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AWAKE e^- Beamline Study

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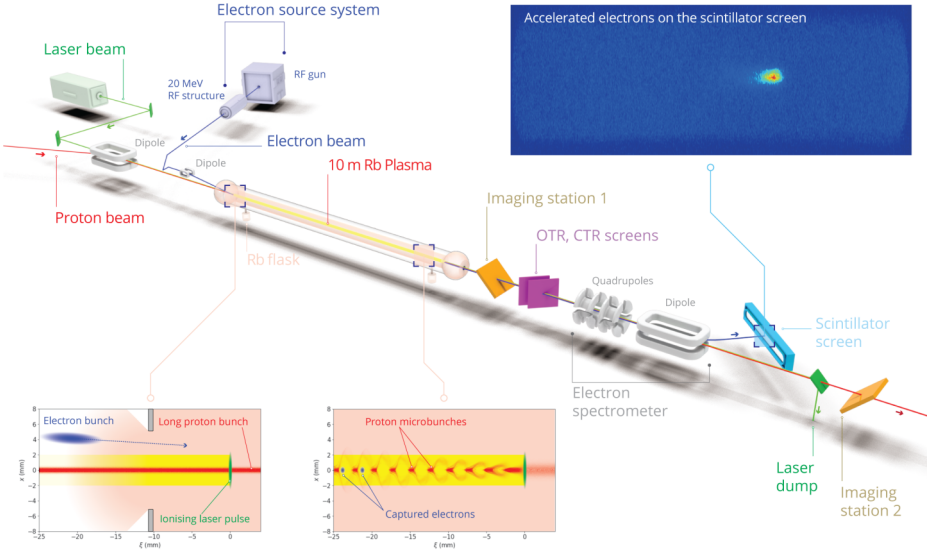

Electron source system
Laser beam
20 MeV
RF structure
RF gun
Dipole
Electron beam
Dipole
10 m Rb Plasma
Proton beam
Rb flask
Imaging station 1
OTR, CTR screens
Quadrupoles
Dipole
Scintillator
screen
Electron
spectrometer
Laser
dump
Imaging
station 2
Accelerated electrons on the scintillator screen
Electron bunch
Long proton bunch
Ionising laser pulse
Proton microbunches
Captured electrons

Basic Parameters

- Proton bunches
  - 400+ GeV, can't kick around easily
  - Delivered by SPS at most every 30s
- e^- bunches
  - Delivered by Photoinjector
  - RF + Booster $\Rightarrow$ 18 MeV
  - Small problem, transport line is long due to physical constrain

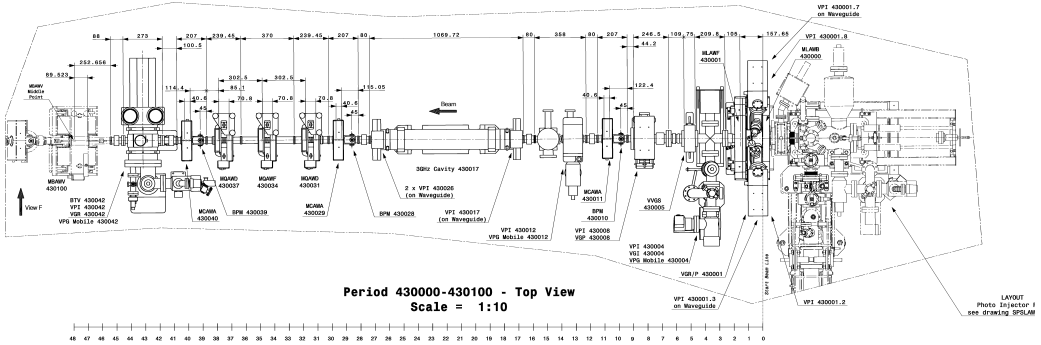
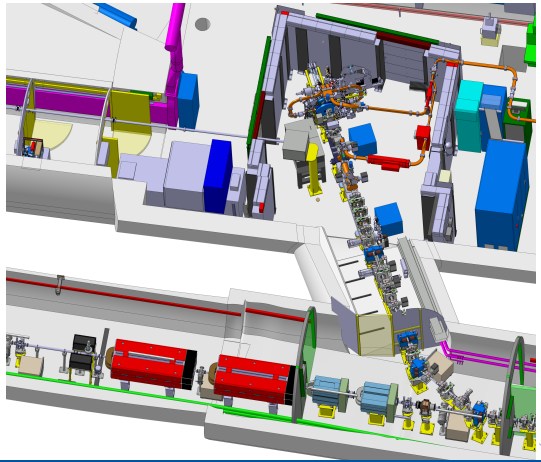


Figure: Transport ← Diag. ← Quadx3 ← Booster ← Diagnostics (pepper pot) ← Solenoid + RF Cathod

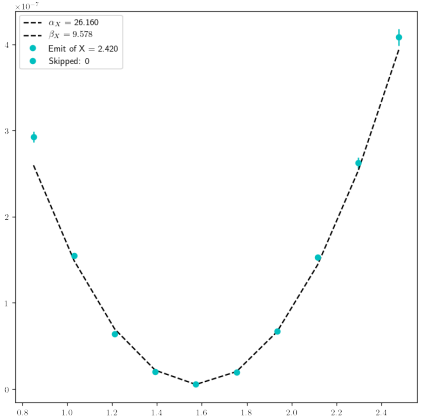
Emittance as Optimization Objective

- High e^- density bunch at low p_z creates problem
- RF only produce 5.8 MeV, space charge effect is pronouced
- Transport line is long due to physical constrain
- Pure optics after the booster (18 MeV), thus **emittance** out of here is critical



Emittance measurement

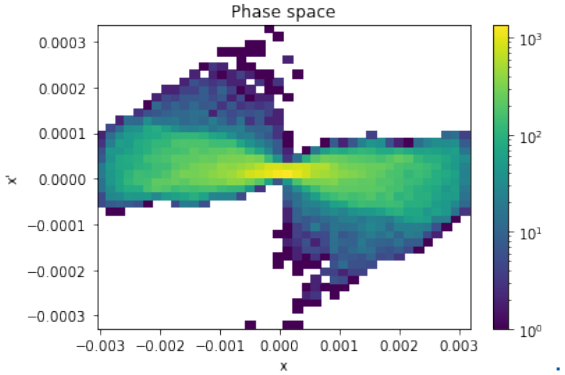
- Through quadruple scan, one can measure emittance indirectly
- Takes >10 minutes for a complete scan
- High measurement rate could enable online optimization



Advanced(?) Beam Control

After talking to SPS expert & Mcahine Learning expert, we think:

- Potential Reinforcement Learning model to achieve online control
- Problem: current emittance measurement involes quadscan



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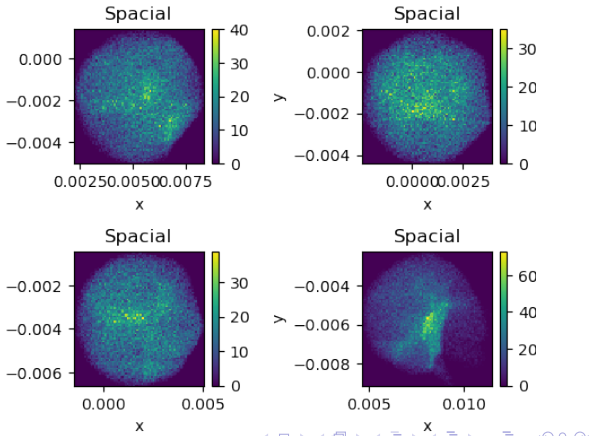
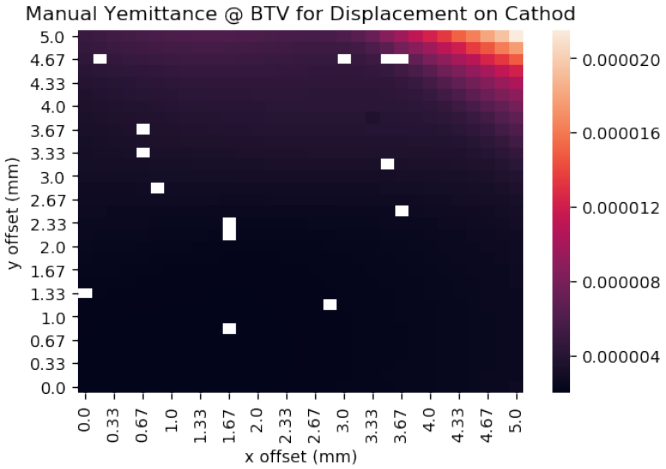
ASTRA — by Klaus Floettmann @ DESY

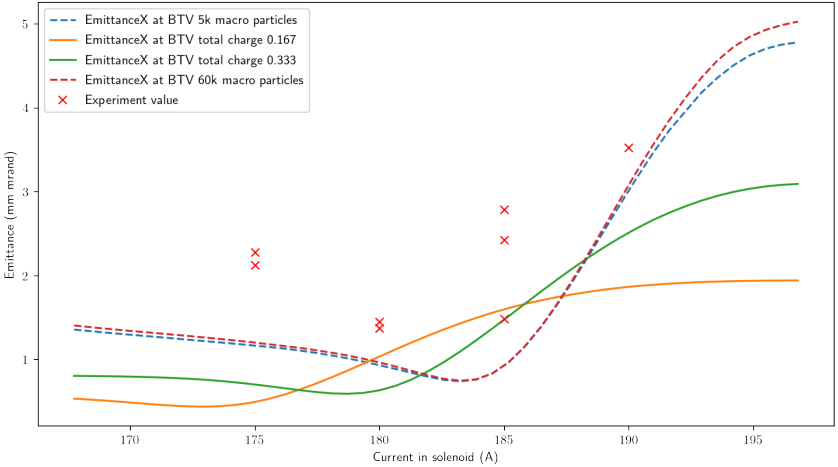
- Splits macro particles distribution @ cathod
- Structures simulated: RF gun, Solenoid, (3D)TWS Booster (no quadruple)
- Runs tracking & space charge simulation (important at low p)

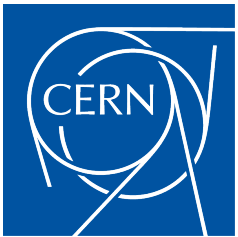


Scan on displacement @ cathod



Scan on Solenoid BMax

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