# Introduction to Spurious Dispersion at TTF2

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- Simulations in elegant
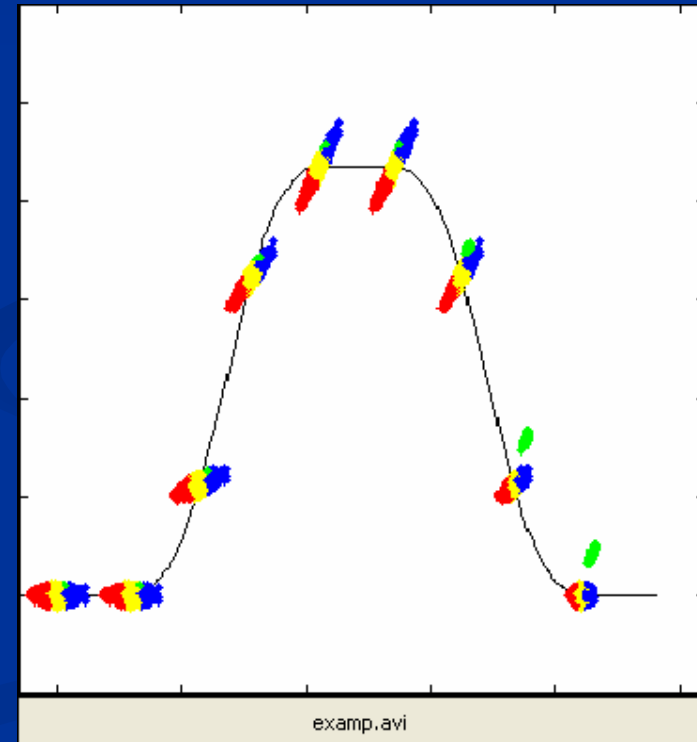
- Dispersion measurements at TTF2

# Introduction

$$\eta_x = \frac{\Delta x}{\Delta p / p}$$

$$\sigma_x = \sqrt{\varepsilon_x \cdot \beta_x(s) + \eta^2(s) \cdot \left(\frac{\Delta E}{E}\right)^2}$$
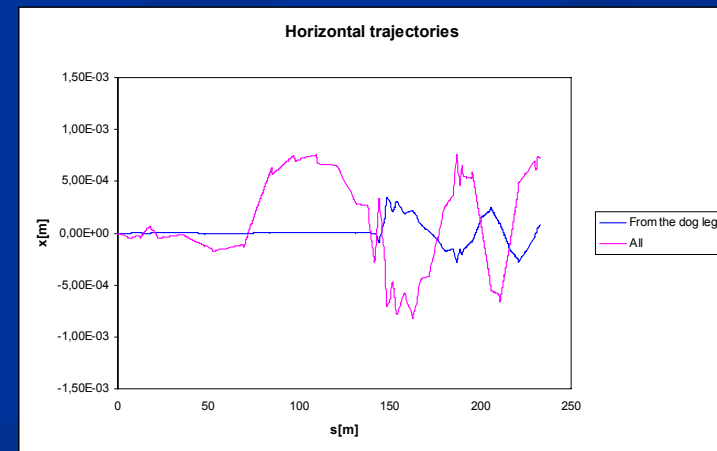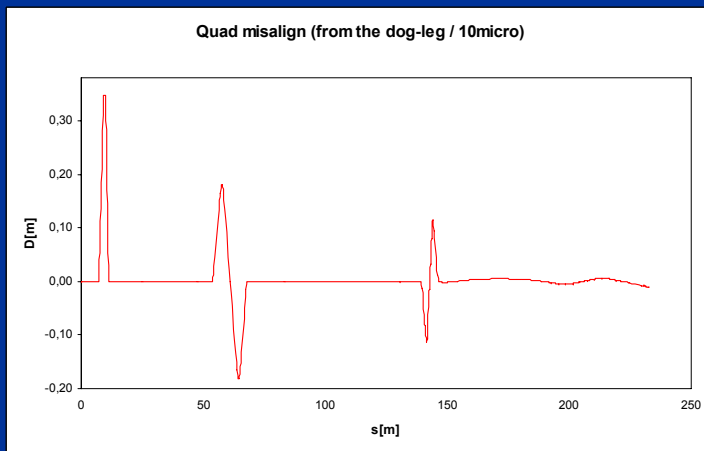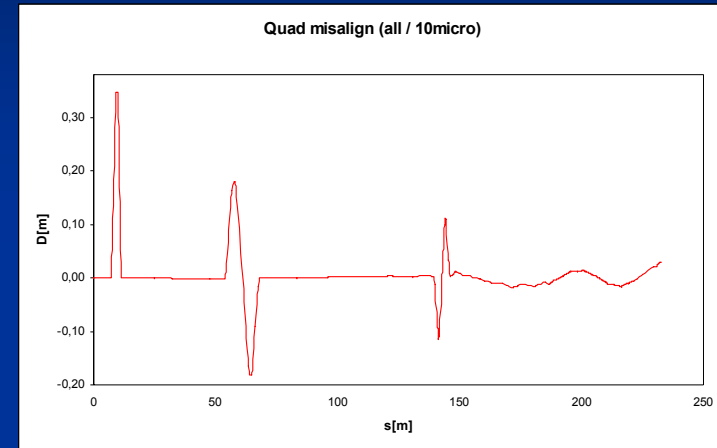
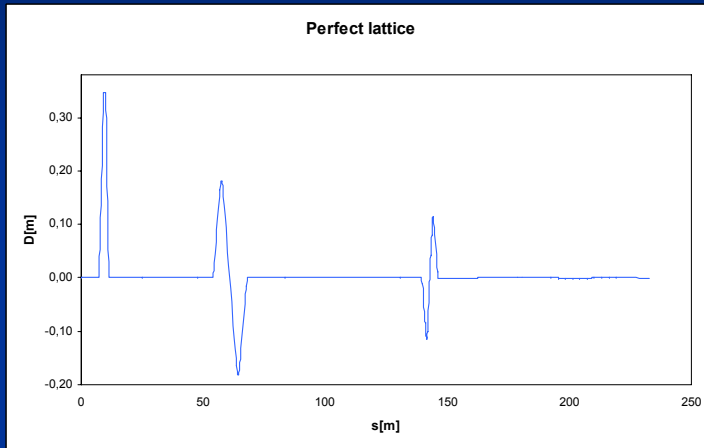Dispersion in LINACS: Not periodic

- **PERFECT LATTICE:**
  Dispersion only generated at bending magnets

- **REAL LATTICE:**
  Spurious Dispersion generated by additional dipole fields
    - Dipole field errors
    - Quadrupole misalignments
    - Energy errors of the particles
    - Gun misalignment
    - Cavity coupler kicks
    - Transverse wake fields
    - Dipole fields from electromagnetic environment
    - Others????

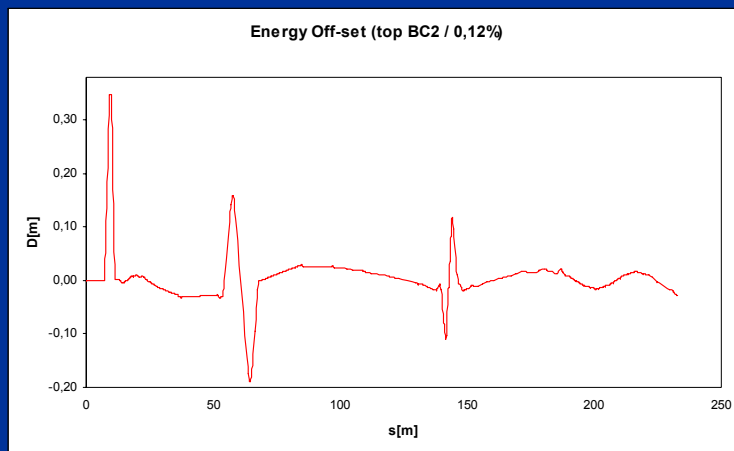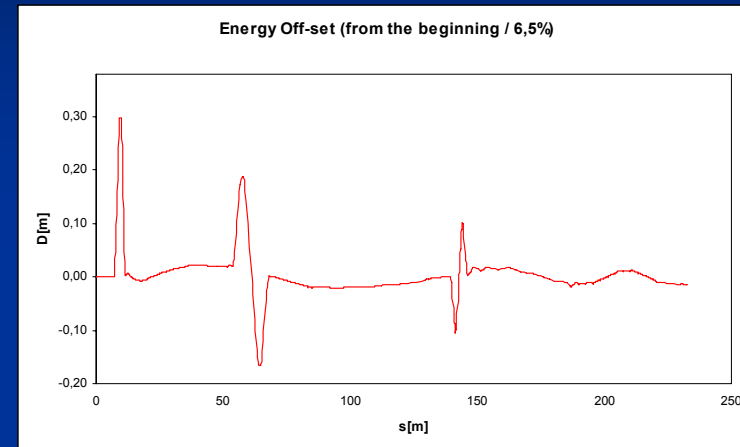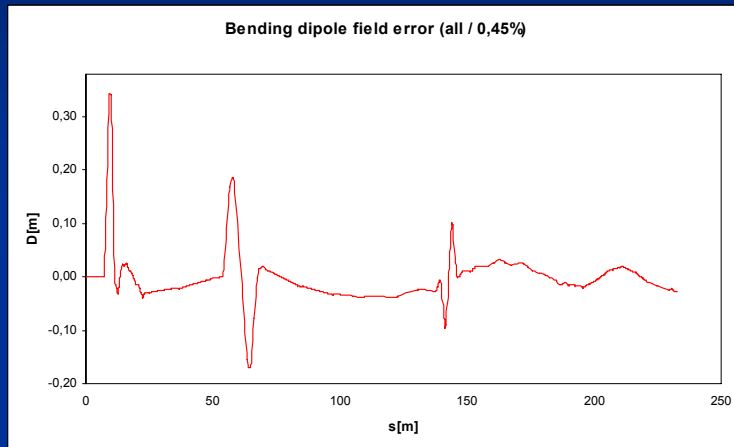    Which of them are more important??



examp.avi

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# Simulations in elegant
## Generation mechanisms



**Perfect lattice**

**Quad misalign (all / 10micro)**

**Quad misalign (from the dog-leg / 10micro)**

**Horizontal trajectories**

From the dog leg
All

# Simulations in elegant
## Generation mechanisms



Bending dipole field error (all / 0,45%)



Energy Off-set (from the beginning / 6,5%)



Energy Off-set (top BC2 / 0,12%)

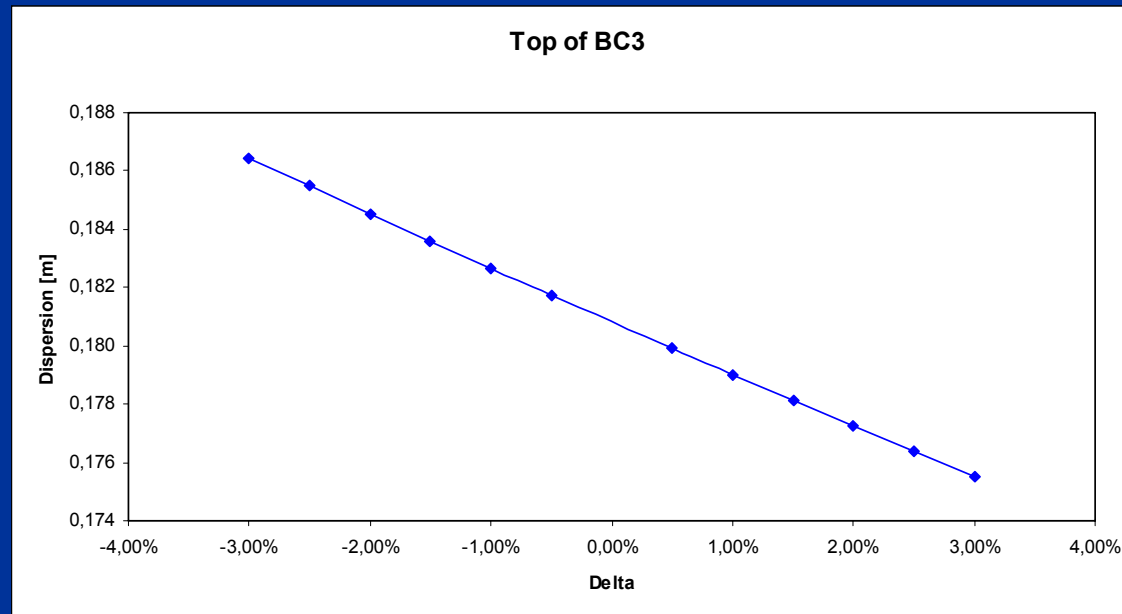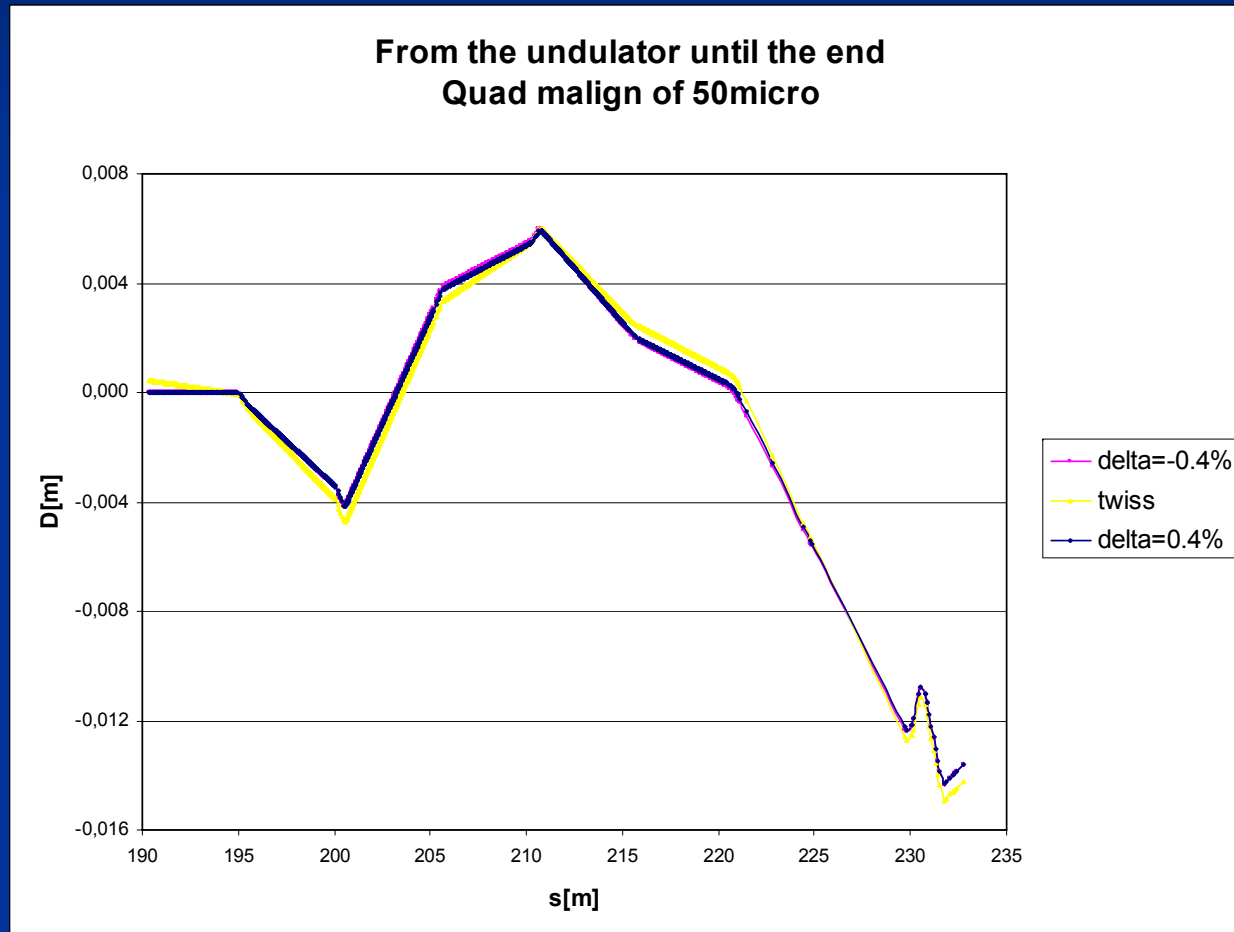| Source | Error | Dispersion (undulator) |
|---|---|---|
| Quad misalign | 15 $\mu$m | |
| Dipole field error | 0.45% | |
| Energy off (beginning) | 6.5% | ~1cm |
| Energy off (top BC2) | 0.12% | |

# Simulations in elegant
## Dispersion measurement

- How to measure η ??
Applying beam energy variations and measuring
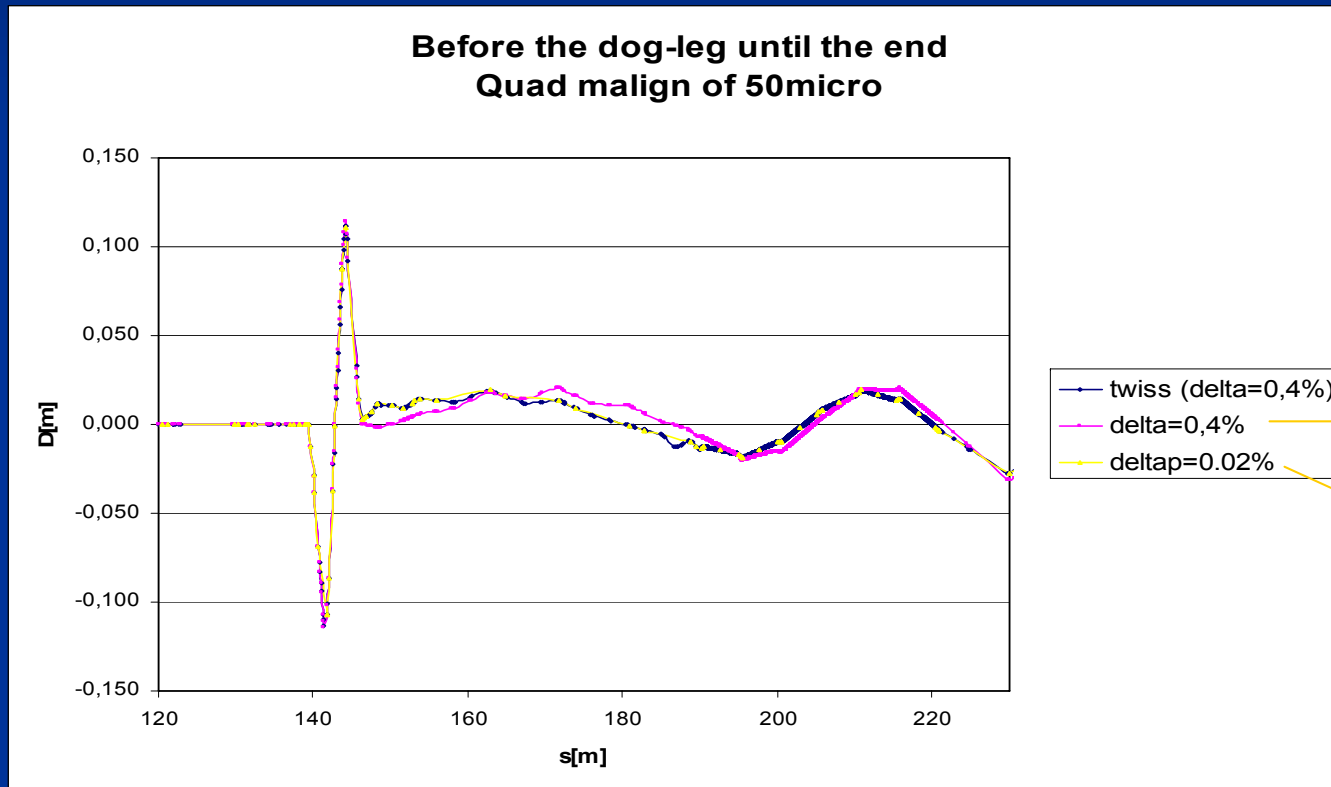the horizontal beam displacement

$$\eta = \frac{\Delta x}{\Delta p \, / \, p}$$

**Top of BC3**

# Simulations in elegant
## Dispersion measurement



From the undulator until the end
Quad malign of 50micro

# Simulations in elegant
## Dispersion measurement



Before the dog-leg until the end
Quad malign of 50micro

twiss (delta=0,4%)
delta=0,4%
deltap=0.02%

$$\eta = \frac{x_{0.4\%} - x_{0.0\%}}{0.4\% - 0.0\%}$$

$$\eta = \frac{x_{0.41\%} - x_{0.39\%}}{0.41\% - 0.39\%}$$

# Dispersion measurements at TTF2

**FEL R&D Program – Weeks 47 & 48 (14-27 November)**

Possible way to start...

1. Change the RF amplitude of the accelerator modules
2. Apply an orbit correction in order to suppress the dispersion due to the accelerator module
3. Read horizontal positions downstream the modules

We get the dispersion at the BPM position (without accelerator module effects)

1. Change the RF amplitude of the accelerator modules
2. Read horizontal positions just downstream the modules

We get the dispersion due to the accelerator module (coupler kick, wake fields...)

# Dispersion measurements at TTF2

**Initial idea**

2 shifts upstream ACC4-ACC5 ??
2 shifts downstream ACC4-ACC5 ??
Undulator???
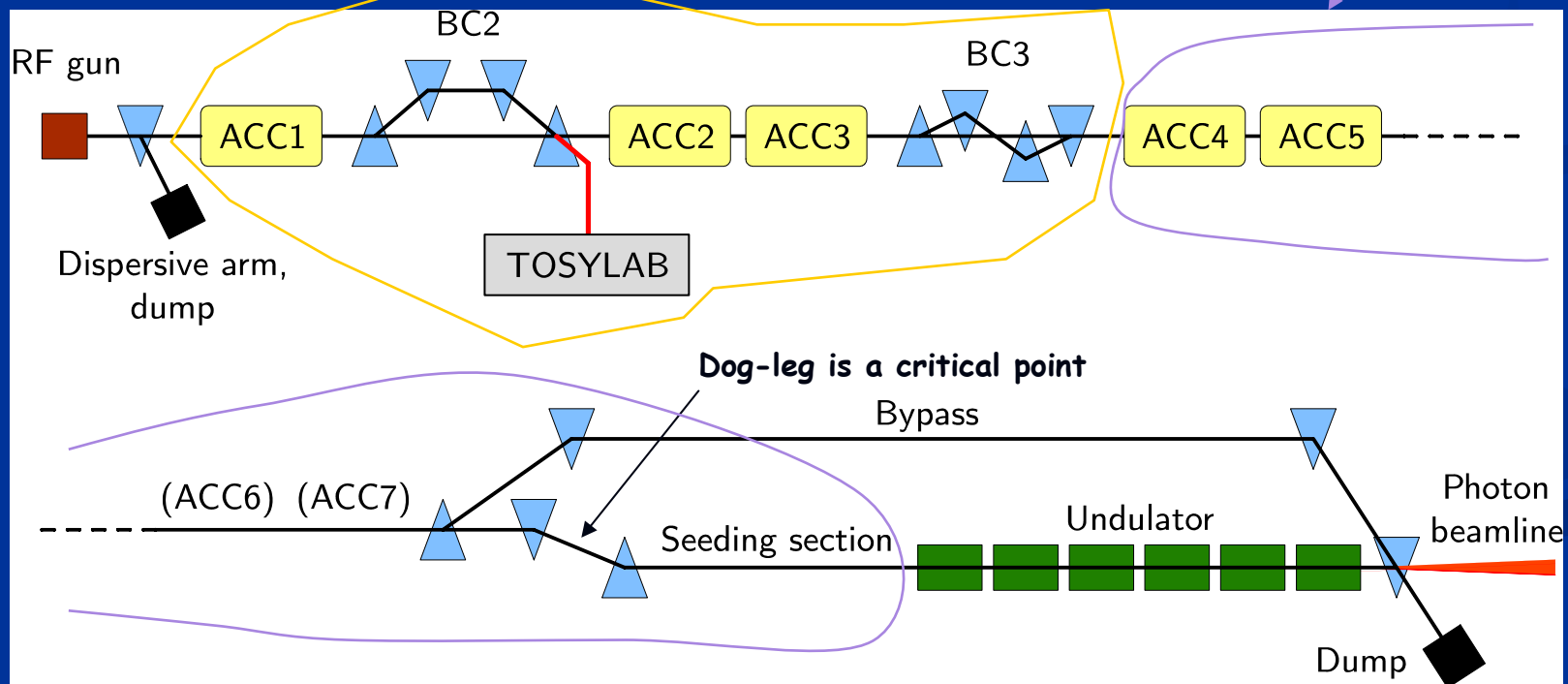
# Dispersion measurements at TTF2
## Next steps

- Reviewing of what has been done in the past

- Preparation of measurement software (acquisition data, orbit feed-backs...)

- Doing elegant simulations:
  - Dog-leg dispersion
  - Simulate more effects
  - ...

Thank you!