



# OSC Flared Chamber BPM Proposal

Jim Shanks

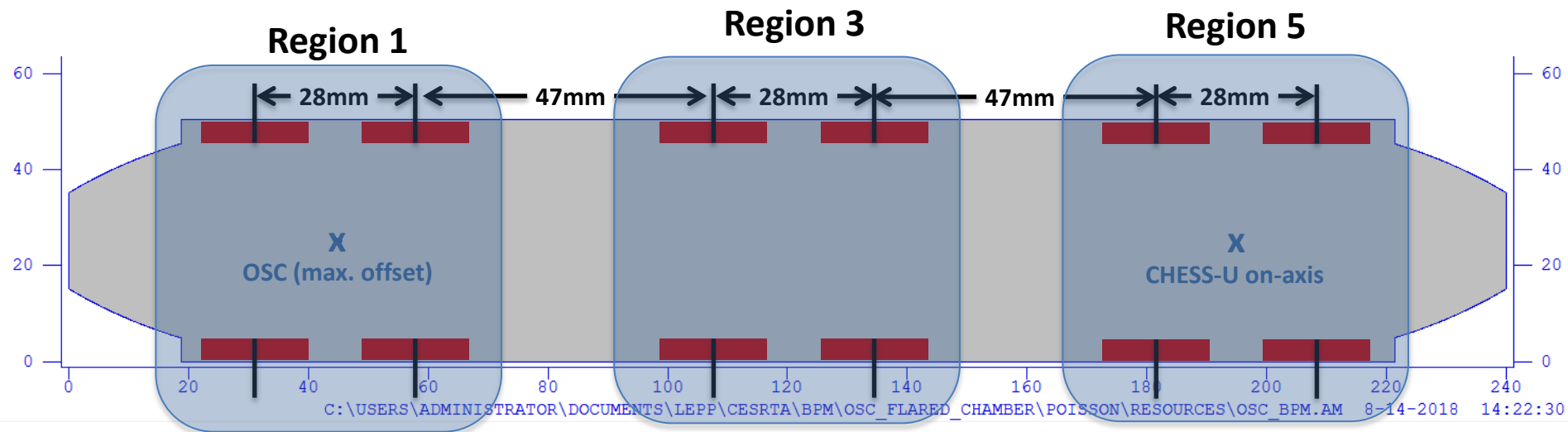
2018.08.22



- Need to accurately measure beam position at Q49
- Flared chamber; anticipate up to 150mm separation between CHES-U on-axis and OSC maximum displacement
  - Need to have accurate position measurements across this entire domain
- Recall: standard CESR vacuum chamber is 90mm wide; “good response region” for BPMs is of order  $\pm 15$ mm horizontally

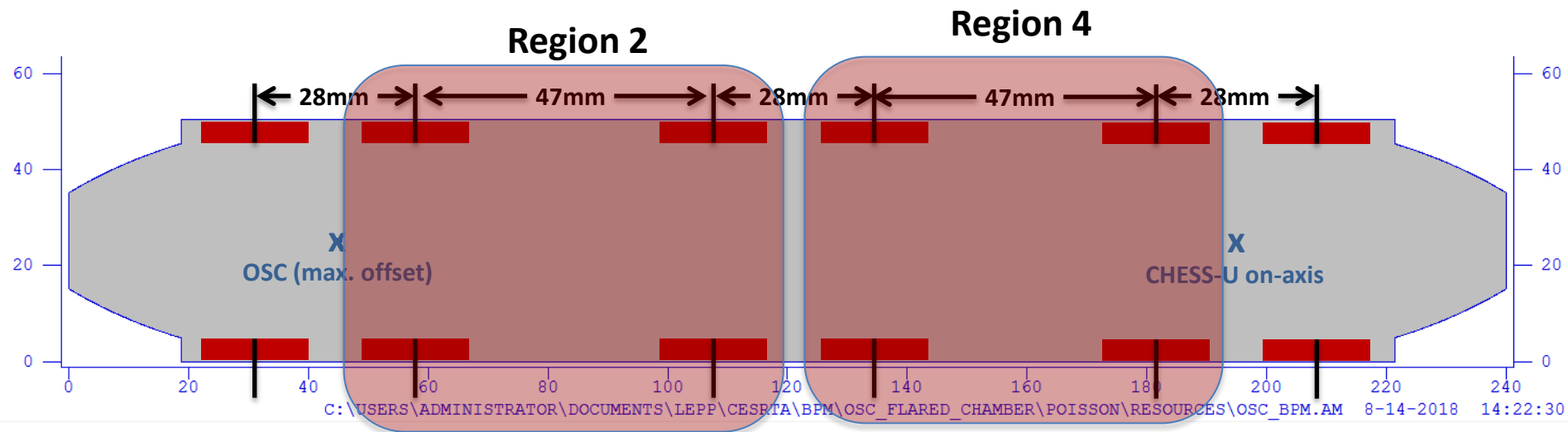


- Start with standard CESR profile, widen by 150mm
- Six standard CESR button blocks (12 buttons)
- Connect four pickups at any given time
- Allows for three “high-resolution” regions
  - CHES-U design trajectory,  $\pm 15\text{mm}$
  - OSC max. excursion,  $\pm 15\text{mm}$
  - Half of OSC max. excursion,  $\pm 15\text{mm}$



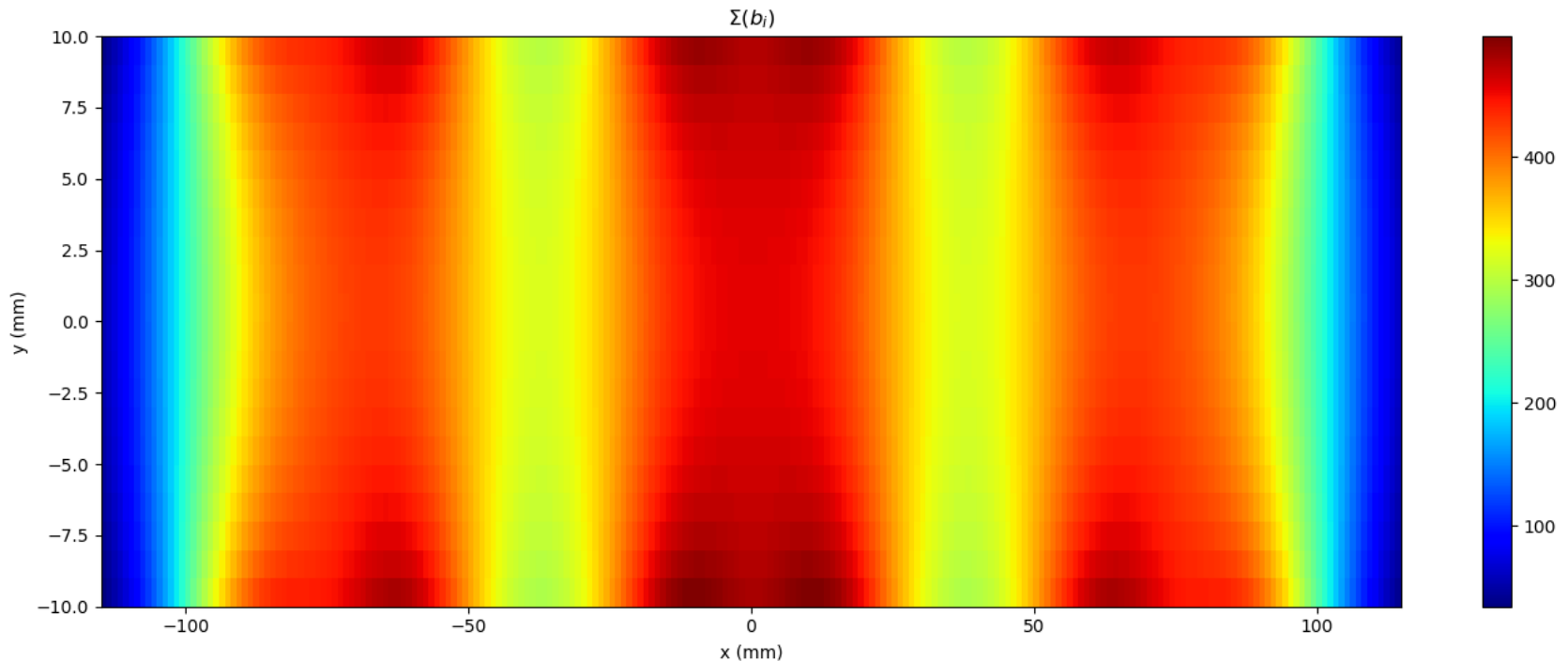


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  - CHES-U design trajectory,  $\pm 15\text{mm}$
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- Two “low-resolution” regions, straddling adjacent button blocks





- Model in Poisson-Superfish using MGB model for standard CESR BPM, extended by 150mm
- Integrate image charge on each button



Sum of all 12 button signals as a function of (x,y) beam coordinates  
(demonstrates stronger signal near buttons, as expected, but mostly just a pretty plot)

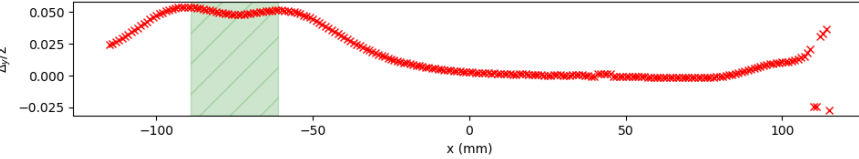
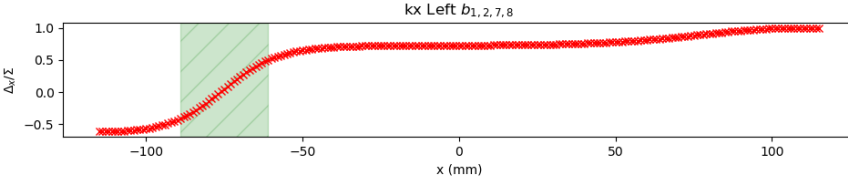


# Calculate $\Delta_{x,y}/\Sigma$ for each region

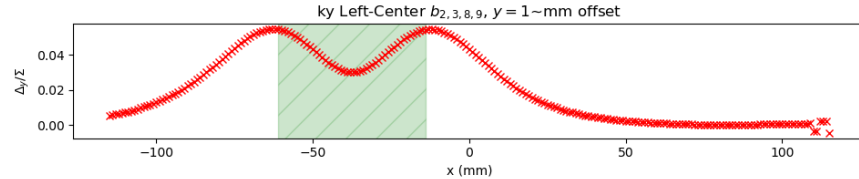
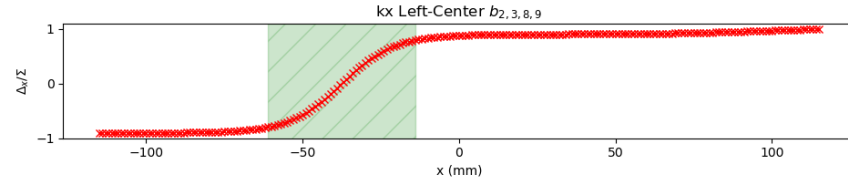
$\Delta_x/\Sigma$  vs.  $x, y=0$  (should be linear)

$\Delta_y/\Sigma$  vs.  $x, y=1\text{mm}$  (should be constant)

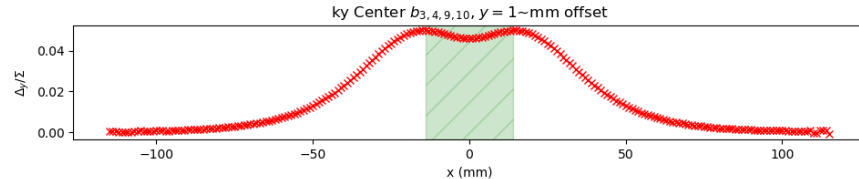
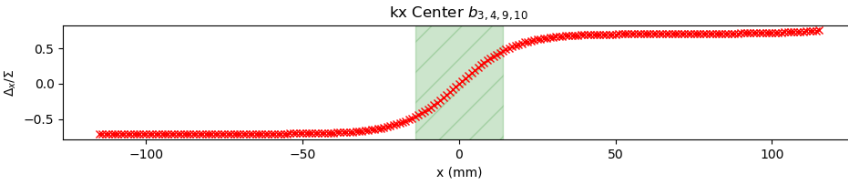
Region 1



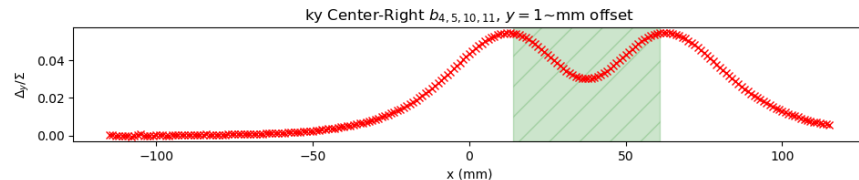
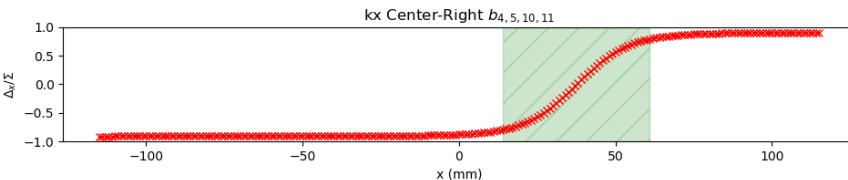
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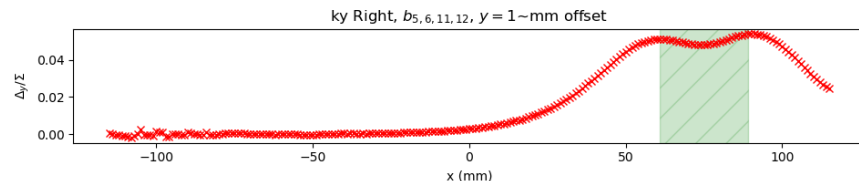
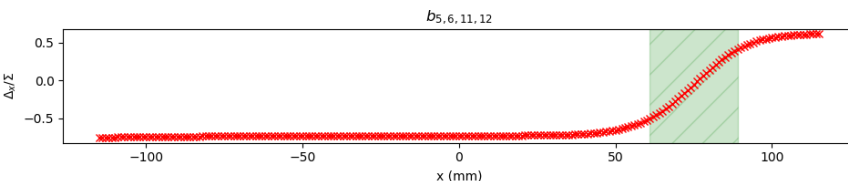
Region 3



Region 4



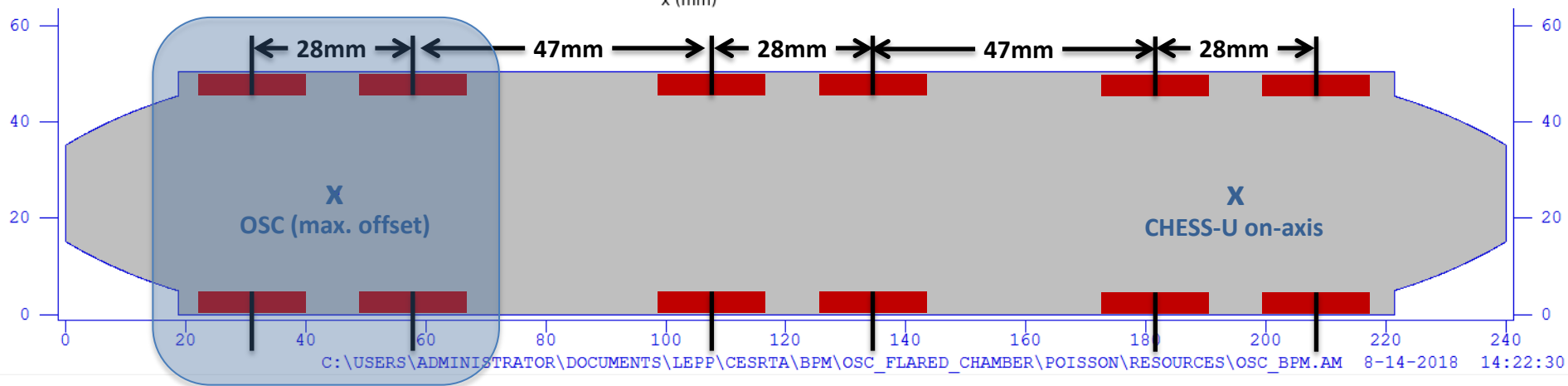
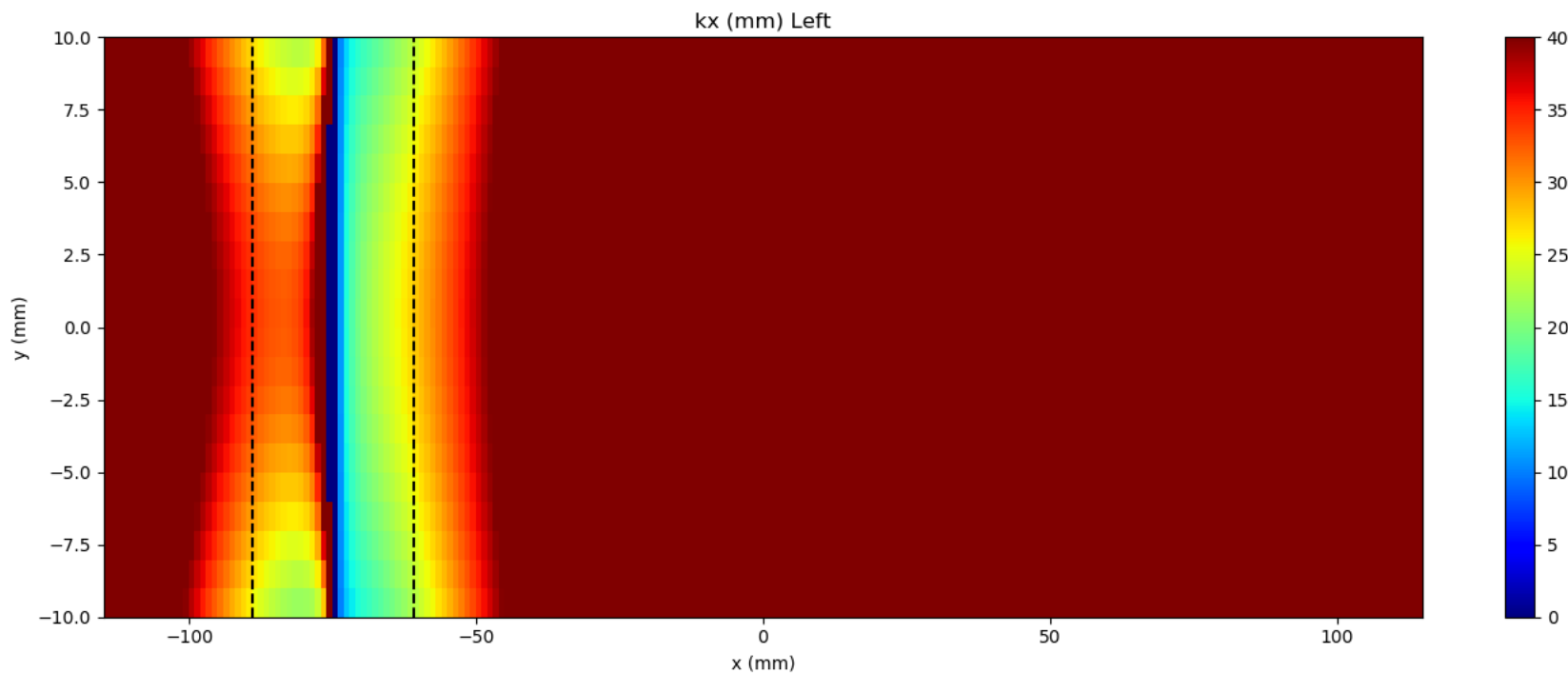
Region 5

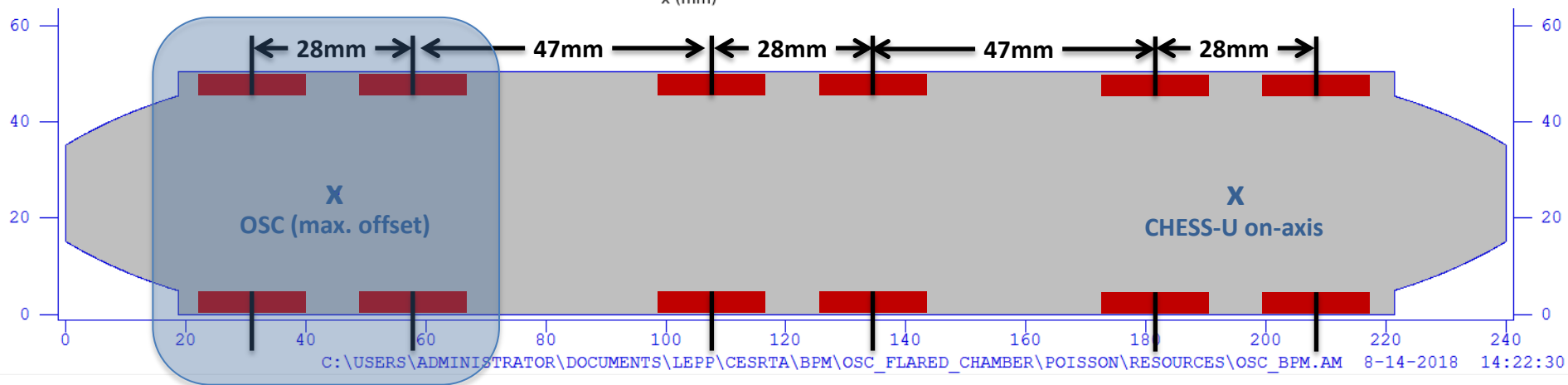
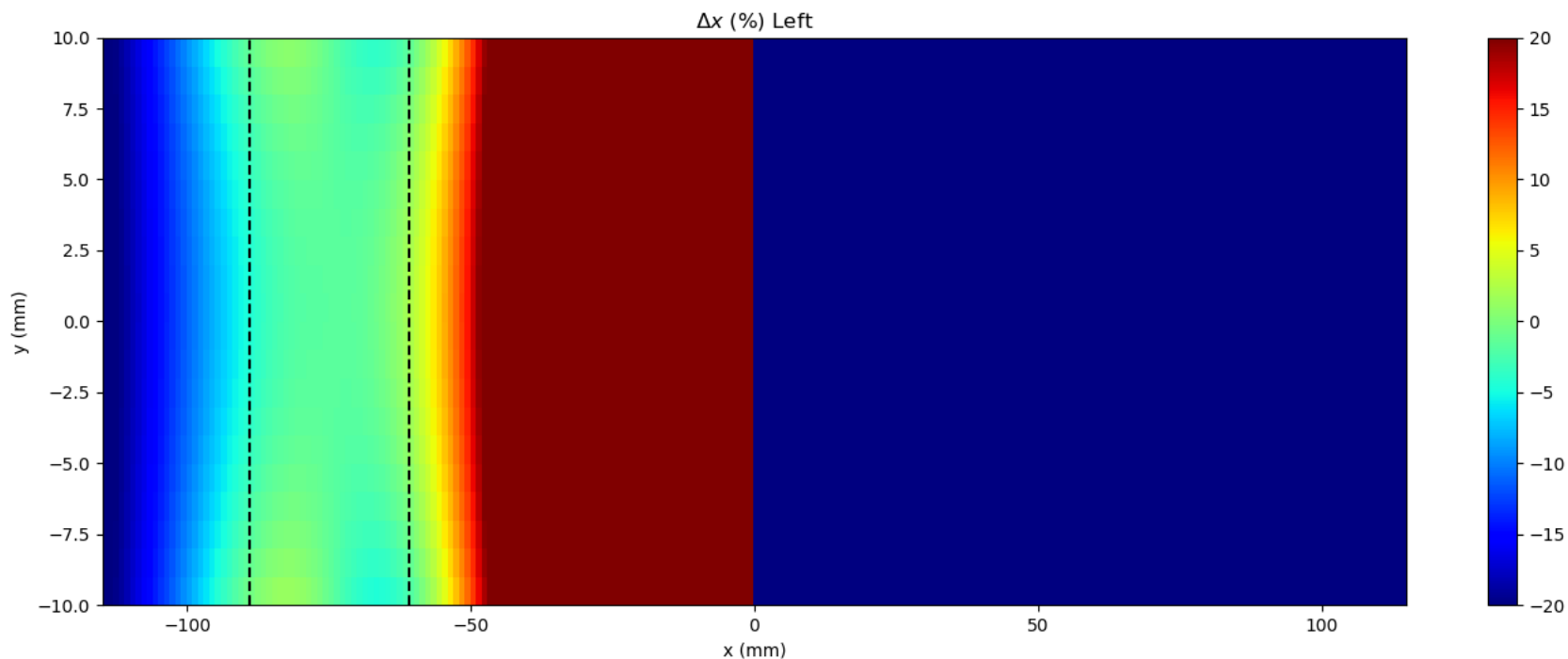


$$x = k_x \Delta_x/\Sigma$$

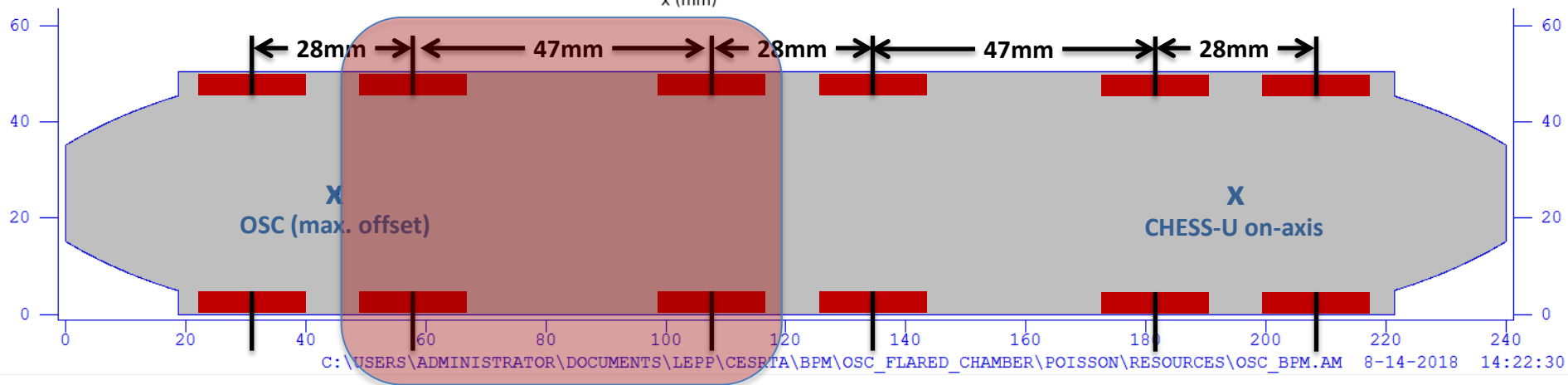
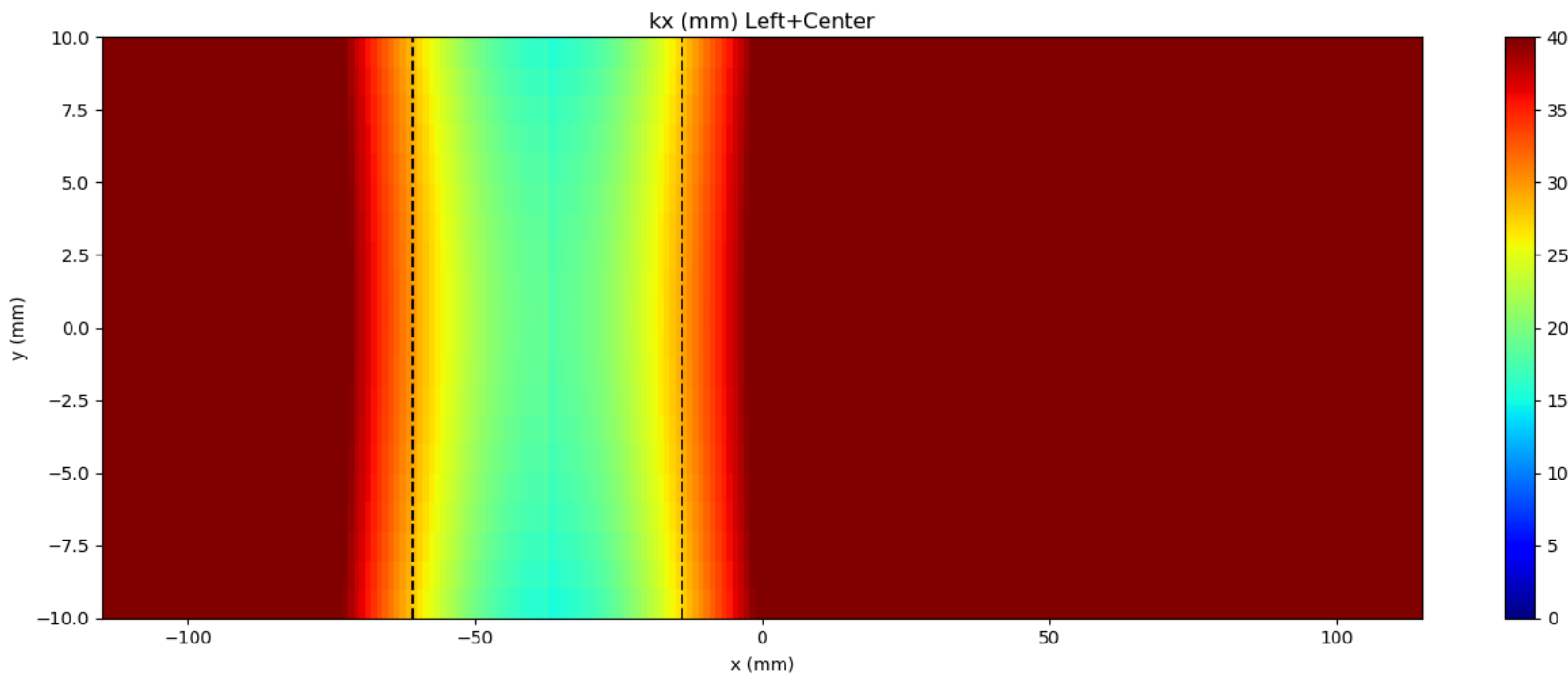
$$y = k_y \Delta_y/\Sigma$$

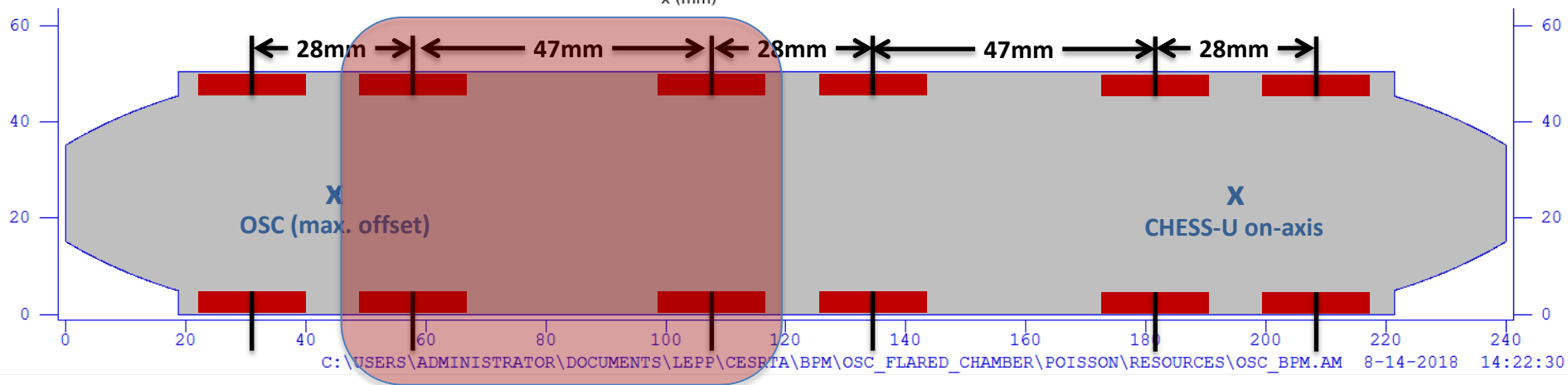
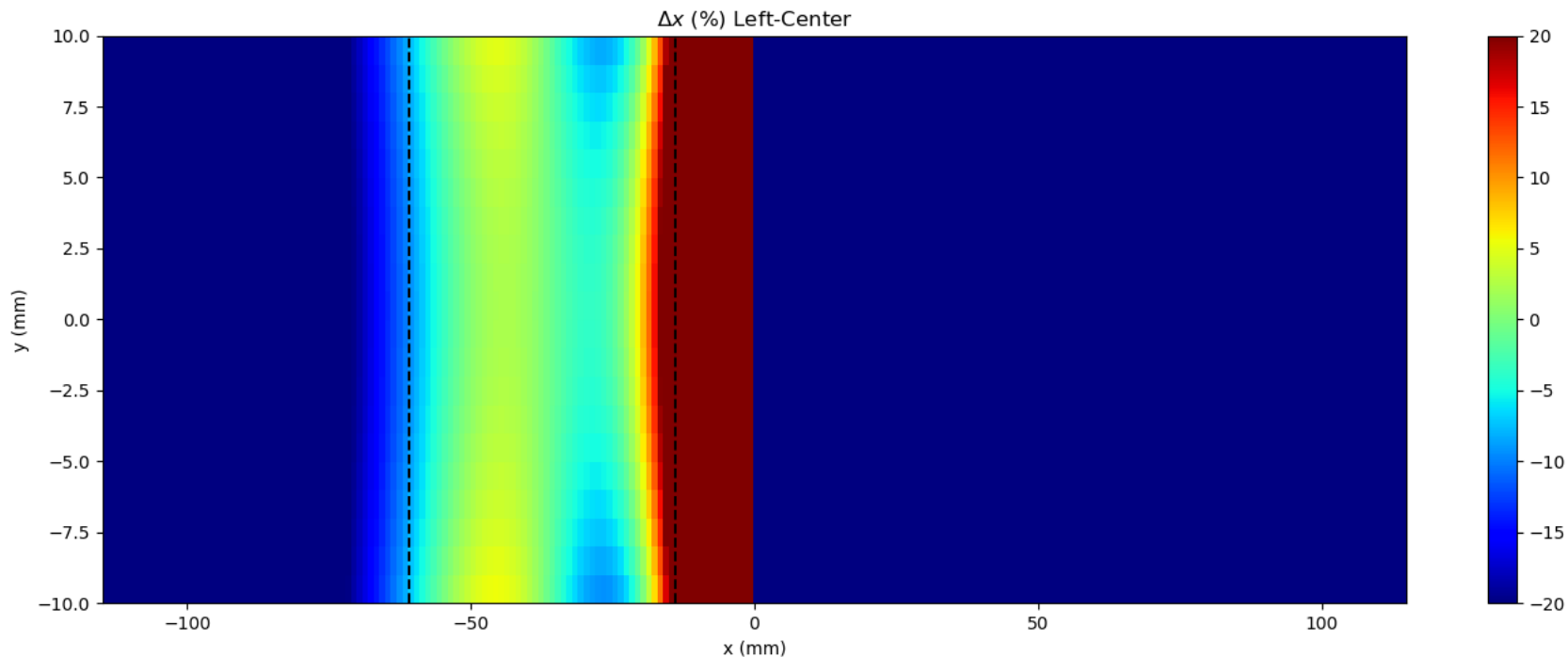
- **Green shading** indicates domain between buttons used for each calculation
- $k_x = x / (\Delta_x/\Sigma)$        $k_y = y / (\Delta_y/\Sigma)$

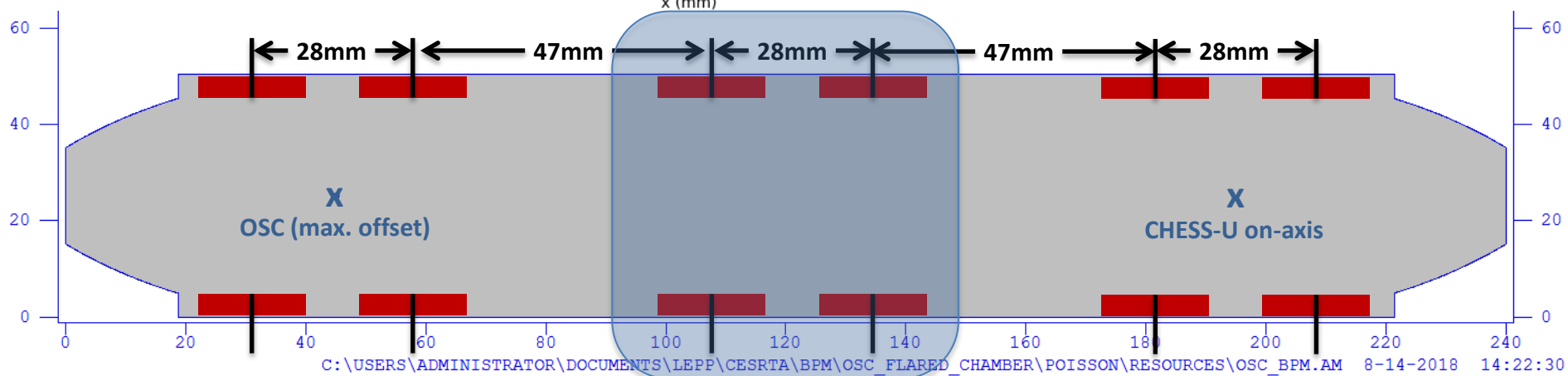
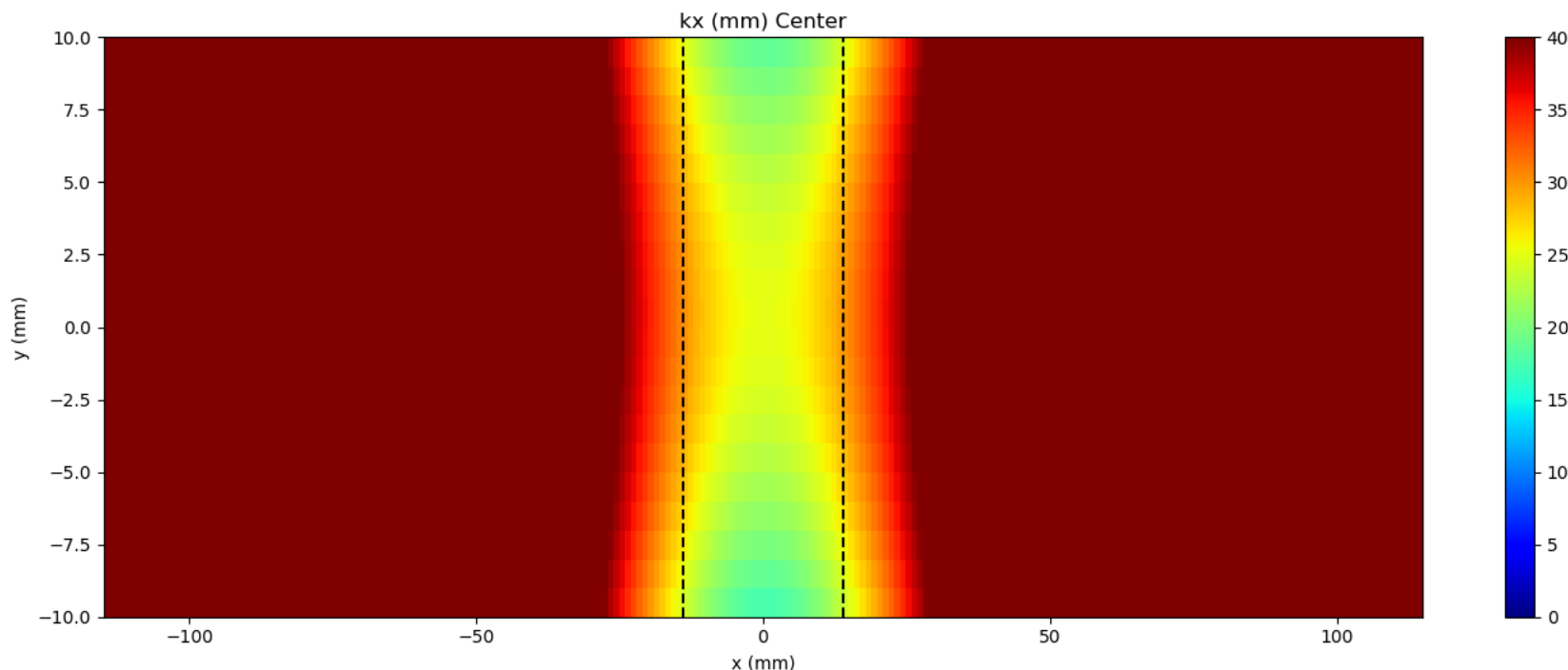




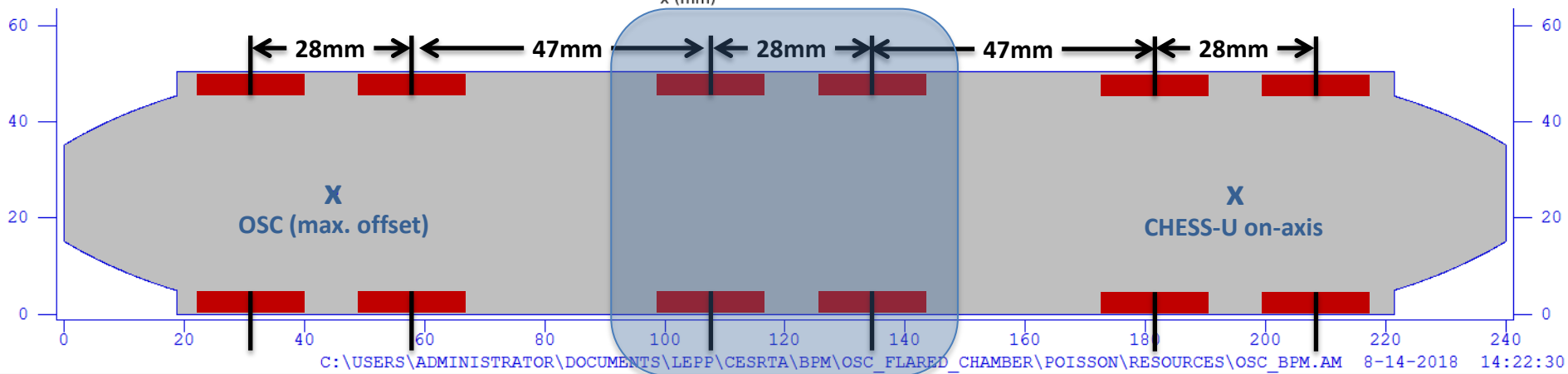
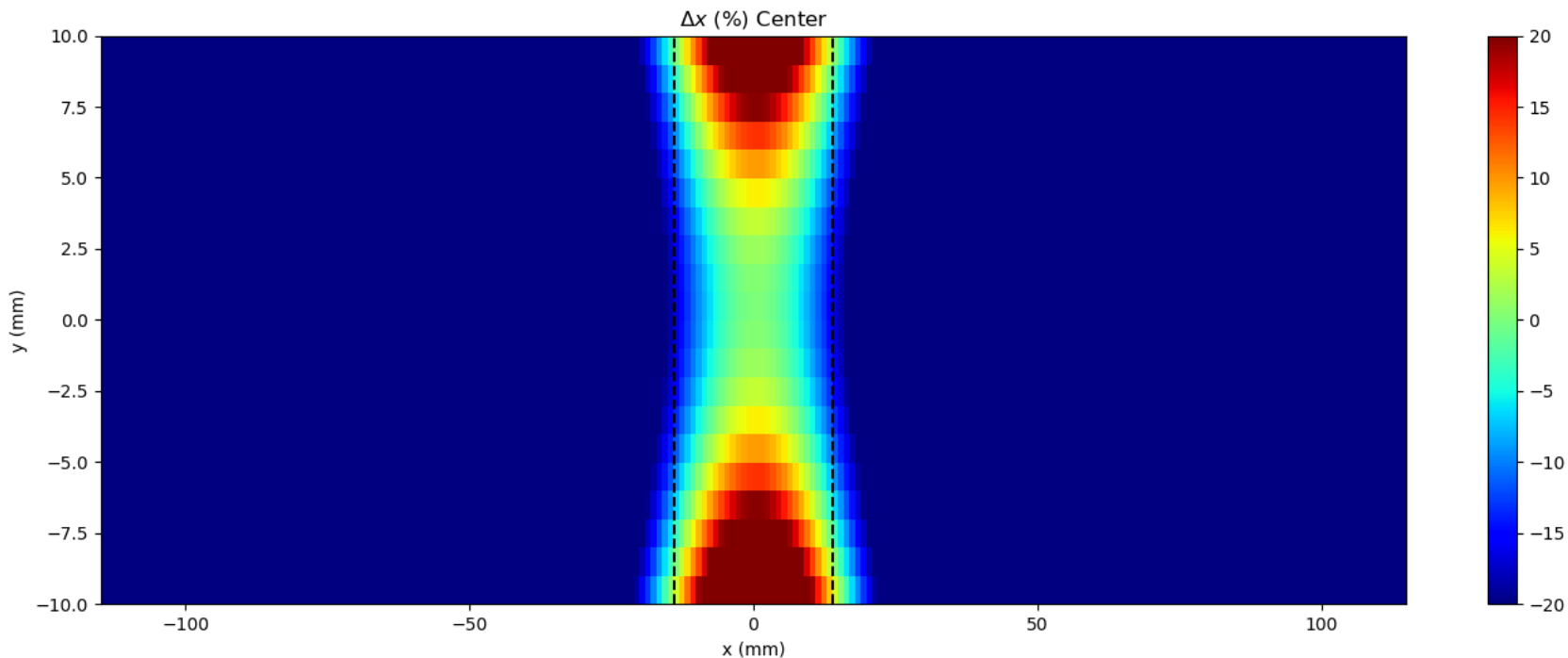


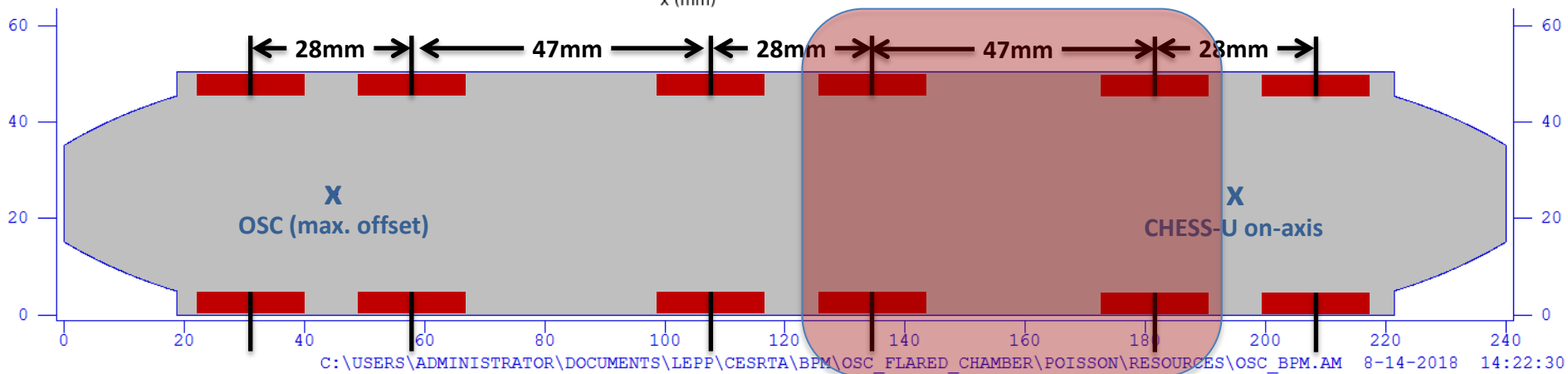
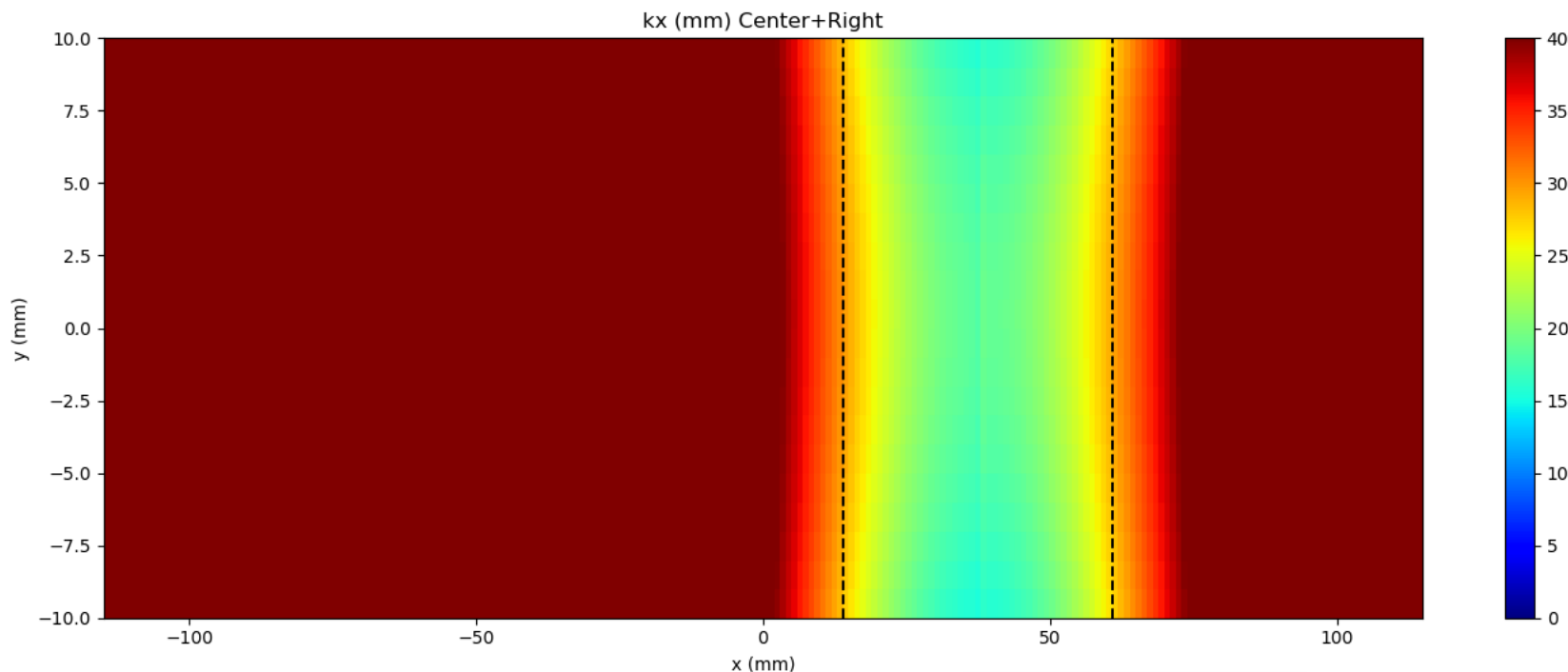


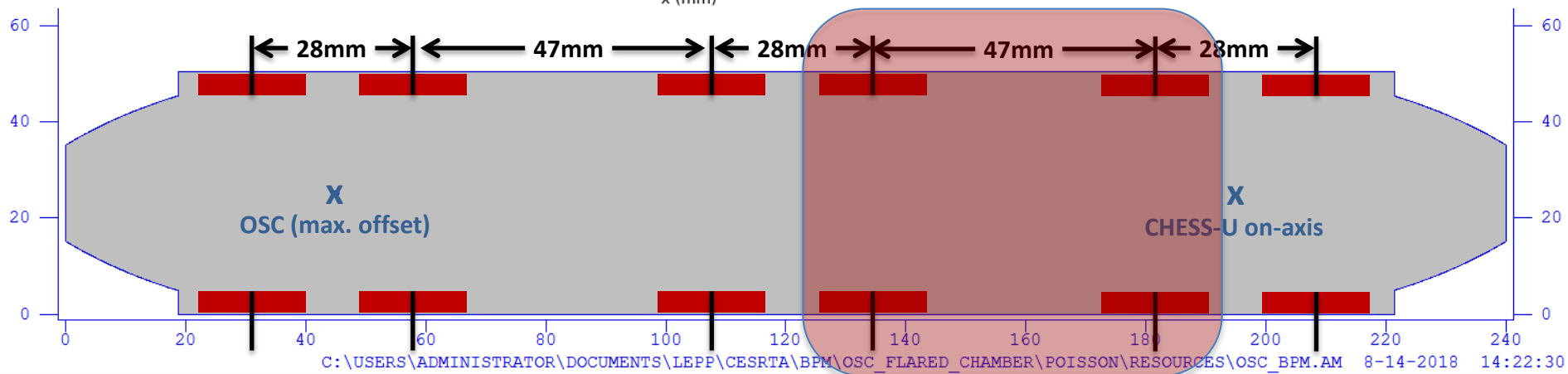
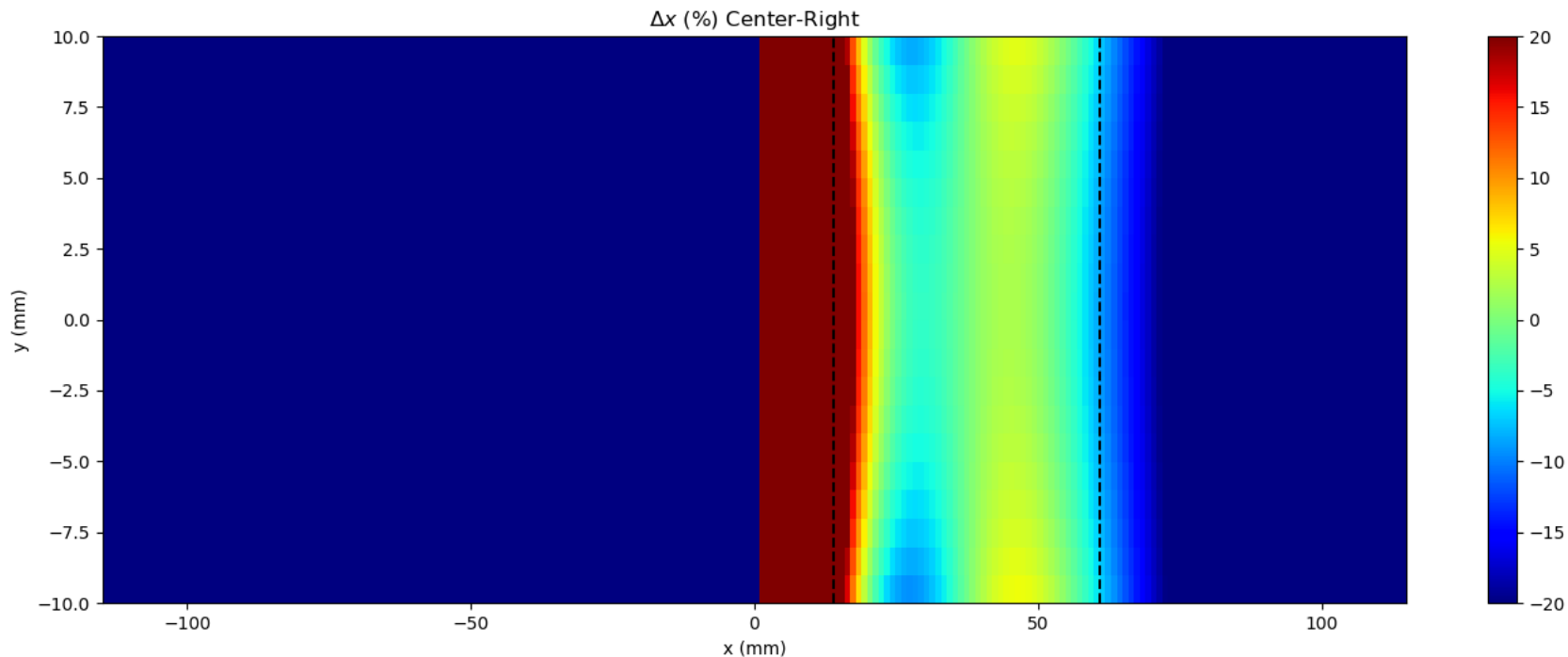


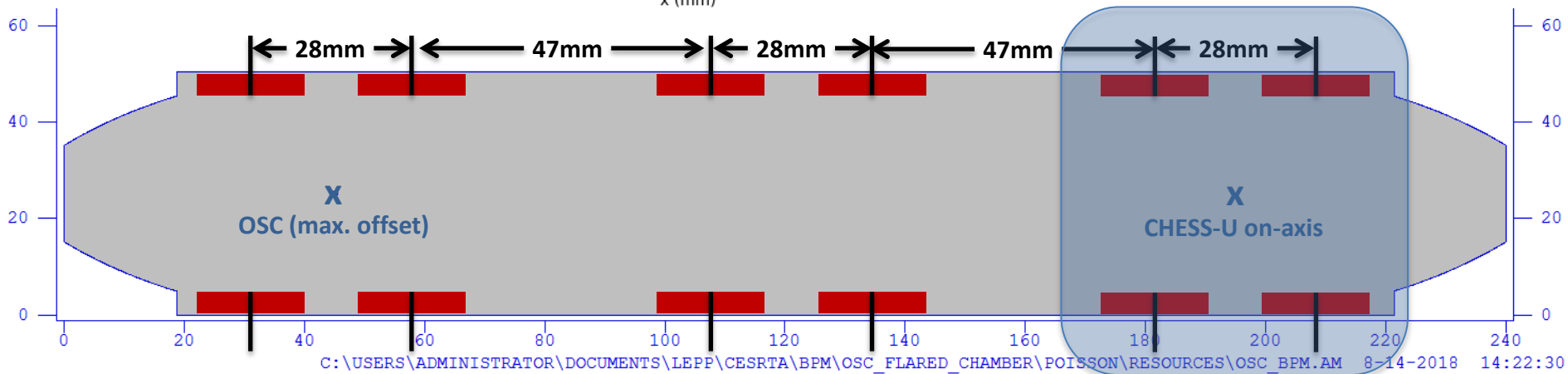
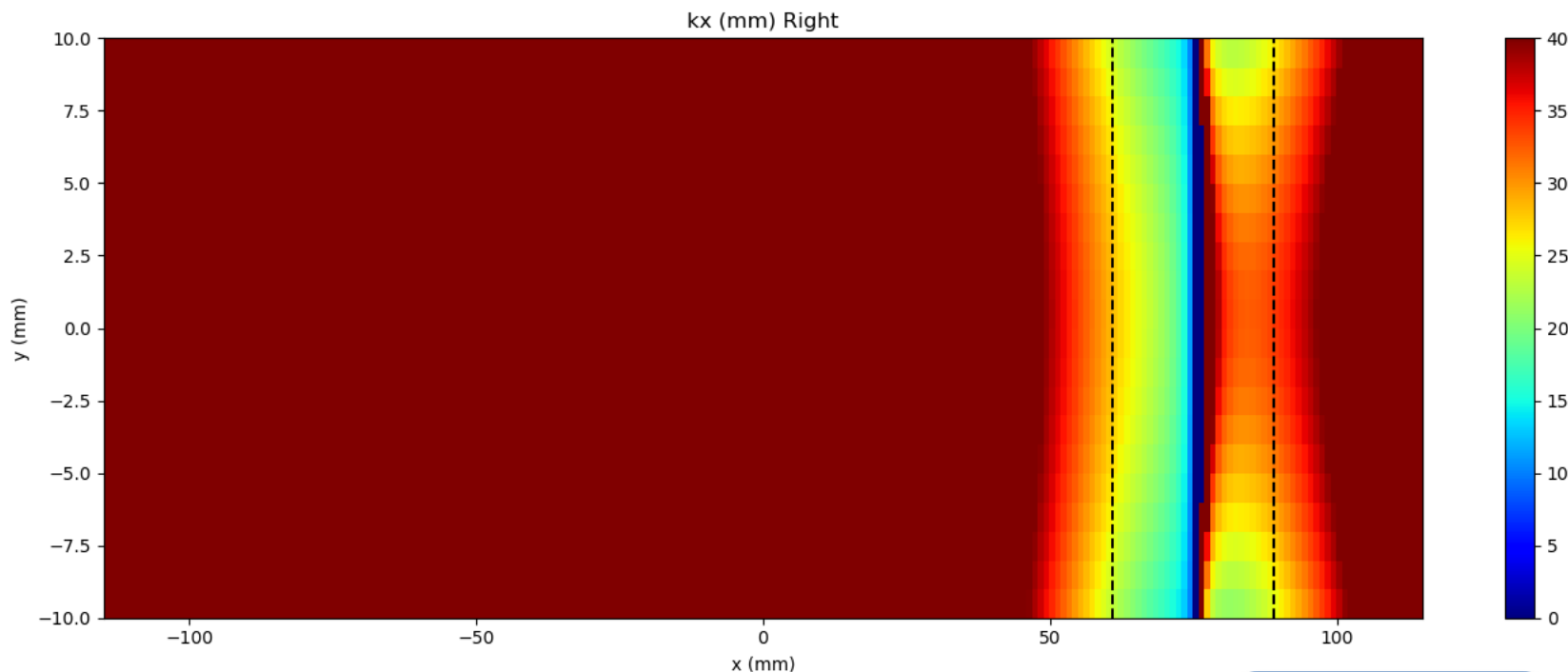


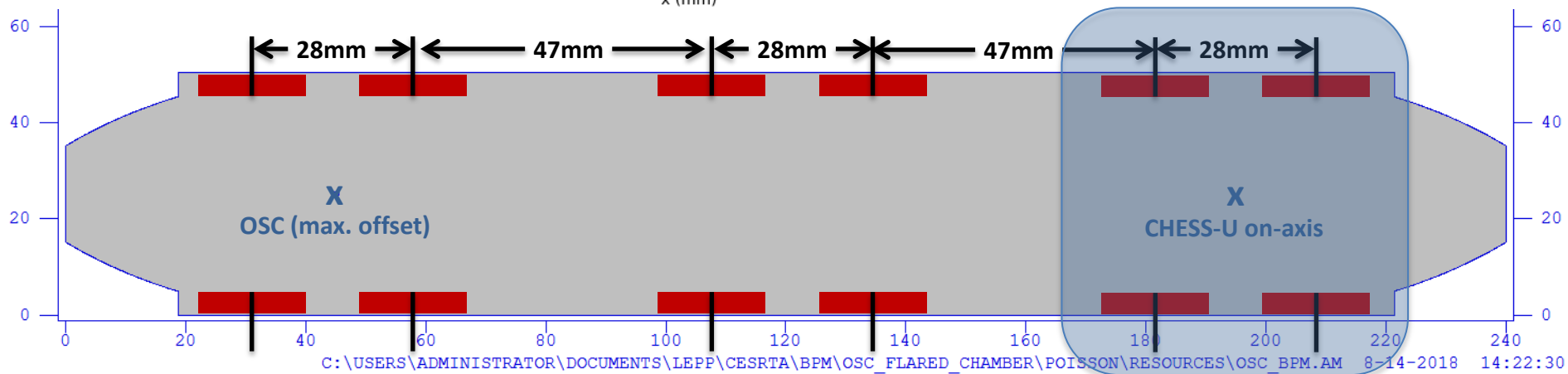
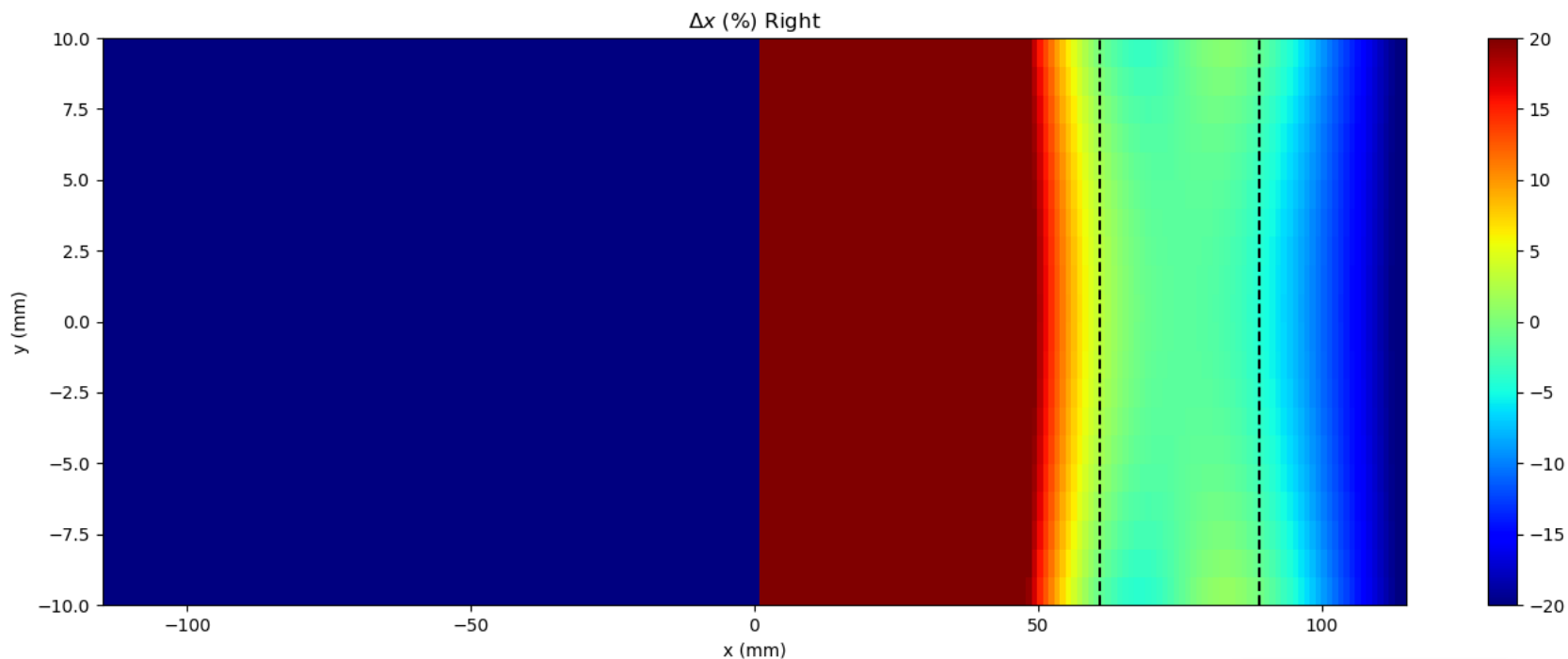
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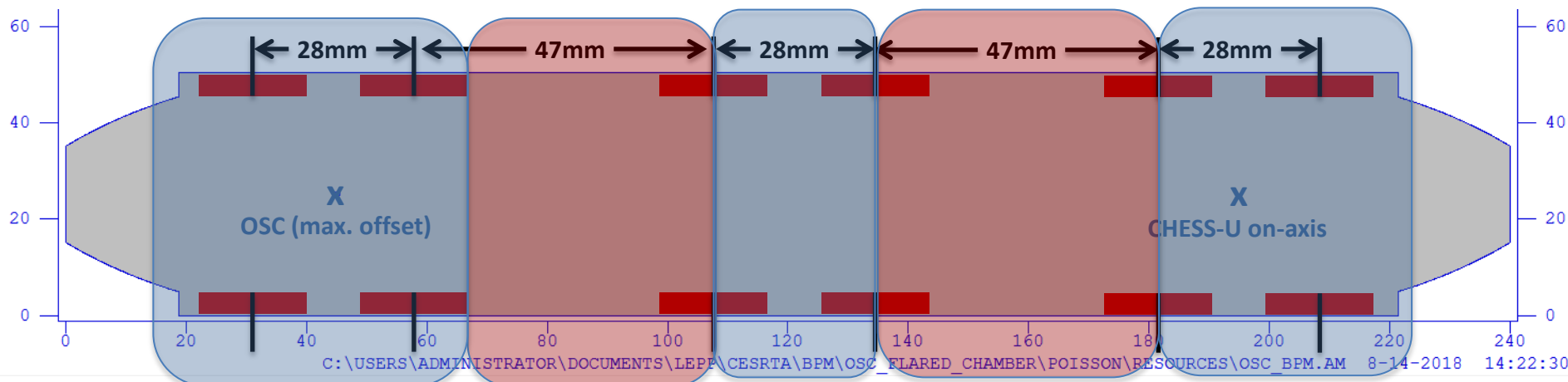
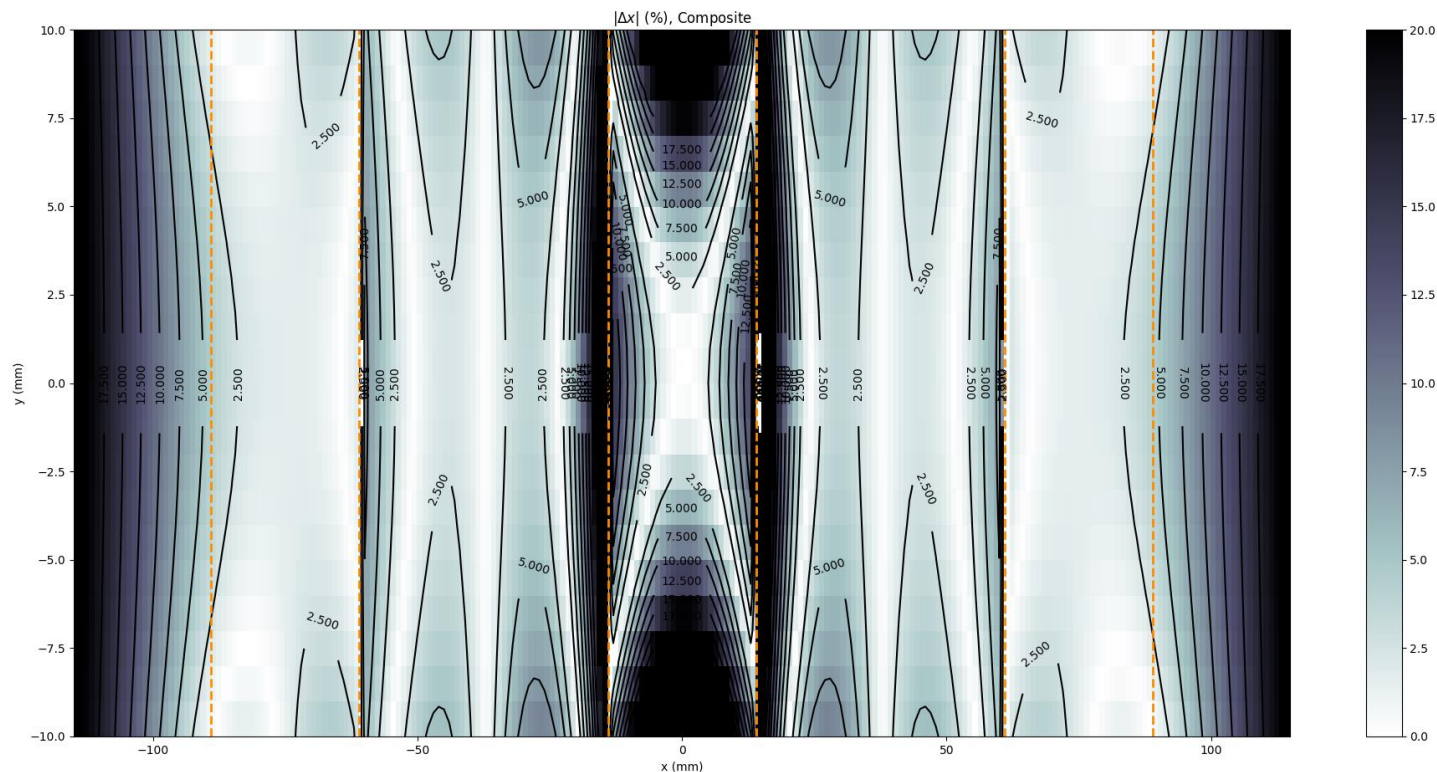






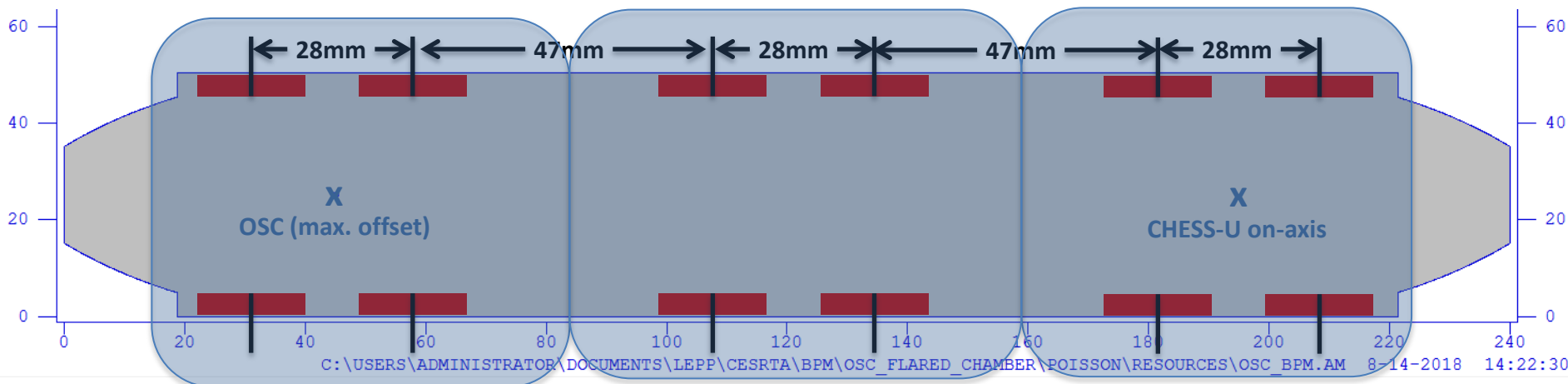
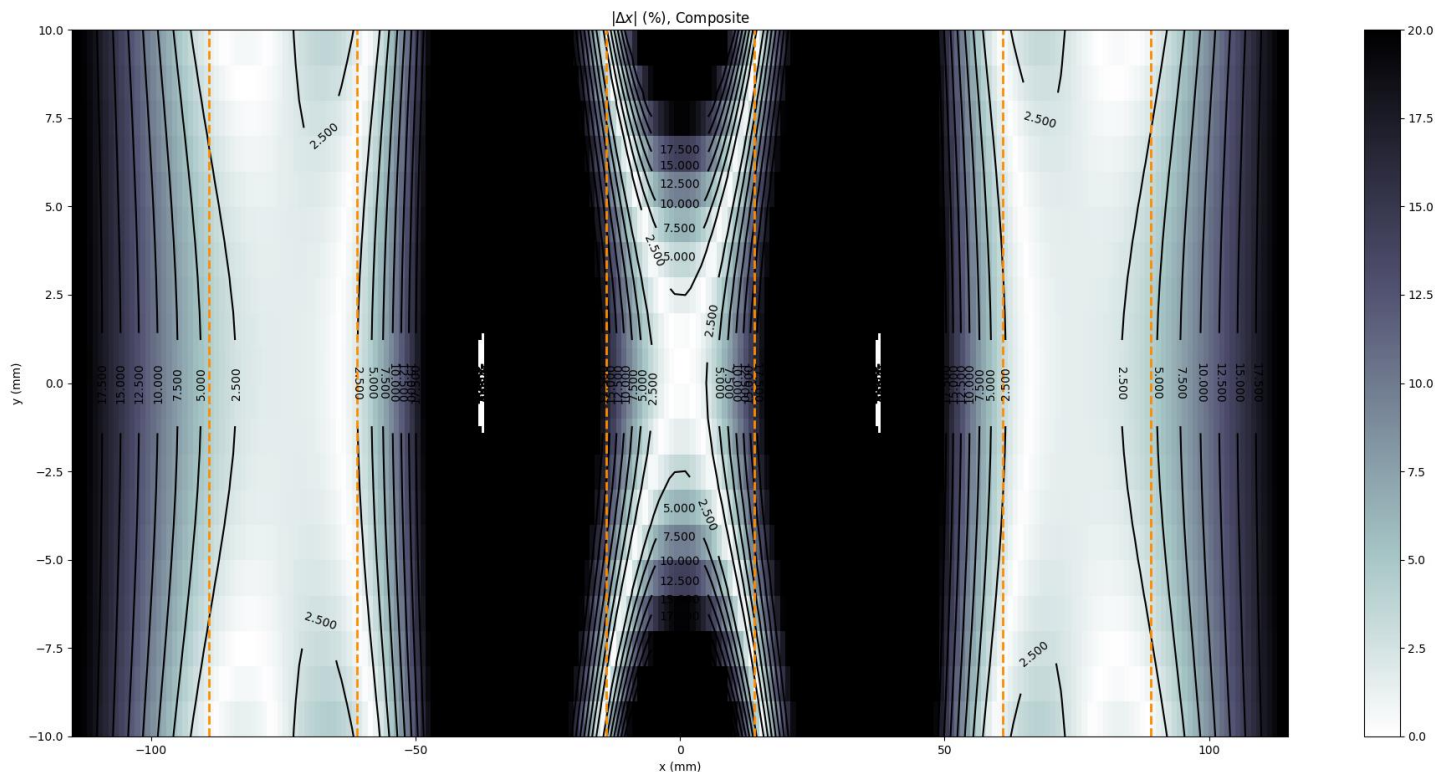


# $\delta_x$ Composite – All Regions



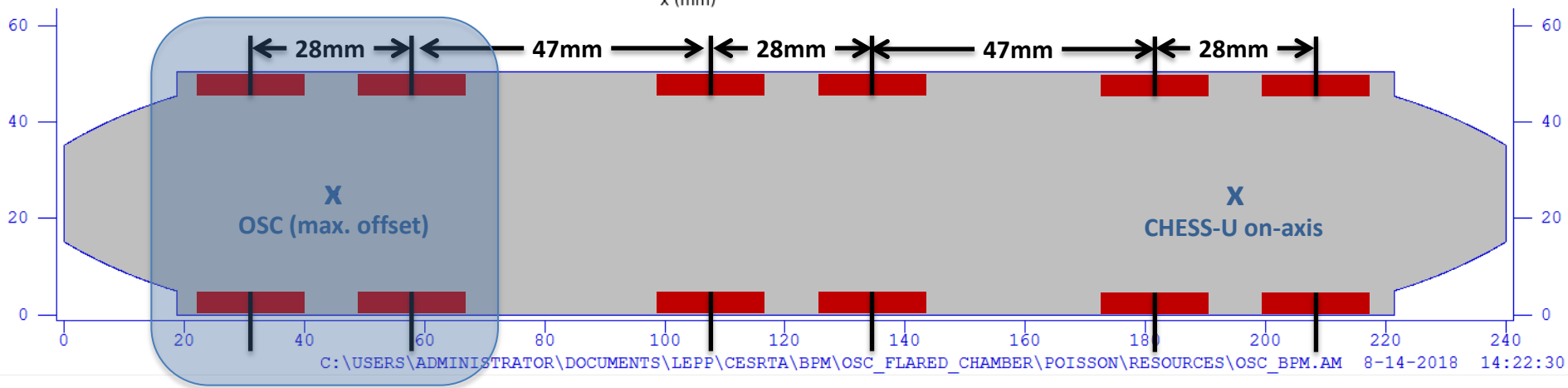
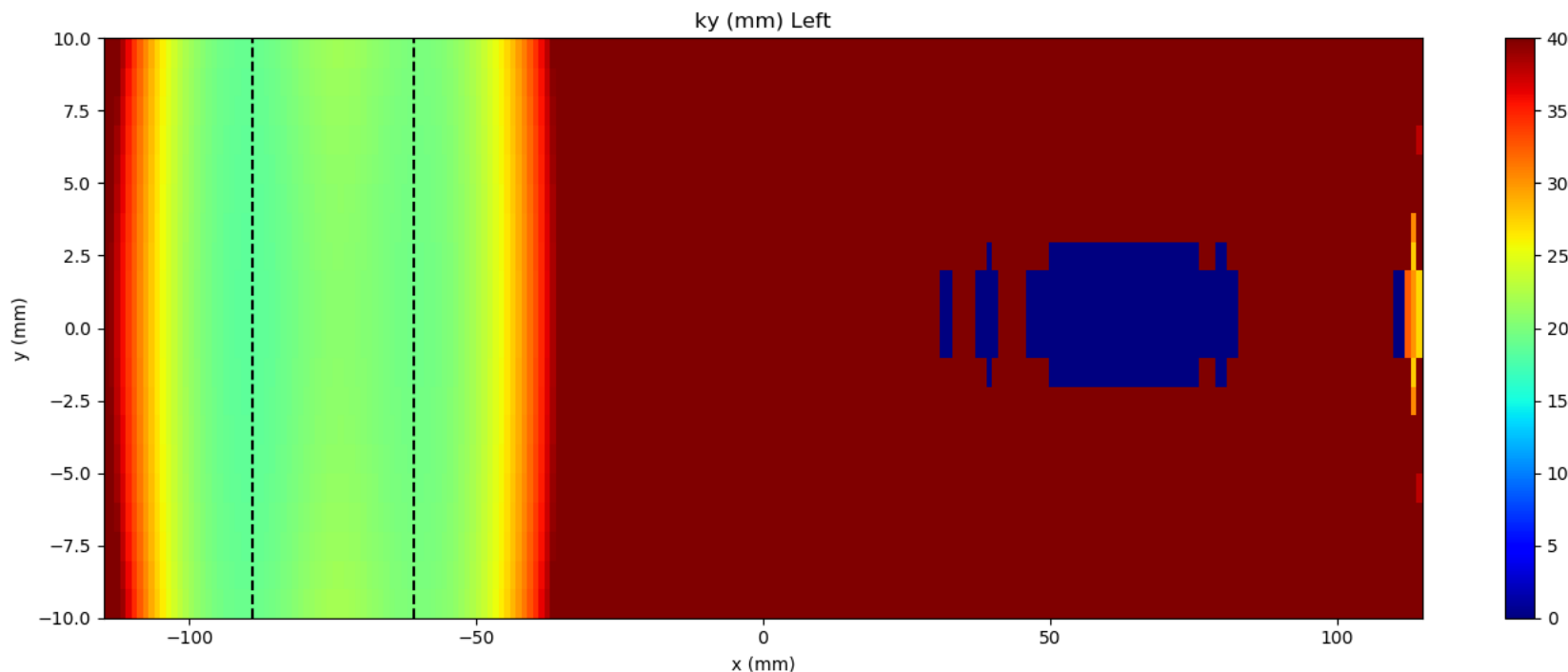


# $\delta_x$ Composite – Regions 1+3+5

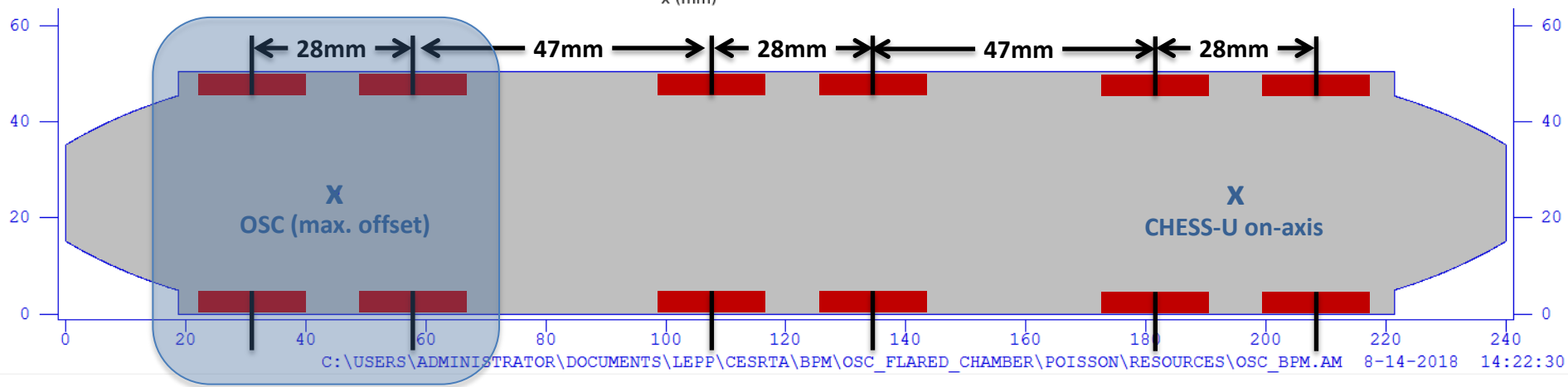
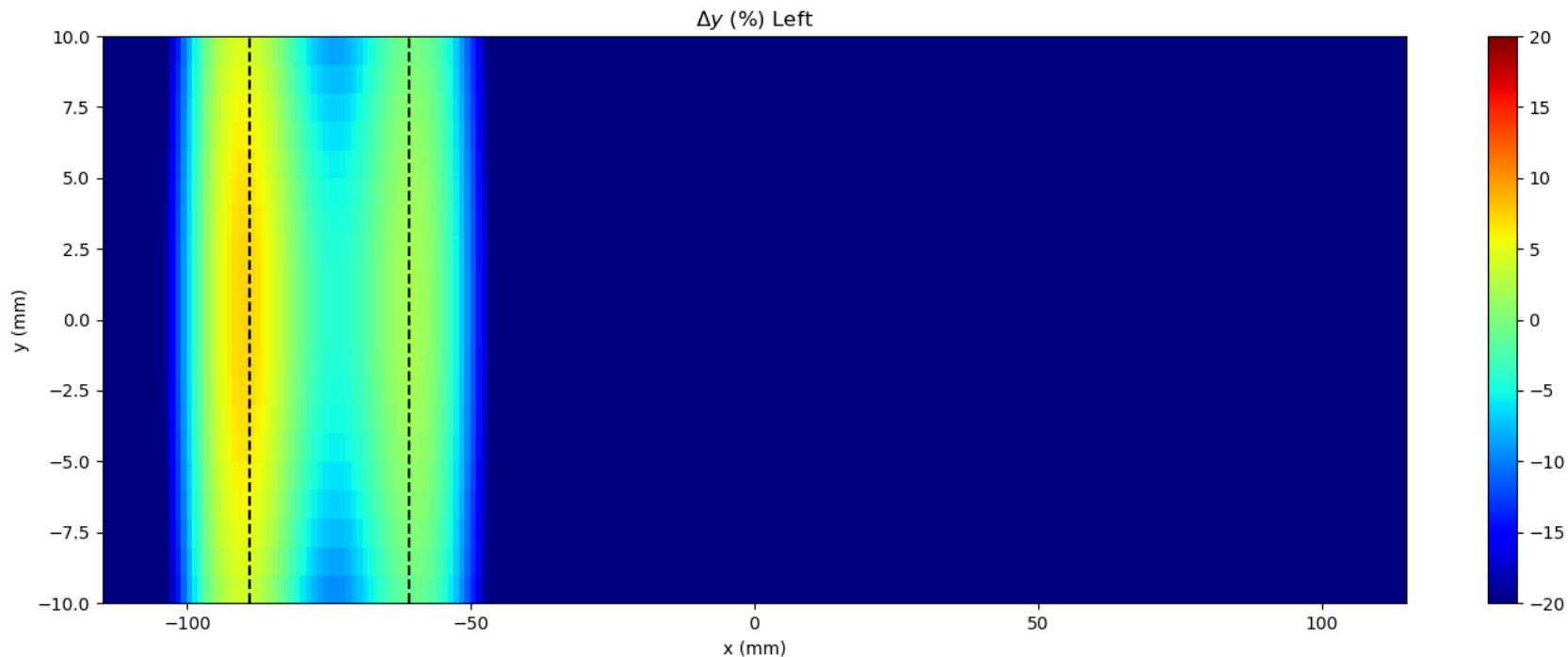


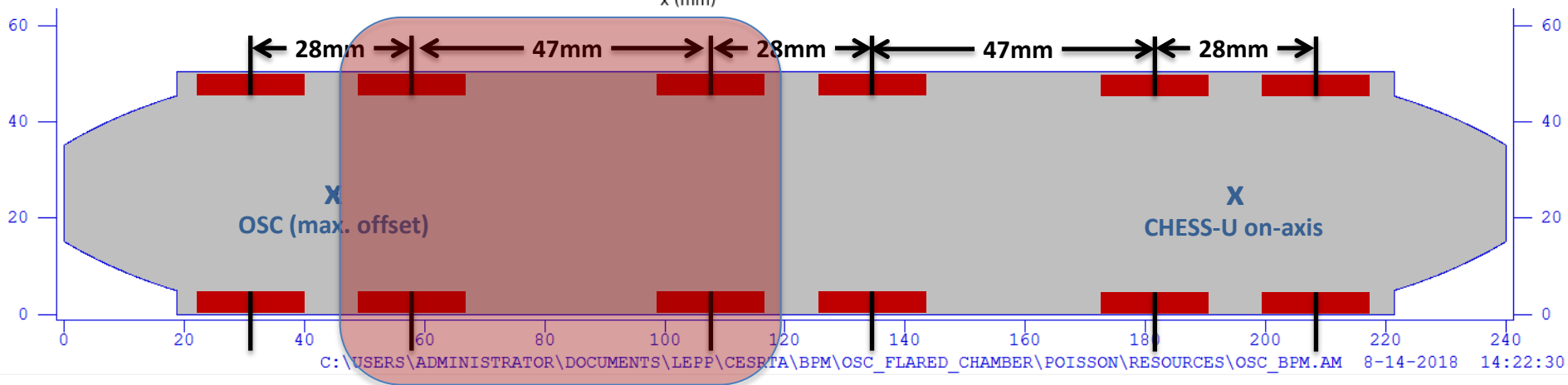
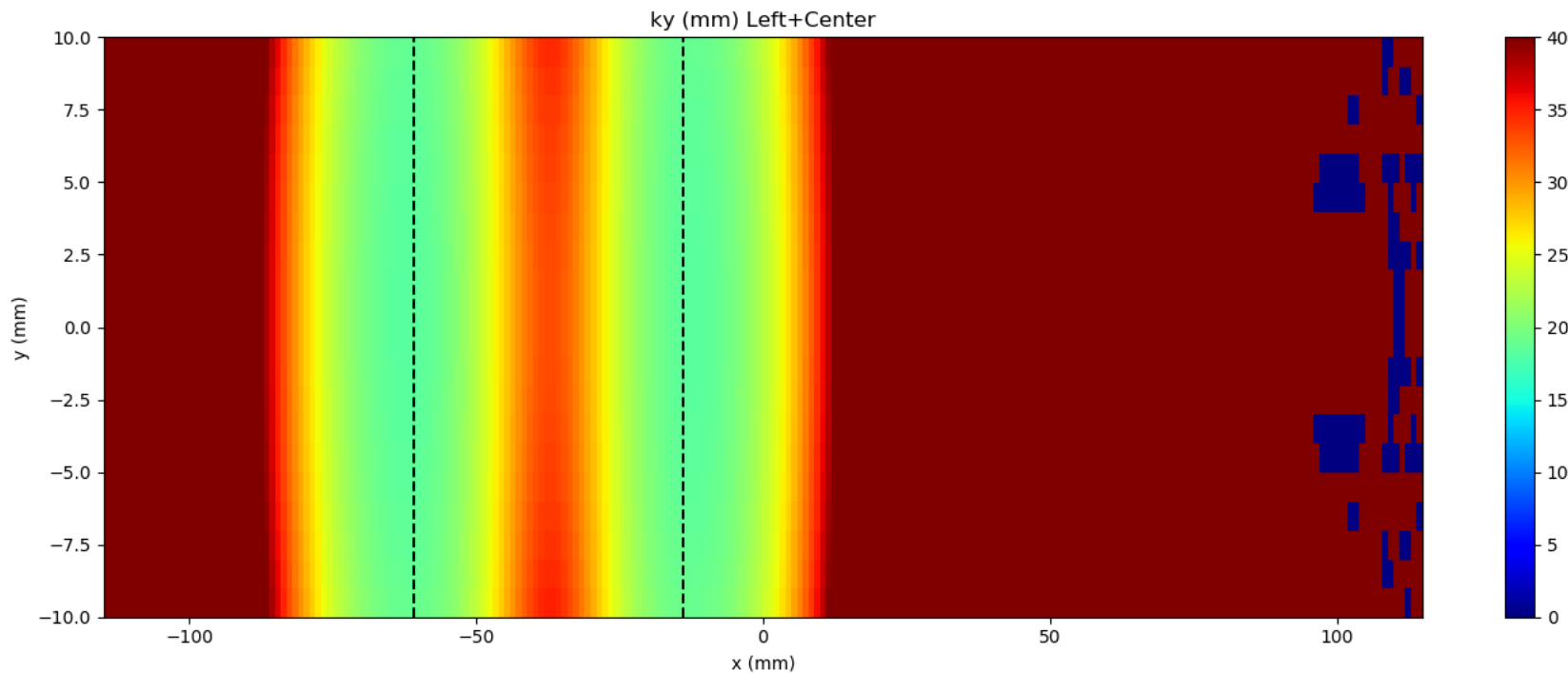


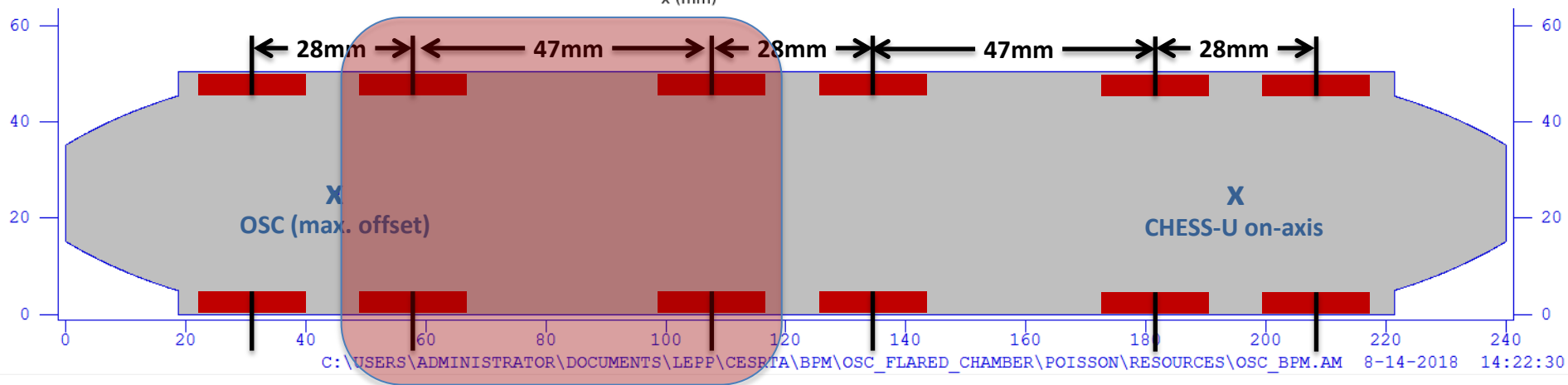
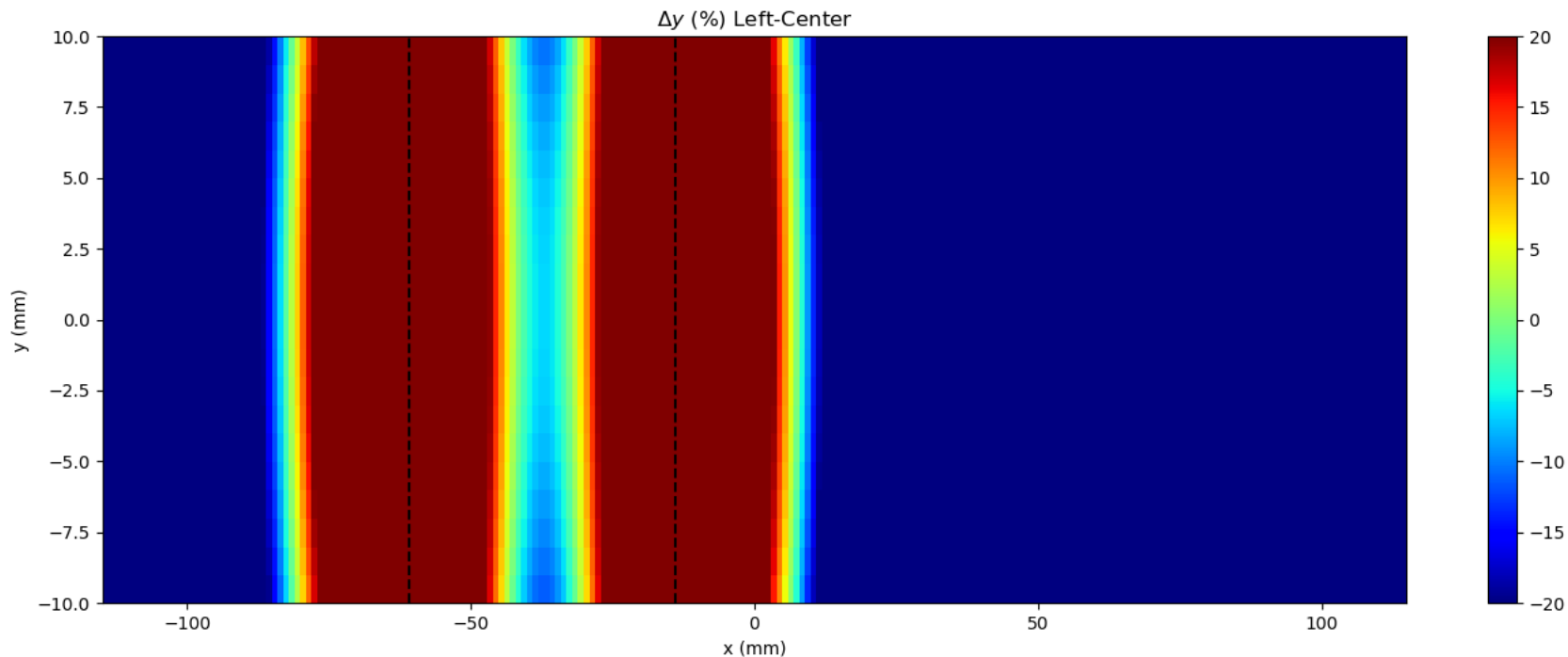
- Using all 5 combinations of buttons, nearly the entire horizontal span can be measured with O[5%] precision using only linear approximation
  - Dead bands at  $\pm 14$ -16mm where measurement is poor
- All 5 combinations are necessary to achieve best accuracy

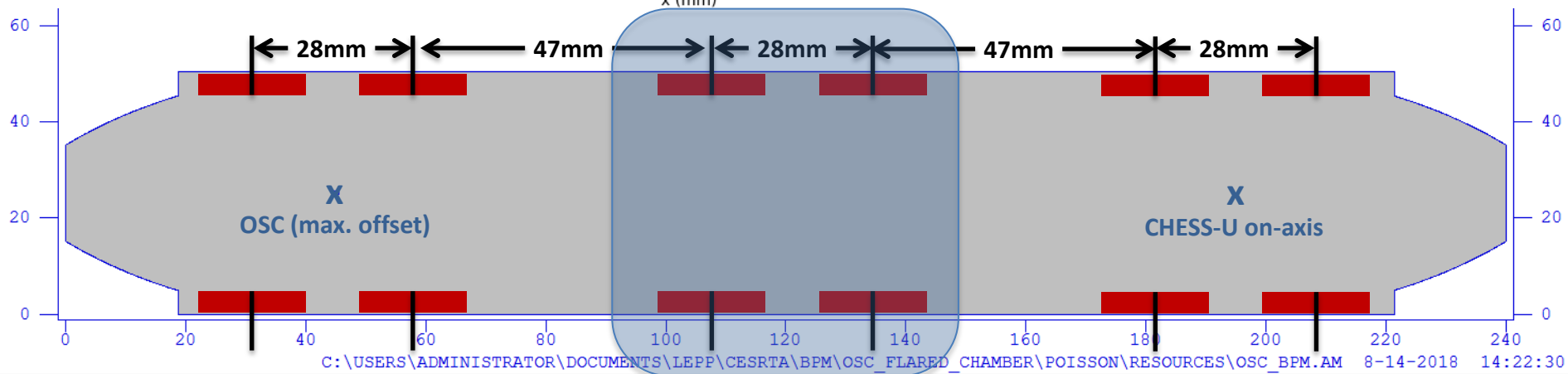
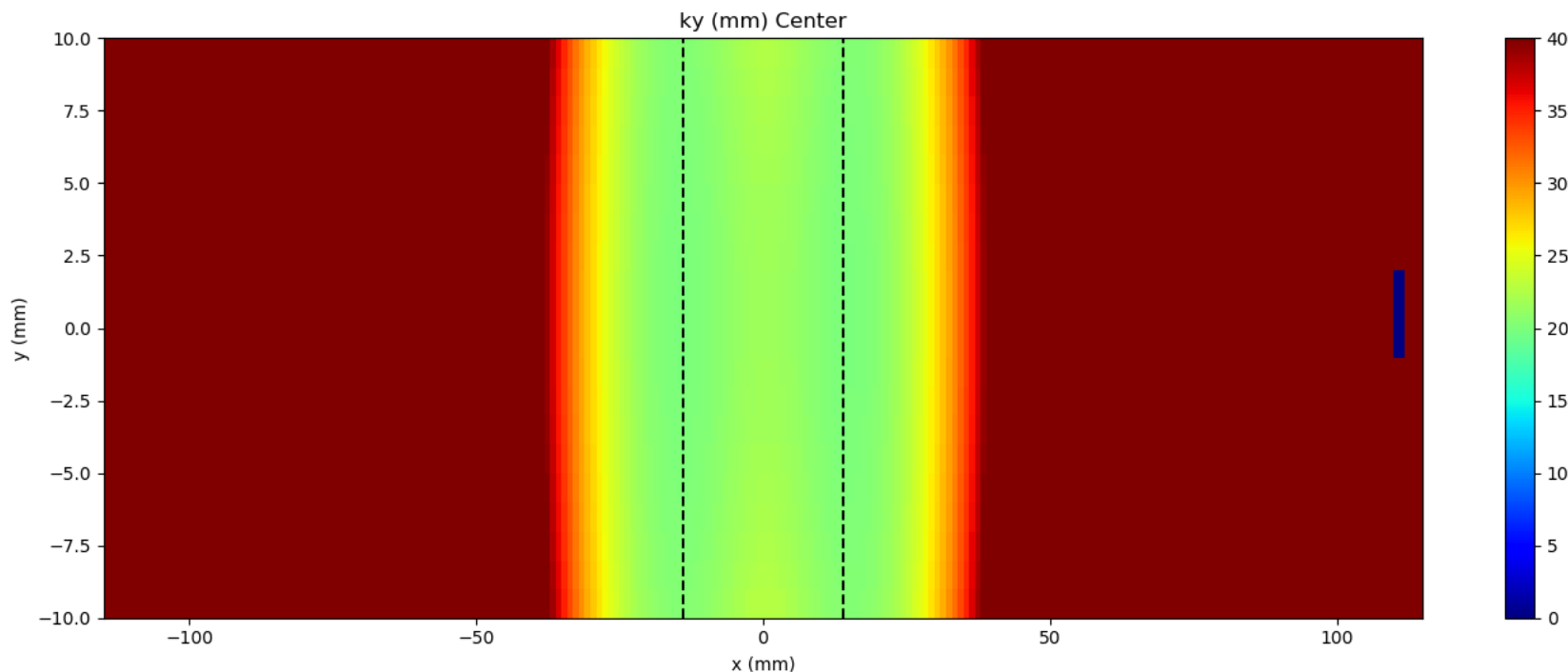


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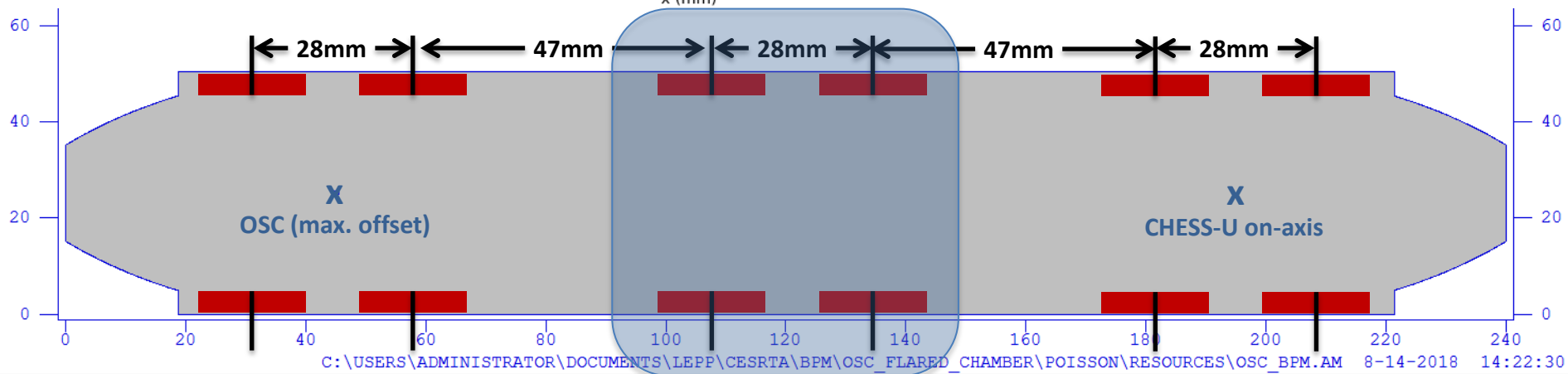
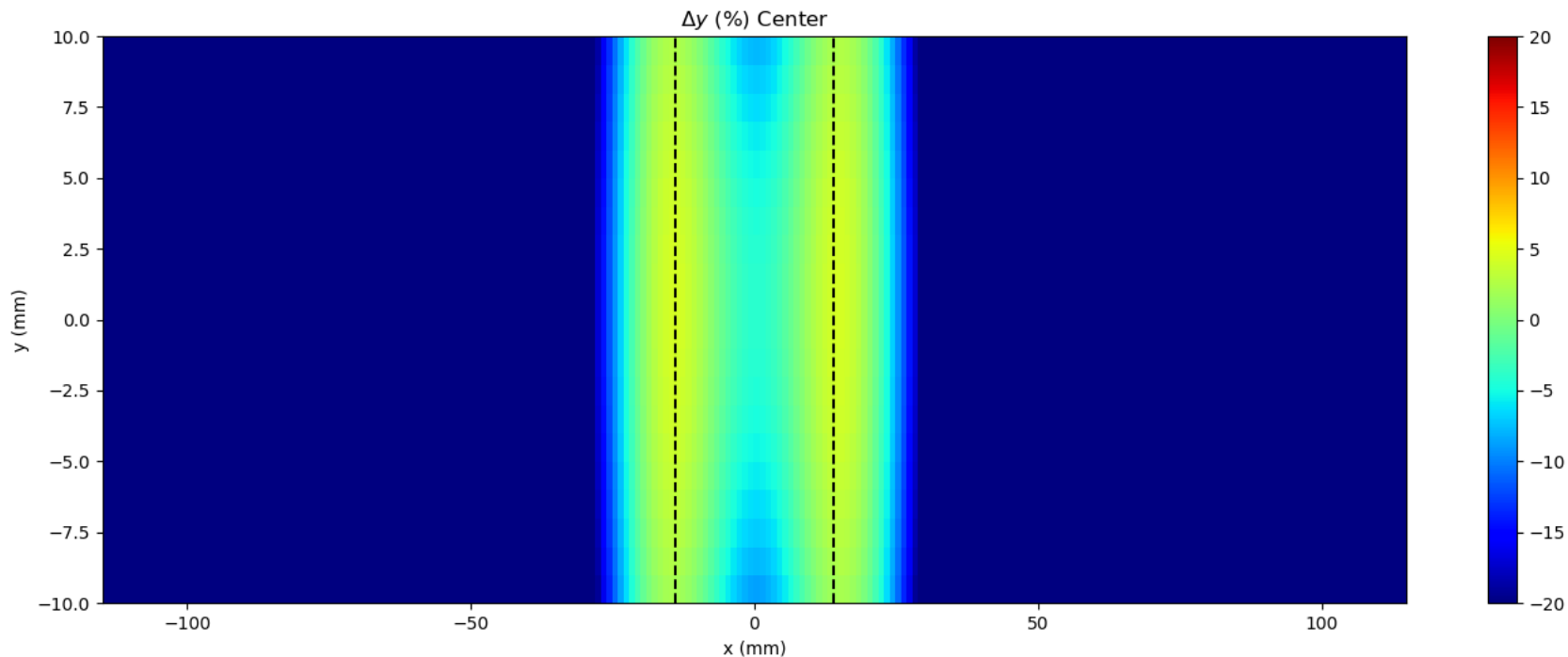


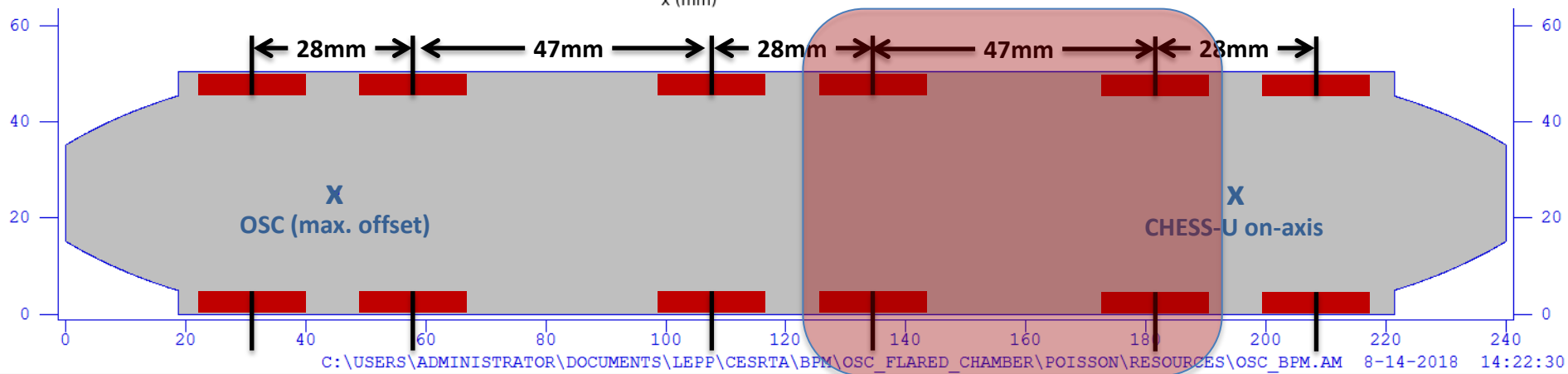
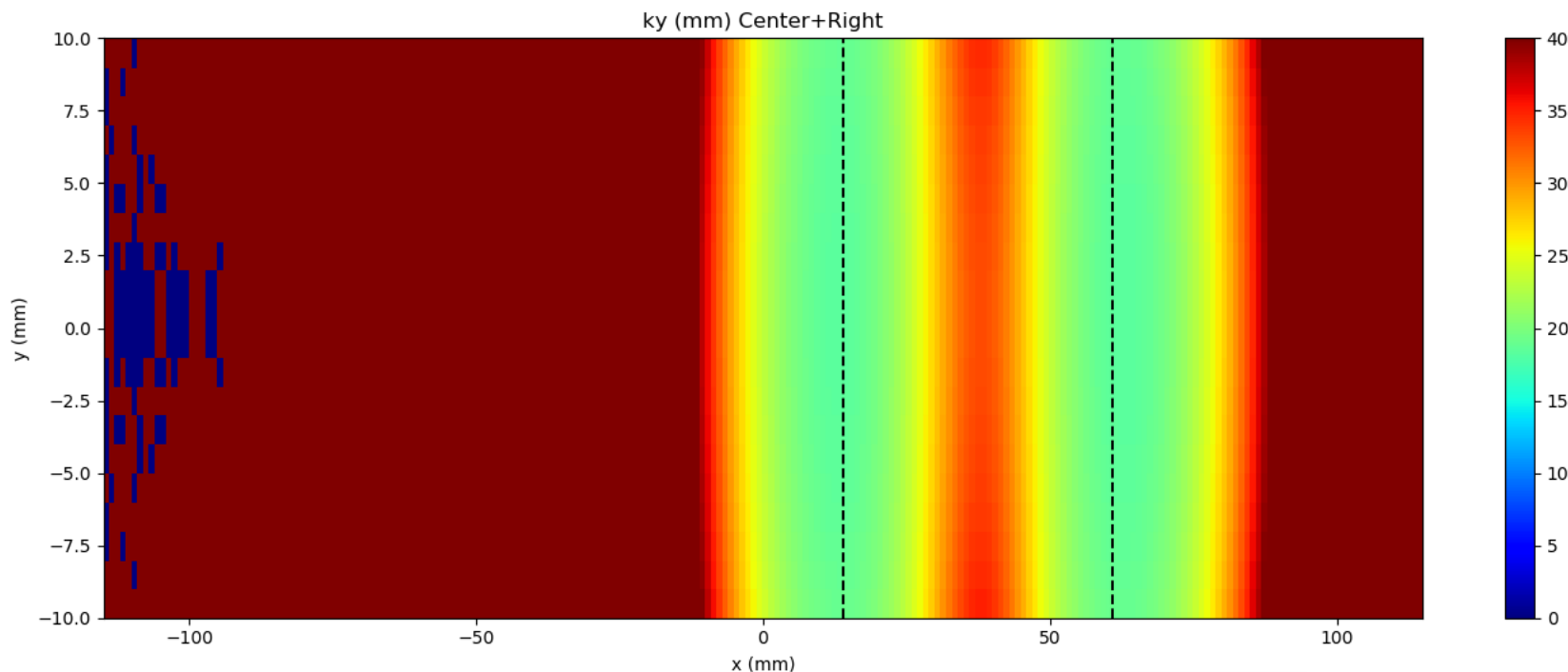


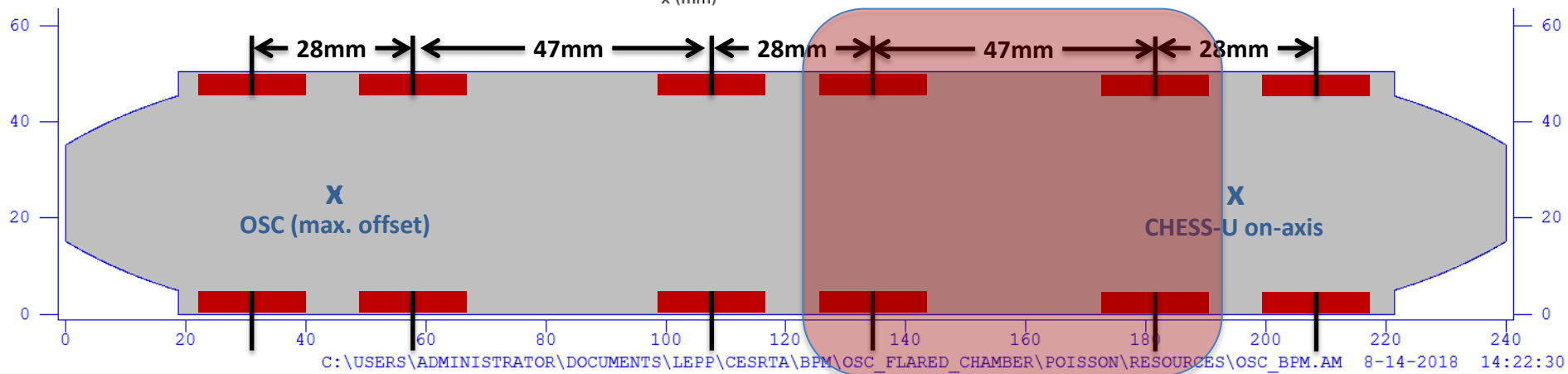
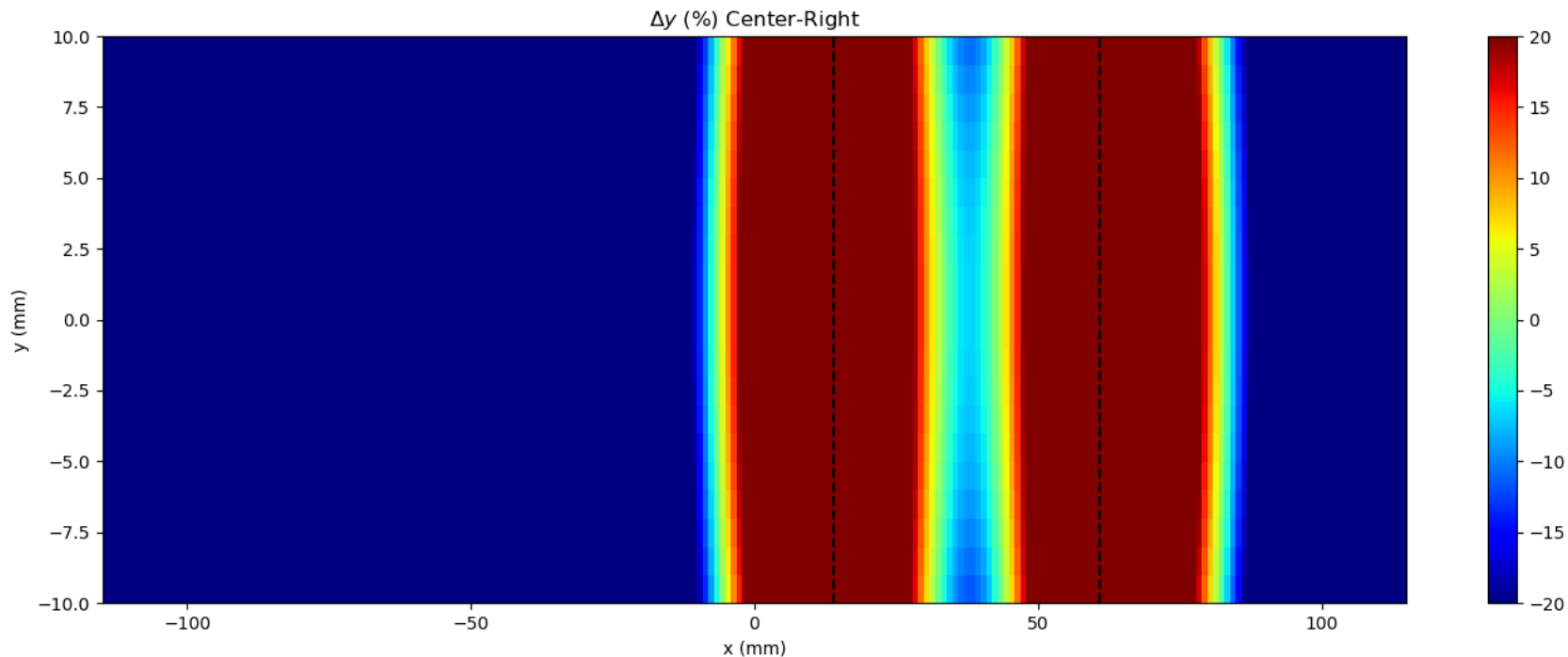


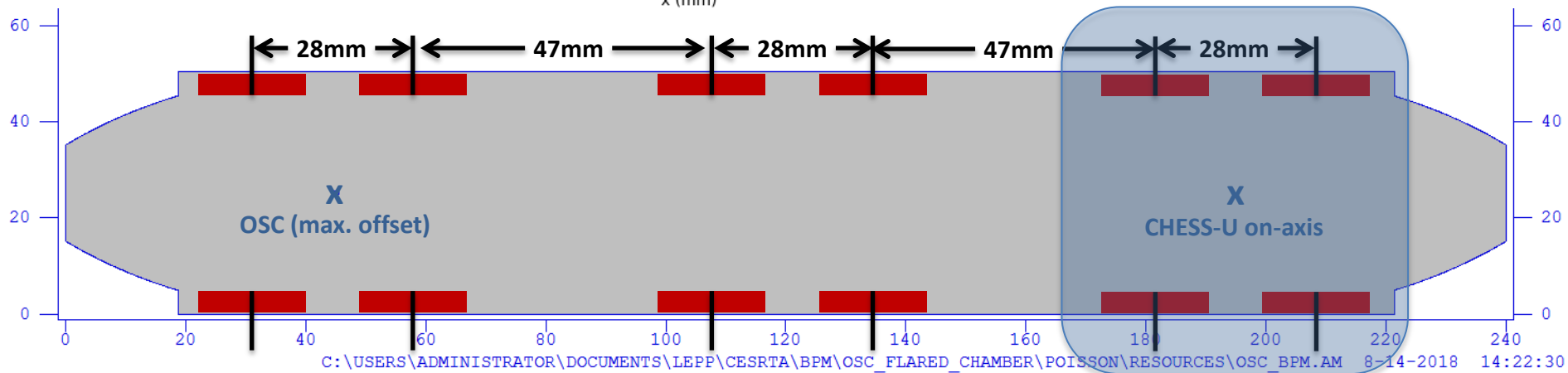
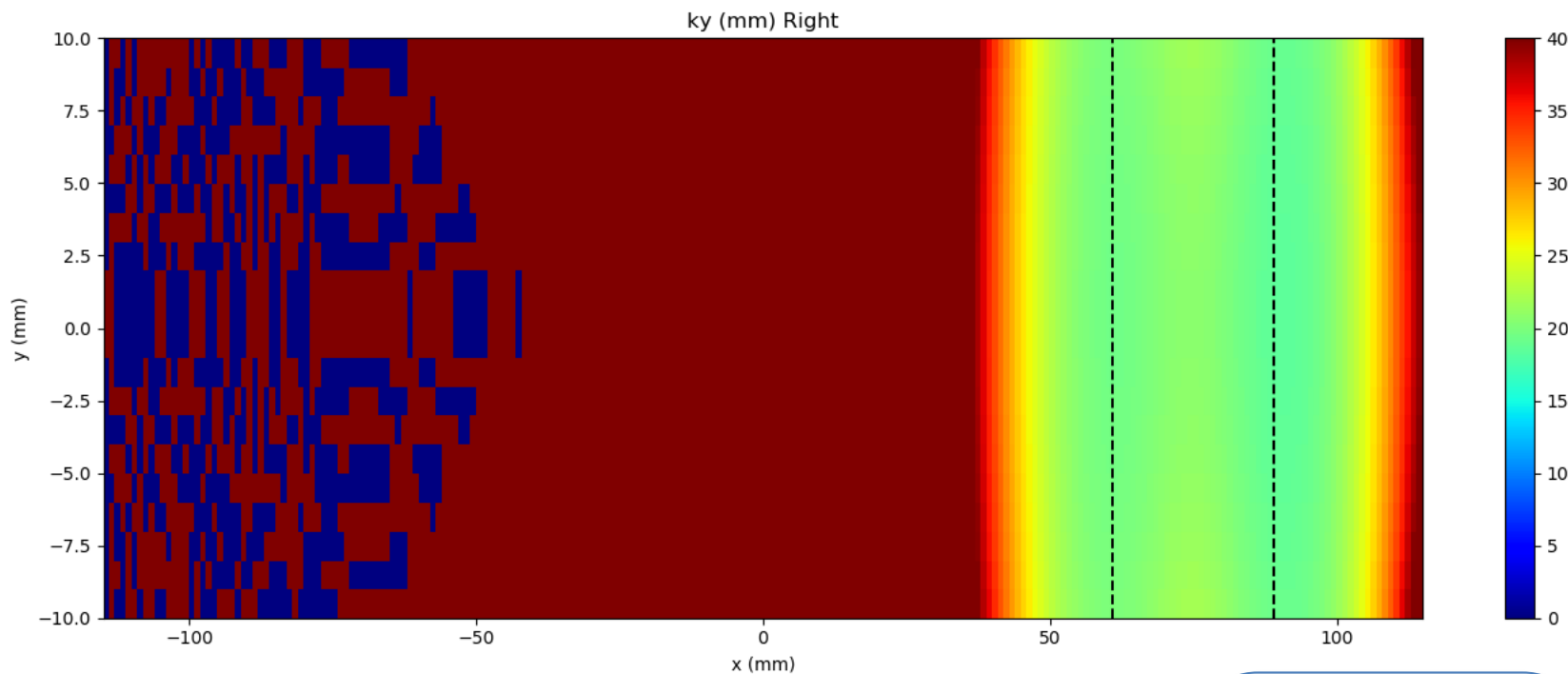


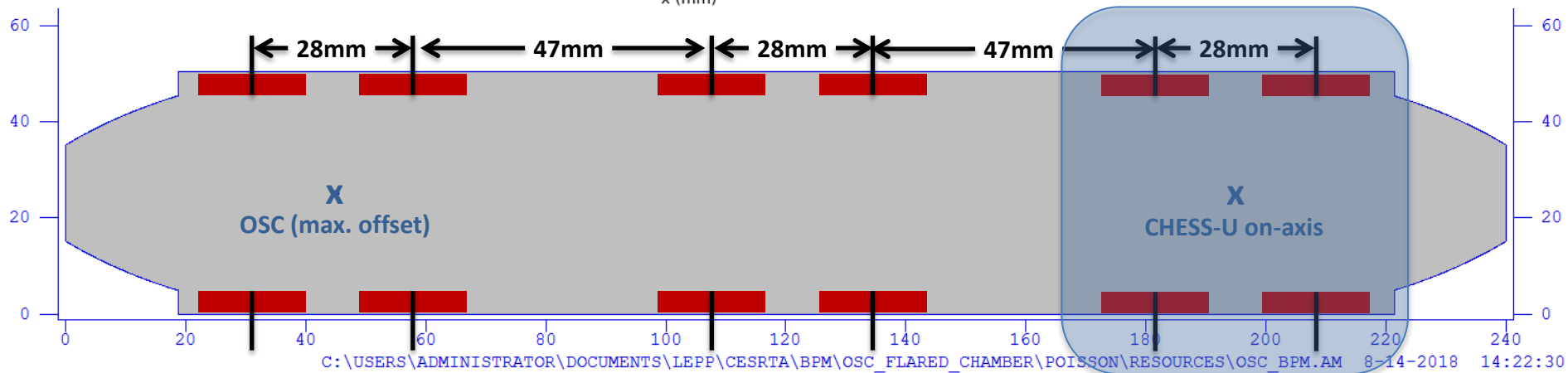
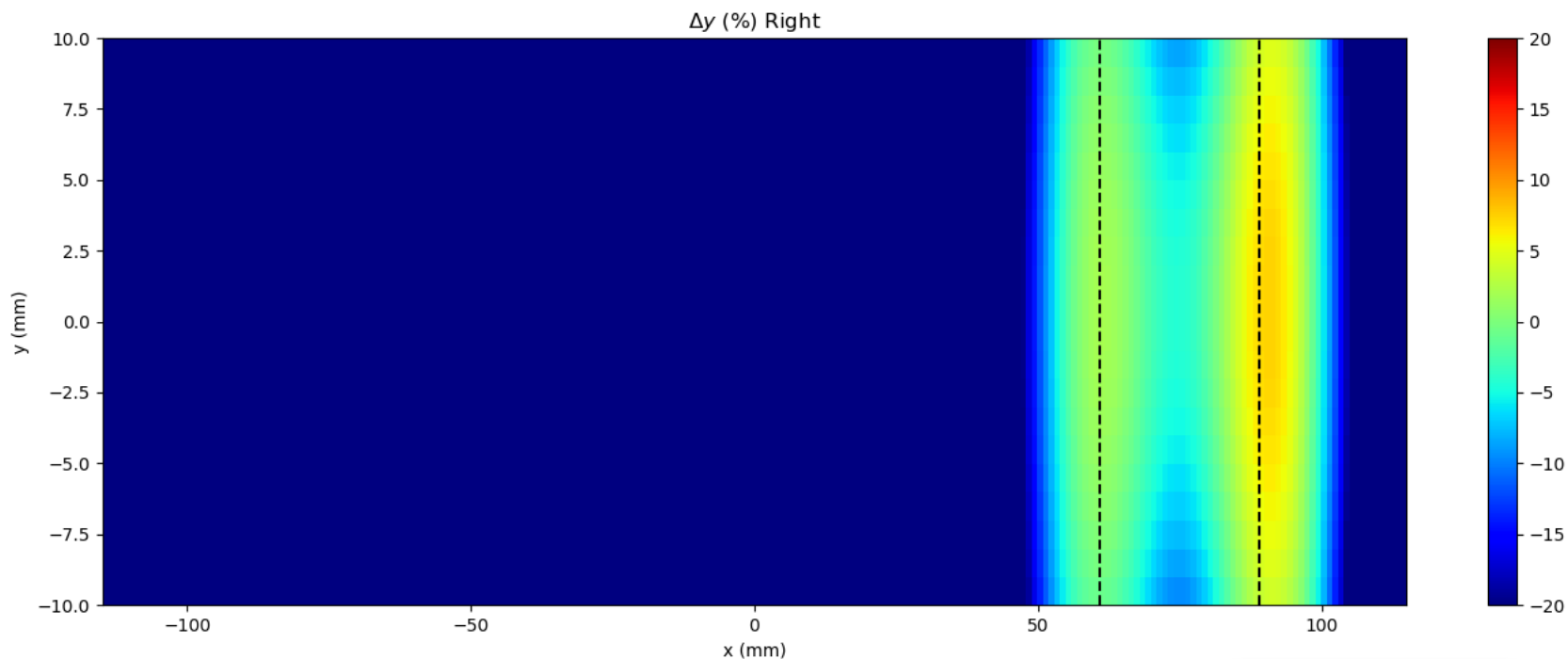






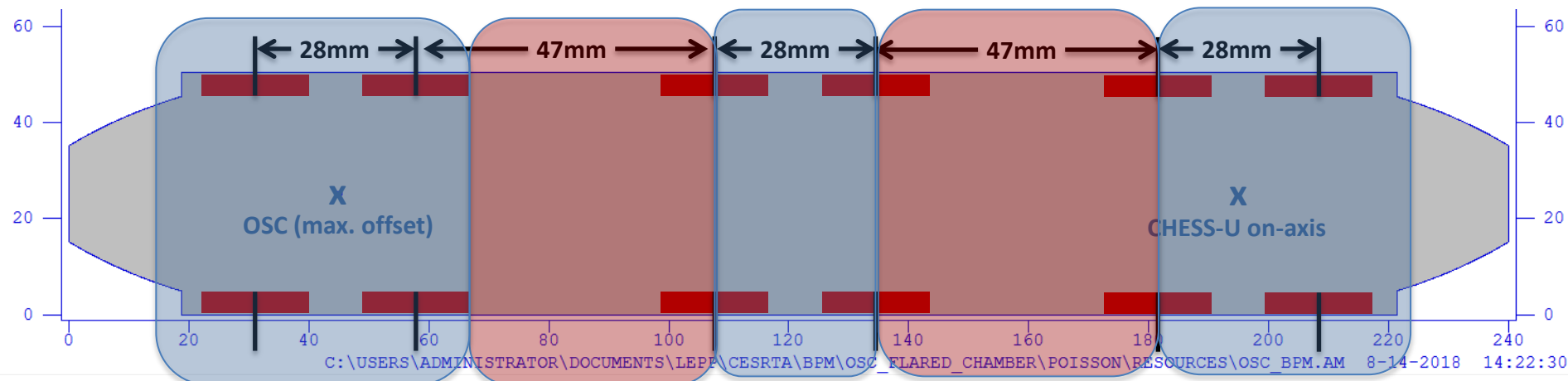
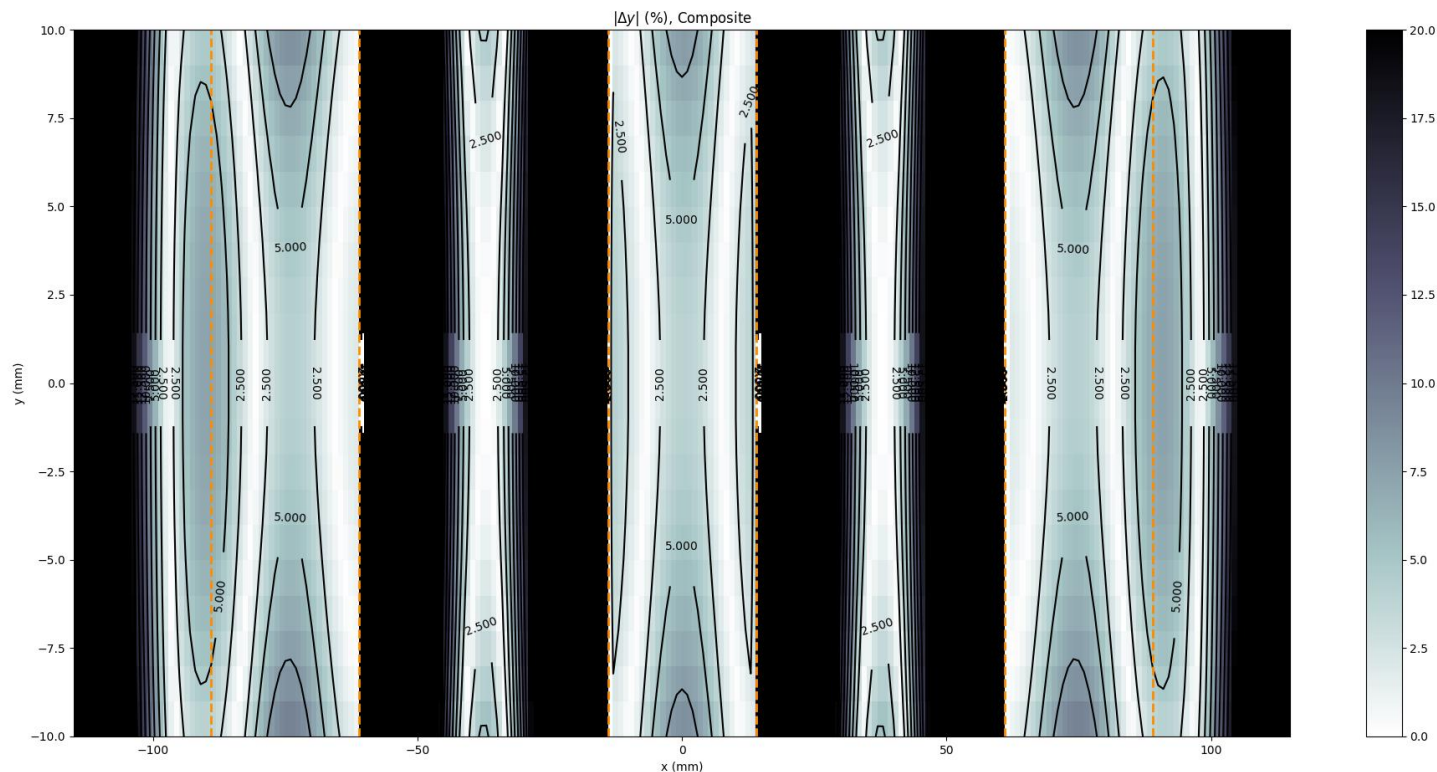






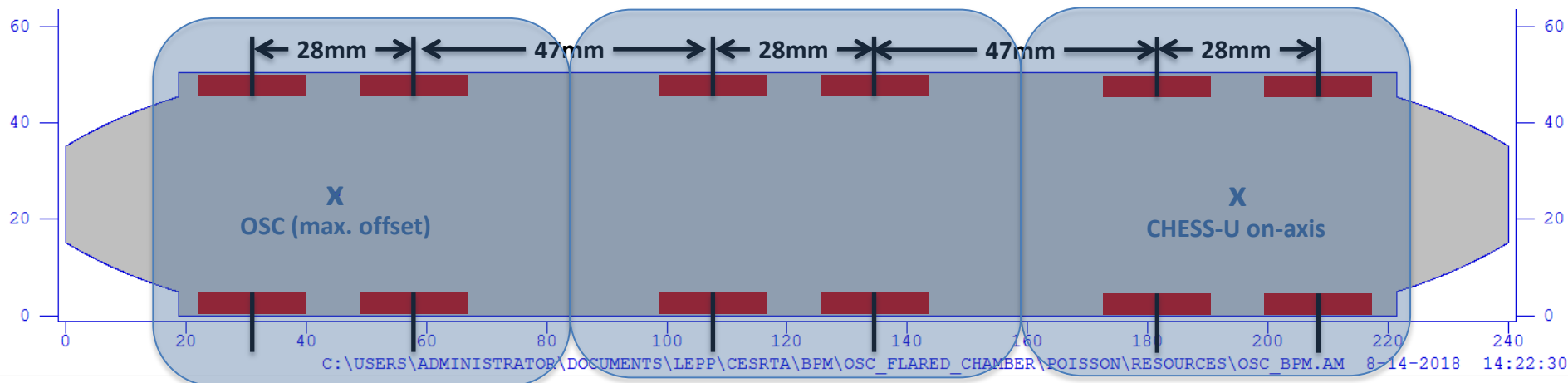
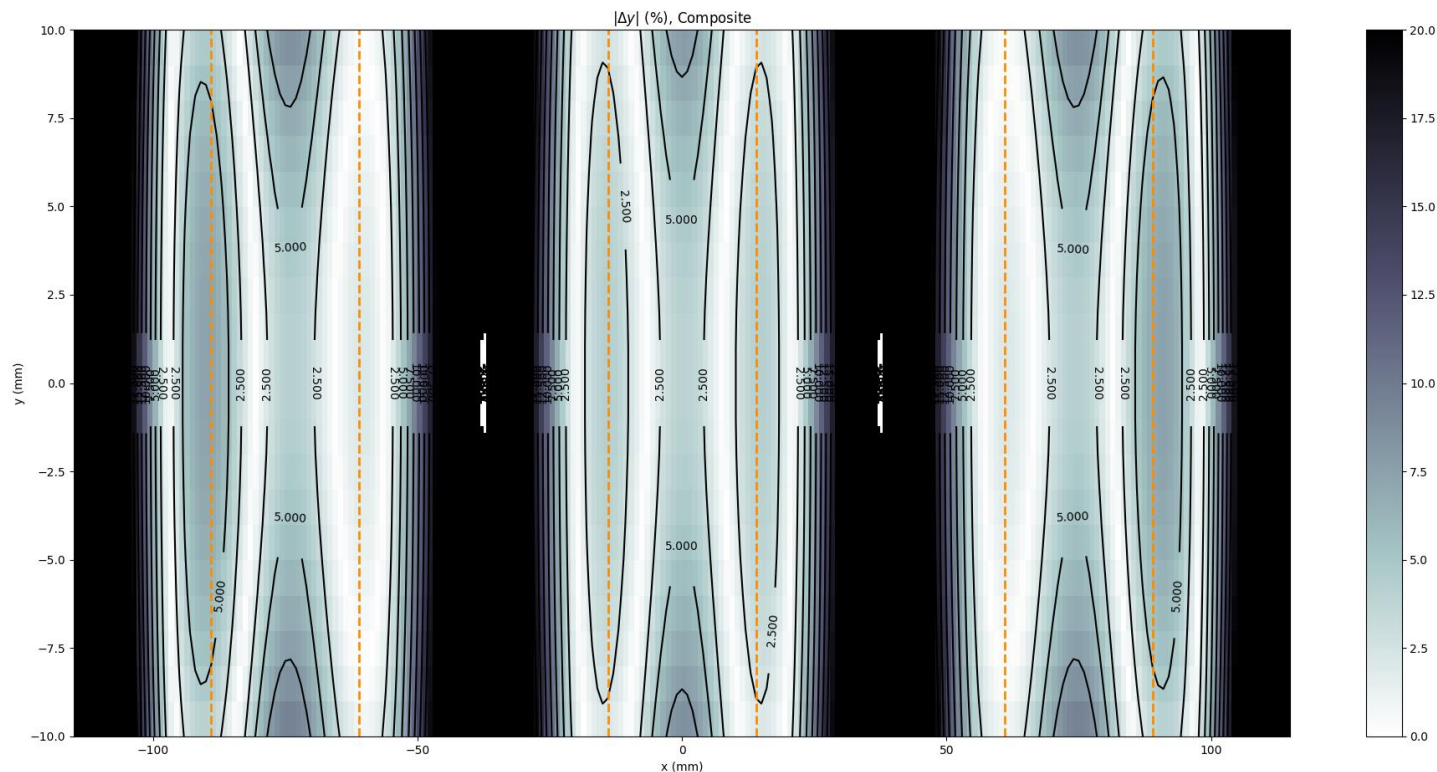


# $\delta_y$ Composite – All Regions





# $\delta_y$ Composite – Regions 1+3+5





- Tradeoff on dead bands when using all 5 button combinations vs. only the three “high-precision” combinations
  - Best-case scenario: dead bands at  $\pm 27$ -47mm