Bruno Latest Developments

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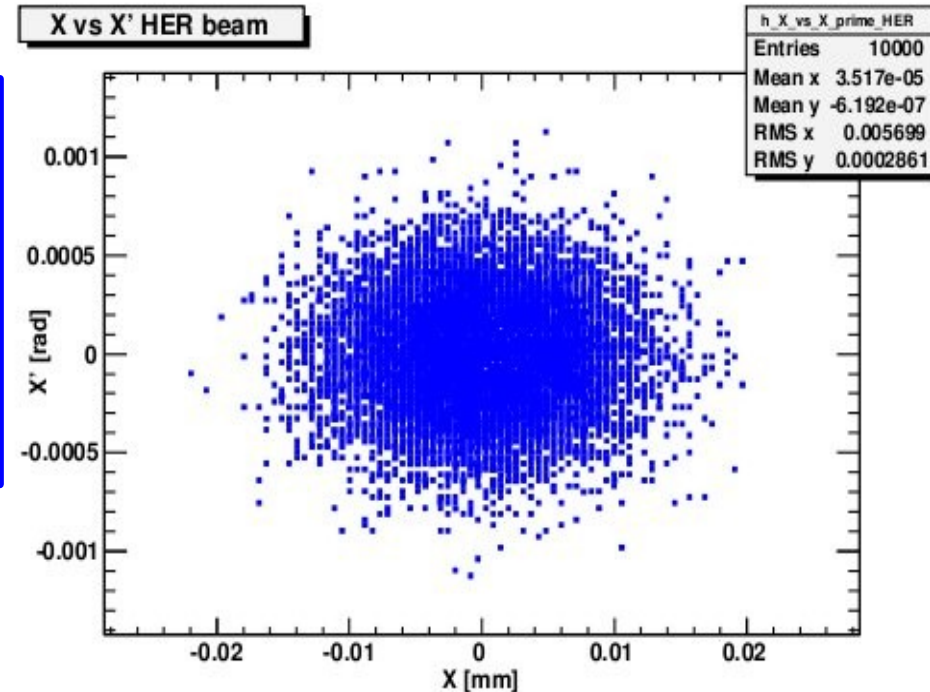di Fisica Nucleare

SEZIONE DI PISA

Outline

- **Validation code**
  - **Final focus magnetic modeling validation (v12 sf10 alyout)**
  - **Beam pipes geometry validation**

- **Bruno development**
  - **IR magnetic modeling**
  - **Bbbrem generator (radiative Bhabha) IP parameters**

- **Summary and outlook**

Final Focus Validation: The method (I)

- **Use final focus v12 sf10 layout**
- **Generate particles (10k) with the beam parameters (HER and LER) at the IP:**
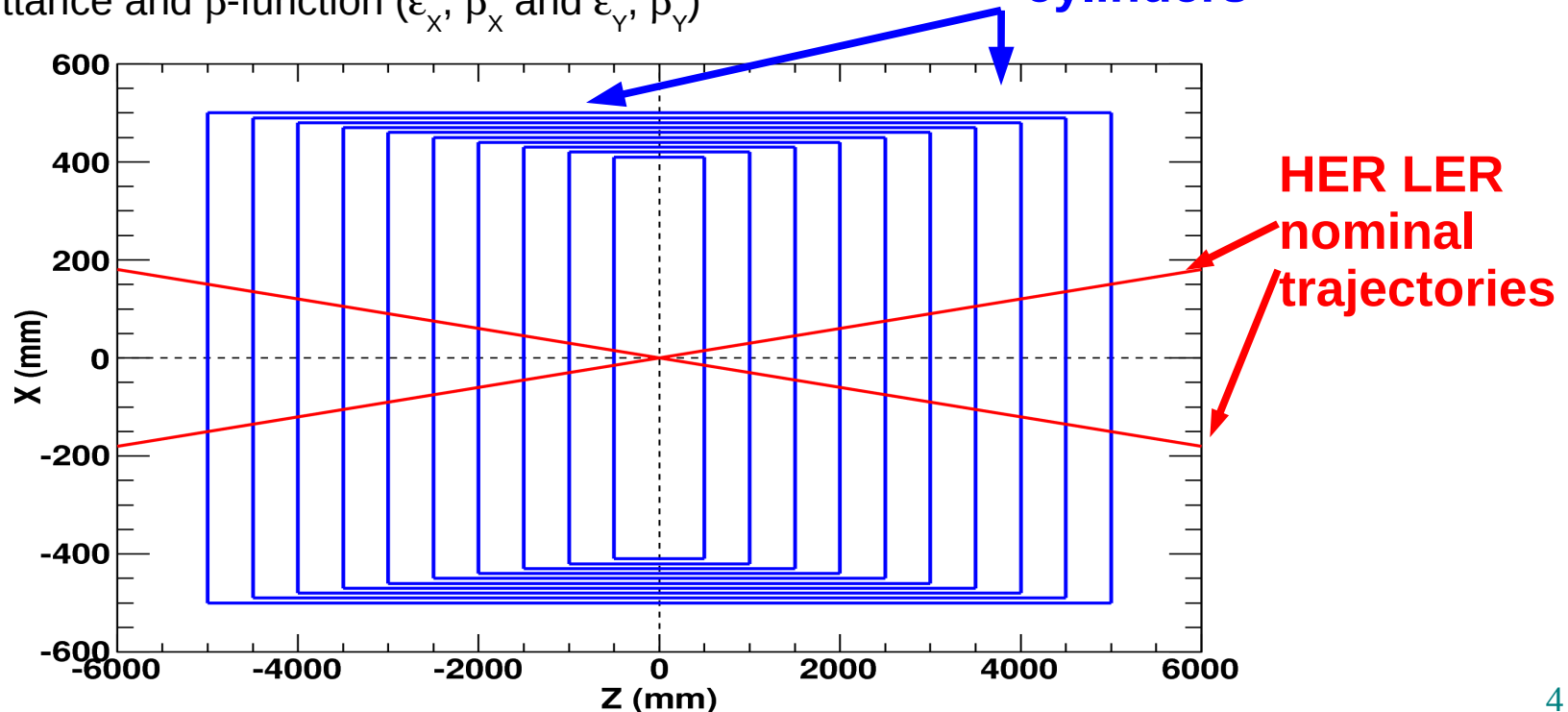 - All particles are generated at $Z = 0$ and at the nominal beam energy

parameter	HER (e^+)	LER (e^-)
Energy	6.69 GeV	4.18 GeV
σ_X	7.3×10^{-3} mm	8.7×10^{-3} mm
β_X	26.0 mm	32.0 mm
σ_Y	36.0×10^{-6} mm	35.0×10^{-6} mm
β_Y	253.0×10^{-3} mm	205.0×10^{-3} mm
α_Z	-30mrad	$\pi+30$mrad

X vs X' HER beam

h_X_vs_X_prime_HER
Entries 10000
Mean x 3.517e-05
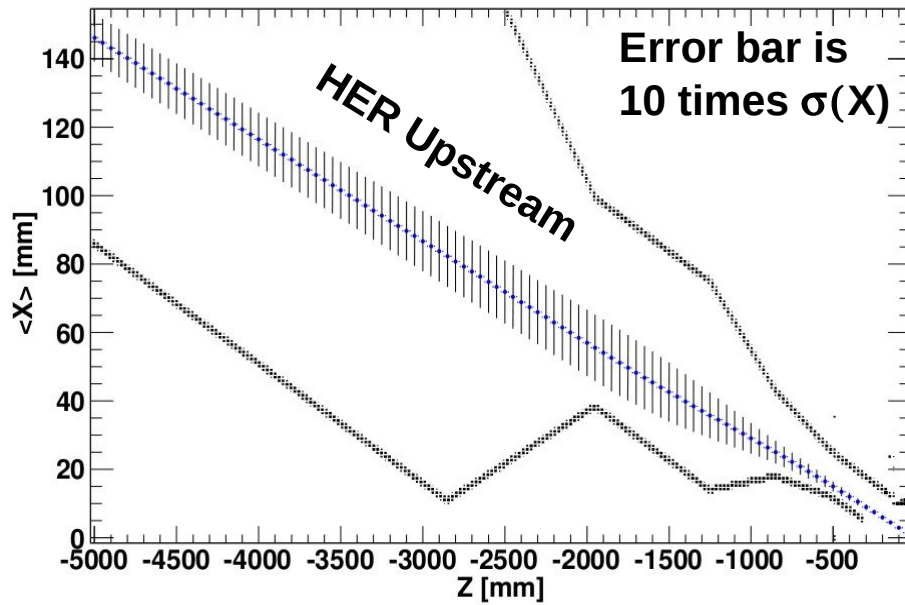Mean y -6.192e-07
RMS x 0.005699
RMS y 0.0002861

- **Feed this particles into Bruno (Guinea pig generator) which transport them into the final focus field**
- **Builds special scoring geometry to study beam optics (see next slides)**
- **Goal: comparison with design values**
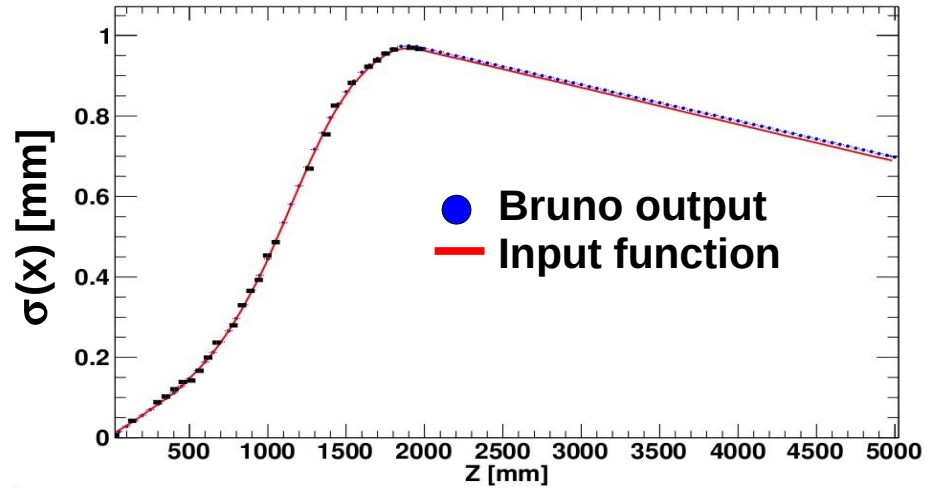
Final Focus Validation: The method (II)

- **Build 100 scoring concentric cylinders (material is vacuum) along Z axis**
  - Half lengths from 5 cm to 5 m. Step size is 5cm.
  - Radius from 40 cm to 50 cm. Step size is 1 mm.
- **Use end-caps of scoring cylinders to sketch beam parameters as a function of Z coordinate**
- **Can calculate in this way quantities like:**
  - Beam sizes and angular dispersion (σ_X, $\sigma(X')$ and σ_Y, $\sigma(Y')$)
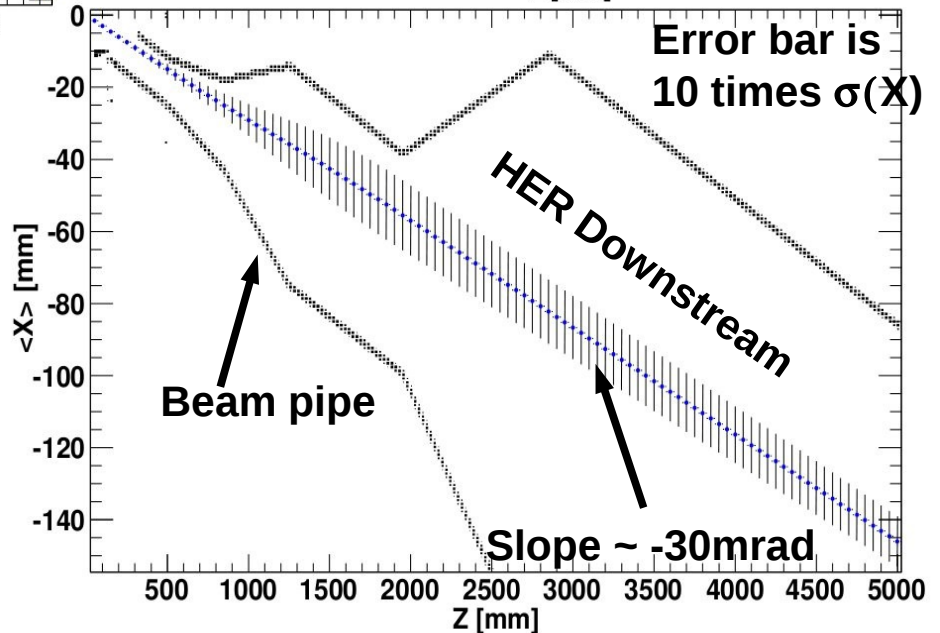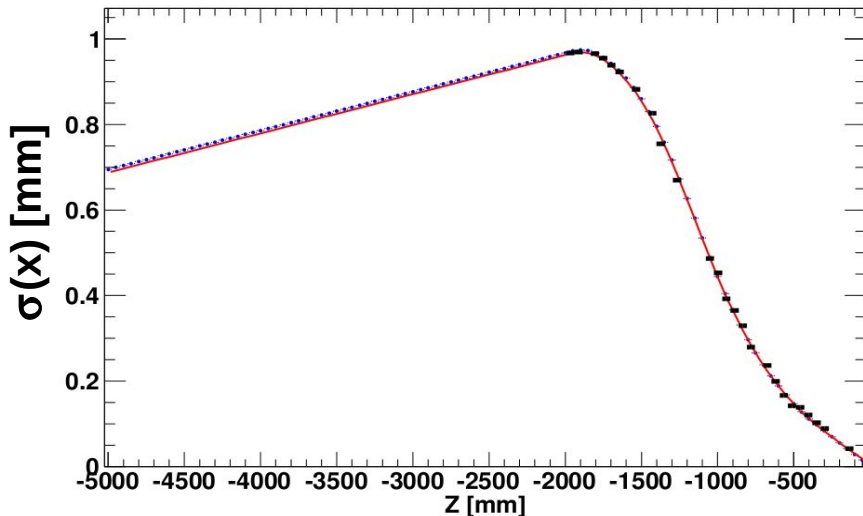 - Emittance and β-function (ε_X, β_X and ε_Y, β_Y)

scoring cylinders

HER LER nominal trajectories

Final Focus Validation: Some plots

Final Focus Validation: Some plots

Z vs σ(ΔX)

Error bar is
10 times σ(X)

HER Upstream

σ(x) [mm]

<X> [mm]

● Bruno output
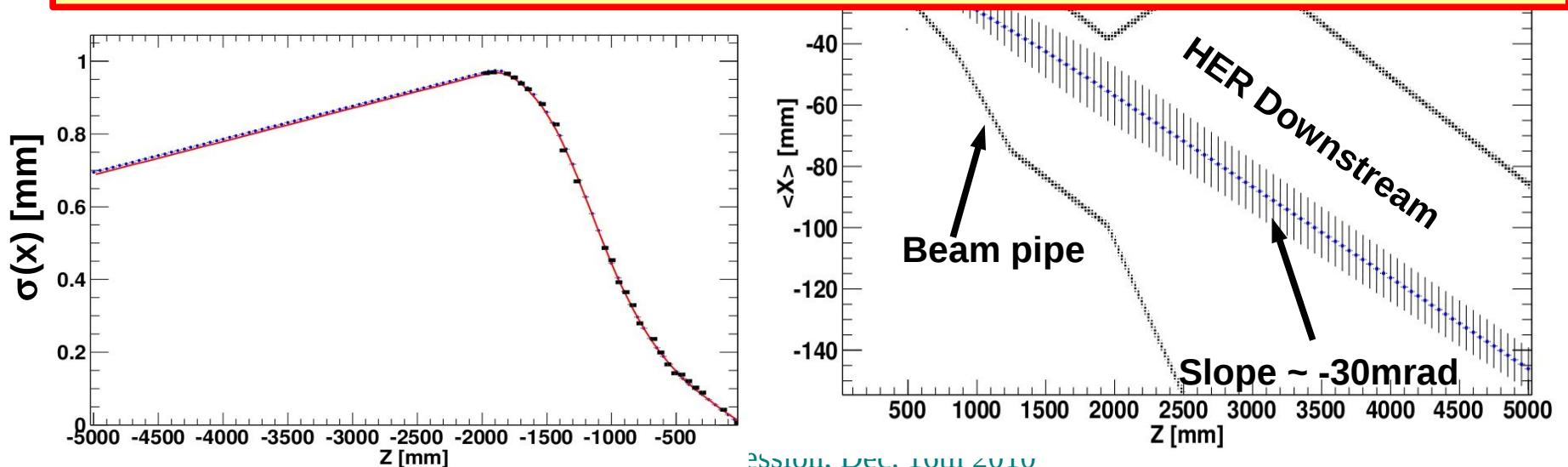— Input function
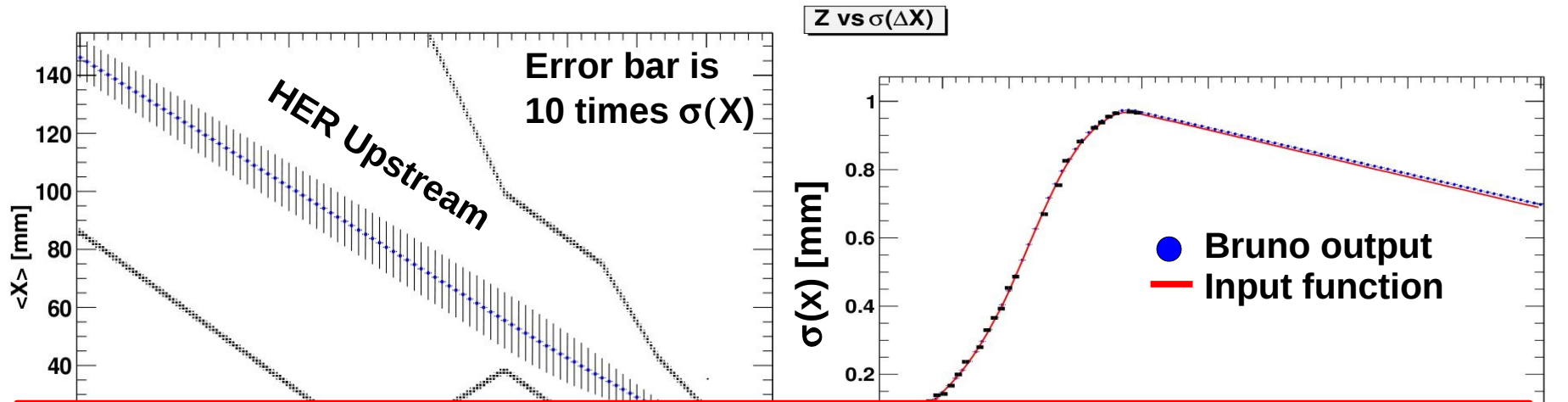
Go to:
**http://mailman.fe.infn.it/superbwiki/index.php/The_validation_machinery_user_guide**
For a description of this standalone validation code

σ(x) [mm]

Z [mm]

<X> [mm]

HER Downstream

Beam pipe

Slope ~ -30mrad

Z [mm]

Beam pipes geometry validation

- **Motivation:** check the implemented beam pipes geometries
- **The method:**
  - Use beam pipes as scoring values (material is vacuum)
  - Turn off final focus magnetic field
  - Shoot particles (Guinea Pig generator) from the top to the bottom with
    - ➢ Y = 200 mm
    - ➢ 10 GeV electrons (going down)
    - ➢ X and Z coordinates

X vs Z
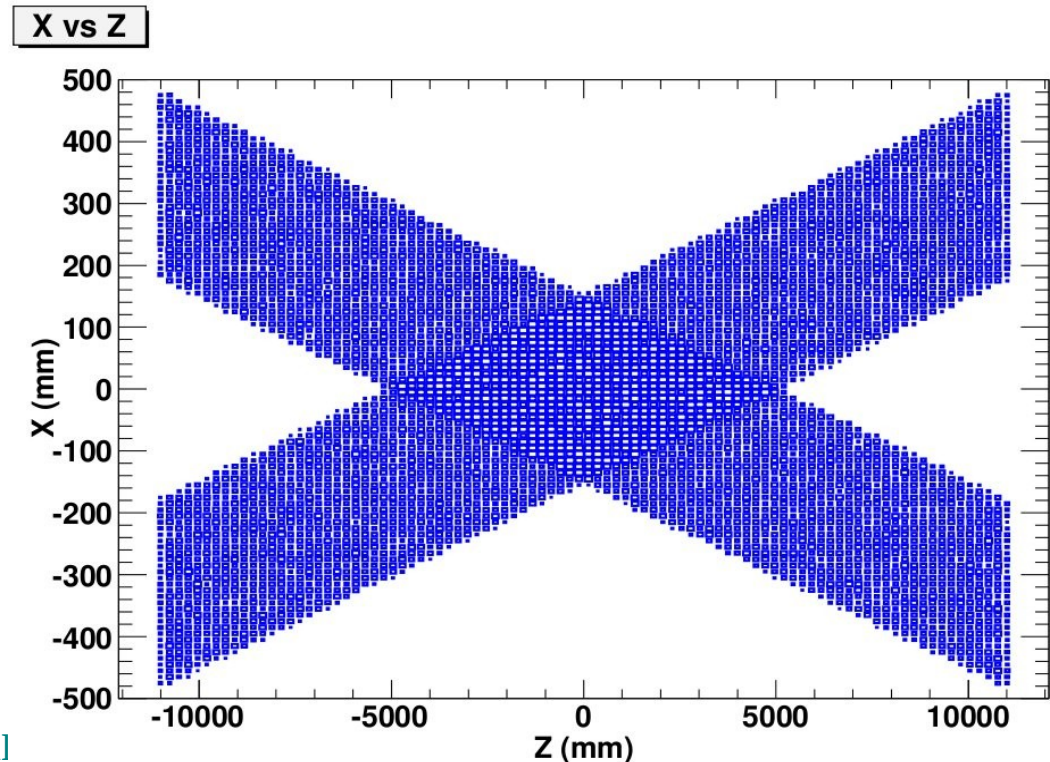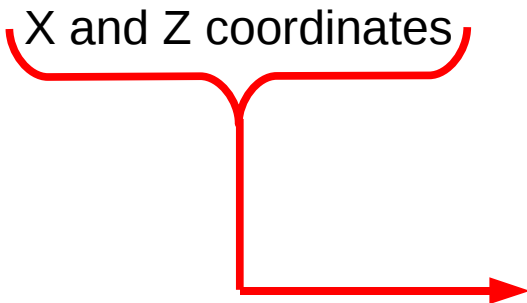
Beam pipes geometry validation
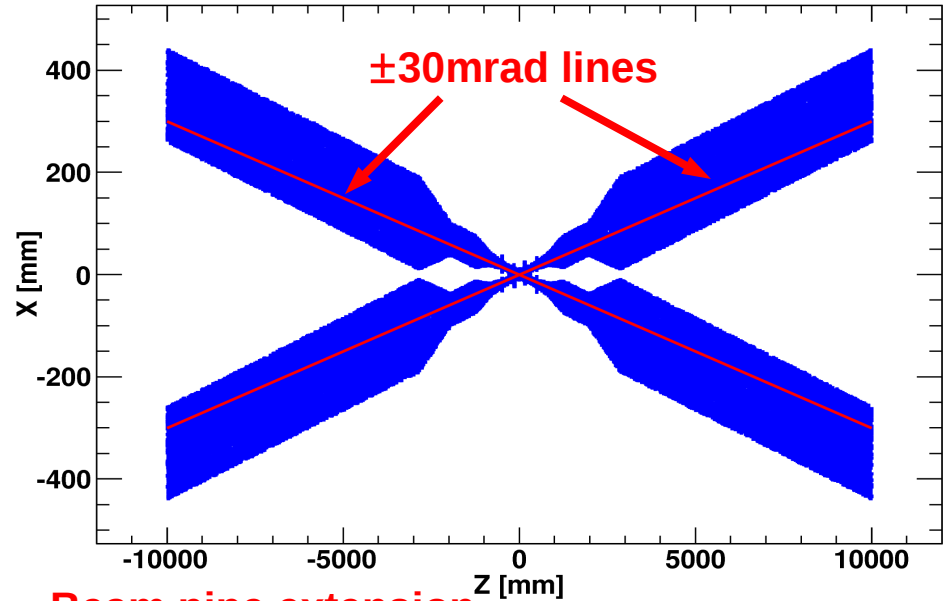
- **Helpful to sketch the geometry and to spot bugs**
- **Beam pipes tilt is higher (35mrad) than 30mrad**
- **Can check the beam pipes extension up to ±10m from IP**
- **Need to document this tool in the SuperB wiki**

±30mrad lines

Beam pipe extension

Ricardo Cenci's pipe ends here

S = 1250mm
R = 30mm

S = 1950mm
R = 30mm

S = 850mm
R = 12mm

S = 2850mm
R = 90mm

S = 10000mm
R = 90mm

Ale
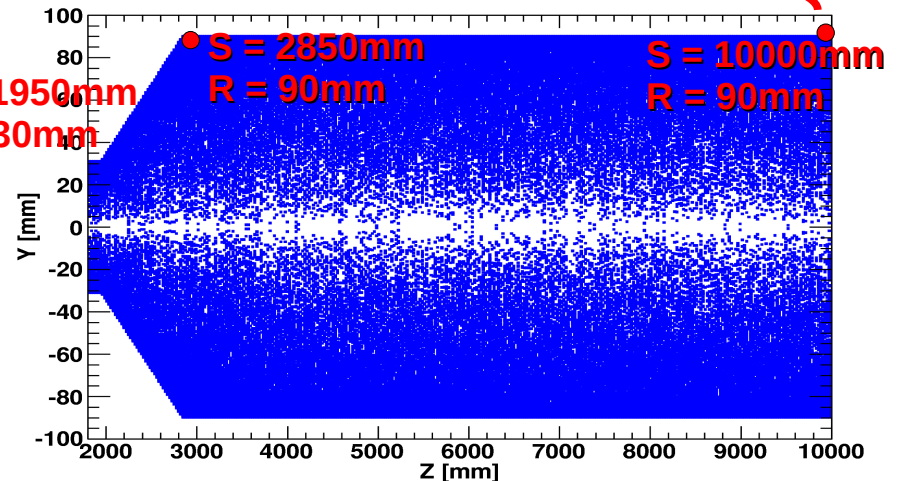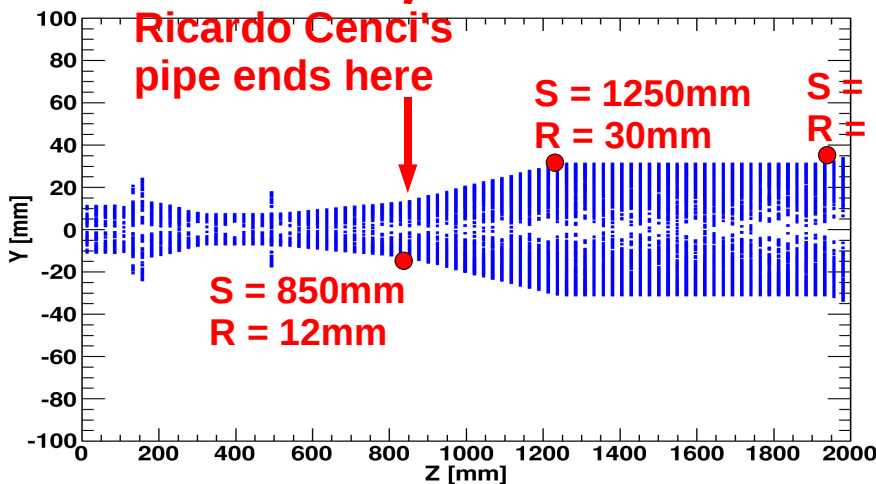
Bruno development: Magnetic IR

- **Previously:**
  - Final focus magnetic field was hard-coded inside Bruno
  - Difficult to follow the evolution of the final focus design
- **Currently:** (Need to document this in the wiki)
  - Modified Bruno to use a magnetic layout input datacard:
    New option in Bruno invocation: -M FinalfocusDatacard

    http://mailman.fe.infn.it/superbwiki/index.php/Bruno_Invocation
  - if datacard is not specified use default one:

    FinalFocus/Final_focus_BField_P4_layout_DataCard.txt
  - Datacard structure: define a list of magnetic elements (cylinders)

```
BeginMagneticElement
  Name        QD0PA
  StartPoint   0.899865  0.  29.9865  cm
  EndPoint     0.929861  0.  30.9861  cm
  Radius       0.899865  cm
  MagCenterPoint  0.914863  0.  30.4863  cm
  MagAxisVector   -0.0299955  0  -0.99955
  Gradient  -0.99955  0  0.0299955  139.12   tesla/m
  ConstantBField  0  0  0  0   tesla
EndMagneticElement
```

Cylinder definition

Quadrupolar field parameters

Constant field parameters

Bruno development: bbbrem IP Parameters

- **Previously:** Bbbrem generator (Radiative Bhabha) needs beam IP parameters for luminosity calculation
  - IP parameters were hard-coded inside Bruno (src/BbbremGenerator.cc)
  - Difficult to follow the evolution of the final focus magnetic layout
- **Currently:** (Need to document this in the wiki)
  - Modified bbbrem generator to read an input file with IP parameters
    New parameter: /generator/bbbrem/IPdatacard (need to document this in wiki)
  - If no IP-datacard is specified use default values (V12 SF10 layout)

HER parameters			LER parameters		
her_energy	6.69	GeV	ler_energy	4.18	GeV
her_pdt	-11		ler_pdt	11	
her_sigma_x	7.334e-3	mm	ler_sigma_x	8.701e-3	mm
her_beta_x	26.0	mm	ler_beta_x	32.0	mm
her_sigma_y	36.0e-6	mm	ler_sigma_y	35.0e-6	mm
her_beta_y	253.0e-3	mm	ler_beta_y	205.0e-3	mm
her_sigma_z	5.0	mm	ler_sigma_z	5.0	mm
her_deltaEoE	1.0e-3		ler_deltaEoE	1.0e-3	
her_alpha_z	-30.0e-3		ler_npart	6.56e+10	
her_npart	5.08e+10				

Summary and outlook

- **A validation machinery for the Bruno final focus magnetic fields simulation is now in place. Machinery can be used to**

  - Check the field configuration $\Rightarrow \sigma(X), \sigma(Y), \sigma(X'), \sigma(Y'), \varepsilon$ and β as a function of Z
  - Check the input geometry of pipes and magnets

- **Validation machinery for Beam geometries validation. Very useful to spot bugs**

- **Bruno development:**

  - Magnetic IR:
    - Input magnetic datacard (List of magnetic elements)
    - Will like to develop an script that translate accelerator group simulation out to a format that Bruno can read
  - Bbbrem generator:
    - IP parameters datacard

Backup

Final Focus Validation: The method (II)

Can sketch down and up stream HER and LER magnetic modeling

- **Downstream:** shoot particles with nominal parameters
- **Upstream:** shoot particles with nominal parameters inverting momenta and charge