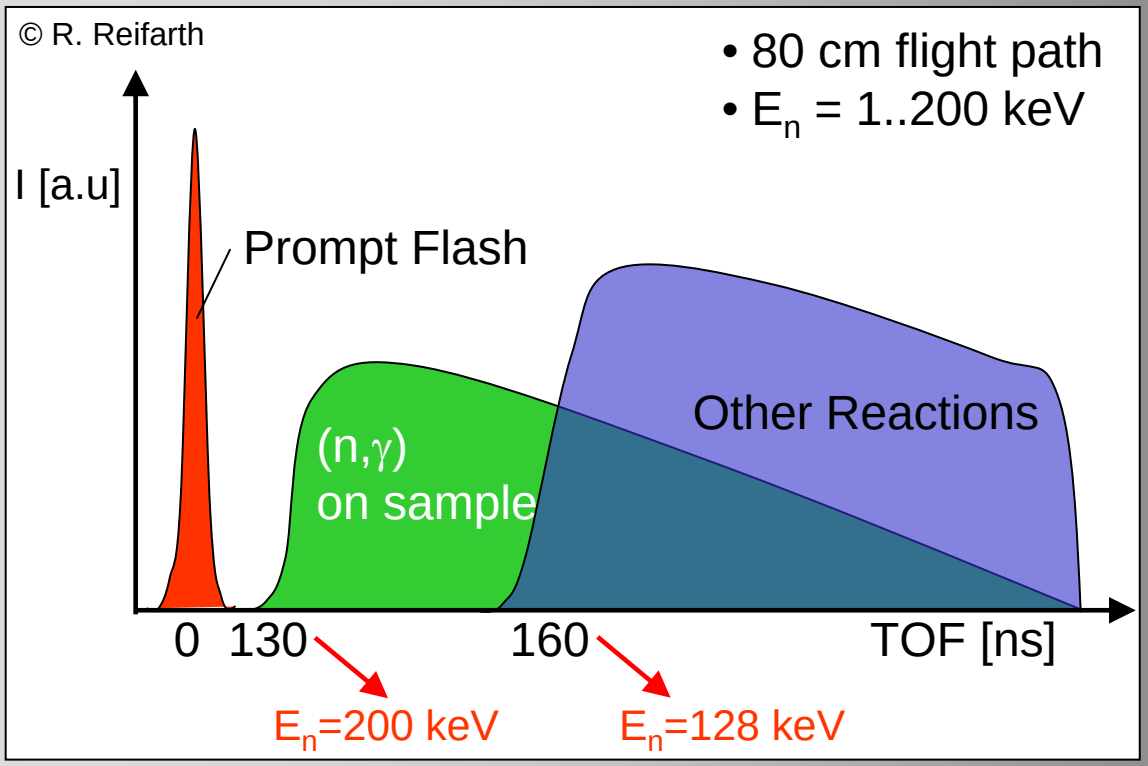




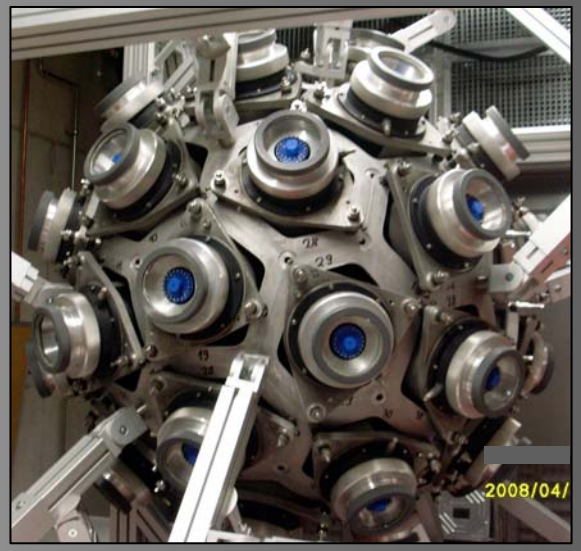
measurement of neutron induced activity

Compressor Mode

- Measurement of differential cross sections of small amounts of (radioactive) samples (advanced fuel cycle, astrophysics)
- Determination of properties of resonances (spins and parities)
- Study of γ-decay - photon strength functions

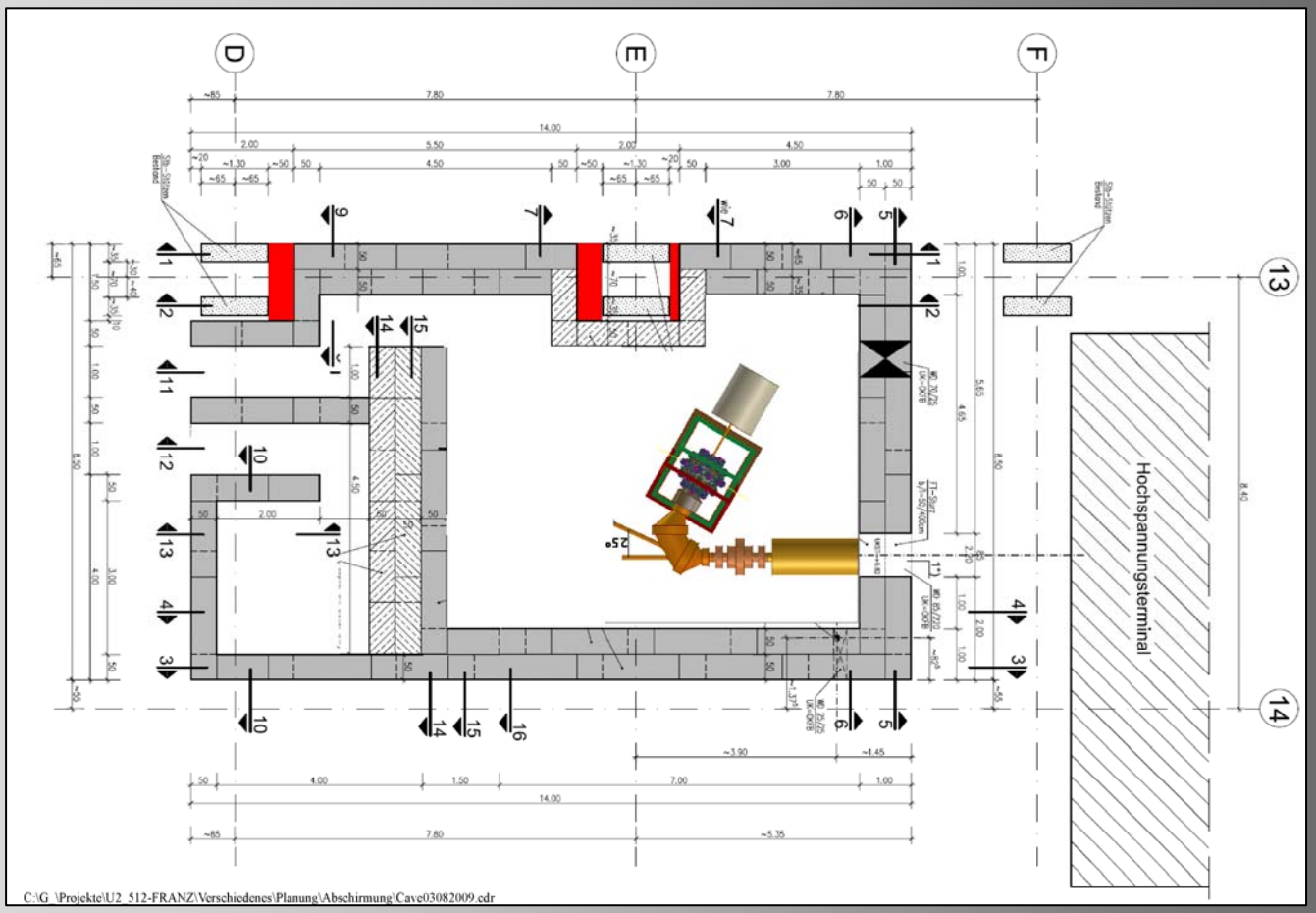


Time of Flight Method



4π BaF_2- detector after transfer from Karlsruhe to Frankfurt.

Shielding



floor plan of FRANZ within the concrete shielding

Thank You!

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K. Stiebing, J. Stroth / *IKF, Goethe Universität Frankfurt*

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