
CERN

Update on e-cloud in TDIS

Galina Skripka and Giovanni Iadarola

Acknowledgements:
Chiara Bracco, David Carbajo Perez, Elias Métral, Antonio Perillo Marcone, Mauro Taborelli, Christina Yin Vallgren

Outline

- e-cloud simulation setup: coating scenarios
- e-cloud depending on the TDIS gap and SEY
- e-cloud with nonuniform SEY:
  - 2 scenarios
  - contributions from chamber segments
  - beam screen coating suggestion
  - comparison of coating scenarios

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e-cloud simulations in TDIS

Request :

1. Apply 1.0 on the jaws for Tank 1 and 2, and 1.6 on the jaws for Tank 3, and 1.6 elsewhere for all the tanks.
2. Apply 1.0 on the jaws for Tank 1, 2 and 3; 1.6 elsewhere.

It would also be very interesting, if you can do a scan of the all the parts with 1.6 as initial value, and go down with the SEY (simulate the scrubbing effect with the beam on RF shield and the jaws).. if it doesn't take you too long time to do so.

Different SEY configurations to simulate:

- Uniform (was done before but for different geometry, `TDIS Internal Review 2016`)
- Nonuniform SEY:

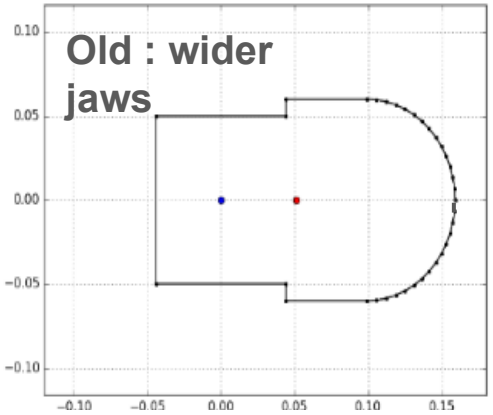
	BP	JS	BS	J1+J2	J3
Baseline: no coat.	1.6	1.6	1.6	1.0	1.6
Coat J3	1.6	1.6	1.6	1.0	1.0

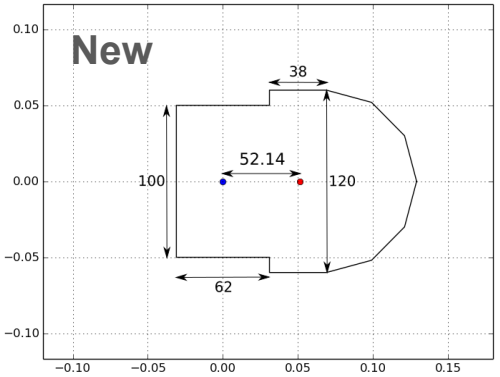
BP – back plate
JS – side of jaws
BS – beam screen
J1/J2/J3 – jaws in tanks 1,2 and 3

Main simulation parameters

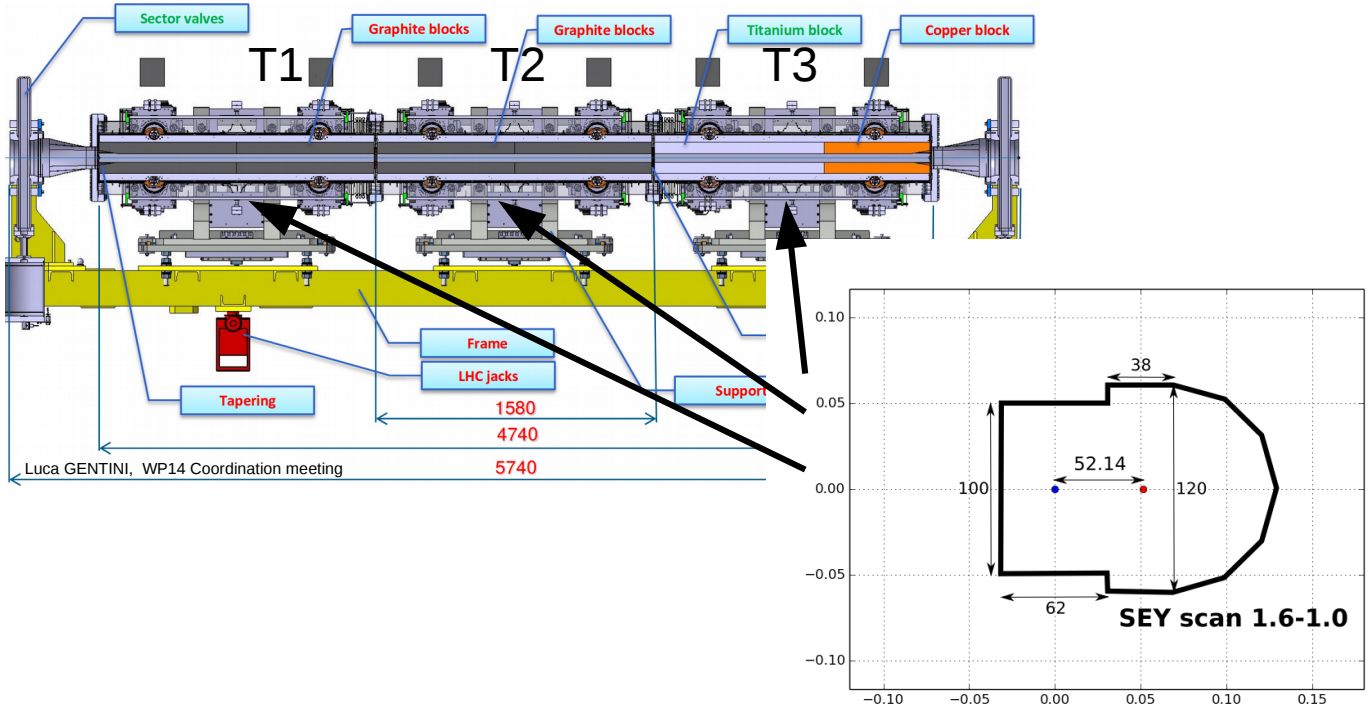
- Beam parameters: 450GeV, 25 ns, 2.2e11 p/bunch
- Two counter-rotating beams (simulated different transverse slices of the device)
- Half-gap scan: 1 - 50 mm
- SEY scan: 1.0 - 1.6

Geometry change





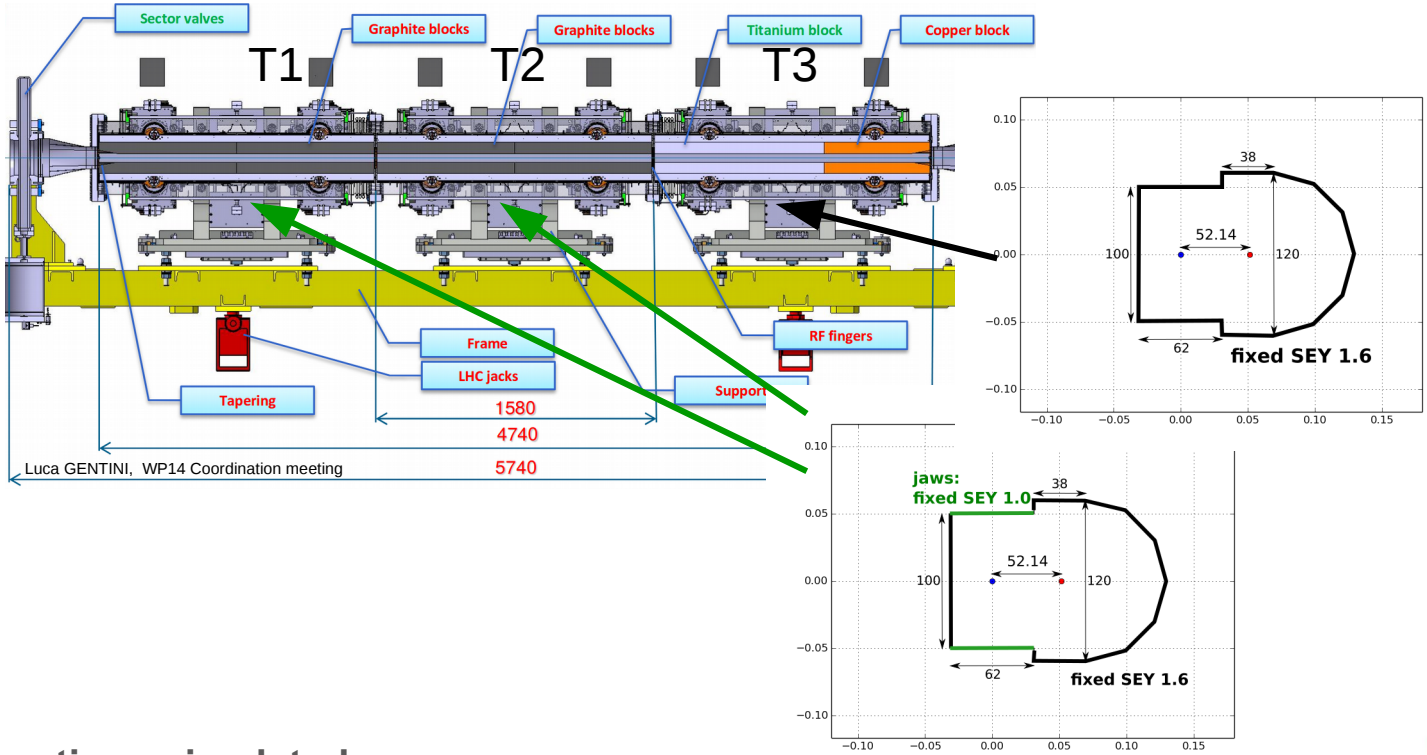
e-cloud simulations in TDIS



Different SEY configurations simulated

- Uniform (was done before but for different geometry): **SEY scan 1.6-1.0, half-gap scan 1-50 mm**

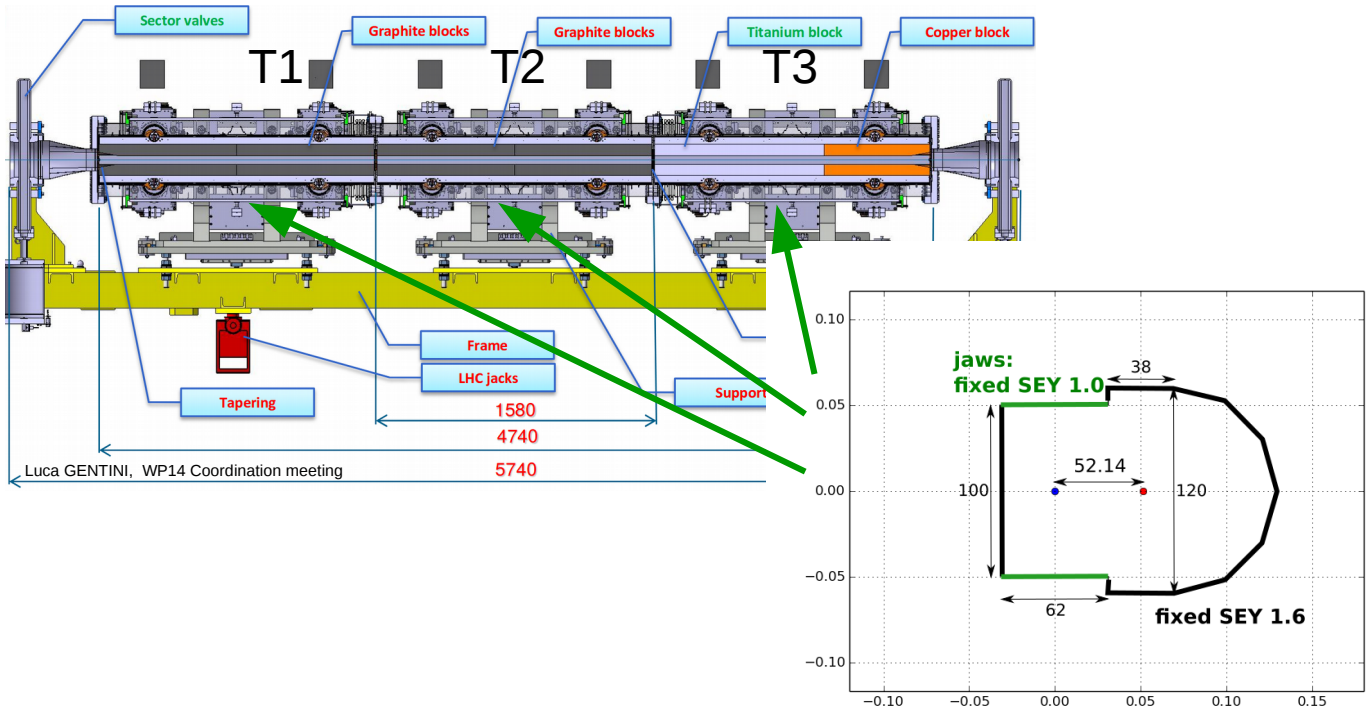
e-cloud simulations in TDIS



Different SEY configurations simulated

- Uniform (was done before but for different geometry): SEY scan 1.6-1.0, half-gap scan 1-50 mm
- Nonuniform
  - **Baseline: T1T2: graphite jaws SEY 1.0 + SEY 1.6 elsewhere**; **T3: SEY 1.6**, half-gap scan 1-50 mm

e-cloud simulations in TDIS



Different SEY configurations simulated

- Uniform (was done before but for different geometry): SEY scan 1.6-1.0, half-gap scan 1-50 mm
- Nonuniform
  - Realistic: T1T2: graphite jaws SEY 1.0 + SEY 1.6 elsewhere; T3: SEY 1.6, half-gap scan 1-50 mm
  - **Coated 3rd jaw(Ti+Cu):** All tanks (**T1T2T3**): **jaws SEY 1.0 + SEY 1.6 elsewhere**, half-gap scan 1-50 mm

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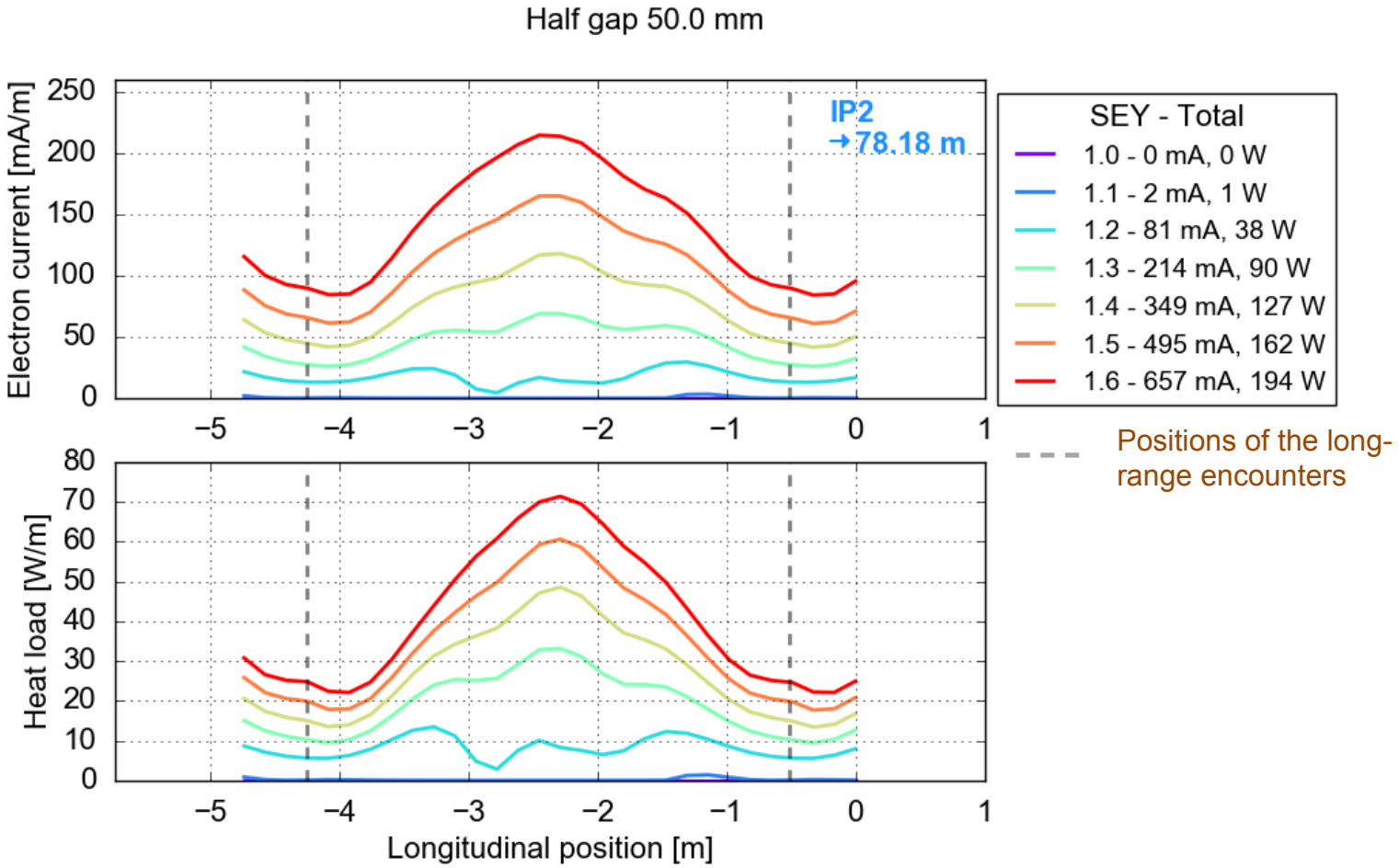
Longitudinal current/heat profiles (uniform SEY)

- Multipacting is stronger at the positions where the two beams are not synchronized (12.5 ns equivalent spacing)



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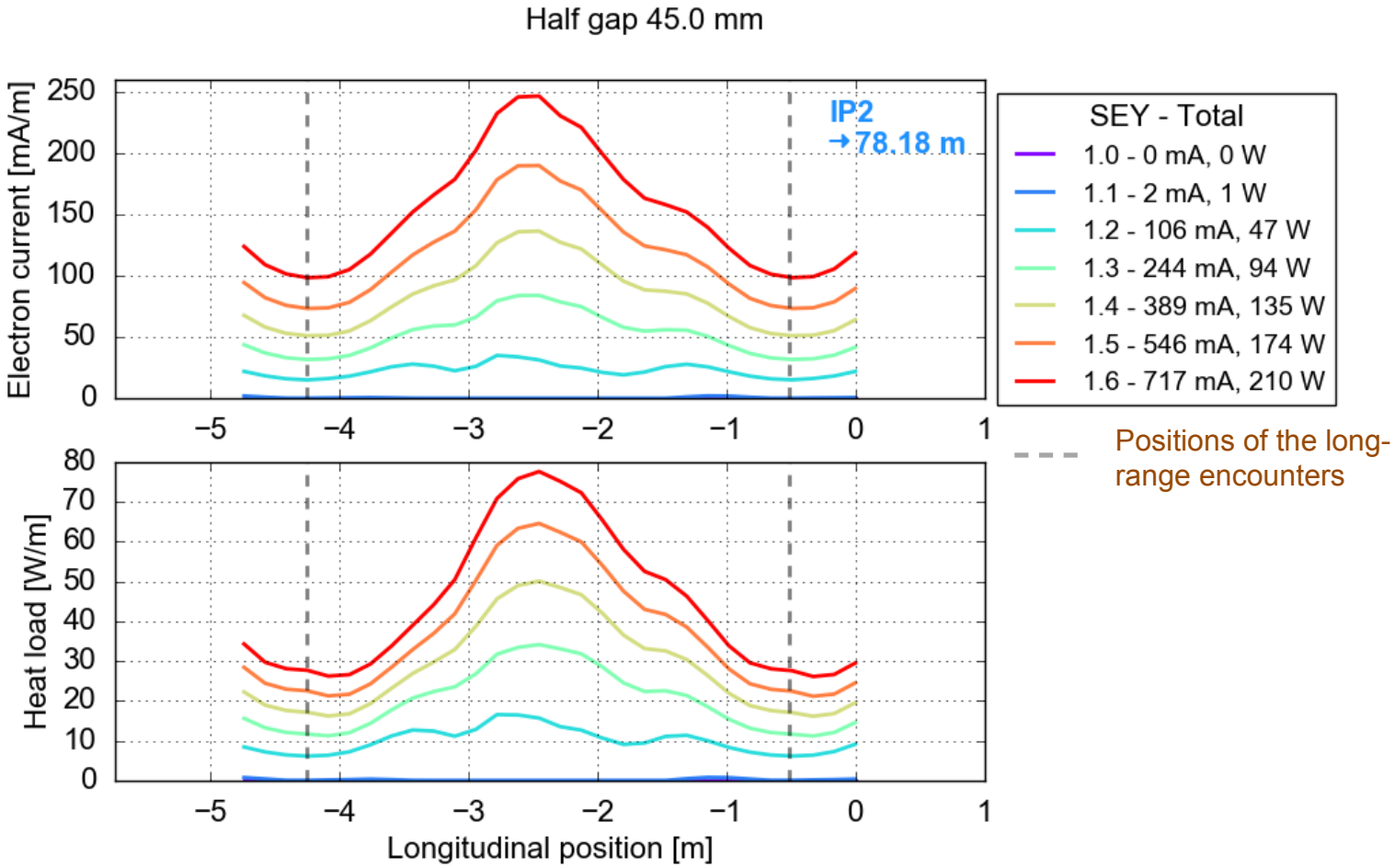

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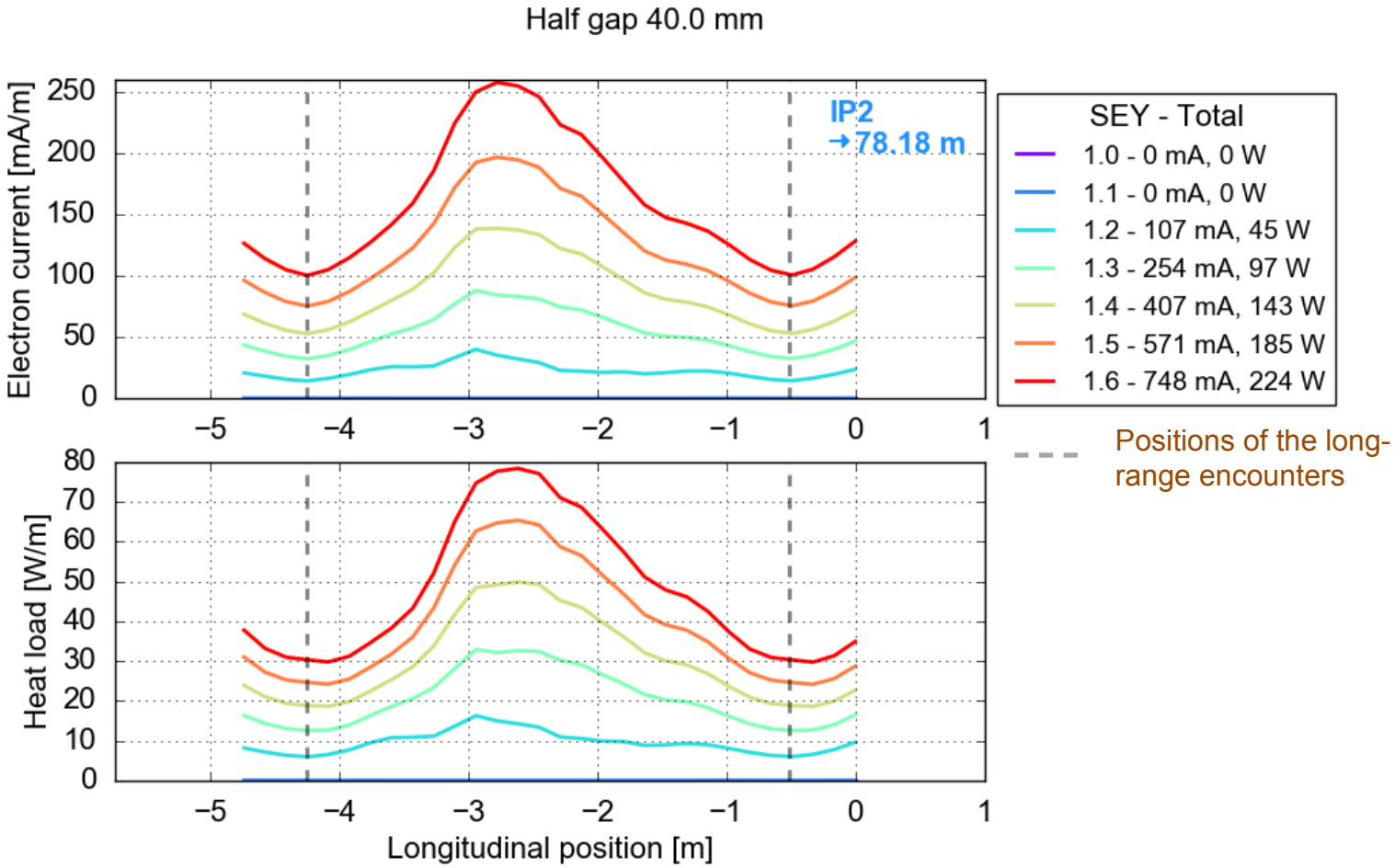

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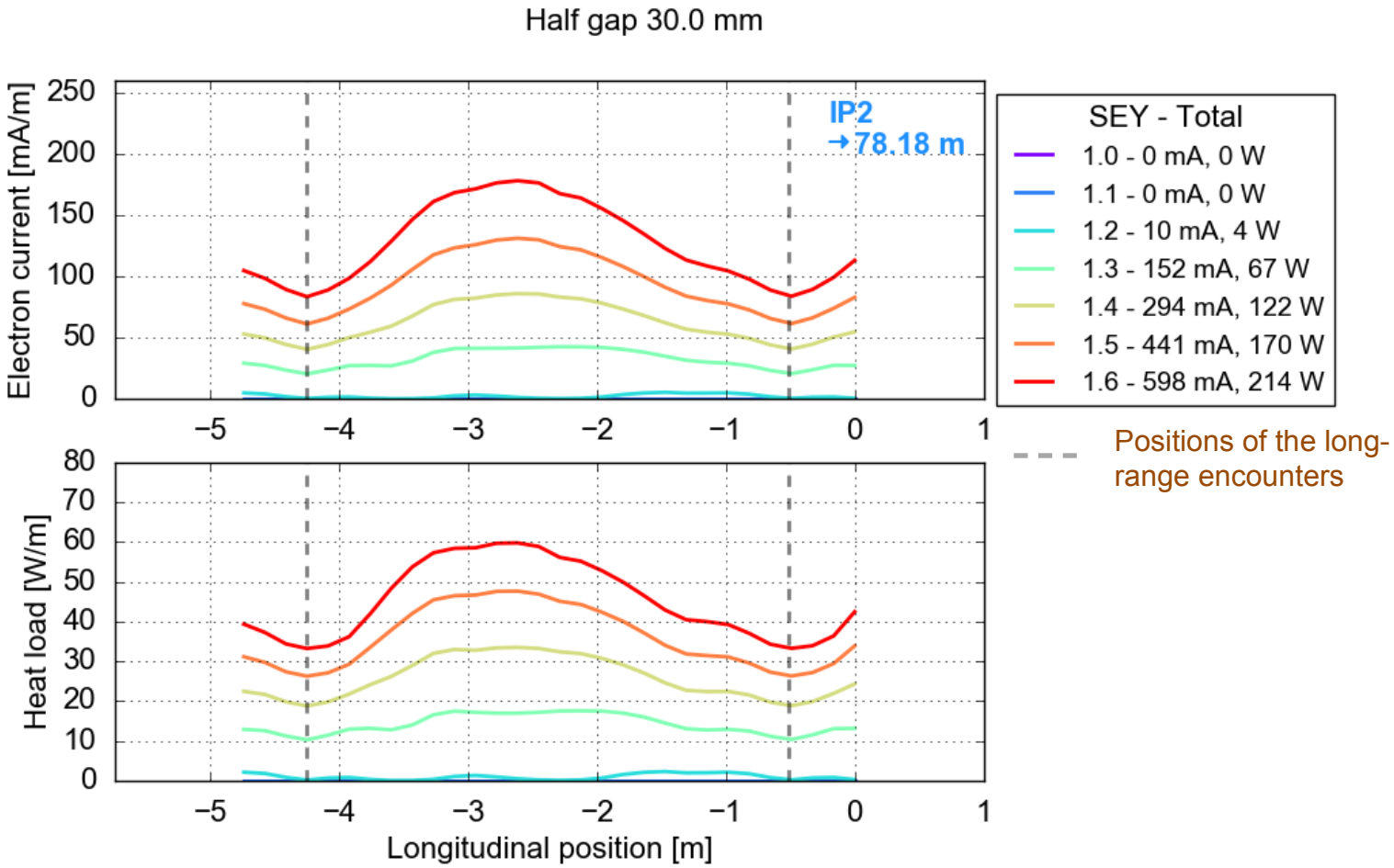

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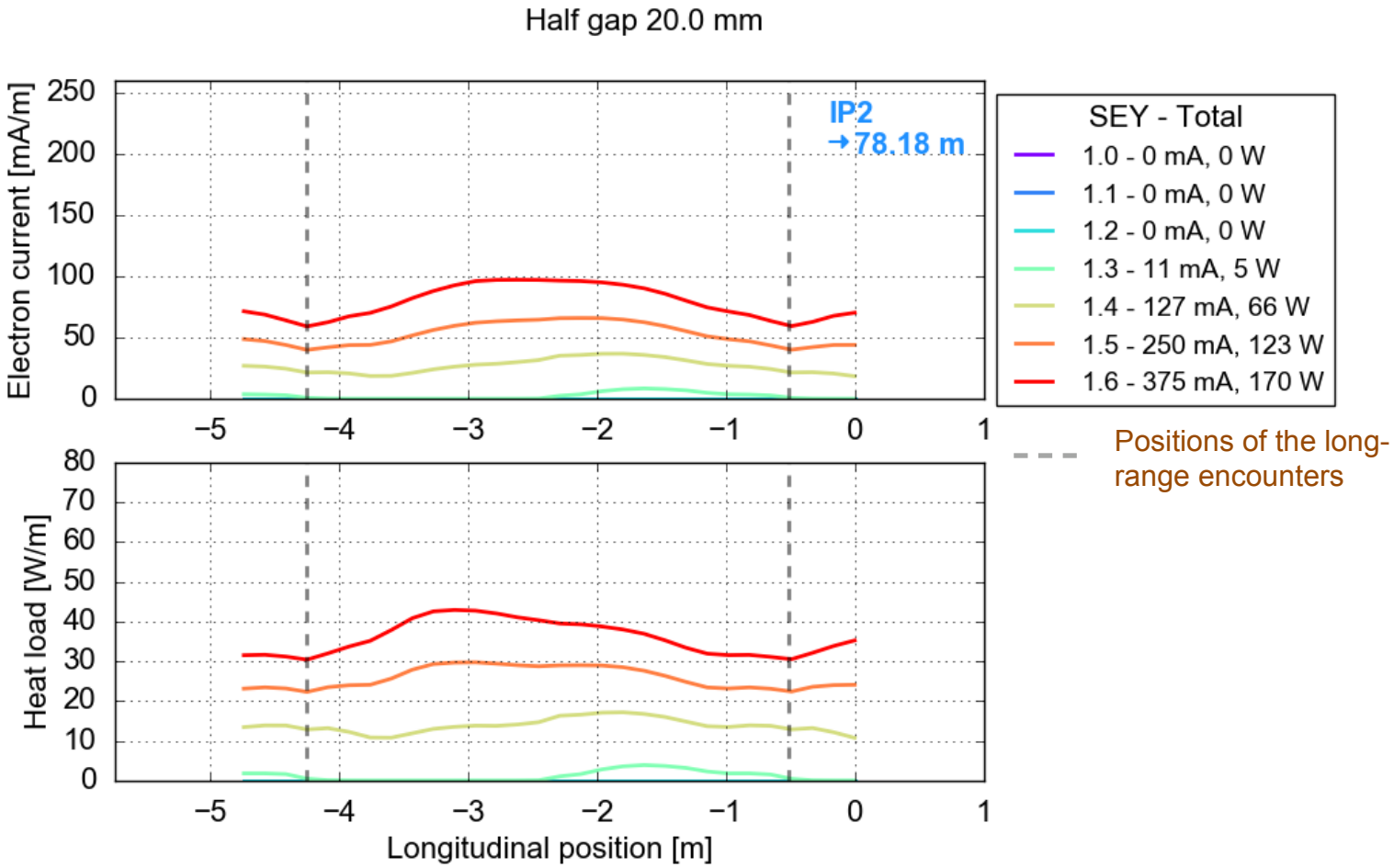

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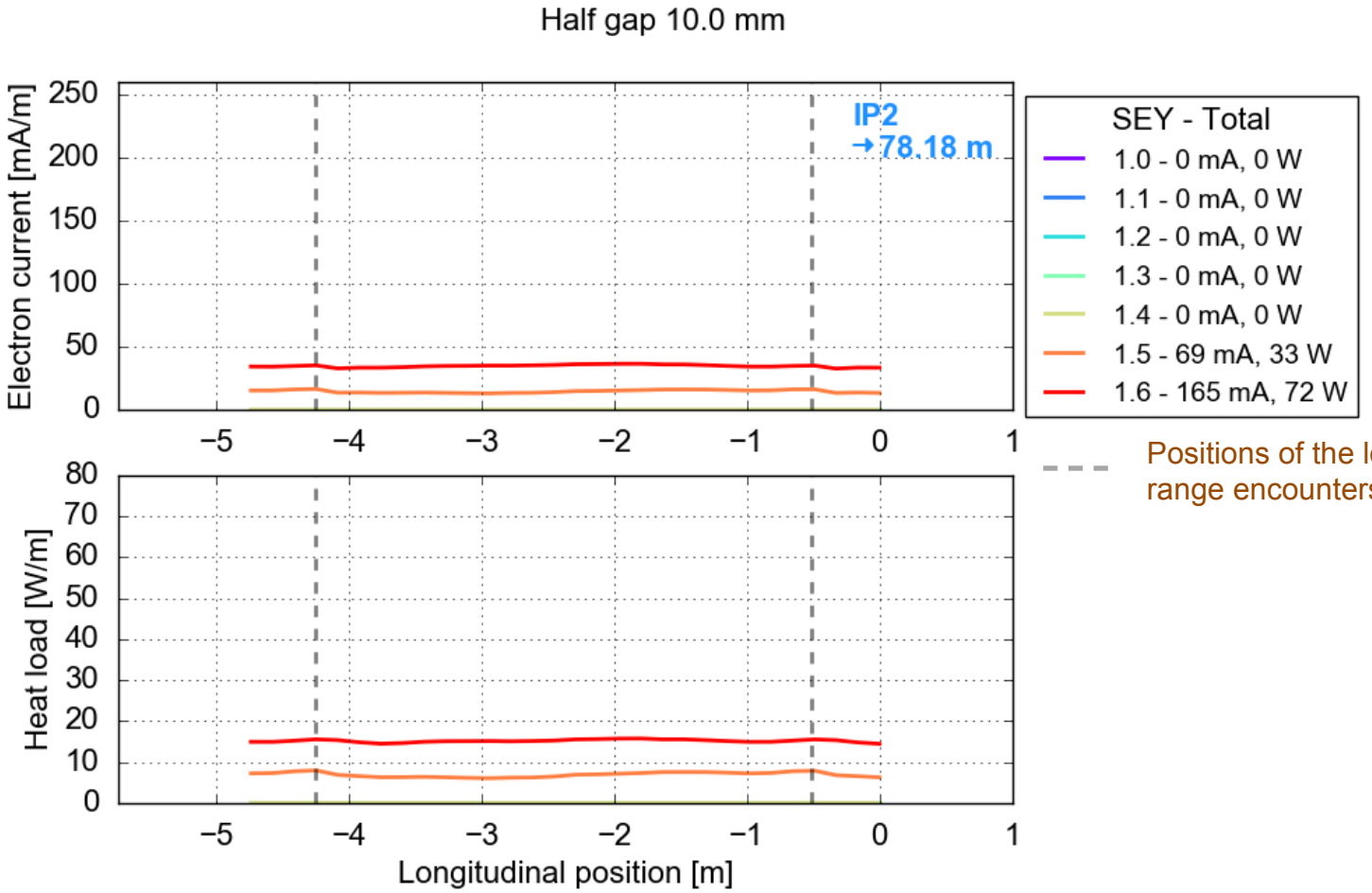

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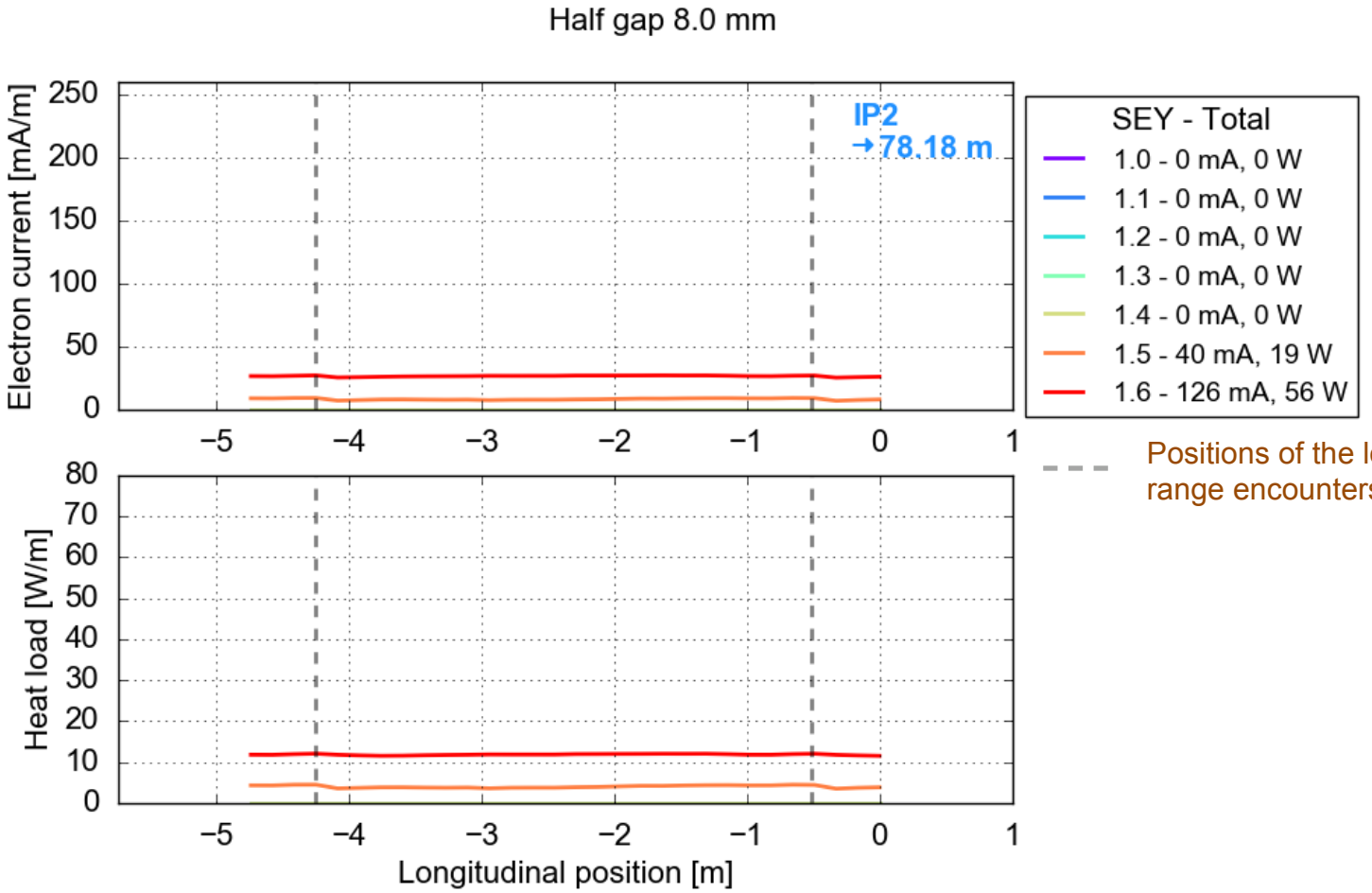

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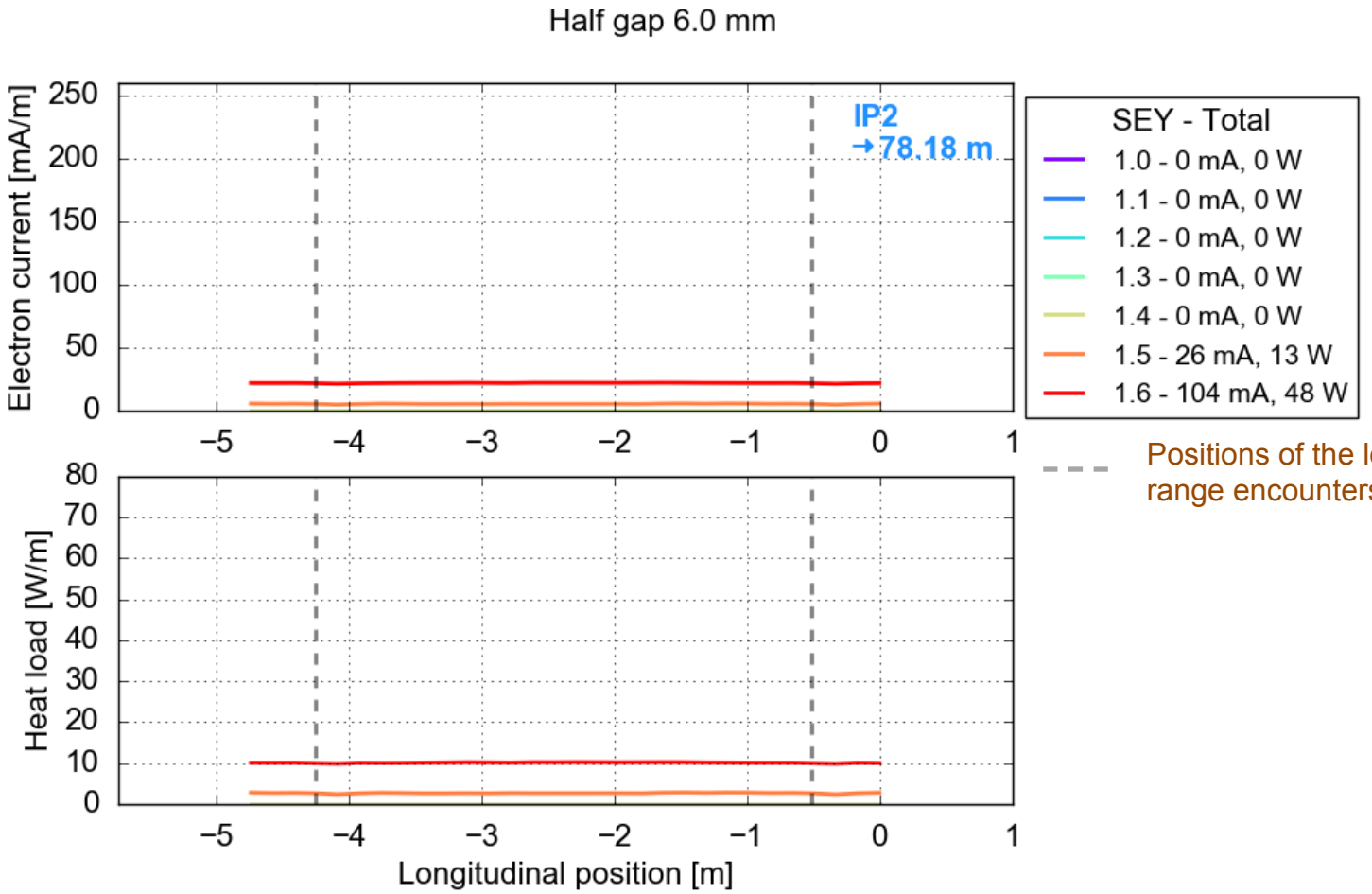

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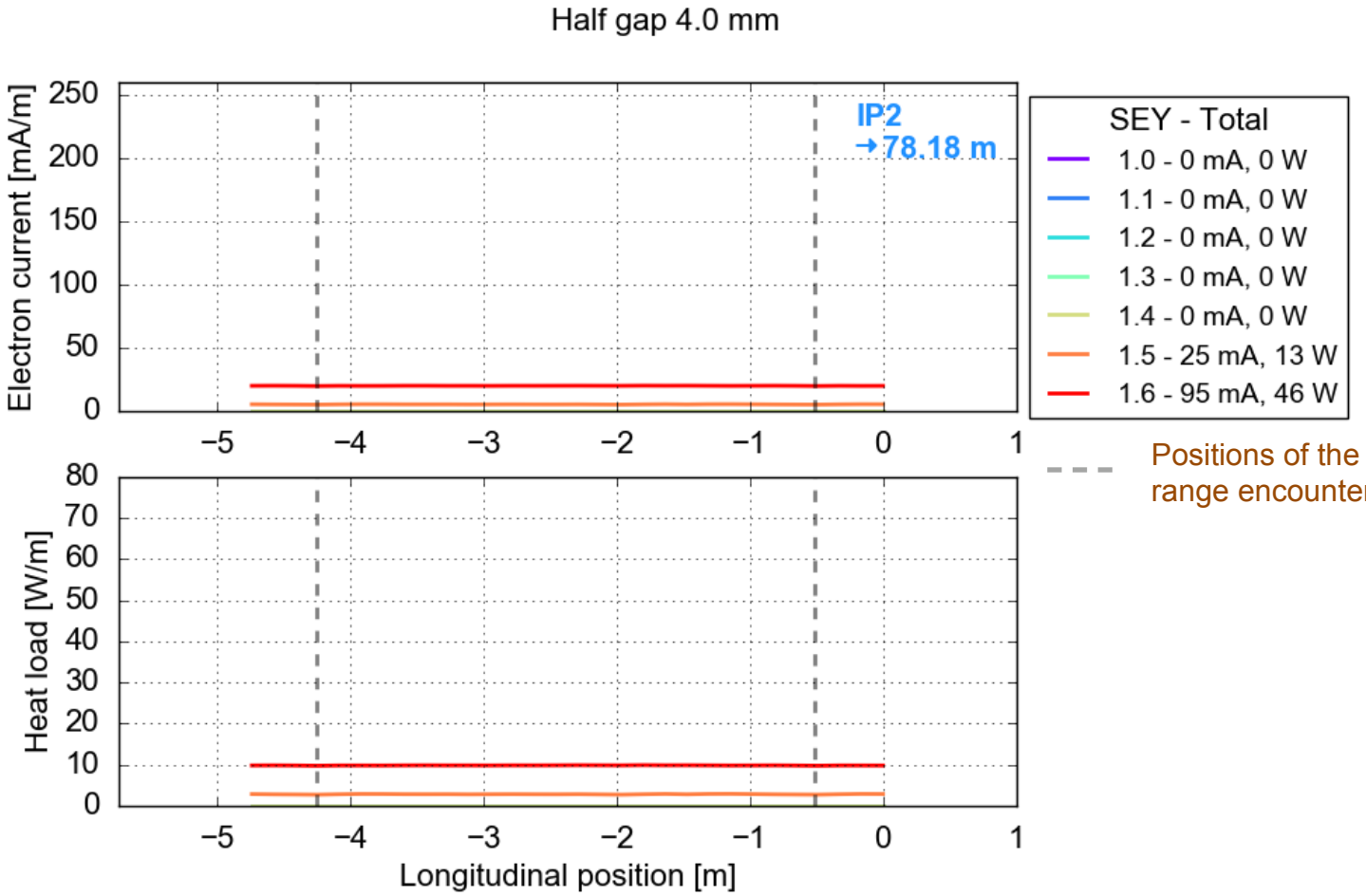

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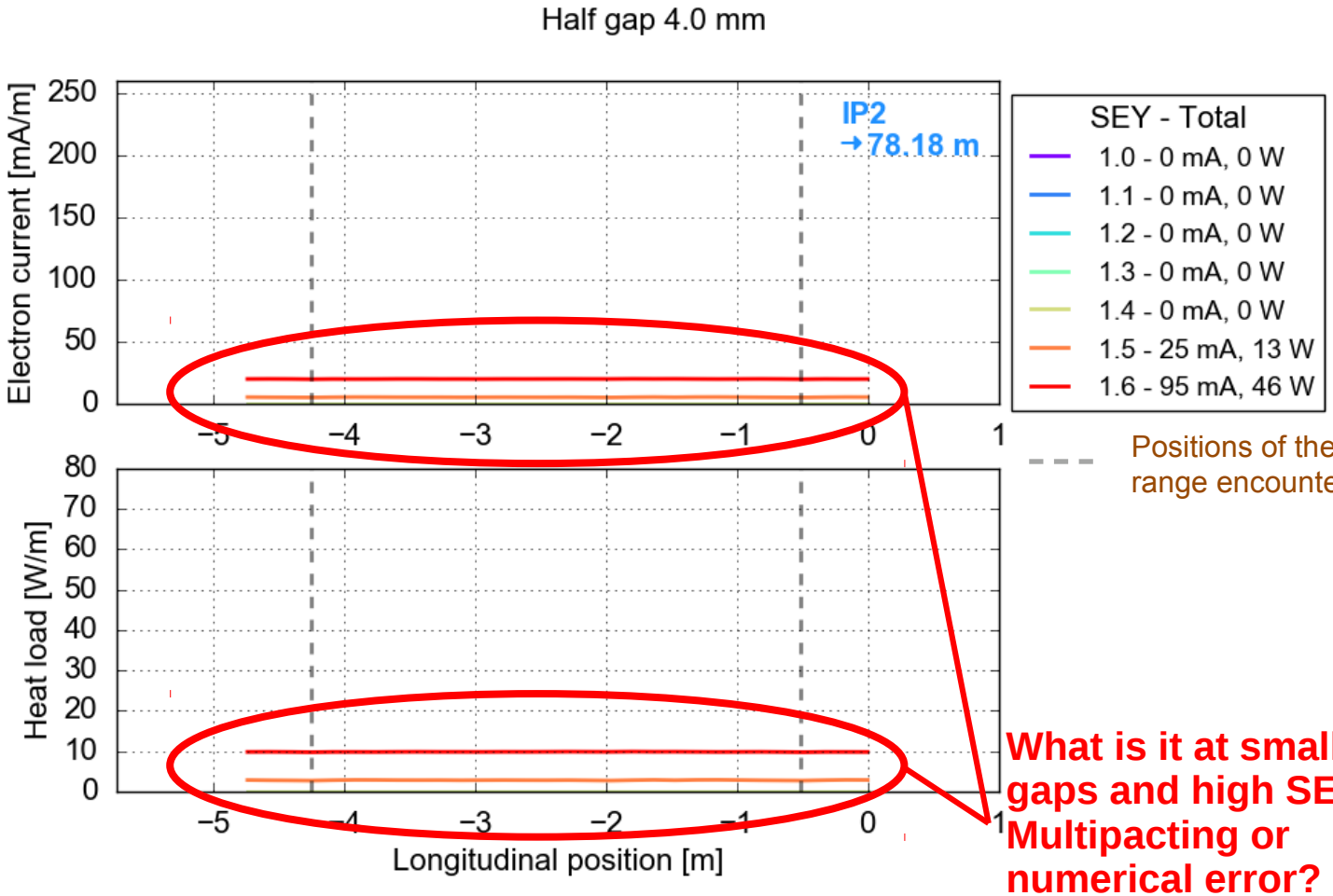
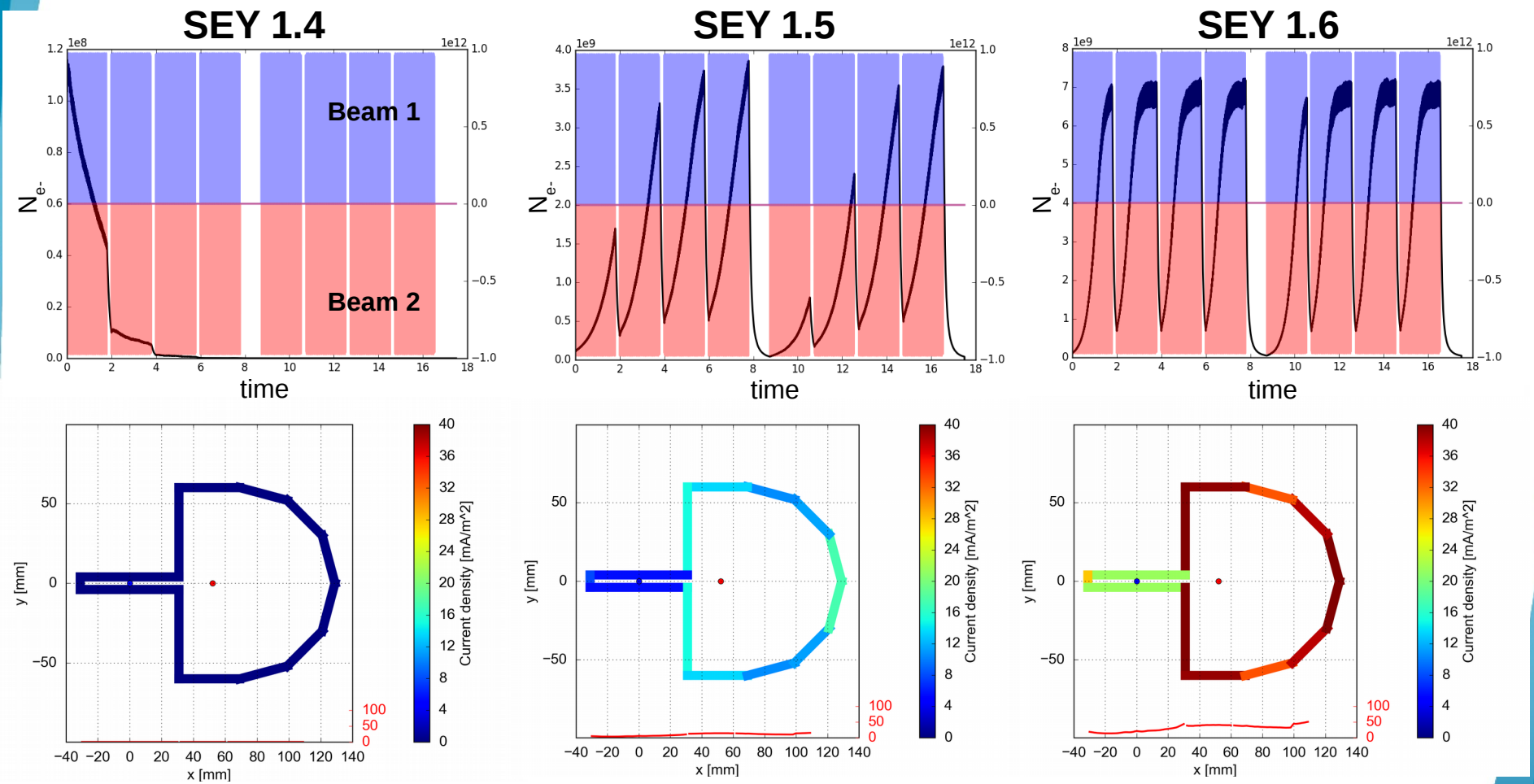


Build-up at small gap and high SEY

- Simulations start with initial seed electrons
- **Multipacting on the beam screen** for small gaps and high SEY



4 mm half-gap, 12.5 ns delay

Longitudinal current/heat profiles (uniform SEY)

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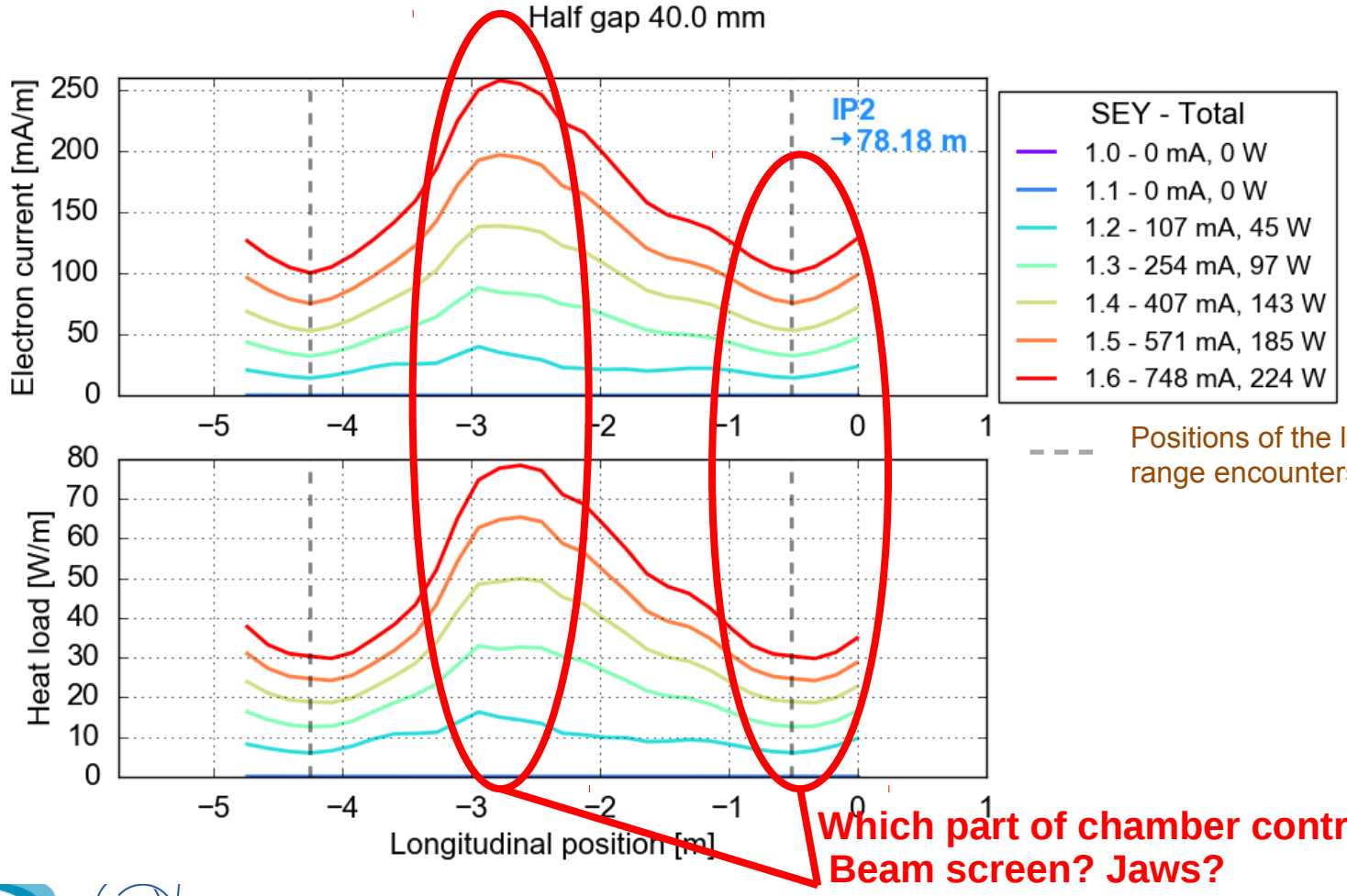
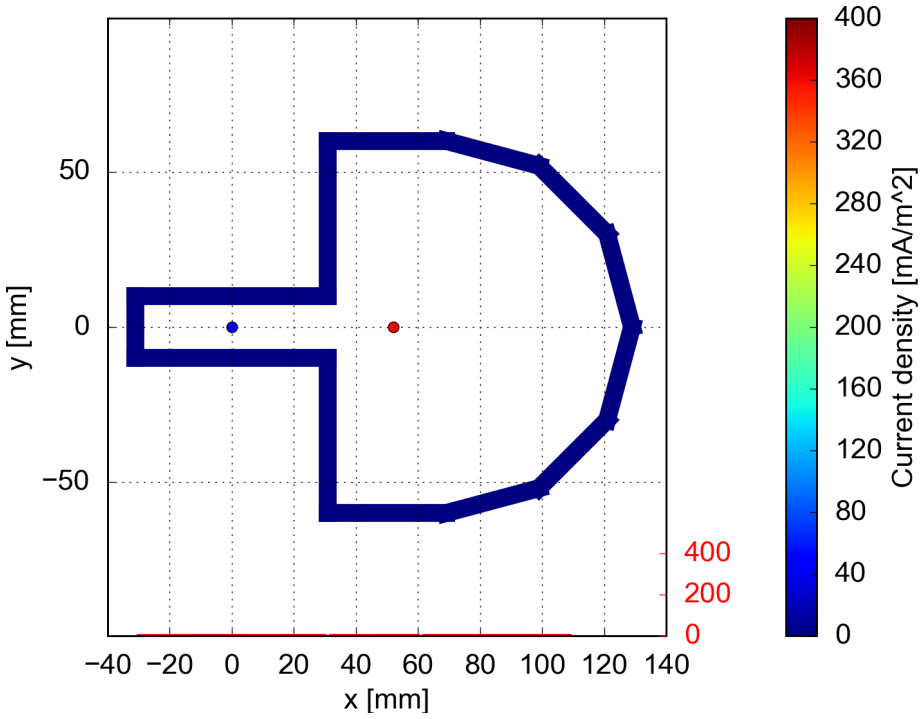
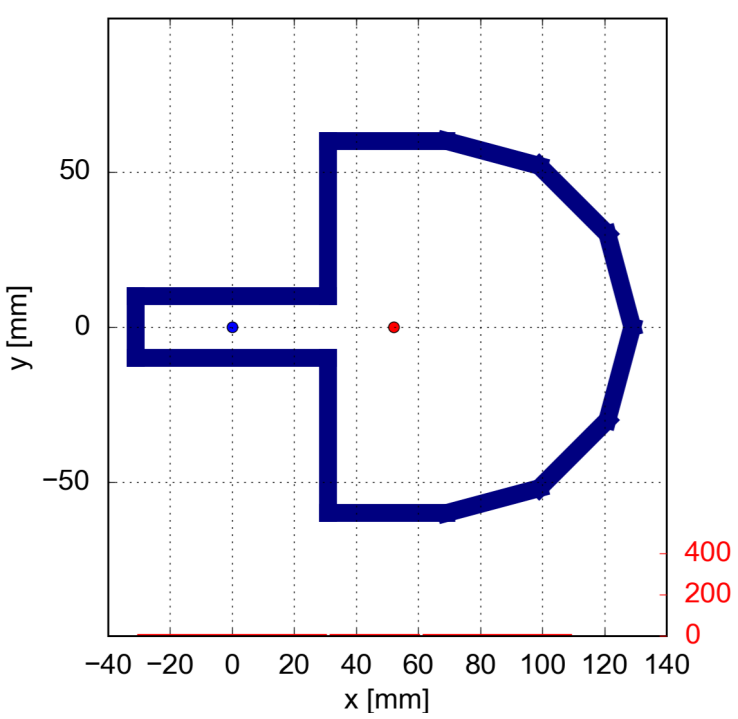


Electron flux on different segments (uniform SEY)

- **At long-range encounter**: e-cloud builds up on the flat part of beam screen
- **Between long-range encounters**: e-cloud builds up on the flat part of beam screen, jaws and on the rounded beam screen part

Uniform SEY 1.4, half-gap 10 mm





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- **At long-range encounter**: e-cloud builds up on the flat part of beam screen
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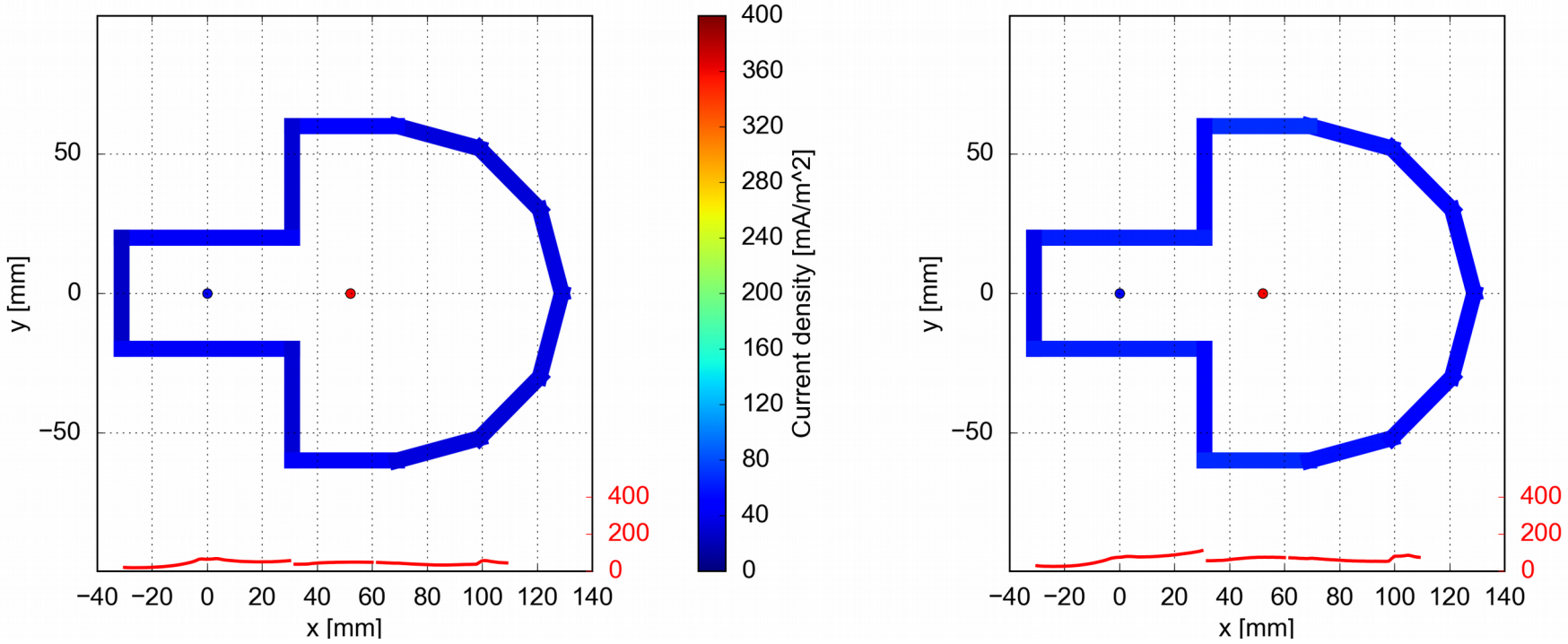
Uniform SEY 1.4, half-gap 20 mm



Electron flux on different segments (uniform SEY)

- **At long-range encounter**: e-cloud builds up on the flat part of beam screen
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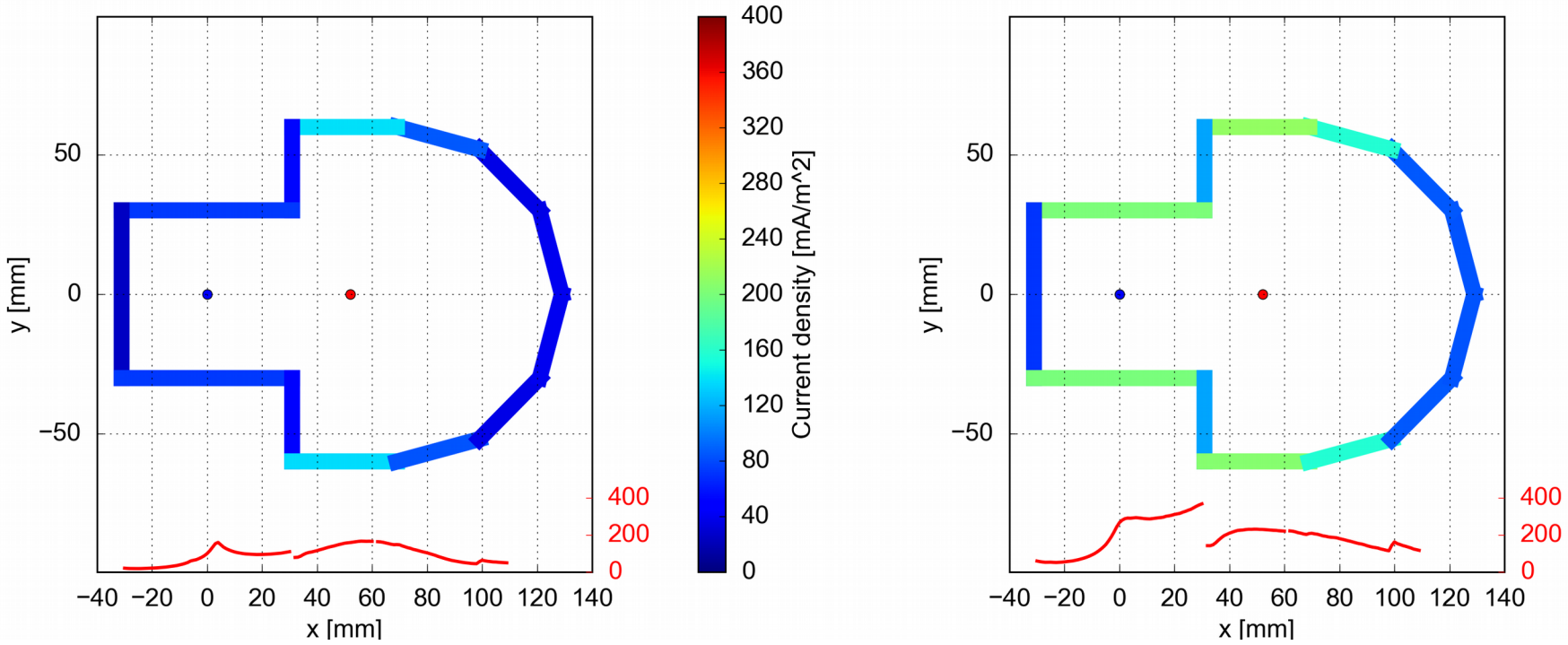
Uniform SEY 1.4, half-gap 30 mm



Electron flux on different segments (uniform SEY)

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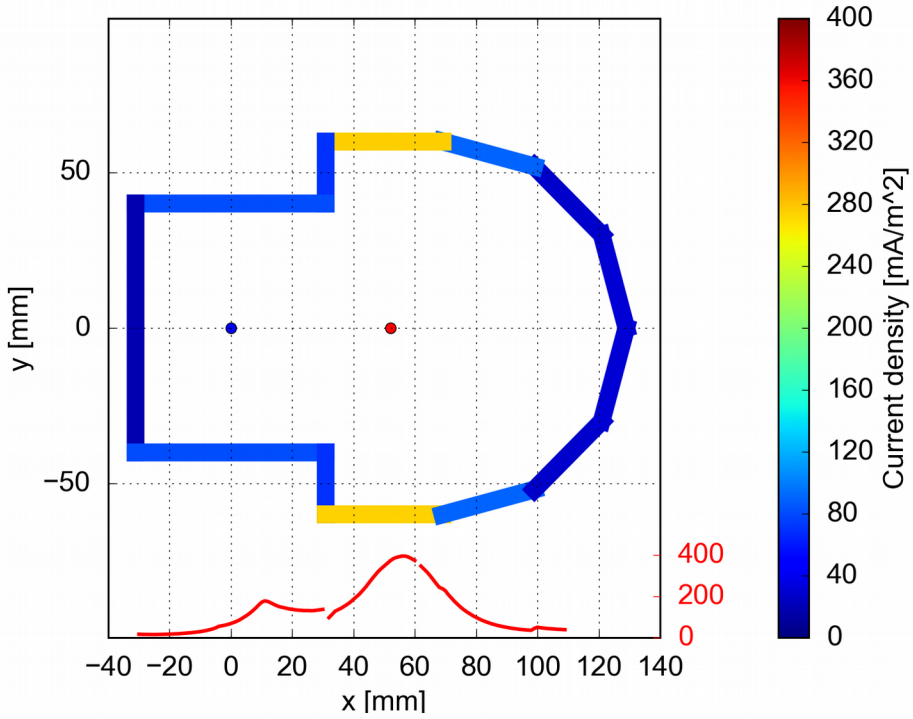
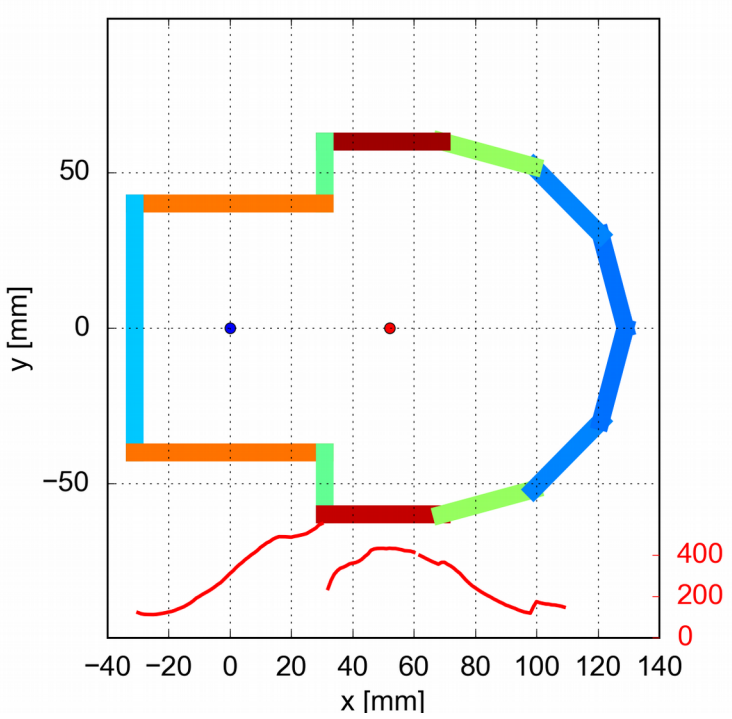
Uniform SEY 1.4, half-gap 40 mm

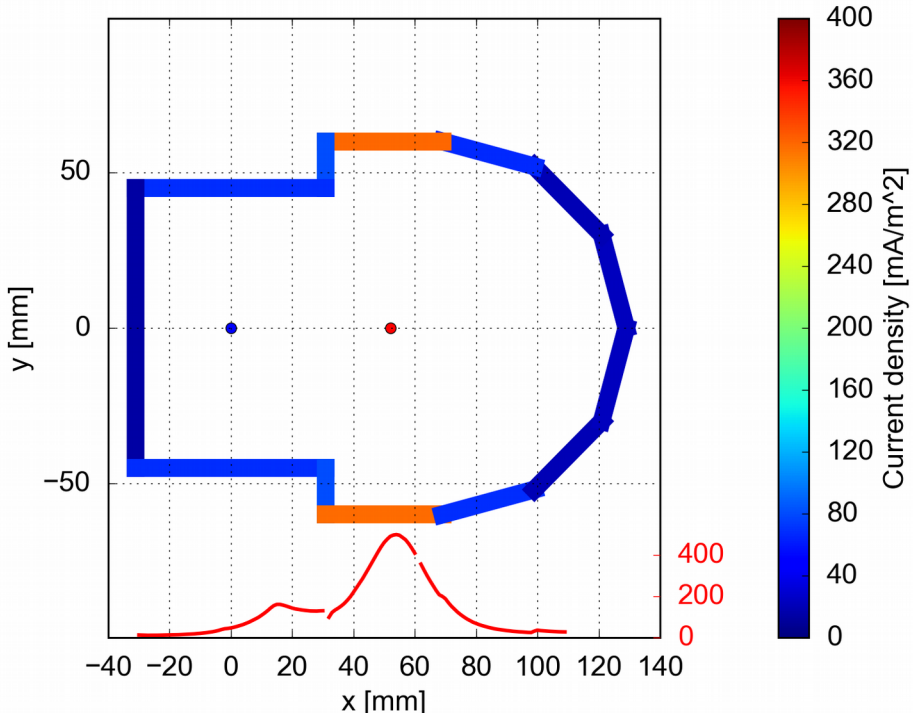


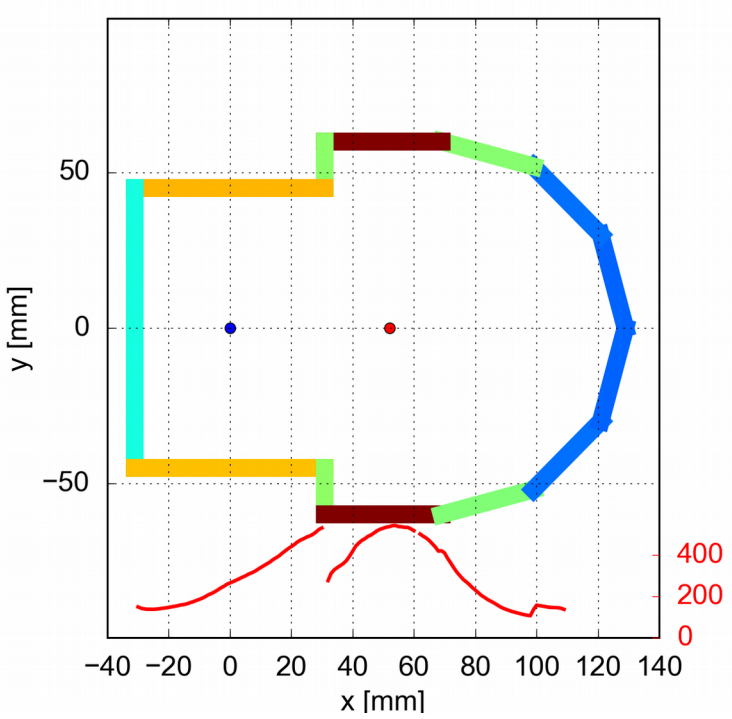


Electron flux on different segments (uniform SEY)

- **At long-range encounter**: e-cloud builds up on the flat part of beam screen
- **Between long-range encounters**: e-cloud builds up on the flat part of beam screen, jaws and on the rounded beam screen part

Uniform SEY 1.4, half-gap 45 mm

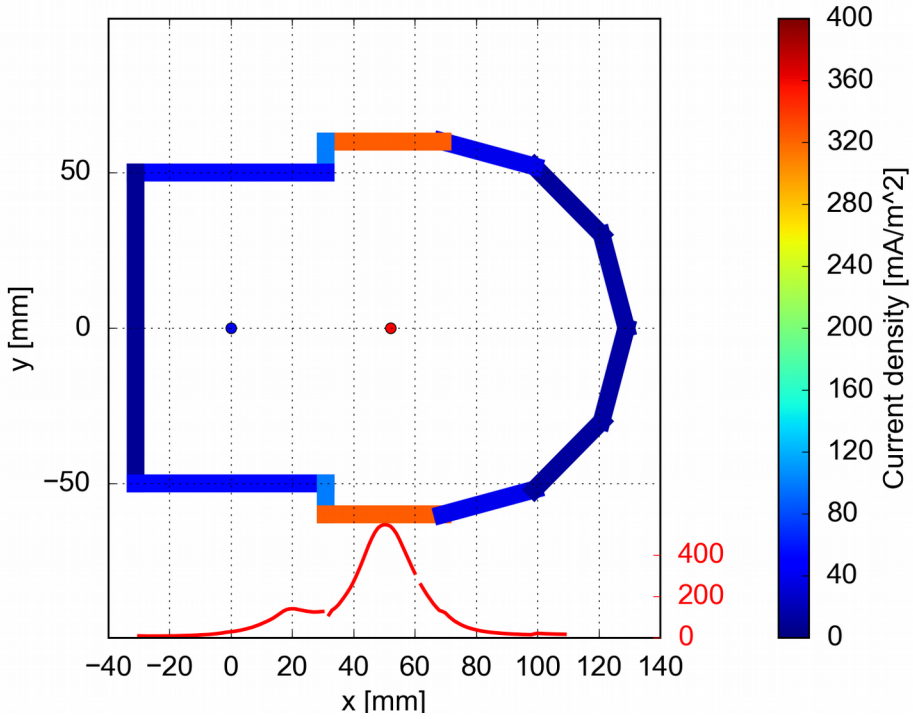


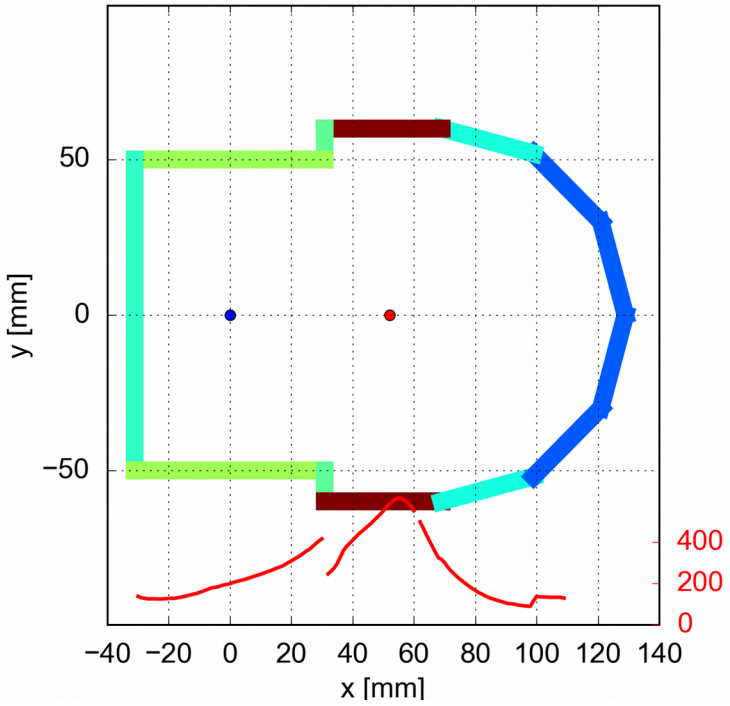


Electron flux on different segments (uniform SEY)

- **At long-range encounter**: e-cloud builds up on the flat part of beam screen
- **Between long-range encounters**: e-cloud builds up on the flat part of beam screen, jaws and on the rounded beam screen part

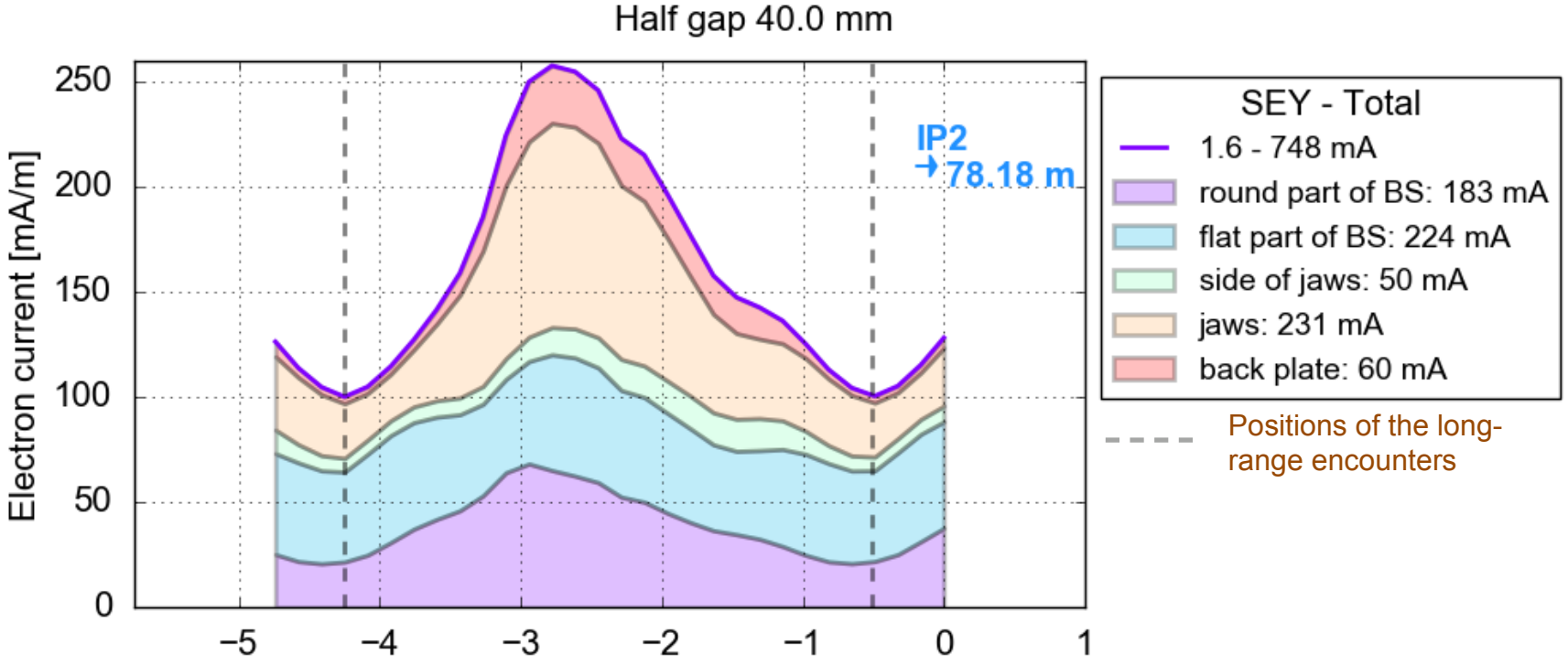
Uniform SEY 1.4, half-gap 50 mm





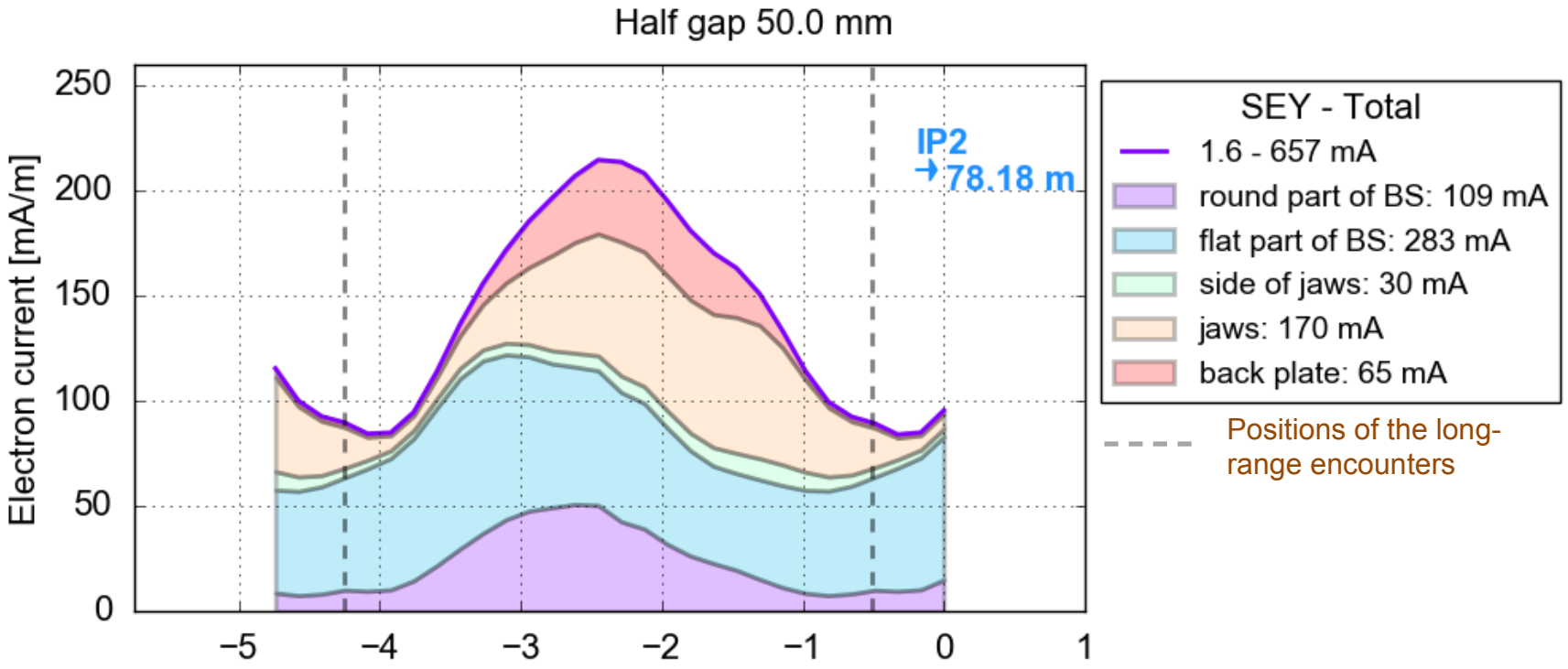
Electron current by segment (uniform SEY)

- **At long-range encounter**: largest contributor is the the beam screen
- **Between long-range encounters:** largest contributor are the jaws
- **Beam screen** (flat and round parts) accounts for **more than a half of the total** current
- Contribution of jaws is highly dependent on the delay



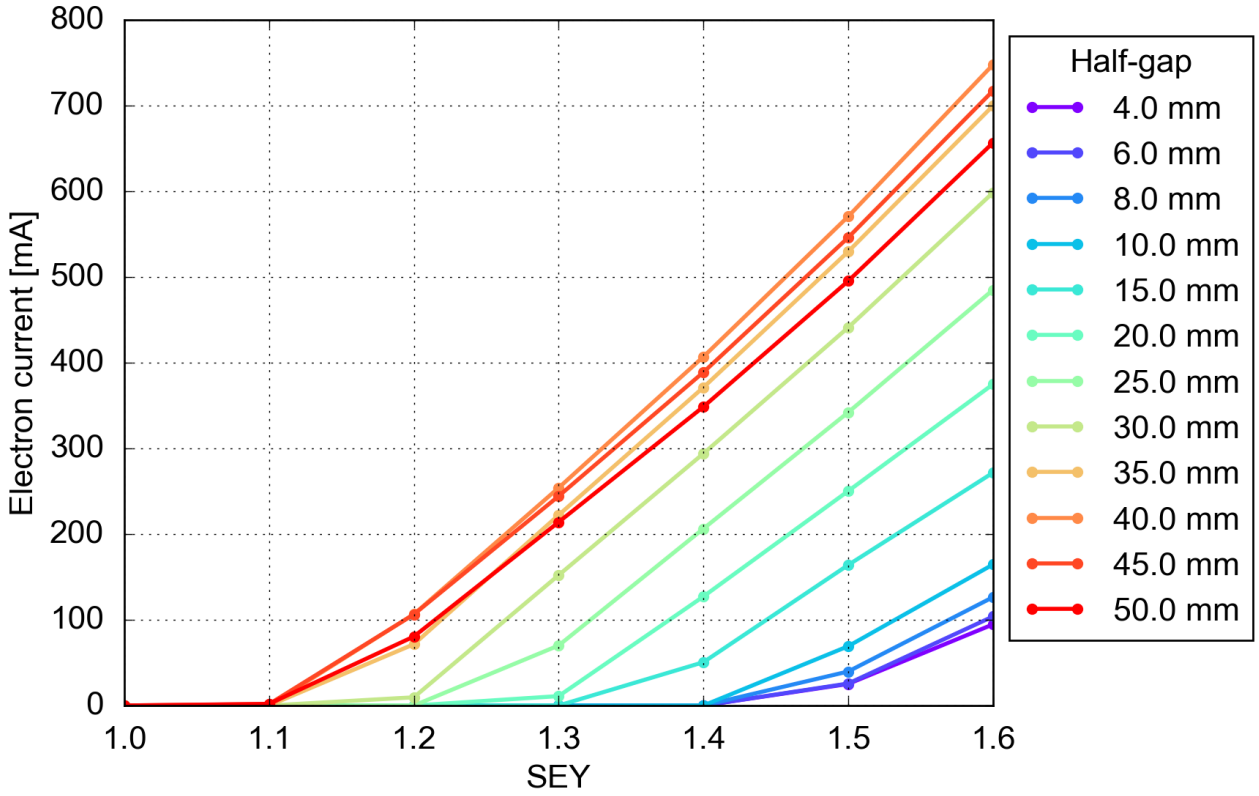
Electron current by segment (uniform SEY)

- Opening the gap from 40 to 50 mm half-gap reduces total current
  - lowers the contribution of jaws by 30%
  - contribution from the beam screen (round and flat parts) is roughly unchanged



Total electron current vs SEY (uniform SEY)

- Electron flux on the walls increases for large gaps
- Maximum is reached at half-gap 40 mm SEY 1.6: **750 mA**
- Multipacting threshold very high for small gaps and decreasing when the jaws are opened



Total electron current vs SEY (uniform SEY)

With old geometry ~680mA

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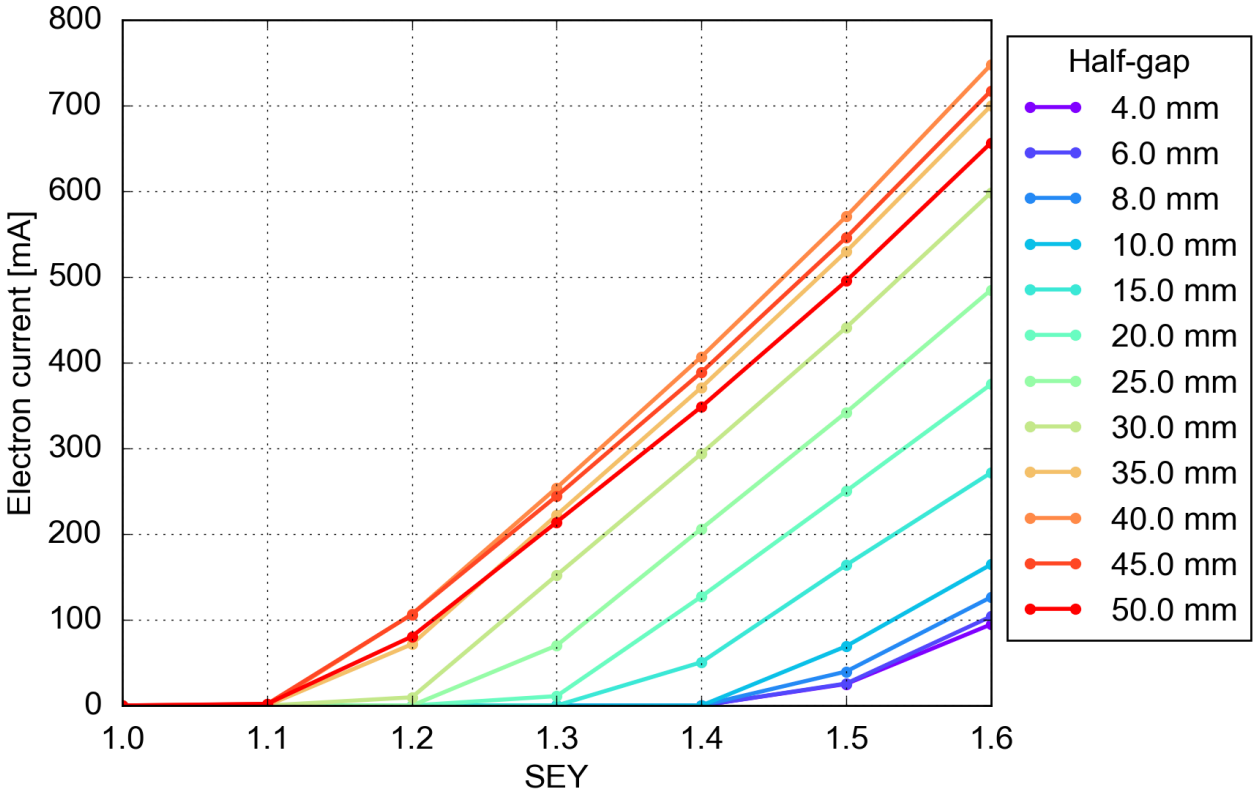

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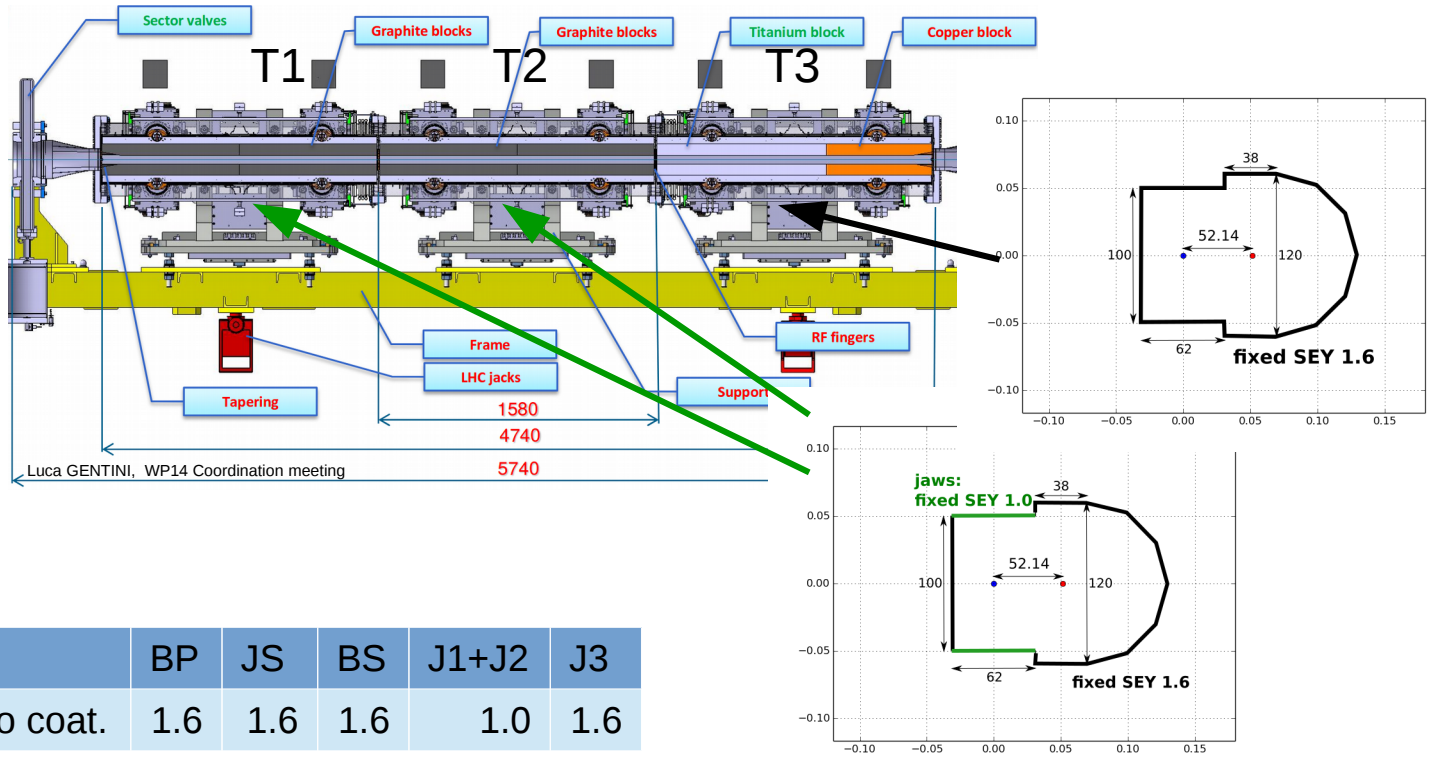
Nonuniform SEY: jaws in tanks 1,2 SEY 1.0 SEY 1.6 elsewhere (BASELINE no coating J3)

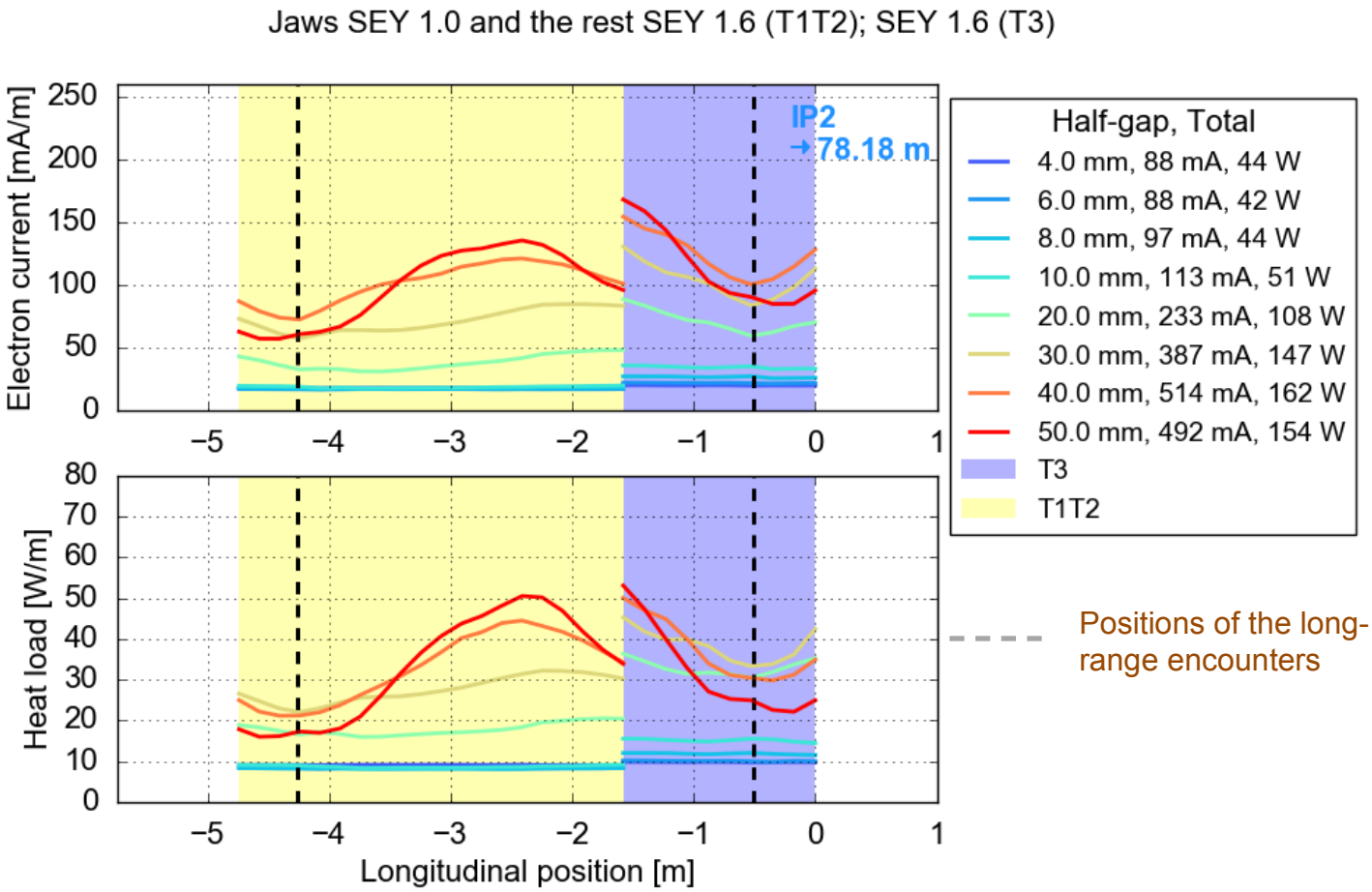


	BP	JS	BS	J1+J2	J3
Baseline: no coat.	1.6	1.6	1.6	1.0	1.6

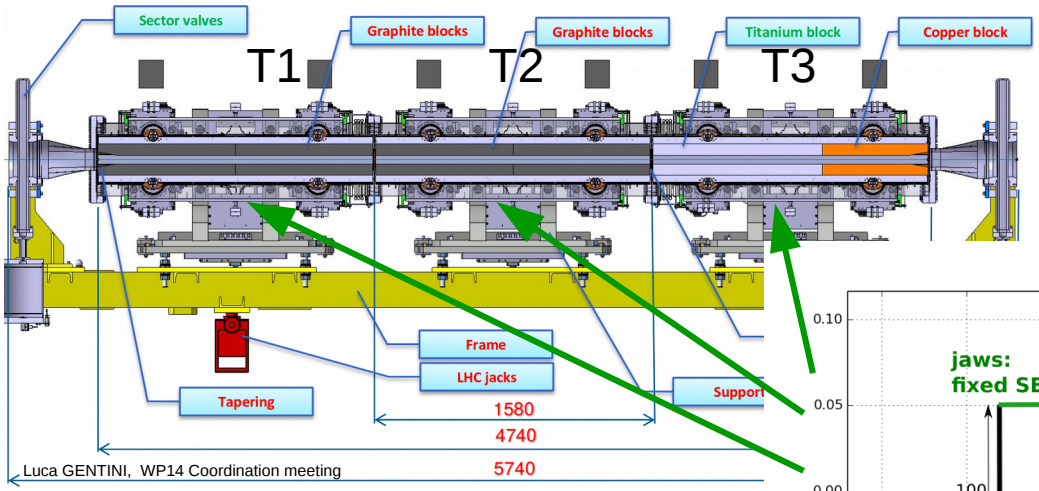
BP – back plate
JS – side of jaws
BS – beam screen
J1/J2/J3 – jaws in tanks 1,2 and 3

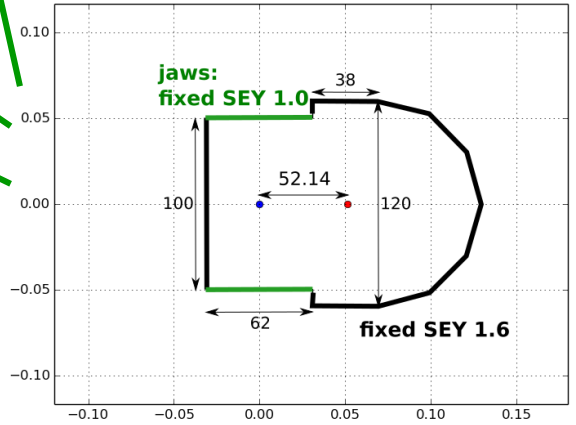
Longitudinal current/heat profiles (nonuniform SEY: jaws 1.0 T1T2)

- Maximum reached for gaps ~40 mm: total **514 mA** e-current



Nonuniform SEY: Coated jaws in tank 3 SEY 1.0





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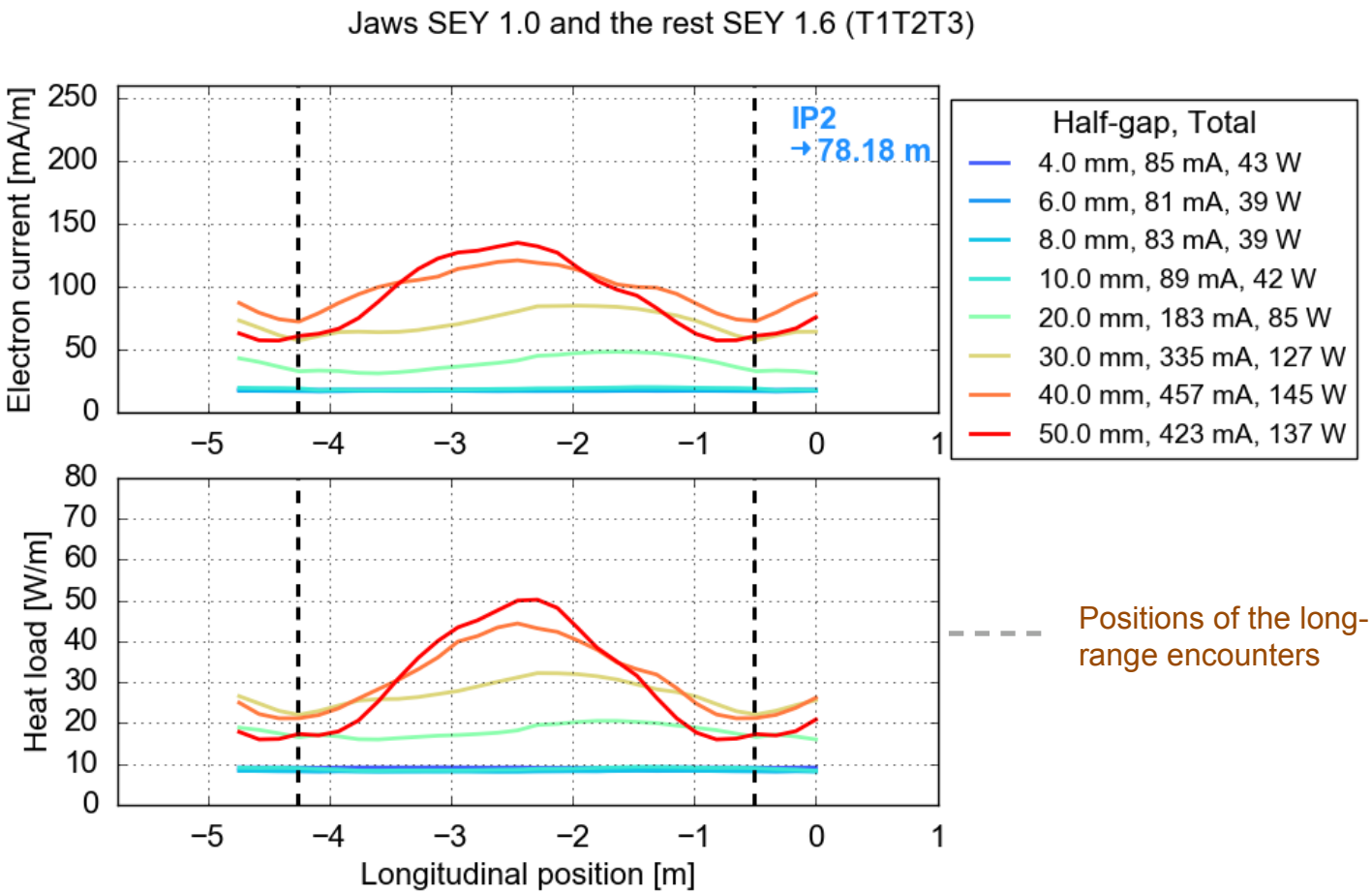
Coat J3	1.6	1.6	1.6	1.0	1.0

BP – back plate
JS – side of jaws
BS – beam screen
J1/J2/J3 – jaws in tanks 1,2 and 3

Longitudinal current/heat profiles (nonuniform SEY: jaws 1.0 T1T2T3)

- Maximum reached for gaps ~40 mm: total **457 mA** e-current



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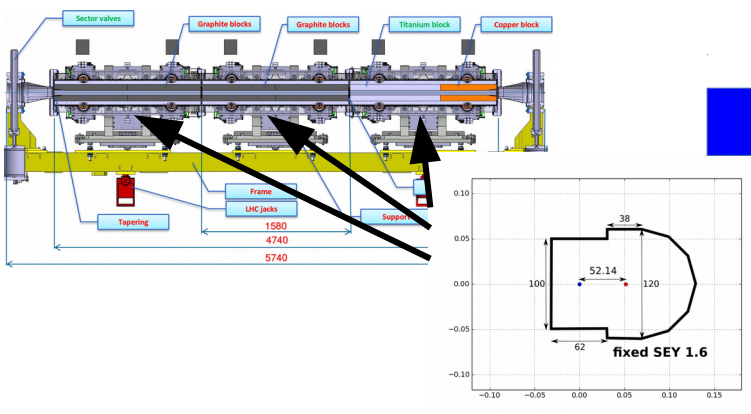
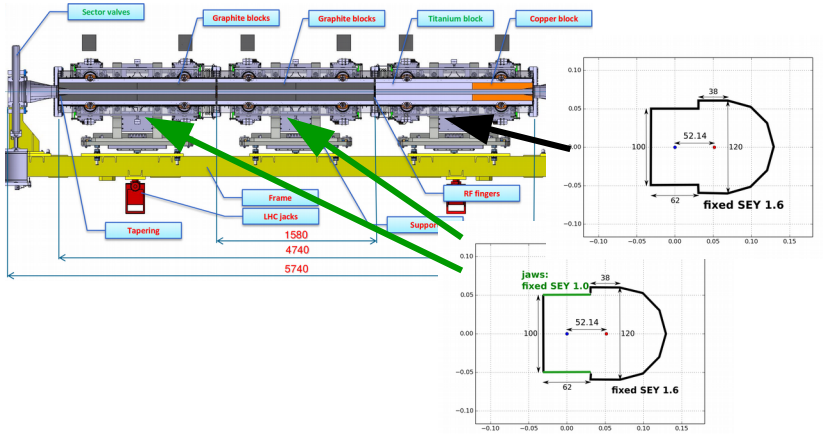
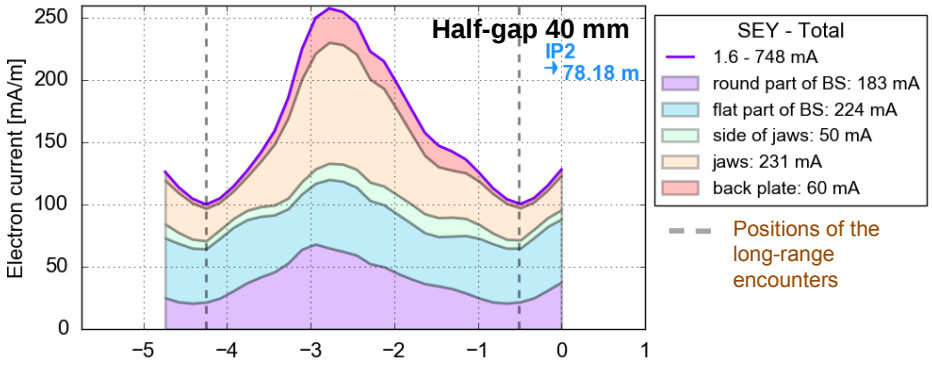
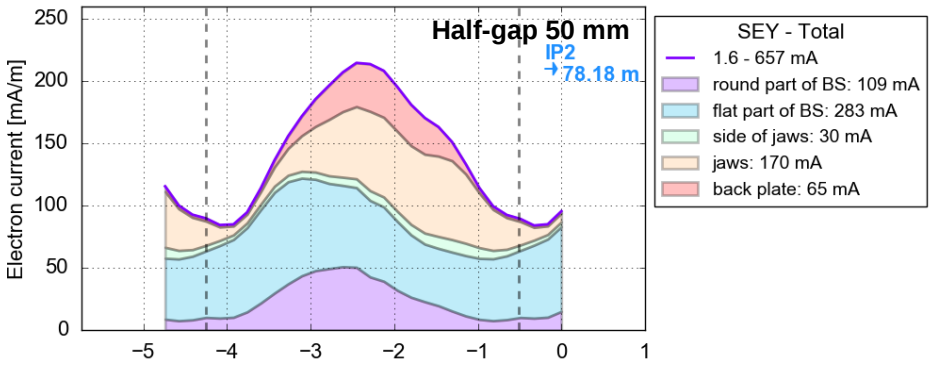
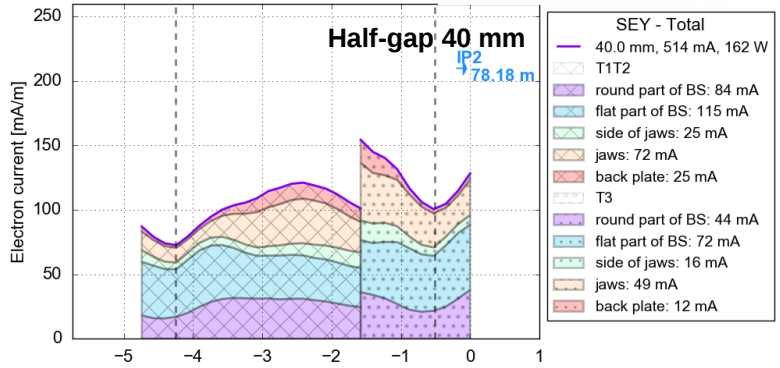
From Uniform to Baseline SEY distribution

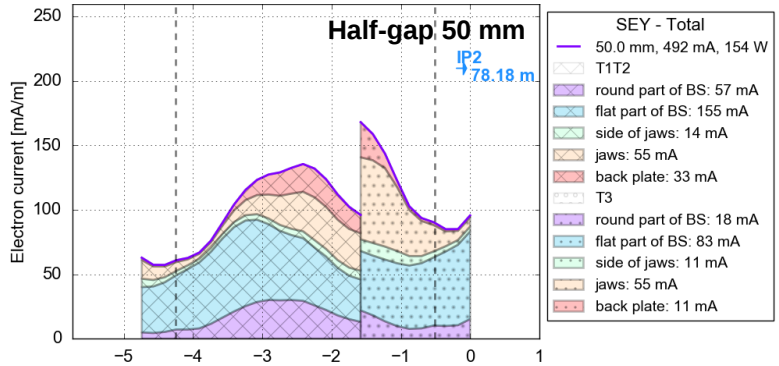




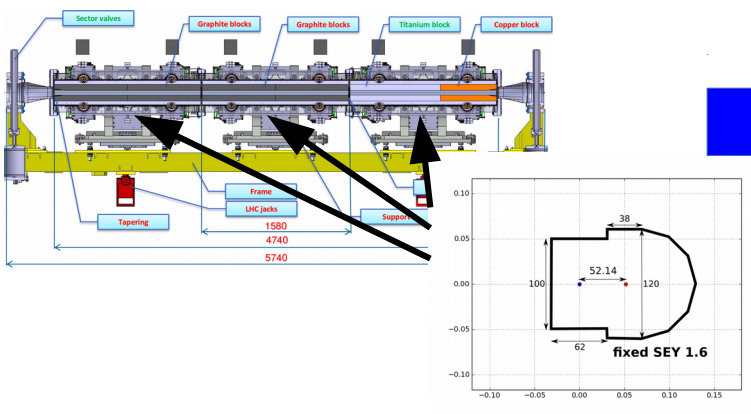


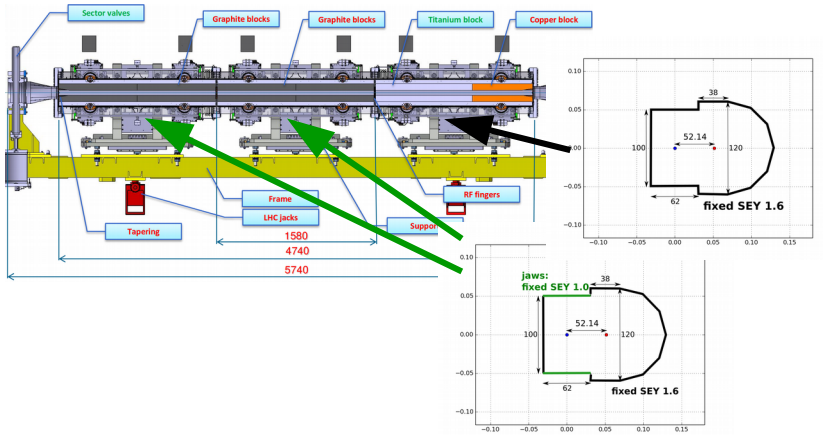


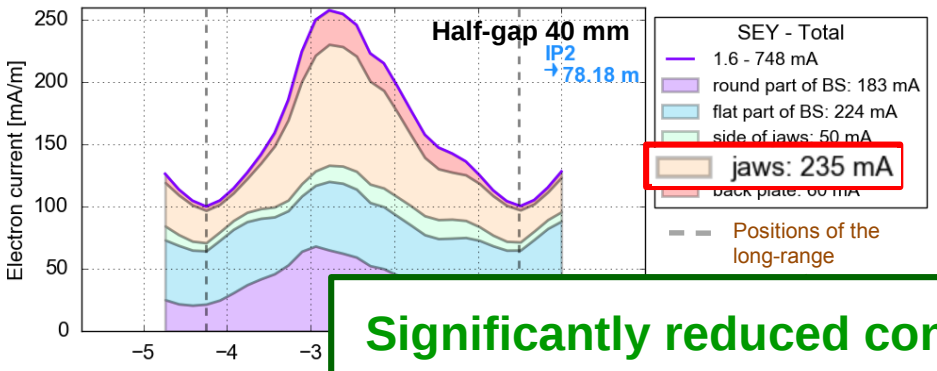


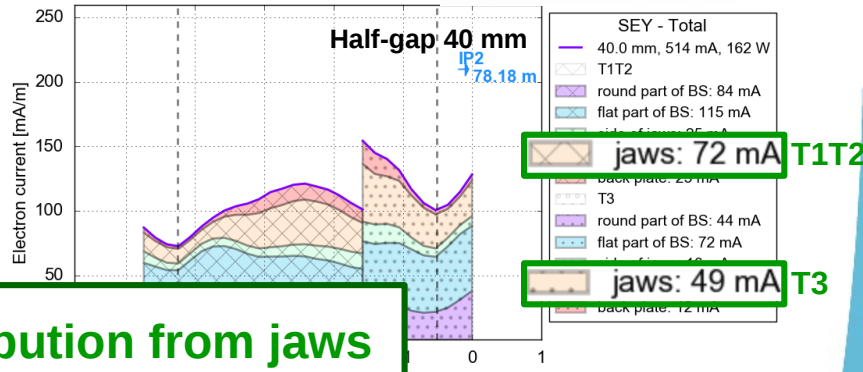


From Uniform to Baseline SEY distribution

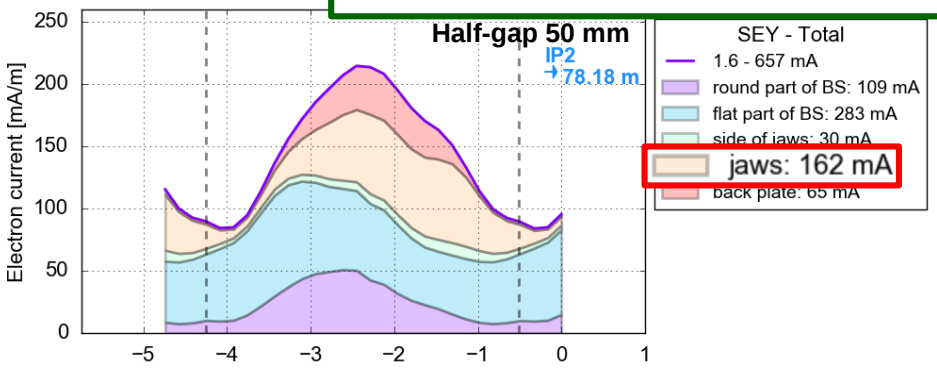


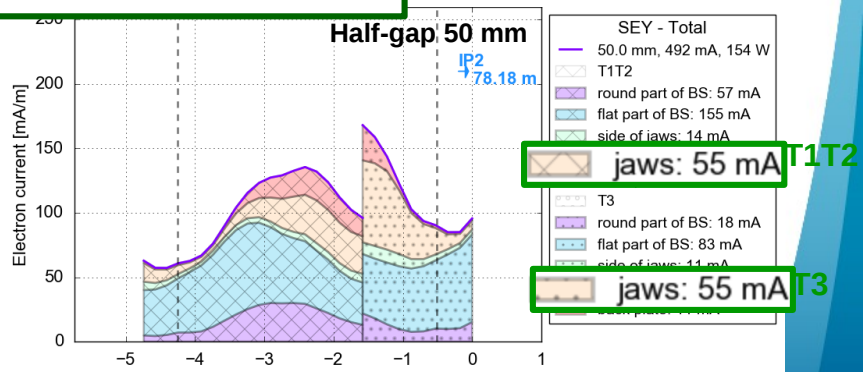




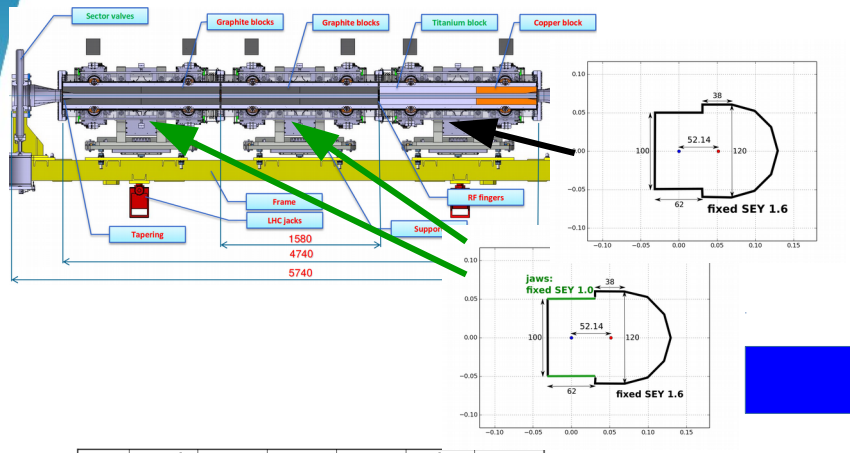


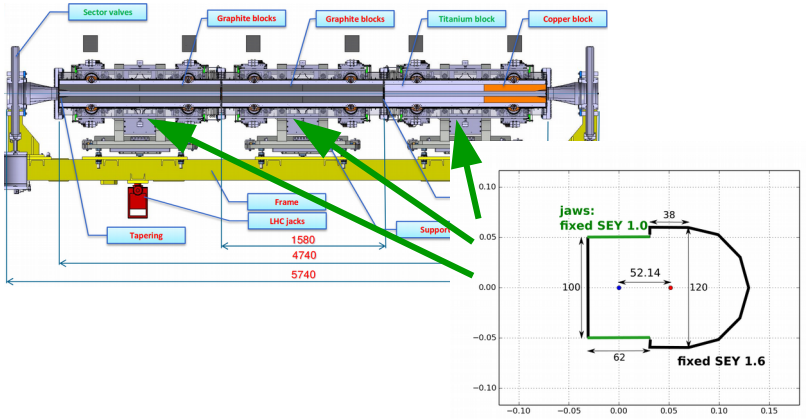
Significantly reduced contribution from jaws

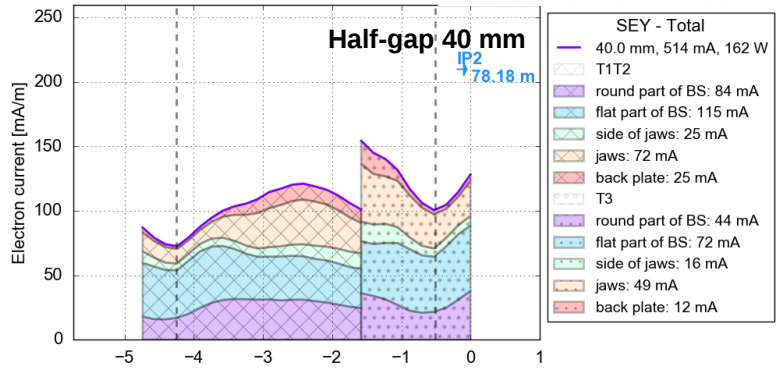


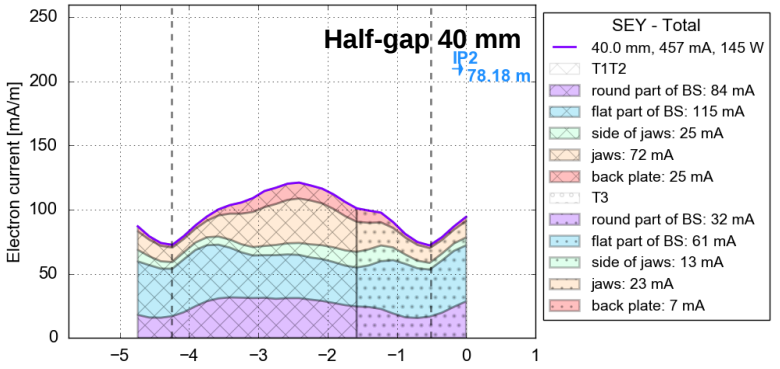


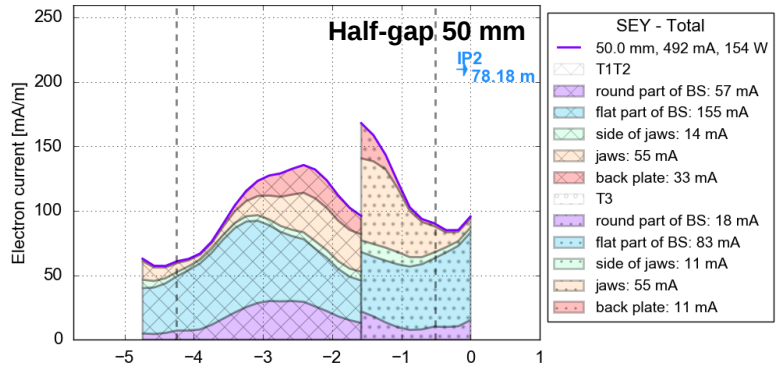
From Baseline to Coated J3

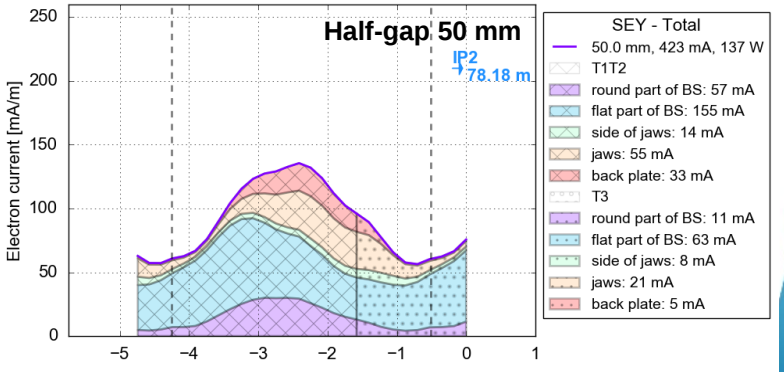




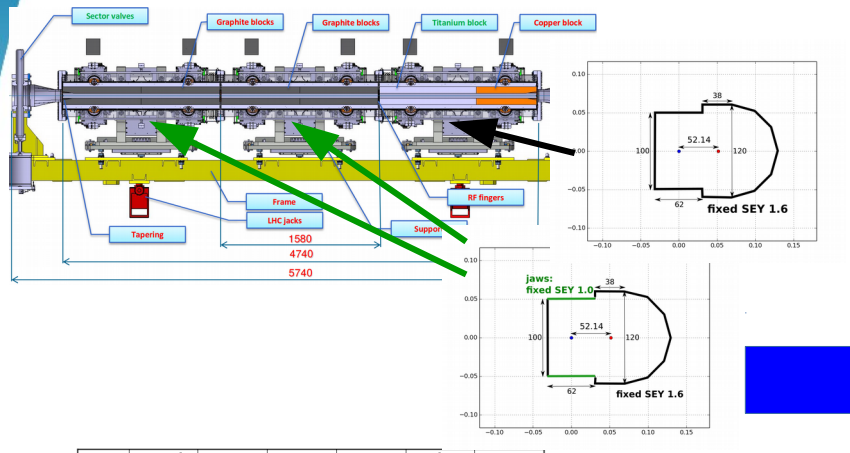


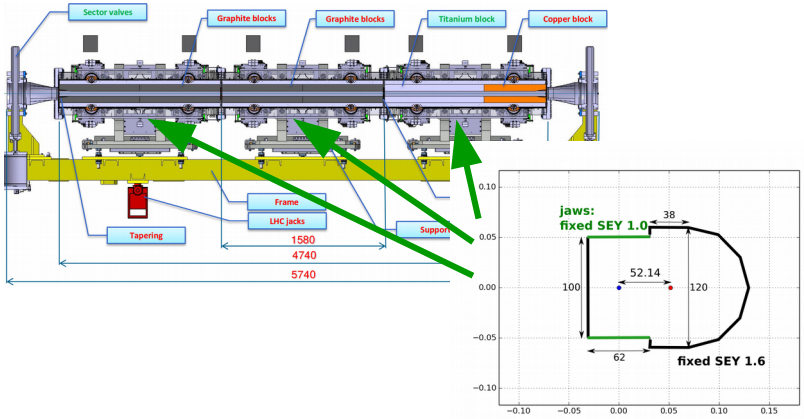


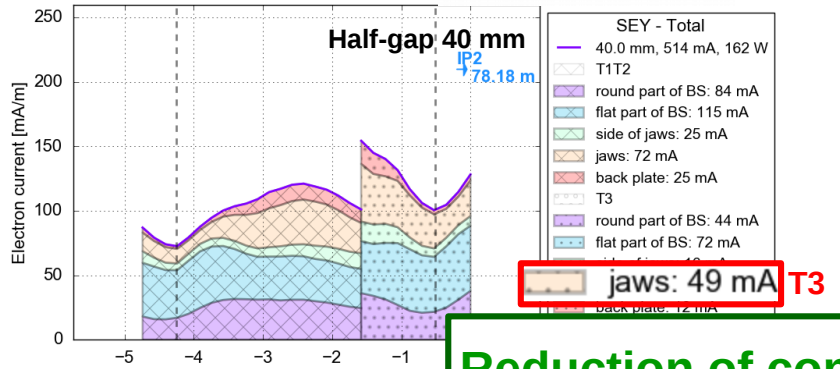


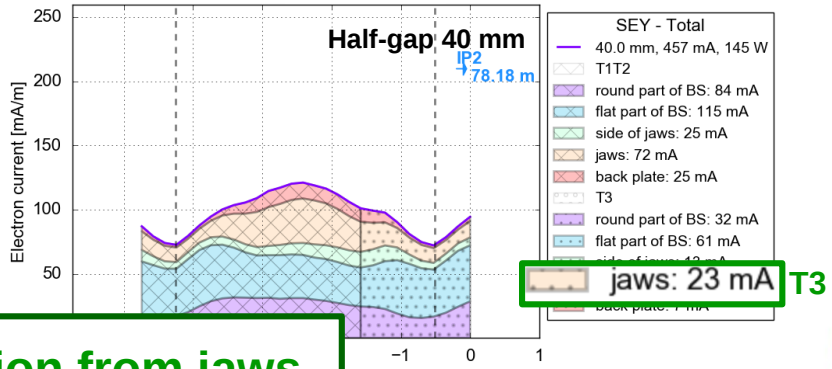


From Baseline to Coated J3

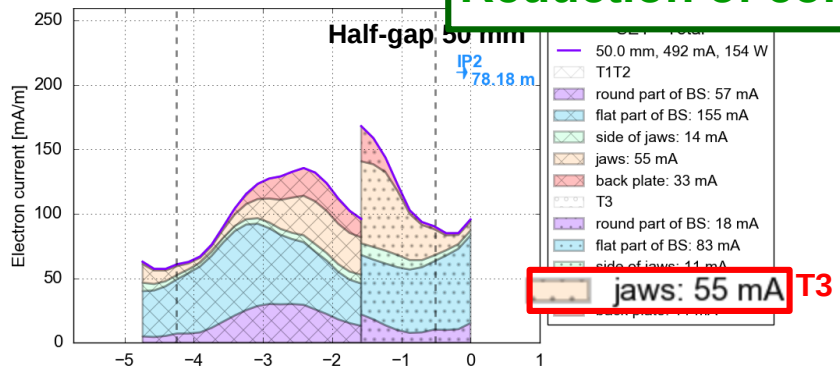


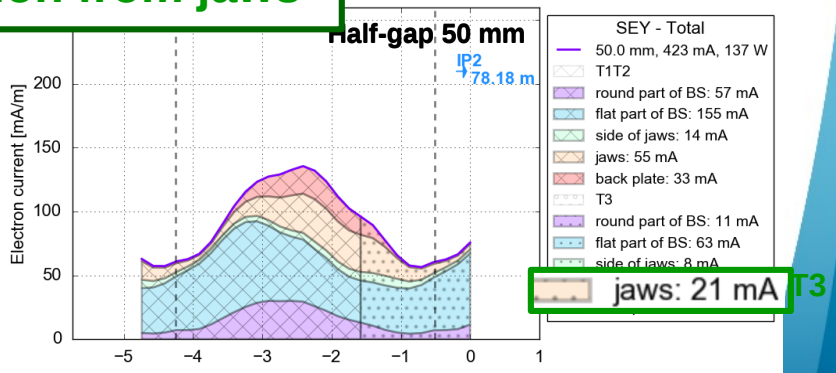




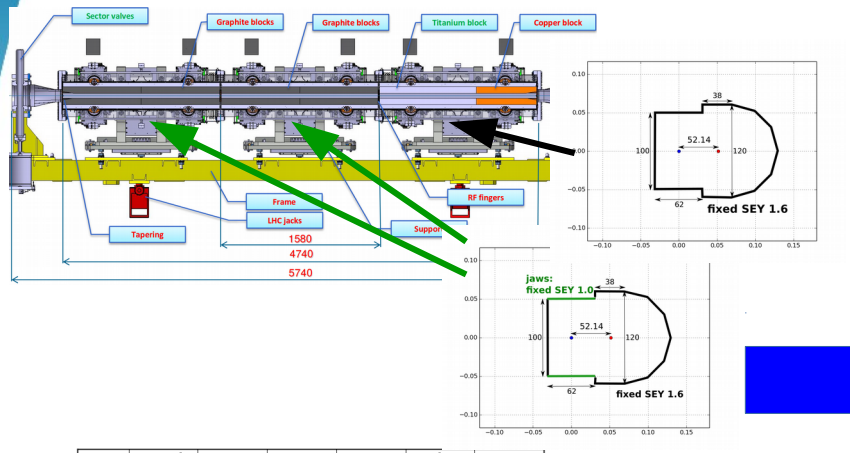


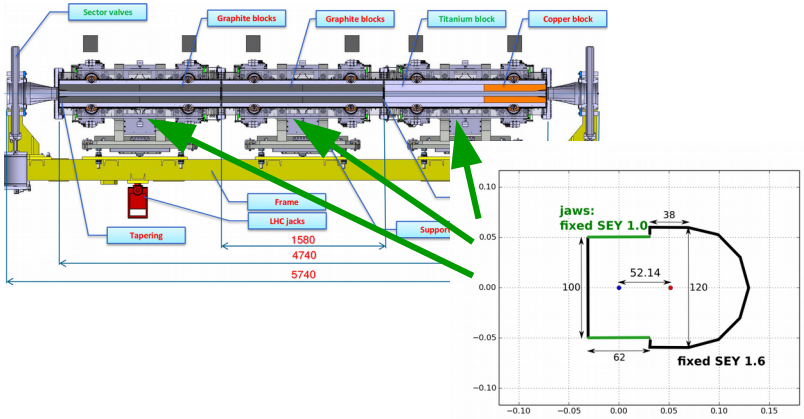
Reduction of contribution from jaws

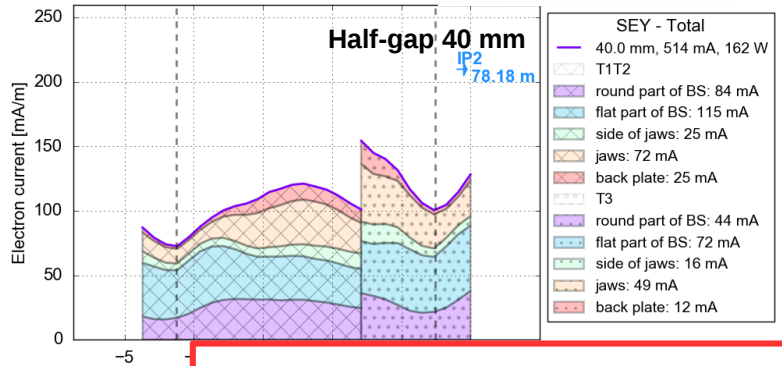


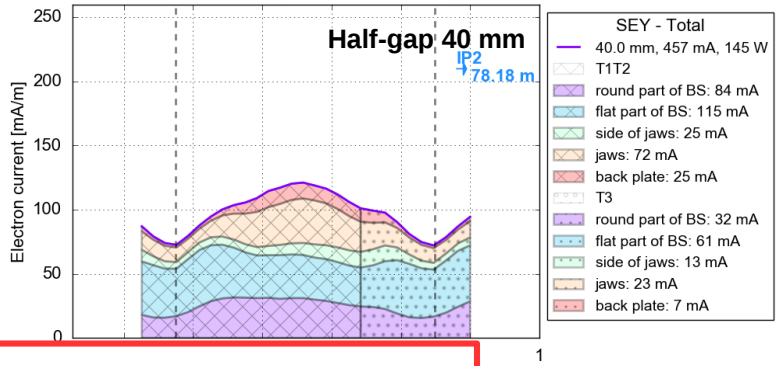


From Baseline to Coated J3

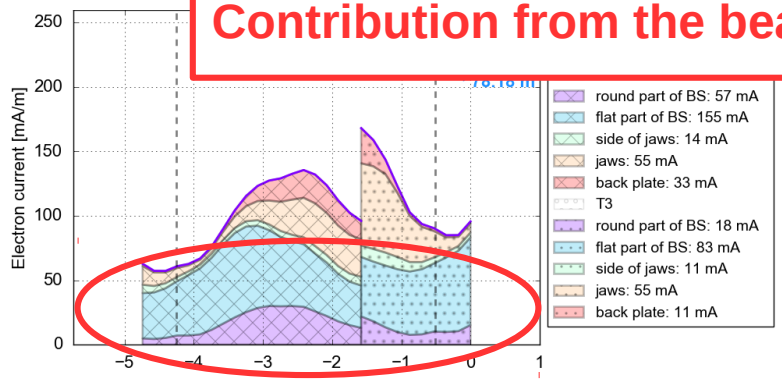


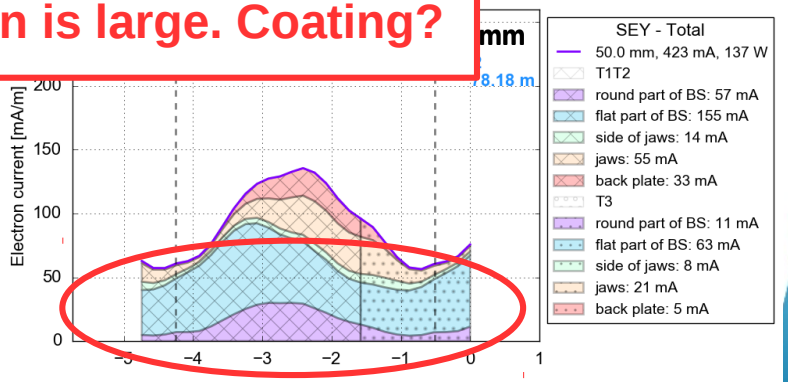






Contribution from the beam screen is large. Coating?

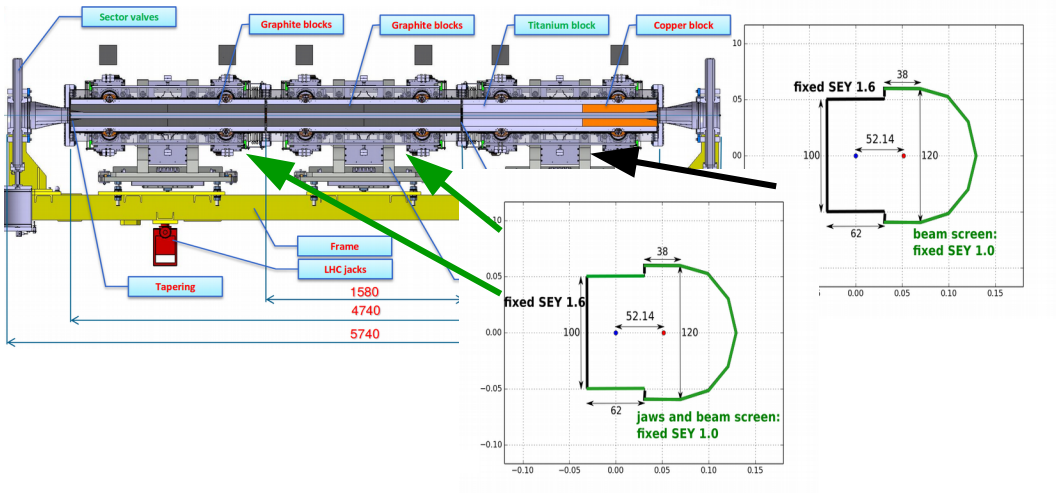




Outline

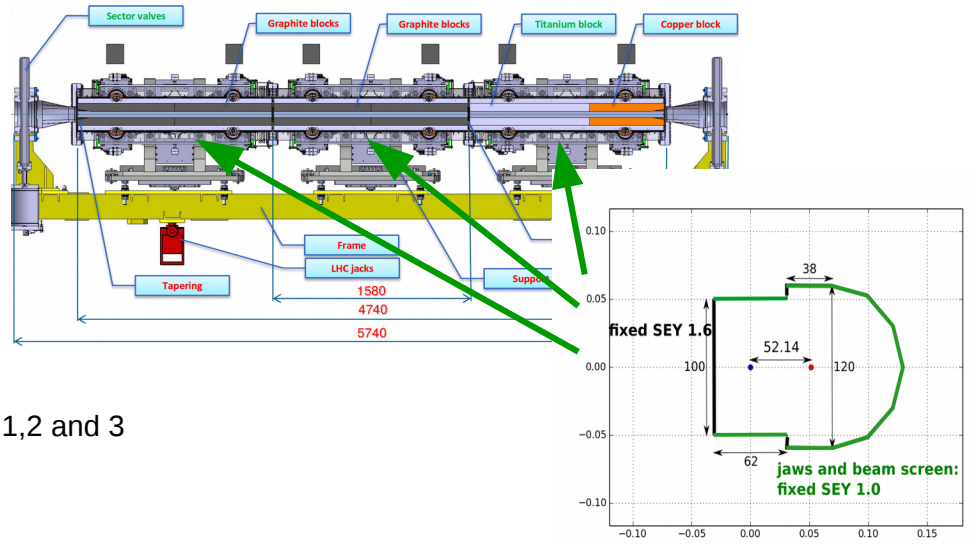
- e-cloud simulation setup: coating scenarios
- e-cloud depending on the TDIS gap and SEY
- e-cloud with nonuniform SEY
  - 2 scenarios
  - contributions from chamber segments
  - beam screen coating suggestion
  - comparison of coating scenarios

Nonuniform SEY: coated beam screen SEY 1.0

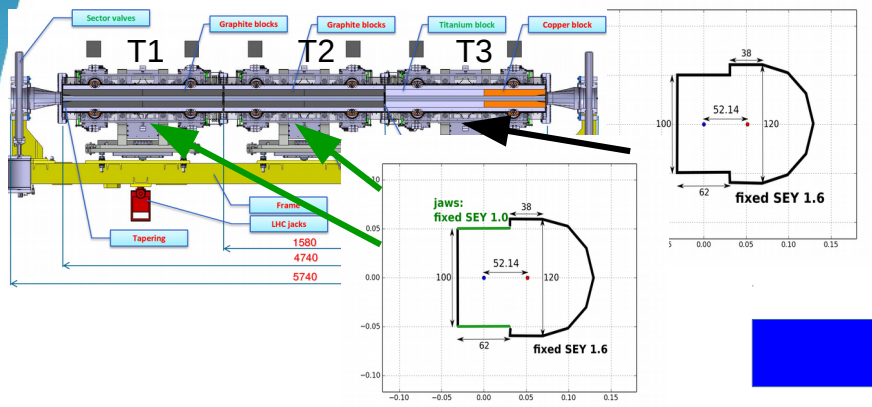


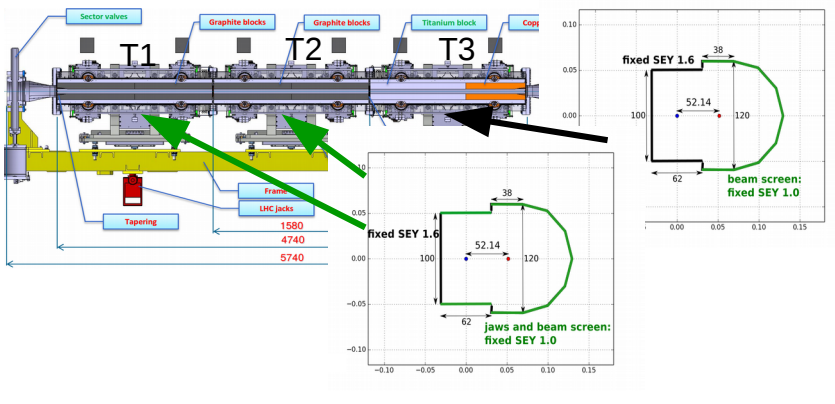
	BP	JS	BS	J1+J2	J3
Baseline and BS	1.6	1.6	1.0	1.0	1.6
Coat J3 and BS	1.6	1.6	1.0	1.0	1.0

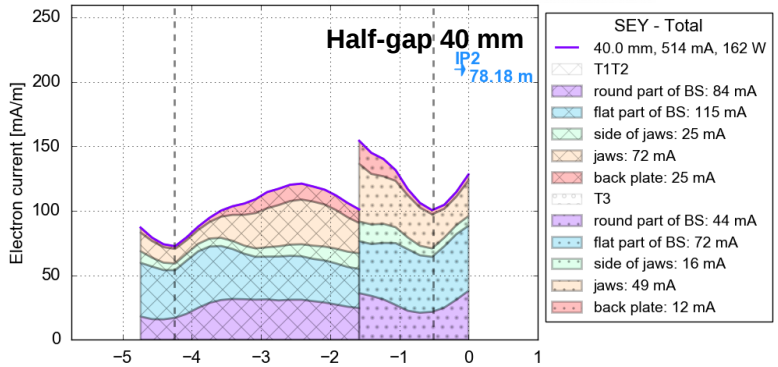
BP – back plate
JS – side of jaws
BS – beam screen
J1/J2/J3 – jaws in tanks 1,2 and 3

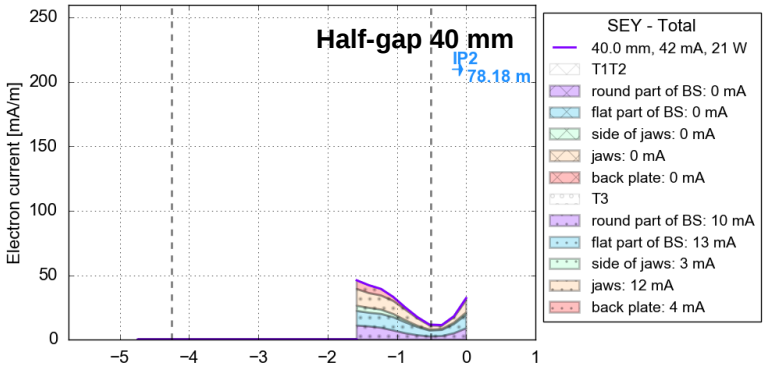


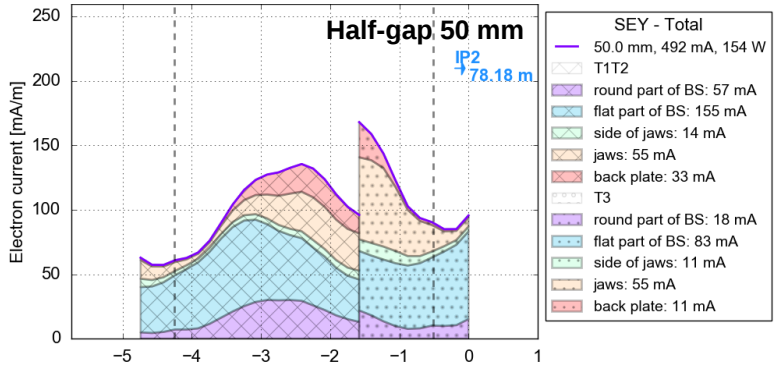
Baseline with coated beam screen

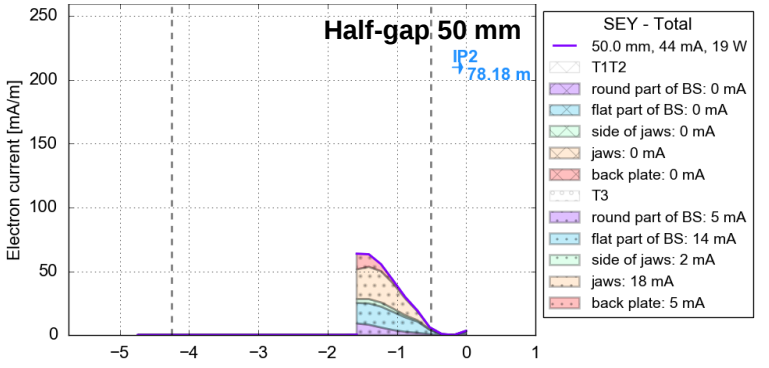




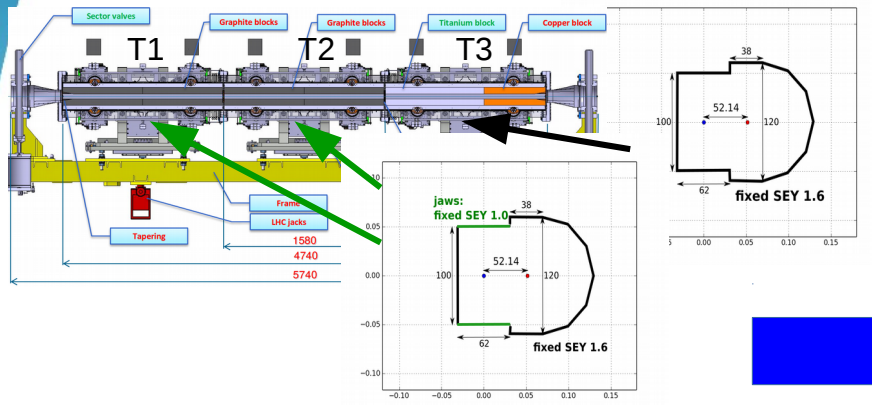


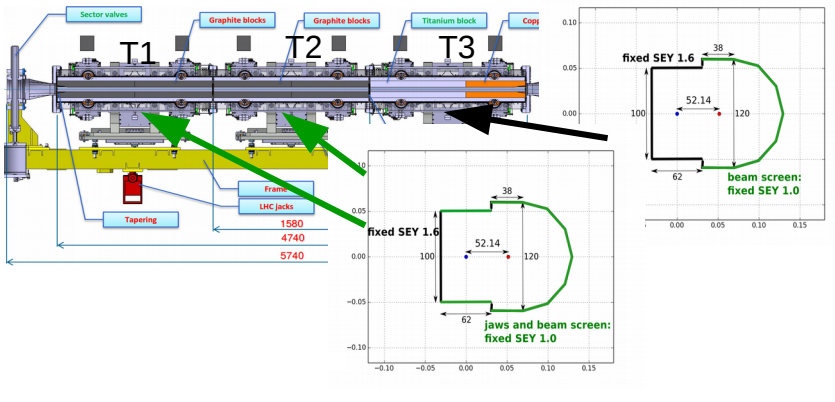


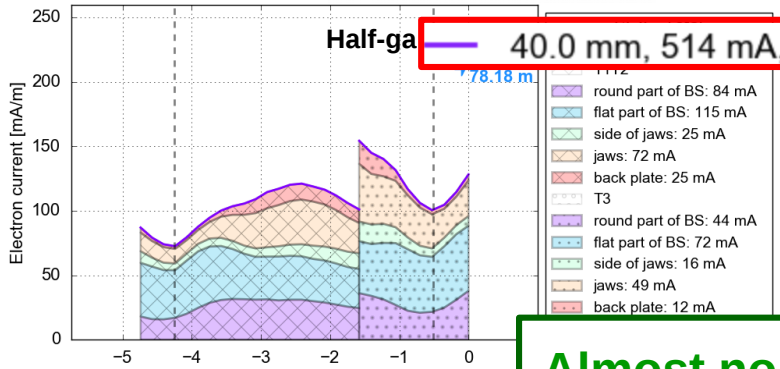


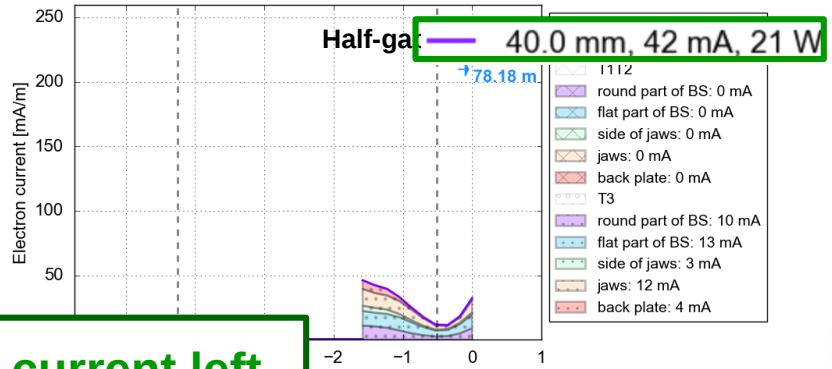


Baseline with coated beam screen

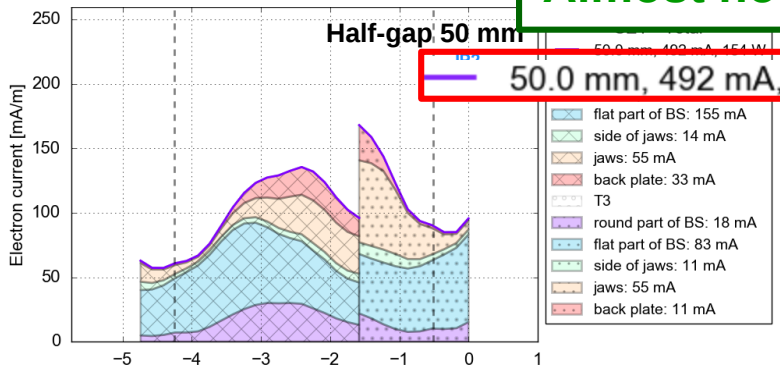


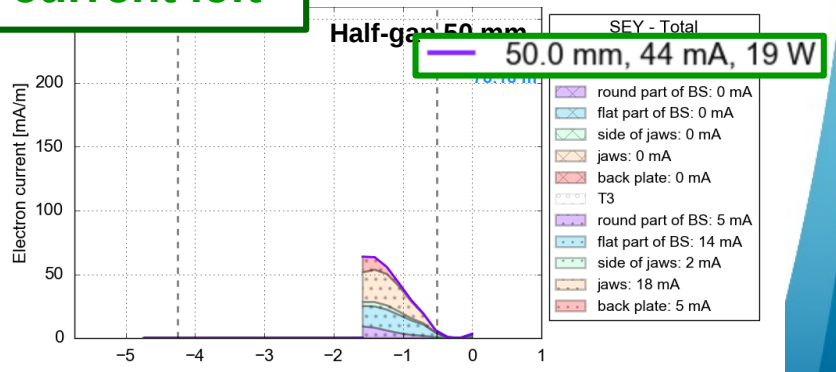




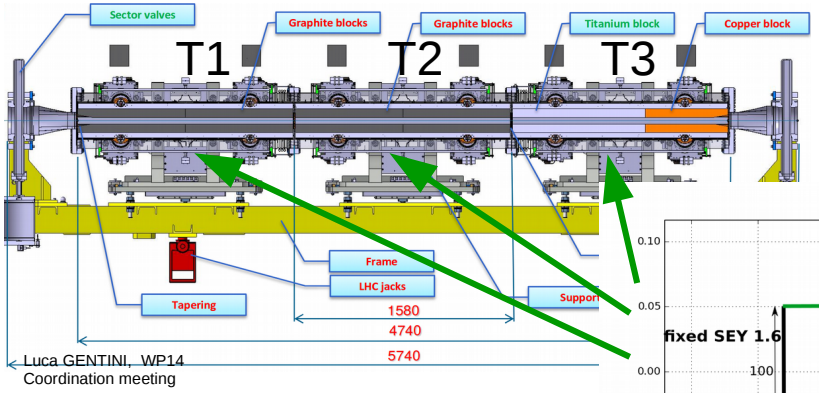


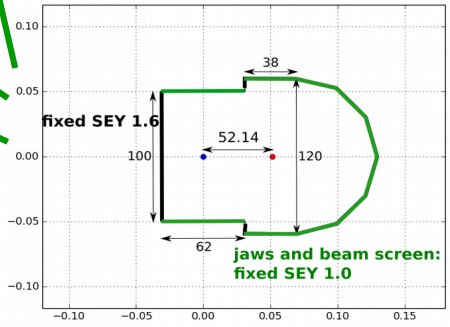
Almost no electron current left





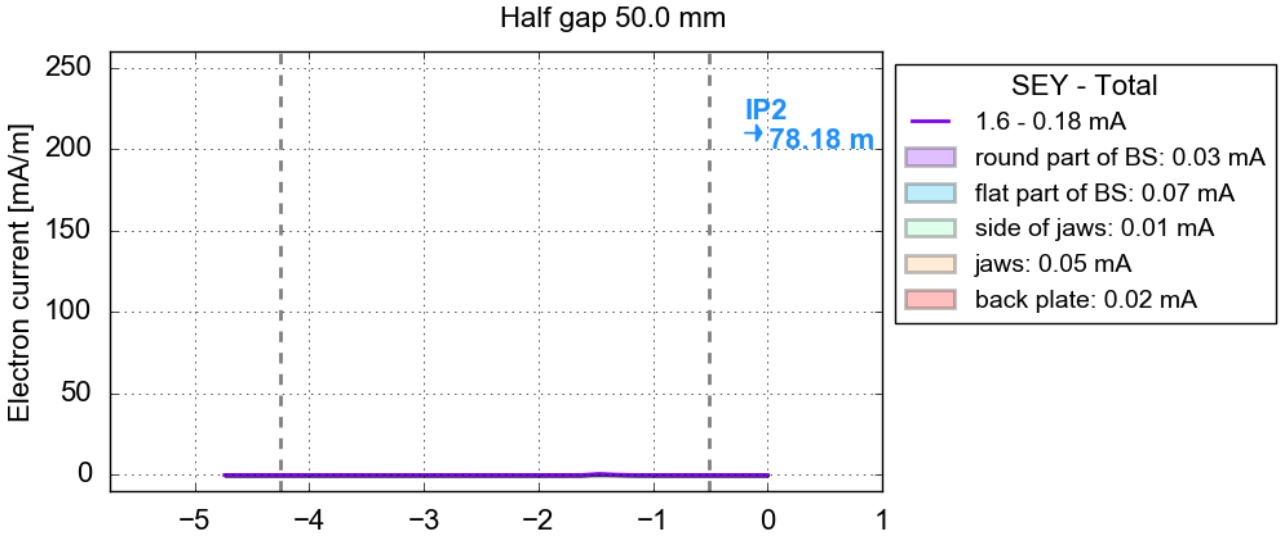
Beam screen and jaws SEY 1.0 in all tanks





If both **beam screen and jaws in T3** are coated with **SEY 1.0**:

NO e-CURRENT



Outline

- e-cloud simulation setup: coating scenarios
- e-cloud depending on the TDIS gap and SEY
- e-cloud with nonuniform SEY
  - 3 scenarios
  - contributions from chamber segments
  - beam screen coating suggestion
  - comparison of coating scenarios

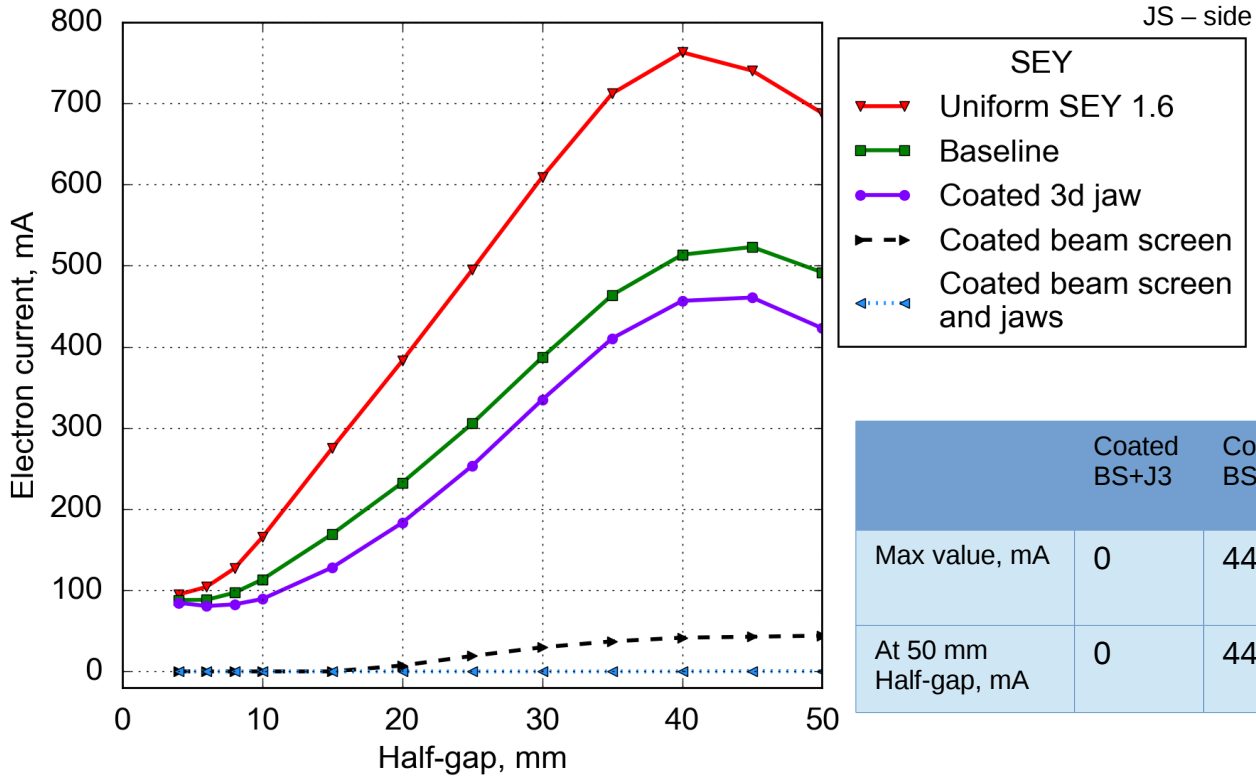
Total electron current vs half-gap

- Electron flux on the walls increases for large gaps
- Maximum is reached at half-gaps ~40 mm
- Coating the jaws in tank 3 allows gaining ~30% (50 mm half-gap)
- Coating the beam screen lowers the current by one order of magnitude and kills multipacting at small gaps

SEY table

	BP	JS	BS	J1+J2	J3
uniform	1.6	1.6	1.6	1.6	1.6
baseline	1.6	1.6	1.6	**1.0**	1.6
coat j3	1.6	1.6	1.6	**1.0**	**1.0**
coat BS	1.6	1.6	**1.0**	**1.0**	1.6
coat BS+j3	1.6	1.6	**1.0**	**1.0**	**1.0**

BP – back plate
JS – side of jaws
BS – beam screen
J1/J2/J3 – jaws in tanks 1,2,3



	Coated BS+J3	Coated BS	Coated J3	Baseline	Uni SEY 1.6
Max value, mA	0	44	457	514	747
At 50 mm Half-gap, mA	0	44	423	492	657

Summary

We simulated the e-cloud in the presence of both beams in the TDIS assuming:

- Different gaps: 1-50 mm
- Uniform SEY: 1.0-1.6

Electron flux on the walls increases for large gaps:

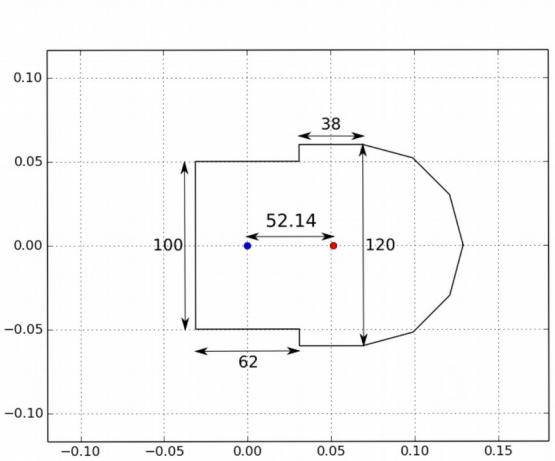
- e-cloud builds up mainly from the surface of the jaws and on the flat parts of the beam screen at locations where two beams are not synchronized
- In between LREs the back plate, side of the jaws and round part of the beam screen also contribute to e-cloud build-up
- Multipacting threshold very high for small gaps and decreasing when the jaws are opened

With nonuniform SEY:

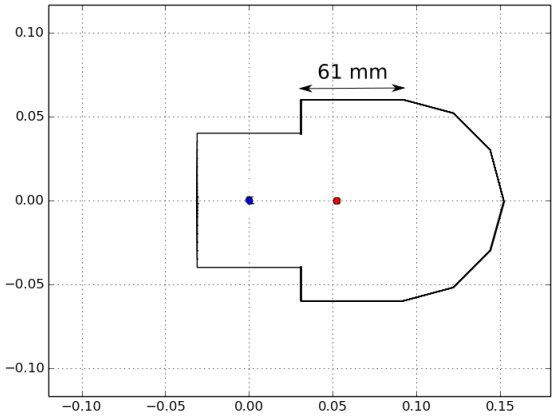
- Simulating realistic Graphite jaws showed that the current on the jaws is 30% smaller than in the uniform 1.6 SEY case
- If coating the Cu+Ti jaws in the 3d tank the electron current is reduced by 15% at half-gap of 50 mm
- Coating the beam screen lowers the total current and heat load by order of magnitude where Cu-Ti jaws become the largest contributor
- **Coating both the beam screen and the Cu+Ti jaws brings electron current to zero**

New beam screen geometry

Longer flat part of beam screen



Flat part of BS:
38 mm → 61 mm

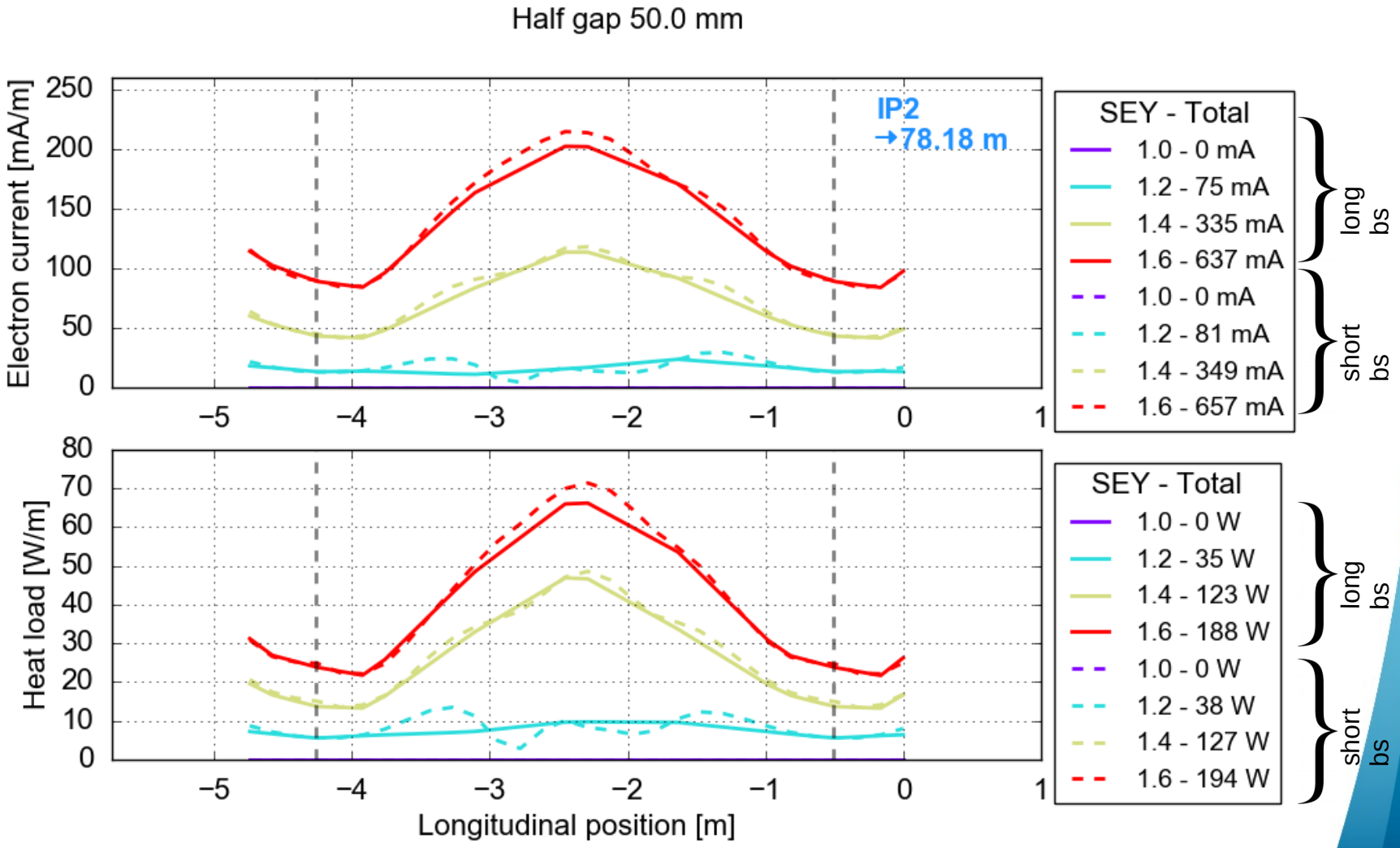


Reduced set of simulations

- Beam parameters: 450GeV, 25 ns, 2.2e11 p/bunch
- Two counter-rotating beams (simulated different transverse slices of the device)
  - reduced number of points along the device
- Half-gap scan: 1 - 50 mm
  - reduced number of gaps
- SEY scan: 1.0 – 1.6 with 0.2 step

Longitudinal current/heat profiles (uniform SEY)

- Less than 5% difference in current and heat load



Longitudinal current/heat profiles (uniform SEY)

- Less than 5% difference in current and heat load