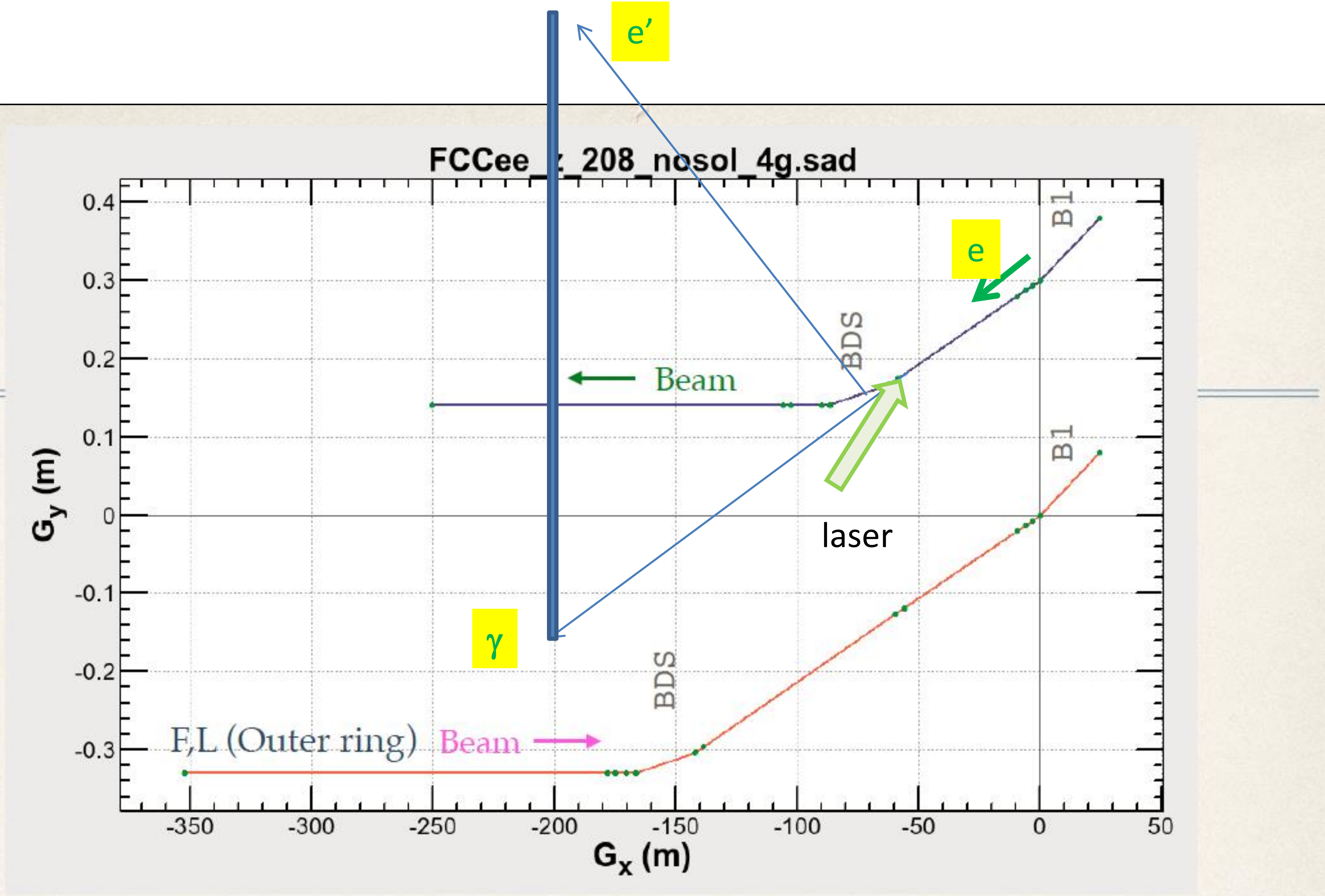
First look at back-scattered Compton polarimeter-and-spectrometer

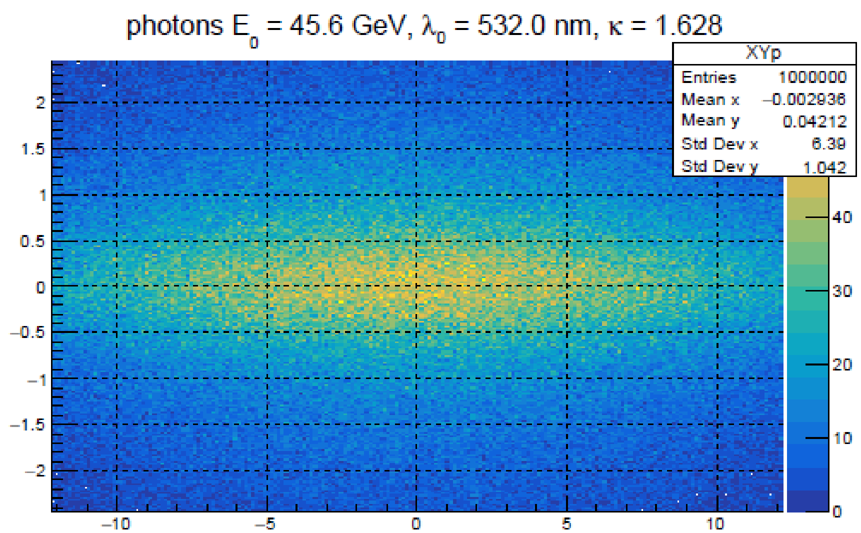
N. Muchnoi (BINP) A. Blondel (Geneva)

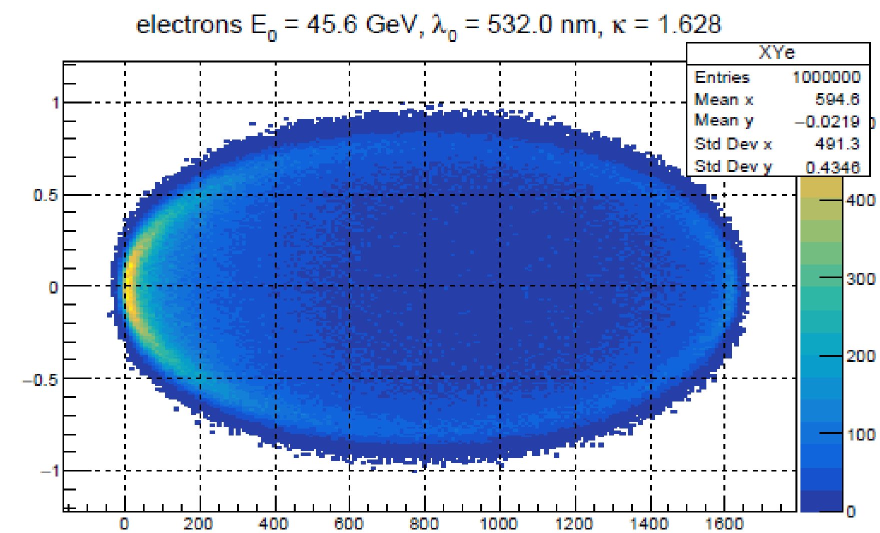


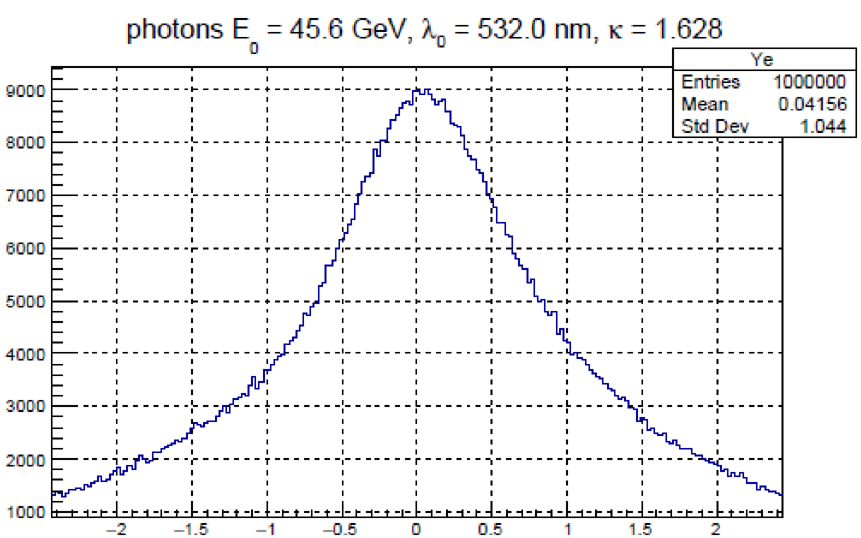
The dispersion suppressor dipole (BDS):

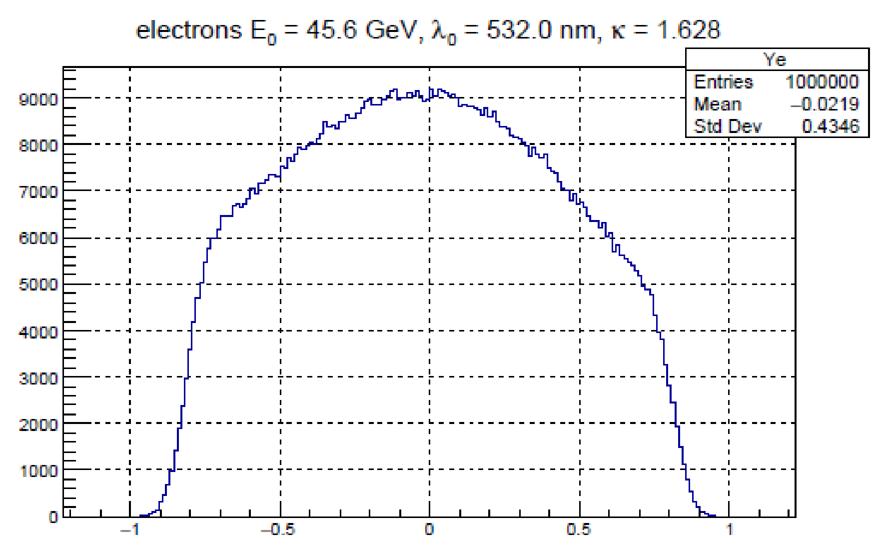
```
;
 BEND    BDS      =(L =24.119925292770883  ANGLE =.002134100603580931    E1 =.5    E2 =.5 )
```

In units of $1/\gamma = m_e c^2/E_{beam}$



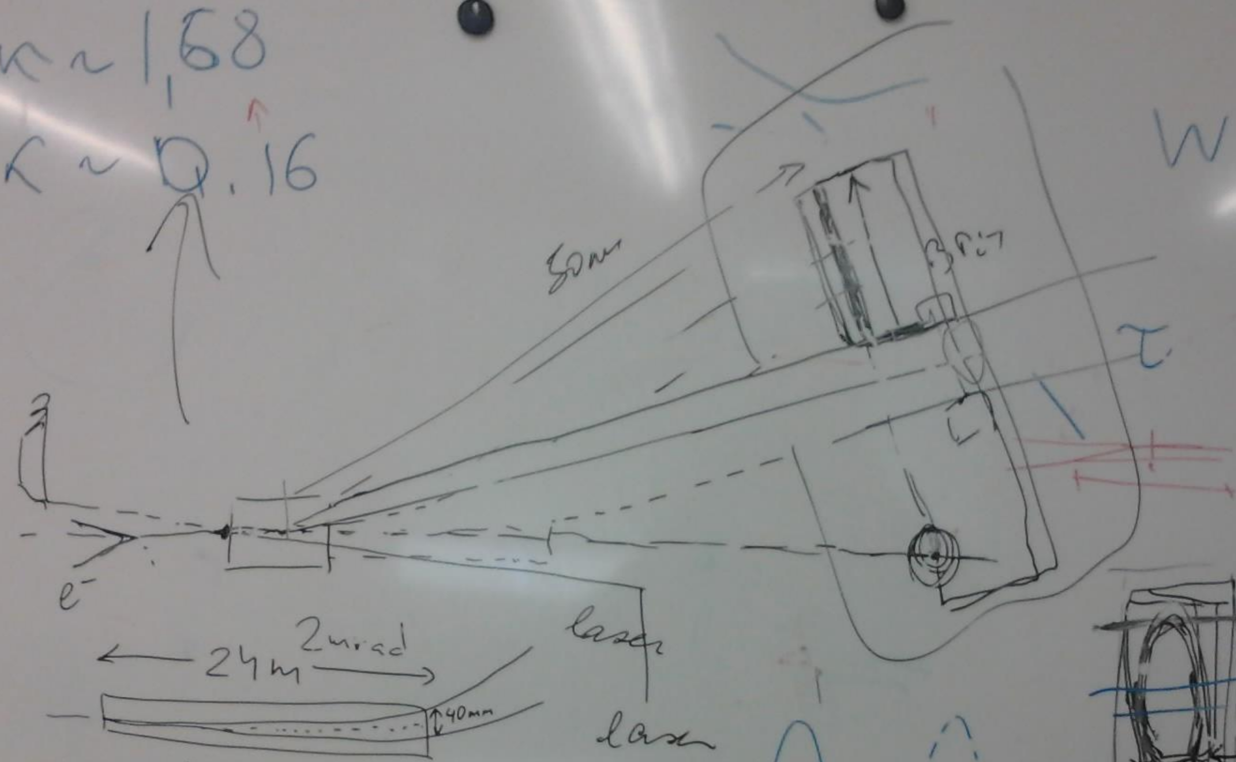






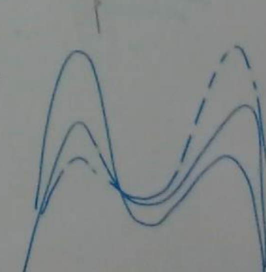
$\kappa \sim 1{,}68$

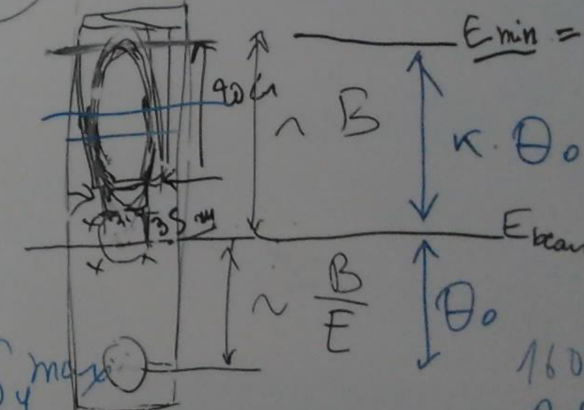
$\kappa \sim 0.16$



$\frac{\Delta L}{L} \sim 10^{-6}$

$$W = \frac{P\,[W]}{0{,}7 \cdot 10^{11}\,[\ldots]}$$





$\sim B$

$\kappa \cdot \theta_0$

$\sim \frac{B}{E}$

θ_0

δ_y^{max}

160

0.1

$\frac{1}{\gamma}$

$$\Delta P = \frac{\sigma}{\sqrt{2N}\,\delta_y^{max}} = \frac{\sqrt{\delta^2 + \sigma_0^2}}{\ldots\,\delta^{max}}$$

http://laser-export.com/prod/527.html

Last updating: 3.4.201

...Laser-compact Group specializes in research, development and manufacturing of **ultra-violet (UV), green and infrared (IR)** diode-pumped solid-state (DPSS) lasers....

ISO 9001:2008 certified

TECH-527

Application fields: materials micromachining, laser marking, photoacoustics, LIBS (laser-induced breakdown spectroscopy), DLIP (Direct Laser Interference Patterning), LIBD (laser-induced breakdown detection), OPO pumping, remote sensing, high technologies R&D, ablation.

Features:

- Active Q-switched mode of operation with nanosecond pulse duration
- High pulse energy and peak power
- Perfect beam quality
- High pulse-to-pulse stability
- Ultra-compact design
- Conductive cooling of laser head
- External / internal triggering, PC control via RS-232
- Fiber-coupling option is available on request

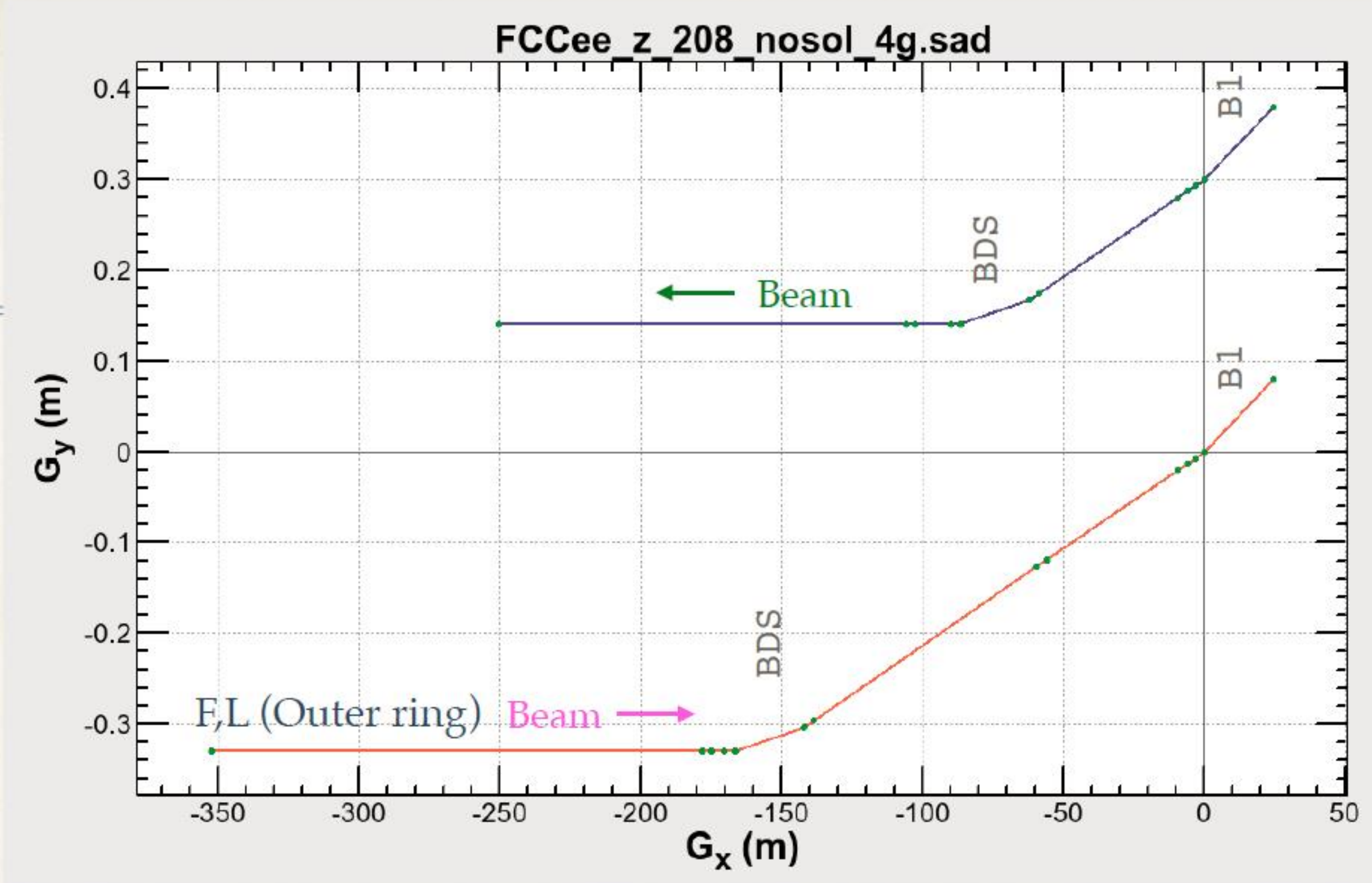
TECH-series datasheet

Parameter / Model	TECH-527			
	Basic	Advanced	Express	Specific
Wavelength, nm	527			
Mode of Operation	Q-switched, external/internal triggering			
Pulse Energy [1,2], μJ	250	500	500	1000
Max. Average Output Power, W	~0.25@1kHz ~0.5@4kHz	~ 2 @4 kHz	~ 0.5 @1kHz	~ 1 @1 kHz
Pulse Duration(FWHM)[1,2], ns	< 5		< 3	<12
Peak Power[1,2], kW	>50	> 100	> 165	>80
Range of Pulse Repetition Rate, kHz Ext. Triggering[3] Int. Triggering: through RS-232[4] without PC[5]	 single pulse - 4 0.01 - 4 1 ±0.01	 single pulse-4 0.01 - 4 4 ±0.01	 single pulse - 1 0.01 - 1 1 ±0.01	
Pulse-to-pulse Stability - StDev/Mean [1,2],%	<3		<2	
Long-term Stability, %/8 hrs	< 2			
Beam Quality	TEMoo, $M^2<1.2$			
Beam Diameter ($1/e^2$, at output aperture), mm	0.6 ±0.2		0.7 ±0.2	0.8 ±0.2
Beam Divergence (full angle,$1/e^2$), mrad	< 3			
Polarization Linearity	> 100:1, vertical (< 5°)			
Laser Trigger to Sync Out Pulse[1,2,6] , ns (av. pulse energy > 80%) Delay (the value is within the range) Jitter	 300 ±250 * < 8 *			
Laser Emission to Sync Out Pulse[1,2,6] , ns (av. pulse energy > 80%) Delay Jitter	 < 50 < 2			
Warm Up Time, min	< 10			
Remote Control of Laser Parameters via interface RS-232	ON/OFF, Ext./Int. Triggering, Pulse Rep. Rate, Pulse Energy			
Data rate via Interface RS-232, bit/s	4800			
Operation Voltage, V	24 ±10%			
Max. Current Consumption, A	< 6			
Power Consumption, W	15-70[7]	20-90[7]	15-70[7]	
Laser Head Heating Power, W	5-20[7]	5-30[7]	5-20[7]	
Operating Temp/Humidity Range °C	+15 to +35 °C / up to 80% non-condensing			
Shipping Temp/Humidity Range (In the manufacturer package)	-20 to +50 °C / up to 80% humidity at 25 °C			
Dimensions of Laser Head (LxWxH), mm	215 x 70 x 40			

Beam Height, mm	21.5
Weight of Laser Head, kg	1.2 ±0.1
Dimensions of PSU (LxWxH), w/o Fan Heat Sink[7], mm	max. 230 x 153 x 47
Weight of PSU w/o Fan Heat Sink , kg	1.9 ±0.1
Weight of Fan Heat Sink, kg	1.7 ±0.1
Fiber Cable Length, m	1.5 ±5%
Minimal long term bending Radius of Fiber Cable, mm	50
LH-PC Cable Length, m	1.5 ±5%
Laser Class	IV
Compliance	CE, RoHS
Drawing of Laser Head	
Drawing of Power Supply	
Drawing of Fan Heat Sink for PSU	

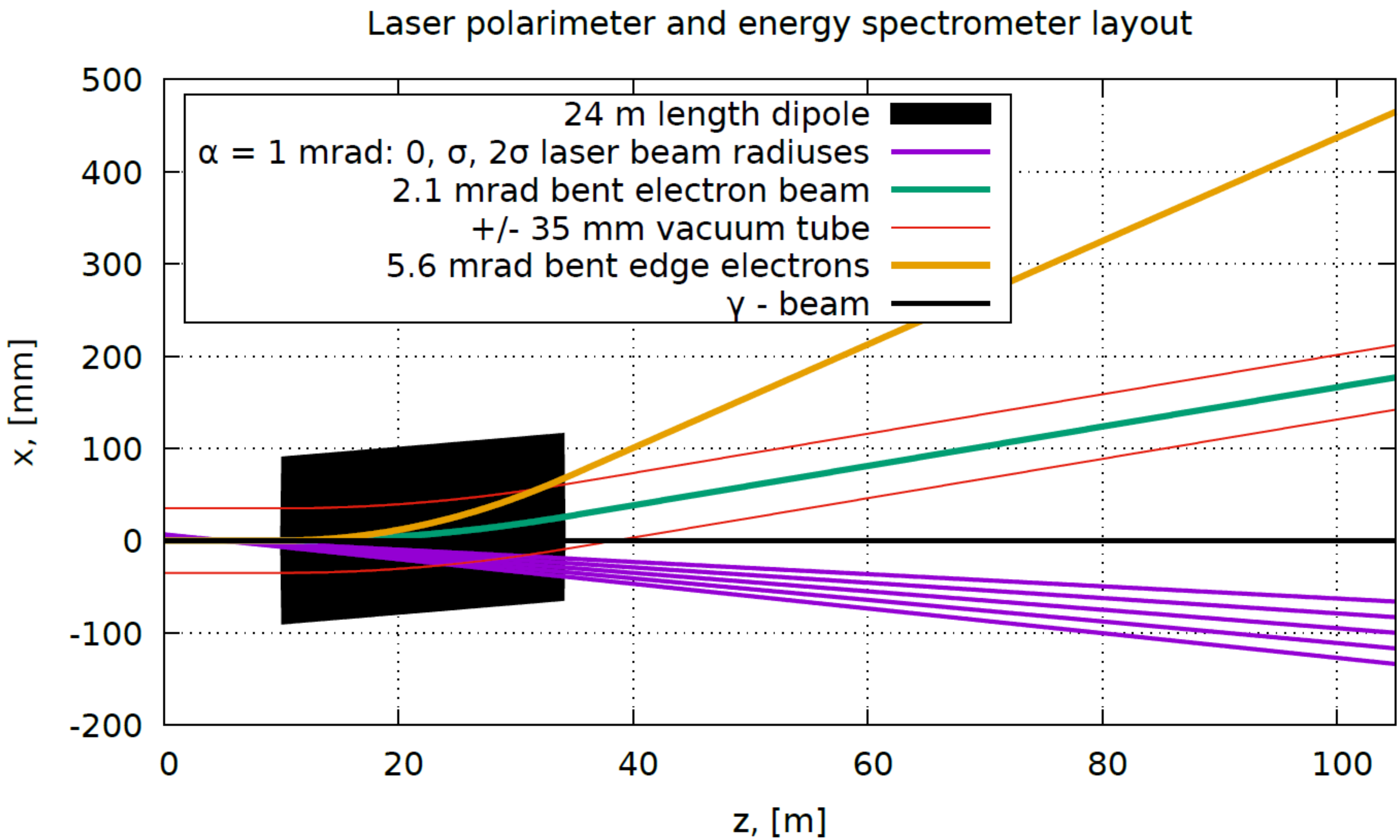
* **For Advanced, Express and Specific line:** Delay and jitter are specified for the case of triggering by the pulse with the certain duration determined by the manufacturer (typ. 200-230 Bμs for Advanced and 800-900 Bμs for Express, Specific). Counted from the fall edge of the trigger pulse. In case of triggering with rise edge, the delay is about 200-230 Bμs and 800-900 Bμs, respectively, and the jitter is approx. 2% of it.

[1] Measured at 1 kHz pulse repetition rate for Basic, Express and Specific line.
[2] Measured at 4 kHz pulse repetition rate for Advanced line.
[3] Triggering with external electric pulse generator; generator is not included in delivery set.
[4] Generation of periodical laser pulses using PC, step 0.01 kHz. Average energy may be changed by software from 10% up to maximum value.
[5] Generation of periodical laser pulses at fixed rep. rate; external generator and/or PC are not required.
[6] Sync Out signal is generated by pulse of laser light.
[7] Depending on pulse repetition rate. Fan Heat Sink to be attached depending on operation conditions and/or pulse repetition rate operation range.

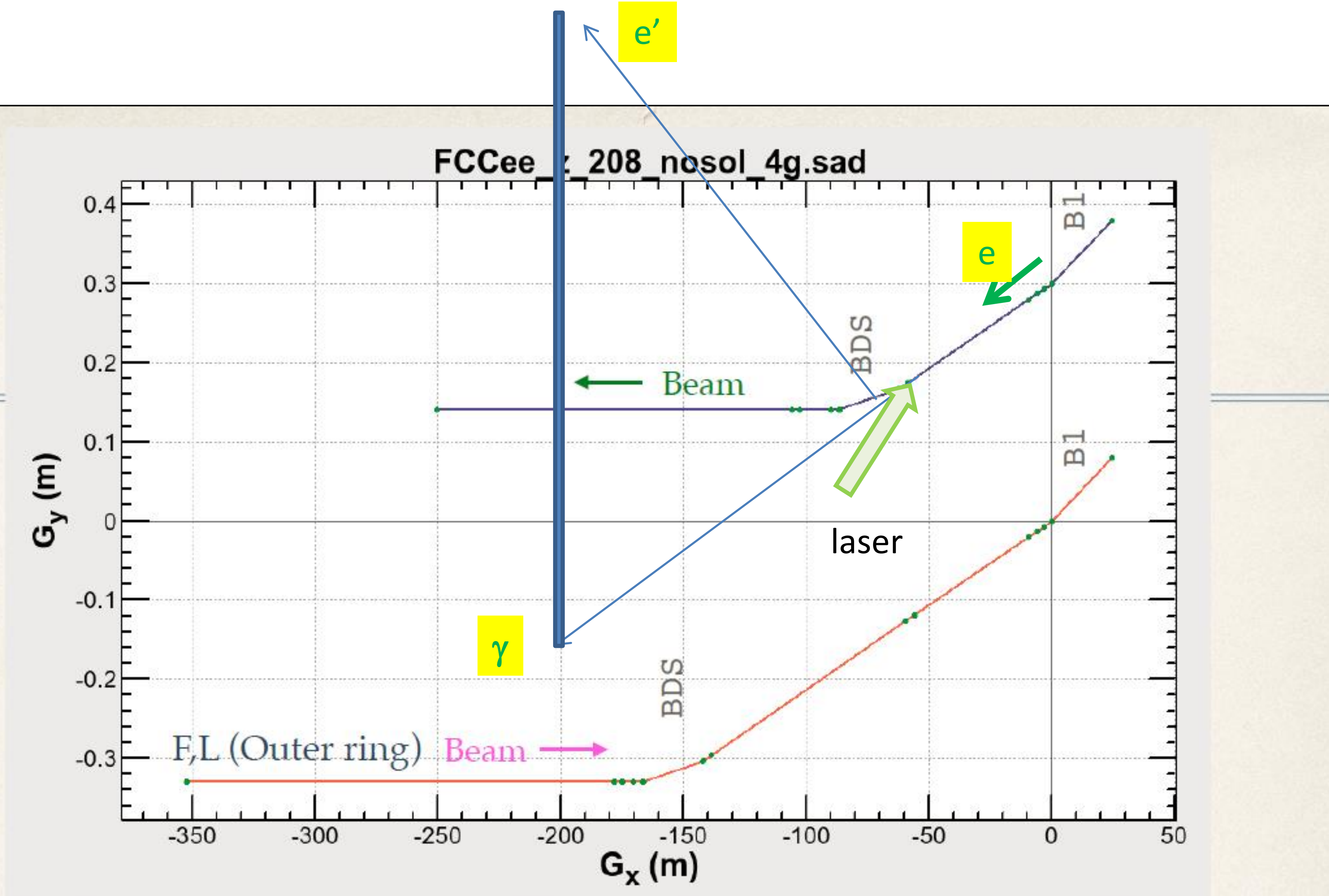


The dispersion suppressor dipole (BDS):

```
;
 BEND   BDS     =(L =24.119925292770883  ANGLE =.0021341006035809 31    E1 =.5    E2 =.5 )
;
```



Laser polarimeter and energy spectrometer layout
24 m length dipole
α = 1 mrad: 0, σ, 2σ laser beam radiuses
2.1 mrad bent electron beam
+/- 35 mm vacuum tube
5.6 mrad bent edge electrons
γ - beam
x, [mm]
z, [m]
500
400
300
200
100
0
-100
-200
0
20
40
60
80
100



The dispersion suppressor dipole (BDS):

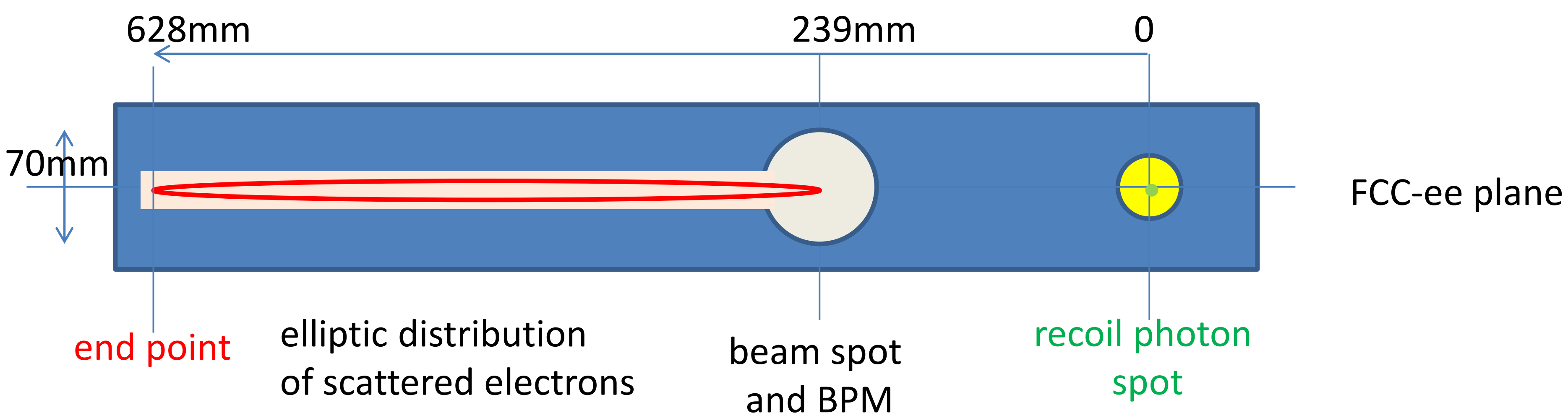
```
;
 BEND    BDS      =(L =24.119925292770883  ANGLE =.00213410060358093l    E1 =.5    E2 =.5 )
```

Using the incoming beam and the dispersion suppressor dipole with a lever-arm of **100m** from the end of the dipole, one finds
-- minimum compton scattering energy at 45.6 GeV is 17.354 GeV
-- distance from photon recoil to Emin electron is 0.628m

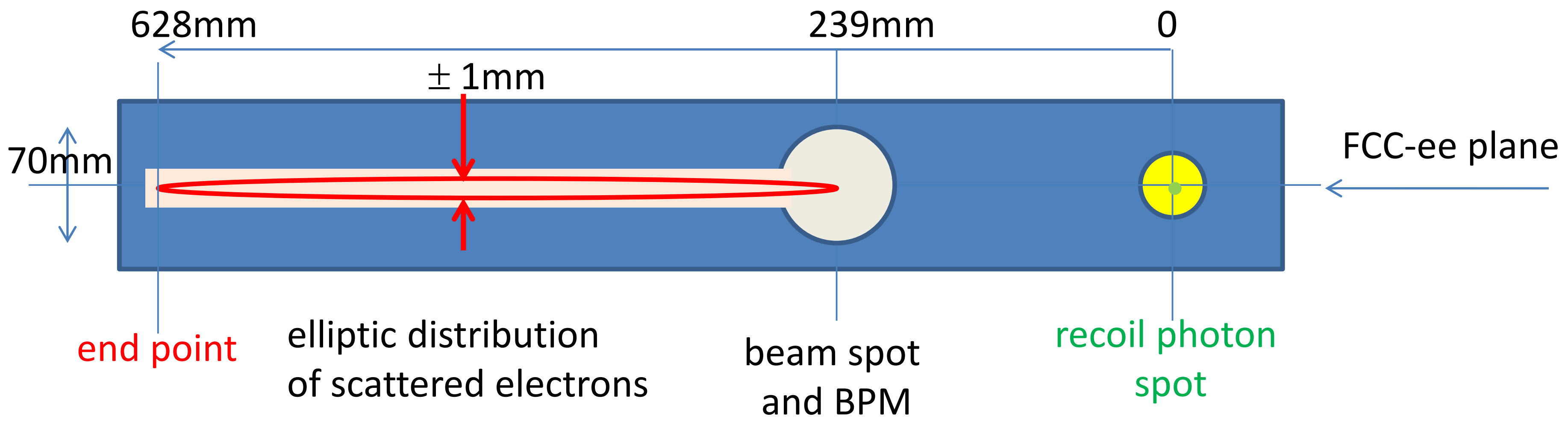
	laser (eV)	beam (GeV)	mc2(MeV)	B field	R	LM	theta	L	true beam
	2.33	45.6	0.511	0.013451	11300	24.119	0.002134	100	45.60005
nominal kappa = 4. E_laser.Ebeam_nom/mc2	1.627567296								
true kappa = 4. E_laser.Ebeam_true/mc2	1.627568924								
nominal Emin	17.35445561								
true Emin	17.35446221								
position of photons	0								
nominal position of beam (m)	0.239182573								
true position of beam (m)	0.239182334	2.39182E-07							
nominal position of min (m)	0.628468308								
true position of min (m)	0.628468069	2.39182E-07							

mouvement of beam and end point is the same:
0.24microns for $\delta Eb/Eb=10^{-6}$

polarimeter-spectrometer situated 100m from end of dipole.



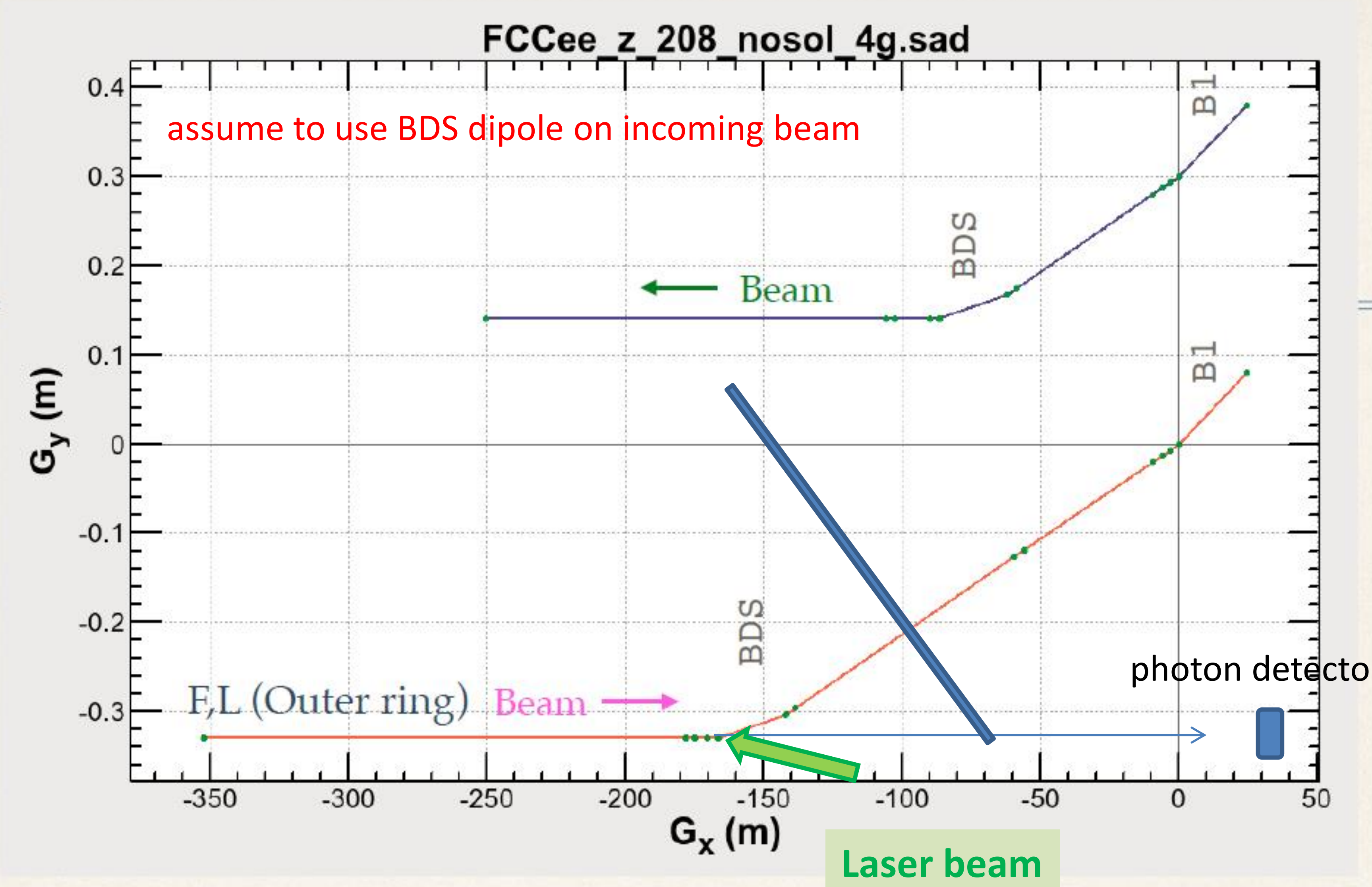
polarimeter-spectrometer situated 100m from end of dipole.



The end point moves by 0.24 microns over 628 mm (0.3 10^{-6})
These relative movements are perhaps visible using a silicon pixel array.
The absolute measurement in the underground conditions seems difficult.

Platina is supposed to be made of invar, insensitive to thermal expansion at level less than 10^{-6} for the changes of temperature to be foreseen.

Synchrotron radiation from the ring should be shielded taking into account the critical energy at W energies.



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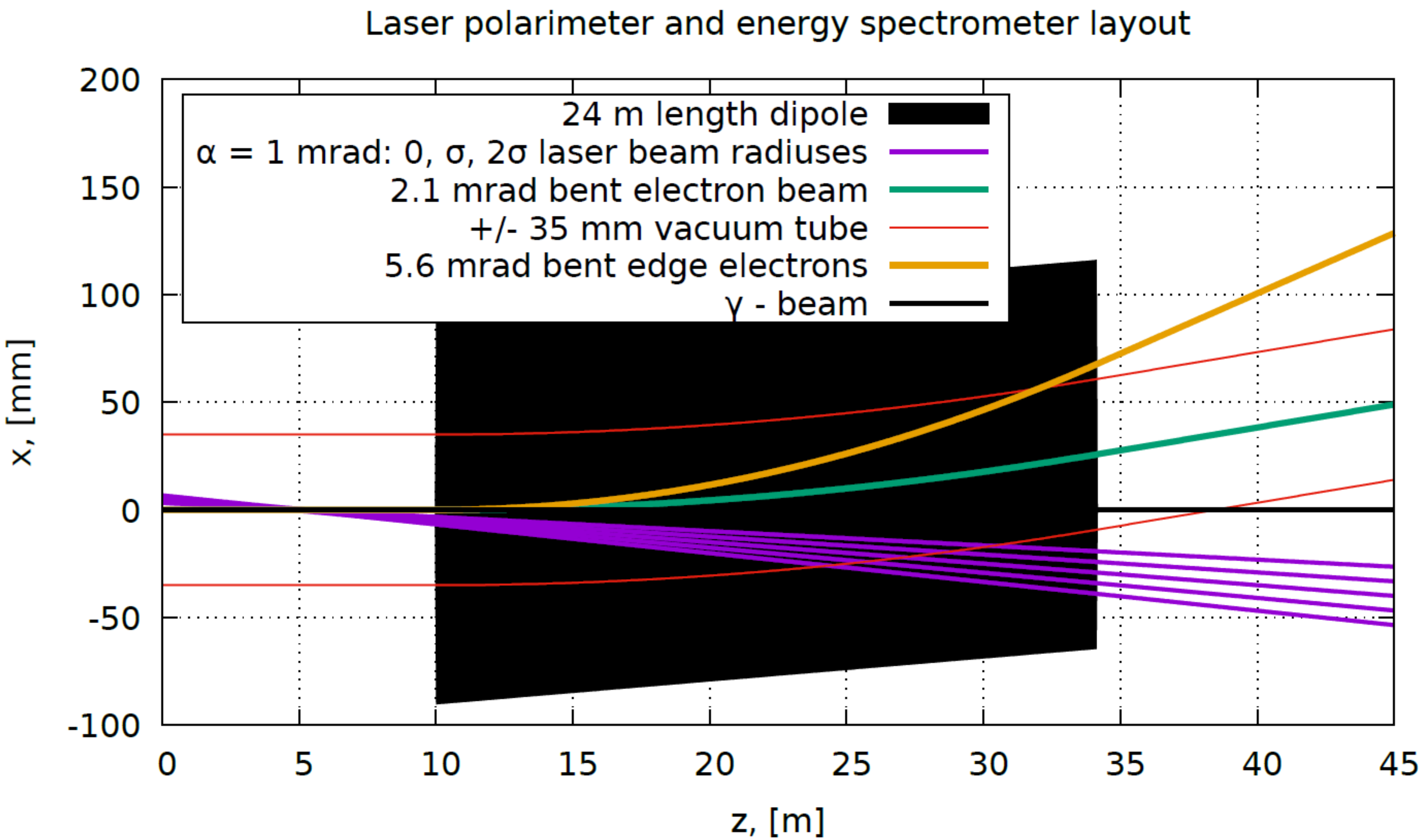
Laser polarimeter and energy spectrometer layout
24 m length dipole
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2.1 mrad bent electron beam
+/- 35 mm vacuum tube
5.6 mrad bent edge electrons
γ - beam
x, [mm]
z, [m]
200
150
100
50
0
-50
-100
0
5
10
15
20
25
30
35
40
45

Using the dispersion suppressor dipole and a lever-arm of **50m** from the end of the dipole, one finds

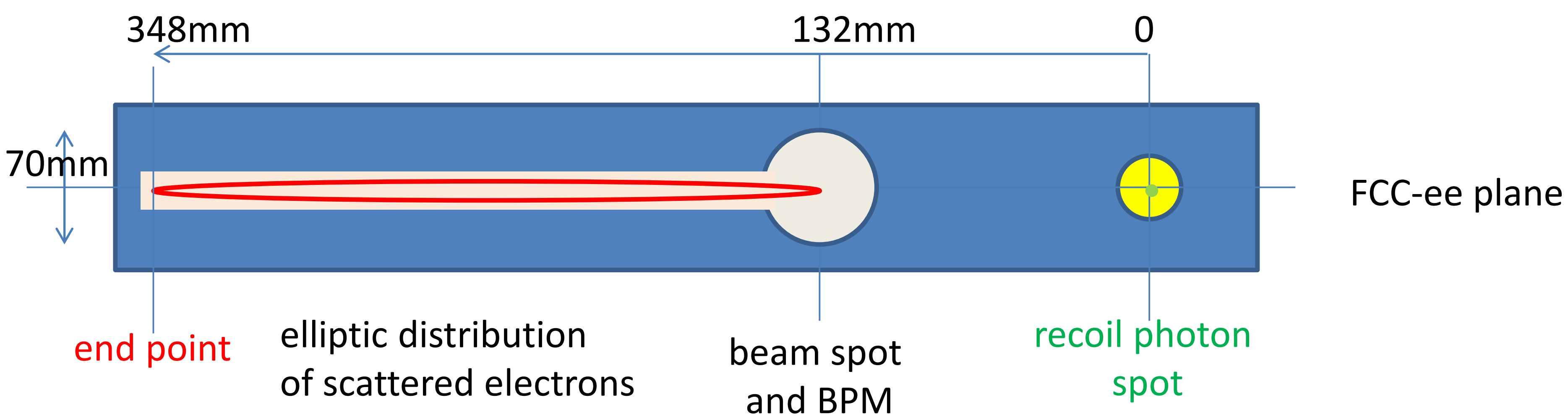
-- minimum compton scattering energy at 45.6 GeV is 17.354 GeV

-- distance from photon recoil to Emin electron is 0.348m

	laser (eV)	beam (GeV)	mc2(MeV)	B field	R	LM	theta	L	true beam
	2.33	45.6	0.511	0.013451	11300	24.119	0.002134	50	45.60005
nominal kappa = 4. E_laser.Ebeam_nom/mc2	1.627567296								
true kappa = 4. E_laser.Ebeam_true/mc2	1.627568924								
nominal Emin	17.35445561								
true Emin	17.35446221								
position of photons	0								
nominal position of beam (m)	0.132461335								
true position of beam (m)	0.132461202	1.32461E-07							
nominal position of min (m)	0.348051071								
true position of min (m)	0.348050938	1.32461E-07							

mouvement of beam and end point is the same:
0.13microns for $\delta Eb/Eb=10^{-6}$

polarimeter-spectrometer situated 100m from end of dipole.



Conclusions to be drawn and written

We know we can make the backscattered compton detector
Adding a measurement of the scattered e+- adds information of beam energy.
Stability is necessary for relative measurements
➔ monitoring purposes, comparison of energy of pilot beam with inteacting beam

Absolute calibration is … challenging (to do it with respect to resonant depolarization)

Installation in ring requires another iteration with infrastructure team.