Buncher-System at ***FRANZ***

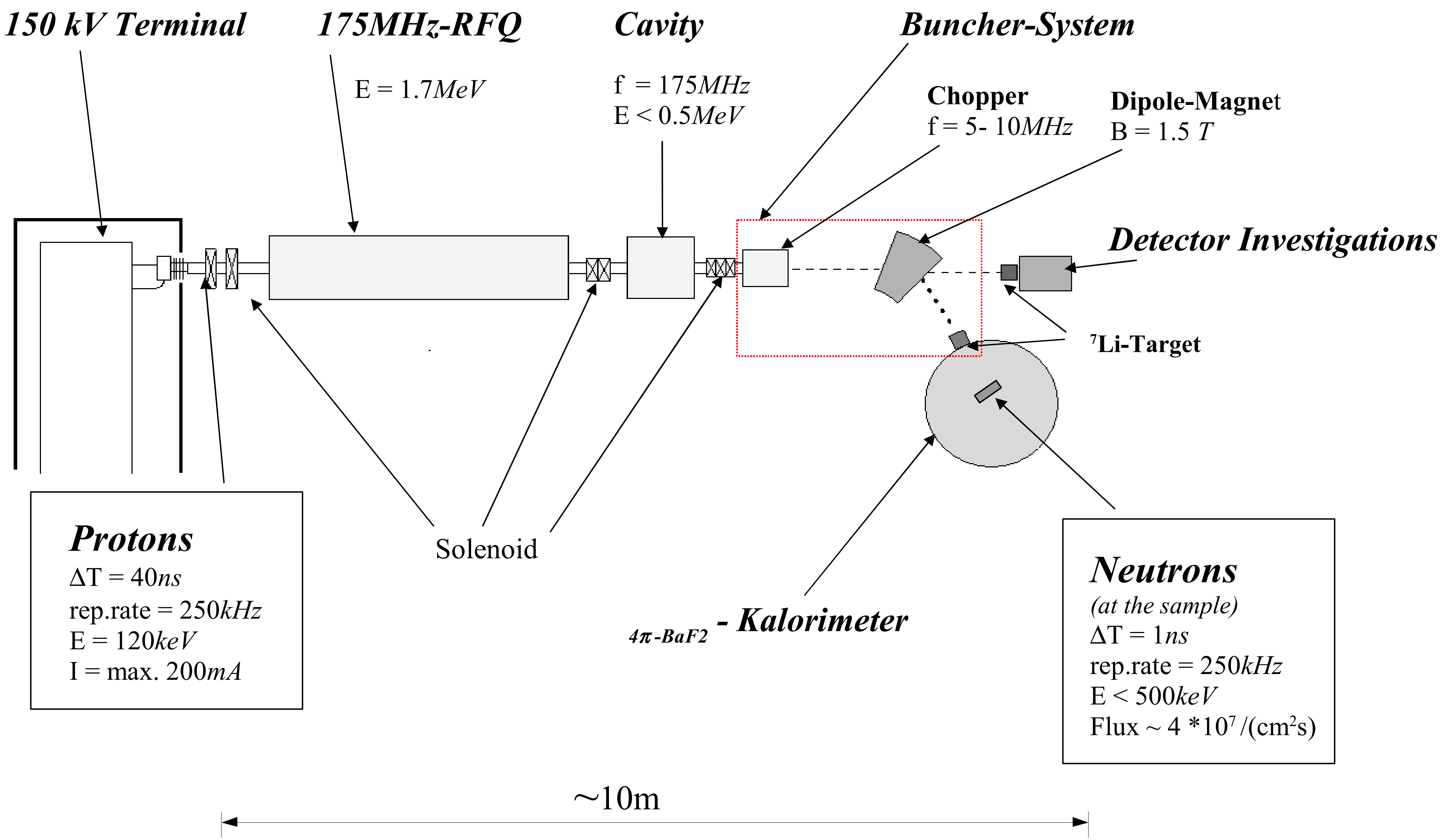
Part 1: ***FRANZ*** (5min)

- Scetch
- Pulse Structure
- Parameters
- Application

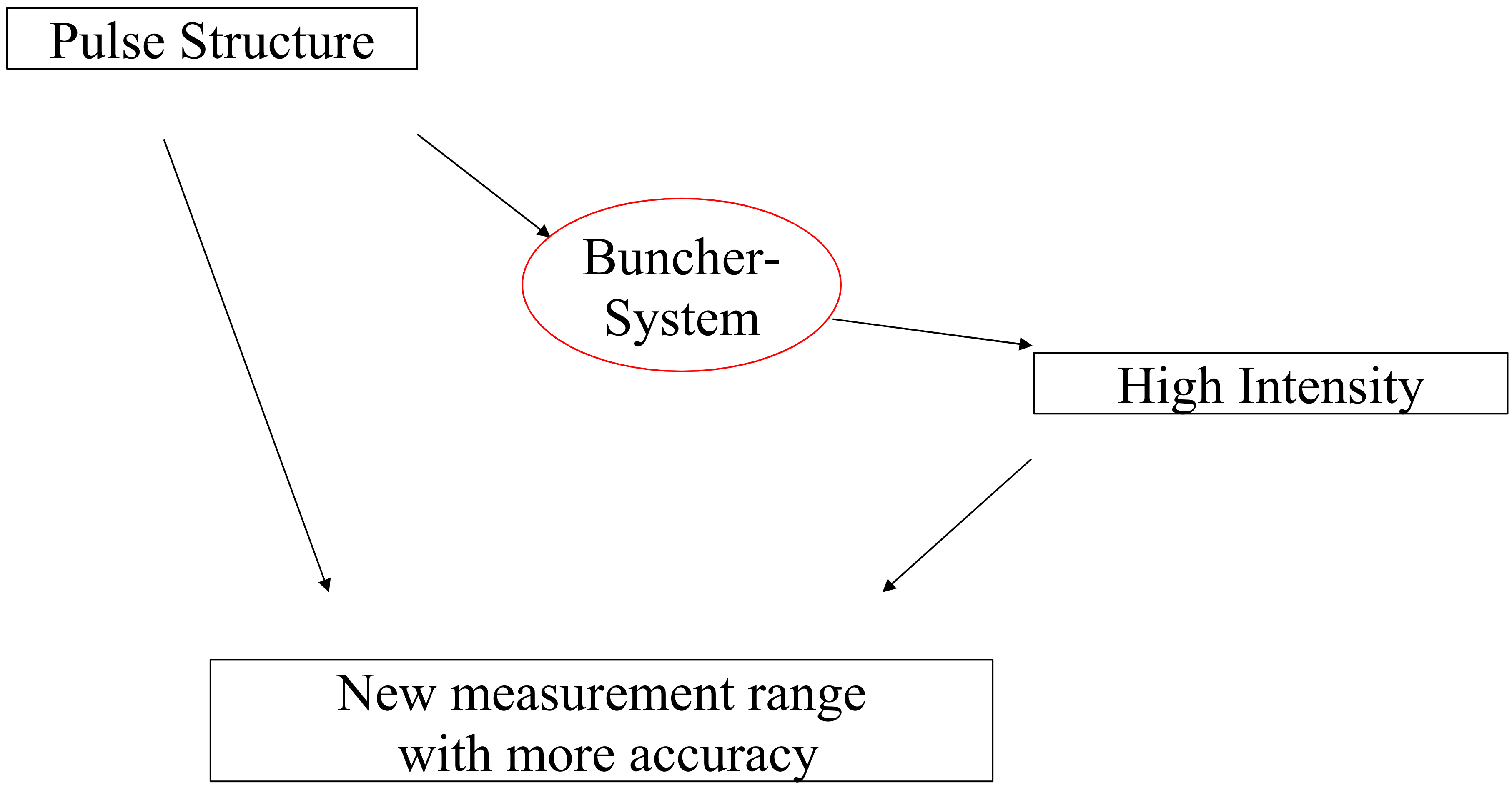
Part 2: ***Buncher-System*** (15min)

- Mobley-Buncher
- xy-Profile of the Dipole Magnet
- Scetch of the chopper
- Two selected Settings
- Constraints / to do

Frankfurt ***N***eutron-Source at the Stern-Gerlach-***Z***entrum (***FRANZ***)



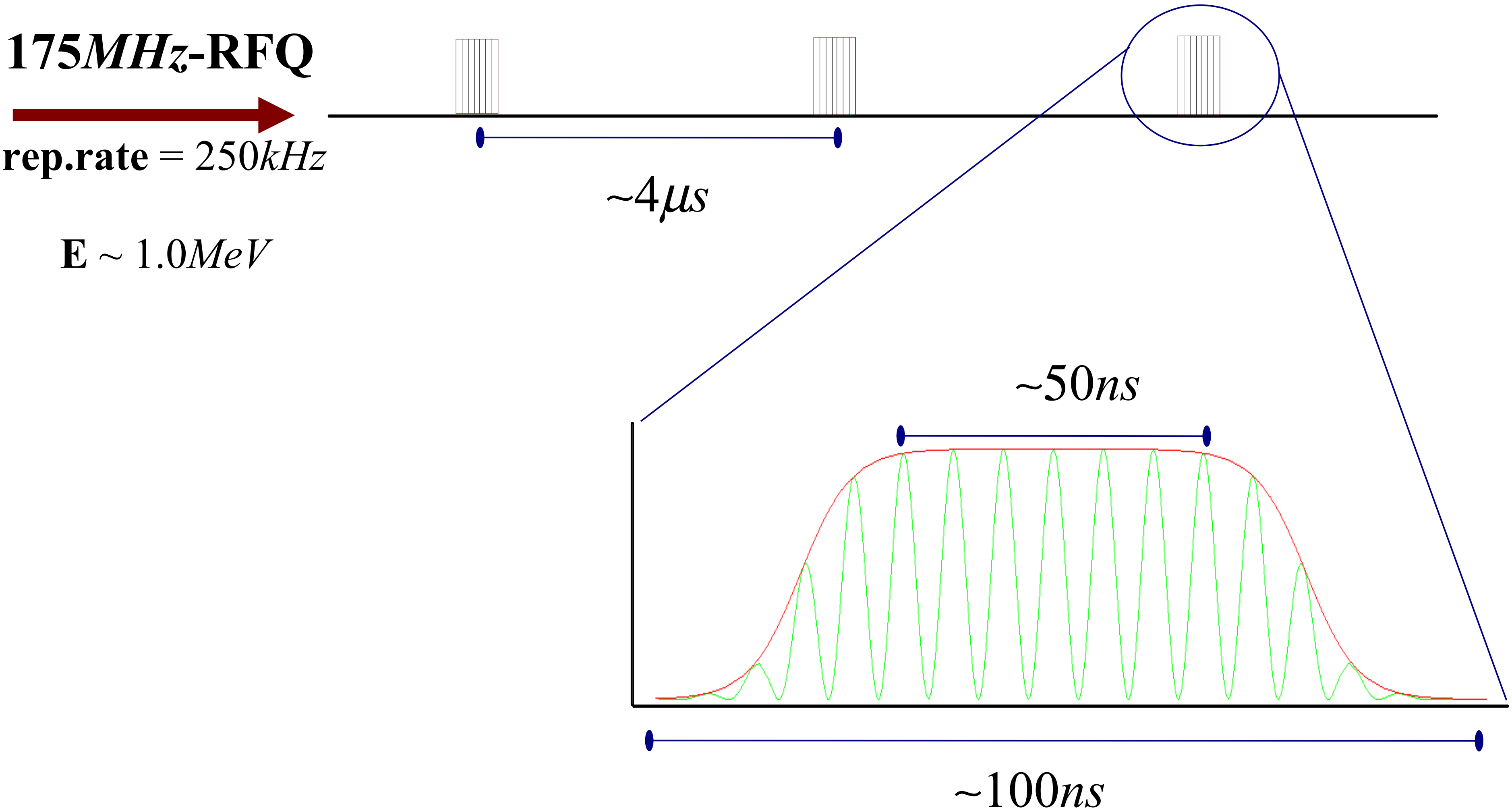
Frankfurt ***N***eutron-Source at the Stern-Gerlach-***Z***entrum (***FRANZ***)



<u>***Fra**nkfurt **N**eutron-Source at the Stern-Gerlach-**Z**entrum*</u>
(***FRANZ***)

Pulse Structure

~ 2 *MeV* Proton-Bunches



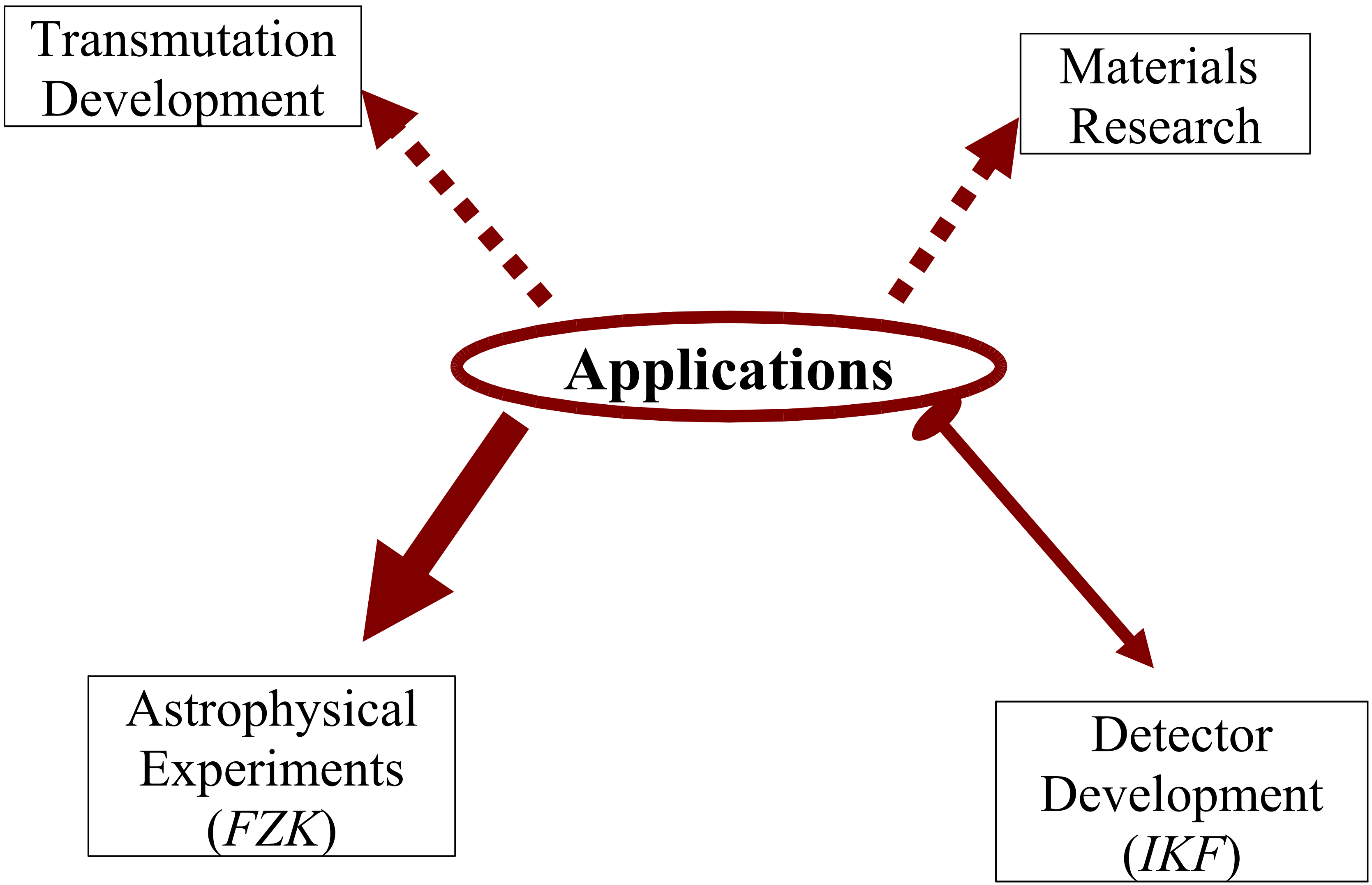
***Fra*nkfurt *N*eutron-Source at the Stern-Gerlach-*Z*entrum (*FRANZ*)**

Tabelle 1: Vgl. von FRANZ mit exitierenden Anlagen

Einrichtung	Nat	Neutronenfluss am Ort der Probe* [$cm^{-2}\ s^{-1}$]	Wiederholrate [Hz]	Flugweg [m]	Pulsbreite [ns]	Energiebereich [keV]
FRANZ (Ffm)	D	$4{\cdot}10^7$	250000	0.4	<1	1-200 (500)
FZ Karlsruhe	D	$1{\cdot}10^4$	250000	0.8	0.7	1-200
DANCE (Los Alamos)	USA	$5{\cdot}10^5$	20	20	250	th -10^5
n_TOF (Genf/CERN)	CH	$5{\cdot}10^4$	0.4	185	6	th -10^6
GELINA (Geel)	B	$5{\cdot}10^4$	800	30	1	th -10^5
ORELA (Oak Ridge)	USA	$2{\cdot}10^4$	525	40	8	th -10^4

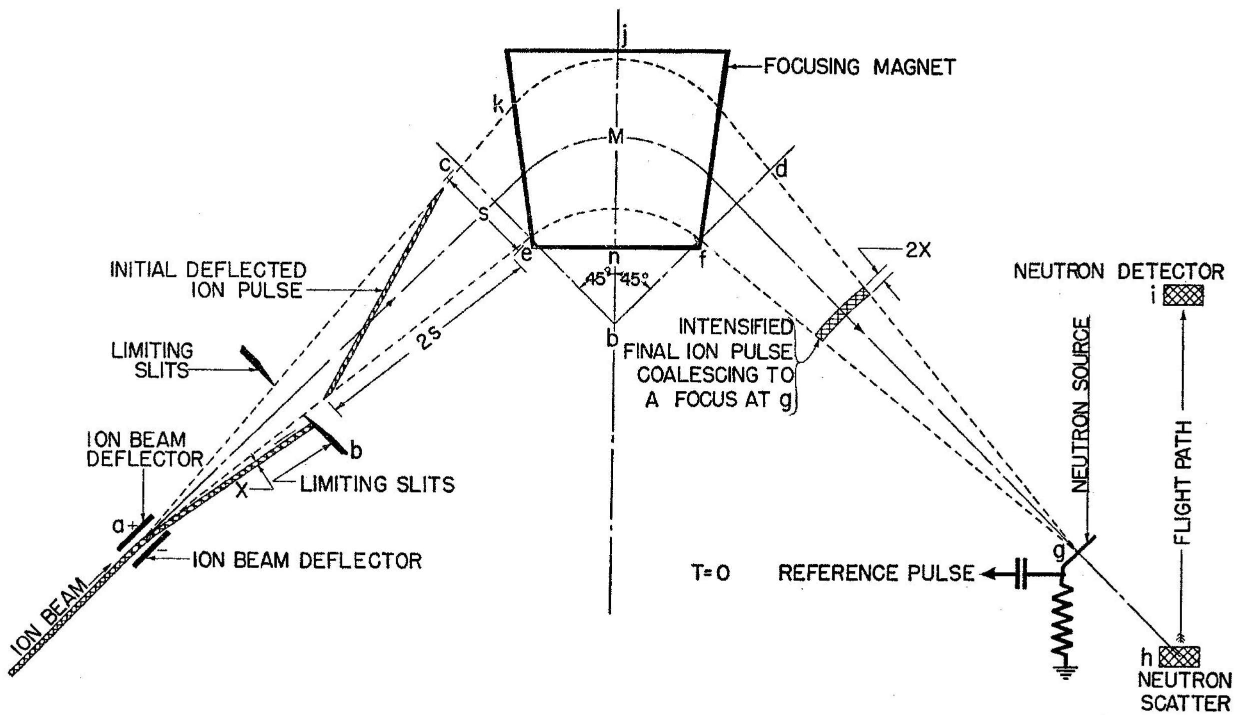
*Integrierter Neutronenfluss zwischen 1 keV und 100 keV

Frankfurt ***N***eutron-Source at the Stern-Gerlach-***Z***entrum (***FRANZ***)

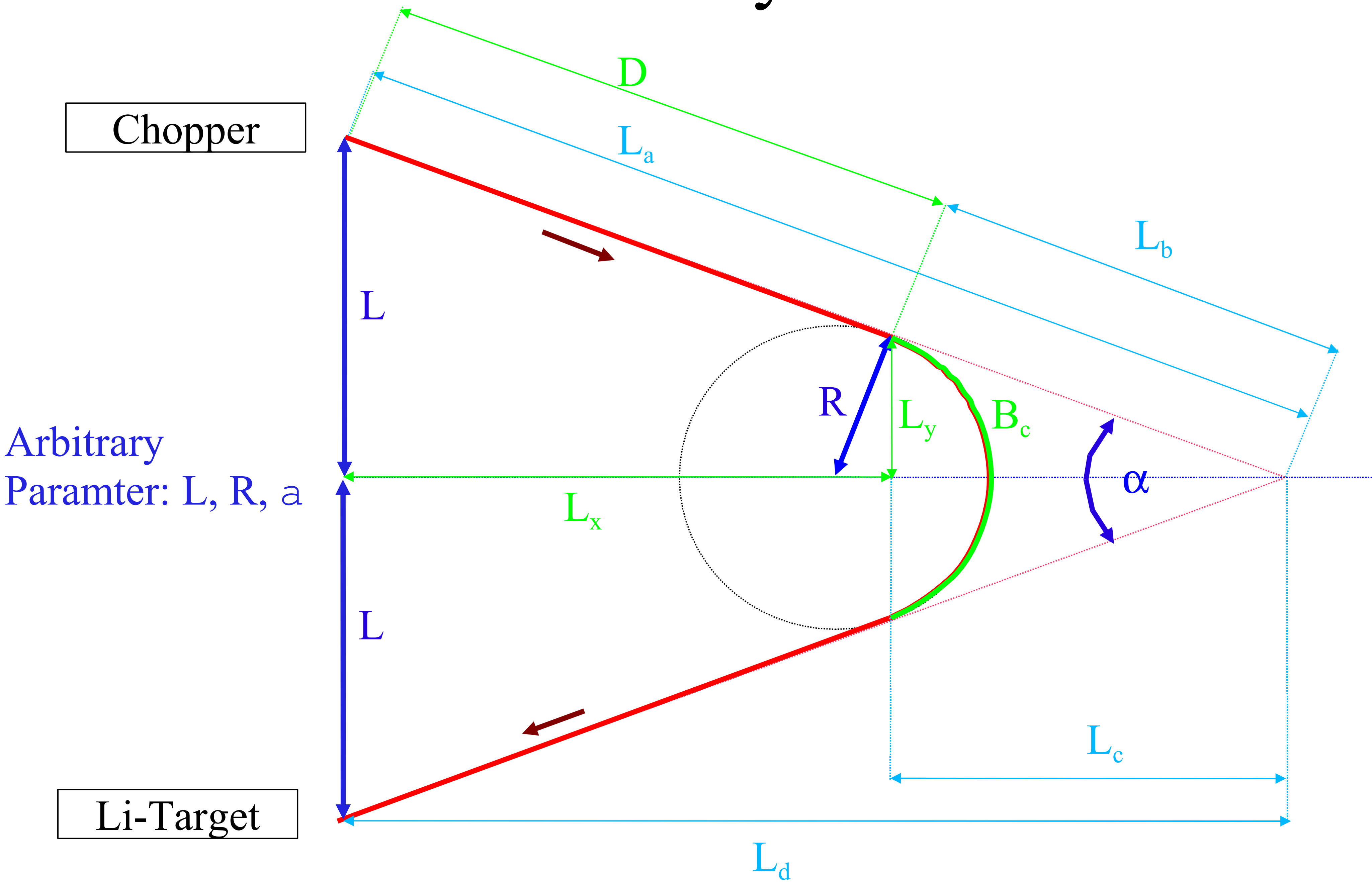


Concept of the Mobley-Buncher

R.C. Mobley: Phys. Rev. **88**(2), 360-361 (1951)



Buncher-System



Drift $$D(L,R,\alpha)=\frac{L}{\sin(\frac{\alpha}{2})}-\frac{R}{\tan(\frac{\alpha}{2})} \quad ; \quad \alpha\in(0,\pi)$$

Bend $$B_c(R,\alpha)=R(\pi-\alpha)$$

Total Path $$s(L,R,\alpha)=2\cdot D(L,R,\alpha)+B_c(R,\alpha)$$

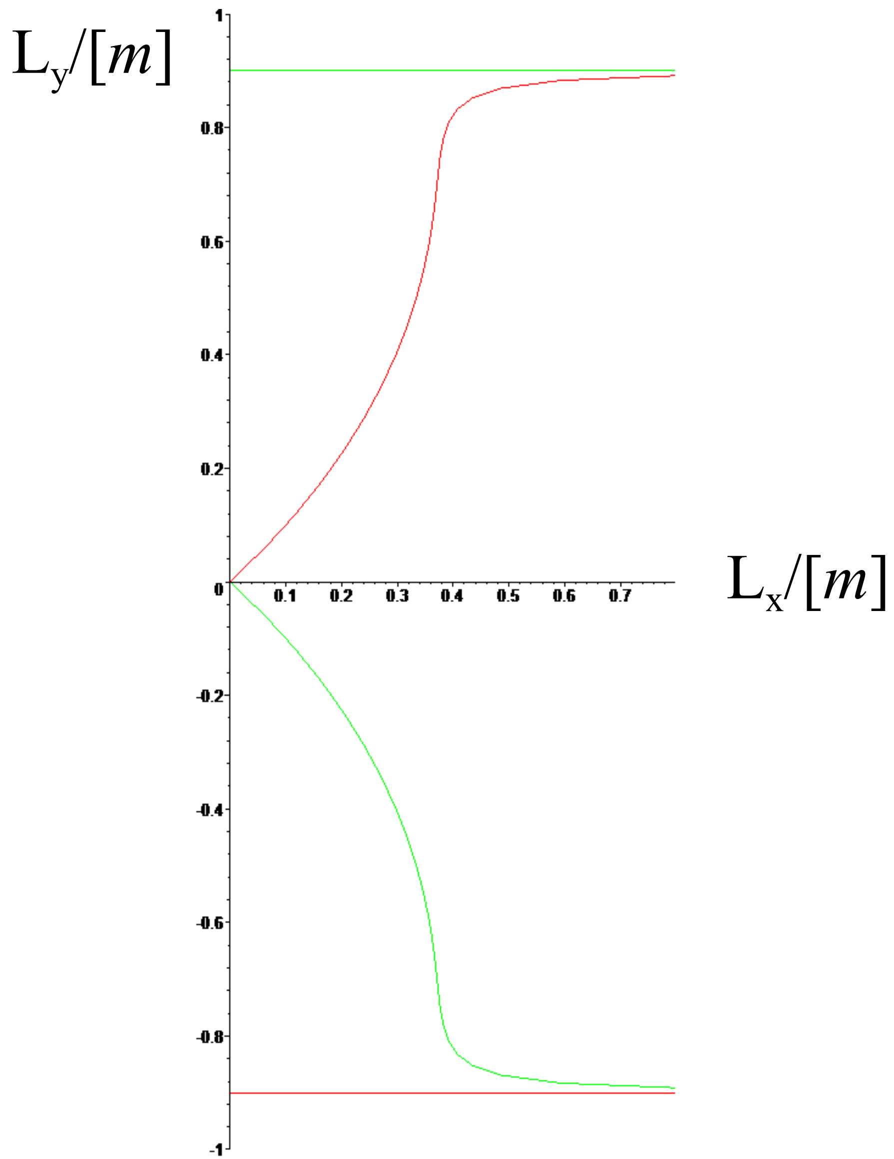
xy-Profile of the Dipole Magnet:

$$L_y = R \cdot \cos\left(\frac{\alpha}{2}\right)$$

$$L_x = \frac{1}{\tan\left(\frac{\alpha}{2}\right)} \left[L - R \cos\left(\frac{\alpha}{2}\right) \right]$$

$$L_x(L_y, L, R) = \frac{L - L_y}{\sqrt{\frac{R^2}{L_y^2} - 1}}$$

xy-Profile of the Dipole Magnet(1):



2*MeV* (Protons) <=> b=0.065
L=1.00 *m*
$R=m_p * v / (e * B)$
R=0.90 *m* <=> B=0.22 *T*

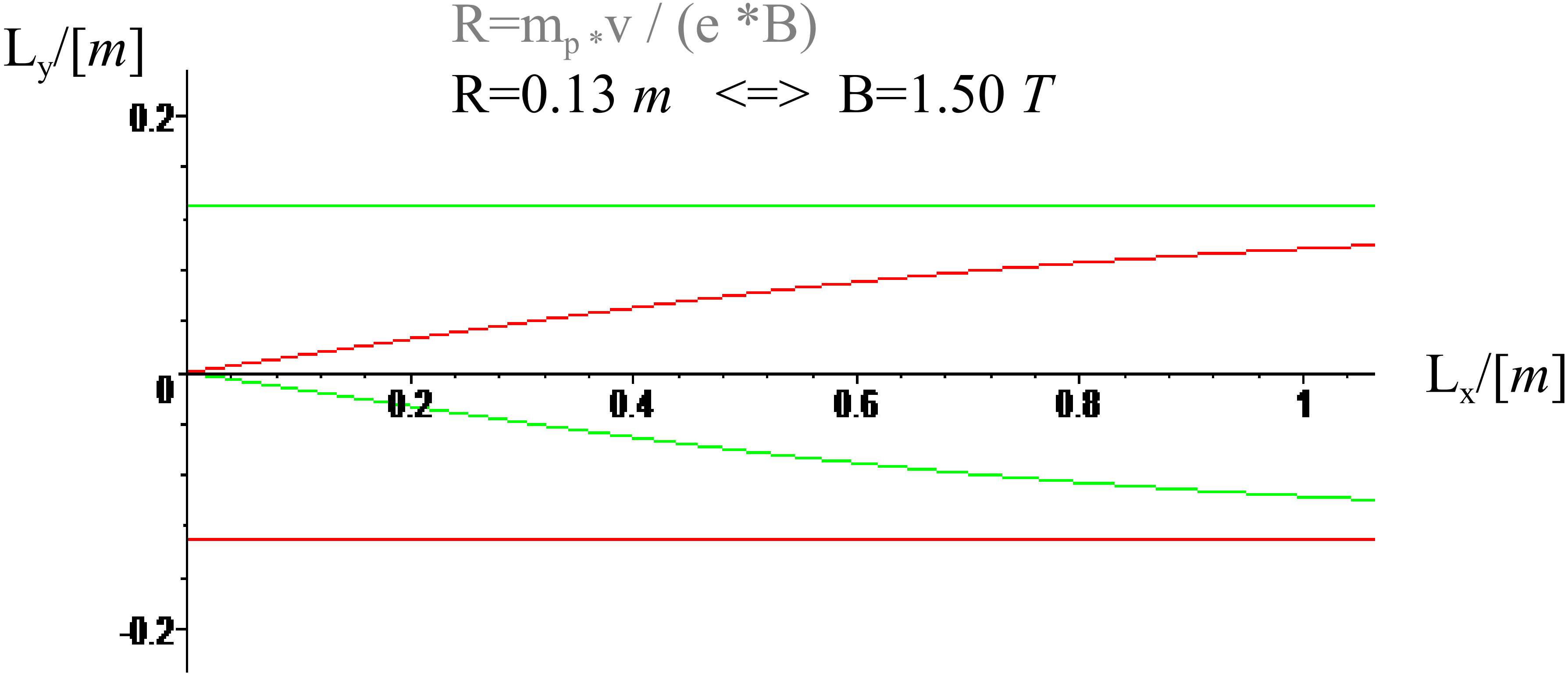
xy-Profile of the Dipole Magnet(2):

2*MeV* (Protons) <=> b=0.065

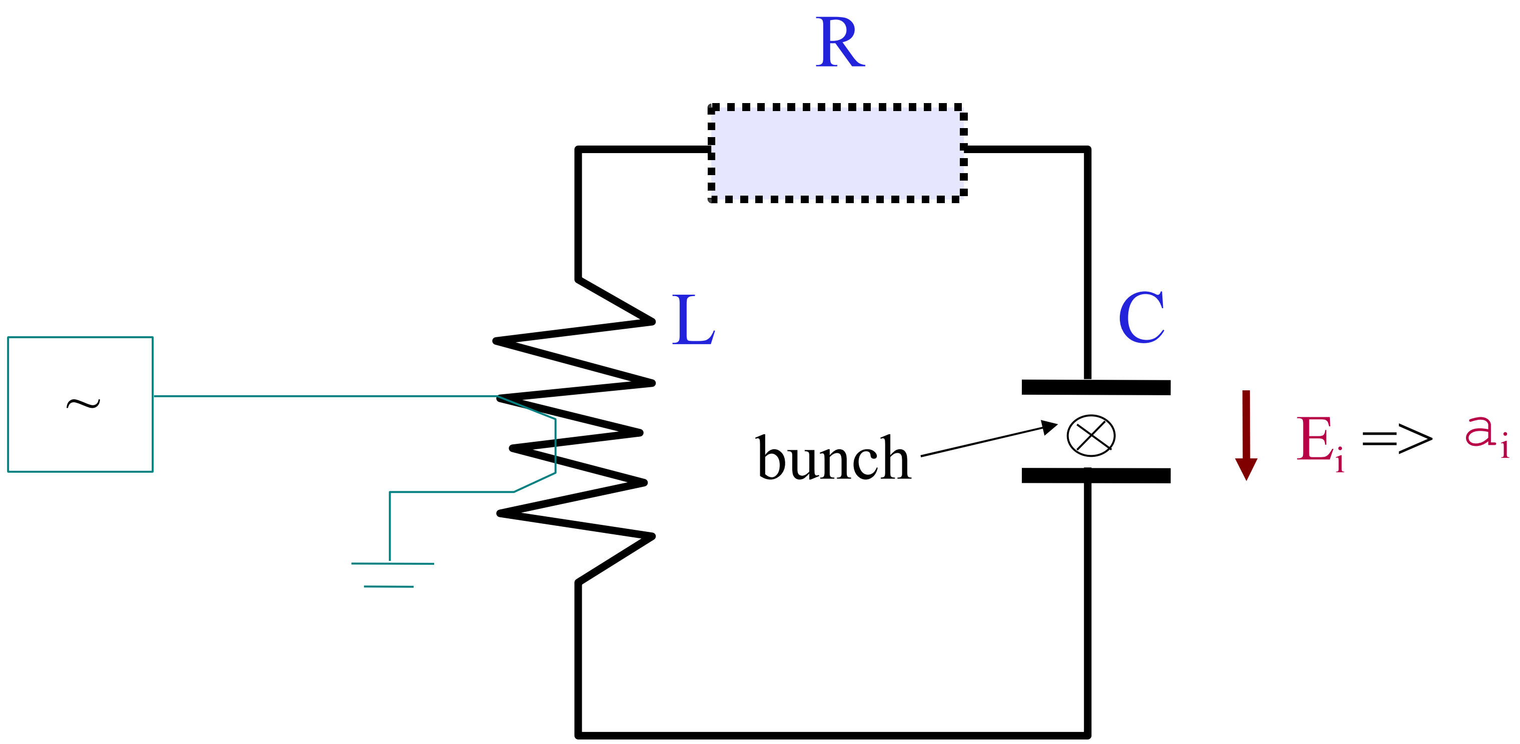
L=1.00 *m*

R=m_p * v / (e * B)

R=0.13 *m* <=> B=1.50 *T*



Chopper



$f_{chopper} \sim 5MHz$

Condition for a_{i} => a_{i+1} :

$$\left| s\left(\alpha_{i}\right) - s\left(\alpha_{i \pm 1}\right) \right| \equiv \Delta s$$

$$\Delta s = \frac{v_{p}}{f_{RFQ}} = \frac{0.065 \cdot c}{175 \cdot 10^{6}} [m] = 0.111 [m]$$

Two selected Settings(1):

$\alpha_4 = 107\,[deg]$

Bunch (i)	α_i ***[deg]***	$\Delta\alpha_{i,i+1}$ ***[deg]***	D_i ***[m]***	$B_{c,i}$ ***[m]***	s_i ***[m]***
1	139.7	14.1	1.017	0.091	2.126
2	125.7	10.4	1.057	0.123	2.238
3	115.3	8.3	1.101	0.147	2.350
4	107.0	6.9	1.148	0.166	2.461
5	100.1	5.9	1.196	0.181	2.573
6	94.1	5.2	1.245	0.195	2.685
7	89.0		1.295	0.207	2.796

$$\Delta L_{x,min}^{i,i+1} = 0.080\,[m]$$

$$\Delta P_{min}^{i,i+1} = 0.076\,[m]$$

$$\Delta\alpha_{1,7} = 50.7\,[deg]$$

$$\alpha_{c,max} = \frac{1}{4}\Delta\alpha_{1,7} = 12.7\,[deg]$$

Two selected Settings(2):

$$\alpha_4 = 81[deg]$$

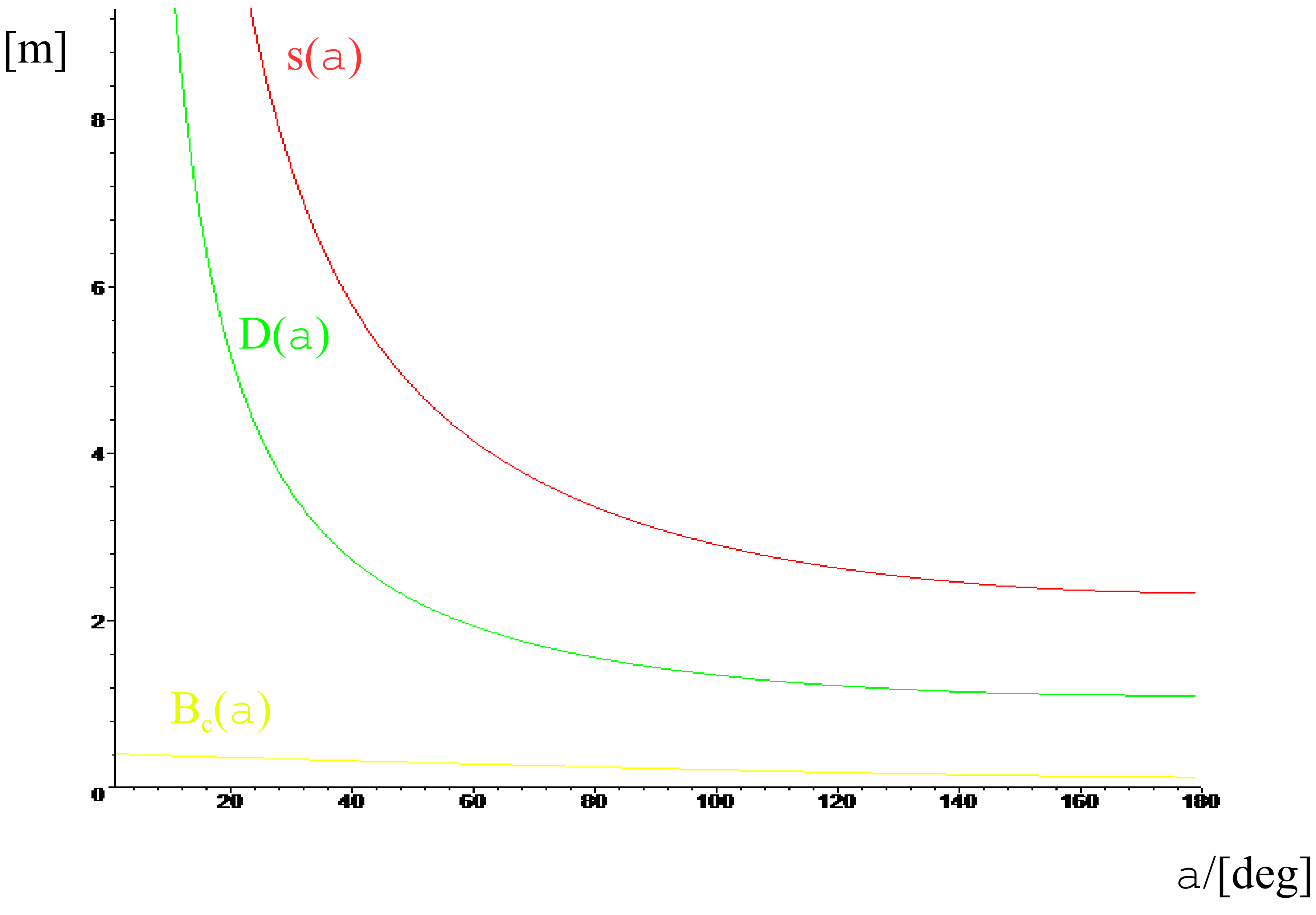
Bunch (i)	α_i *[deg]*	$\Delta\alpha_{i,i+1}$*[deg]*	D_i*[m]*	$B_{c,i}$*[m]*	s_i*[m]*
1	95.1	5.3	1.236	0.193	2.665
2	89.8	4.7	1.286	0.205	2.776
3	85.2	4.2	1.336	0.215	2.888
4	81.0	3.7	1.388	0.225	3.000
5	77.3	3.4	1.439	0.233	3.111
6	73.9	3.1	1.491	0.241	3.223
7	70.8		1.543	0.248	3.335

$$\Delta L_{x,min}^{i,i+1} = 0.069[m]$$

$$\Delta \alpha_{1,7} = 24.3[deg]$$

$$\Delta P_{min}^{i,i+1} = 0.066[m]$$

$$\alpha_{c,max} = \frac{1}{4}\Delta\alpha_{1,7} = 6.1[deg]$$



[m]
s(a)
D(a)
$B_c(a)$
8
6
4
2
0
20
40
60
80
100
120
140
160
180
a/[deg]

„Linearity“ of a :

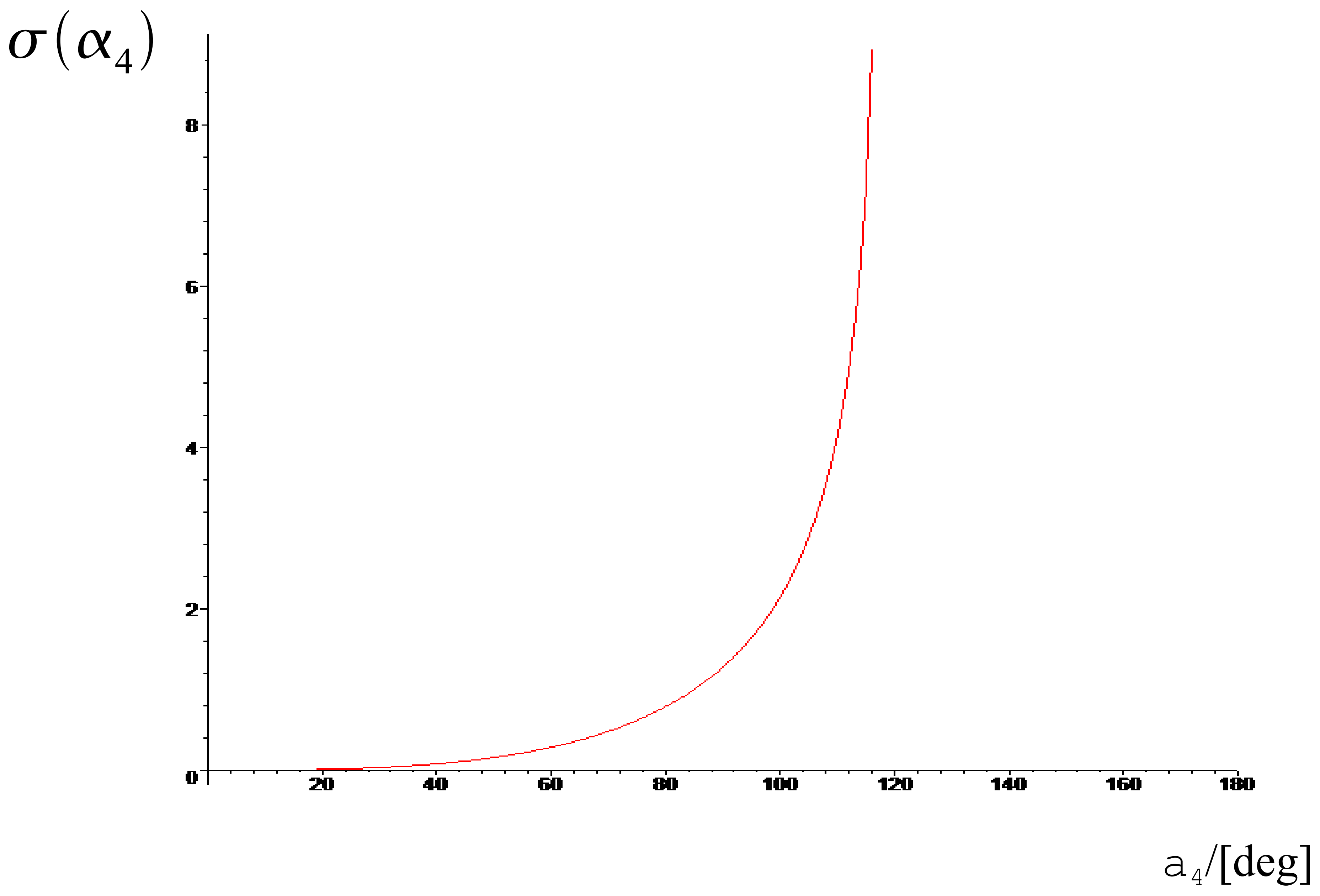
$$\alpha \equiv \alpha_4$$

=> $\{\alpha_1 , \alpha_2 , \alpha_3 , \alpha_5 , \alpha_6 , \alpha_7 \}$

=> $\Delta\alpha_{i,\,i+1} \equiv |\alpha_i - \alpha_{i+1}|$

=> $\overline{\Delta\alpha} \equiv \frac{1}{6}\sum_{i=1}^{6} \Delta\alpha_{i,\,i+1}$

$$\sigma(\alpha) \equiv \sqrt{\frac{1}{6-1}\sum_{i=1}^{6}\left(\Delta\alpha_{i,\,i+1} - \overline{\Delta\alpha}\right)^2}$$



$\sigma(\alpha_4)$
8
6
4
2
0
20
40
60
80
100
120
140
160
180
a4/[deg]

Constraint / to do

- space charge, beam dynamics => max. drift
- linearity of Da + max. E-Field => max. bending angle
- shunt impedance + skin-effekt => geometry of the chopper