Status of SPS Ionization Profile Monitor

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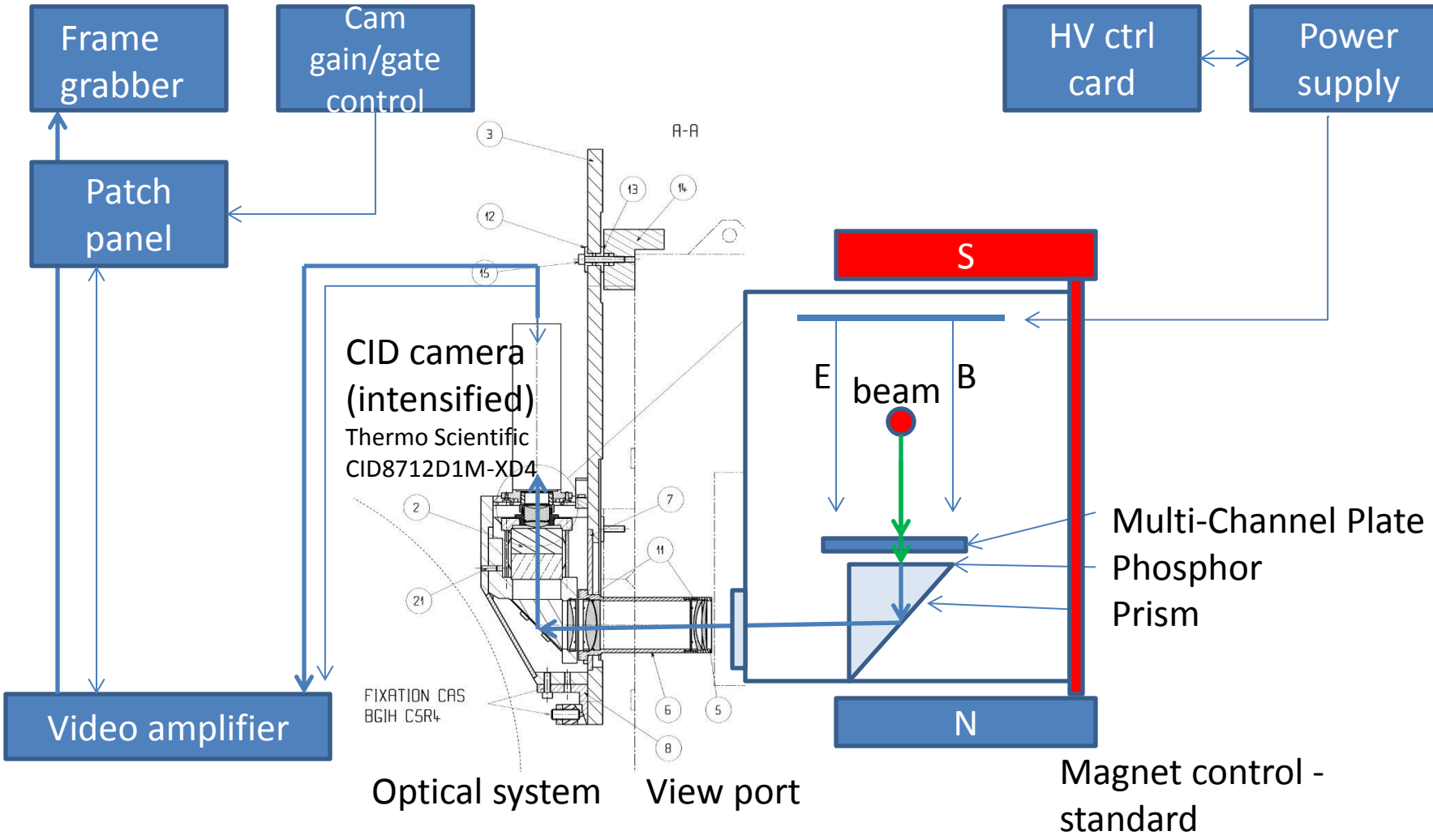
Outlook

- The system architecture
- Renovation
- Status
- Future upgrades
- Expected performance

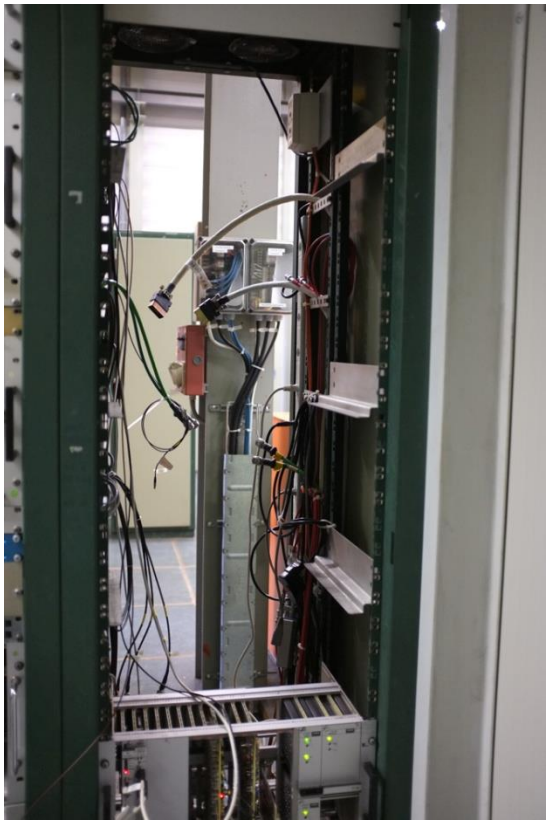
System architecture (simplified)



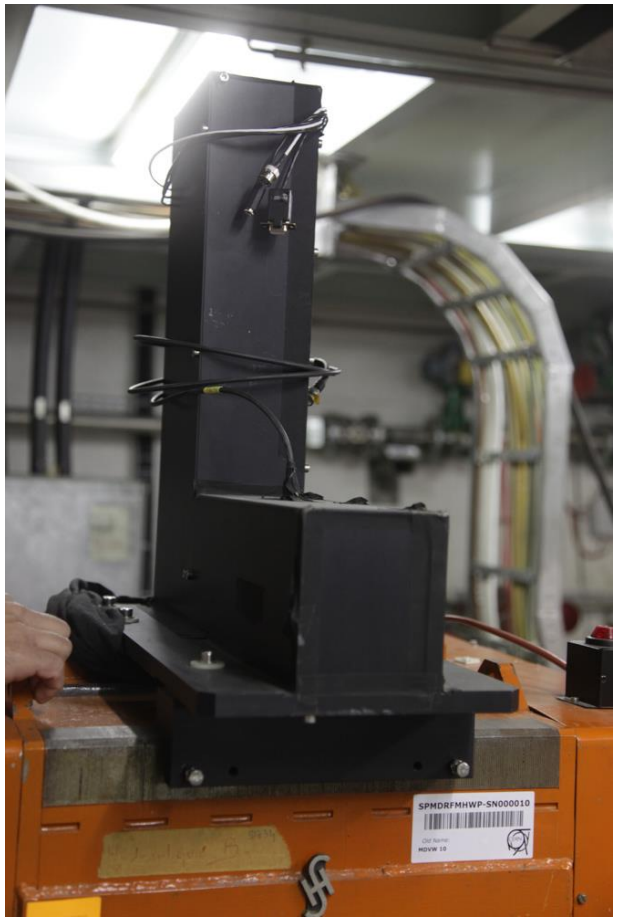
Renovation 2012

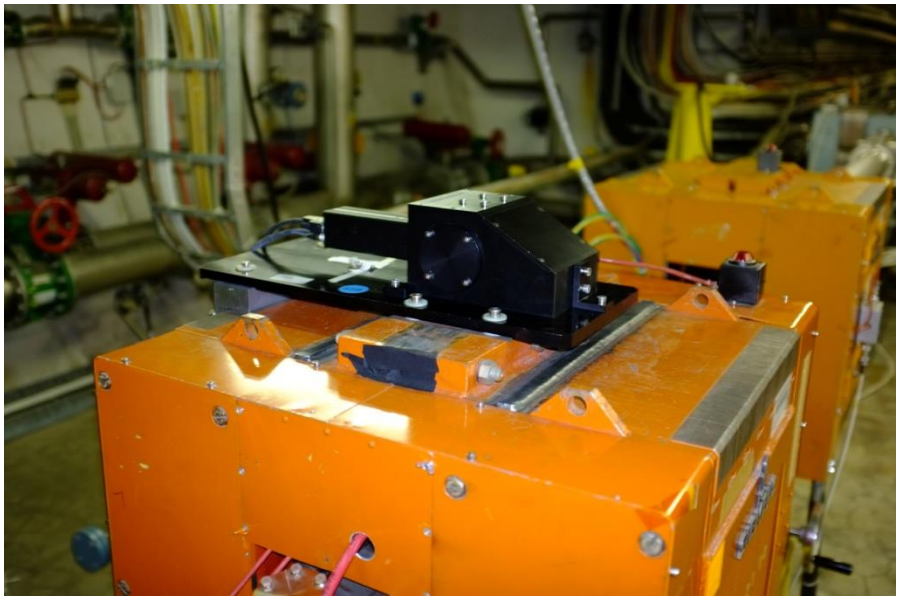
- Winter TS 2011/2012:
  - MCPs exchanged (vacuum opened)
  - Electronics (surface and tunnel) exchanged to the same as in LHC
  - Optical systems and cameras exchanged to the same as in LHC

Renovation – surface electronics



Renovation – optical systems and cameras

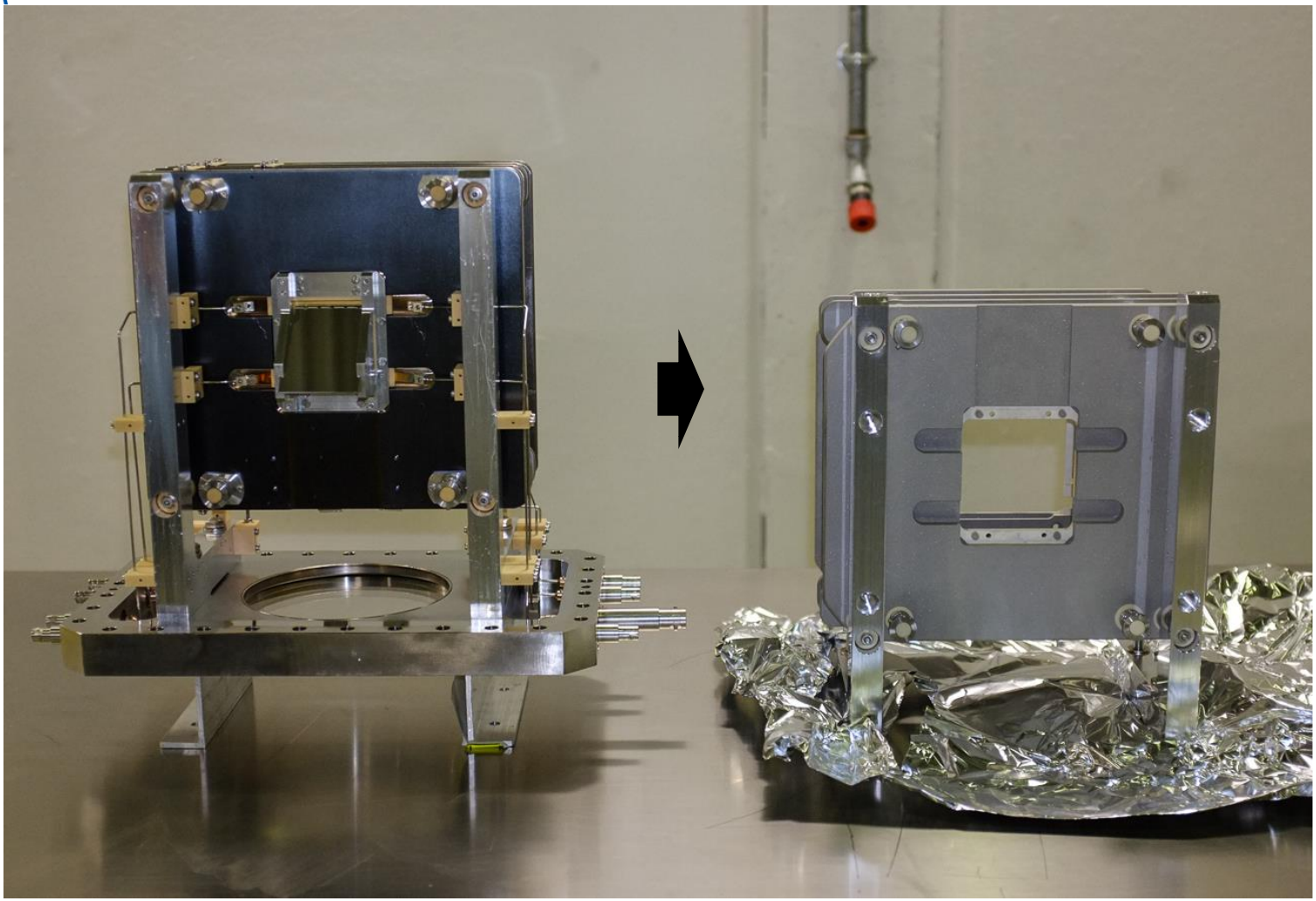




Renovation LS1

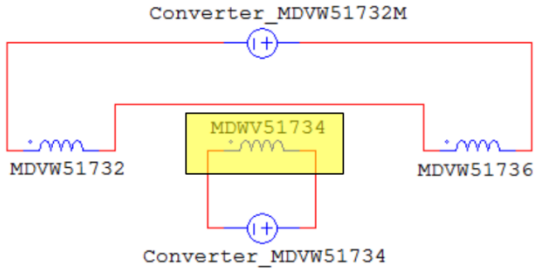
- Exchange of electric cage (the same as in LHC):
  - Ceramic electrodes – better for impedance
  - Fully identical systems in LHC and SPS (spare parts, easier interventions in future)
  - Some parts were *almost* broken and no spare parts available - and any new intervention (MCP exchange) could result in incapacitation of a monitor

Renovation – electric cage



Renovation LS1

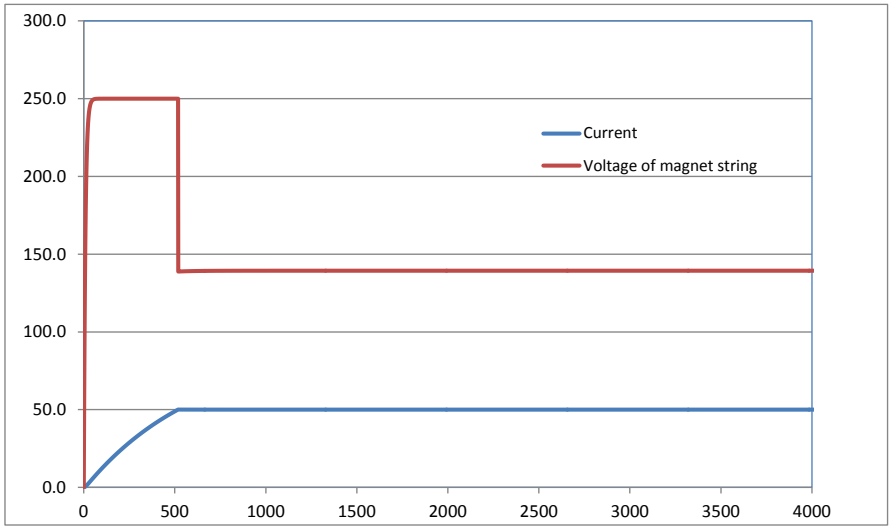
- Change of magnet topology:
  - Before two corrector magnets to close the orbit bump made by main detector magnet
  - Separate PC
  - Unsafe

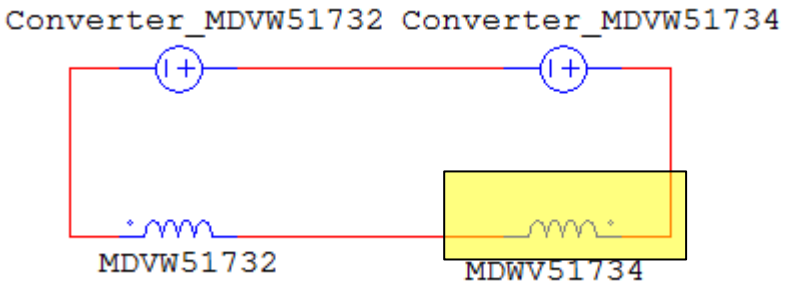


Proposed Hardware configuration

Scenario #5

- Two existing converters rated 125V/125A in a serial configuration (Master/slave) with two magnets in series,
  - Current reference = variable di/dt (max voltage is used, no control of the current during ramp up),
  - Max requested current = 50A,
  - Total Load (magnet + cables) resistance @45°C = 2.79Ω,





➔ **Rise time = 0.517 second**

2013 tested with beam implemented during LS1

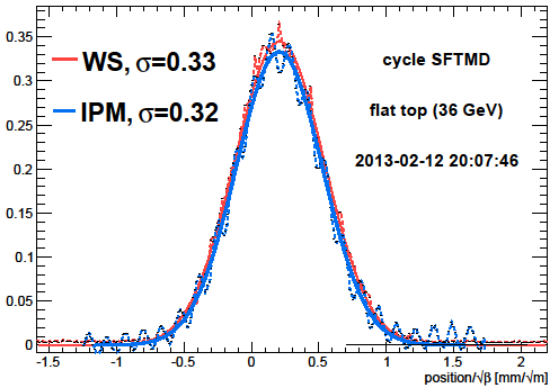
This configuration is relevant

Renovation LS1

- Front-End software
  - Dedicated technical student
  - HV control class moved to FESA3, tested, running
  - Image class: restructured and moved to FESA 3 but still some errors, probably to be solved fast.
- Update of expert application

Status

- During Run I detector suffered from beam-generated noise on video signal.
- After several iterations noise was reduced and first signals (on vertical monitor) were observed – end of the Run 1.
- Now: beam (probably) seen in analog channel in BA5 but FE software image class not functional.
- Now: issues with communication (gain/gate) with one of the cameras – TS next week



Still to be done

- Improvements in image processing (digital filtering) — Next months
- New HV controller card – prototypes produced, need to be programmed and testes, ready - beginning 2015. — Next months
- Lack of EGP-based calibration system for horizontal monitor: need to produce new vacuum chamber – not planned, calibration can be done using beams during MD. — LS2
- Flanges in SPS still slightly different than in LHC, may be exchanged in the future. — LS2
- In far future: use technologies being developed for PS: — later
  - Hybrid silicon pixel detector fast readout
  - Compact magnet with build-in corrector and potentially stronger field.

Expected performance

- Measurement of beam emittance
  - in both planes
  - with several Hz acquisition rate
    (tested: ~12 Hz)
- Will need beam-based MCP calibration every a few months (depending on usage)
- Beam space charge may affect measurement of vertical profile for small-emittance beams at high energy
  (and we are working on correction procedure)

Conclusions

1. SPS IMP hardware and electronics completely renovated.
2. Magnet PC reconfigured – now meeting Machine Protection requirements.
3. Updated FE software almost ready.
4. Will need some time for commissioning and calibration.
5. Potentially more work needed with proper signal processing.
6. Expected to be able to read images with a few Hz.

Thank you for your attention

and

thanks to many people who worked on this project or helped in one way or another:

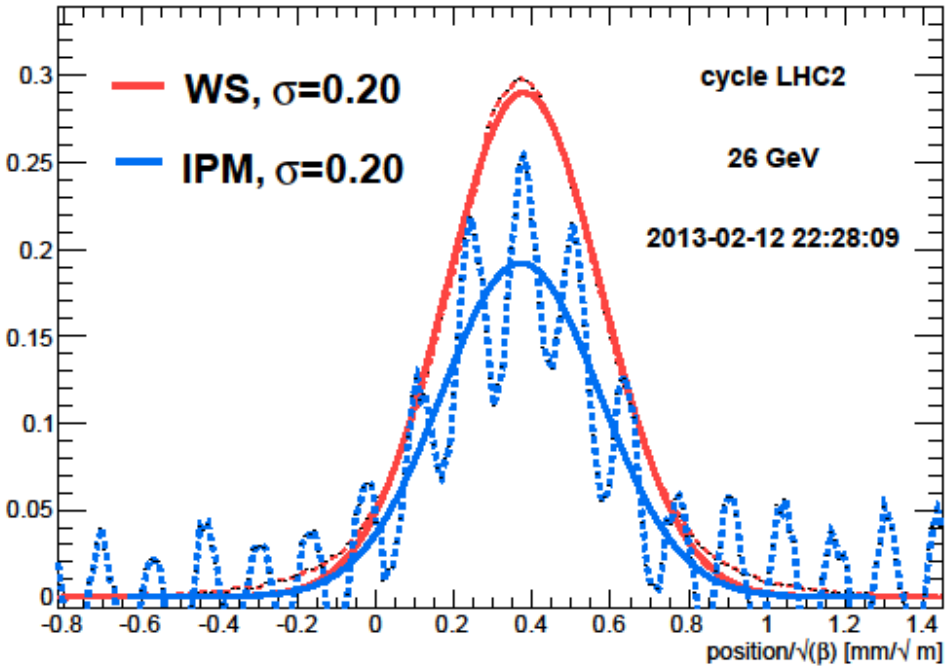
Ana Guerrero, Bogna Blaszczyk, Dominik Vilsmeier, Joel Adam, Karel Cornelis, Jeremie Bauche, Gilles Le Godec, Pierre Thonet, Morad Hamani, Gerhard Schneider and others

Spare slides

Measurements on February 12th

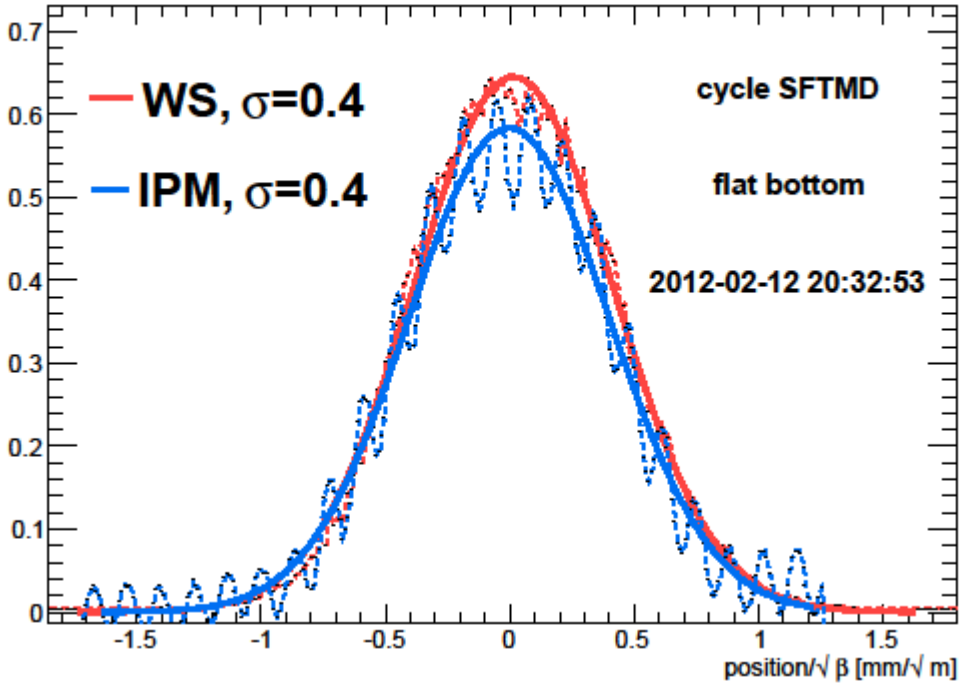
- Only vertical IPM was working
- Signal seen before on LHCION, idea was to explore it
- **SFTMD and LHC2 also measured!**
- 40 scans with scanner 416V
- IPM was very stable, but not calibrated so the analysis is not tuned: no filtering on video, no tilt correction, etc.
- no camera gain control
- WS data: LoggingDB, IPM data: root files on VM
- Synchro WS-IPM: ±5s (my guess)

LHC2 at 26 GeV



WS: scan IN
Emittance (WS) = 1.05 µm
Beam size in IPM = 1.93 mm

SFTMD at injection



WS: scan IN

Good agreement!

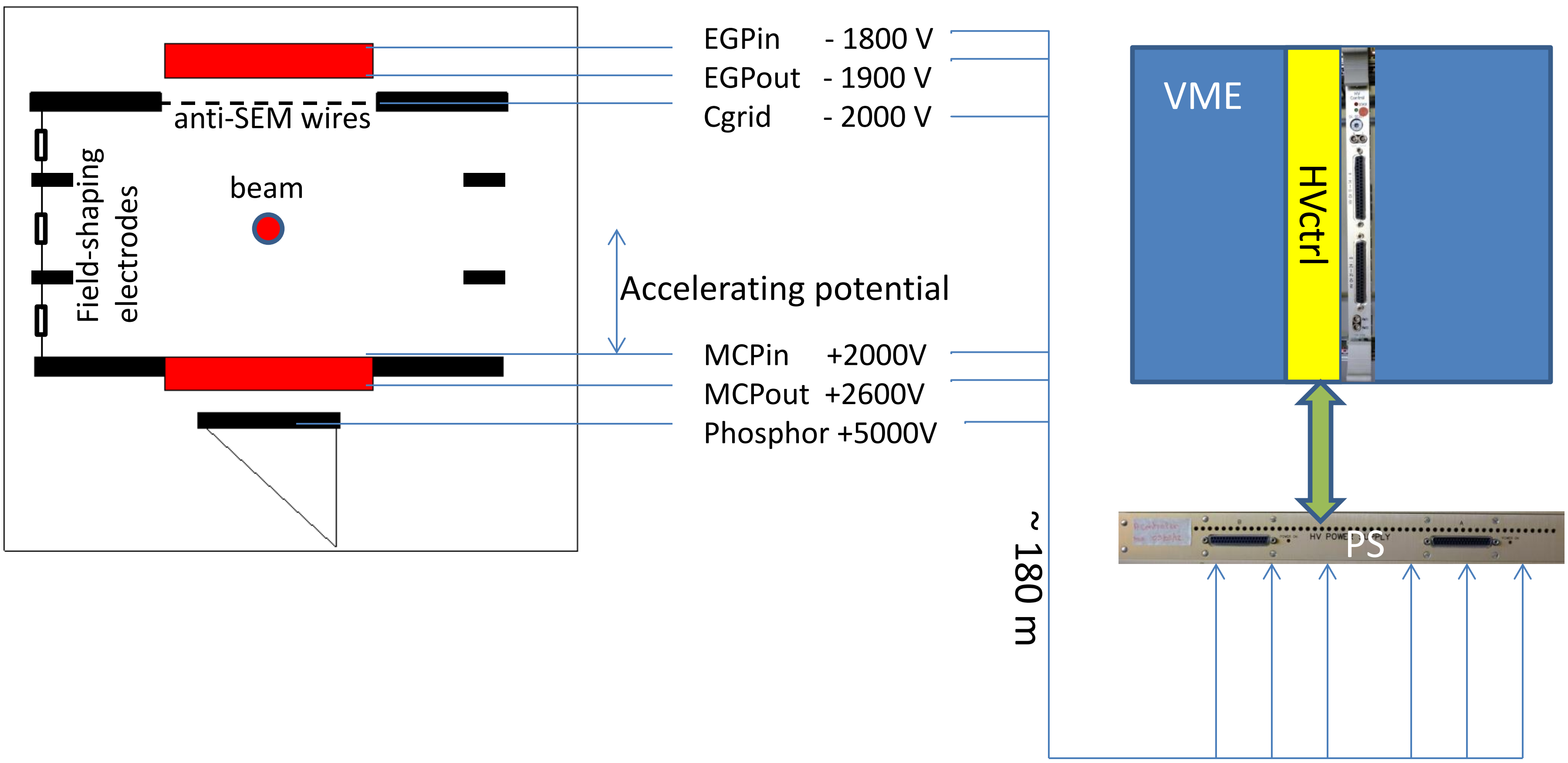
LS1 improvements

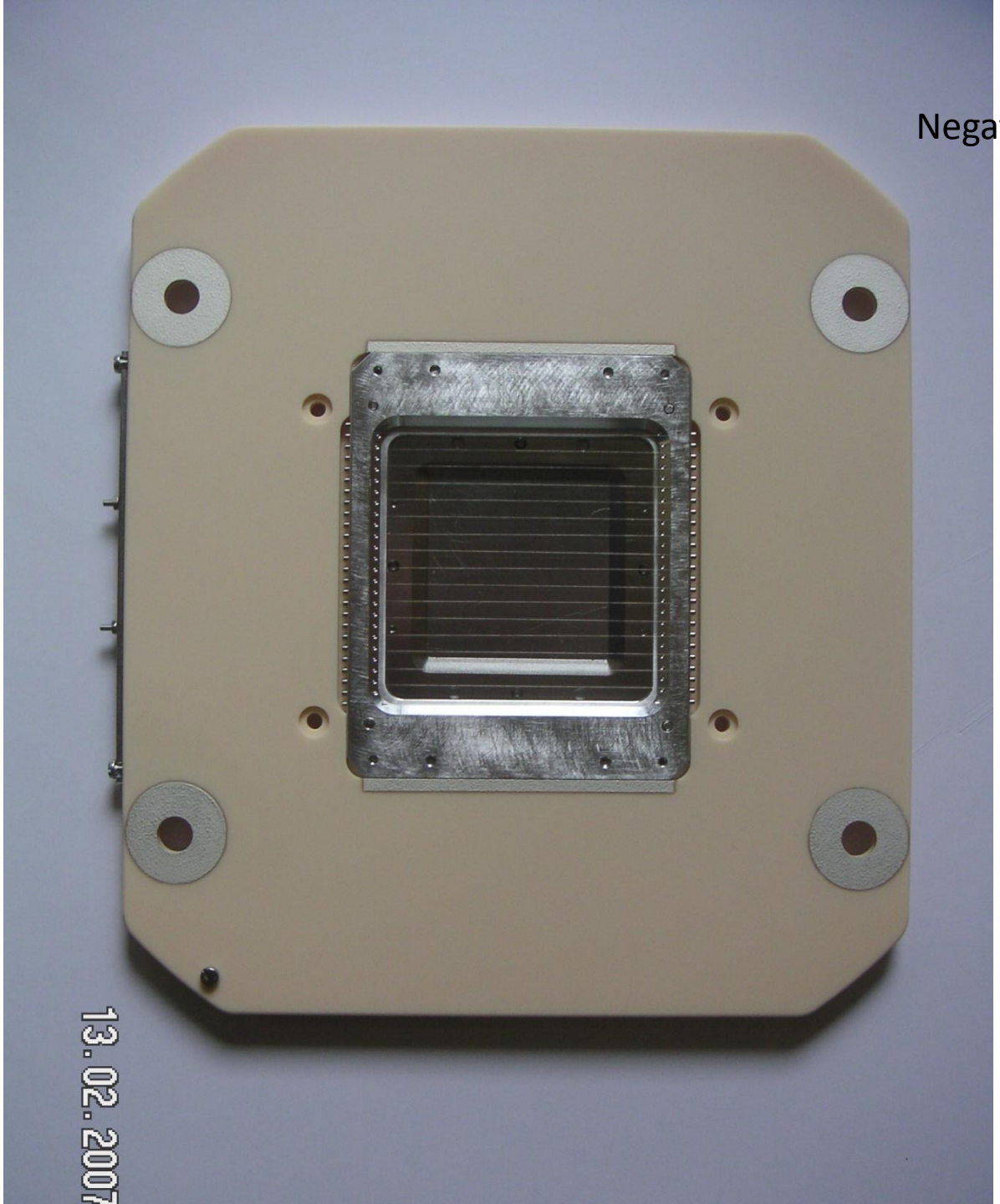
1. **Construction of new detectors, exactly the same as in LHC**
   - Ceramic electrodes
   - Modern design
2. Exchange of cables (short ones), tunnel cable shielding, testing, camera communication
3. **Change from current 2-corrector scheme to single corrector one**:
   - Tested with beam in February
   - Powering scenario which assures cycling mode proposed by Gilles Le Godec

safe operation

4. Studies ongoing to understand MCP issues
5. Synchronization with machine (bunch-by-bunch)

System: HV cage + PS + control





Negative electrode

Hardware failures (other than already mentioned)

- HV ctrl card – problem with compatibility with VME (linux CPU)
- 5 CID cameras stopped working, in most cases we suspect that intensifier reached MTTF (tbc by ThermoFischer).
- failures of MCPs
  - "conditioning effect" for MCPs
  - too high input electron current might kill MCP
  - abrupt HV change might kill MCP (and dump the beam!)

Killed MCP: creation a conducting channel through the plate: cannot set HV anymore, cannot amplify the signal.