RF DESIGN OF A NOVEL BACKWARD TRAVELLING WAVE LINAC FOR PROTON THERAPY

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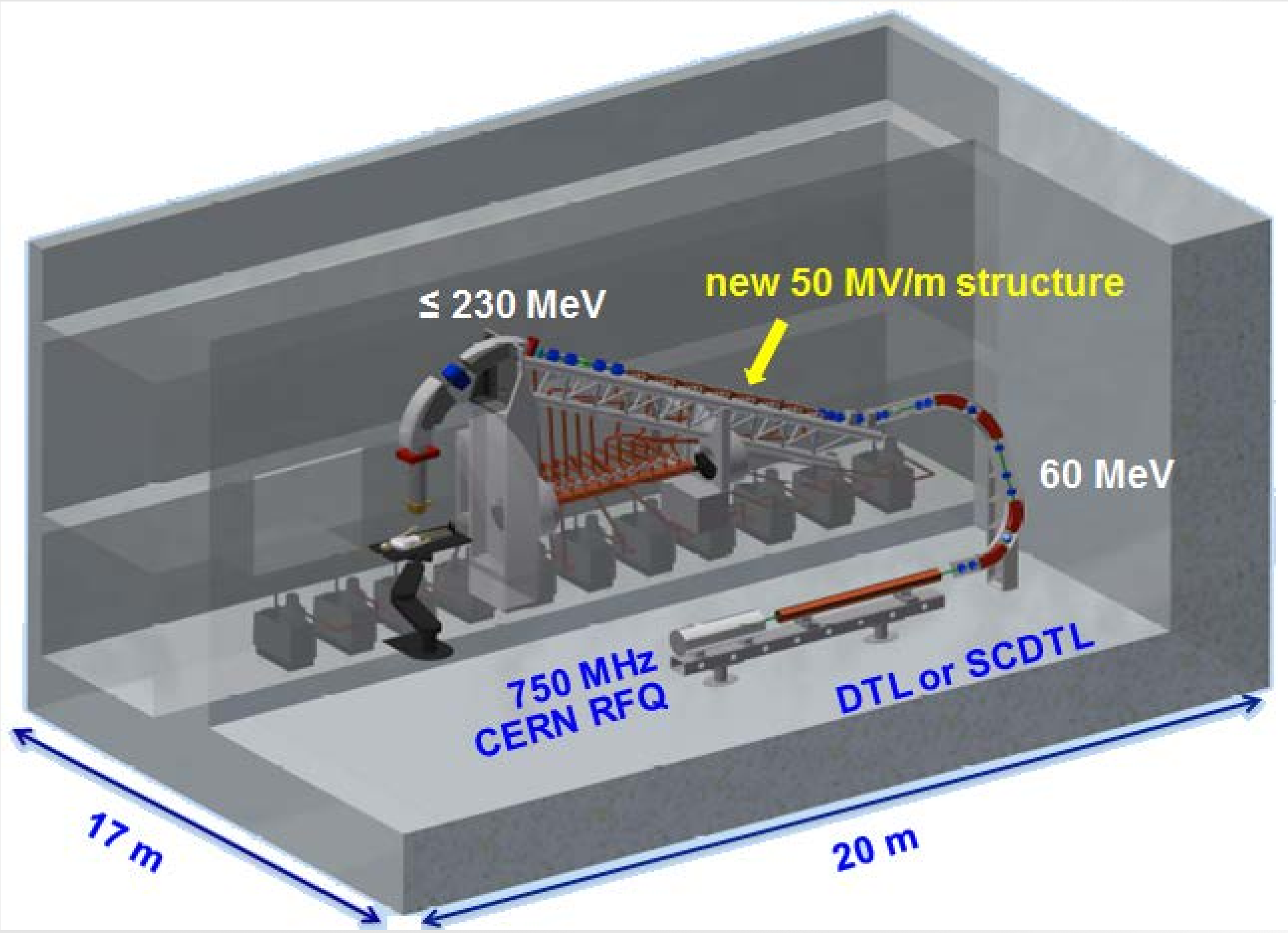
A single room protontherapy facility has been designed by TERA Foundation at CERN in collaboration with the CLIC group.



A linac based proton therapy facility

Design the prototype of a high gradient 3 GHz proton accelerator operating in a backward travelling wave mode with 5π/6 phase advance

GOALS AND CONSTRAINTS

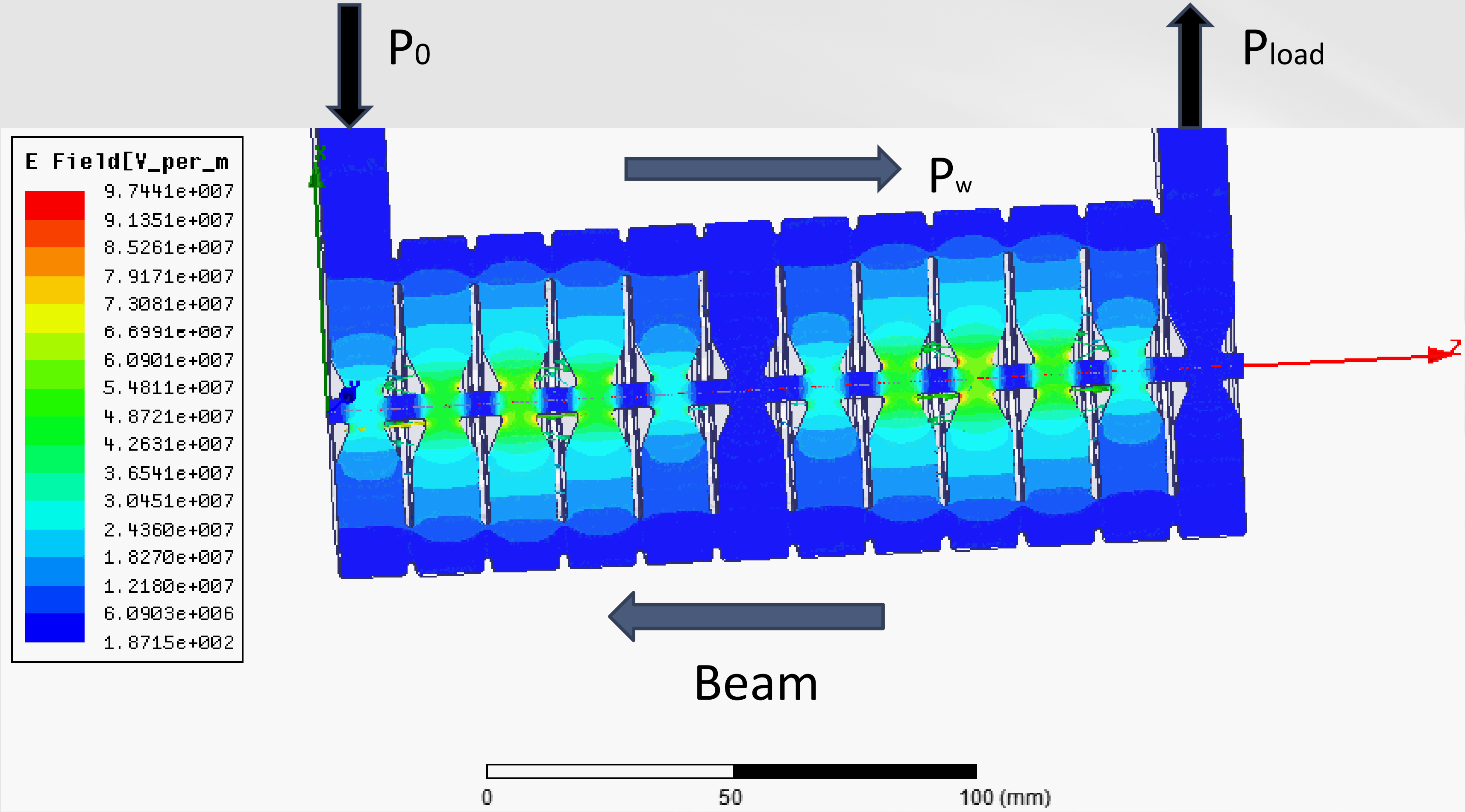
- $\boldsymbol{E_a = E_0 T \geq 50\ MV/m}$ ⟹ **COMPACT SIZE**
- $\boldsymbol{S_c/E_a^2 < 7 \cdot 10^4\ A/V}$ * ⟹ **ACCEPTABLE BDR**

* Scaled values from:

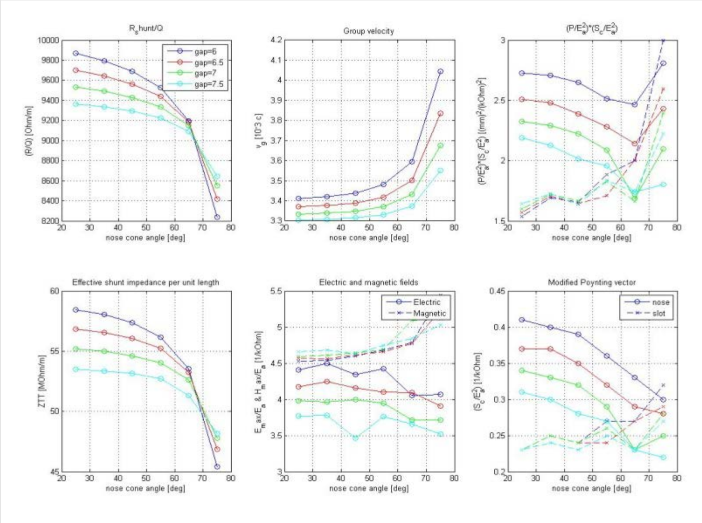
$$\frac{S_c^{15} \cdot t_{\text{pulse}}^5}{BDR} = const.$$

with:
$S_c < 4\ \text{MW/mm}^2$
$t_{\text{TERA}} = 2500\ \text{ns}$
$t_{\text{CLIC}} = 200\ ns$
$BDR = 10^{-6}\ bpp/m$

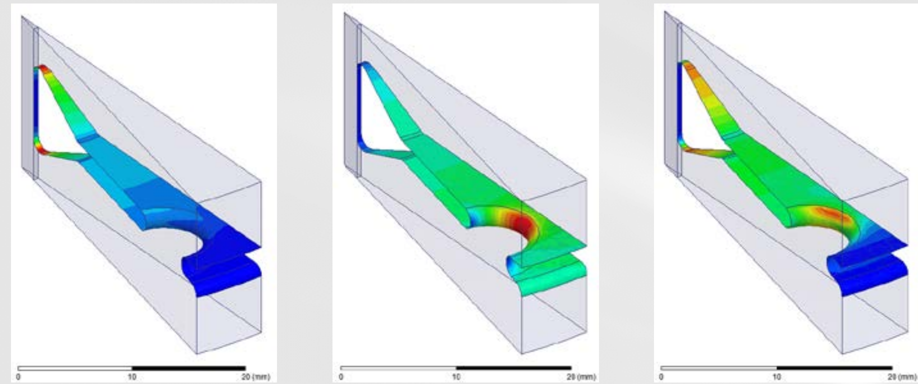
Project summary and goals



A backward travelling wave structure



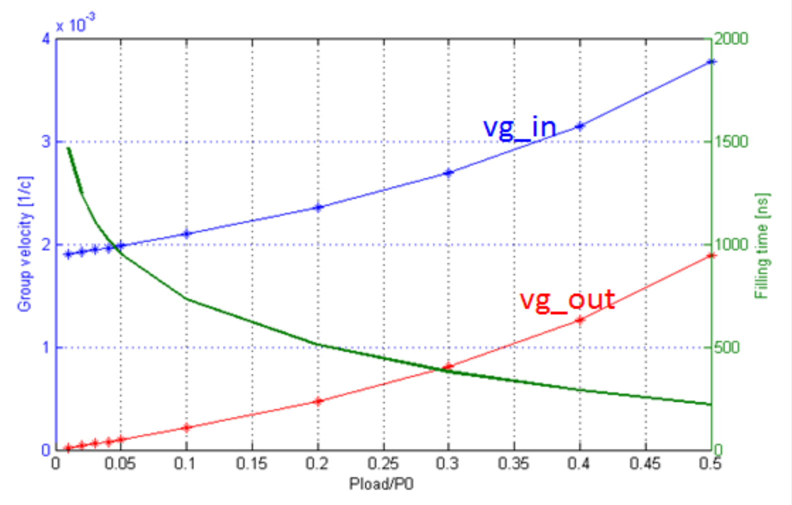
E **H** **Sc**

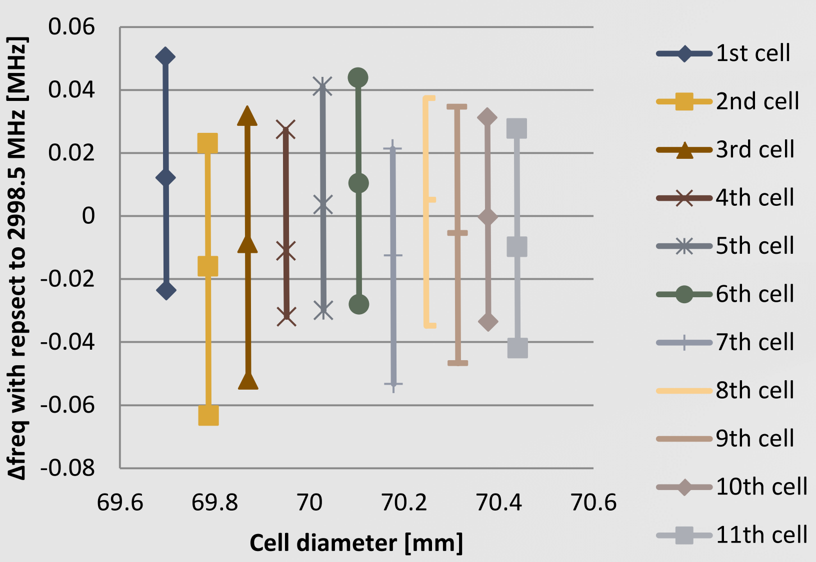


Fixed geometry parameters	
Iris thickness [mm]	2.0
Gap [mm]	7.0
Nose cone angle [°]	65
Bore radius [mm]	2.5
Nose inner radius [mm]	1.0
Nose outer radius [mm]	2.0
Corner inner radius [mm]	1.0
Corner outer radius [mm]	1.0
Number of cell	12
Cell length [mm]	15.82

Averaged accelerating parameters	
Frequency [GHz]	2.9985
Q	7194
Rshunt/Q [MΩ/m]	7394
ZTT [MΩ/m]	53.2
vg [‰c]	2.926
Es/Ea	3.86
Hs/Ea [1/kΩ]	4.64
Sc/Ea^2 nose[1/kΩ]	0.26
Sc/Ea^2 slot [1/kΩ]	0.25

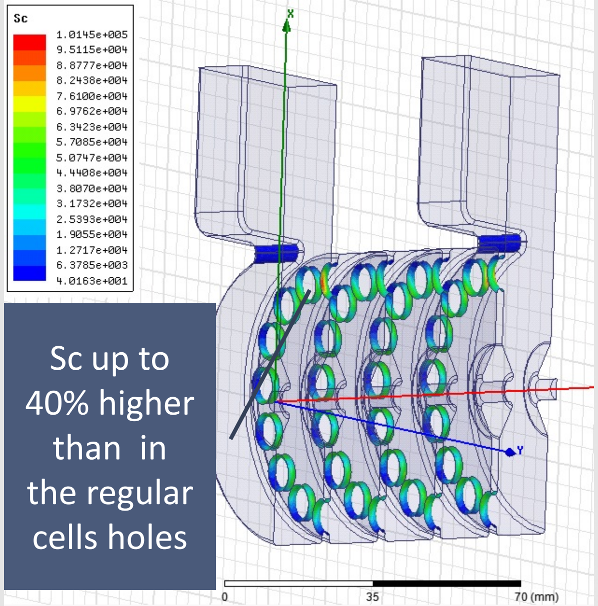
Regular cell design





- *Constant-gradient* structure
- Tapering accomplished by means of coupling hole radii reduction from cell to cell
- Group velocity ranging between 0.4% and 0.2% of c in the structure
- Cell diameter adjusted accordingly in order to maintain the resonant frequency of 2.9985 GHz

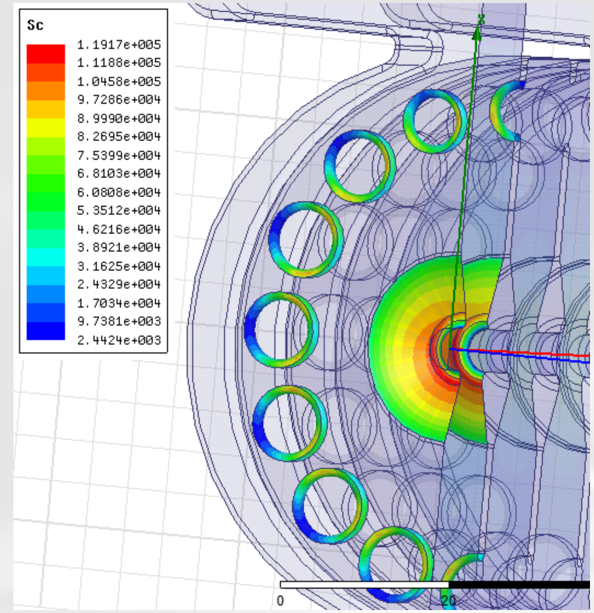
Tapering



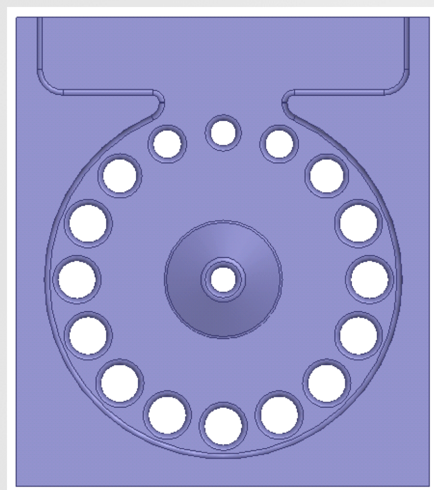
Sc up to 40% higher than in the regular cells holes

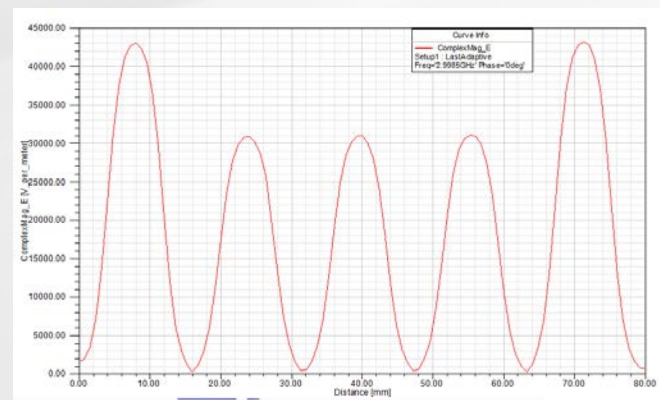
By reducing the coupling holes radius closer to the coupling slot the problem is solved

But we affect the vg, so the Ez

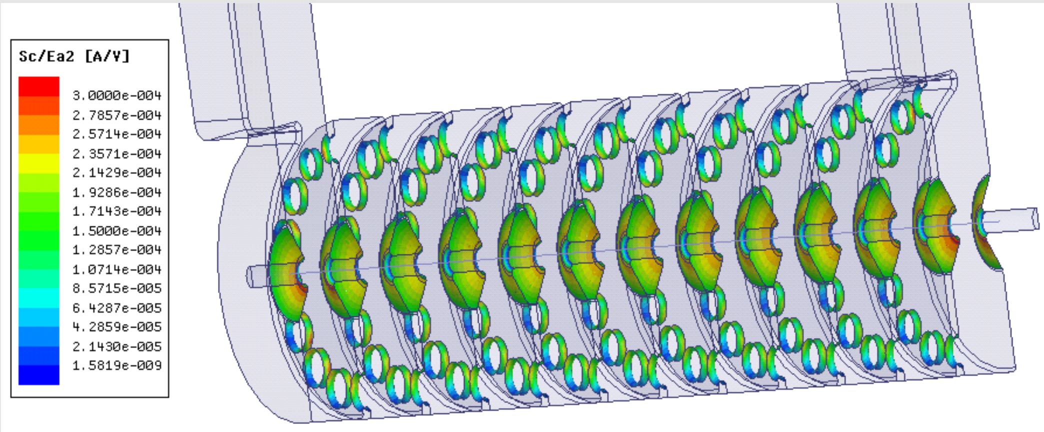


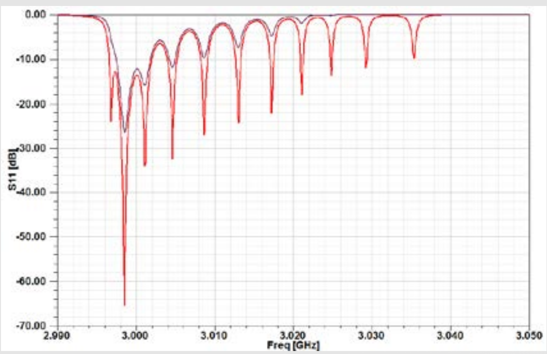
- **Particular effort dedicated to the input coupler design**
- **Asymmetric design of the coupling hole radii to compensate for local enhancement of Sc**

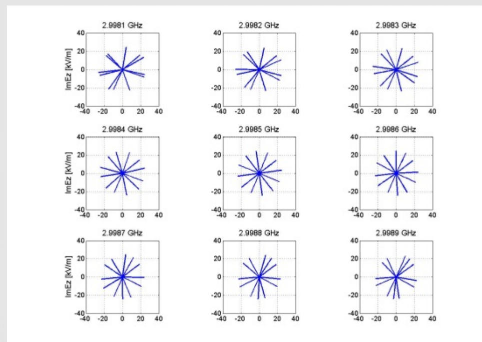


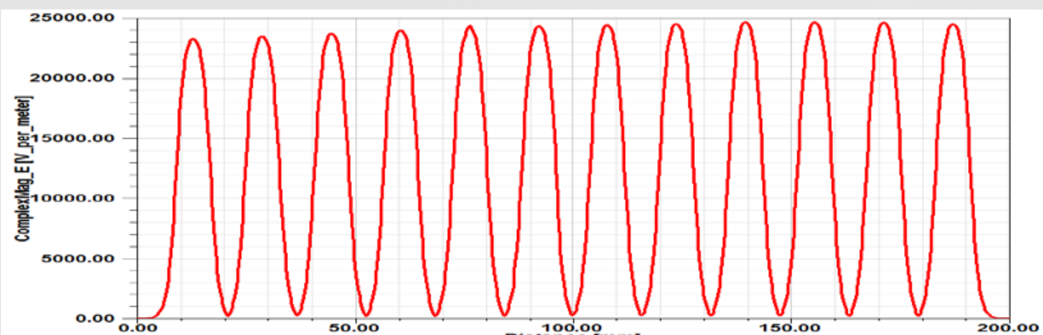


Couplers design









- The S_c/E_a^2 constraint has been widely respected
- A reflection lower than -50 dB at the resonant frequency of 2.9985 GHz has been reached
- Even electric field profile along the structure
- Phase advance of $5\pi/6$ at the chosen operating frequency

Main results and conclusions

Thank you for your attention!

…and see you in few minutes at poster 61

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