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# Update on Rectilinear Cooling Lattice

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# Lattice of the before-merging section



## ➤ Cooling cells parameters (baseline)

[Update on the Rectilinear Cooling Lattice – Annual meeting 2024](#)

|  | Stage 1 | Stage 2 | Stage 3 | Stage 4 |
|--|---------|---------|---------|---------|
| Cell length (m)                            | 1.8     | 1.2     | 0.8     | 0.7     |
| Number of cells                            | 58      | 89      | 81      | 149     |
| Stage length (m)                           | 104.4   | 106.8   | 64.8    | 104.3   |
| Pipe radius (cm)                           | 30      | 25      | 15      | 13      |
| $B_{z,max}$ (T)                            | 2.5     | 3.7     | 5.7     | 7.2     |
| Solenoid coil length (mm)                  | 286.6   | 232.8   | 244.6   | 217.2   |
| Solenoid coil inner-radius (mm)            | 400     | 400     | 200     | 190     |
| Solenoid coil thickness (mm)               | 150     | 150     | 125     | 125     |
| Solenoid coil current (A/mm <sup>2</sup> ) | 57.6    | 149.5   | 131.5   | 193.2   |
| Transverse beta $\beta_T$ (cm)             | 70      | 45      | 30      | 23      |
| Dispersion (mm)                            | 60      | 57      | 40      | 30      |
| On-axis wedge length (cm)                  | 14.5    | 10.5    | 15      | 6.5     |
| Wedge apex angle (deg)                     | 45      | 60      | 100     | 70      |
| Wedge window thickness ( $\mu$ m)          | 100     | 100     | 100     | 100     |
| RF frequency (MHz)                         | 352     | 352     | 704     | 704     |
| Number of RFs                              | 6       | 4       | 5       | 4       |
| RF length (cm)                             | 19      | 19      | 9.5     | 9.5     |
| Maximum RF gradient (MV/m)                 | 25.8    | 25.8    | 31.4    | 31.7    |
| RF phase (deg)                             | 18.5    | 23.2    | 23.7    | 25.7    |
| RF inner-radius (mm)                       | 326.2   | 326.2   | 163.1   | 163.1   |
| RF iris-radius (mm)                        | 300     | 250     | 150     | 130     |
| RF window thickness ( $\mu$ m)             | 50      | 50      | 50      | 50      |

$$R_{iris} = R_{pipe}$$

$$R_{iris} \leq 0.5 \cdot R_{inner}$$

➤ Baseline: 300 mm + 250 mm + 150 mm + 130 mm

|         | $\epsilon_T$ (mm) | $\epsilon_L$ (mm) | $\epsilon_{6D}$ (mm <sup>3</sup> ) | Transmission | Length (m) | Cells # |
|---------|-------------------|-------------------|------------------------------------|--------------|------------|---------|
| Start   | 17.1              | 45.9              | 13500                              |              |            |         |
| Stage 1 | 5.46              | 18.9              | 567                                | 77.1%        | 104.4      | 58      |
| Stage 2 | 2.71              | 7.39              | 55.5                               | 85.8%        | 106.8      | 89      |
| Stage 3 | 1.68              | 4.02              | 11.6                               | 87.0%        | 64.8       | 81      |
| Stage 4 | 1.34              | 1.75              | 3.44                               | 91.3%        | 104.3      | 149     |

➤ Reduced: 280 mm + 160 mm + 100 mm + 70 mm

|                | $\epsilon_T$ (mm) | $\epsilon_L$ (mm) | $\epsilon_{6D}$ (mm <sup>3</sup> ) | Transmission | Length (m)  | Cells #    |
|----------------|-------------------|-------------------|------------------------------------|--------------|-------------|------------|
| Start          | 17.1              | 45.9              | 13500                              |              |             |            |
| Stage 1        | 5.21              | 17.7              | 483                                | 75.1%        | 104.4       | 58         |
| Stage 2        | 2.45              | 6.65              | 40.6                               | 84.3%        | 106.8       | 89         |
| Stage 3        | 1.55              | 3.69              | 9.07                               | 86.3%        | 64.8        | 81         |
| Stage 4        | 1.27              | 2.02              | 3.45                               | 93.6%        | 64.4        | 92         |
| <b>Stage 4</b> | <b>1.26</b>       | <b>1.75</b>       | <b>2.96</b>                        | <b>92.1%</b> | <b>81.9</b> | <b>117</b> |

- **Same  $\epsilon_{6D}$ :**  
 ~1.4% transmission loss  
 ~10% channel length reduction  
 ~15% number of cells reduction

- **Same  $\epsilon_L$ :**  
 ~2.2% transmission loss  
 ~6% channel length reduction  
 ~9% number of cells reduction



# Transmission vs pipe radius (same $\epsilon_{6D}$ )



## ➤ Stage 1

|                     |        |        |        |        |
|---------------------|--------|--------|--------|--------|
| <b>Pipe radius</b>  | 300 mm | 280 mm | 260 mm | 240 mm |
| <b>Transmission</b> | 77.1%  | 76.1%  | 73.6%  | 69%    |

## ➤ Stage 2

|                     |        |        |        |        |
|---------------------|--------|--------|--------|--------|
| <b>Pipe radius</b>  | 250 mm | 190 mm | 160 mm | 130 mm |
| <b>Transmission</b> | 85.8%  | 85.8%  | 84.2%  | 75%    |

## ➤ Stage 3

|                     |        |        |        |       |       |
|---------------------|--------|--------|--------|-------|-------|
| <b>Pipe radius</b>  | 150 mm | 110 mm | 100 mm | 90 mm | 80 mm |
| <b>Transmission</b> | 87%    | 86.2%  | 85.5%  | 82.4% | 75.9% |

## ➤ Stage 4

|                     |        |        |       |       |       |
|---------------------|--------|--------|-------|-------|-------|
| <b>Pipe radius</b>  | 130 mm | 100 mm | 80 mm | 70 mm | 60 mm |
| <b>Transmission</b> | 91.3%  | 91.3%  | 91.3% | 91.3% | 79.2% |