Slice Energy Spread Measurement (Motivation)

4 shifts

- **Contributions of momentum measurement resolution**

measured beam size

betatron

Slice E spread

TDS voltage

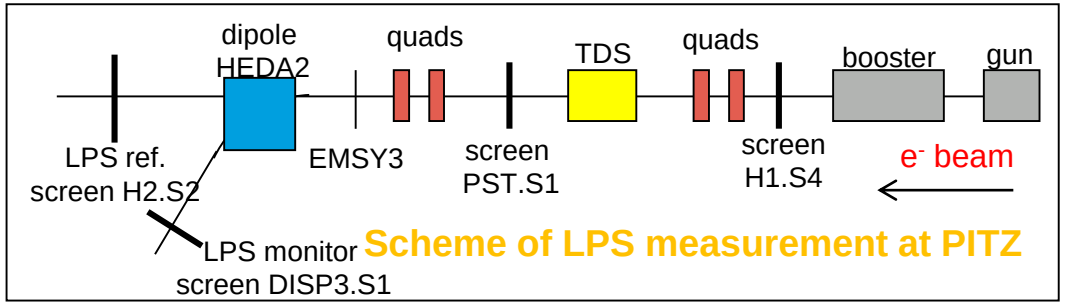
Beam size at TDS

$$\sigma_M^2 = \sigma_R^2 + \frac{m_e c^2 \beta \varepsilon_n}{E} + \frac{D^2 \sigma_{E0}^2}{E^2} + \frac{D^2 e^2 k^2 V^2 \cos^2(\phi) m_e c^2 \beta_T \varepsilon_{n_T}}{E^3}$$

monitor resolution

Dispersion *D*

- **Scan**
  1. **energy (extract the monitor res.)**
  2. **TDS voltage (extract the slice E spread)**
- **Prevoiously we only scan TDS amplitude set point**



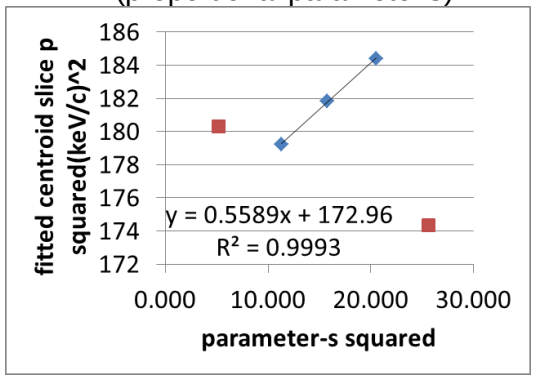
Scheme of LPS measurement at PITZ

- **Betatron contribution could be minimized with the EMSY1 slit cut**

- **Next steps**
  - **Using slit to reduce betatron contribution**
  - **Scan beam energy to fit for monitor resolution**
  - **Scan TDS voltage to fit for center slice momentum spread**

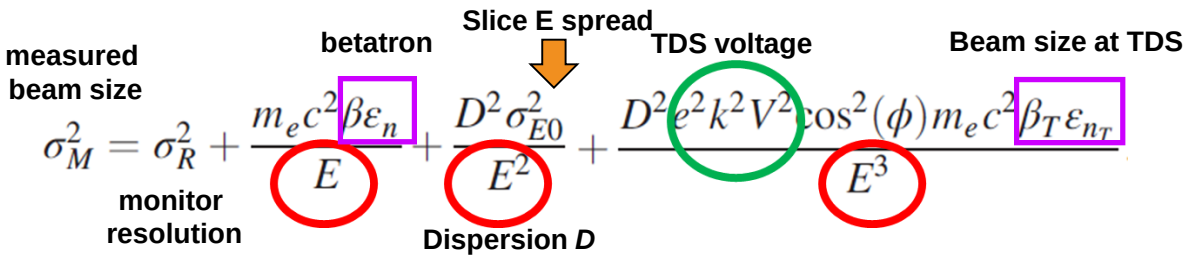
First measurement at PITZ w/ charge 10 pC, 19 MeV/c

Scan of TDS voltage
(proportional parameter *s*)

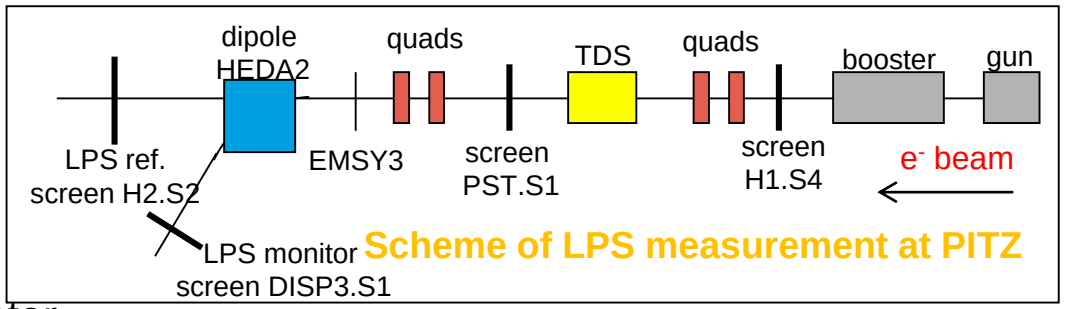


Slice Energy Spread Measurement (Procedure)

- **Contributions of momentum measurement resolution**



- **E scan**
  - **momentum range (E^{-1} fitting) : eg. 12, 14, 16, 18, 20 MeV/c**
- **TDS scan**
  - **SP range (s^2 fitting) : 5 sps starting from highest streaking**



- parameter
  - laser: 6ps Gaussian, BSA: 0.7mm, LEDA: ~6.2MeV/c

E scan (TDS off--V=0)

1. Prepare 10pC 16MeV/c beam and booster BBA
2. Focus beam at PST.s1 with solenoid and focus beam at H2.s2 with steering free H1.q9,.q10,pst.qt5
3. Center beam in x at H2.S2
4. Capture beam at H1.s4, H1.s5, PST.s1 (make sure same beam size with H1.q9, H1.q10 for all Energy)
5. Run LPSgrap at DISP3.s1
6. Do step 2-6 for other energies/use ratio of booster E gain to booster sp (rule of three)

TDS scan (new)

1. Prepare 20MeV/c beam at H2.S2 and DISP3.s1 (same method)
2. Add EMSY1 slit x and prepare beam at H2.S2 again
3. Try EMSY3 and check beam at DISP3 if improving
4. Measure emittance x with EMSY3
5. Choose TDS sp for highest streaking at DISP3.s1
6. Run TDS script to find zero crossing phase at DISP3.s1
7. Center beam in y at zero crossing phase at DISP3.s1
8. Run LPSgrap at DISP3.s1
9. change TDS sp and do step 6-8

Slice Energy Spread Measurement (E scan)

- **Contributions of momentum measurement resolution (TDS off)**

measured beam size

betatron

total E spread

$$\sigma_M^2 = \sigma_R^2 + \frac{m_e c^2 \beta \varepsilon_n}{E} + \frac{D^2 \sigma_{E0}^2}{E^2}$$

monitor resolution

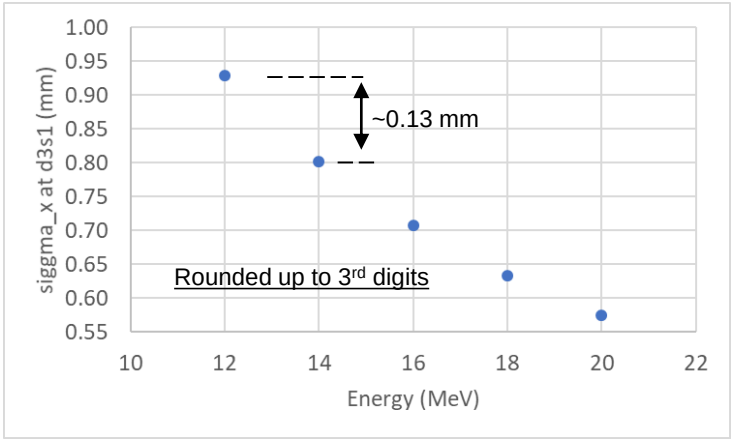
Dispersion *D*

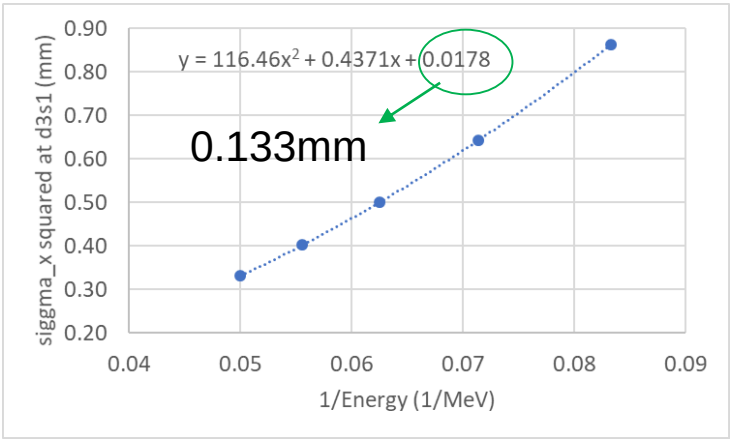
- **With beam focusing at h2.s2, betatron contribution is minimized**

- **Scenario based on last results & monitor resolution = scaling factor**

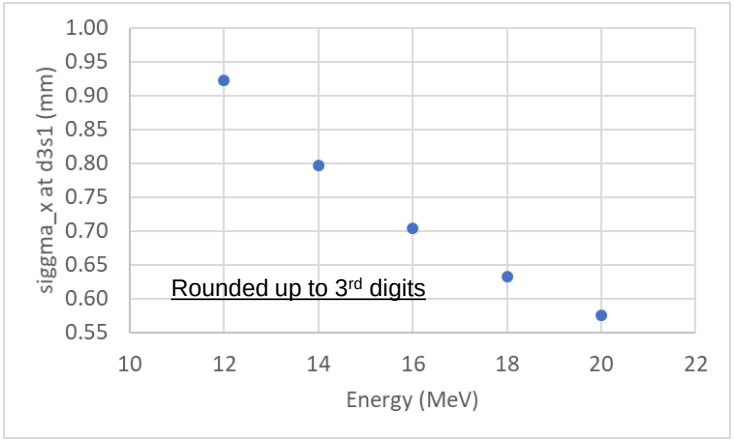
alpha (emsy x-stat) =	1.92567
beta(m) (emsy x-stat) =	13.44067
emittance(um) (emsy x-stat) =	0.90933
drift (m) from h2s1 to d3s1 =	2.35680
drift (m) from h2s1 to heda2 =	0.83700
drift (m) from heda2 to d3s1 =	0.69940
rho (m) d3d1	0.59683
bending angle (deg)	60.00000
beta (m) at d3s1 =	2.17569
beta (m) at reference screen =	6.30956
estimated x-rms at reference screen =	0.39160
monitor resolution(keV/c/pixel) =	2.78414
screen scale (mm/pixel) =	0.13187
scale(MeV/c/m) =	21.11307
Disp (m) =	0.90555
p(MeV/c) =	19.11895
E (MeV/c) =	19.12578
rel. gamma =	37.41478
fitting term =	173.68652
corrected centroid sliced p spread(keV/c) =	11.93199
centroid sliced p spread(keV/c) before correction =	13.19190

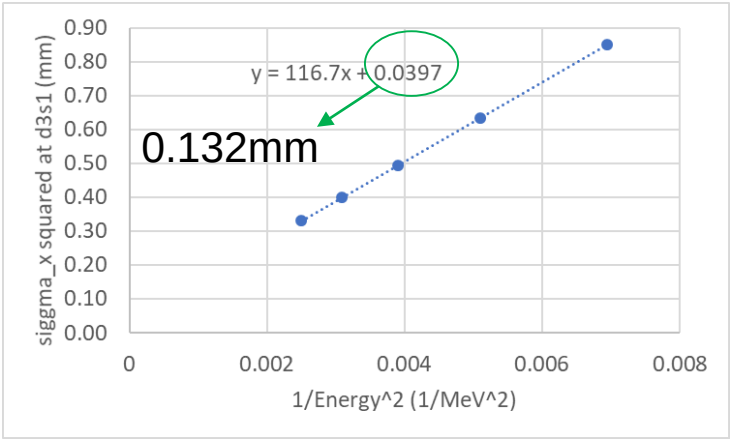
To extract D3S1 monitor resolution = 0.132 mm
Scenario 1: fix betatron x emittance_n at EMSY3 (or energy x sigma_x^2 at h2.s2)





Scenario 2: fix sigma_x at h2.s2





Energy Chirp vs Booster Phase at 17 MeV/c

2 shifts

- **Save time by using same charge and previous 17-MeV/c setup**
- **OMA scan at HEDA1 for booster phase from 5, 10, 15, 20, 25 deg**
- **Apply rule of three on booster gradient sp to get 17-MeV/c for all phases (booster gradient sp/energy gain)**
- **Prepare beam with the same method (previous side) to DISP3.s1 and run LPSgrap**