# Tuning FLASH for high beam currents

# PLAN-A: Keep FLASH as it is

- Keep Ql's around 3e6, and Pk's as described in excel sheet (flash_wg_20100214.xls)
- Flat without beam
- Tilt with beam
- With 3mA of beam loading
  - Tilts range from -10.6% to 4.5%
  - Cavities quench or very close to quench limit
  - Shortening the pulse won't help with <1% tilt
    - (eg. 100 usec pulse still shows 2% tilts)
  - Changing tinj won't help
    - (eg -50 usec changed tilt from -1.88 to -1.85 MV/m)
- Only solution (if no Ql change) is lowering power

# PLAN-A: Keep FLASH as it is

| ACC6 | 24.56 MV/m | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pin [MW] | 1.8 | | | | | | | |
| | | | | | | | | |
| Qext | 2.95 | 2.97 | 3.00 | 2.98 | 3.00 | 2.98 | 2.99 | 2.98 |
| A [dB] | 7.85 | 7.54 | 8.16 | 8.31 | 12.27 | 12.03 | 10.28 | 10.37 |
| Pcav [kW] | 312 | 335 | 290 | 280 | 113 | 119 | 178 | 174 |
| Ecav (end of fill) [MV/m] | 29.70 | 30.74 | 28.56 | 28.11 | 17.80 | 18.32 | 22.39 | 22.18 |
| Ecav (end of flat) [MV/m] | 30.39 | 31.75 | 29.19 | 28.56 | 15.92 | 16.52 | 21.56 | 21.26 |
| Tilt [MV/m] | 0.7 | 1.0 | 0.6 | 0.4 | -1.9 | -1.8 | -0.8 | -0.9 |
| Tilt [%] | 2.3 | 3.3 | 2.2 | 1.6 | -10.6 | -9.8 | -3.7 | -4.1 |
| Ecav, max | 34 | 32 | 34 | 32 | 21 | 21 | 29 | 26 |
| ΔE | 3.61 | 0.25 | 4.81 | 3.44 | 5.08 | 4.48 | 7.44 | 4.74 |
| | cav1 | cav2 | cav3 | cav4 | cav5 | cav6 | cav7 | cav8 |

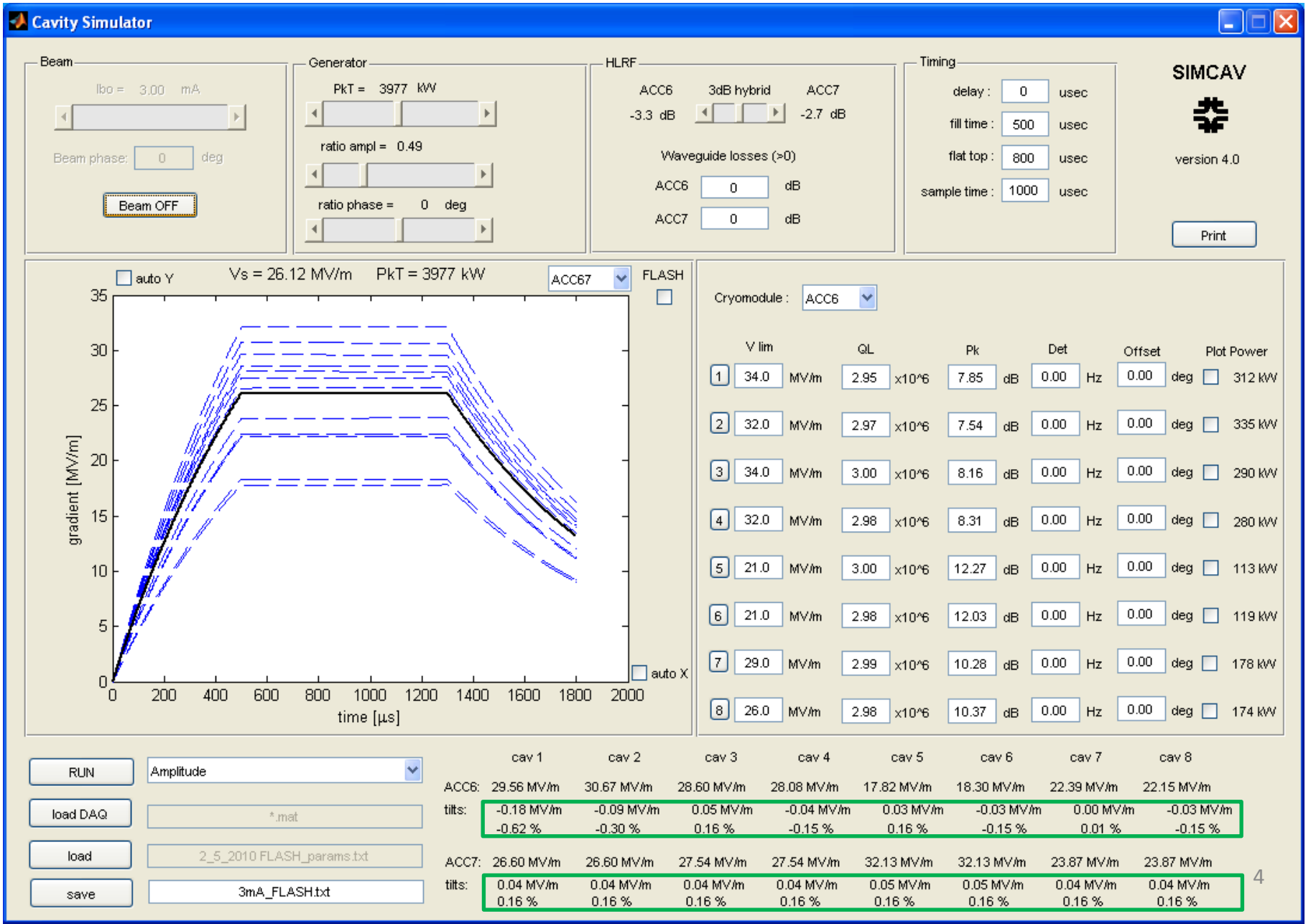
| ACC7 | 27.69 MV/m | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pin [MW] | 2.2 | | | | | | | |
| | | | | | | | | |
| Qext | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| A [dB] | 9.38 | 9.38 | 9.08 | 9.08 | 7.74 | 7.74 | 10.32 | 10.32 |
| Pcav [kW] | 251 | 251 | 269 | 269 | 366 | 366 | 202 | 202 |
| Ecav (end of fill) [MV/m] | 26.57 | 26.57 | 27.50 | 27.50 | 32.09 | 32.09 | 23.84 | 23.84 |
| Ecav (end of flat) [MV/m] | 26.74 | 26.74 | 27.89 | 27.89 | 33.54 | 33.54 | 23.37 | 23.37 |
| Tilt [MV/m] | 0.2 | 0.2 | 0.4 | 0.4 | 1.5 | 1.5 | -0.5 | -0.5 |
| Tilt [%] | 0.6 | 0.6 | 1.4 | 1.4 | 4.5 | 4.5 | -2.0 | -2.0 |
| Ecav, max | 29 | 31 | 34 | 30 | 35 | 39 | 27 | 26 |
| ΔE | 2.26 | 4.26 | 6.11 | 2.11 | 1.46 | 5.46 | 3.63 | 2.63 |
| | cav1 | cav2 | cav3 | cav4 | cav5 | cav6 | cav7 | cav8 |

$I_b$ = 3mA

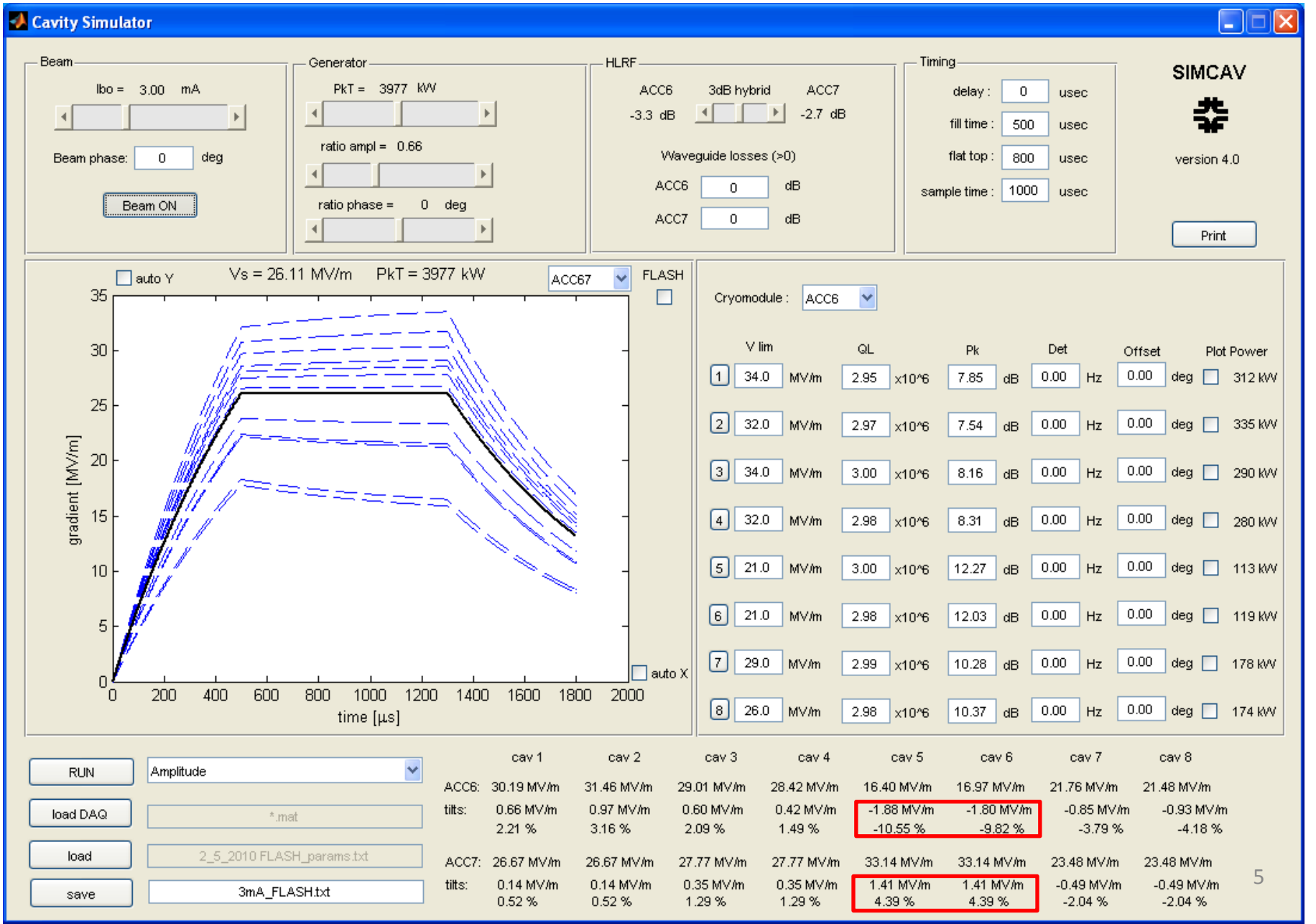
Extreme tilts

Risk of cavity quench

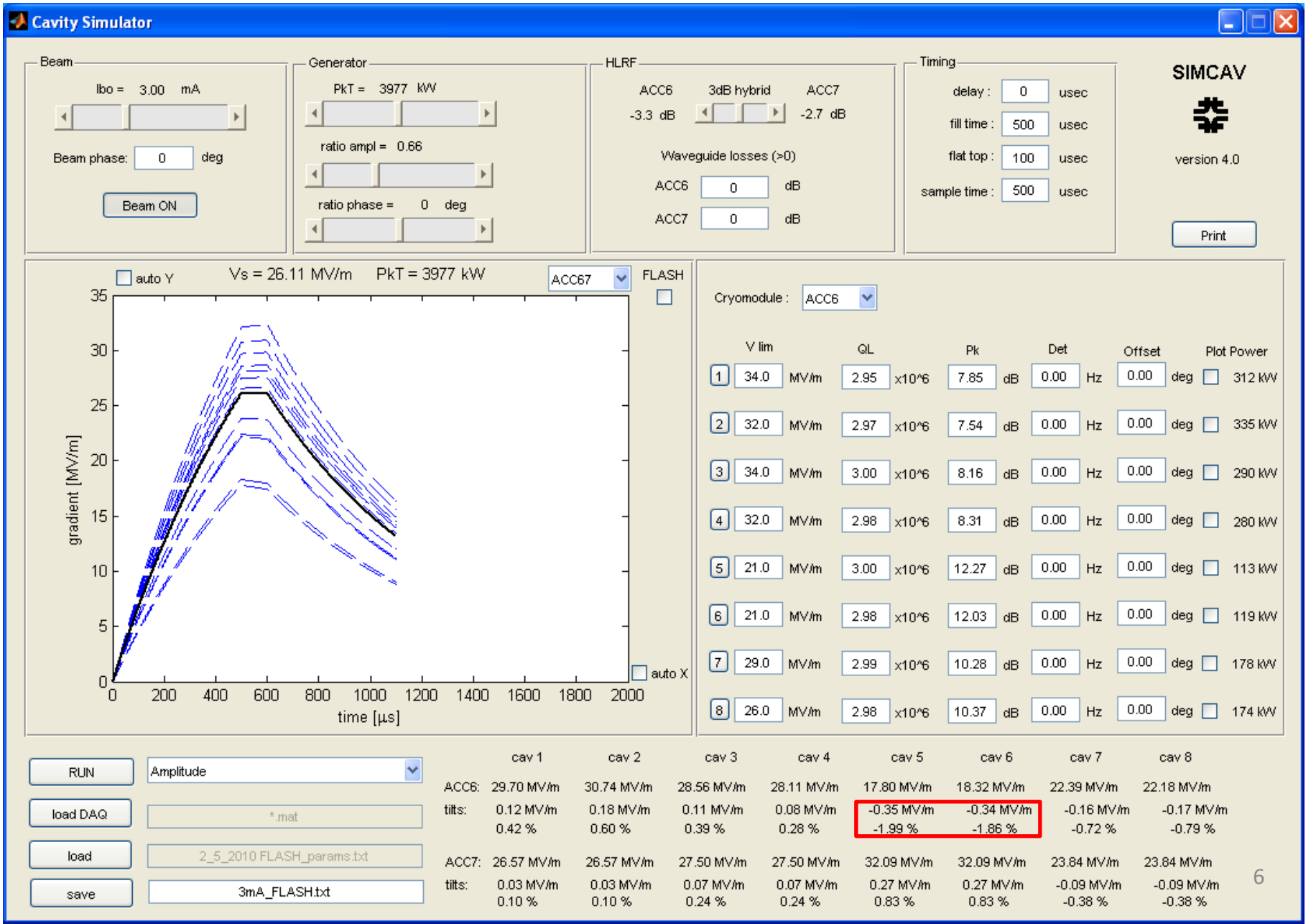
# PLAN-A: Keep FLASH as it is



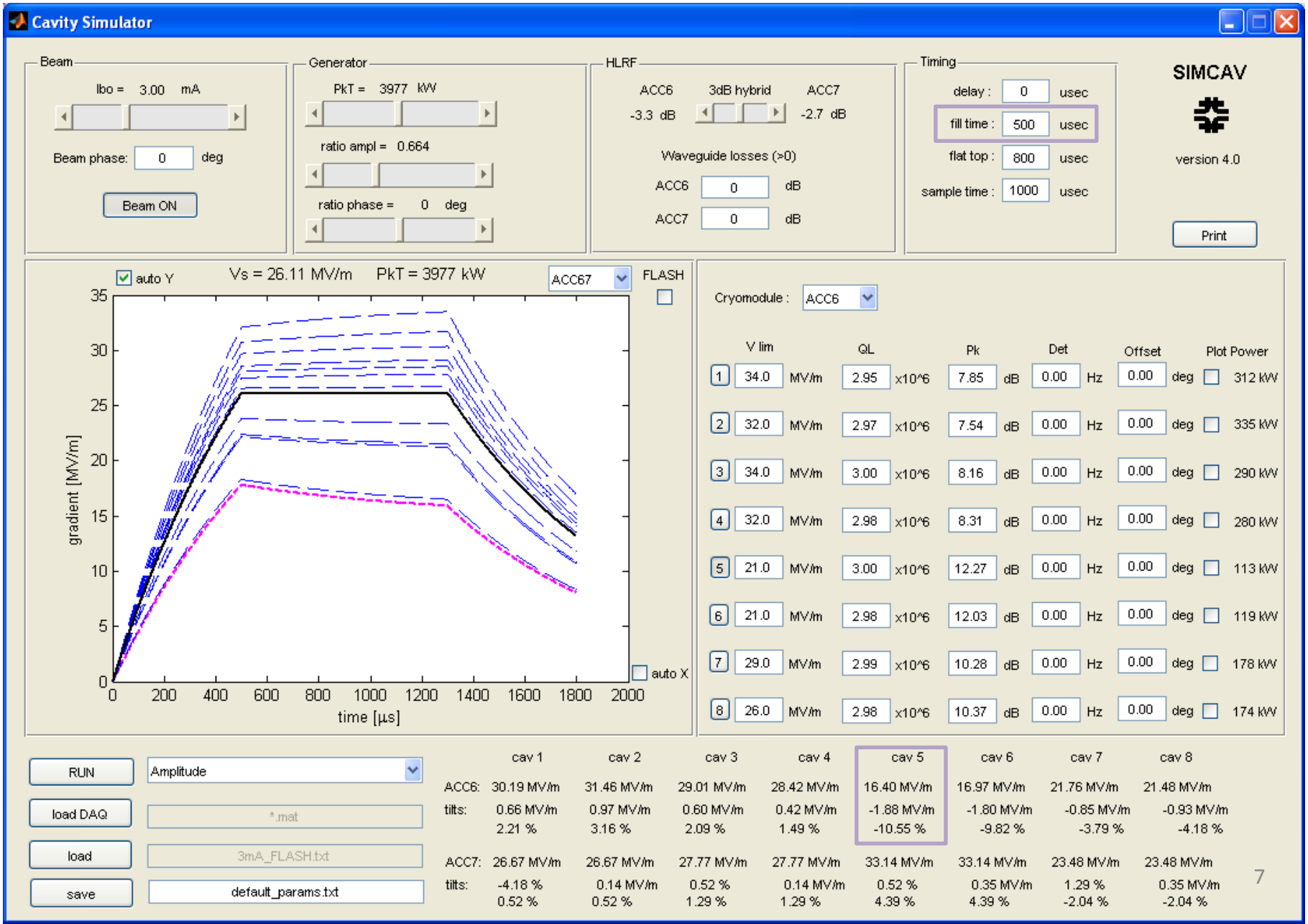
# PLAN-A: Keep FLASH as it is



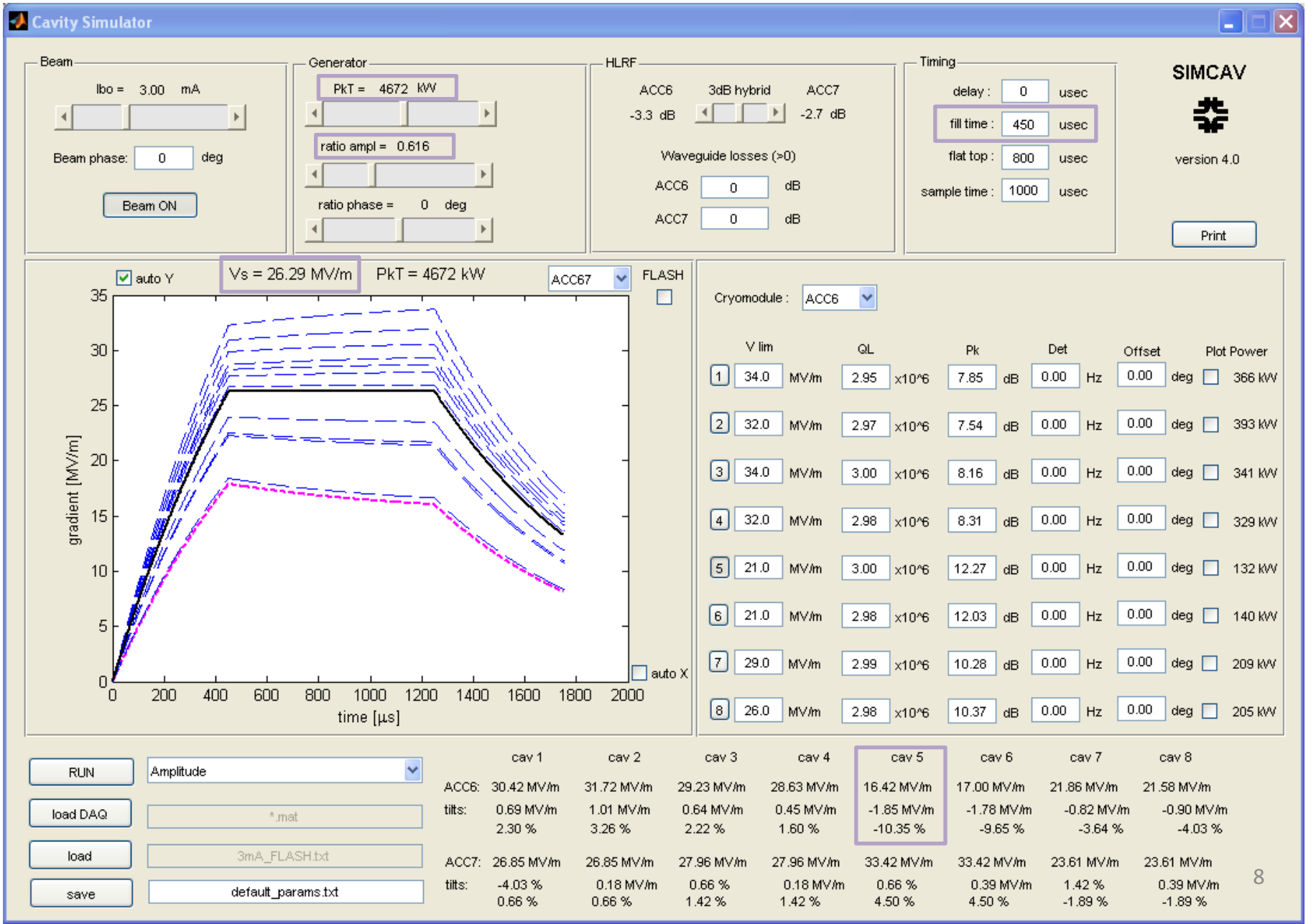
# PLAN-A: Keep FLASH as it is



# PLAN-A: Keep FLASH as it is



# PLAN-A: Keep FLASH as it is



# PLAN B: use low Ql's, keep Pk's

- As described in Shin's document (PkQl-lik control for ACC6/7 at FLASH, June 19 2010)
- **Flat** with 3mA beam
- **Flat** with 6mA beam
- **No** solution for 9mA beam
- Tilt without beam
- For 3mA configuration
  - Ql's are in the 0.77-1.07x$10^6$ range
  - Tilts range from **6.2% to -2.4%**
  - Shortening the pulse **won't help**
    - (eg. 100usec flat top still shows 2% tilts )
  - Changing $t_{inj}$ **won't help**

# PLAN B: use low Ql's, keep Pk's

| ACC6 | 24.41 MV/m | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pin [MW] | 1.8 | | | | | | | |
| | | | | | | | | |
| Qext | 0.80 | 0.78 | 0.81 | 0.82 | 1.07 | 1.05 | 0.92 | 0.93 |
| A [dB] | 7.85 | 7.54 | 8.16 | 8.31 | 12.27 | 12.03 | 10.28 | 10.37 |
| Pcav [kW] | 312 | 335 | 290 | 280 | 113 | 119 | 178 | 174 |
| Ecav (end of fill) [MV/m] | 28.58 | 29.40 | 27.67 | 27.29 | 18.34 | 18.80 | 22.39 | 22.21 |
| Ecav (end of flat) [MV/m] | 28.11 | 28.77 | 27.30 | 26.99 | 19.48 | 19.85 | 22.77 | 22.66 |
| no beam Tilt [MV/m] | -0.5 | -0.6 | -0.4 | -0.3 | 1.1 | 1.1 | 0.4 | 0.4 |
| no beam Tilt [%] | -1.6 | -2.1 | -1.3 | -1.1 | 6.2 | 5.6 | 1.7 | 2.0 |
| Ecav, max | 34 | 32 | 34 | 32 | 21 | 21 | 29 | 26 |
| ΔE | 5.89 | 3.23 | 6.70 | 5.01 | 1.52 | 1.15 | 6.23 | 3.34 |
| | cav1 | cav2 | cav3 | cav4 | cav5 | cav6 | cav7 | cav8 |

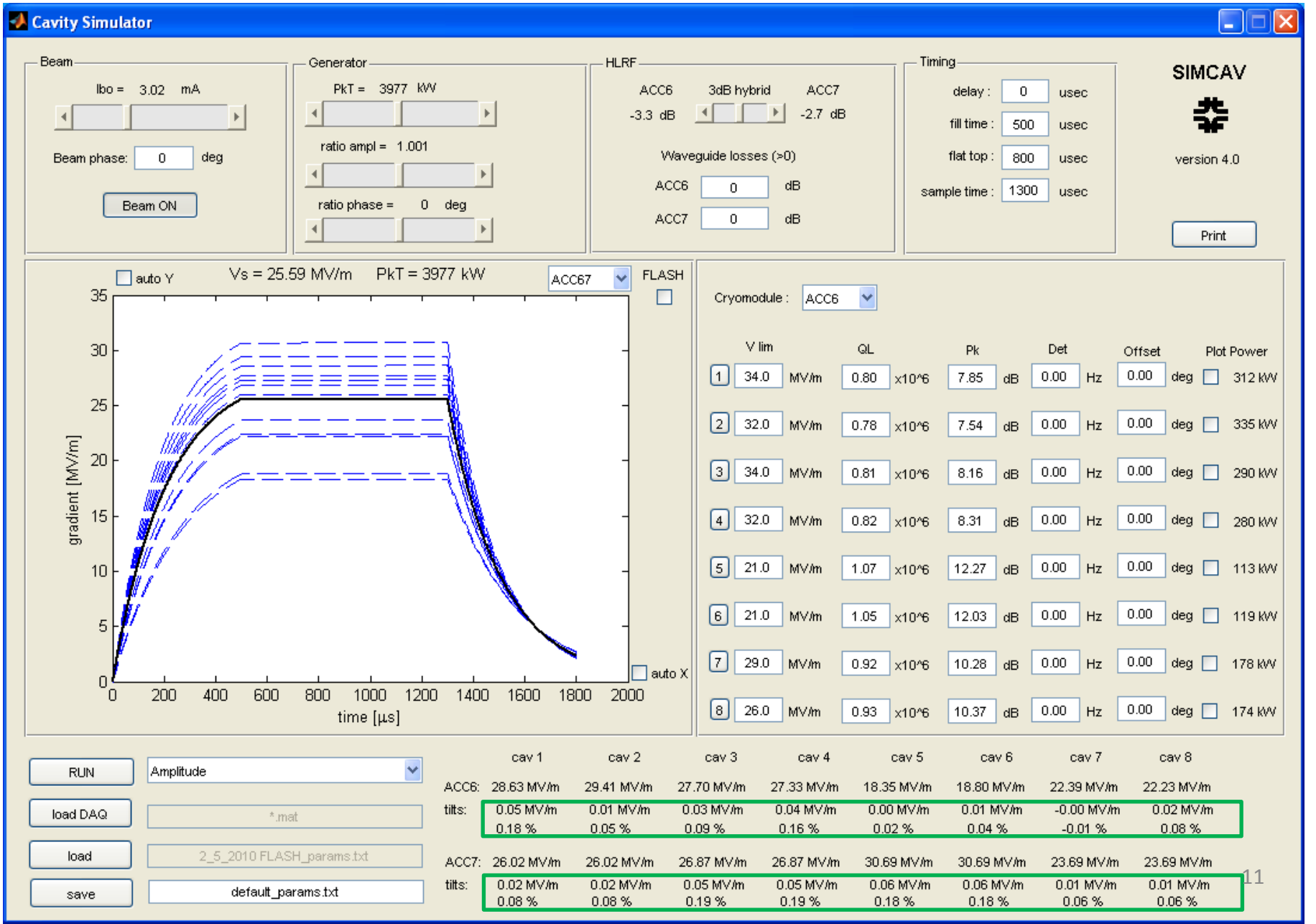
$I_b$ = 3mA

Extreme tilts

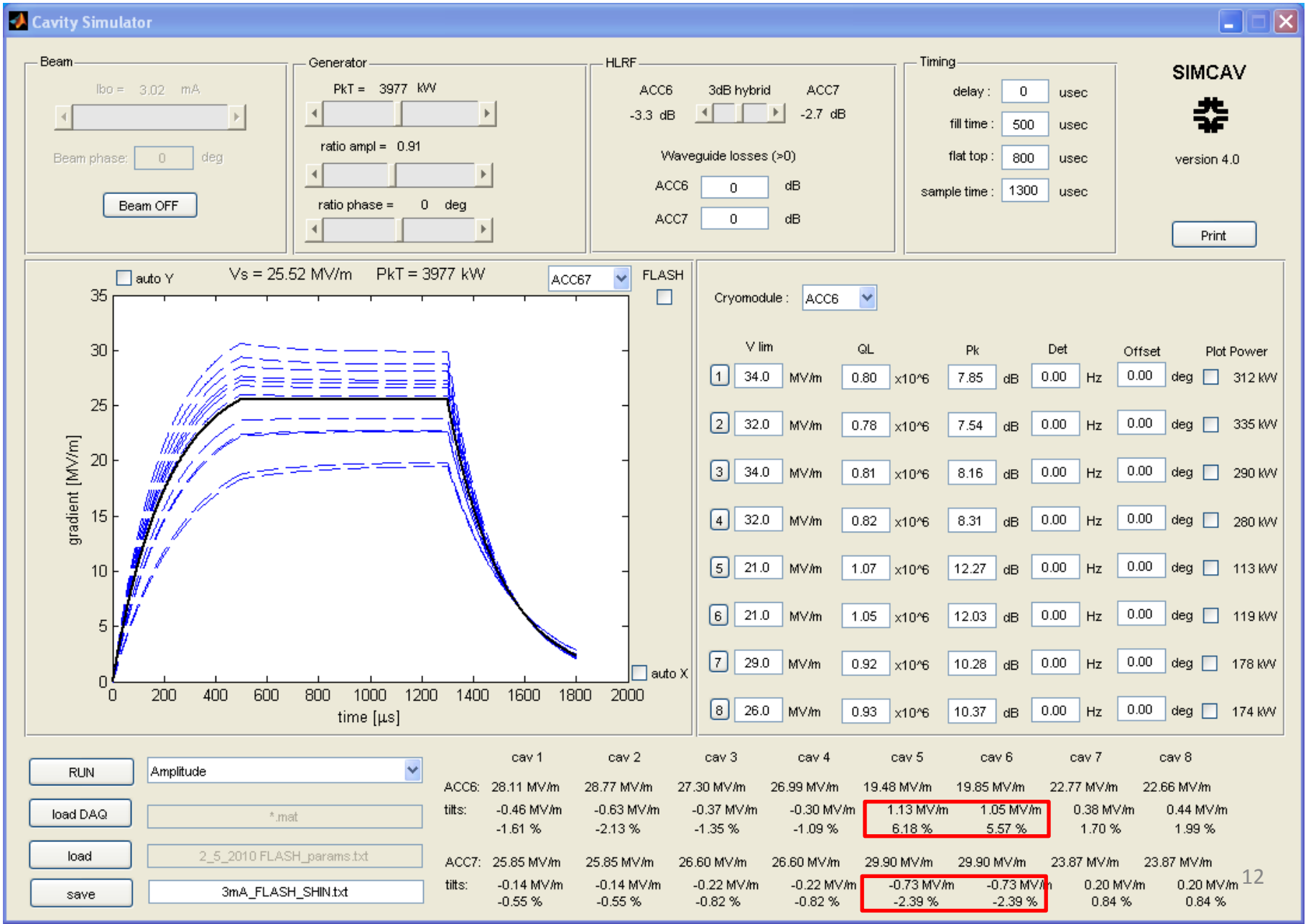
| ACC7 | 26.67 MV/m | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pin [MW] | 2.2 | | | | | | | |
| | | | | | | | | |
| Qext | 0.84 | 0.84 | 0.83 | 0.83 | 0.77 | 0.77 | 0.89 | 0.89 |
| A [dB] | 9.38 | 9.38 | 9.08 | 9.08 | 7.74 | 7.74 | 10.32 | 10.32 |
| Pcav [kW] | 251 | 251 | 269 | 269 | 366 | 366 | 202 | 202 |
| Ecav (end of fill) [MV/m] | 26.00 | 26.00 | 26.82 | 26.82 | 30.64 | 30.64 | 23.67 | 23.67 |
| Ecav (end of flat) [MV/m] | 25.85 | 25.85 | 26.60 | 26.60 | 29.90 | 29.90 | 23.87 | 23.87 |
| Tilt [MV/m] | -0.1 | -0.1 | -0.2 | -0.2 | -0.7 | -0.7 | 0.2 | 0.2 |
| Tilt [%] | -0.6 | -0.6 | -0.8 | -0.8 | -2.4 | -2.4 | 0.8 | 0.8 |
| Ecav, max | 29 | 31 | 34 | 30 | 35 | 39 | 27 | 26 |
| ΔE | 3.15 | 5.15 | 7.40 | 3.40 | 5.10 | 9.10 | 3.13 | 2.13 |
| | cav1 | cav2 | cav3 | cav4 | cav5 | cav6 | cav7 | cav8 |

Risk of cavity quench

# PLAN B: use low Ql's, keep Pk's



# PLAN B: use low Ql's, keep Pk's



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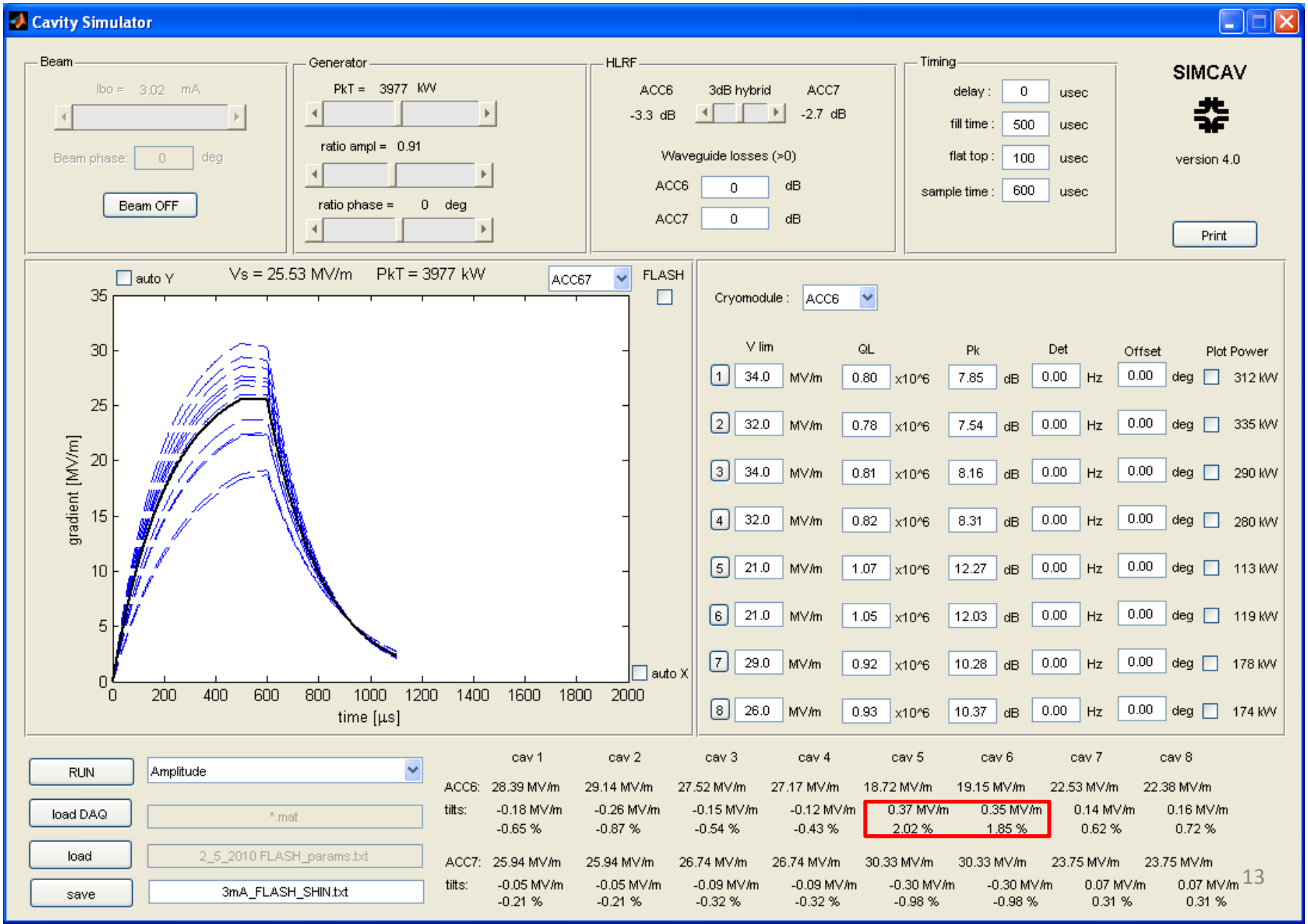
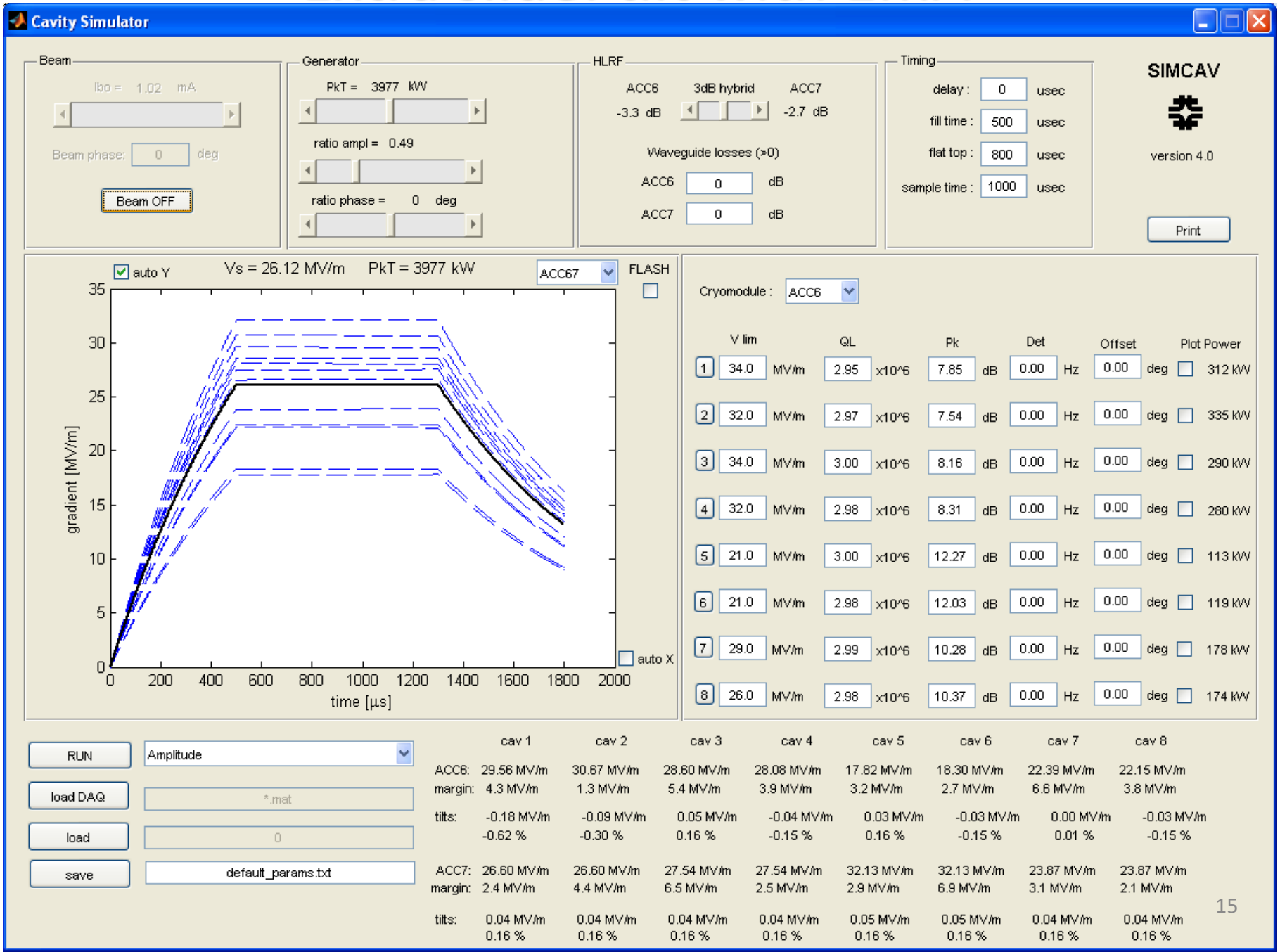


# Summary:

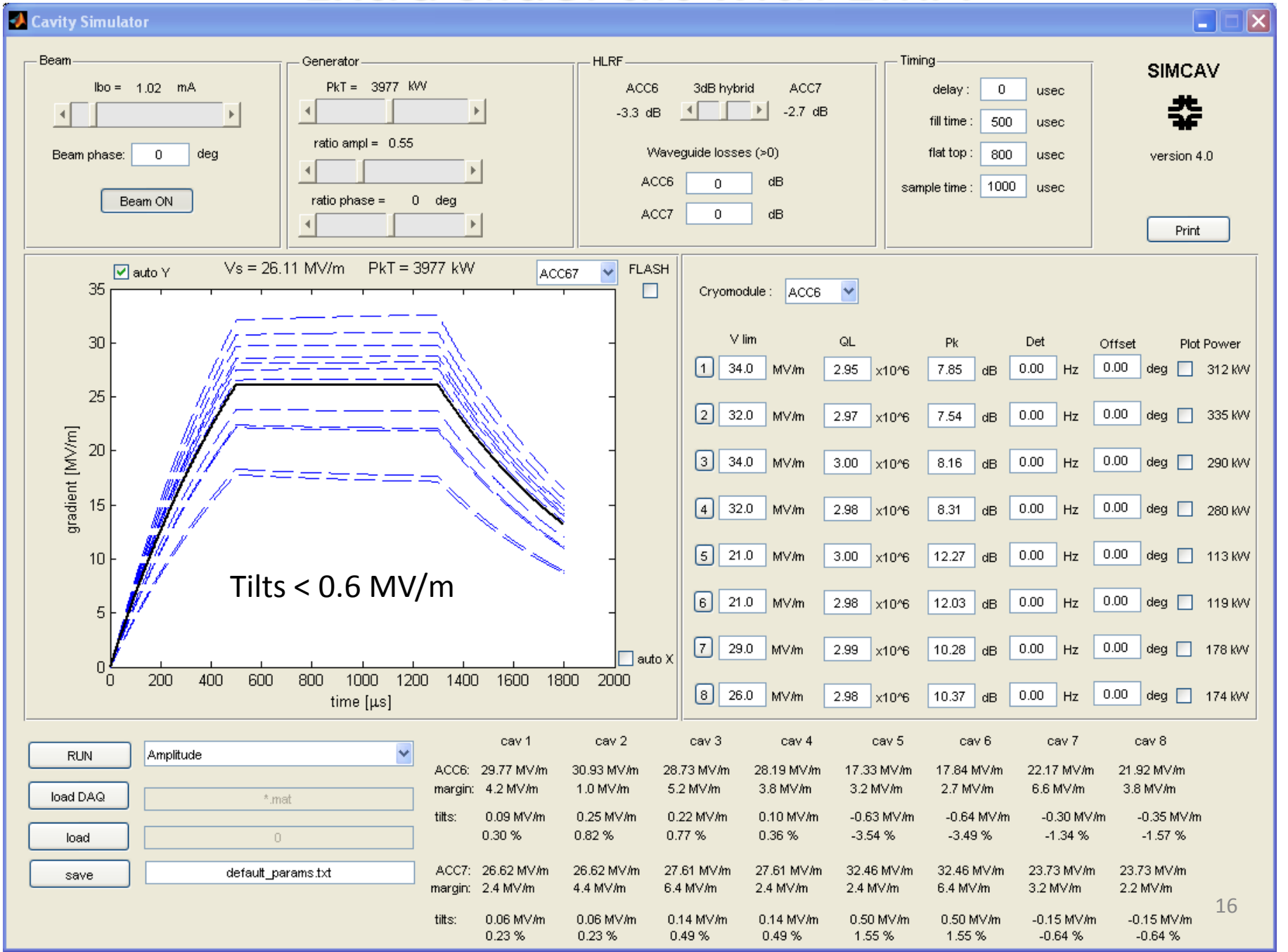
- If Pk's and Ql's remain as they are:
  - Beam ON tilts range from -36% to 15%
    - 200 usec flat top (-13% +5%)
  - Need to lower gradient for 9mA
    - 23.4 MVm instead of 26.1 MV/m
    - ACC6 cav2 : 1.4 MV/m safe margin

- If only Ql's are changed:
  - You **can** adjust the Ql's for flat with **3mA**
    - Beam OFF tilts range from +6.2% to -2.4%
    - 200 usec flat top (+3.4% to -1.6%)
  - You **can** adjust the Ql's for flat with **6mA**
    - Beam OFF tilts range from +36% to -8.6%
    - 200 usec flat top (+12.72% to -4.5%)
    - Need to lower gradient 22.5 in stead of 26.1MV/m
  - **No** solution for **9mA**

# Extra slide: tilt with 1mA

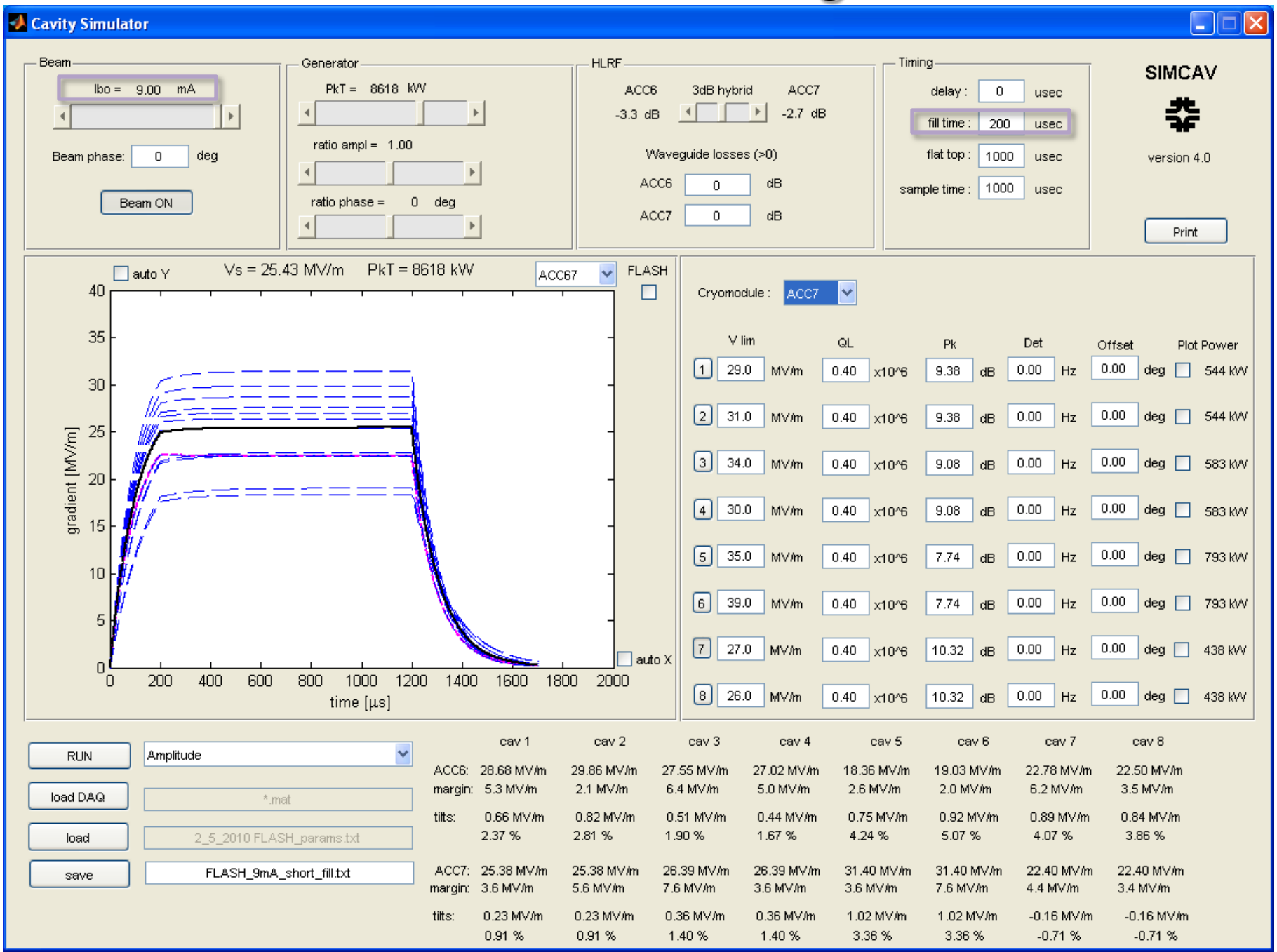


# Extra slide: tilt with 1mA



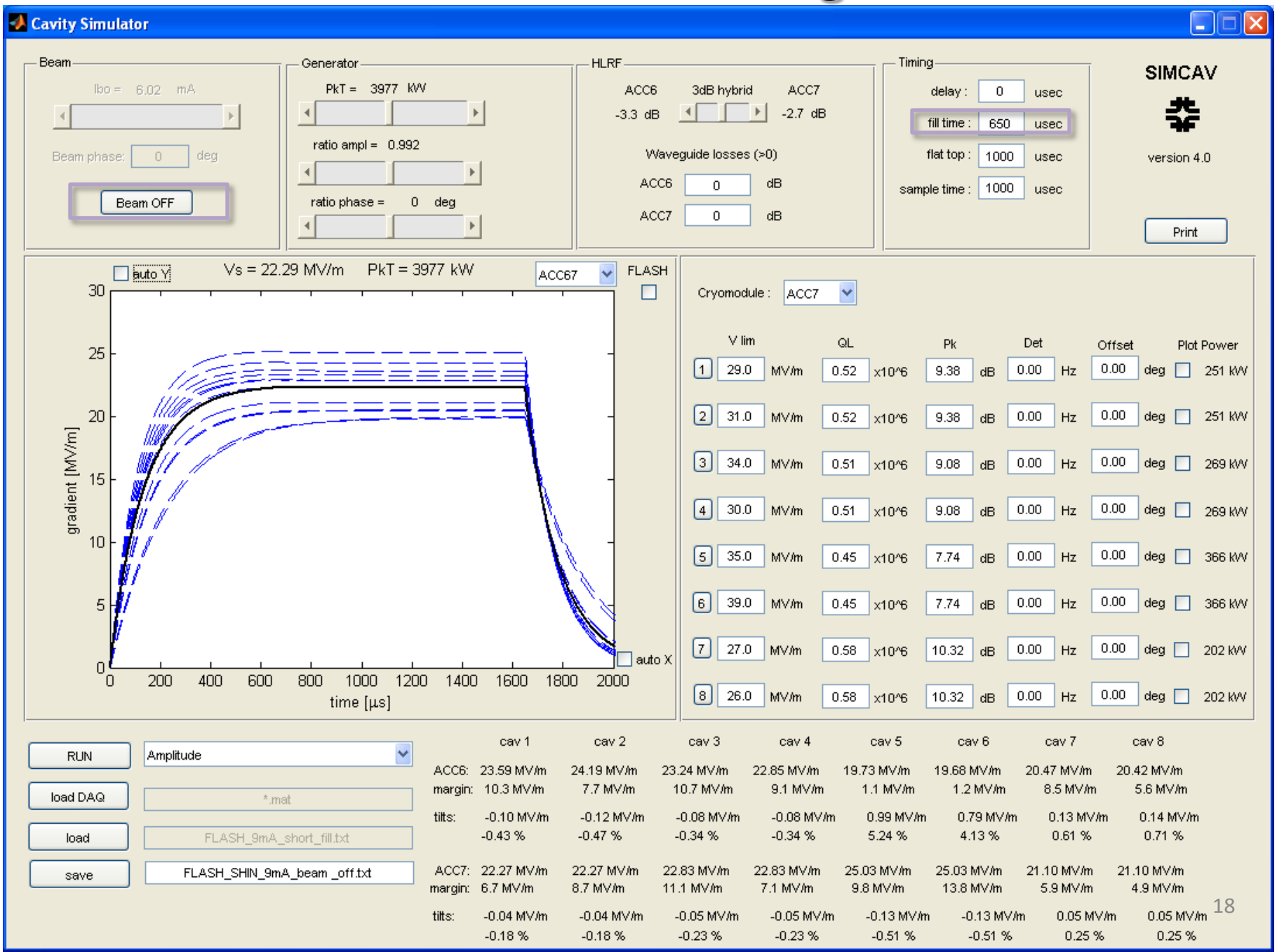

| | cav 1 | cav 2 | cav 3 | cav 4 | cav 5 | cav 6 | cav 7 | cav 8 |
|---|---|---|---|---|---|---|---|---|
| ACC6: | 29.77 MV/m | 30.93 MV/m | 28.73 MV/m | 28.19 MV/m | 17.33 MV/m | 17.84 MV/m | 22.17 MV/m | 21.92 MV/m |
| margin: | 4.2 MV/m | 1.0 MV/m | 5.2 MV/m | 3.8 MV/m | 3.2 MV/m | 2.7 MV/m | 6.6 MV/m | 3.8 MV/m |
| tilts: | 0.09 MV/m | 0.25 MV/m | 0.22 MV/m | 0.10 MV/m | -0.63 MV/m | -0.64 MV/m | -0.30 MV/m | -0.35 MV/m |
| | 0.30 % | 0.82 % | 0.77 % | 0.36 % | -3.54 % | -3.49 % | -1.34 % | -1.57 % |
| ACC7: | 26.62 MV/m | 26.62 MV/m | 27.61 MV/m | 27.61 MV/m | 32.46 MV/m | 32.46 MV/m | 23.73 MV/m | 23.73 MV/m |
| margin: | 2.4 MV/m | 4.4 MV/m | 6.4 MV/m | 2.4 MV/m | 2.4 MV/m | 6.4 MV/m | 3.2 MV/m | 2.2 MV/m |
| tilts: | 0.06 MV/m | 0.06 MV/m | 0.14 MV/m | 0.14 MV/m | 0.50 MV/m | 0.50 MV/m | -0.15 MV/m | -0.15 MV/m |
| | 0.23 % | 0.23 % | 0.49 % | 0.49 % | 1.55 % | 1.55 % | -0.64 % | -0.64 % |

# Extra slide: if more tilting allowed

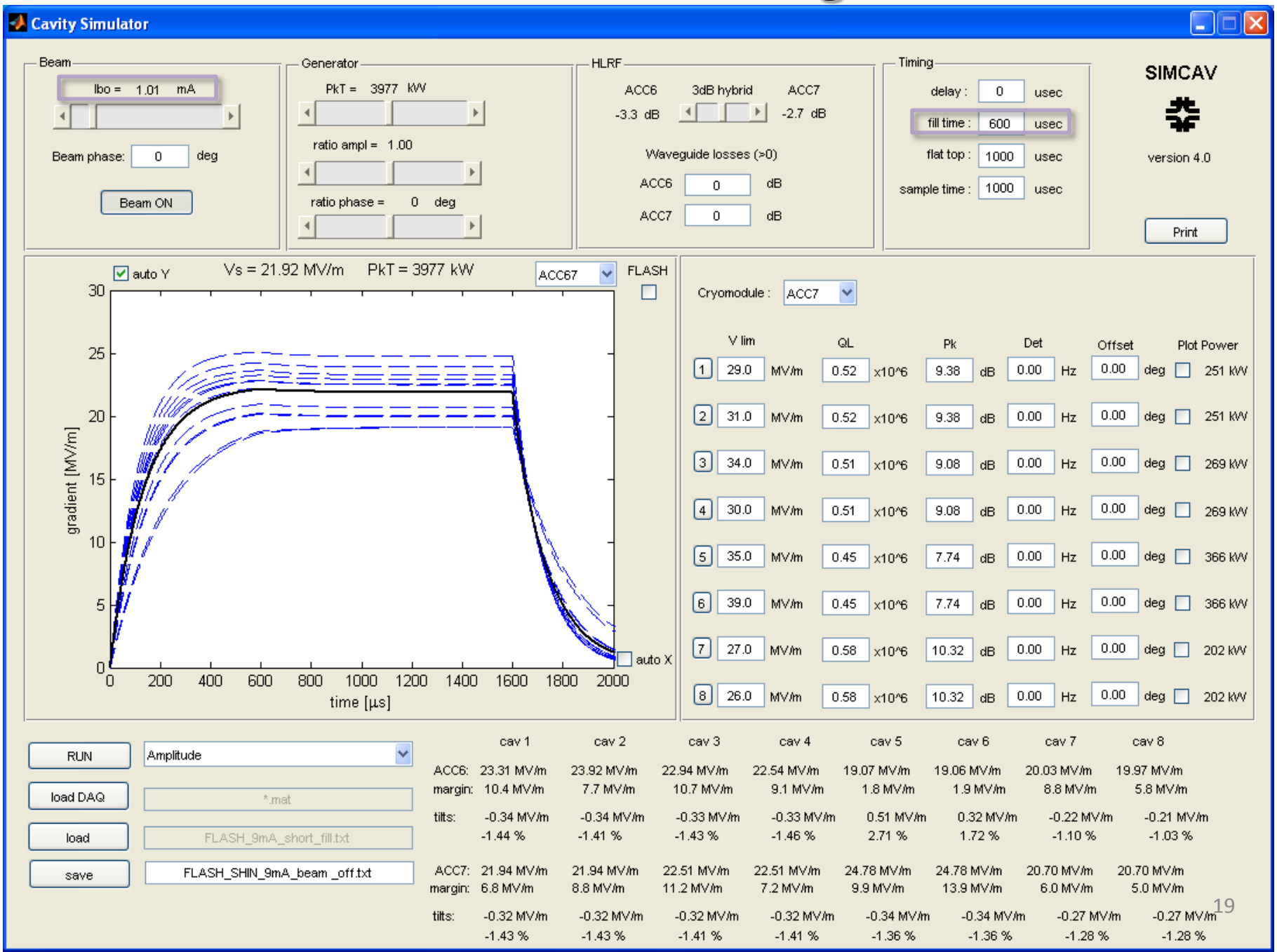



| | cav 1 | cav 2 | cav 3 | cav 4 | cav 5 | cav 6 | cav 7 | cav 8 |
|---|---|---|---|---|---|---|---|---|
| ACC6: | 28.68 MV/m | 29.86 MV/m | 27.55 MV/m | 27.02 MV/m | 18.36 MV/m | 19.03 MV/m | 22.78 MV/m | 22.50 MV/m |
| margin: | 5.3 MV/m | 2.1 MV/m | 6.4 MV/m | 5.0 MV/m | 2.6 MV/m | 2.0 MV/m | 6.2 MV/m | 3.5 MV/m |
| tilts: | 0.66 MV/m | 0.82 MV/m | 0.51 MV/m | 0.44 MV/m | 0.75 MV/m | 0.92 MV/m | 0.89 MV/m | 0.84 MV/m |
| | 2.37 % | 2.81 % | 1.90 % | 1.67 % | 4.24 % | 5.07 % | 4.07 % | 3.86 % |
| ACC7: | 25.38 MV/m | 25.38 MV/m | 26.39 MV/m | 26.39 MV/m | 31.40 MV/m | 31.40 MV/m | 22.40 MV/m | 22.40 MV/m |
| margin: | 3.6 MV/m | 5.6 MV/m | 7.6 MV/m | 3.6 MV/m | 3.6 MV/m | 7.6 MV/m | 4.4 MV/m | 3.4 MV/m |
| tilts: | 0.23 MV/m | 0.23 MV/m | 0.36 MV/m | 0.36 MV/m | 1.02 MV/m | 1.02 MV/m | -0.16 MV/m | -0.16 MV/m |
| | 0.91 % | 0.91 % | 1.40 % | 1.40 % | 3.36 % | 3.36 % | -0.71 % | -0.71 % |

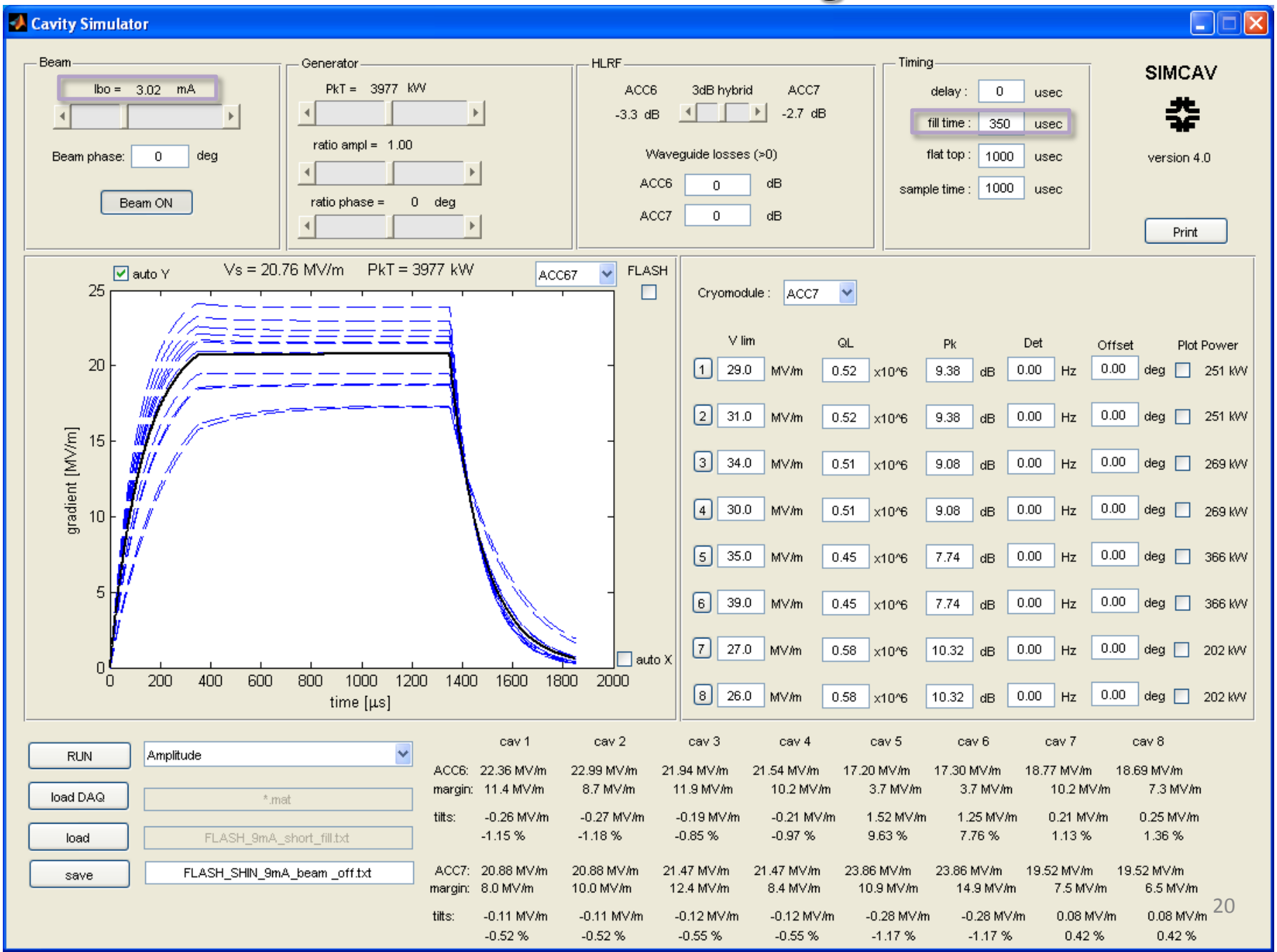
# Extra slide: if more tilting allowed



# Extra slide: if more tilting allowed



# Extra slide: if more tilting allowed



# Extra slide: if more tilting allowed