UPPSALA
UNIVERSITET

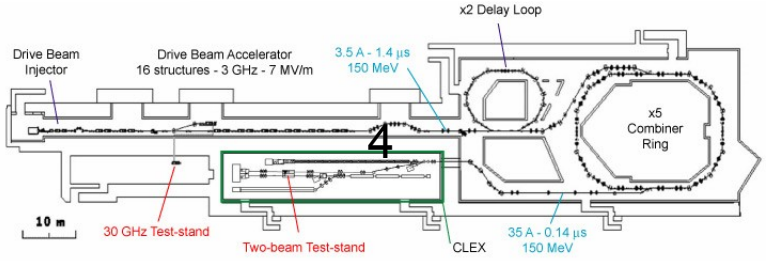
Experiments in the Two-beam Test-stand

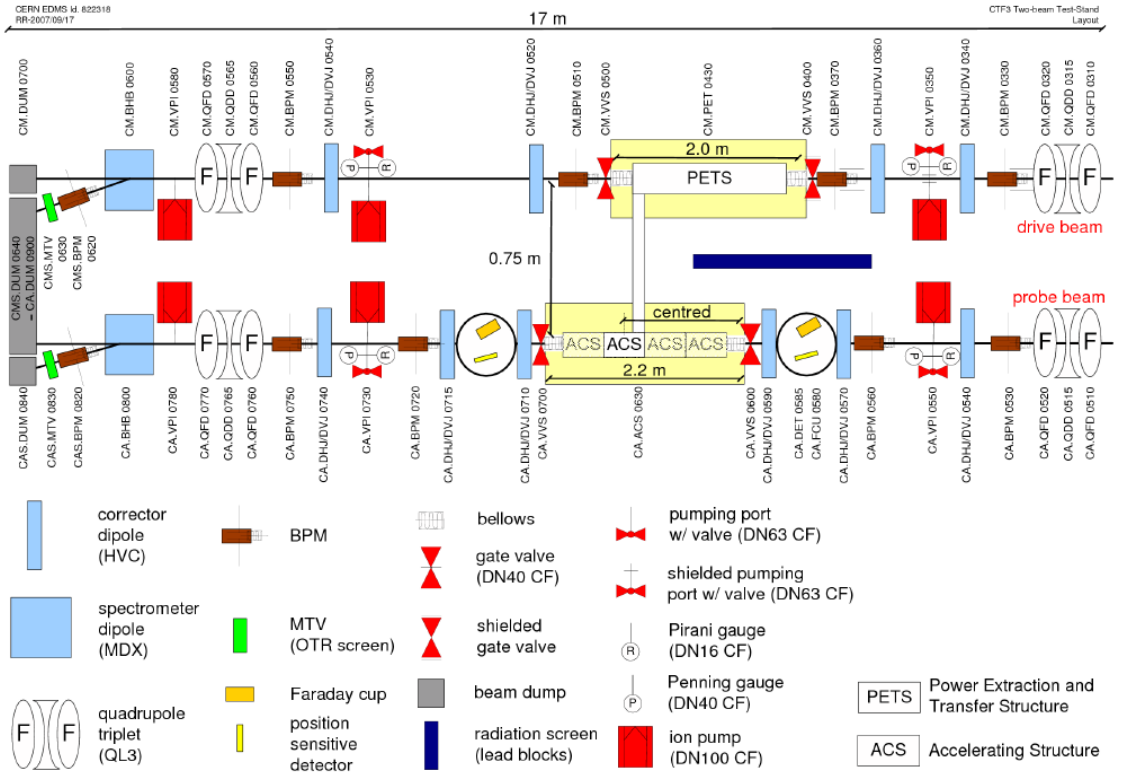
Volker Ziemann
for the CTF3 Two-beam Test-stand crowd

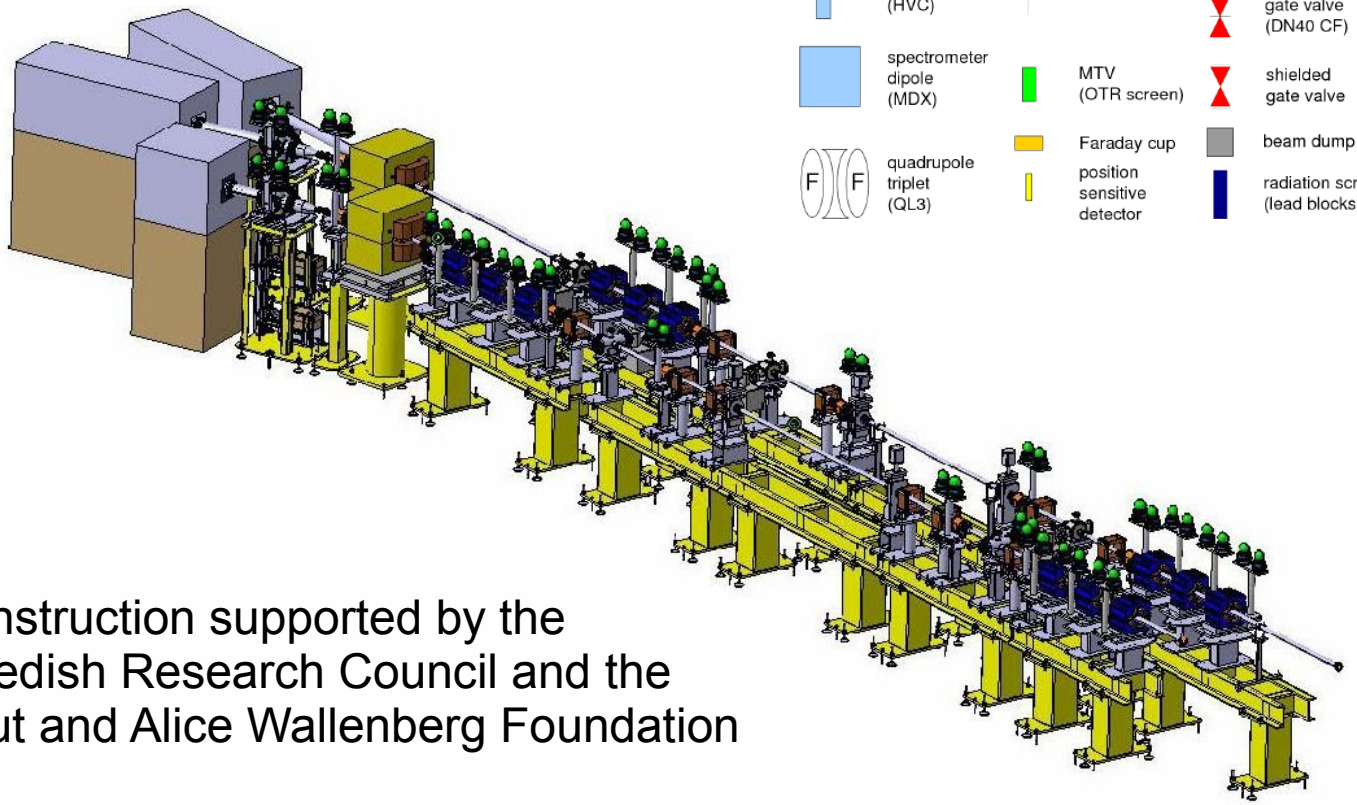
Department of Physics and Astronomy
Uppsala University

UPPSALA UNIVERSITET

Layout







Construction supported by the Swedish Research Council and the Knut and Alice Wallenberg Foundation

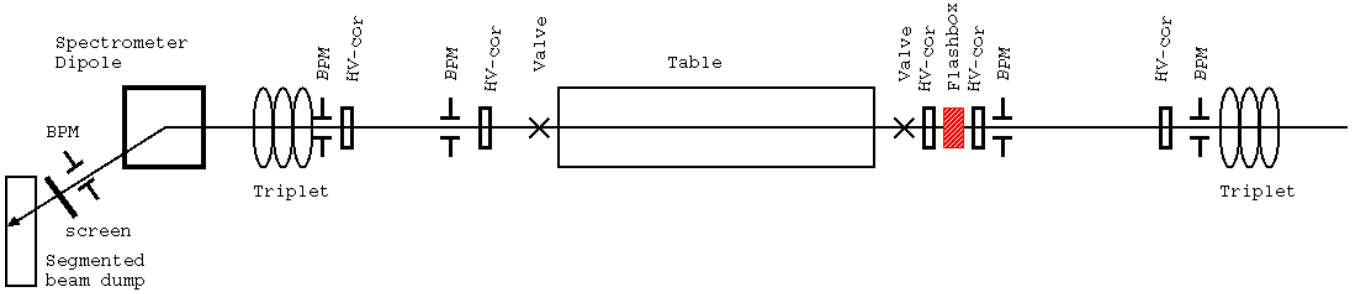
UPPSALA UNIVERSITET

Global Strategy

- Commission drive beam without PETS
  - make the diagnostics work (BPM, OTR)
- Test PETS structures with beam
- Commission probe beam without structures
- Test RF-structures first without probe-beam and then with probe beam
  - Conditioning
  - Effect of probe-beam on breakdown
  - Effect of breakdown on probe-beam (kicks)

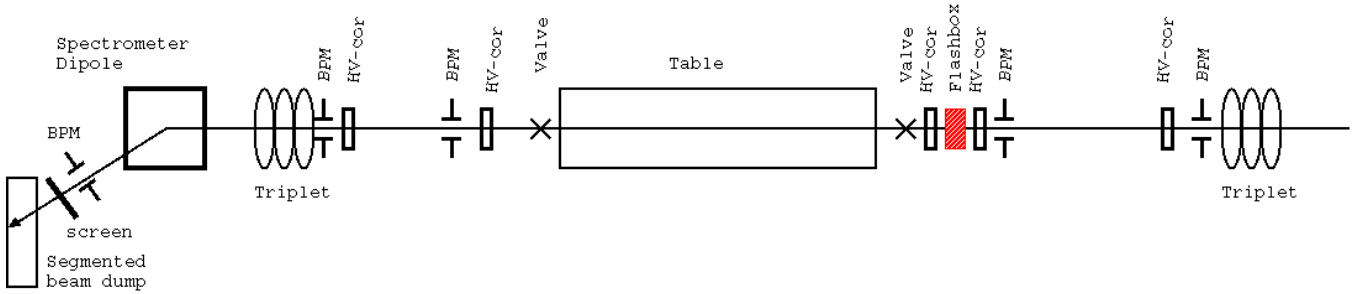
What do the PETS do to the beam?

- Losses (BPM sum-signal)
- Energy loss along the pulse (BPM5 after dipole)
- Energy spread (OTR)
- Kicks along the pulse (BPM diff-signal)
- Dependence on pulse length (Gun, tail-clipper)
- Dependence on drive beam intensity?



RF power generation with PETS

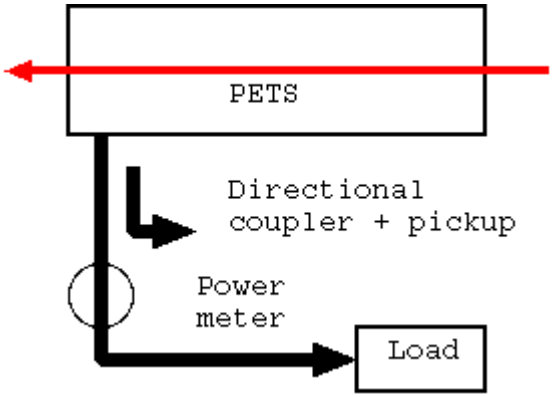
- How much power is generated?
- Are wakefields generated, asymmetry in RFout
- adjusting the beam position and size
  - x,x',y,y', size, waist position
- to optimize power generation
- Drive-beam pulse length (Gun, tail-clipper)
- Beam intensity



UPPSALA UNIVERSITET

Reliability

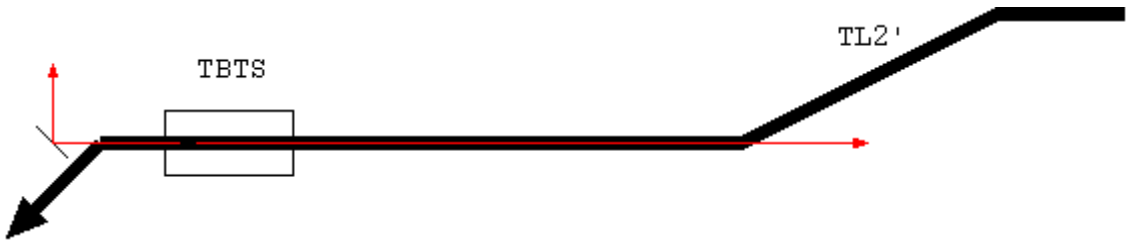
- How susceptible are PETS to breakdown?
- How to diagnose that?
  - RF generated
  - Energy loss along the bunch
  - Beam position along the bunch
  - Momentum spread on OTR
  - Light? X-rays? Other radiation (PIN diodes?)



UPPSALA UNIVERSITET

Additional PETS diagnostics?

- Difficult to look into the PETS
- Might be interesting during PETS-breakdown
  - as is done now for accelerating structures
- Zero-degree port in last dipole before TBTS
- Movable screen in straight ahead dump line



UPPSALA UNIVERSITET

PETSONOFF

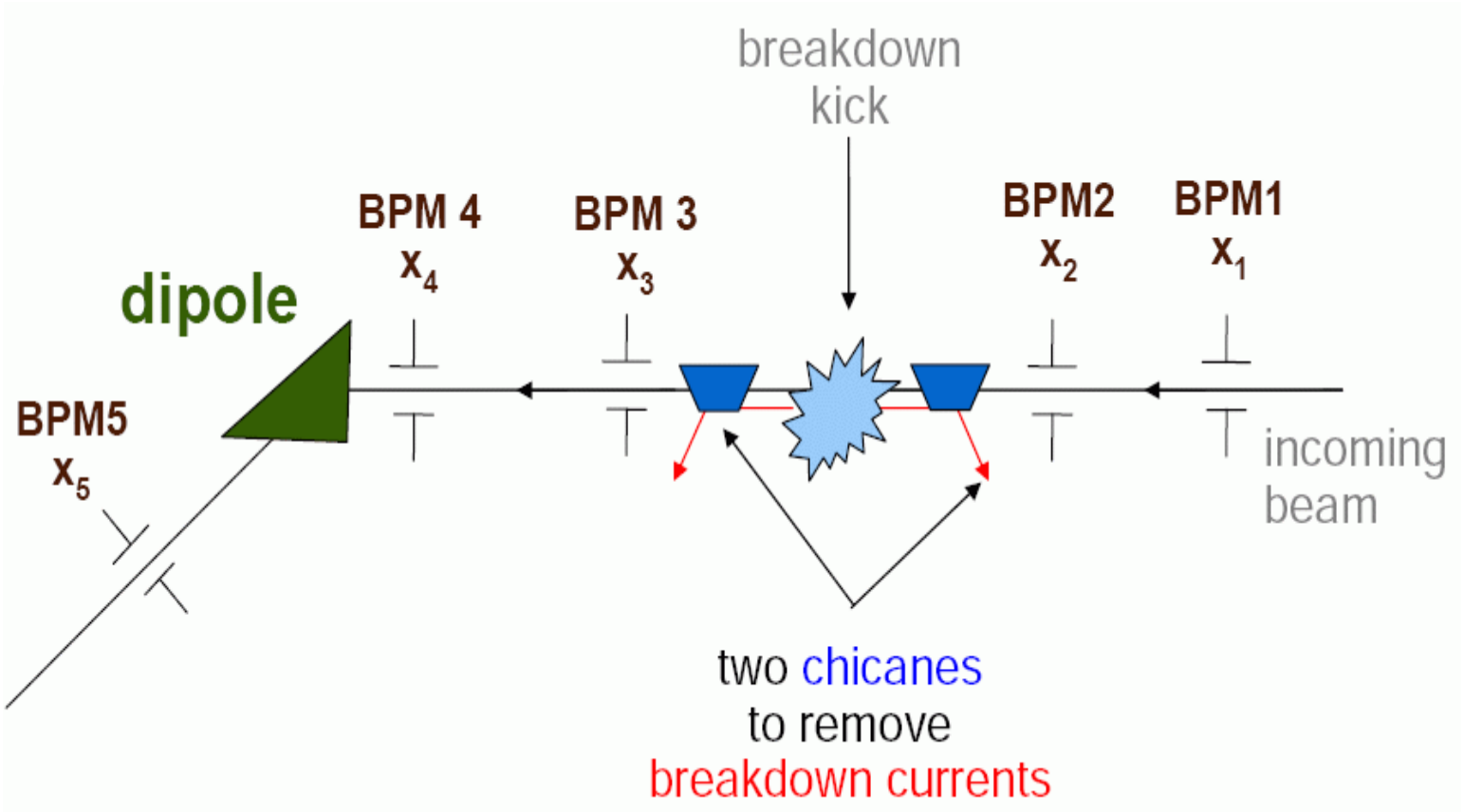
- Turn off power generation in PETS in case of breakdown in the accelerating structures.
- Speed of the turn-off operation
  - within a very long drive-beam pulse?
  - and observe output power
  - otherwise pulse-to-pulse
- Reliability
  - switch 10000 times with 10 s period -> 1 day
- Relatives (variants) of Petsonoff?

UPPSALA
UNIVERSITET

Accelerating Structures

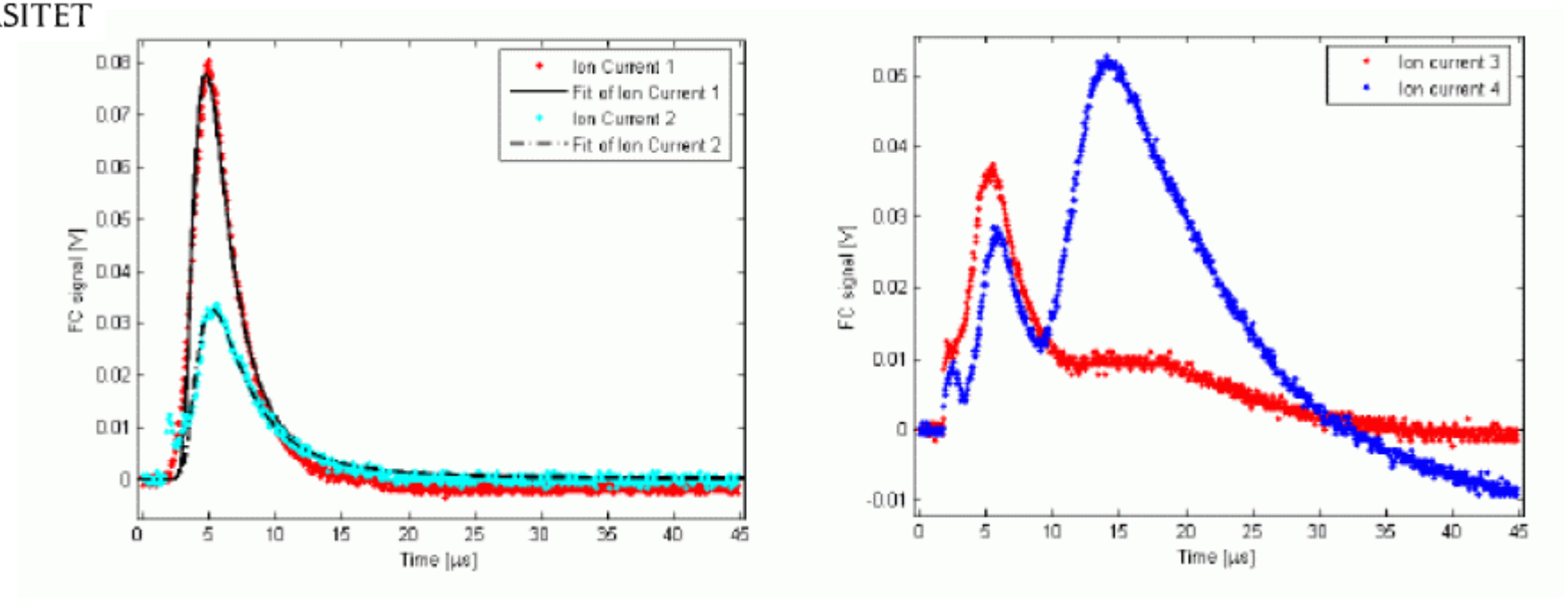
- Conditioning
  - Gradient and breakdown rate
  - Dark current (time structure, intra & inter-pulse)
- Beam in accelerating structures
  - Beam loading (probably not much, though)
  - Does beam increase the breakdown rate?
- What happens during breakdown?
  - Beam energy and transverse kicks
  - Ions (flavour, time-structure)
  - Light and X-rays (temporal and spectral information)

Transverse Kicks Measurement



- Conceptually similar to SLC beam-beam kick determination
- M. Johnson: *Beam-based diagnostics of RF-breakdown in the Two-beam Test-stand.* CLIC Note 710
  - 10 μm BPM accuracy → ~10 μrad angle accuracy

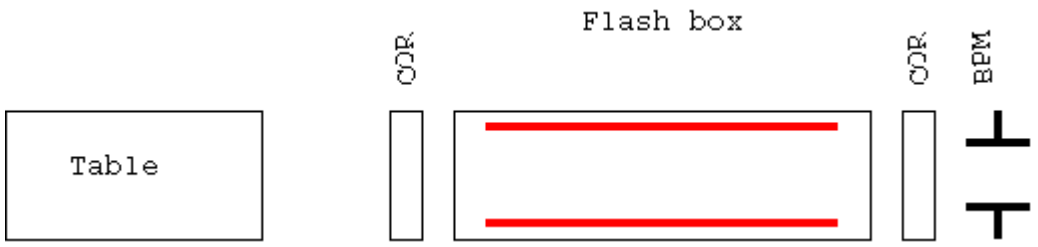
Ion currents



- Observe ions ejected from accelerating structures in 1BTS
- Arrival time profile at Faraday cup is consistent with 'Hot Coulomb explosion' model (T~50 000 K)
- Sometimes multiple peaks
- Want to observe also in TBTS → Flashbox

Flashbox

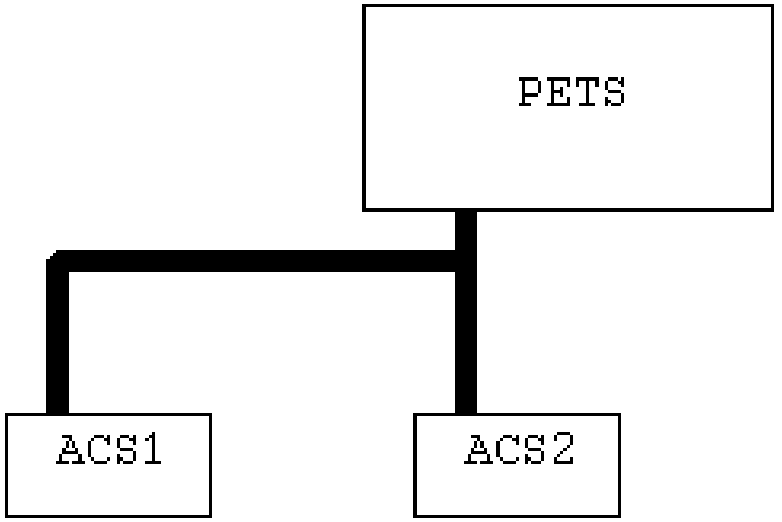
- Small chicane initially suggested (V. Dolgashev, SLAC) to avoid blinded BPMs during breakdown.
- Will deflect
  - prompt electrons (ns scale)
  - ions to the other side (μs scale)
- Additional DC voltage will aid separating the kV ions.
- Under design and first prototype should come later this year.



- Ion spectroscopy with a segmented detector.
- Arrival time (speed) and momentum yield ion flavour.
- Spectroscopy of breakdown electrons.
- Also plan integrate optical feedthrough to pick up light (JK)
  - time
  - spectrum
- Could be installed in drive and probe beam line.
- Contribute to the understanding of RF breakdown physics.

PETS/ACS Correlations

- One PETS drives two accelerating structures



- Does breakdown in accelerating structures trigger
  - breakdown in PETS
  - breakdown in adjacent accelerating structures
- PETSONOFF trigger logic

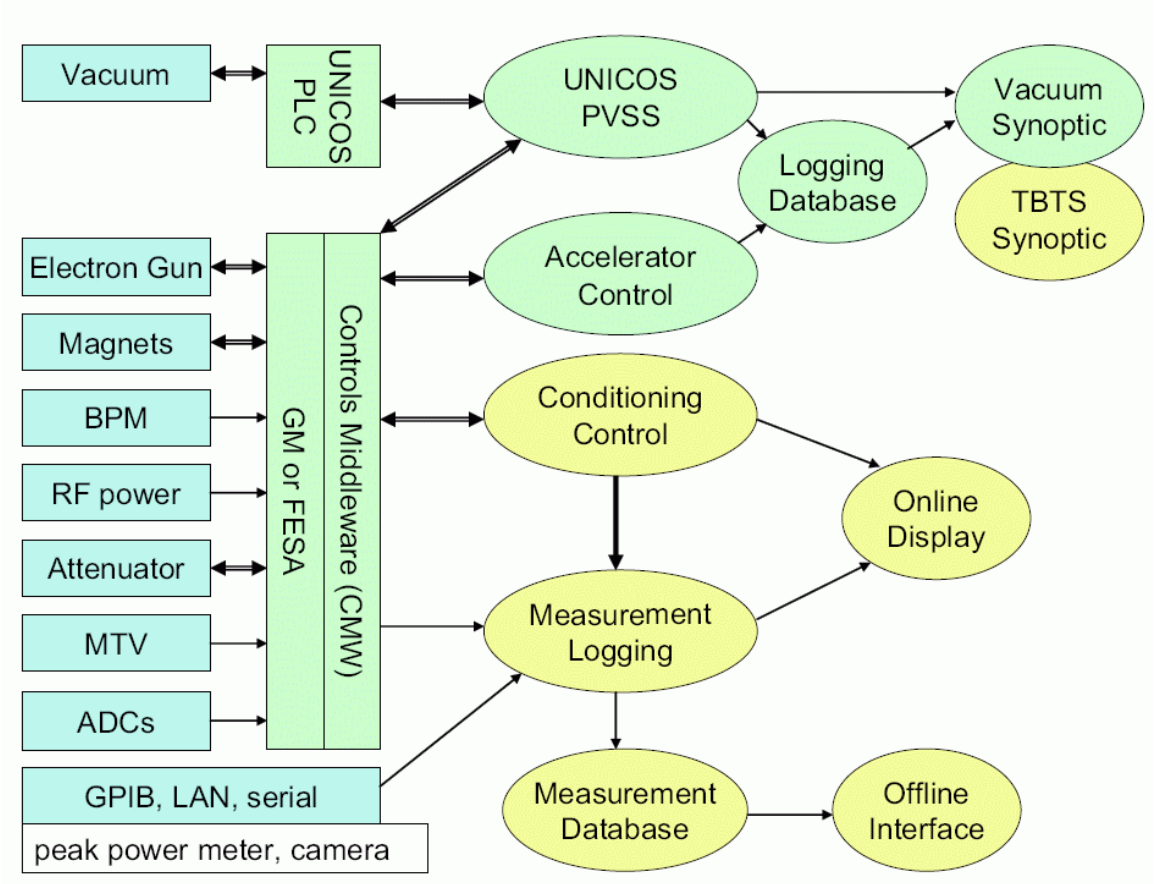
UPPSALA UNIVERSITET

Combinatorics

- Test different incarnations of
  - PETS
  - PETSONOFF
  - Accelerating structures
- Standard tests
  - Conditioning (gradient, breakdown rate)
  - Beam-loading
  - Effect on beam (energy, spread, kicks)

UPPSALA UNIVERSITET

Data Acqusition



- Synchonization is very important
  - BPM (LAPP)
  - RF (Acqiris)
- Automatic logging
- Database
- Integrated approach

UPPSALA UNIVERSITET

Conclusion

- Systematic tests of PETS
  - Effect on beam
  - RF output optimization
- Systematic tests of accelerating structures
  - Conditioning
  - Effect of probe beam on breakdown rate
  - Effect of breakdown on beam dynamics
  - Breakdown mechanism
- Interaction of PETS and accelerating structures