

# **Optics status and progress**

**Demin Zhou**

Acknowledgements:

M. Benedikt, M. Crouch, R. De Maria, S. Fartoukh, M. Giovannozzi, M. Hofer, Y. Nosochkov, K. Oide, T. Risselada, L. Riesen-Haupt, D. Sagan, D. Schoerling, R. Thomas, P. Thrane, E. Todesco, D. Tommasini, F. Zimmermann

14th HE-LHC design meeting, CERN, May. 23, 2017

# Outline

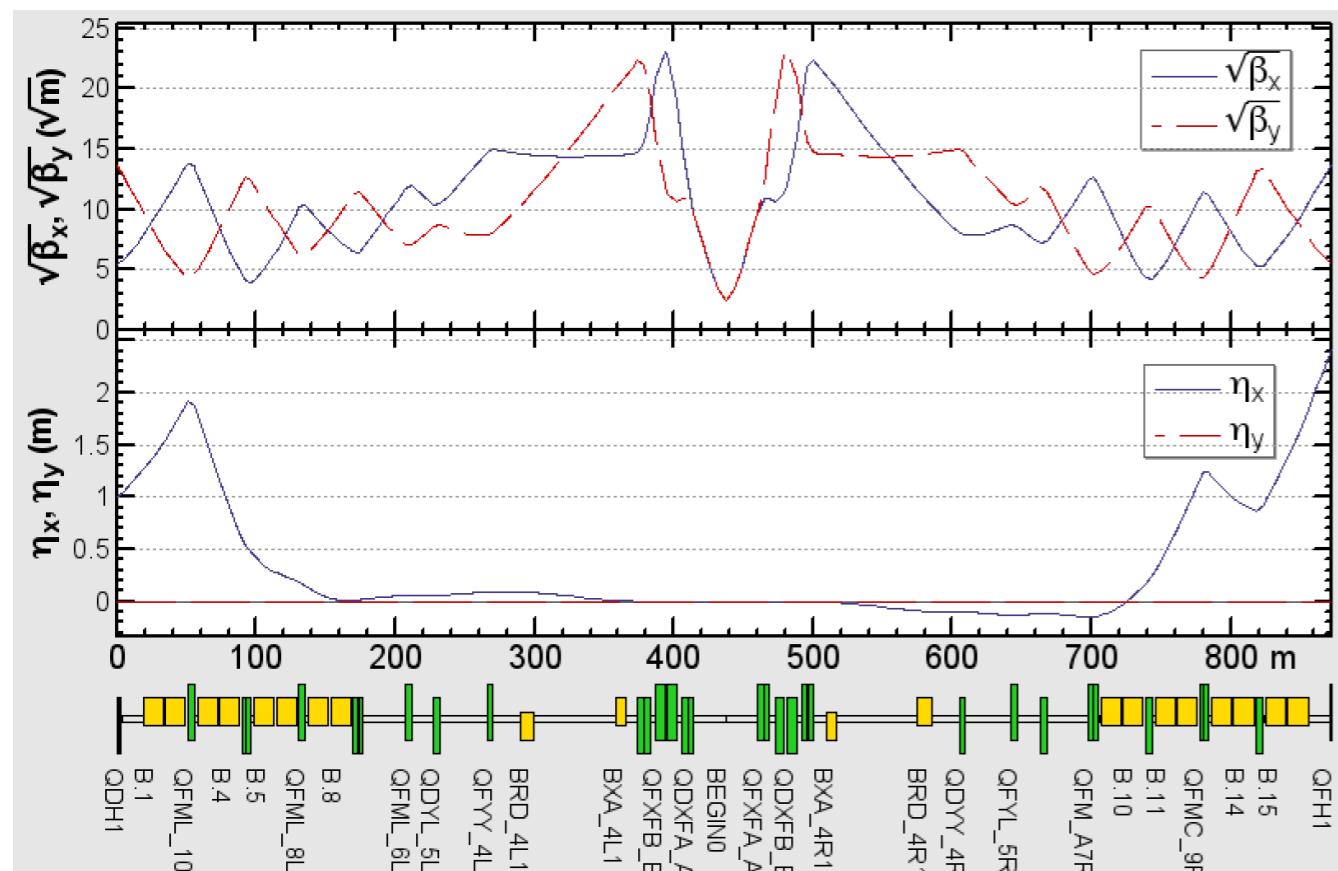
- Tests of using 60deg x24 arc cells
  - **Injection optics for HL-LHC (HLLHCV1.0, opt\_inj.madx)**
- Tests of using 90deg x20 arc cells
  - **Injection optics for HL-LHC (HLLHCV1.0, opt\_inj.madx)**
- Summary

# 1. Tests of using 60deg x24 arc cells

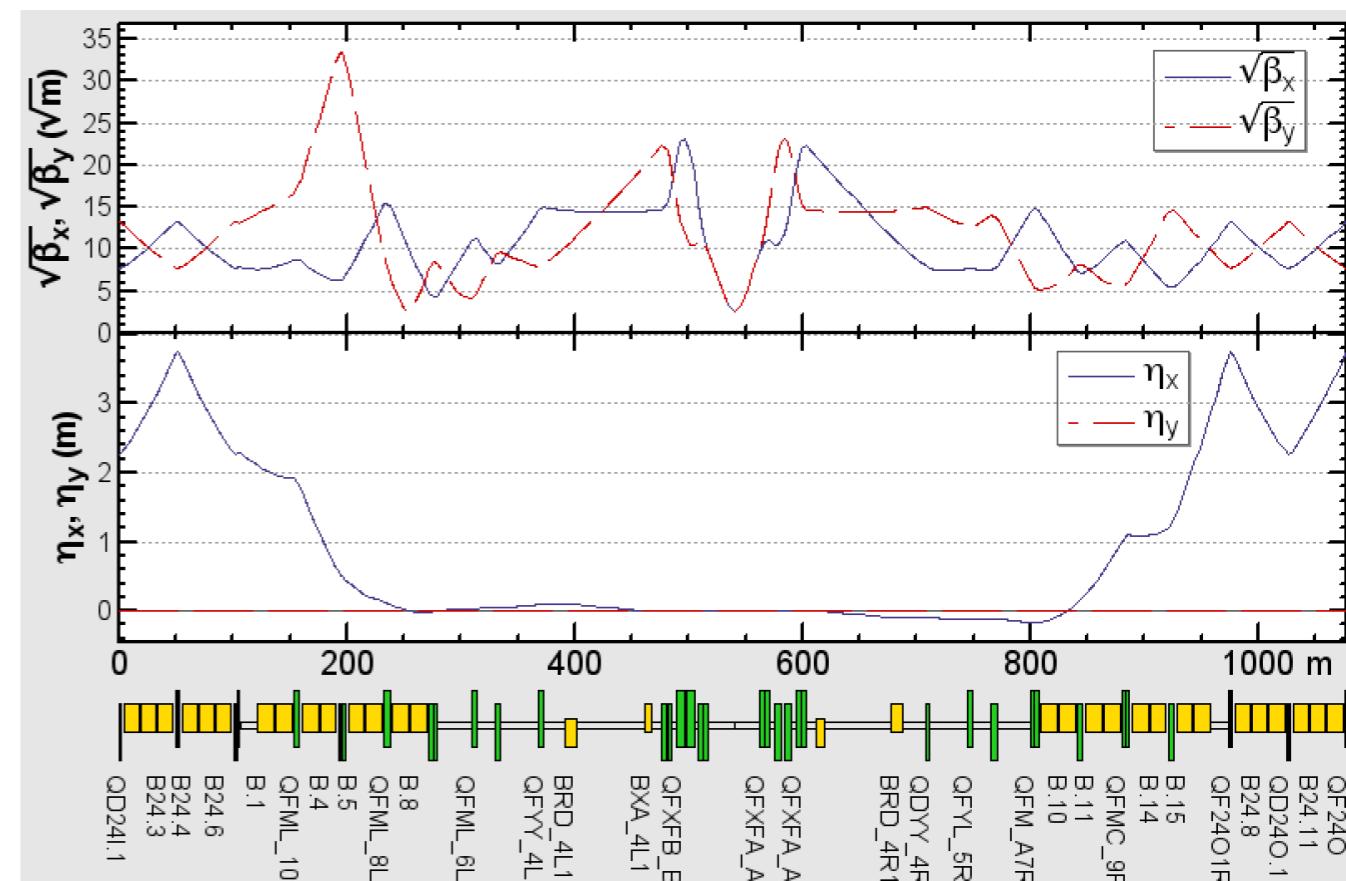
## ► Preliminary results (linear optics matching)

- IR1 (ATALS)
- Large beta peak in DSL1 can be controlled, but compete with dispersion control [This is generally truth for matching DOFO cell to DSs]

HLLHCV1.0 (opt\_inj)



60deg-cell matched

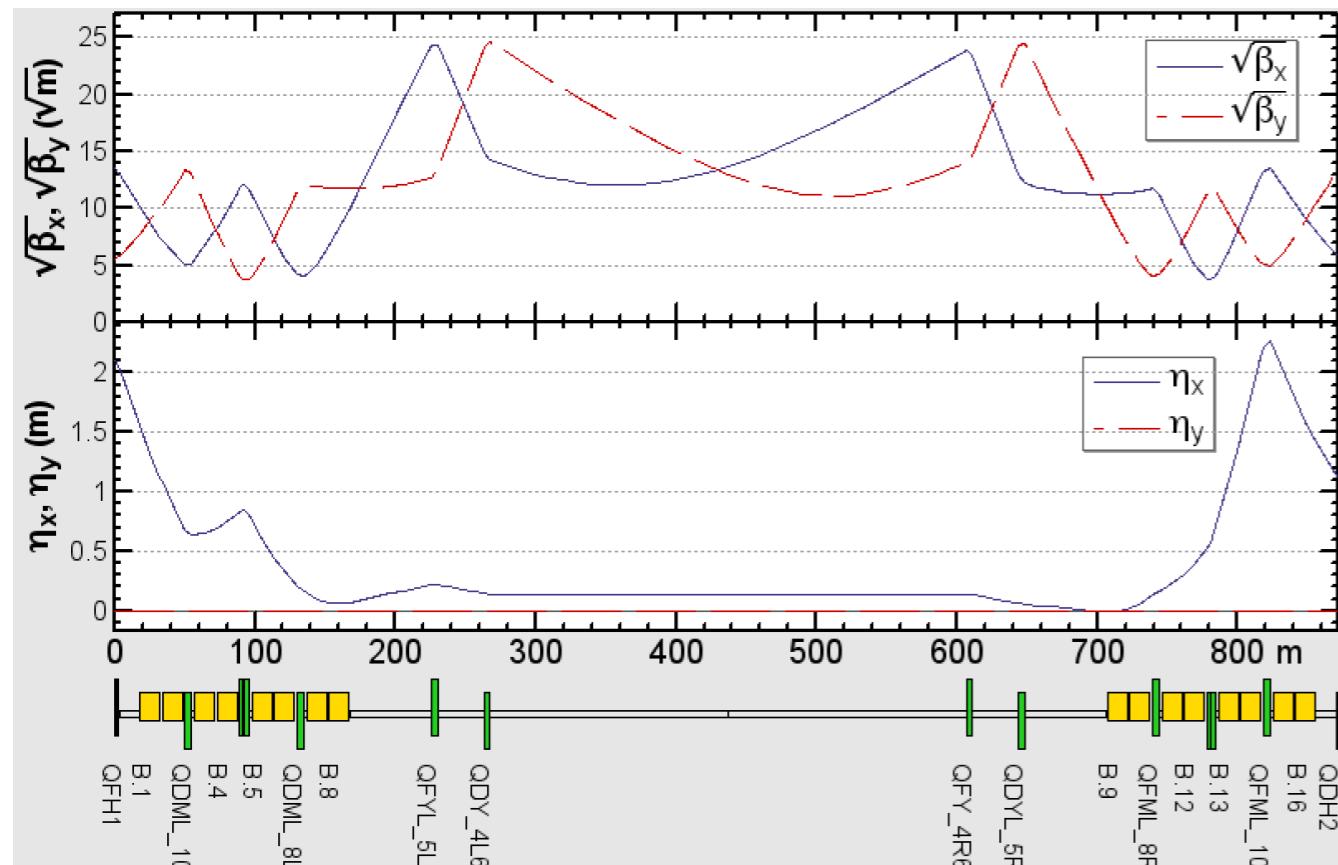


# 1. Tests of using 60deg x24 arc cells

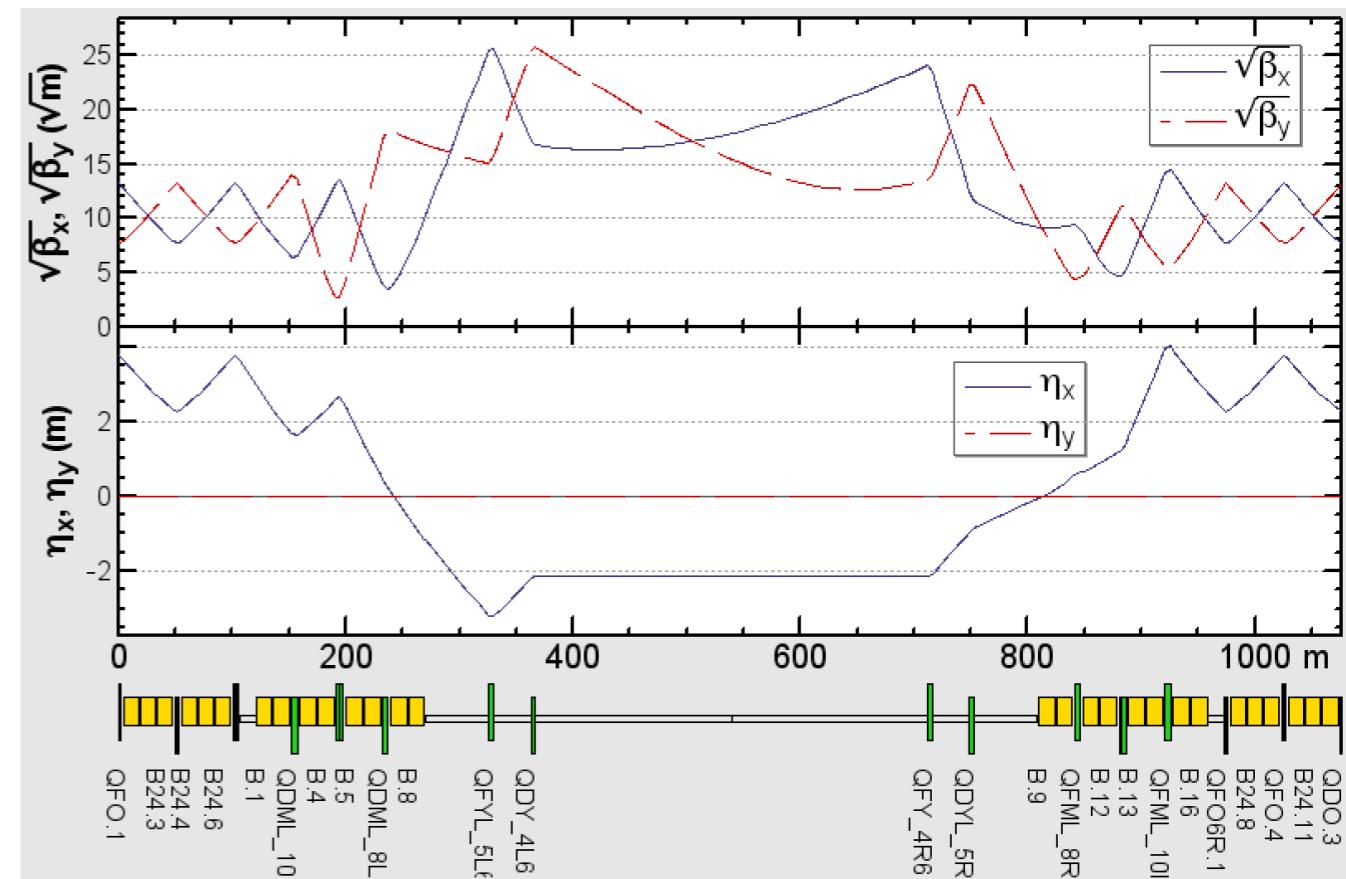
## ► Preliminary results (linear optics matching)

- IR6 (Beam dump)
- Shift QY\* by 2.8 m to the arc side
- Free EX at IP6 (Need to modify DS if controlling EX preferred?)

HLLHCV1.0 (opt\_inj)



60deg-cell matched

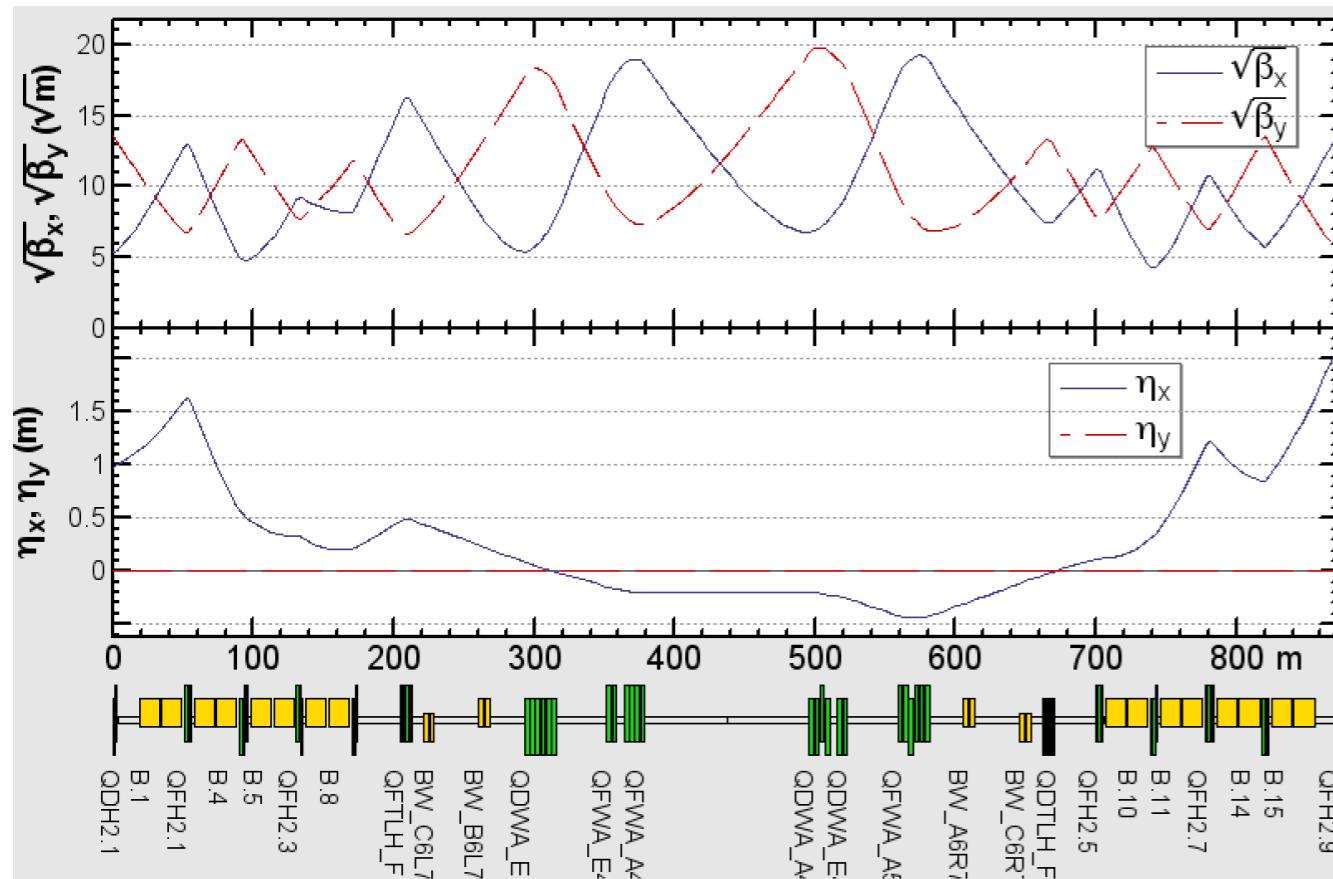


# 1. Tests of using 60deg x24 arc cells

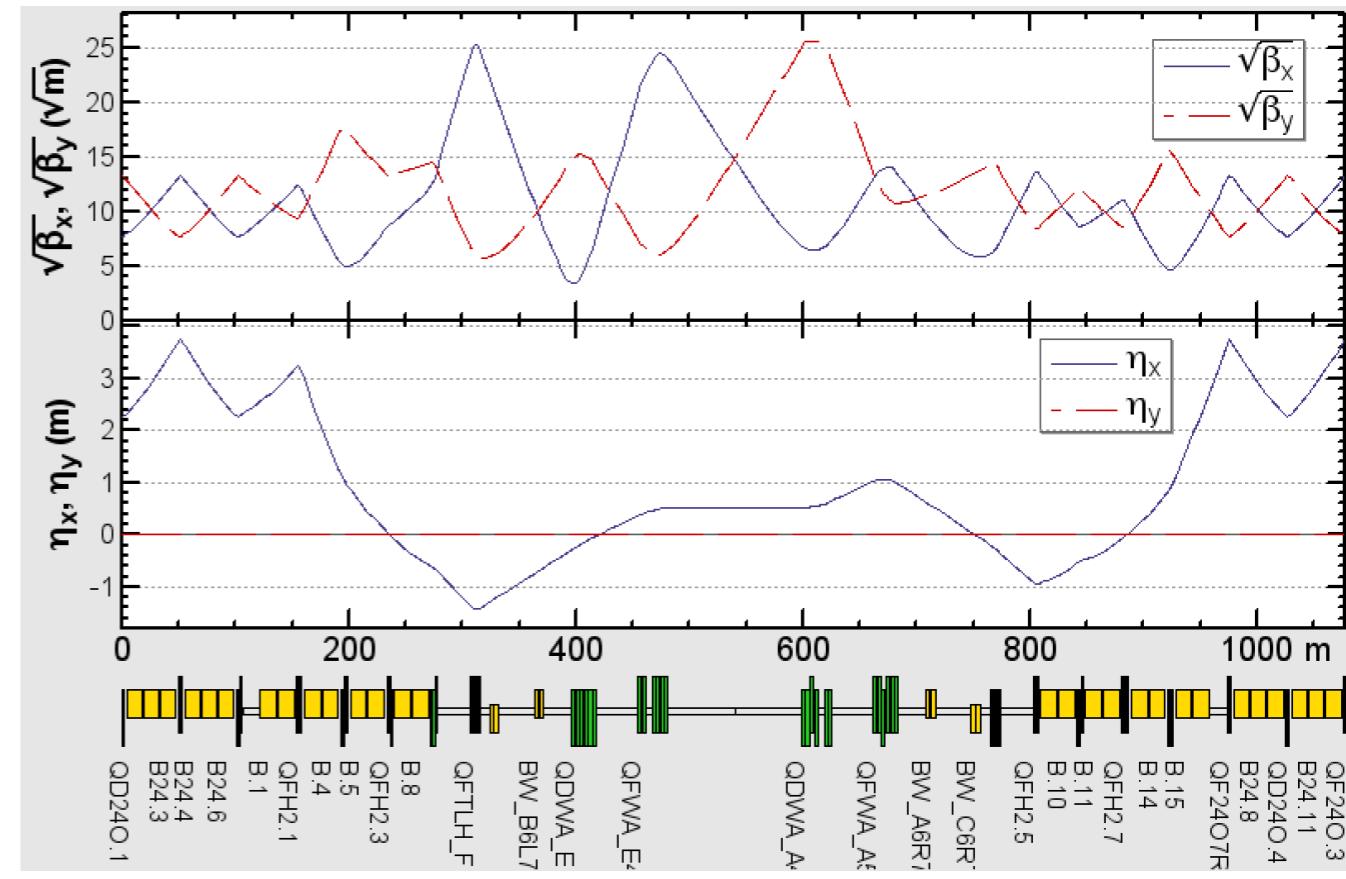
## ► Preliminary results (linear optics matching)

- IR7 (Betatron collimation)
- Shift QTLH\* by 0.388 m to the arc side
- Free EX at IP6 (Need to modify DS if controlling EX preferred?)

HLLHCV1.0 (opt\_inj)



60deg-cell matched

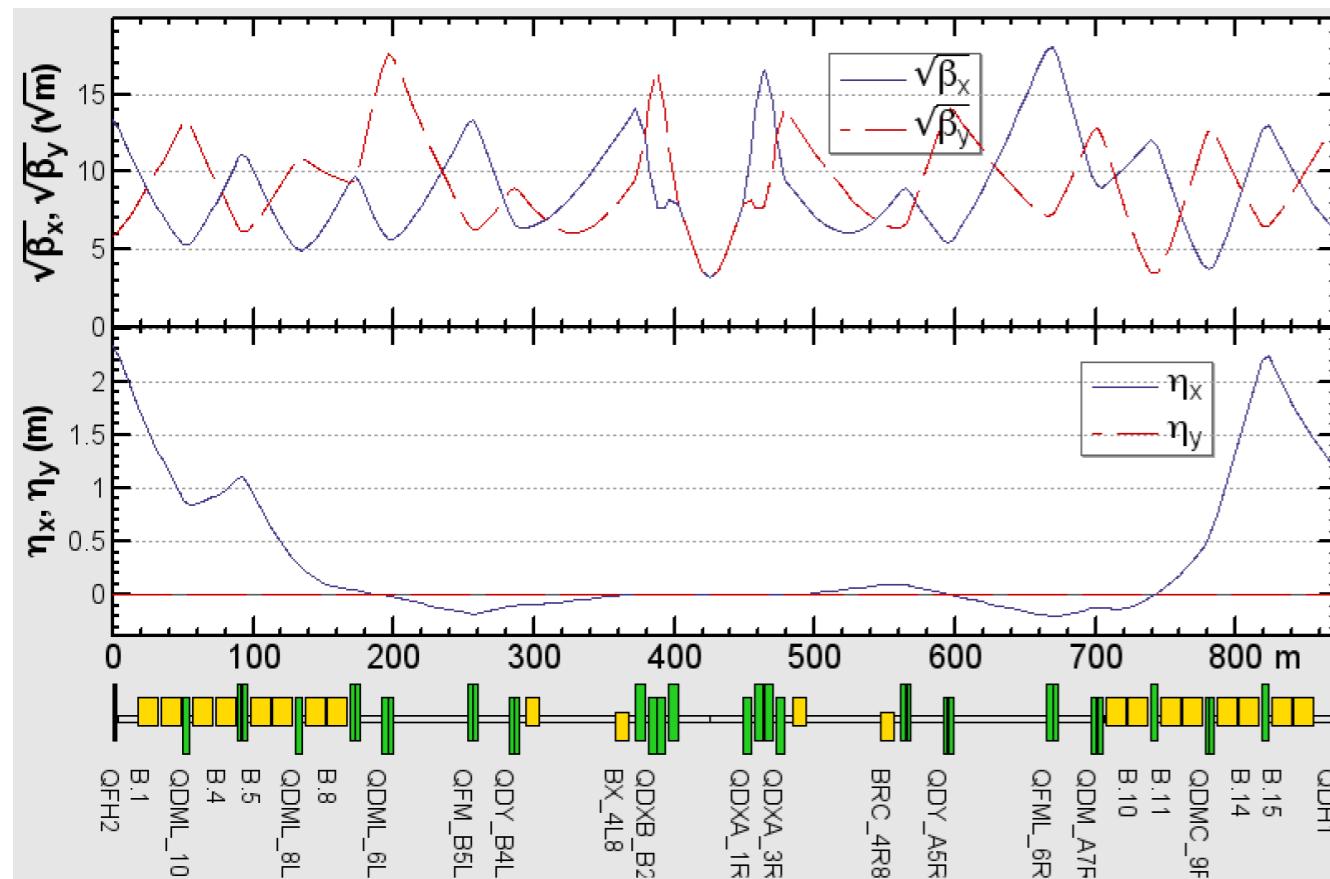


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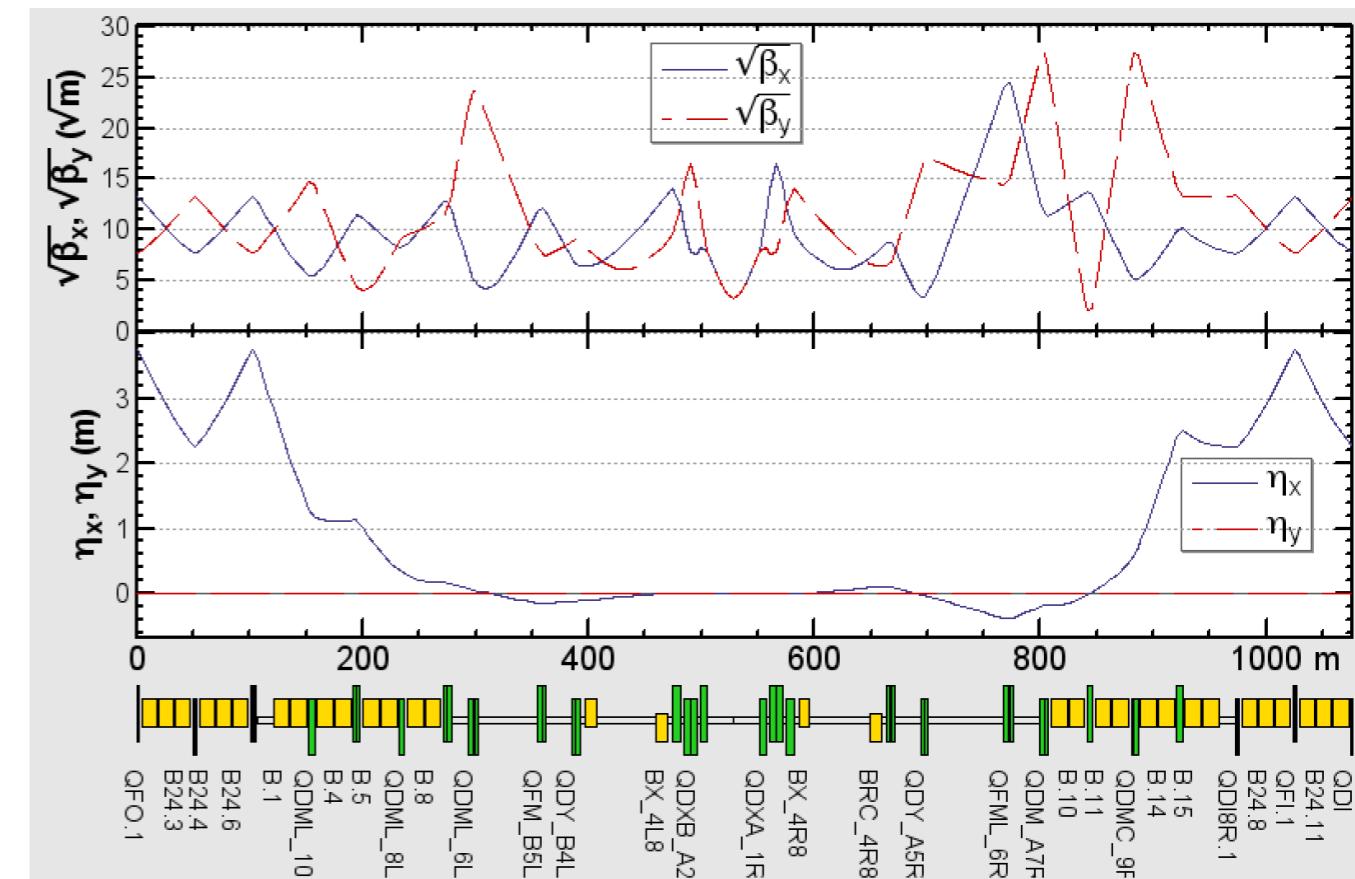
## ► Preliminary results (linear optics matching)

- IR8 (LHC-B & injection b2)

HLLHCV1.0 (opt\_inj)



60deg-cell matched

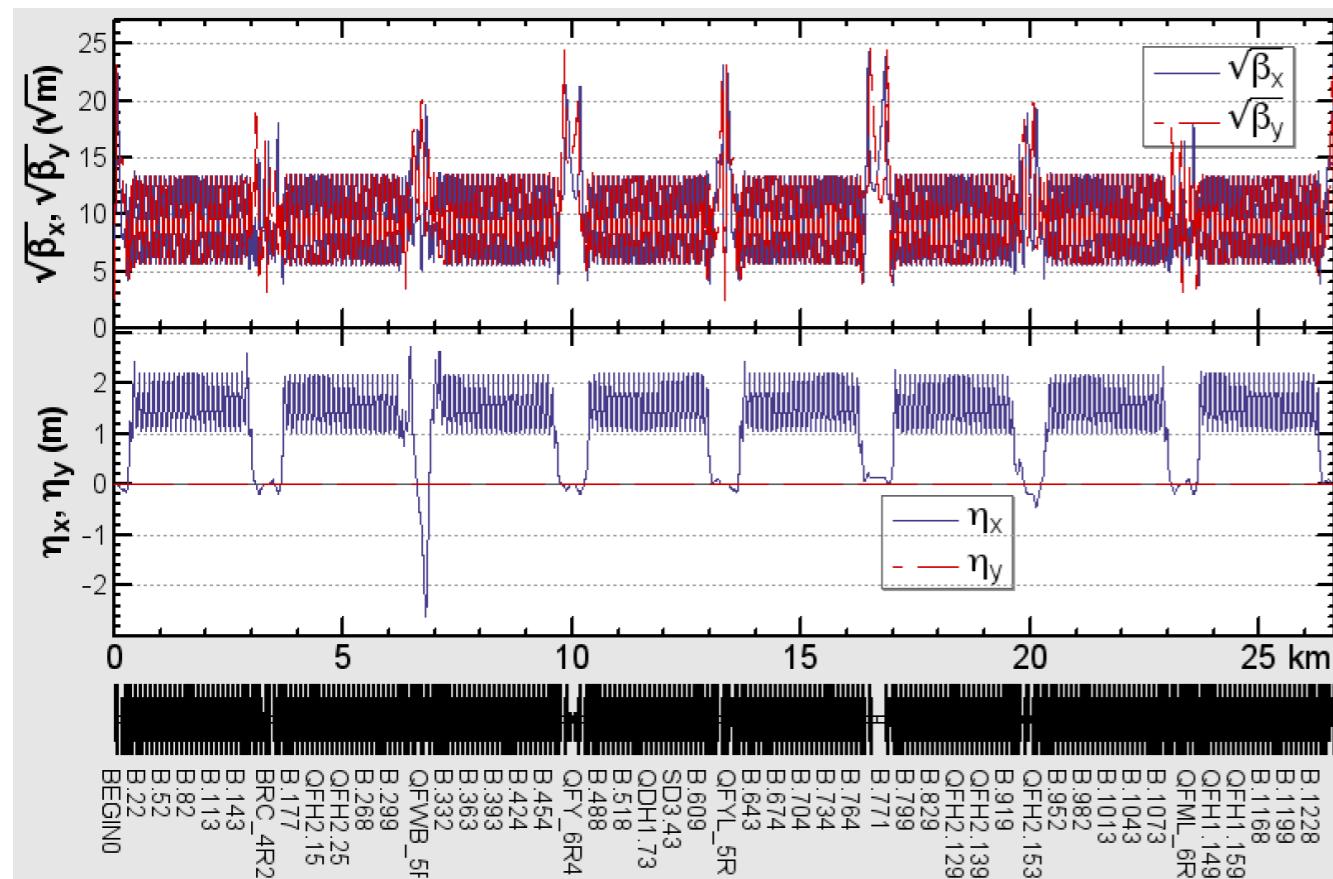


# 1. Tests of using 60deg x24 arc cells

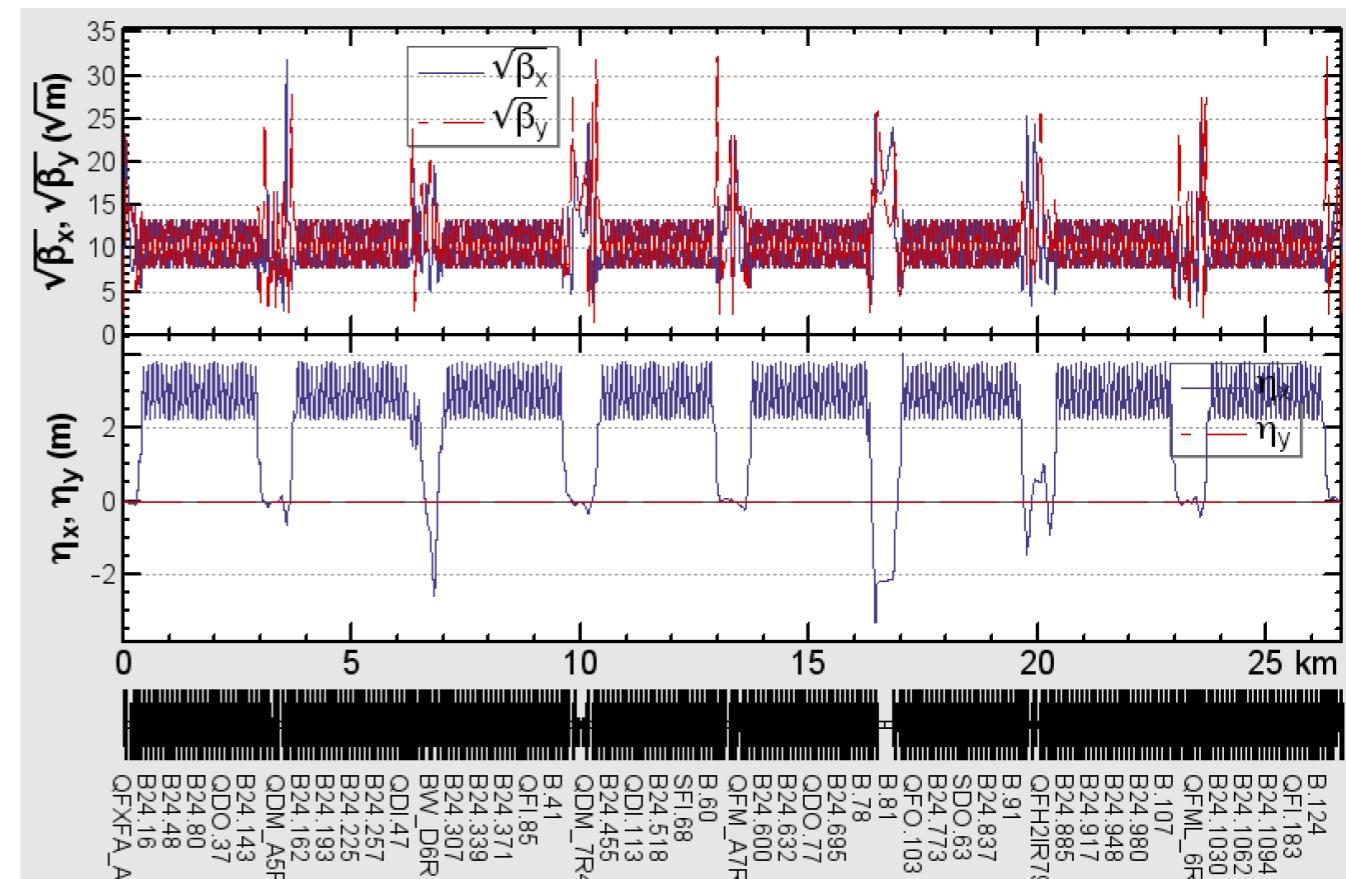
## ► Preliminary results (linear optics matching)

- Whole ring

HLLCV1.0 (opt\_inj)



60deg-cell matched

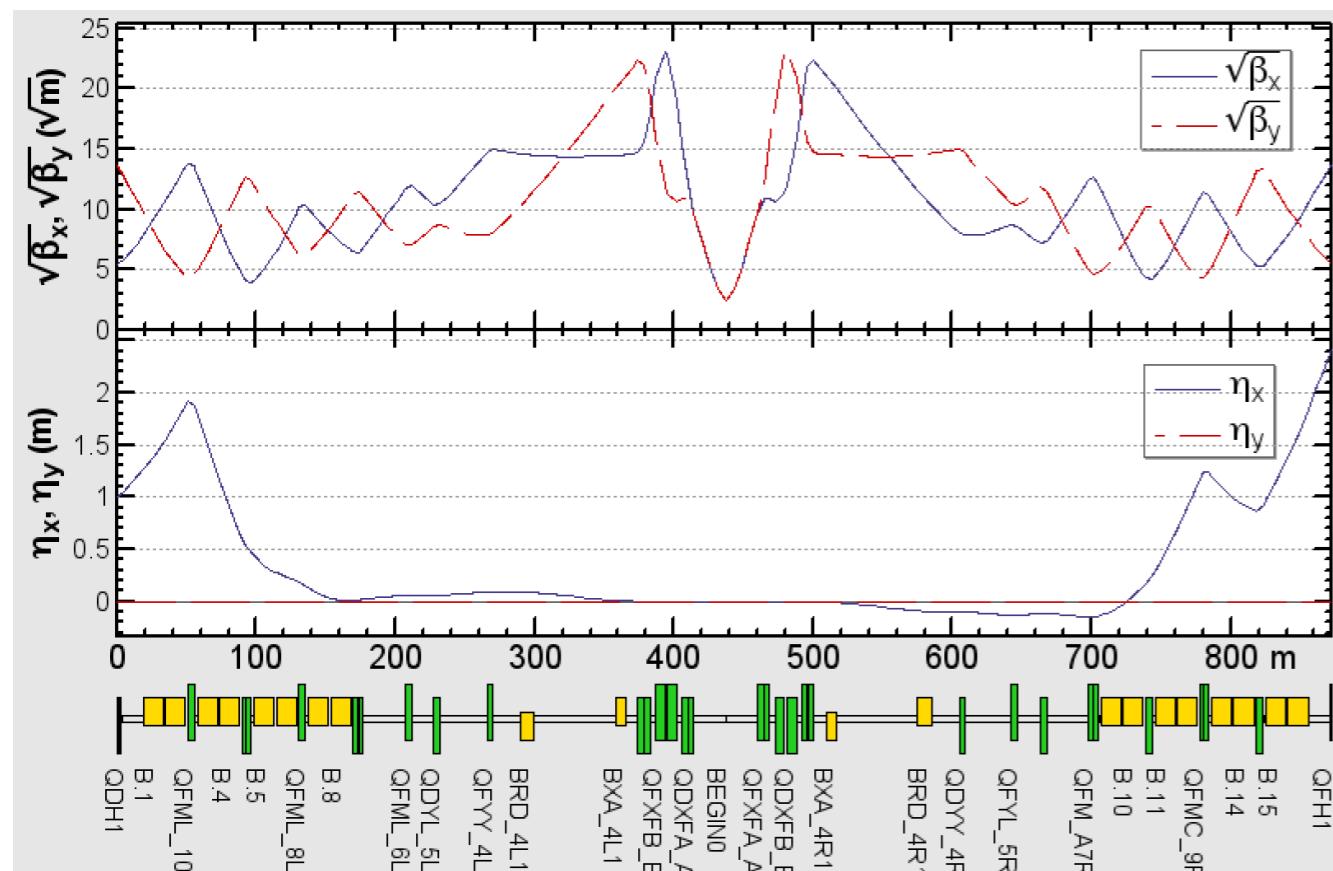


## 2. Tests of using 90deg x20 arc cells

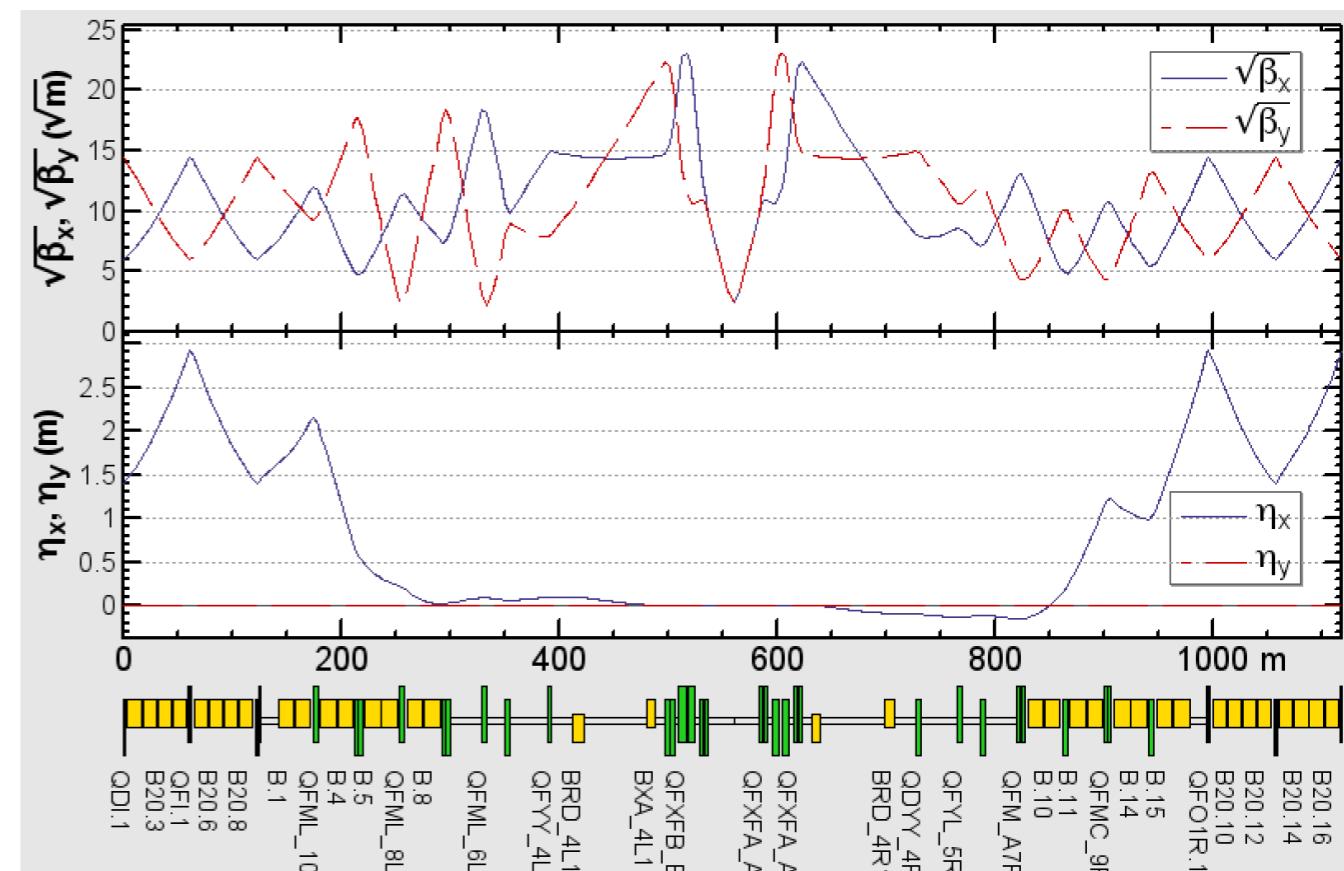
### ► Preliminary results (linear optics matching)

- IR1 (ATALS)
- Need optimization of matching sections between IR and arcs

HLLHCV1.0 (opt\_inj)



90deg-cell matched

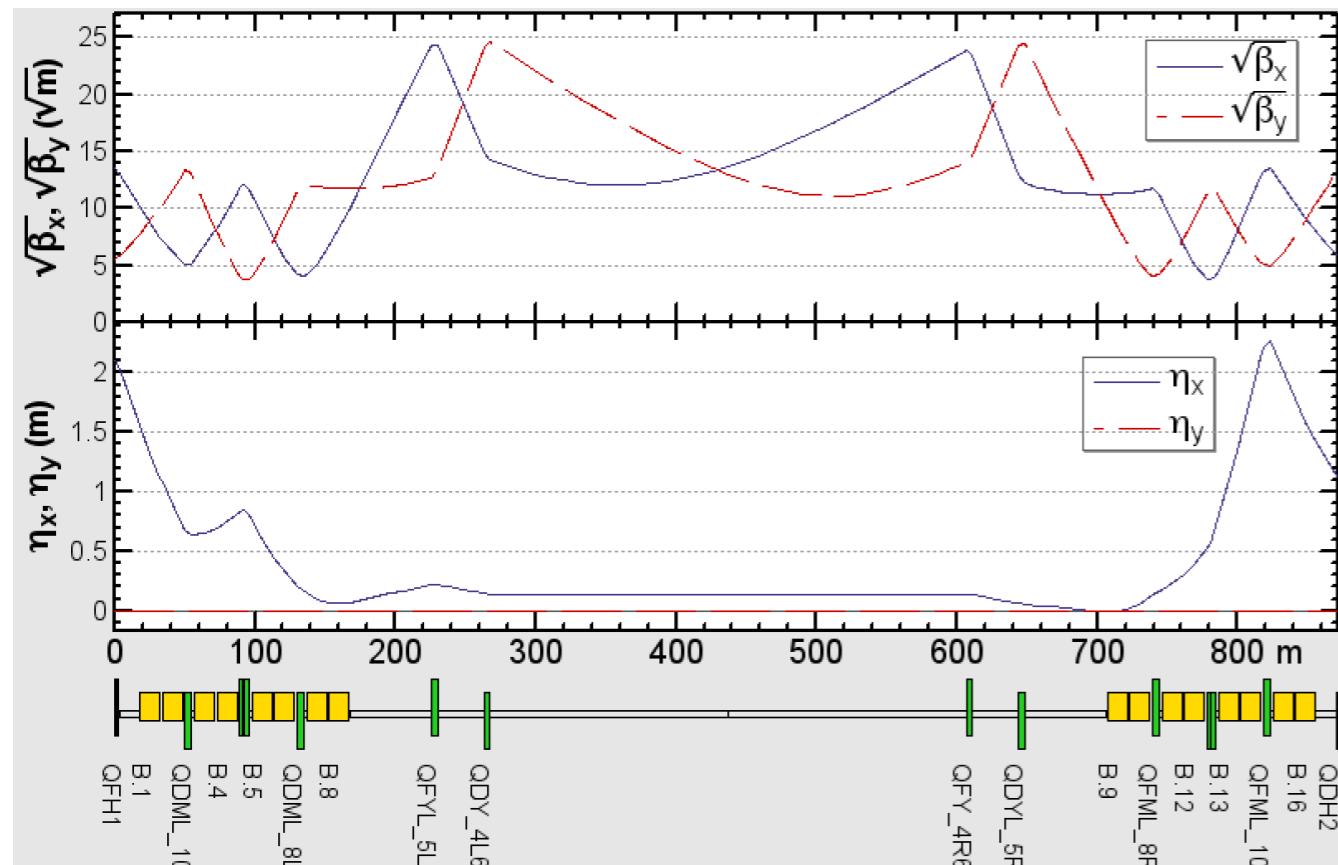


## 2. Tests of using 90deg x20 arc cells

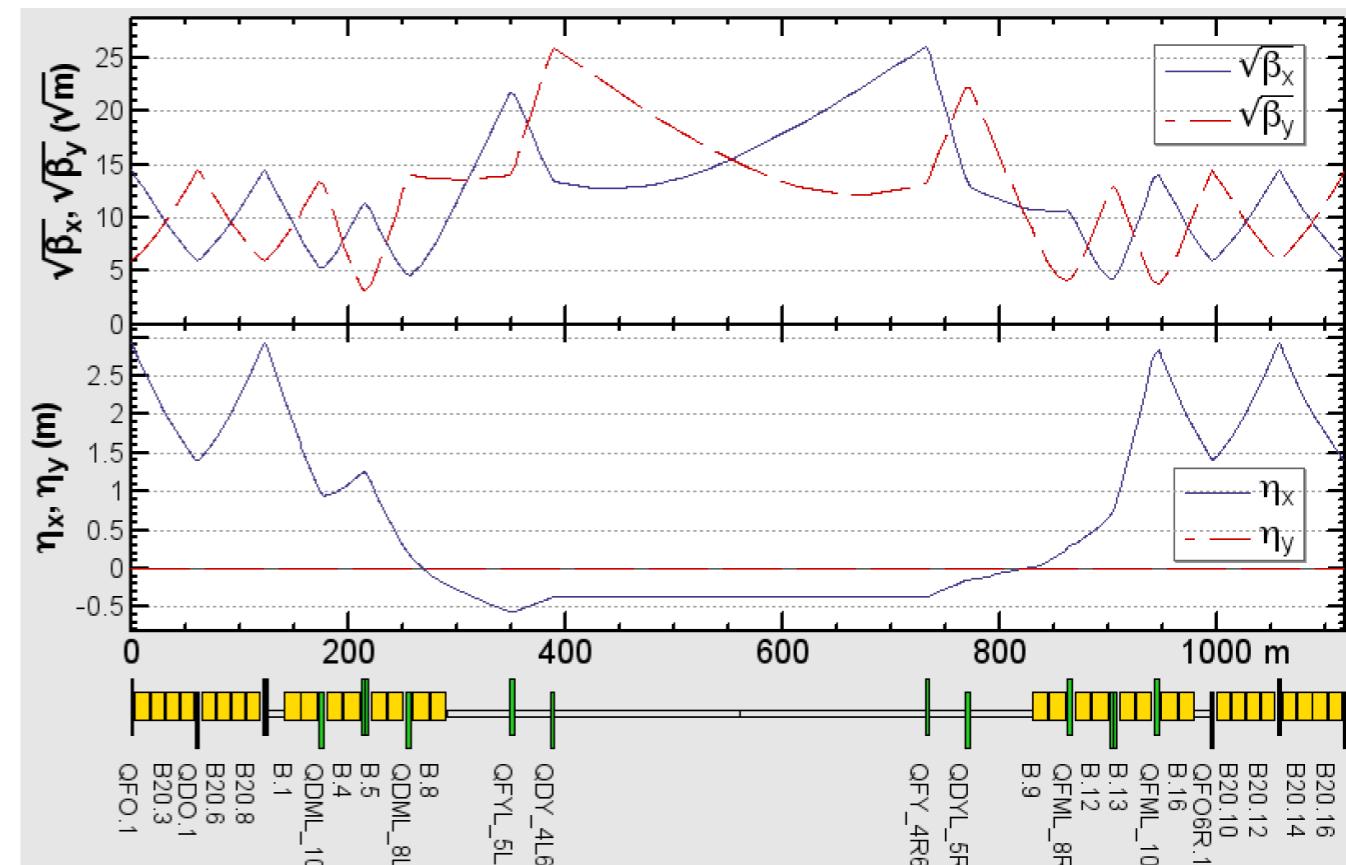
### ► Preliminary results (linear optics matching)

- IR6 (Beam dump)
- Shift QY\* by 0.8 m to the arc side
- Free EX at IP6 (Need to modify DSs and matching quads if controlling EX preferred)

HLLHCV1.0 (opt\_inj)



90deg-cell matched

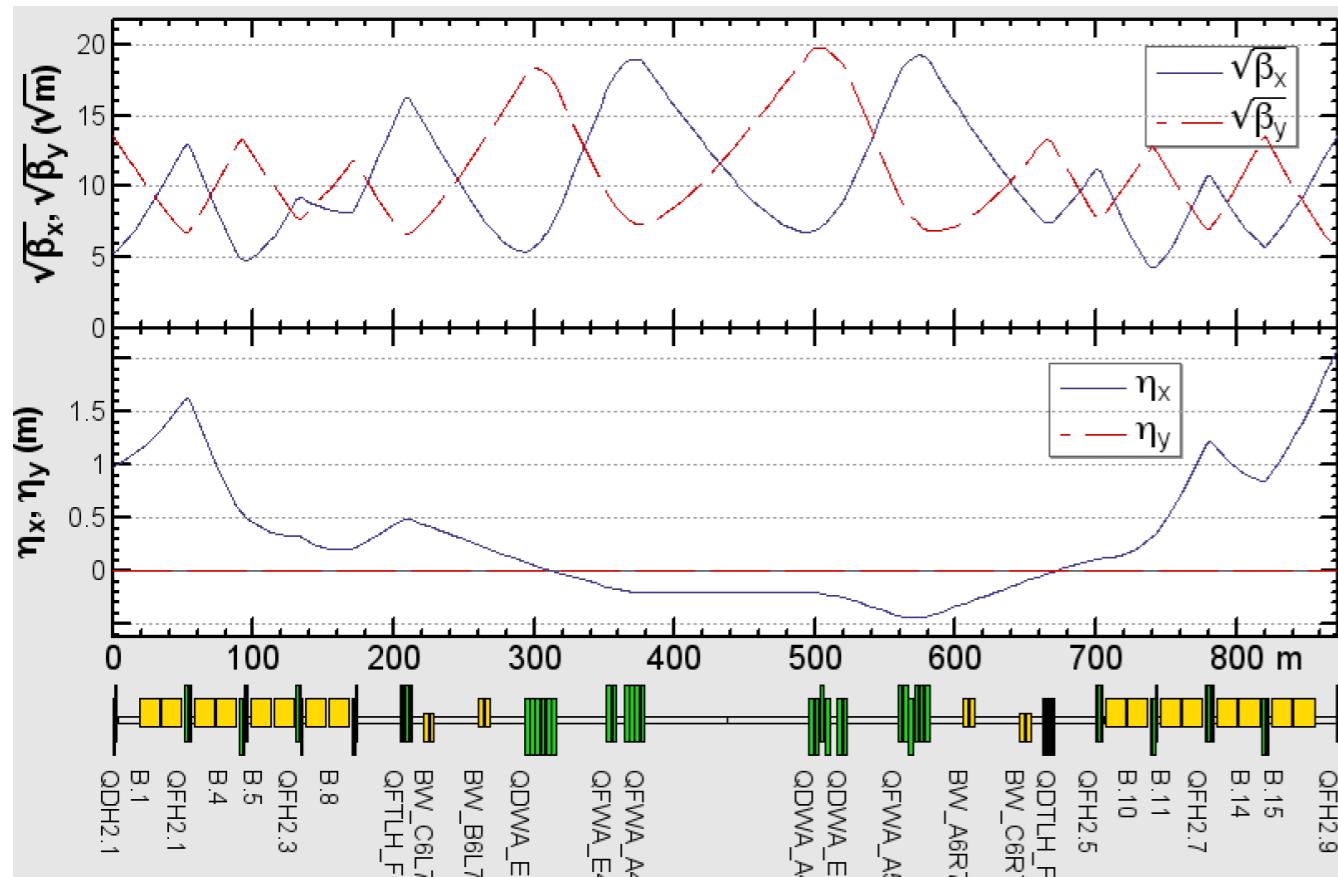


## 2. Tests of using 90deg x20 arc cells

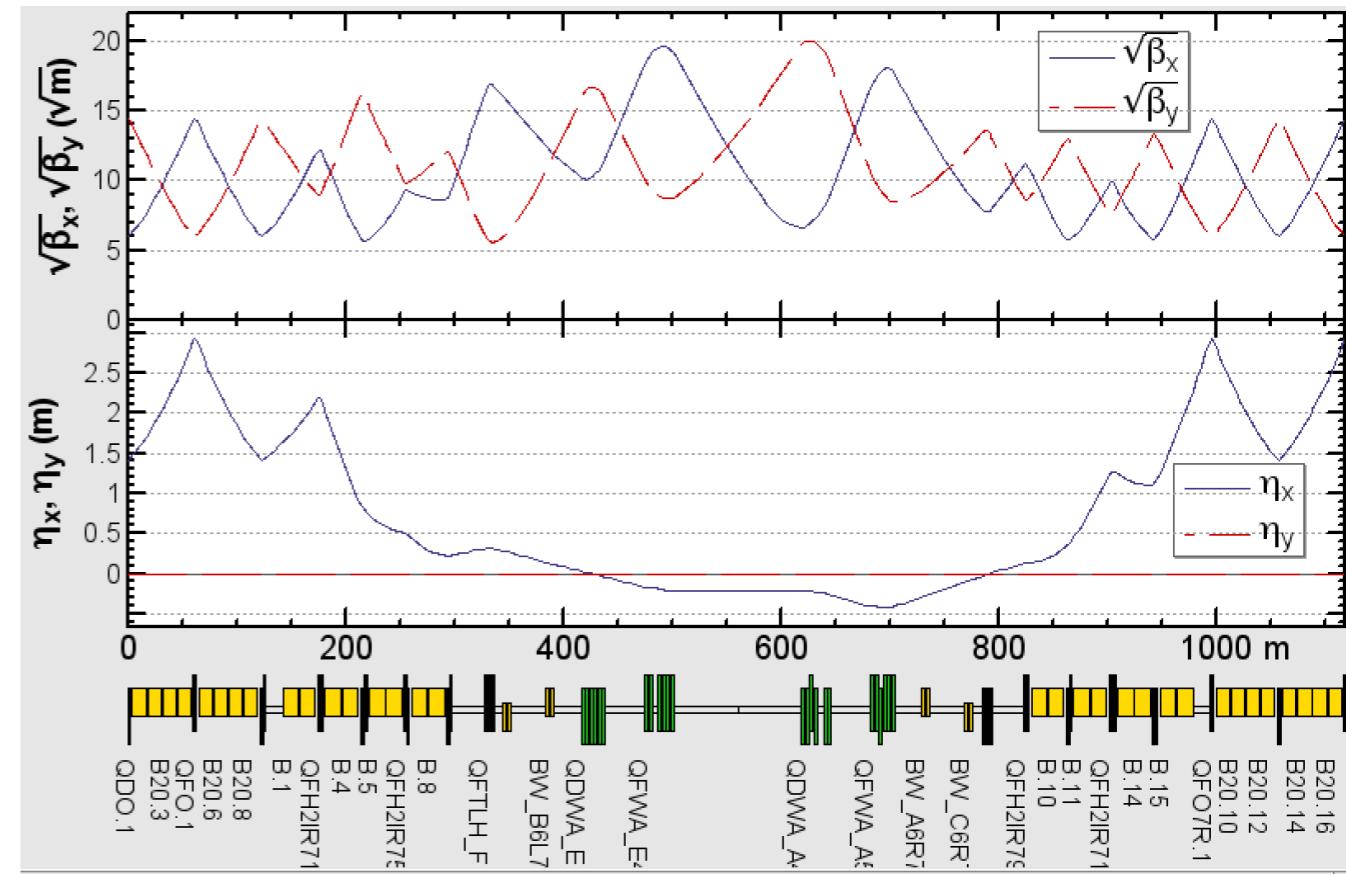
### ► Preliminary results (linear optics matching)

- IR7 (Betatron collimation)
- Shift QTLH\* by 0.2 m to the arc side
- Free EX at IP6 (Need to modify DS if controlling EX preferred?)

HLLHCV1.0 (opt\_inj)



90deg-cell matched

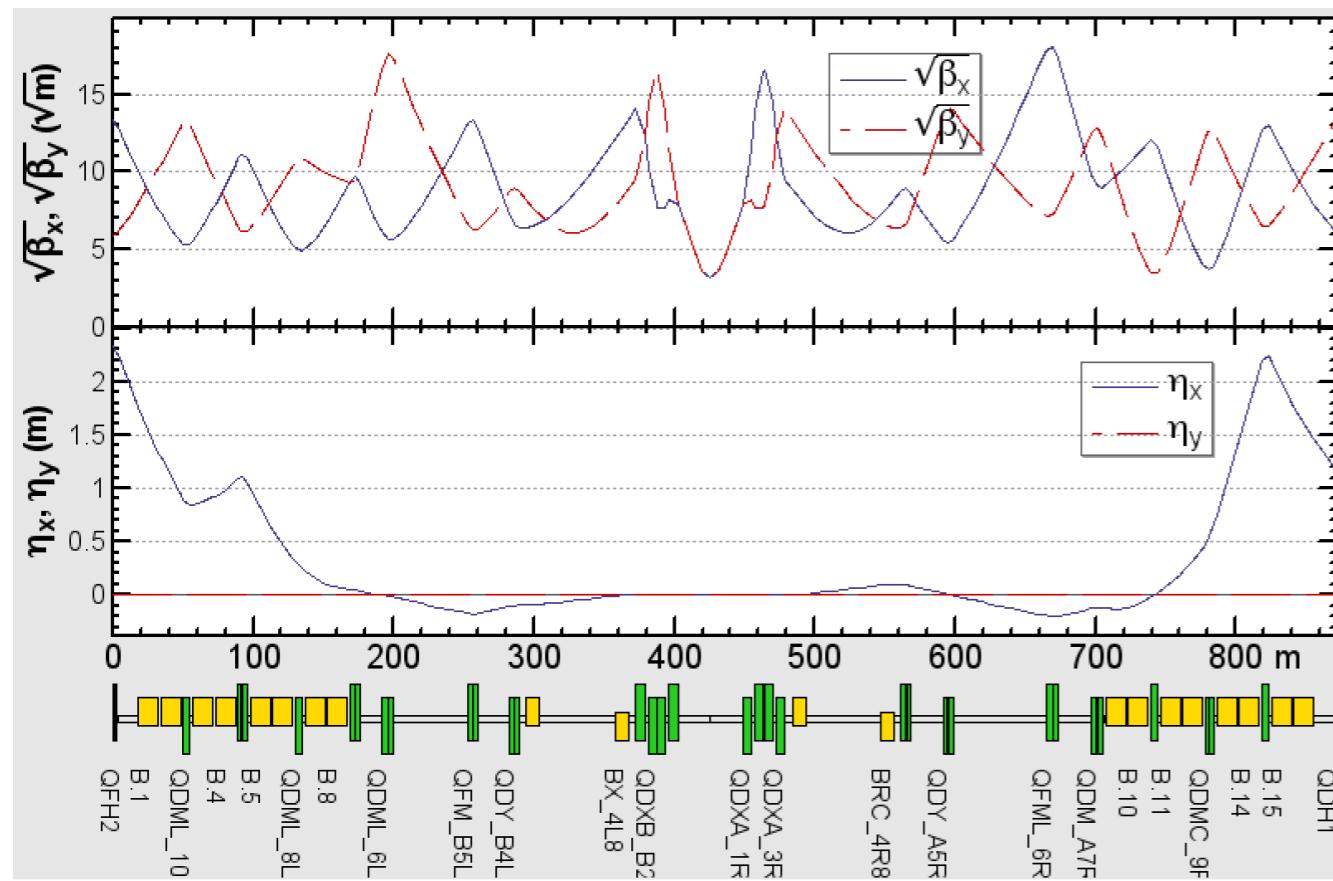


## 2. Tests of using 90deg x20 arc cells

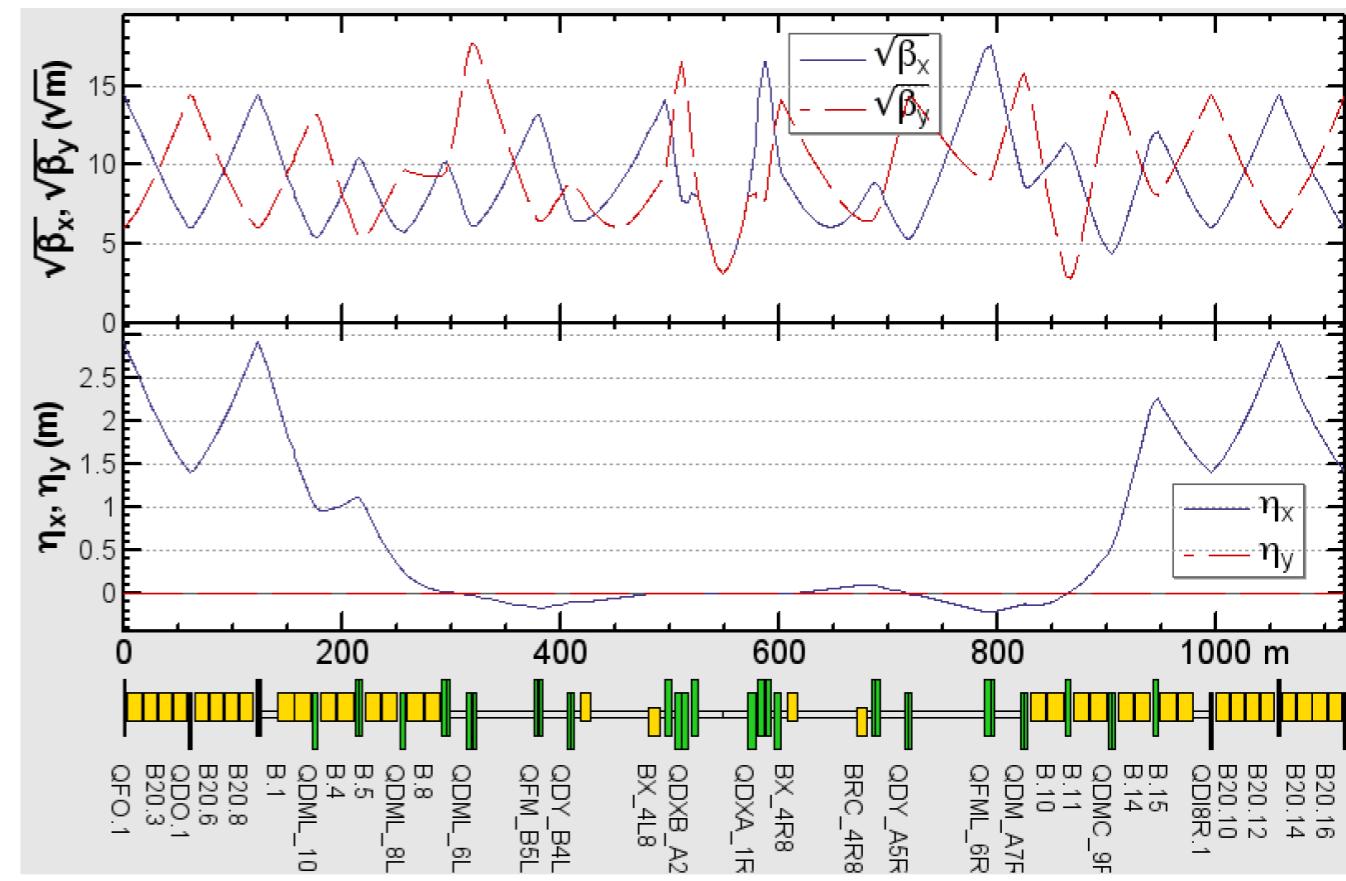
### ► Preliminary results (linear optics matching)

- IR8 (LHC-B & injection b2)

HLLHCV1.0 (opt\_inj)



90deg-cell matched

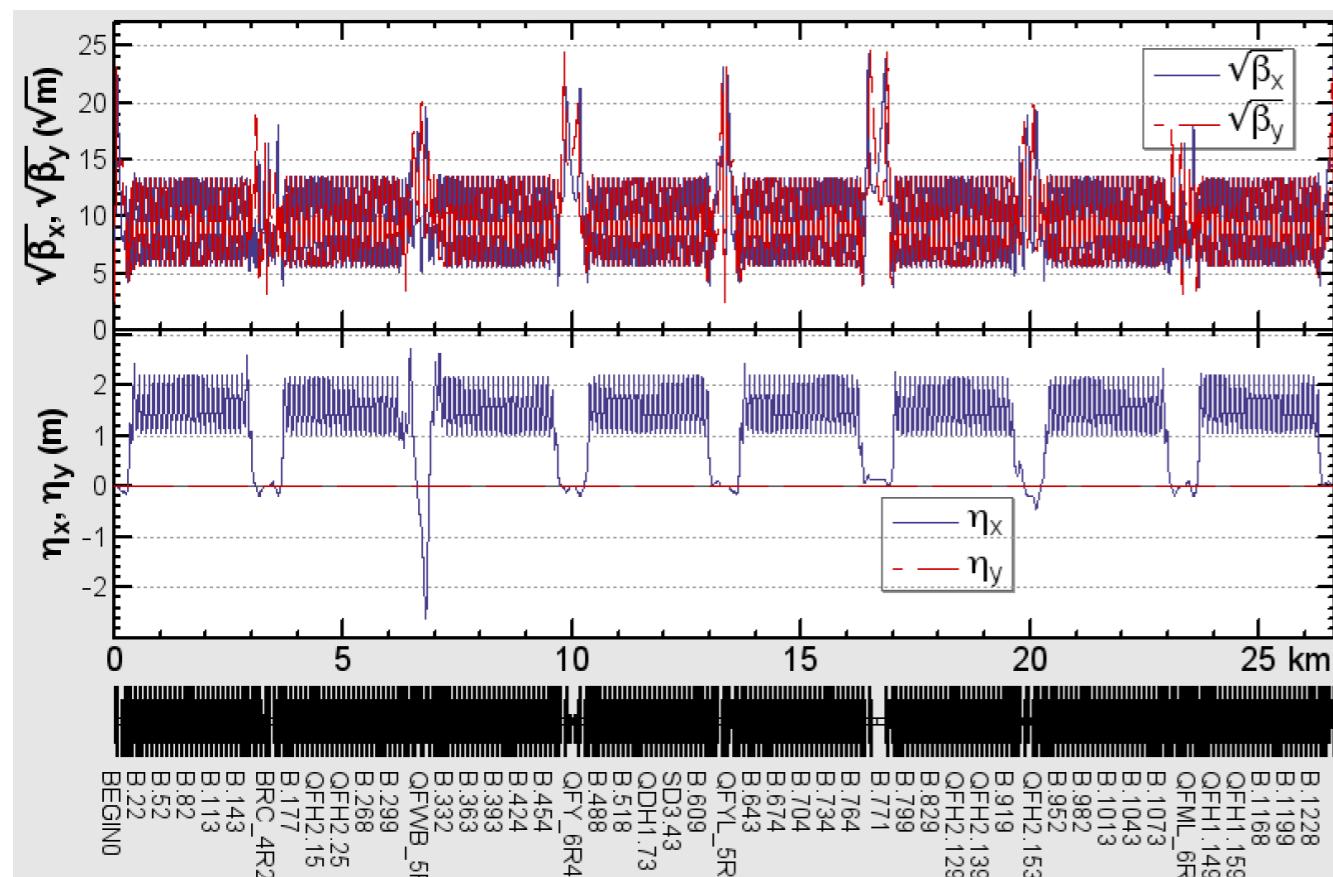


## 2. Tests of using 90deg x20 arc cells

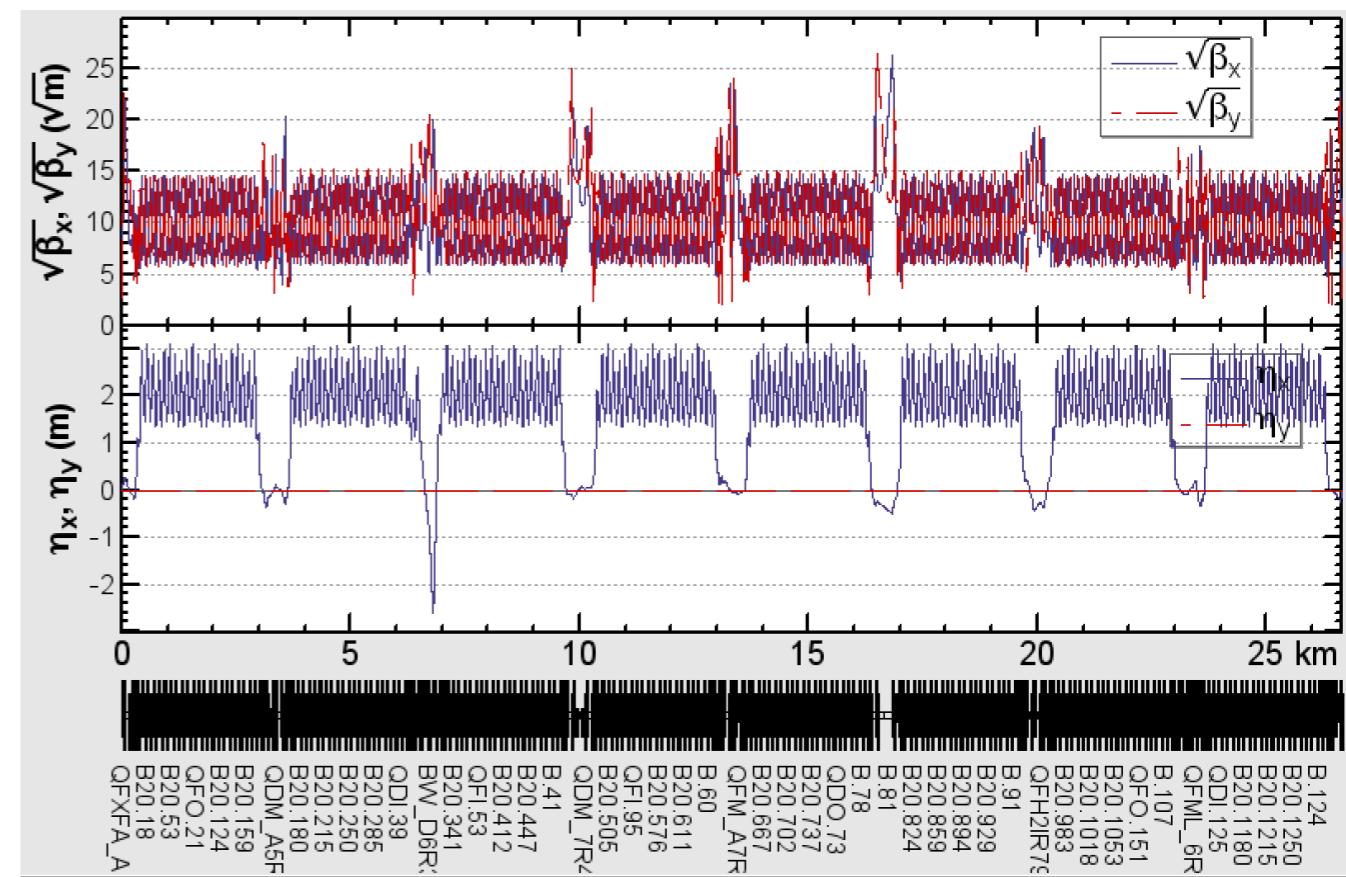
### ► Preliminary results (linear optics matching)

- Whole ring

HLLHCV1.0 (opt\_inj)



90deg-cell matched



### 3. Summary

#### ➤ Options for arc cells

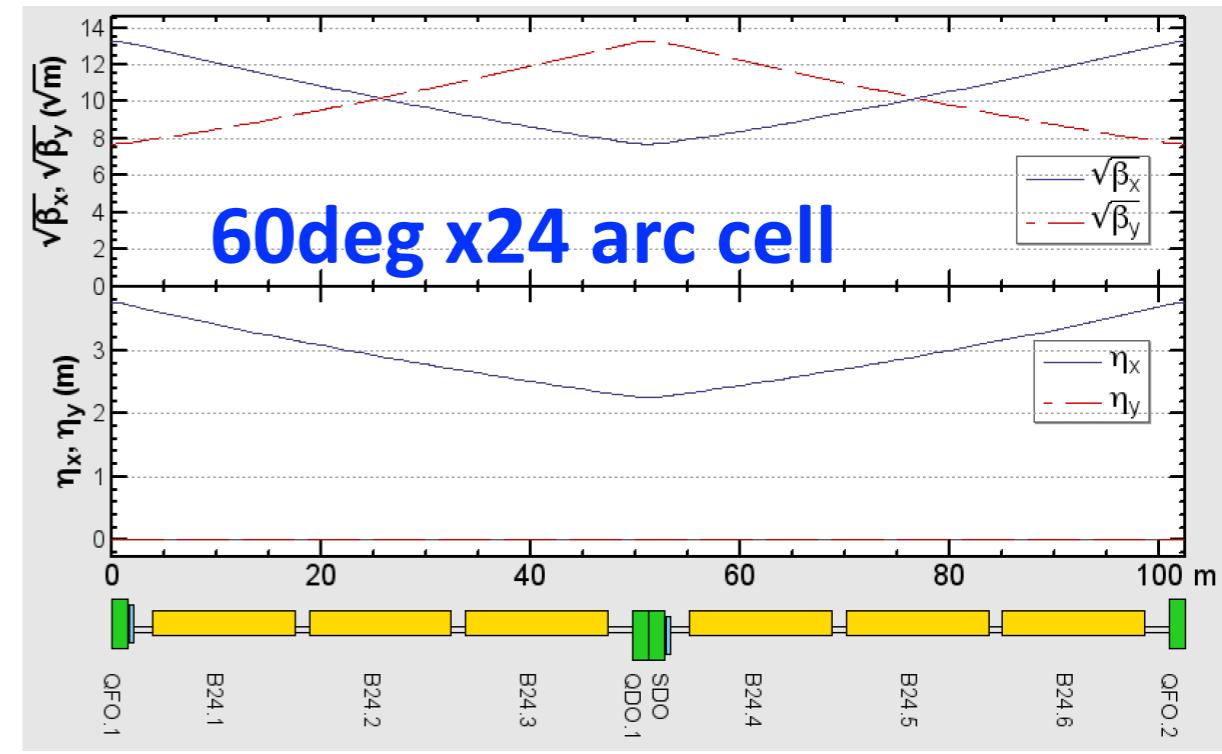
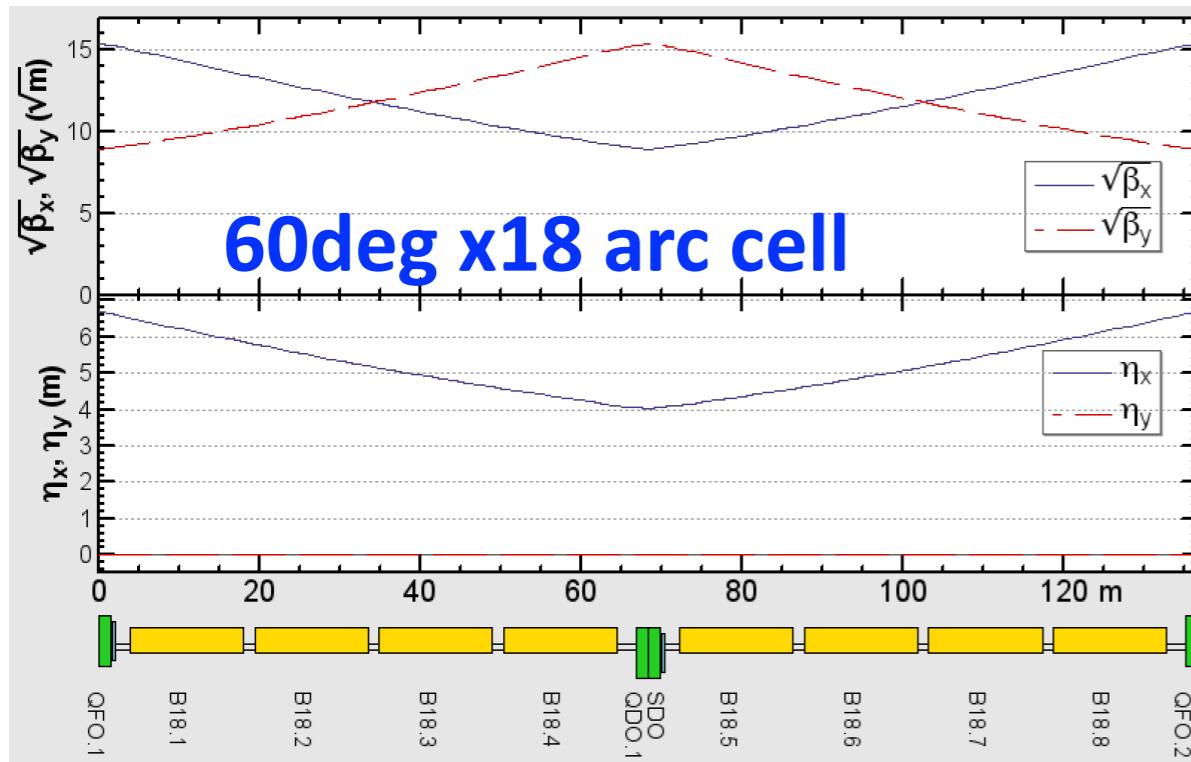
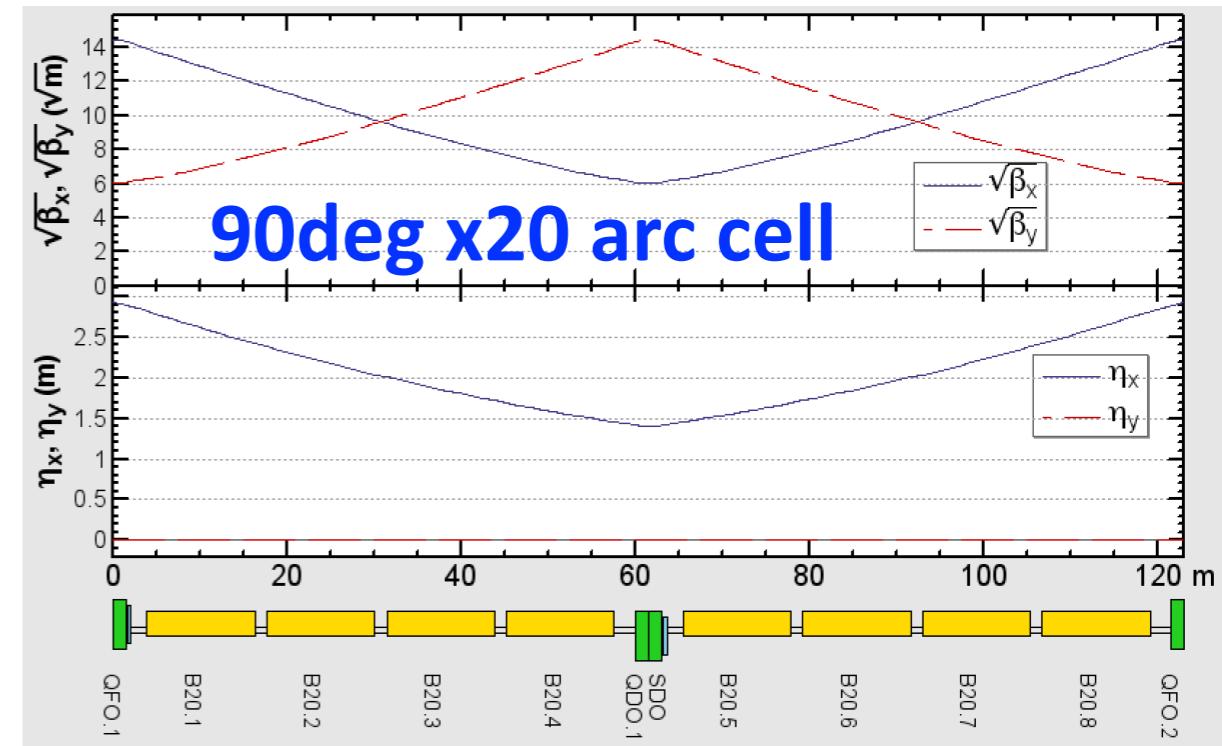
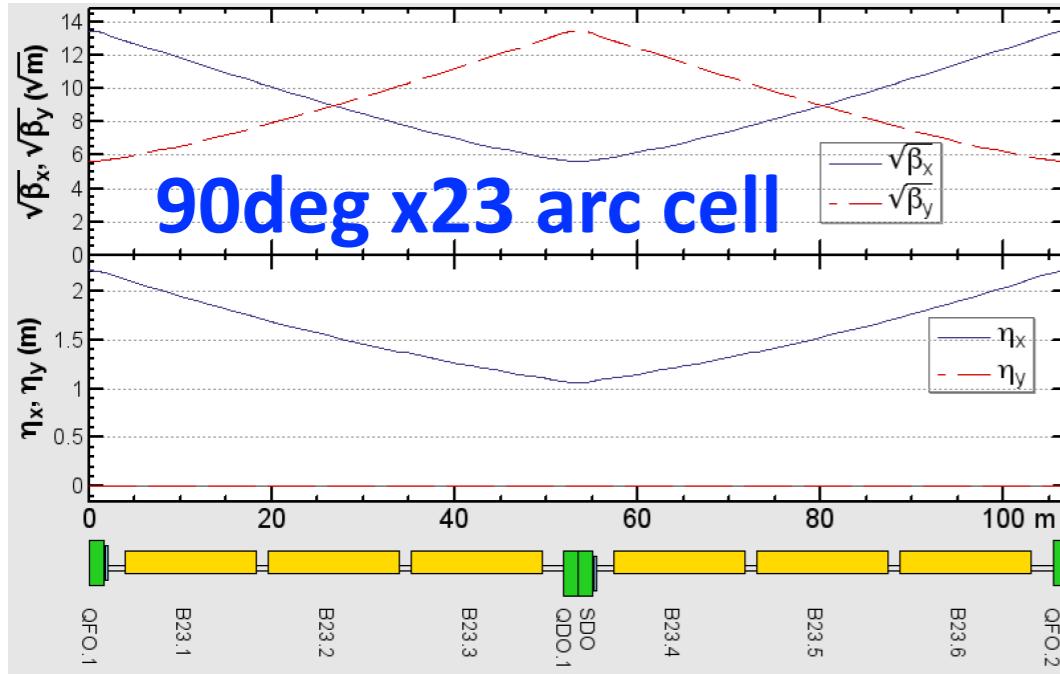
- Use the same spacing drifts between magnets
- Fit to total arc length of LHC

	LHC-like	60°x24 HE-LHC(Yuri)	90°x20 HE-LHC	60°x18 HE-LHC
Arc cell phase advance [deg]	90/90	60/60	90/90	60/60
Arc cell length [m]	106.9584	102.5018	123.00	136.669
K1 [m <sup>-1</sup> ]	0.02697	0.0199	0.0234	0.01485
$\beta_{\max/\min}$ [m]	181.3/31.54	176.6/59.48	208.68/36.24	235.74/79.22
$\eta_{\max/\min}$ [m]	2.21/1.07	3.75/2.26	2.92/1.41	6.67/4.02
Dipole length [m]	14.3 [x6]	13.56 [x6]	12.39 [x8]	14.1 [x8]
Dipole field [T] @13.5TeV	16.06	16.23	15.99	15.61
Filling factor	0.802	0.794	0.806	0.825

# 3. Summary

## ► Options for arc cells

- Compare arc cell



### 3. Summary

#### ➤ Options for arc cells

- 60deg x18 arc cells tried, but even harder to match to (HL-)LHC DSs and IRs
- 90deg x20 arc cells is the easiest to match to (HL-)LHC DSs and IRs  
[Minimum changes in DSs and matching sections between DSs and IRs]

#### ➤ Chromaticity correction and nonlinear optimization (tune-dependence) to be done

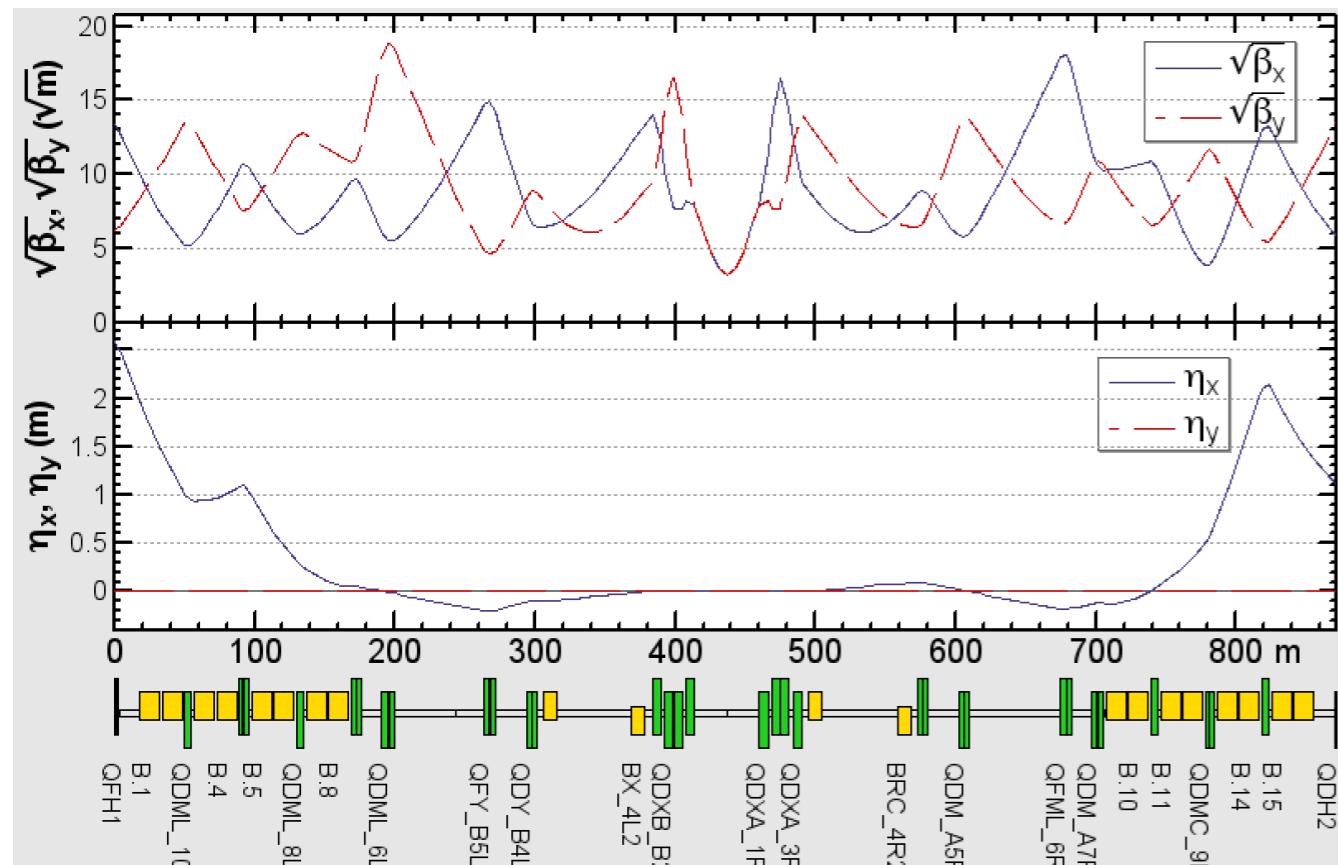
# **Backup slides**

## 2. Tests of using 90deg x20 arc cells

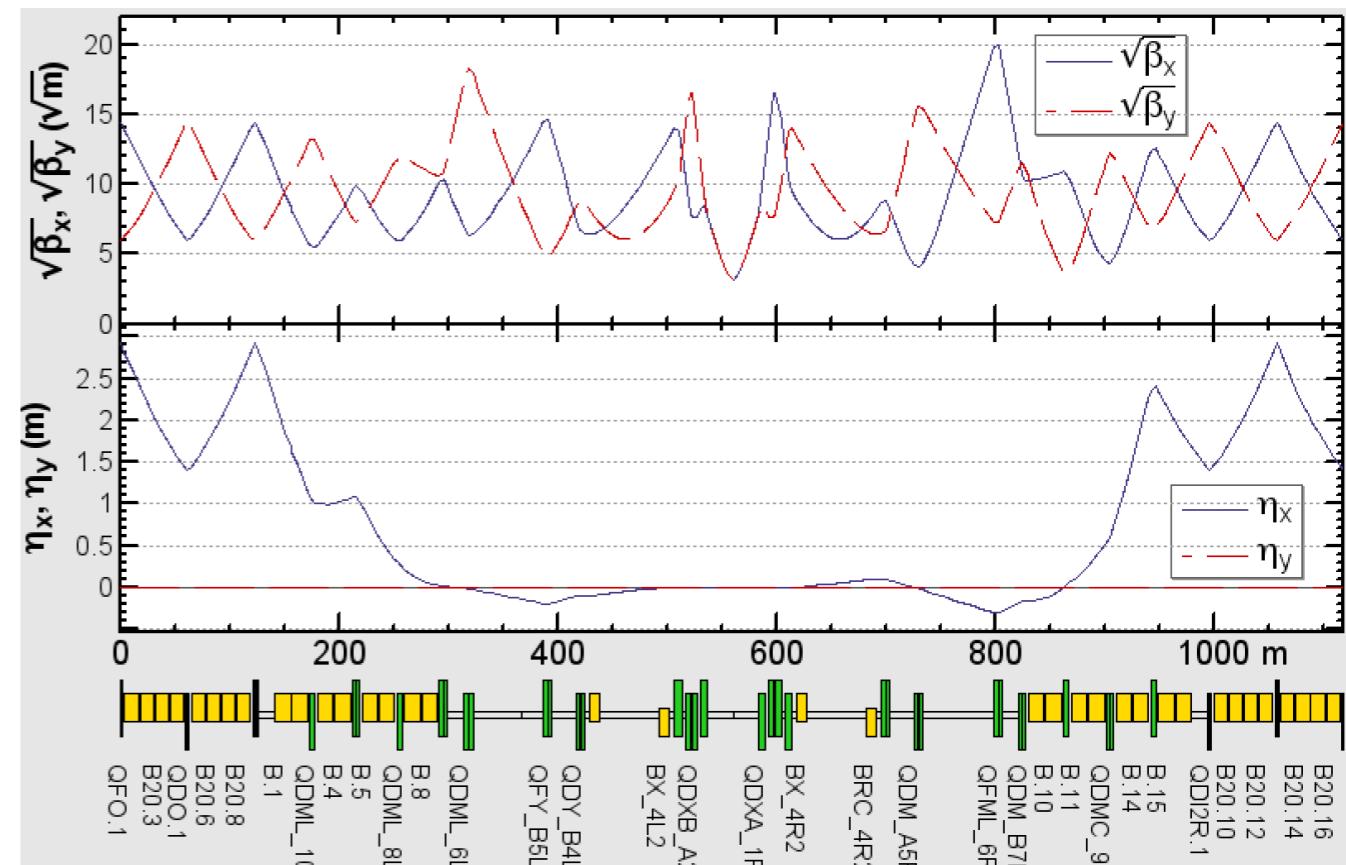
### ► Preliminary results (linear optics matching)

- IR2 (ALICE & injection b1)
- Triplets not join matching

HLLHCV1.0 (opt\_inj)



90deg-cell matched

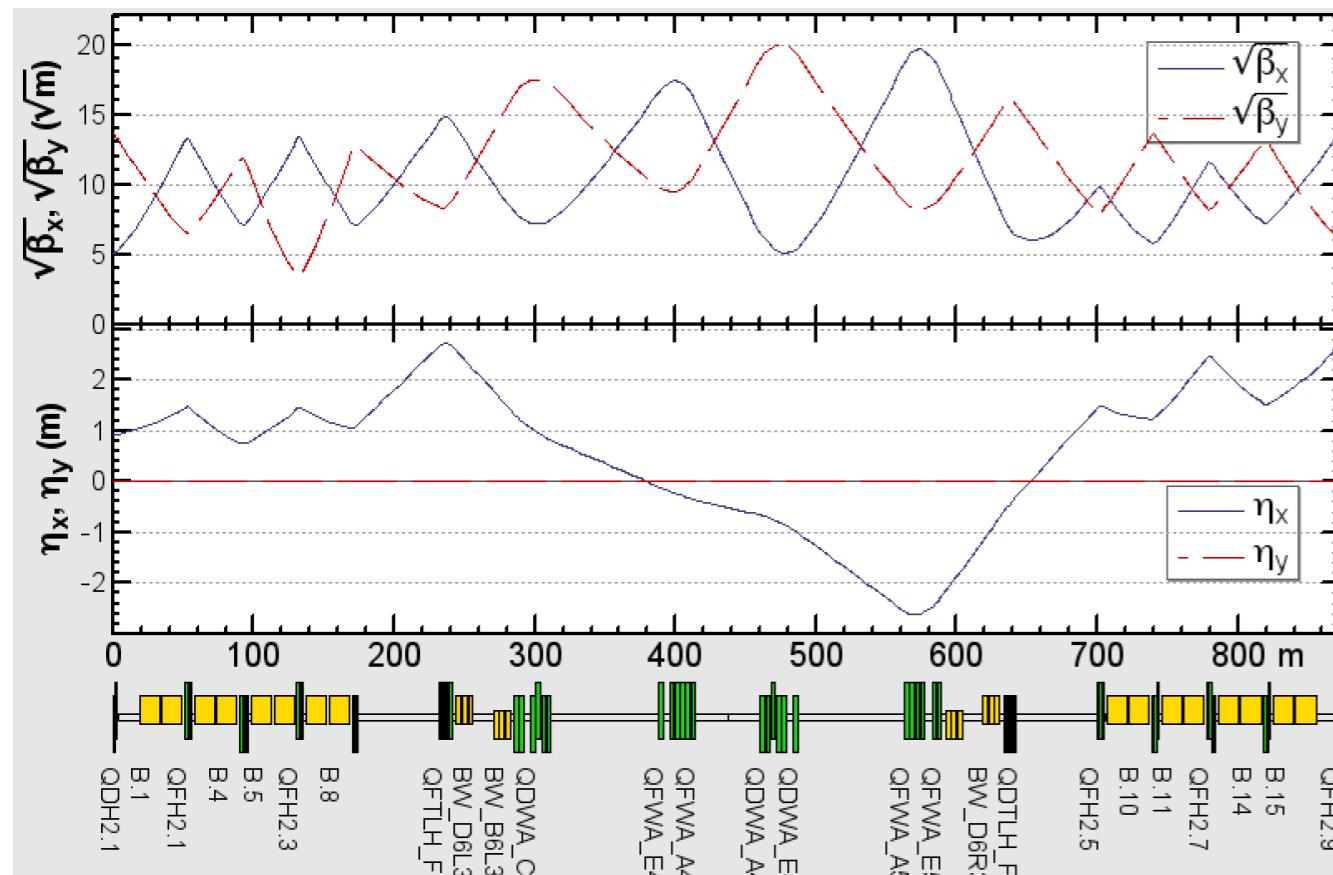


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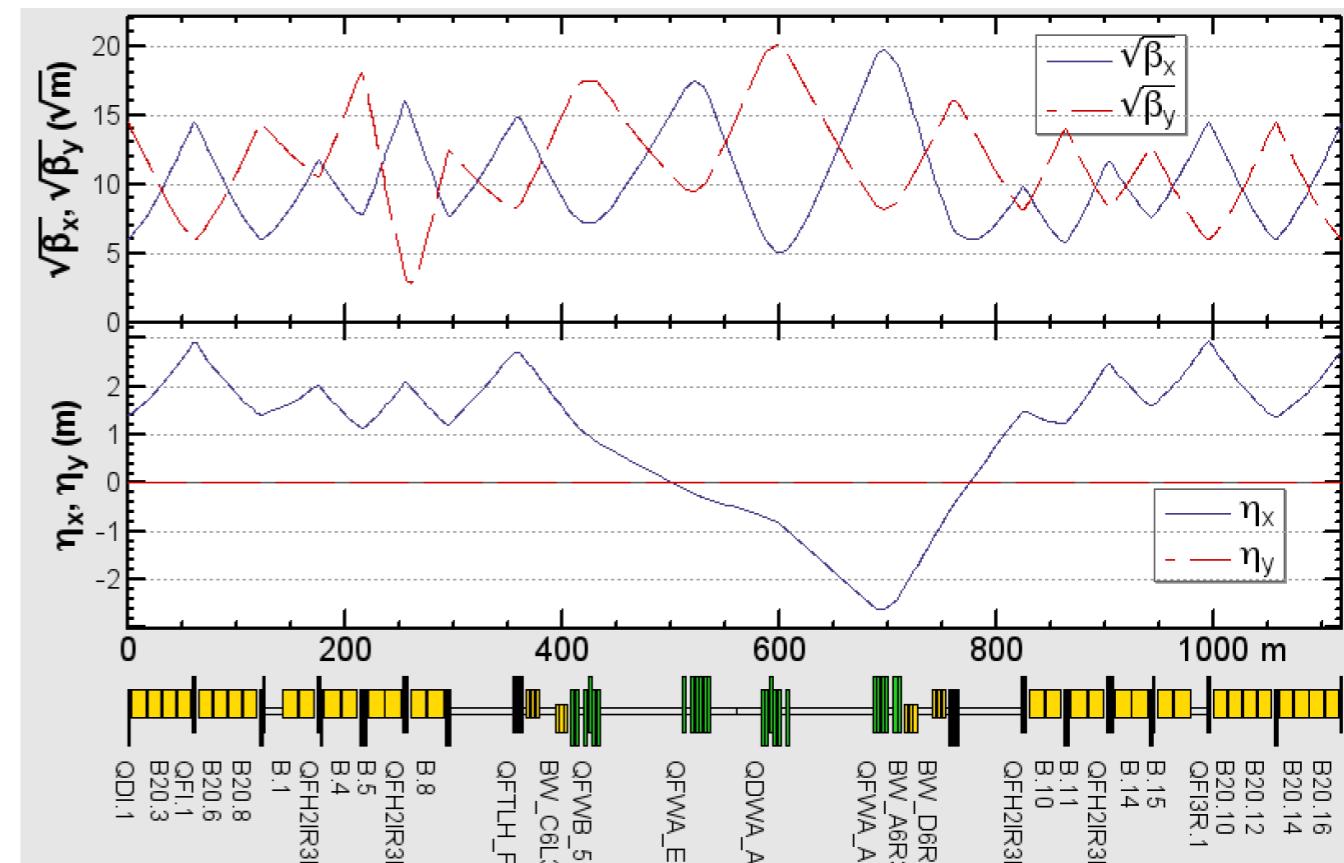
### ► Preliminary results (linear optics matching)

- IR3 (Momentum collimation)

HLLHCV1.0 (opt\_inj)



90deg-cell matched

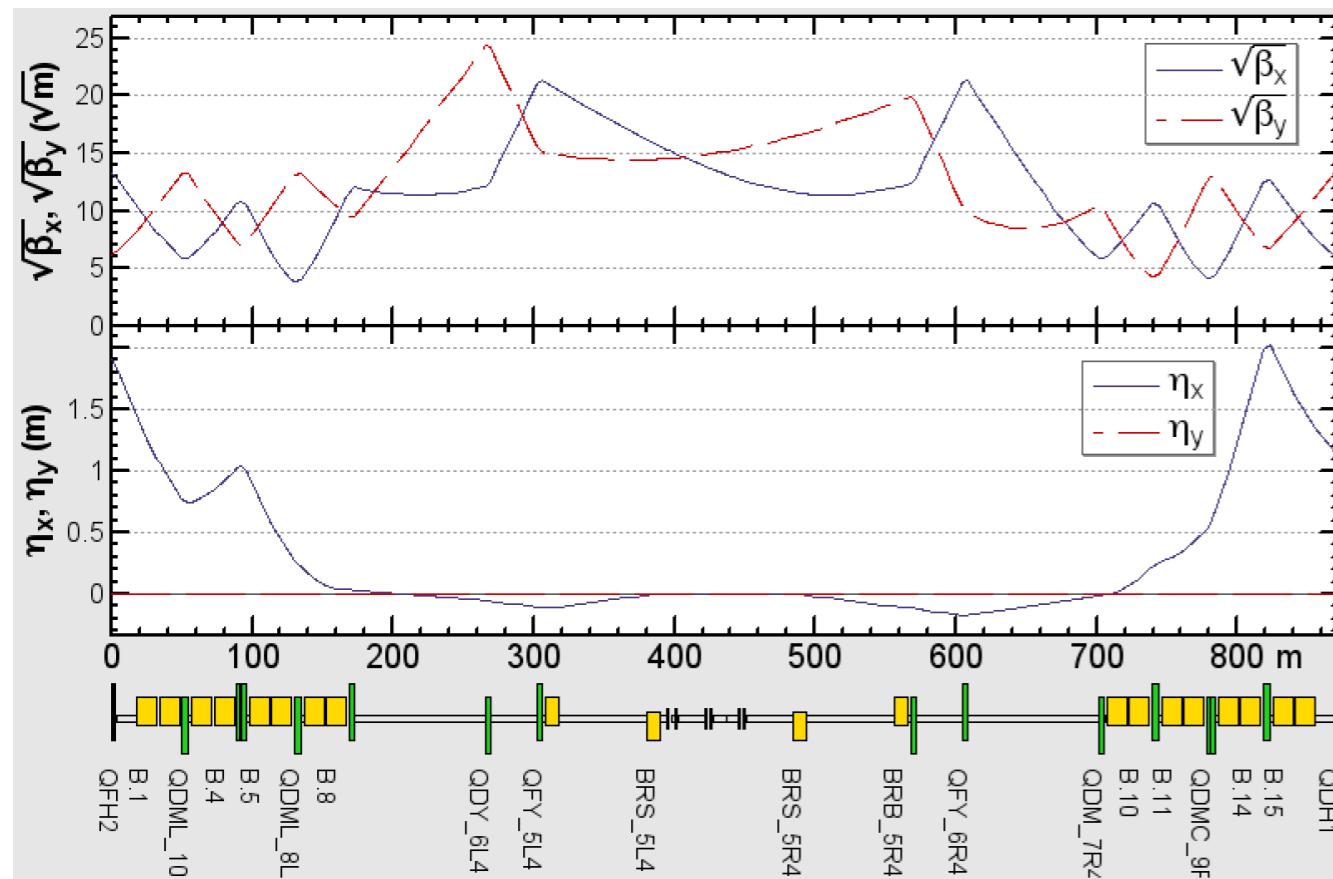


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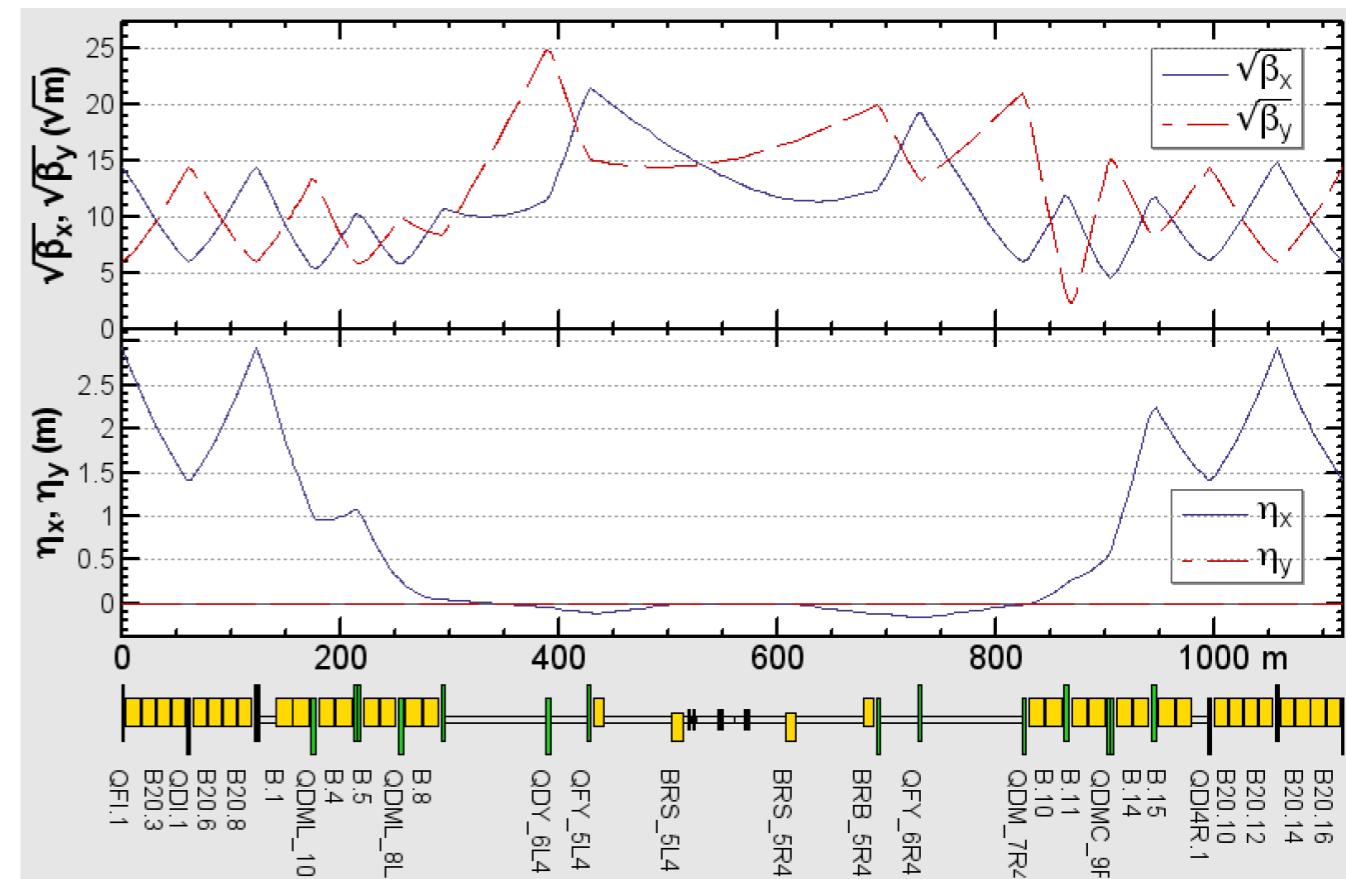
### ► Preliminary results (linear optics matching)

- IR4 (RF & BI)

HLLHCV1.0 (opt\_inj)



90deg-cell matched

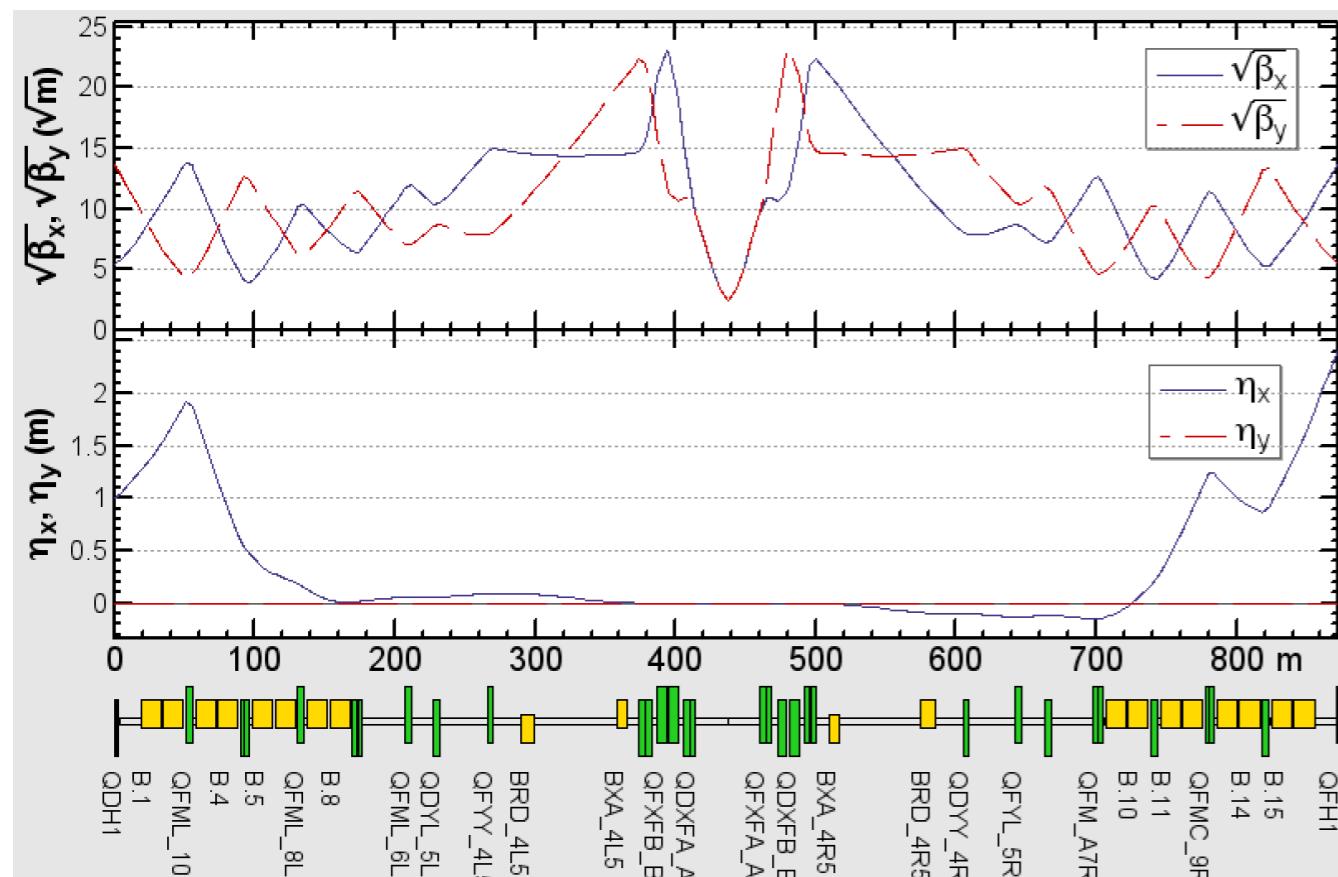


## 2. Tests of using 90deg x20 arc cells

### ► Preliminary results (linear optics matching)

- IR5 (CMS)

HLLHCV1.0 (opt\_inj)



90deg-cell matched

