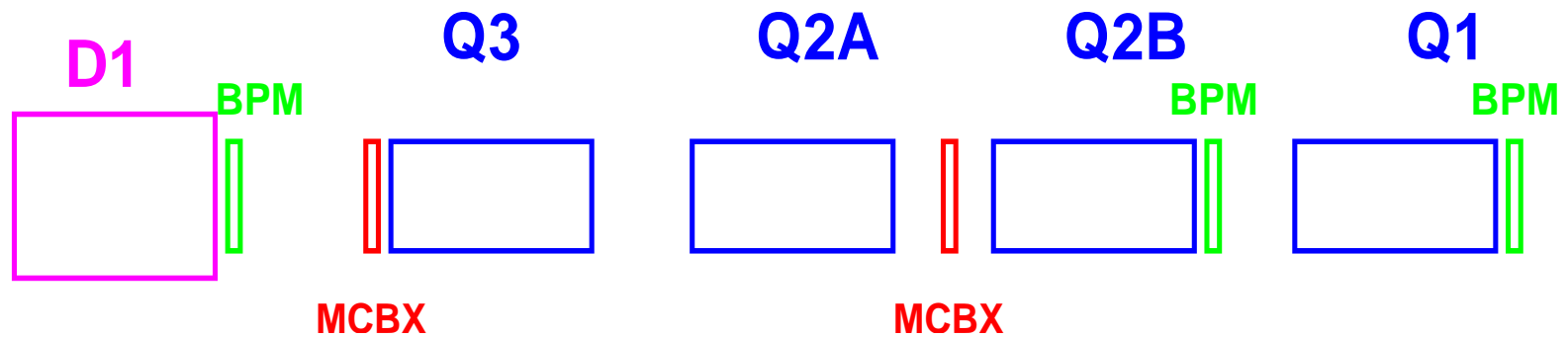


# How (and why) do we use MCBX for crossing angles and separation bumps

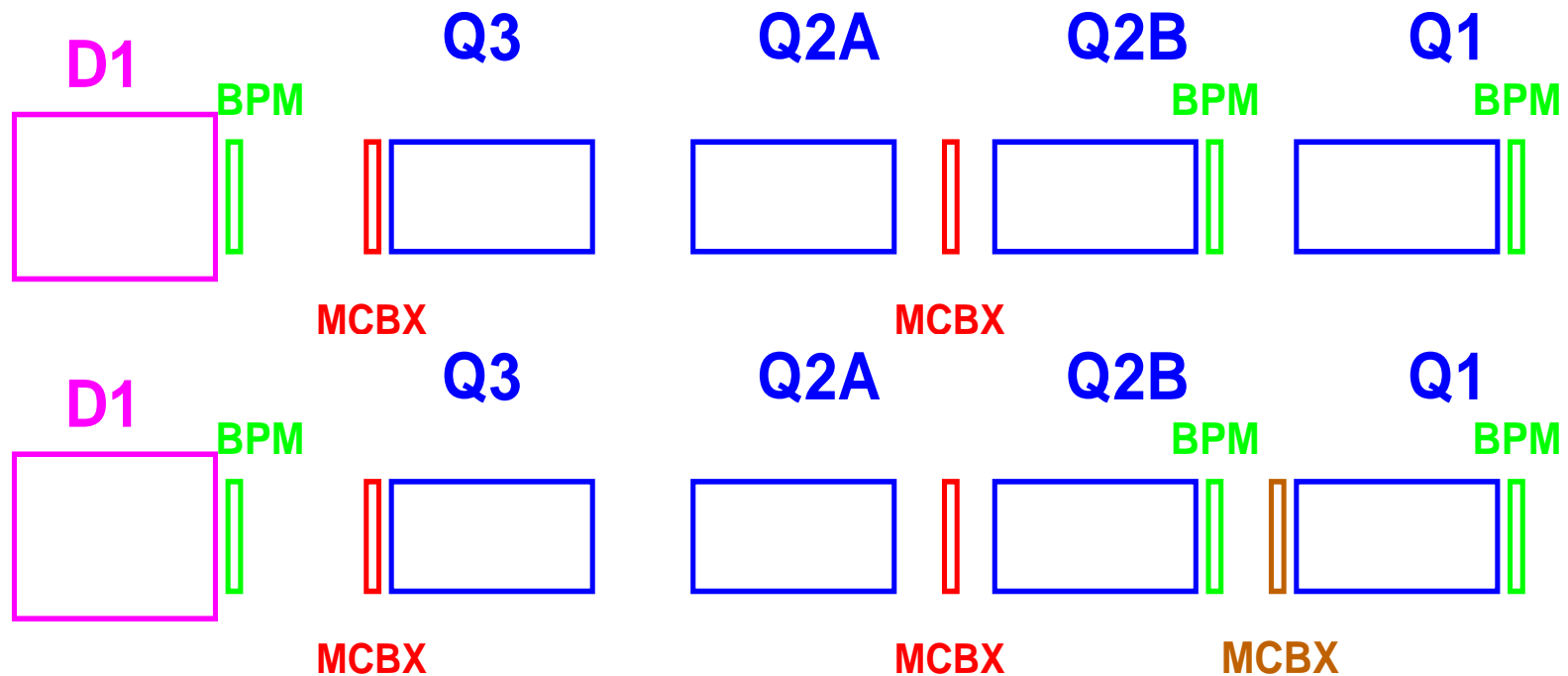
**W. Herr**

## Original layout ( - 1999)



- No MCBX foreseen for crossing angle or separation

## Modified layout (2000 - )



- MCBX added near Q1 for crossing angle/separation only

## Powering requirements

Due to symmetry conditions for two beams:

▣ Crossing angle:

➤  $ACBX1.left = - ACBX1.right$

▣ Separation bump:

➤  $ACBX1.left = ACBX1.right$

See also: LHC-Project-Reports 315 and 367.

## Why use MCBX ?

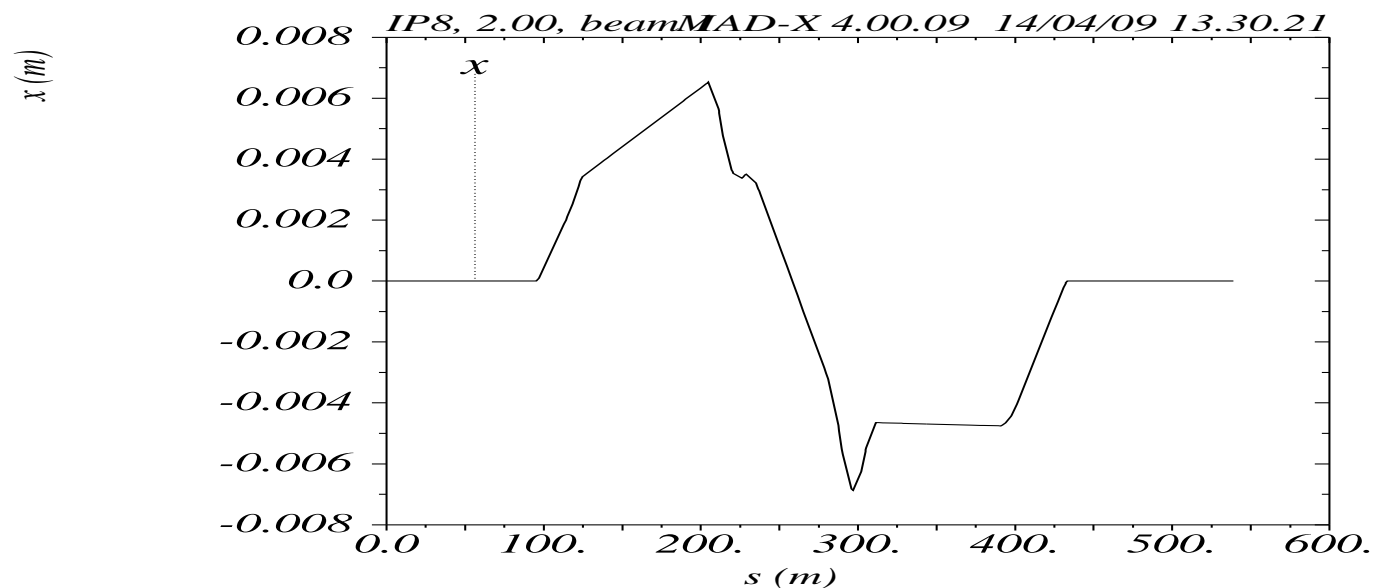
### ■ Crossing angle and parallel separation :

- In principle: 4-magnet bumps
- Can (should be ) separate for the two beams

### ■ Problem:

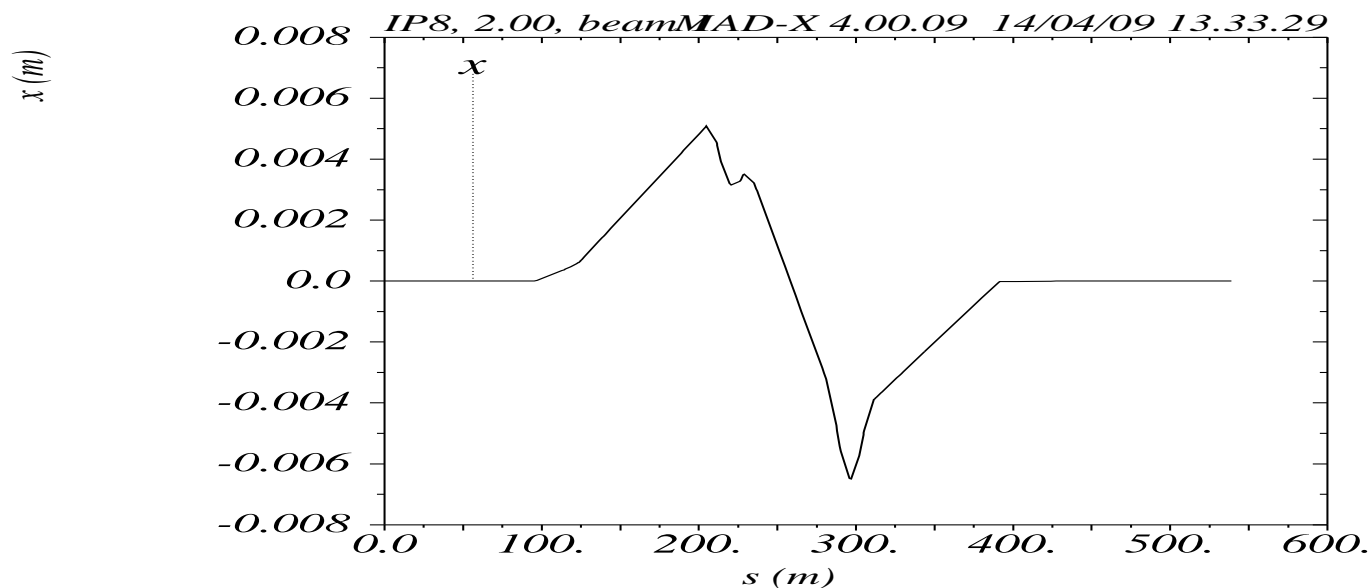
- Insufficient strength for crossing angle at low  $\beta$  at collision energy

## Crossing angle - collision



➤ Crossing angle at  $\beta = 2$  m at IP8, no MCBX

## Crossing angle - collision



➤ Crossing angle at  $\beta = 2$  m at IP8, with MCBX

## Why use MCBX ?

- Insufficient strength for crossing angle at low  $\beta$  at collision energy
  - Maximum required strength without MCBX:  
 $\approx 130 \mu\text{rad}$  (MCBY at Q4)
  - Maximum required strength with MCBX:  
 $\approx 50 \mu\text{rad}$  (MCBY at Q4)
- ➔ For crossing angle at low  $\beta$  at collision energy, MCBX indispensable



## Why use MCBX ?

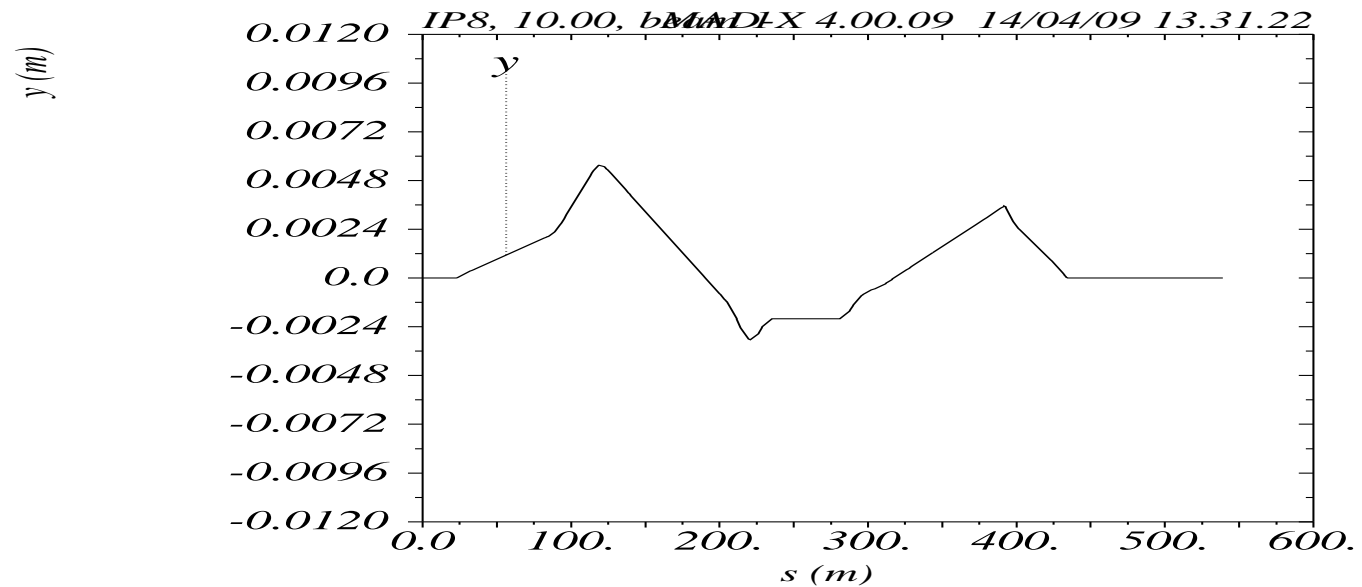
### ■ Crossing angle and parallel separation :

- In principle: 4-magnet bumps
- Can (should be ) separate for the two beams

### ■ Problem:

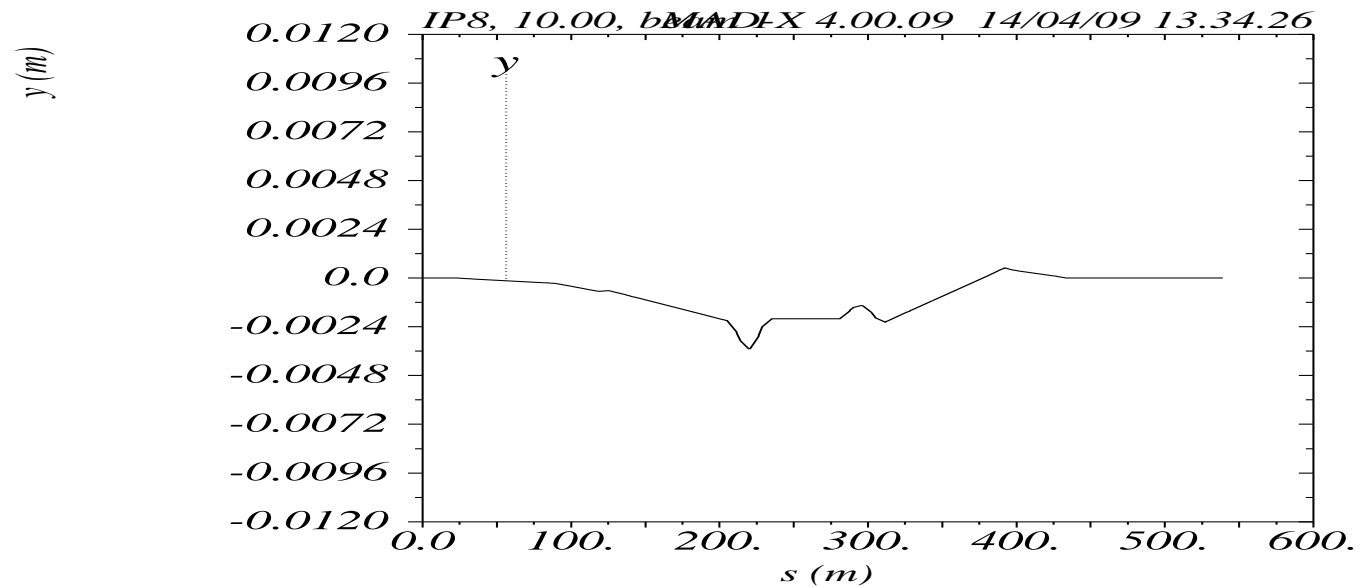
- Insufficient strength for crossing angle at low  $\beta$  at collision energy
- Large aperture required for separation bump at injection

## Separation bump - injection



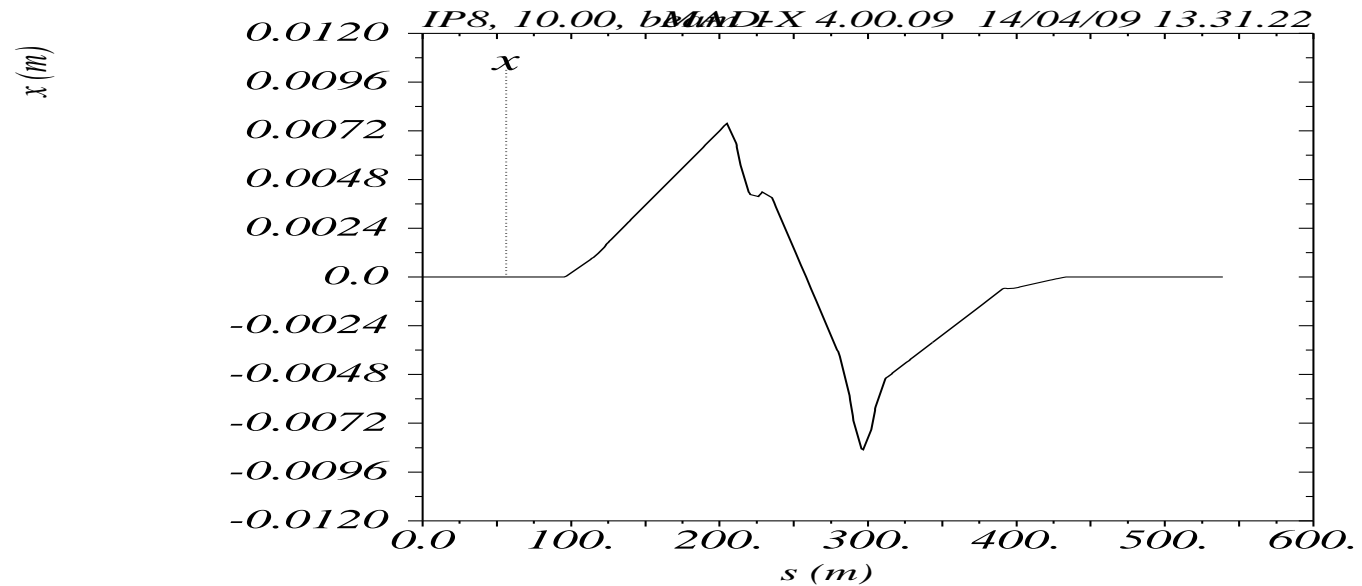
- Parallel separation at  $\beta = 10$  m at IP8, no MCBX

## Separation bump - injection



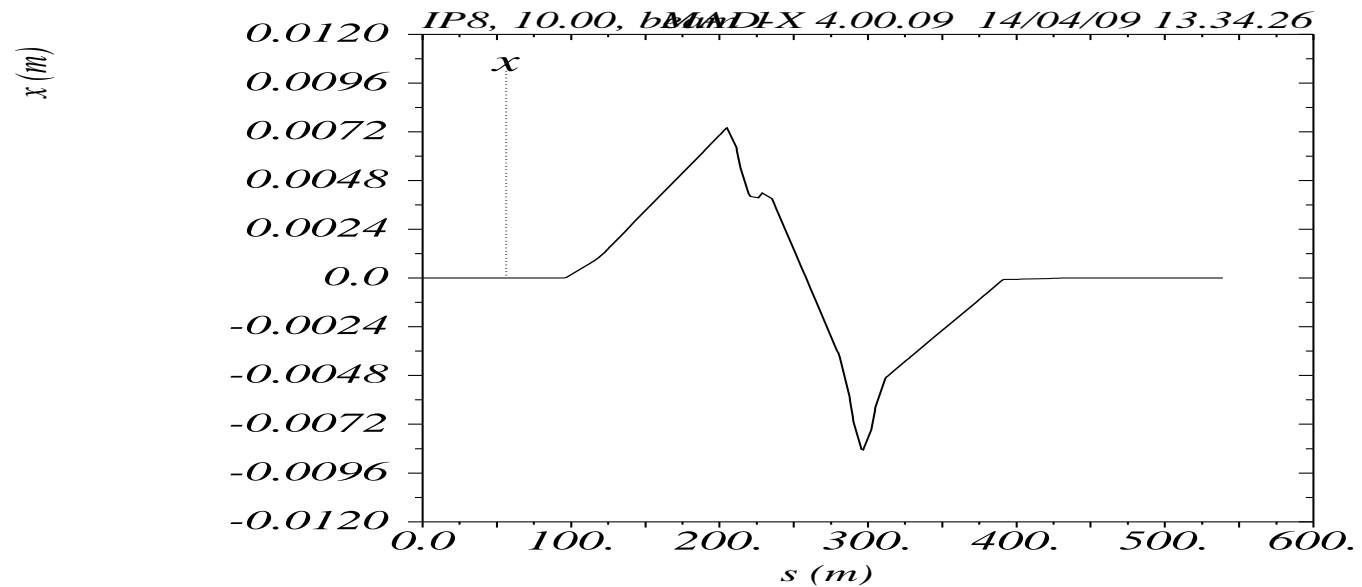
- Parallel separation at  $\beta = 10$  m at IP8, with MCBX

# Crossing angle - injection



➤ Crossing angle at  $\beta = 10$  m at IP8, no MCBX

## Crossing angle - injection

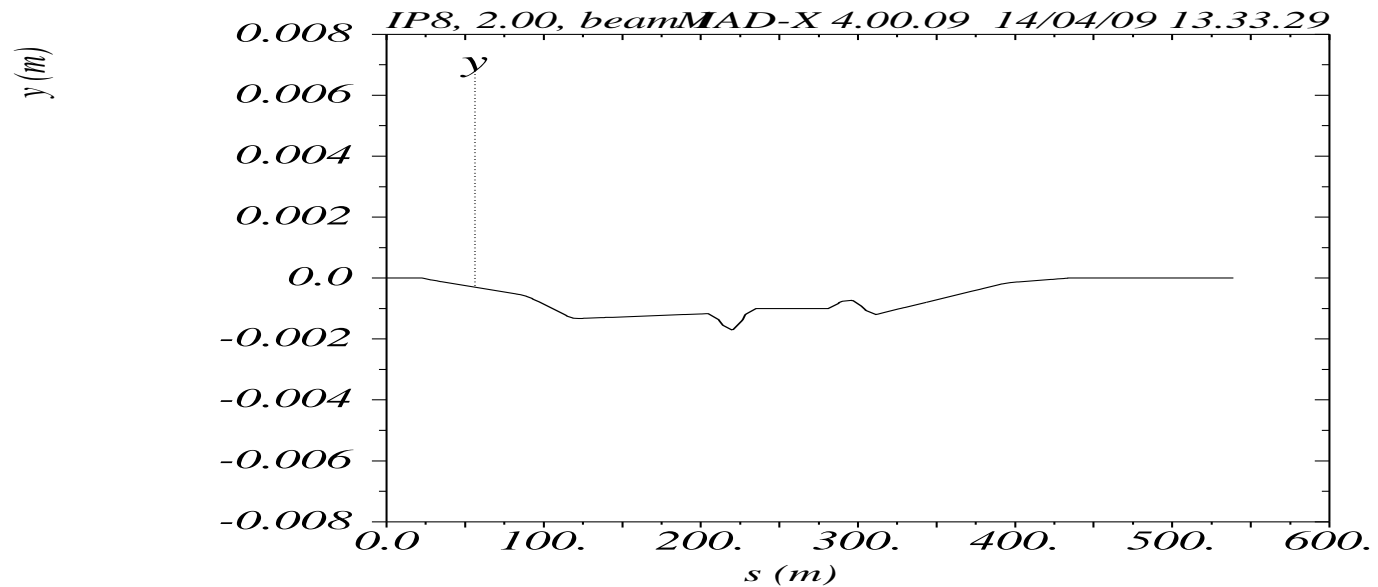


➤ Crossing angle at  $\beta = 10$  m at IP8, with MCBX

## Summary: injection

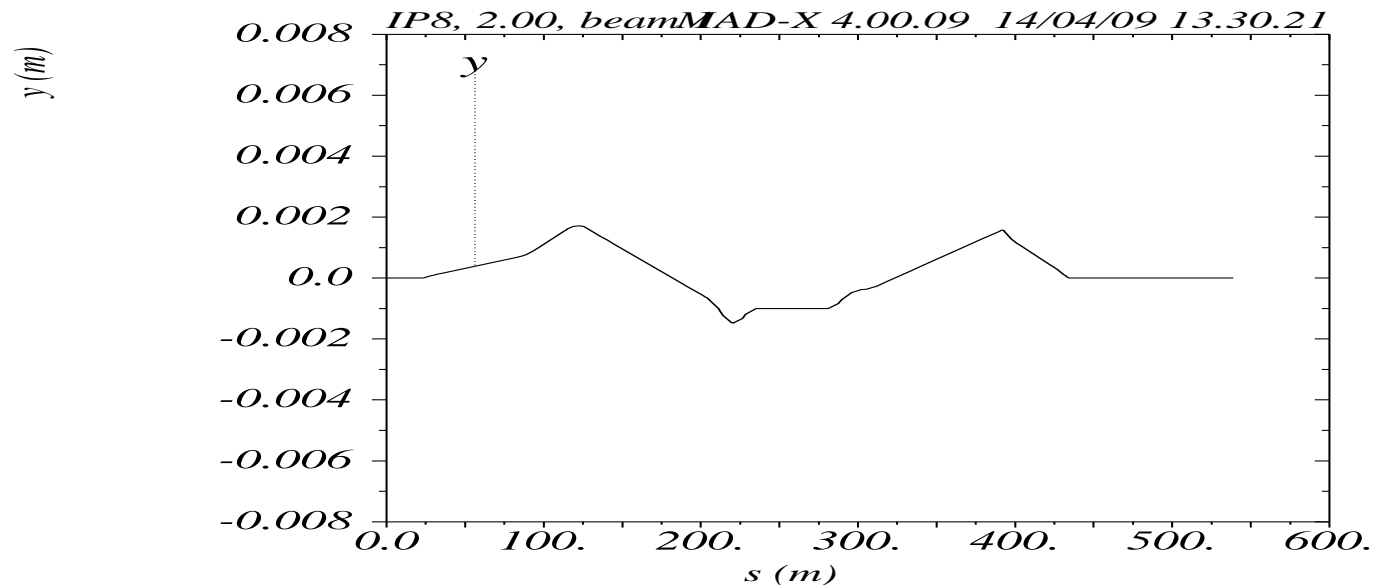
- No issue for crossing angle (works with or without MCBX)
- For parallel separation bump used to keep required aperture small (not a strength issue)
- What about separation bump at collision energy ?

## Separation bump - collision



- Parallel separation at  $\beta = 2$  m at IP8, with MCBX

## Separation bump - collision



- Parallel separation at  $\beta = 2$  m at IP8, no MCBX
- Aperture loss much smaller than at injection



## Separation bump - collision

- At injection: MCBX used to reduce required aperture
  - At high energy and low  $\beta$ :
    - Smaller beam size
    - Smaller separation needed (1.2 mm instead 4 mm)
- ➔ Aperture not the issue for separation bump

## Required strengths

Strengths increase on other correctors (e.g. in IP8):

- MCBY at Q4 from  $\approx 10 \mu\text{rad}$  to  $\approx 90 \mu\text{rad}$
- Maximum strength MCBY at Q4:  $\approx 135 \mu\text{rad}$  at 5 TeV
- $90 \mu\text{rad}$  correspond to  $\approx 50 \text{ A}$

## Conclusions

- MCBX strictly required for crossing angle, but static
- MCBX for separation bump not needed at top energy
  - MCBX for separation bump can be ramped down **before** going into collision, and can stop discussing MCBX ramp rates
  - Separation bump controlled only by (non-common) correctors, strengths are sufficient for IP8
  - Ramping speed determined by these (non-common) correctors