Emittance Measurement

Preparations

- Option: Adjust BSA size
- If BSA was changed: BBA
- Option: update steerer settings
- Create folder in \Measure\TransvPhSp\"year"\"emittance folder": yyyymmddS with S=N,M or A or start fastscan3 to create folder automatically
- Create excel file for solenoid scan and statistics (copy from older folder)

Laser conditions

- Document laser transverse profile at VC2
    - Adjust laser to 1 pulse and LT <50%
    - Connect Video Client to VC2 (if needed: turn camera on)
    - Push in mirror VC2
    - Open shutter, adjust LT to have no saturation
    - Menu: "Image", then "Background" → Grab and Save e.g. 10 frames (\Measure\Laser\TransverseProfile\VC2\"year"\ "emittance folder": yyyymmddS with S=N,M or A)
    - Load Background (Menu), load Image (Menu)
    - Print VC2 pictures to logbook
        1. Circular area of interest, add information: xRMS; yRMS
        2. X-cut
        3. Y-cut
    - Close shutter
    - Pull out mirror VC2
- Document laser longitudinal profile with OSS
    - Start LabView script on Streak Camera Control computer (Measure with OSS HiRes – use this.vi) – run measurement
    - Switch on OSS
    - Increase laser to 600 pulses, simultaneously press 'save to file' in LabView
    - Create folder in \Measure\Laser\OSS\"year": yyyymmddS with S=N,M or A
    - Save file as hhmm.oss (hours, minutes)
    - Open MatLab on Streak Camera Control computer, choose Fit Program for flat top or Gauss, run program
    - Fit OSS measurement, print to PITZ log book ("cold OSS")
    - Wait a few minutes, repeat measurement and fit, print to logbook ("warm OSS")
    - Close LabView and Matlab
    - Decrease laser to 1 pulse, switch off OSS

Charge/Momentum

- Option: Phase scan
- Option: Adjust Gun phase to have strong electron beam
- Put solenoid to high current to collect charge (e.g. 425A for Faraday cups; 350A for High1.ICT1))

- Start MatLab script for charge measurement – standard: High1.ICT1 (for Q<500pC use Low. FC1)
- Adjust LT until charge needed for measurement is reached
- Measure charge; print to logbook
- Remove Low.FC1/2 from beam pipe if it was used
- Measure momentum after gun with LEDA
    - Disp1.Scr1: YAG
    - Connect Video Client to Disp1.Scr1 (Bin2x2)
    - Adjust Low.Dipole current, solenoid+bucking current and number of laser pulses to see gun phase sweep around maximum on screen (typical numbers for 1nC, gun at full power: Low.Dipole -1.75A, solenoid 480A, 3 pulses)
        1. If needed adjust steerer magnets (Low.ST2 or Low.ST1)
    - Run OMA script (open MatLab, go to /doocs/measure/scripts/MatlabScripts/OMA/OMA and type “oma” or type “otetool oma”) – (statistics: typical 20 or 30)
    - Print momentum scan and statistics for momentum distribution at MMMG phase to logbook
    - For off-crest measurement: Also print statistics for momentum distribution at off-crest phase to logbook
- Re-measure charge at MMMG gun phase (or off-crest phase if that is the one used for measurement), optionally adjust LT until charge needed for measurement is reached
- Remove Low.FC1/2 from beam pipe if it was used
- Option: If adjustment is big re-measure momentum and charge
- Degauss dipole
- Measure momentum after booster with HEDA1 (only if booster is on)
    - Connect Video Client to High1.Scr5
    - Steering: place beam in center of High1.Scr5; most important: vertical (reference screen for Disp2.Scr1) – lens f100 to see the whole screen
    - Focus the beam at High1.Scr5 using High1.Q6 (closest quad to HEDA1 dipole) to minimize the vertical beam size (use bigger magnification lens and full frame to be more precise) – keep beam position unchanged
    - Make screenshot in the logbook where the vertical RMS beam size can be seen clearly (for small sizes use bigger magnification lens)
    - Disp2.Scr1: YAG and lens f120 (zoom)
    - Connect Video Client to Disp2.Scr1 (Bin2x2)
    - Adjust High1.Dipole current, solenoid+bucking current and number of laser pulses to see gun phase sweep around maximum on screen (typical numbers for 1nC, gun+booster at full power: High1.Dipole -91A, solenoid 390A, 1 pulse)
    - Run OMA script (statistics: typical 10 or 20)
    - Print momentum scan and statistics for momentum distribution at MMMG phase to logbook
- Option: Re-check charge at High1.ICT1
- Degauss High1.Q1
- Degauss dipole

Emittance measurement with EMSY1

- *EMSY2: High1.Scr1 → High1.Scr3; High1.Scr4 → High1.Scr5*
- Open shell in LINUX, type: "fastscan3" if not already running
- Option: Open shell in LINUX, type: "emcalc3"
- In fastscan3: Click 'Options…'
- Fill must file: click 'Open…'
- Print Program report (Musthaves) to logbook
- Adjust 'Video server' to High1.Scr1
- Beam size measurement at EMSY1 (High1.Scr1) vs. solenoid current
    - Connect Video Client to High1.Scr1 (Bin 2x2)
    - High1.Scr1: YAG and lens f160 (or f250)
    - Option: Adjust High1.St1 to center the beam on High1.Scr1
    - Scan solenoid+bucking current to find range around beam minimum. Range for emittance measurement e.g. I_{min} to I_{min}+8A (or compare to earlier measurements)
    - Adjust table in excel file to solenoid scan range
    - Set solenoid+bucking current to maximum value of range
    - Measure beam size
        1. Adjust camera gain and number of pulses to be close to saturation (minimize number of pulses to reduce jitter)
        2. Click 'Scan…' then 'Fast scan, EMSY and MOI' then 'EMSY'
        3. Click 'Plot EMSY and create beam.log'
        4. Print EMSY spot to logbook
        5. Fill in EMSY Xrms and Yrms , NoP and gain in Excel Table
        6. Set solenoid+bucking current to next value of range, go to point 1.
    - Option: Manual calculation of beam size
        1. In emcalc3: Click 'Calculate…', go to folder with measured beam size (EMSY1.imc), start e.g. with highest solenoid current
        2. Click 'Open' or double click
        3. Click 'Process EMSY spot only'
        4. Fill Xrms and Yrms into excel file
        5. Print EMSY spot to logbook
        6. Go to point 1
    - Option: print beam size summary to log book
    - Remove High1.Scr1
    - Connect Video Client to High1.Scr4 (Hint: open second AVINE video client)
    - High1.Scr4: YAG and lens f160 (or f250)
    - In fastscan3: Click 'Options…'
    - Adjust Video server to High1.Scr4
    - Set solenoid+bucking current to maximum value of range
    - Grab Mask Of Interest (MOI)
        1. Adjust camera gain and number of pulses to be close to saturation (minimize number of pulses to reduce jitter)
        2. Click 'Scan…' then 'Fast scan, EMSY and MOI' then 'MOI'
        3. Fill MOI Gain and NoP into excel file
        4. Set solenoid+bucking current to next value of range, go to point 1.

- High1.Scr1: set to X single slit (10μm for projected emittance, 50μm for thermal emittance)
- Option: scan of alpha angle
  - Set slit position to center of beam, adjust #pulses and camera gain
  - In fastscan3: Click 'Tools' then 'Tune angle orientation'
  - Accept new value if ok
  - Print graph to logbook
- Set solenoid+bucking current to maximum value of range
- X emittance measurement
  1. Set slit position to center of beam
  2. Adjust camera gain and number of pulses to be close to saturation (minimize number of pulses to reduce jitter)
  3. Find range for scan: Move slit in plus and minus direction until it disappears
  4. Adjust 'EMSY device' to EMSY1X
  5. In fastscan3/Options: Fill in range in 'Scan from' and 'Scan to'
  6. Option: adjust actuator speed to have about 100 to 200 frames
  7. Click 'Scan…' then 'Fast scan, EMSY and MOI' then 'Fast Scan'
  8. If saturation level is not correct, abort measurement and go to point 2.
  9. Fill EMSY_X Gain and NoP into excel file
  10. Click: 'Emittance calculation', then 'Save measured data'
  11. Print statistics windows (Saturation along scan, Saturation inside of MOI, Sum) to logbook
  12. Print phase scan results window to logbook: left click on phase space picture, then 'shift + left click' (red frame of picture will blink)
  13. Fill EmitX_2D and EmitX_2D, nonscaled into excel file
  14. Set solenoid+bucking current to next value of range, go to point 1.
- High1.Scr1: set to Y single slit (10μm for projected emittance, 50μm for thermal emittance)
- Option: scan of beta angle
  - Set slit position to center of beam, adjust #pulses and camera gain
  - In fastscan3: Click 'Tools' then 'Tune angle orientation'
  - Accept new value if ok
  - Print graph to logbook
- Set solenoid+bucking current to maximum value of range
- Y emittance measurement
  1. Set slit position to center of beam
  2. Adjust camera gain and number of pulses to be close to saturation (minimize number of pulses to reduce jitter)
  3. Find range for scan: Move slit in plus and minus direction until it disappears
  4. Adjust 'EMSY device' to EMSY1Y
  5. In fastscan3/Options: Fill in range in 'Scan from' and 'Scan to'
  6. Option: adjust actuator speed to have about 100 to 200 frames
  7. Click 'Scan…' then 'Fast scan, EMSY and MOI' then 'Fast Scan'
  8. If saturation level is not correct, abort measurement and go to point 2.
  9. Fill EMSY_Y Gain and NoP into excel file
  10. Click: 'Emittance calculation', then 'Save measured data'

11. Print statistics windows (Saturation along scan, Saturation inside of MOI, Sum) to logbook
12. Print phase scan results window to logbook
13. Fill EmitY_2D and EmitY_2D, nonscaled into excel file
14. Set solenoid+bucking current to next value of range, go to point 1.

- Print excel table+graph to logbook (solenoid scan)
- Statistics: set solenoid+bucking current to minimum emittance value
- Add 'Stat1' to folder name in fastscan3
  - measure EMSY and MOI (Option: use EMSY and MOI from solenoid scan and use original folder)
  - Repeat X and Y emittance measurement several times (usual: 3)
- Add 'Stat2' to folder name in fastscan3, measure emittance
- Add 'Stat3' to folder name in fastscan3, measure emittance
- Print excel table+graph to logbook (statistics)