Preliminary estimations of laser stripping for project x ICD-2

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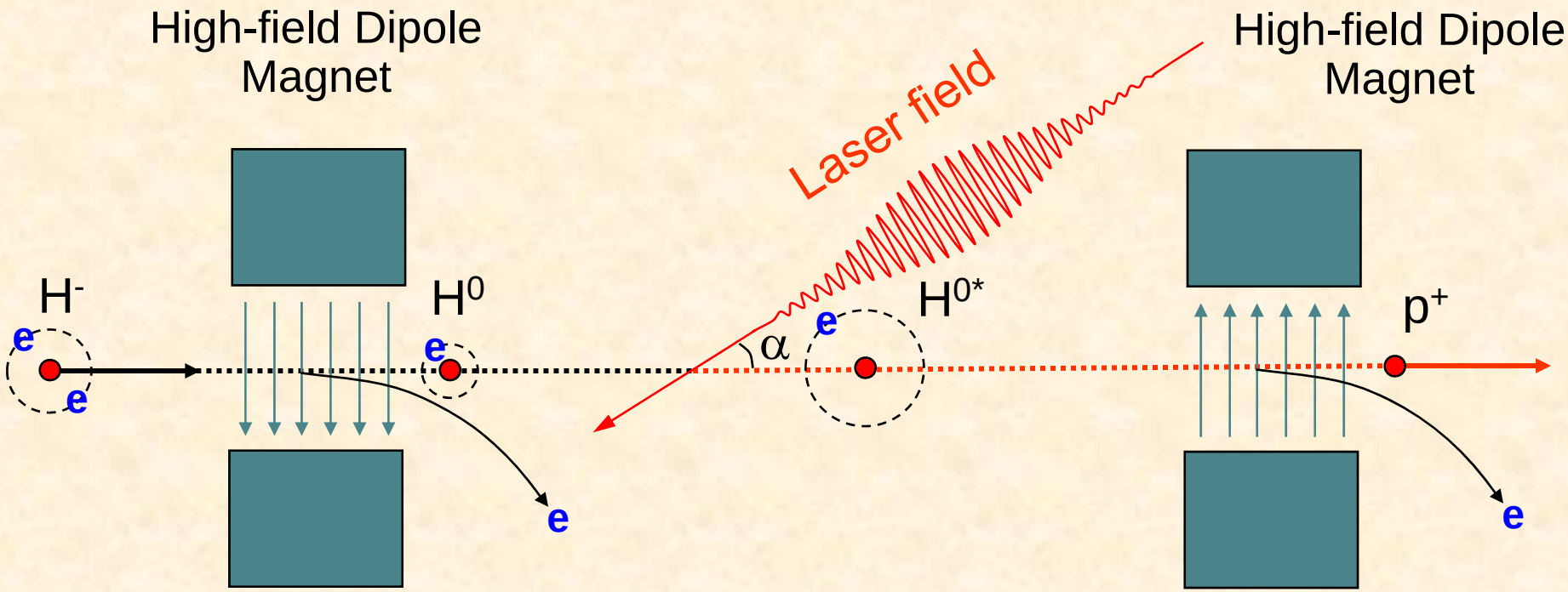
Three-Step Stripping Scheme

V. Danilov



Step 1: Lorentz Stripping

$H^- \rightarrow H^0 + e^-$

Step 2: Resonant laser Excitation

$H^0\ (n=1) + \gamma \rightarrow H^{0*}\ (n=3)$

Step 3: Lorentz Stripping

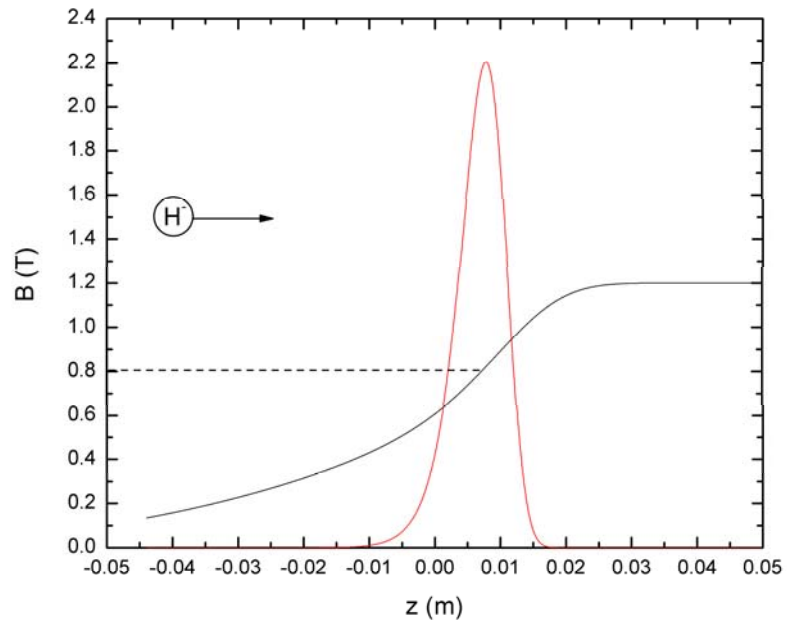
$H^{0*} \rightarrow p + e^-$

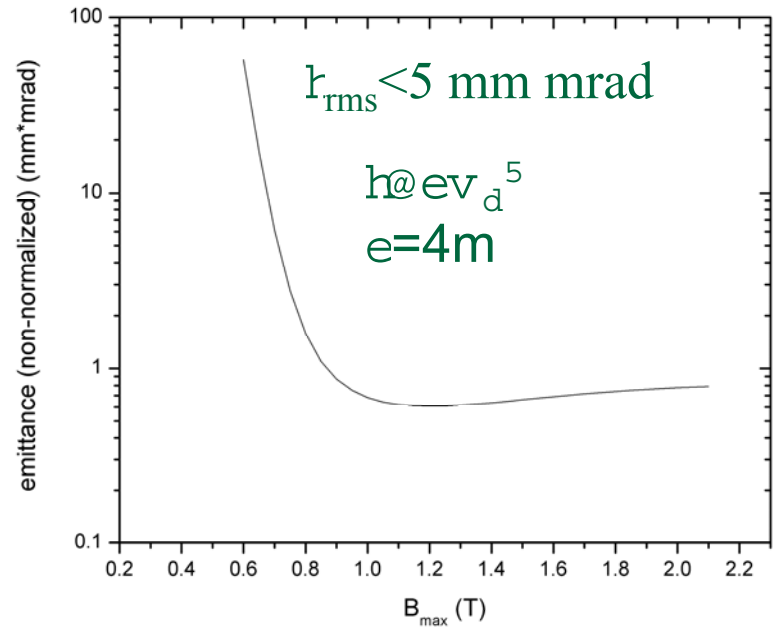
The First step

Fringe field:

$$F(s) = \frac{B_{max}}{1 + \exp[a_1 + a_2(\frac{s}{D}) + a_3(\frac{s}{D})^2 + a_4(\frac{s}{D})^3 + a_5(\frac{s}{D})^4 + a_6(\frac{s}{D})^5]}$$

D=4 cm

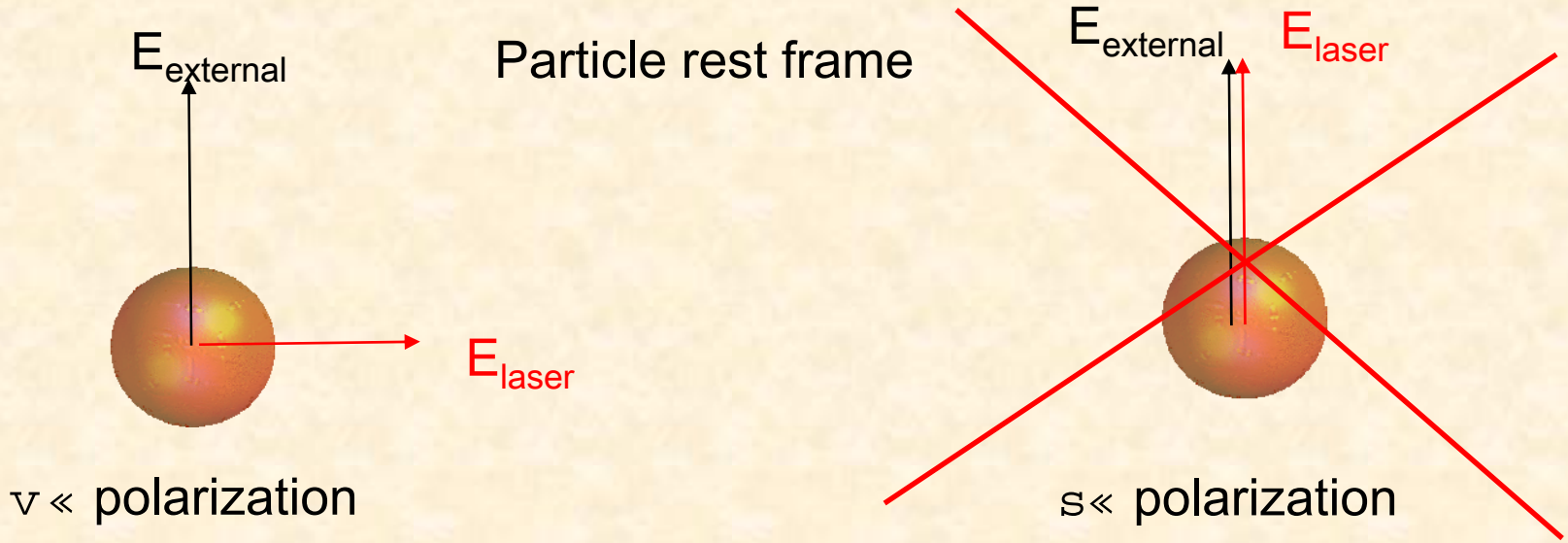




Requirements of design of the first magnet:

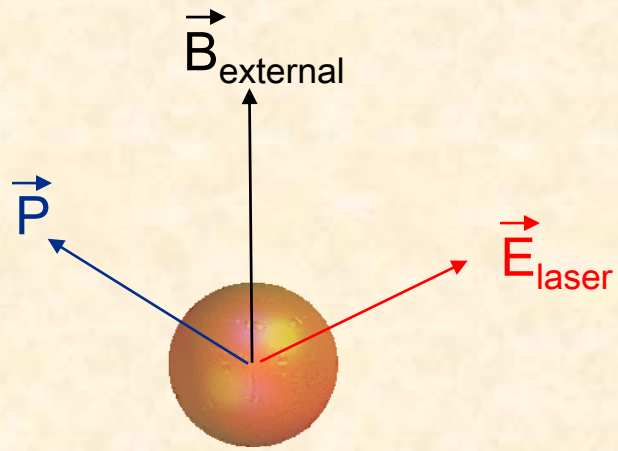
Derivative of transverse magnetic field at point B=0.8 T, (for T=2 Gev) should be as much as possible

Laser polarization



Requirements for laser polarization in laboratory frame:

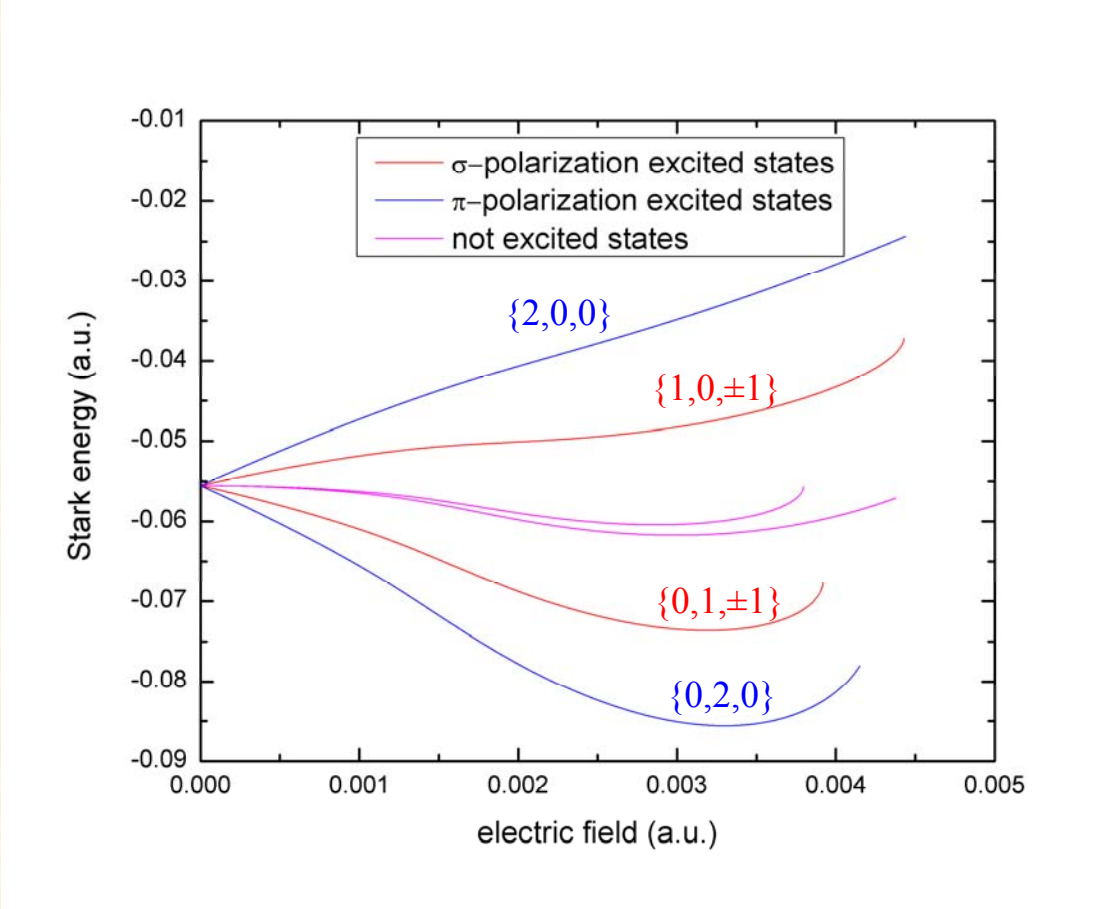
Vectors $\vec{E}_{laser}$ 4 $\vec{P}$, $\vec{B}_{external}$ must lie in the same plane



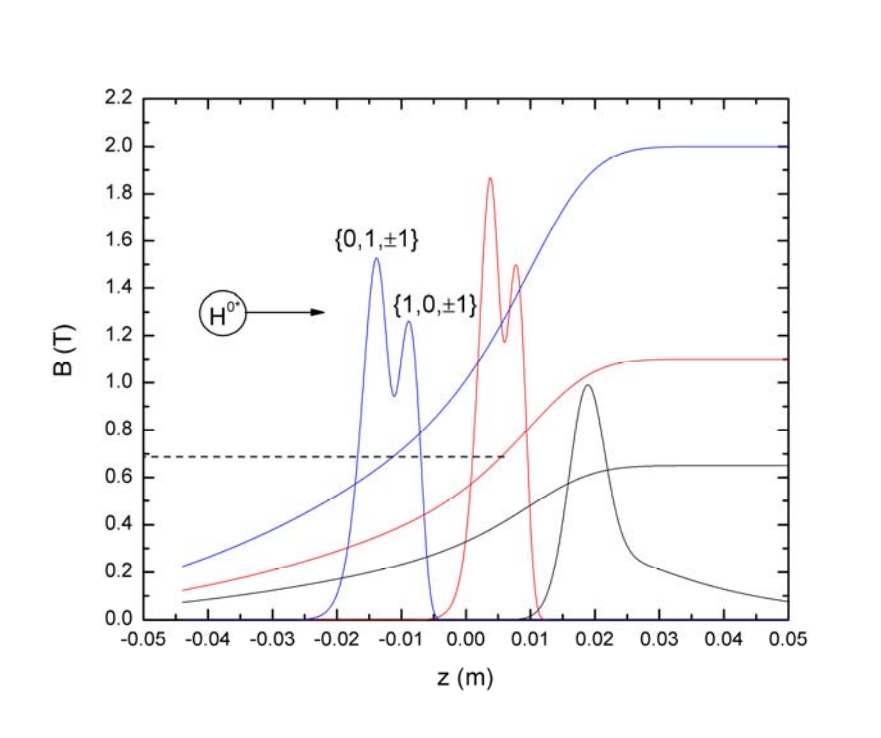
The first reason for the v polarization

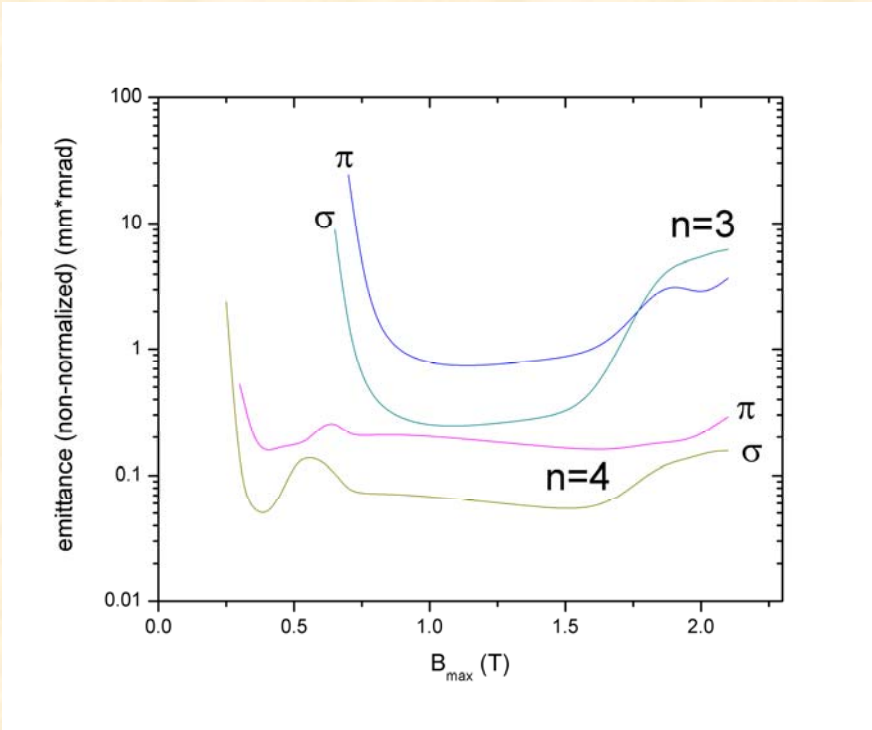
v polarization leads to less Stark splitting and better excitation

n=3



The third step and the second reason for the ν polarization

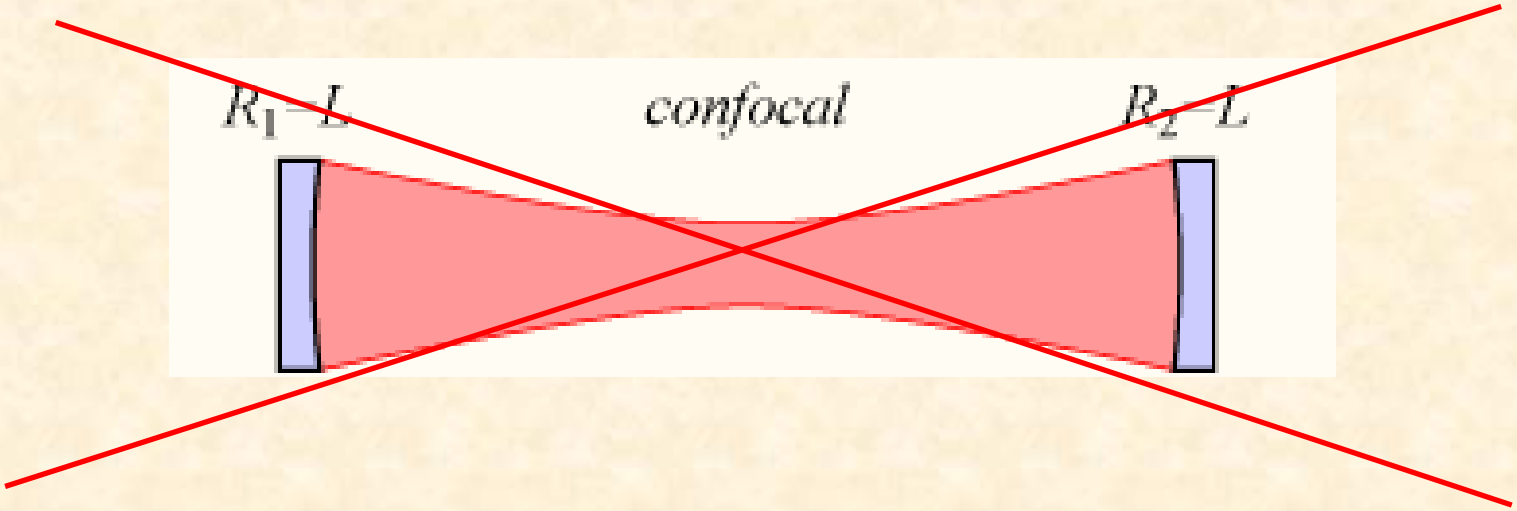


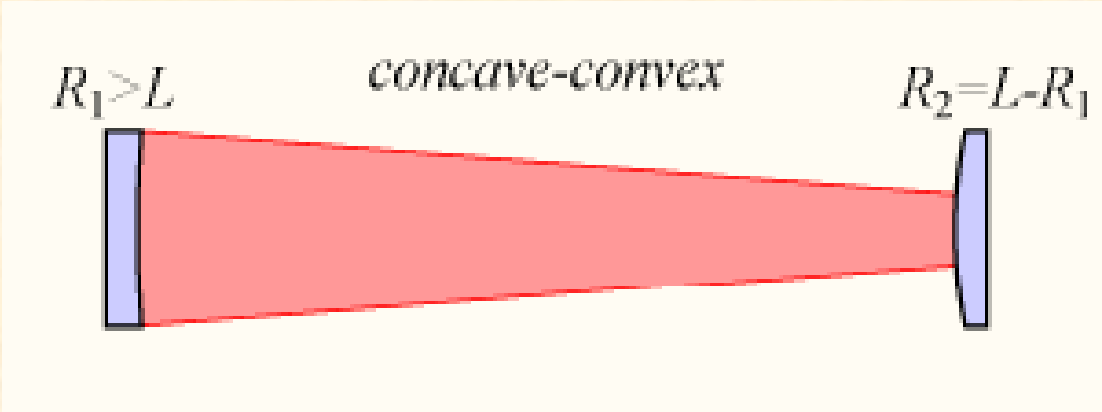


Requirements for design of the second magnet:

1. Derivative of transverse magnetic field at point B=0.7 T (for T=2 Gev) should be as much as possible
2. Excitation of the 3rd level of hydrogen atom is optimal
3. The field at the interaction point should be as low as possible
4. The interaction point should be located closer to the second magnet

Type of cavity



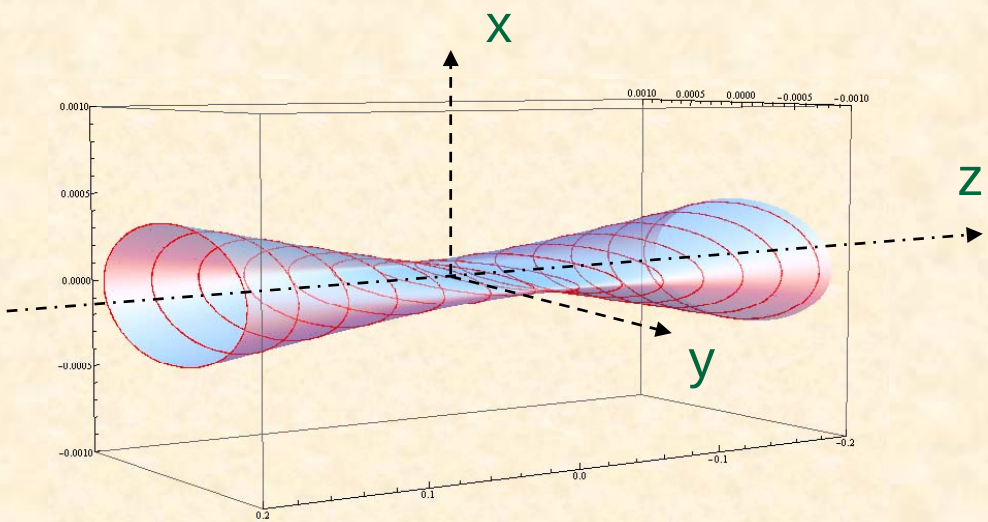


Laser field

Presented in form of Elliptical Gaussian beam

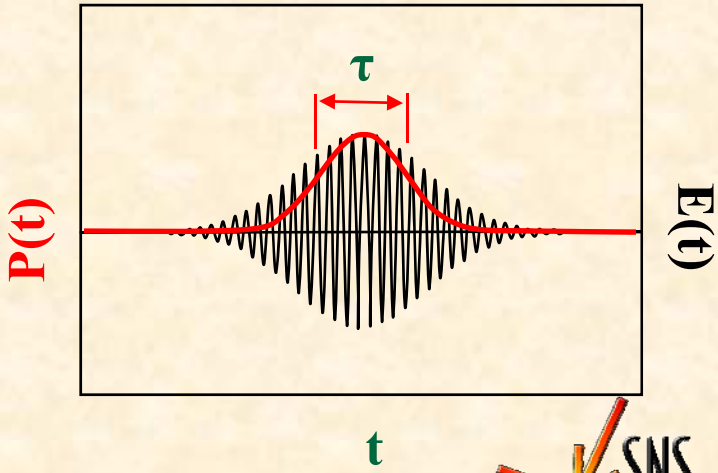
Laser beam parameters

w_x, w_y	waists on x and y axes
f_x, f_y	positions of waists
λ	wavelength
P	power of the beam



Temporal shape of laser micropulse

$$P(t) = P_0 \exp\left(-\frac{t^2}{2\tau_{rms}^2}\right)$$



Results of calculation

H^0 beam parameters

$v_T/T = 0.25*10^{-3}$

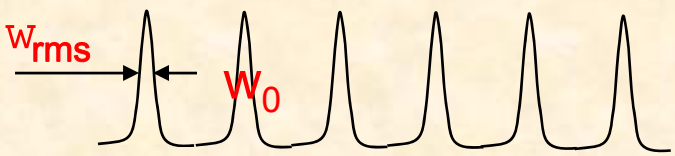
λ @ 858 nm

w_{rms} = 10 ps

$\varepsilon_{rms\ x,y}$ = 0.3 mm*mrad (norm)

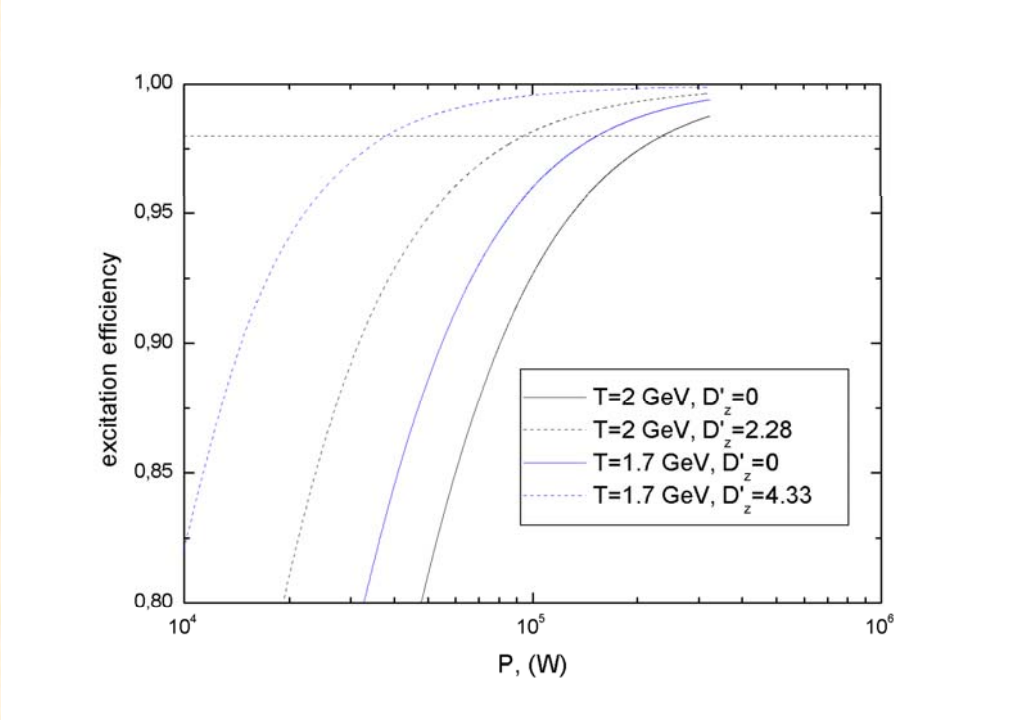
$\beta_{x,y}$ = 4 m

Laser field



ν@658 P Kz

Excitation efficiency (without external field) as a function of laser beam power

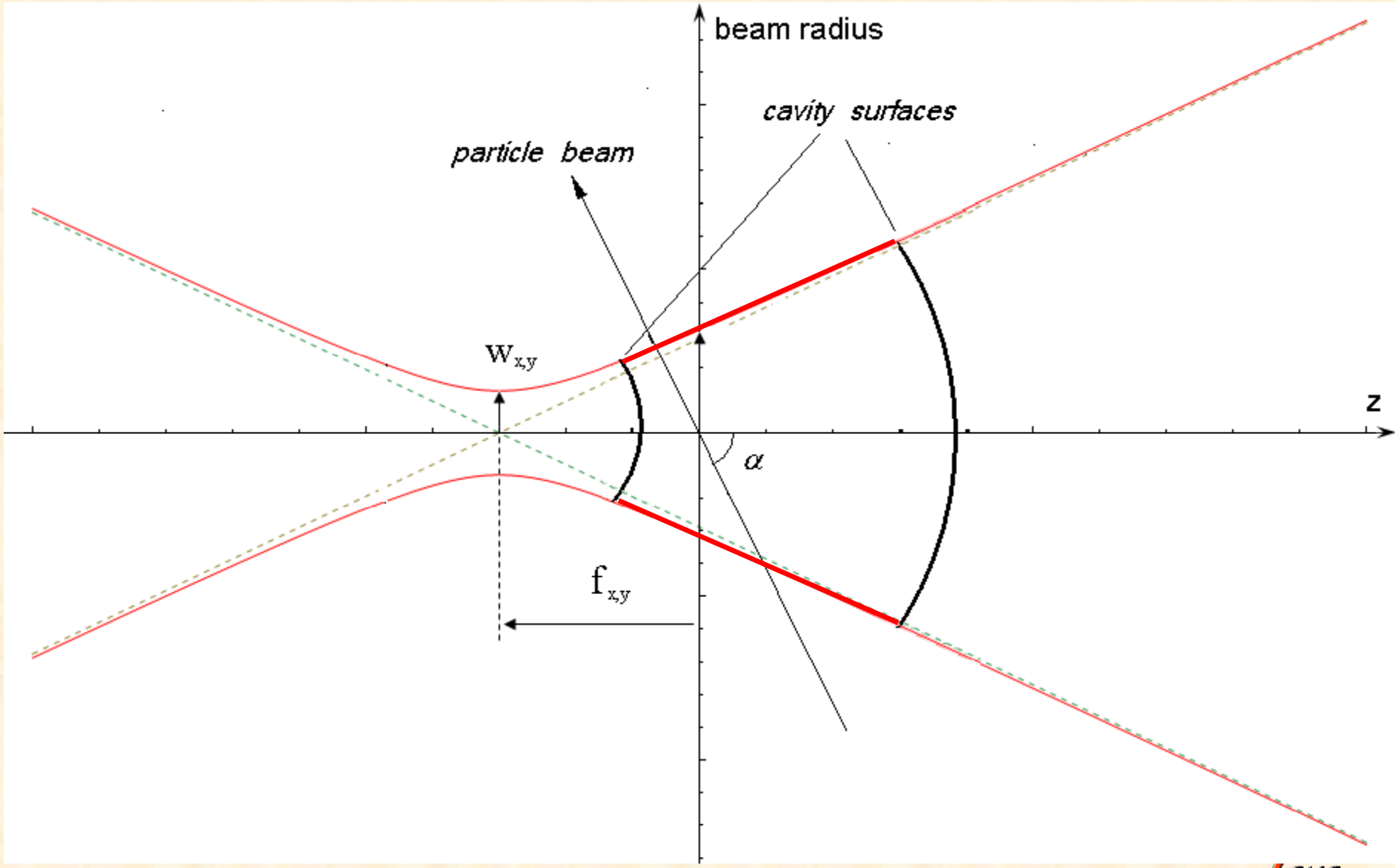


T (GeV)	D'_z	w_x (um)	w_y (um)	f_x(cm)	f_y(cm)	w_{rms} (ps)	w_0 (mJ) (eff=98%)	$\overline{P}_{4us}$ (kW) (eff=98%)	δ_{inc}
2	0	113	496	-71	-435	16	0.72	234	40^0
2	2.28	269	313	-265	-286	18	0.3	97.5	40^0
1.7	0	60	493	-22	-449	20	0.48	156	25^0
1.7	4.33	190	362	-113	-357	24	0.12	39	25^0

Conclusions

- **Preliminary estimations have shown feasibility of laser stripping (~100 W during 4us, total average power about 10 watts (4% duty factor), assuming 1000 FP cavity amplification for 532 nm light)**
- **There must be provided possibility of varying beam energy and dispersion derivative and transverse size of the beam in injection point for easier realization of laser stripping**
- **The final design of laser stripping must be performed in close coordination with magnets and magnetic field field design, laser beam cavity design and H^- beam optics design. (Recommendation for all these designs are listed in the presentation)**

Elliptical cavity and laser beam parameters

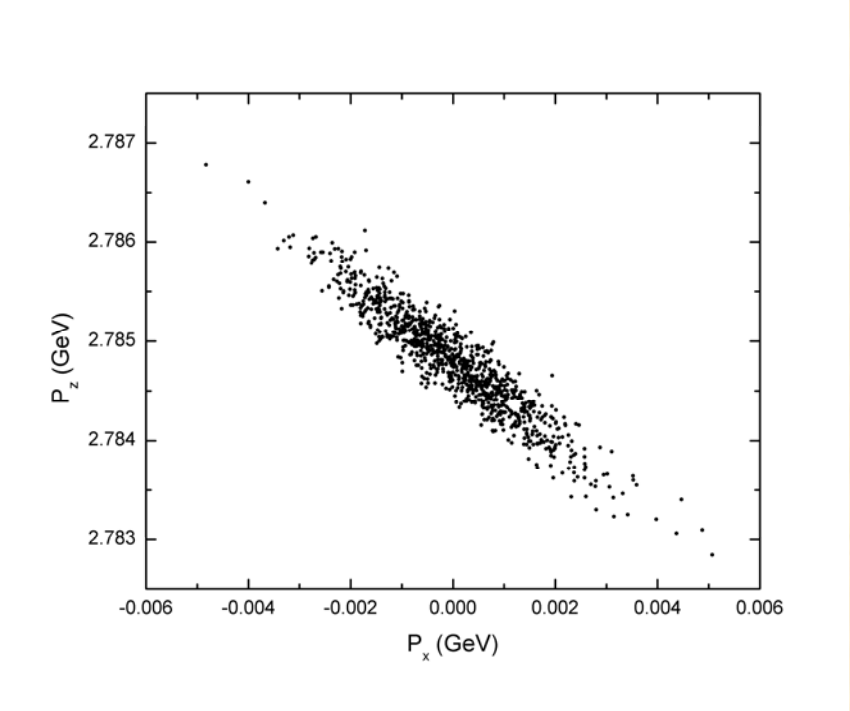
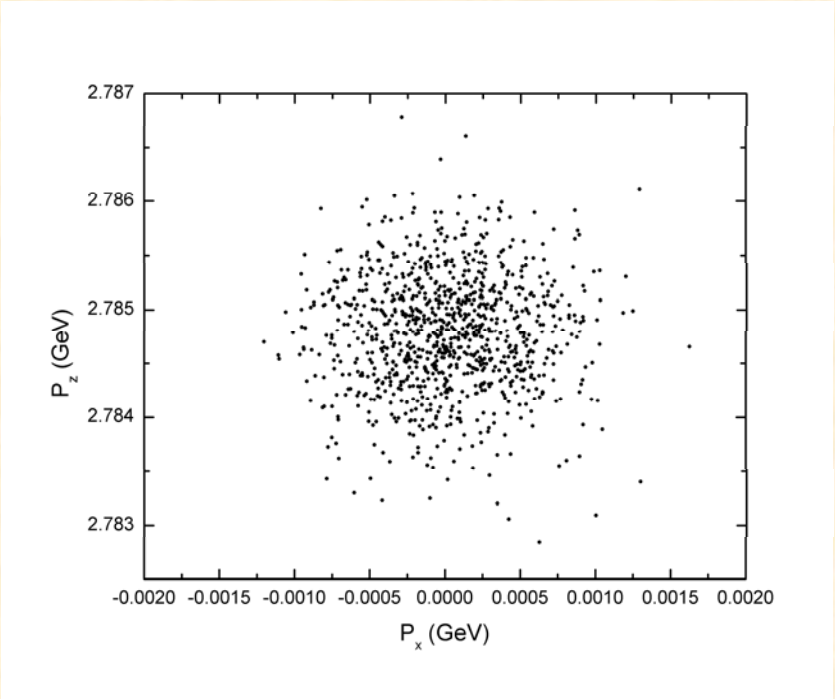


Recommendation for H^- beam optics

- **For better LS efficiency the optimal energy of the beam is lower then 2 GeV (It can be optimized and calculated exactly)**
- **Decrease of vertical transverse size of the beam or decrease of vertical beta function will also lead to better efficiency**
- **Dispersion derivative?**

Dispersion derivative

$D_x'>0$



$D_x'=0$