The Effect of Beam Chopping on the Emittance Growth of Negative Hydrogen Ion Beam

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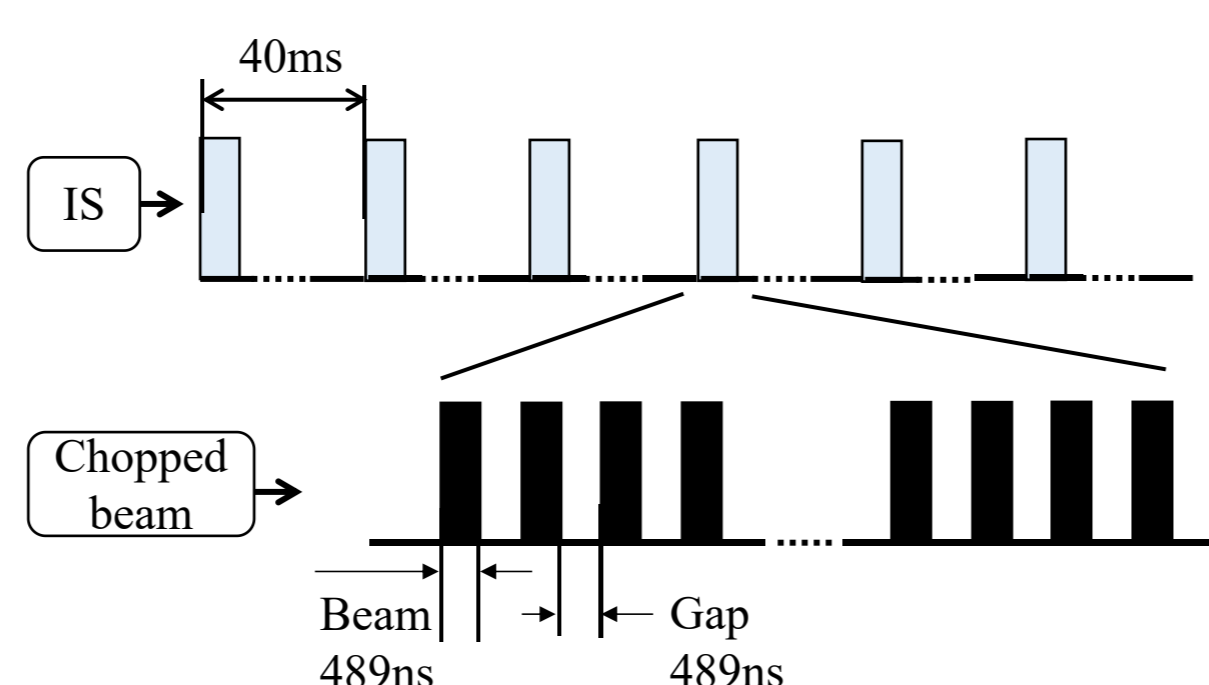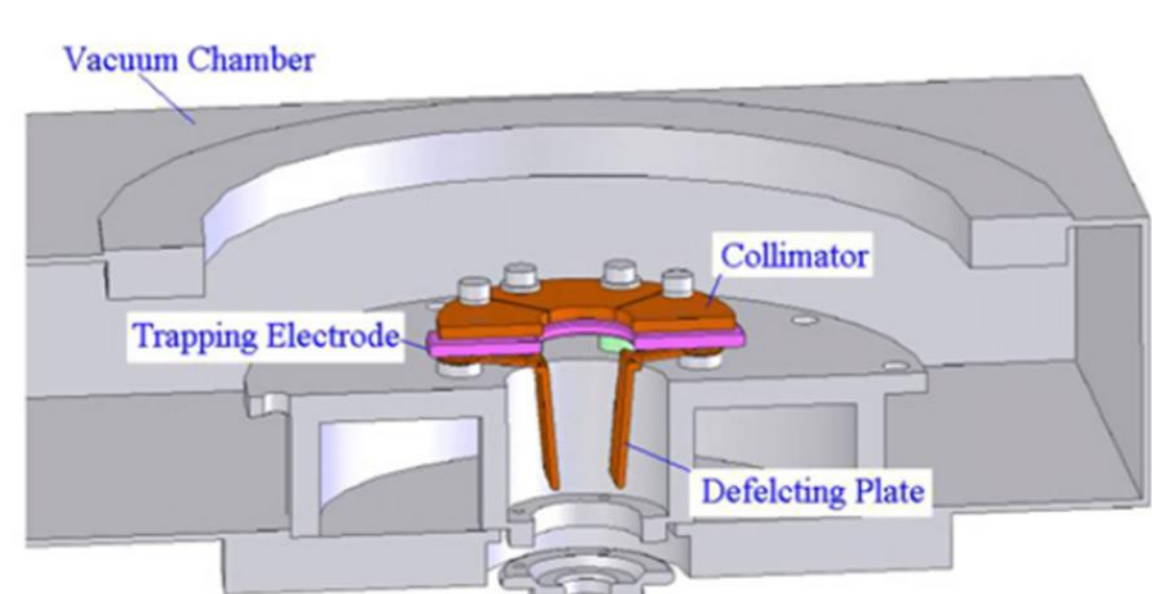## ☐ 1. Motivation

■ Accelerator of China Spallation Neutron Source (CSNS)

> **Beam power upgrade of CSNS project II**
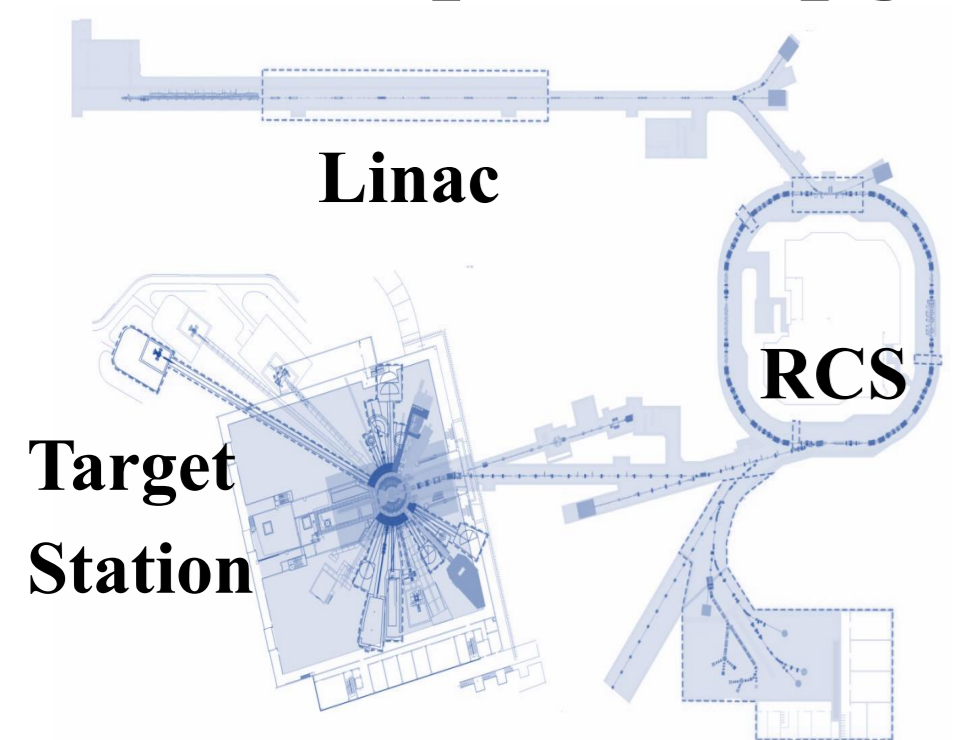
	CSNS-I	CSNS-II
Beam power (kW)	100	500
Repetition rate (Hz)	25	25
Average beam current (uA)	62.5	312
Beam energy (GeV)	1.6	1.6

■ Role of the beam chopper in CSNS LEBT

> **Fast electric chopper**
> **The chopped beam pulses synchronize with the period of Rapid Cycling synchrotron (RCS)**
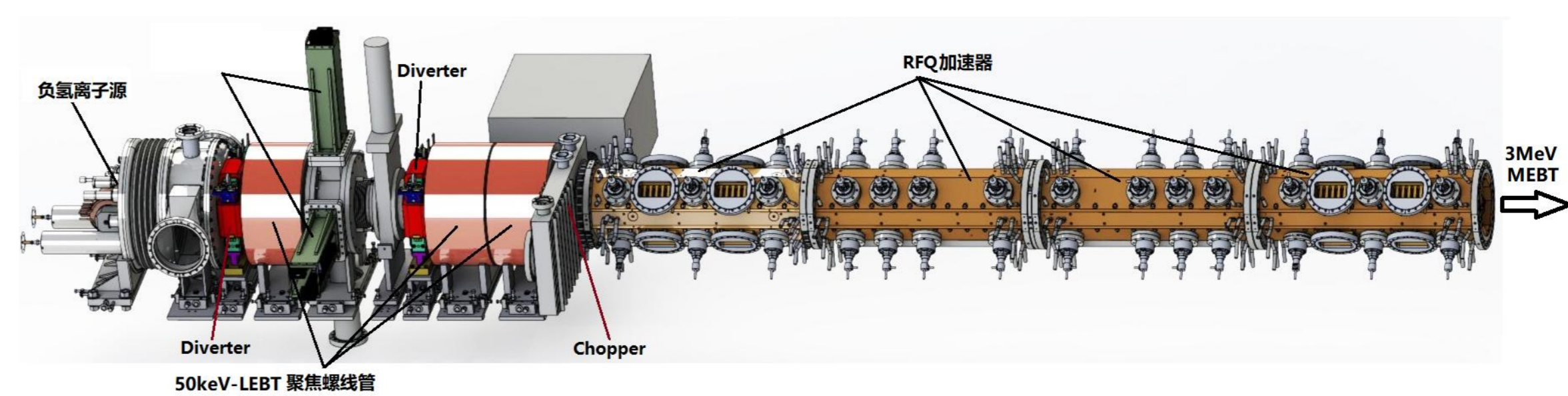

■ Problems induced by the electric chopper for CSNS-II

> **Destroy the space charge compensation (SCC) at RFQ entrance.**
> **Cause the rapid growth of H- beam emittance**
> **Lower down the beam transmission rate in RFQ and downstream accelerator**
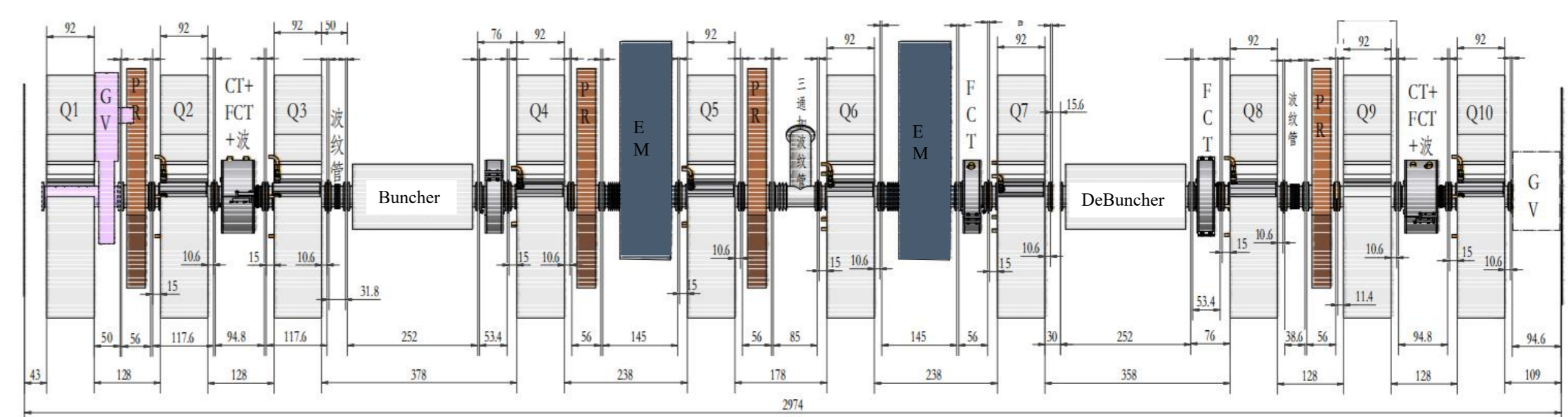> **Limit the beam power upgrade of CSNS-II**

☐ 2. Experimental Methods

■ Experimental setup
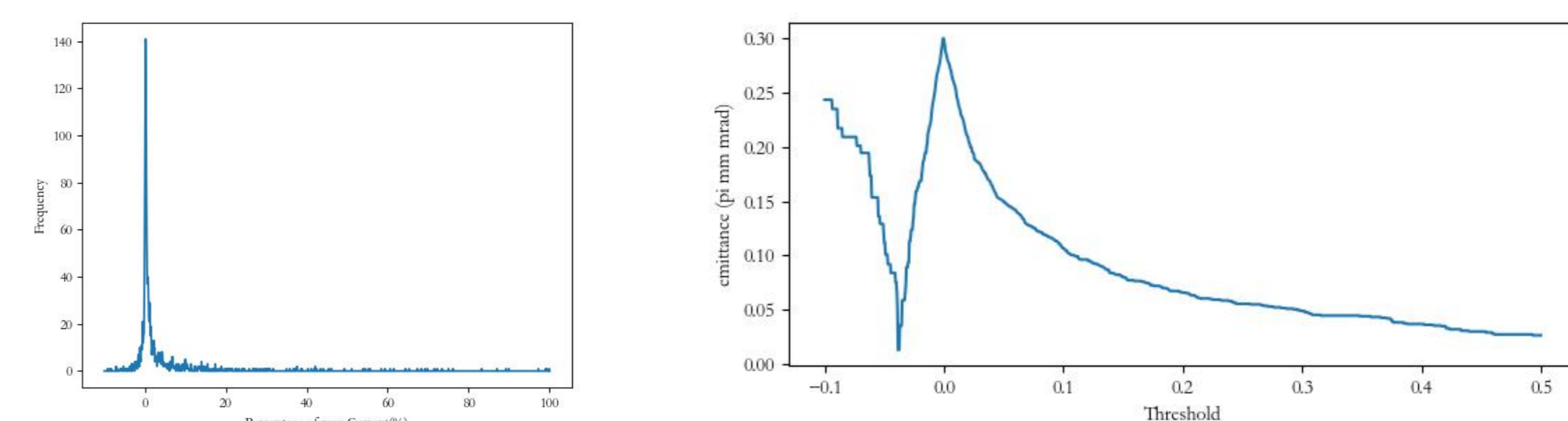
> **The LEBT and RFQ layout of CSNS**

> **The MEBT layout of CSNS**
> > **The emittance is measured by double-slits emittance monitor (EM)**

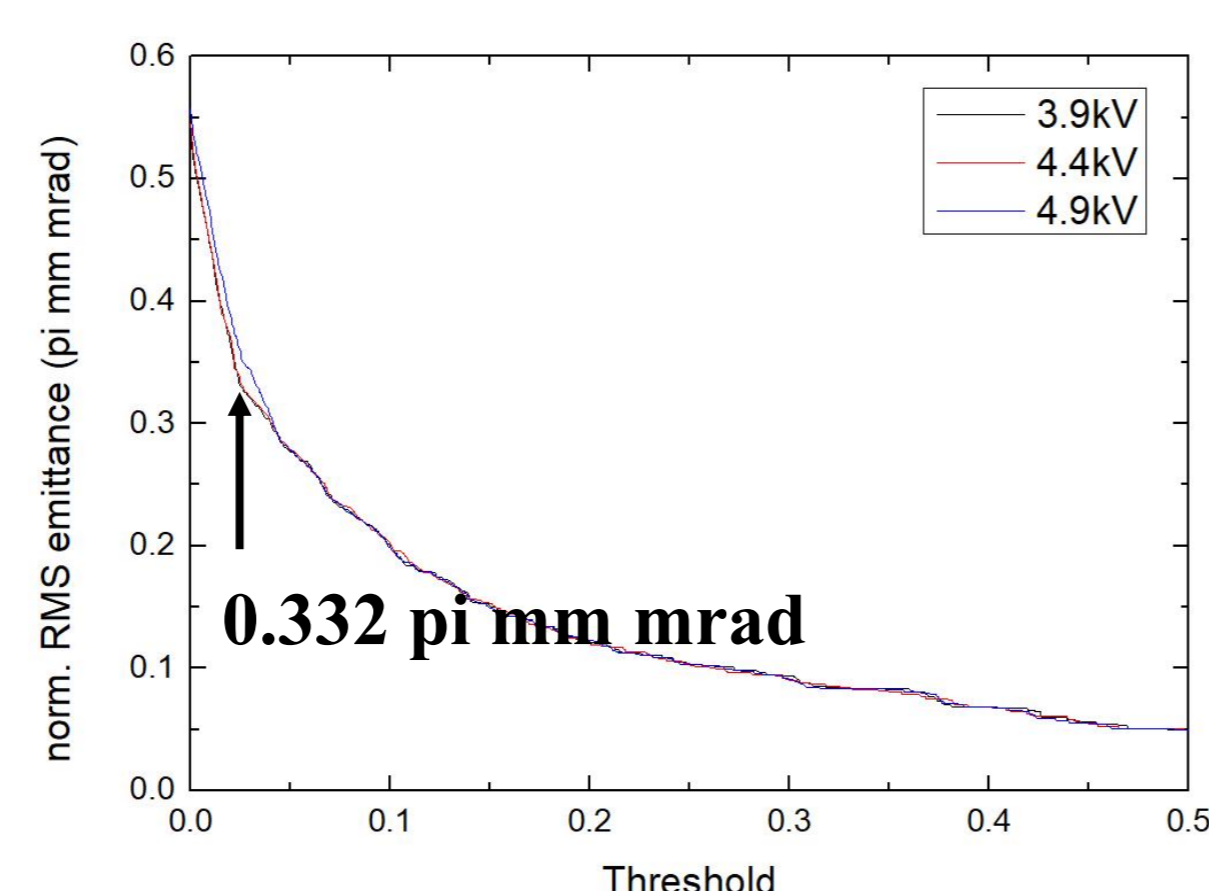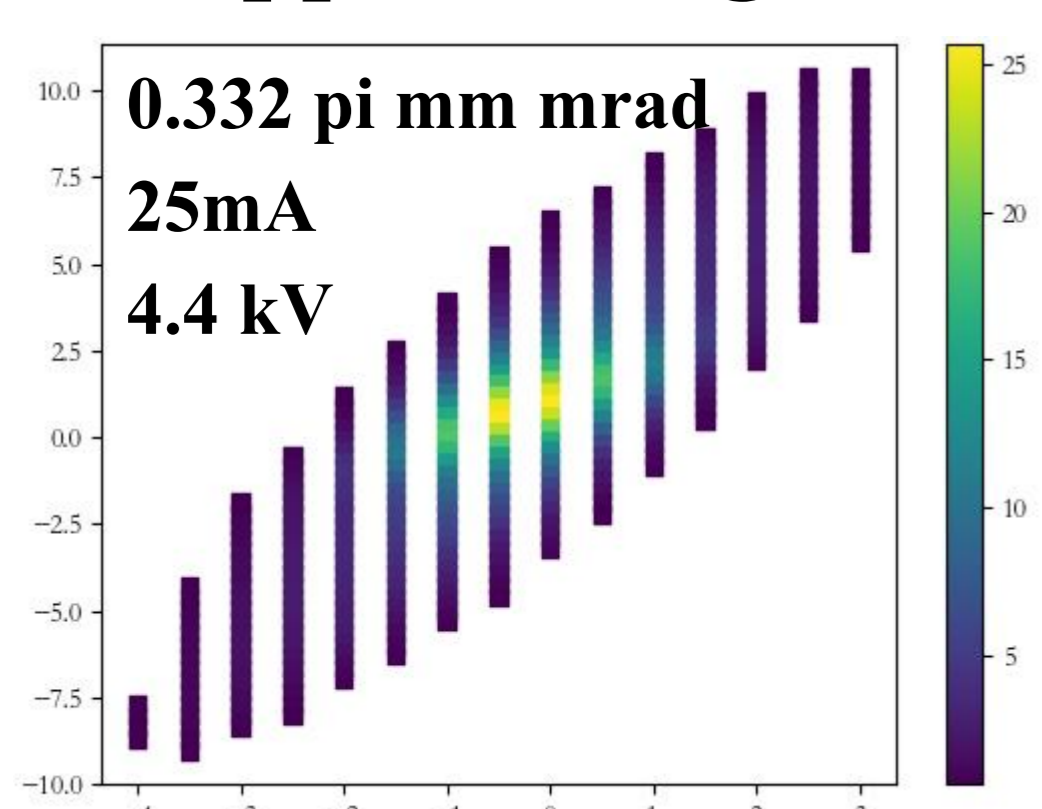### ■ Data processing method

> **Background signal removal**
> **Noise signal removal: Threshold method**
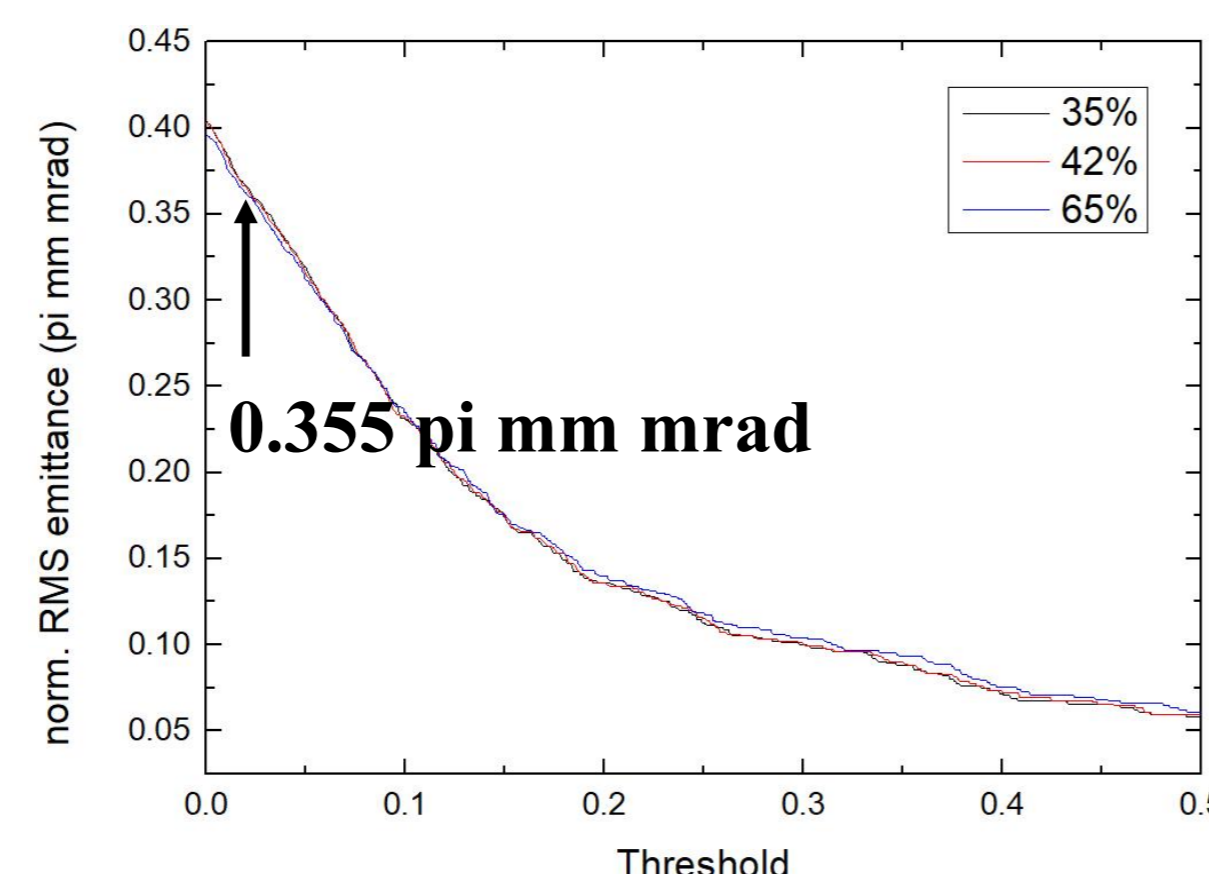> **Normalized RMS emittance calculation**

☐ 3. Results

■ Fixed beam parameters

> **Chopper Voltage**

0.332 pi mm mrad
25mA
4.4 kV

0.332 pi mm mrad

> **Chopped beam rate**

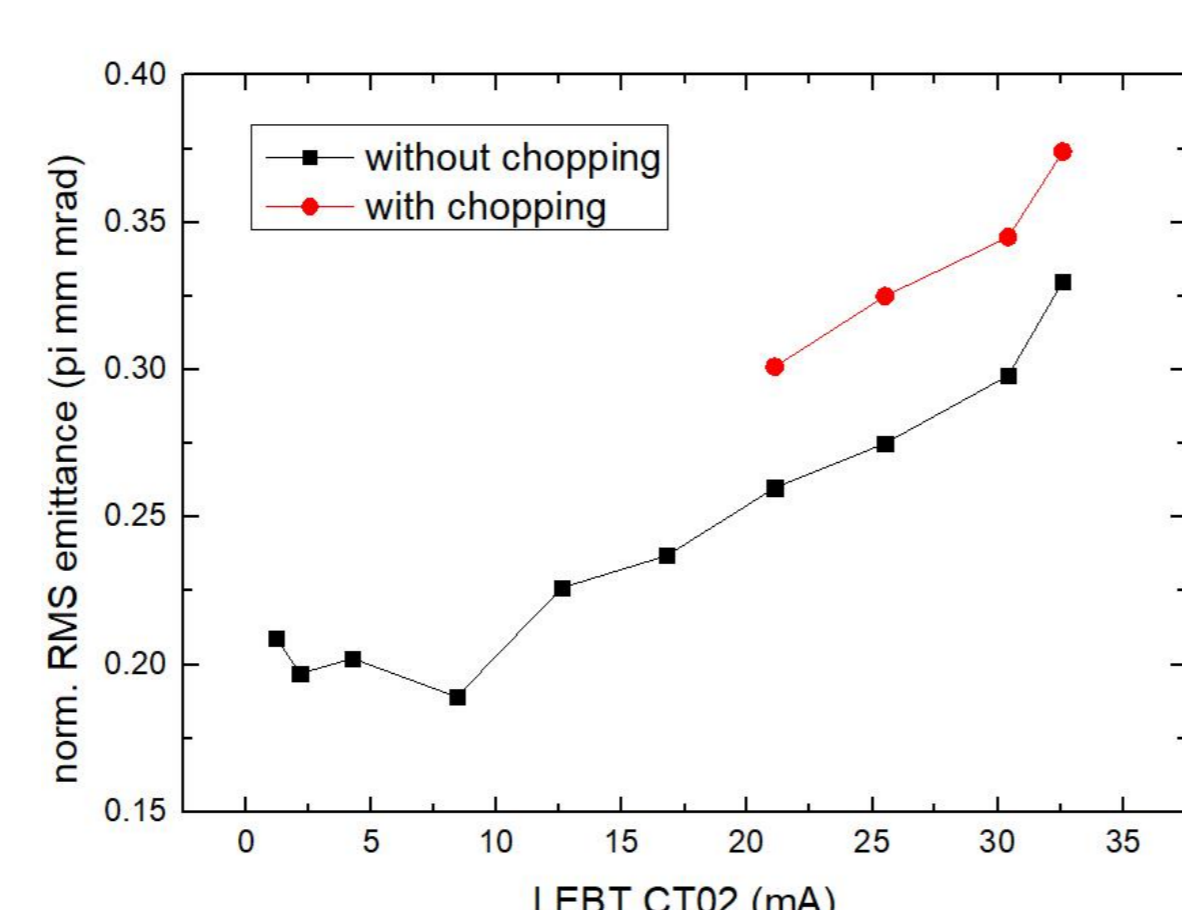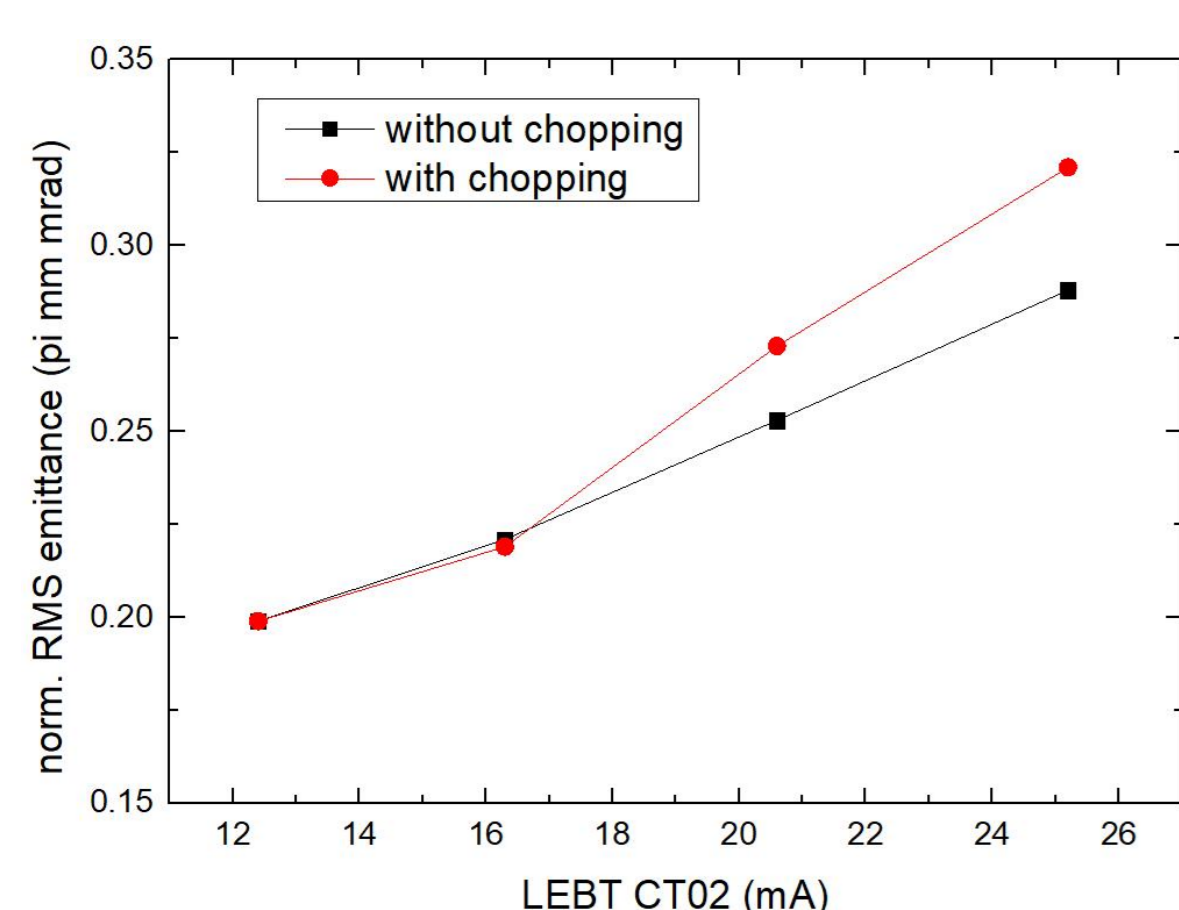0.355 pi mm mrad
30mA
65%

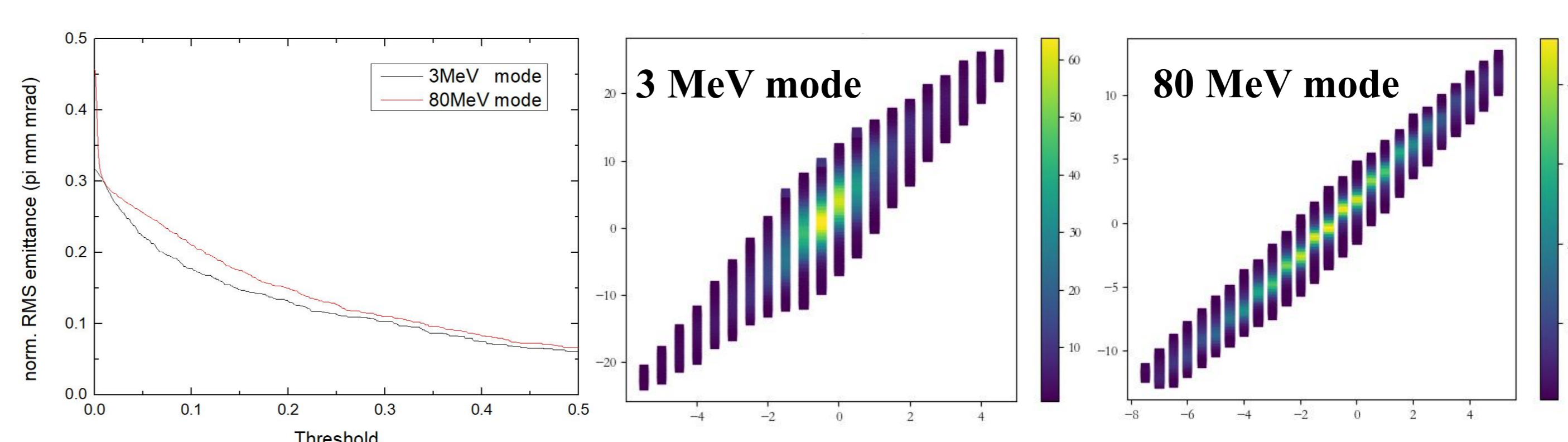0.355 pi mm mrad
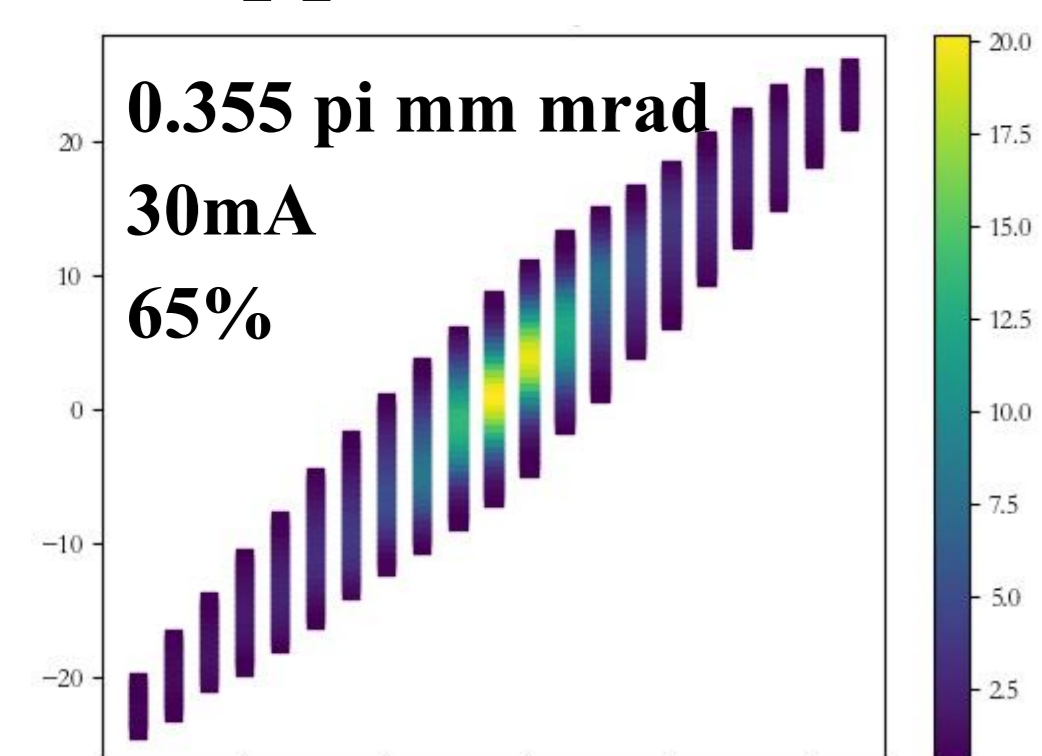
■ Fixed chopper parameters

> **w/o chopping with different beam current**

☐ 4. Discussion

■ Influence of beam focusing state on emittance calculation

> **Threshold method: looking for inflection point**

3 MeV mode

80 MeV mode

■ The effect of chopper voltage to the emittance growth is not obvious while chopper voltage is above 3.9 kV

■ Emittance growth caused by SCC effect destruction is not significant below 16mA

■ Emittance growth at 50 mA

> **Without chopping, extrapolation of linear fitting: 0.401 pi mm mrad at 50 mA**
> **With chopping, extrapolation of linear fitting: 0.469 pi mm mrad at 50 mA**

☐ 5. Future Directions

■ Simulation of emittance growth induced by beam chopping
■ Redesign of the chopper
> **Shorten the length of SCC destruction**