# Synchrotron Radiation Background Studies for an Alternative FCC-ee optics

#### K.D.J. André for the MDI study group



FCC week 2023 - June 8th 2023 - Kevin André



The lattice design upstream the IP is based on 'weak' dipoles and **short** straight sections. There is a **30 mrad crossing angle** at the IP. The central beam pipe radius is **10mm** over **18cm** along the Z axis and is tapered to 15mm in QC1.



#### Beam parameters and assumptions

The beam parameters, specifically the transverse beam emittances come from MAD-X and MAD-8 simulations. The beam current is computed to reach the same luminosity as V22 lattice. (<u>ref</u>)

	V_6	V_61a Baseline		e (V22)
	Z	tt	Z	tt
Emittance $\epsilon_x$ [nm.rad]	0.53	2.03	0.71	1.49
Emittance ε <sub>y</sub> [pm.rad]	1.06	4.06	1.42	2.98
Beta value $\beta_x^*$ [m]	0.15	1.00	0.10	1.00
Beta value $\beta_{y}^{*}$ [mm]	0.80	1.60	0.80	1.60
Beam current I <sub>e</sub> [mA]	1126 (1454)	5 (5.7)	1280	5

I assumed the same **primary** and **secondary** collimator apertures as the baseline: **11** and **13**  $\sigma_x$  respectively for the **Z** operation mode and **15** and **17**  $\sigma_x$  respectively for the **tt** operation mode.







FCC week 2023 - June 8th 2023 - Kevin André

### Synchrotron radiation collimation scheme

#### Synchrotron radiation collimation scheme (V22 vs. V61)



#### Synchrotron radiation collimation scheme

Name	s [m]	half-gap [mm]	plane
QC3L. <b>H</b>	-31.2	9 - 13	Н
QC3L.V	-31.3	10	V
QT1L. <b>H</b>	-20.1	9 - 13.5	Н
QF1L. <b>H</b>	-11.25	9 - 14	Н
QF1L. <b>V</b>	-11.45	10	V
QC0L.msk	-5.56	R = 15	H&V
IP.msk	-2.12	7 - 8	Н

The QT1L.H SR collimator avoids SR power deposition between s=-20 and QF1L.H SR collimator. Further optimisation of the SR collimator apertures could require 2 SR horizontal collimators instead of 3.

FCC week 2023 - June 8th 2023 - Kevin André

## 45.6 GeV operation mode

#### SR power deposition at Z energy 45.6 GeV - First study



- Only one mask present in the design at s=-2.1m
- Peaks of SR power deposition present at aperture reductions.
- High power deposited in the mask because there are no SR collimators upstream.
- Power deposited in the CC around 20 to 30W due to the solenoid, etc..

#### SR power deposition at Z energy 45.6 GeV - Latest study



- SR collimators and masks in the lattice.
- Peaks of SR power deposition present at SR collimator positions.
- Slightly high power deposited in the mask could be improved with better SR collimation.
- Power deposited in the CC around **320mW** due to the solenoid, etc..

#### SR from dipoles upstream the IP



Some optimisation could be done with the SR collimators.

 $10^{-3}$ 

-10

-5

10

5

0 Distance from the IP [m]

#### SR from quadrupoles



FCC week 2023 - June 8th 2023 - Kevin André

#### SR from the solenoid / anti-solenoid



The solenoid and anti-solenoid create the same SR photons as in the baseline with the peak deposition happening just before s=80m.

SR power deposited in the CC **150mW**.

#### Symmetric horizontal mask aperture comparison

9 mm mask aperture is not sufficient.

6, 7 and 8 mm provide an increasing power deposited in the CC, *i.e.* the protection performance of the mask decreases.

However, 8mm has the lowest heat load in the mask 40 W/A.

Whereas 6 and 7 mm mask aperture collect 85 W/A and 65 W/A respectively. It could be improved by tighter apertures of the upstream SR collimators.



10 seeds of 100000 primaries total of 1M primaries (*i.e.* positrons)

#### Comparison with the baseline design



10 seeds of 100000 primaries total of 1M primaries (*i.e.* positrons)

#### Comparison with the baseline design - Zoom



10 seeds of 100000 primaries total of 1M primaries (*i.e.* positrons)

#### Summary and next steps

- The alternative optics and lattice designs feature equivalent power deposition in the CC w.r.t. the baseline lattice regarding SR from the beam core.
- □ Tighter aperture SR collimators at **Z energy** is possible w.r.t. the baseline.
- □ A 6 mm mask aperture provides a better SR collimation efficiency.

Next steps:

- □ Re-perform the study with the tt operation mode.
- □ Perform tail studies to evaluate the efficiency of the SR collimation.
- □ Realise the study without anti-solenoid in the future. (A. Ciarma poster)

# Thank you for your attention.

○ FCC