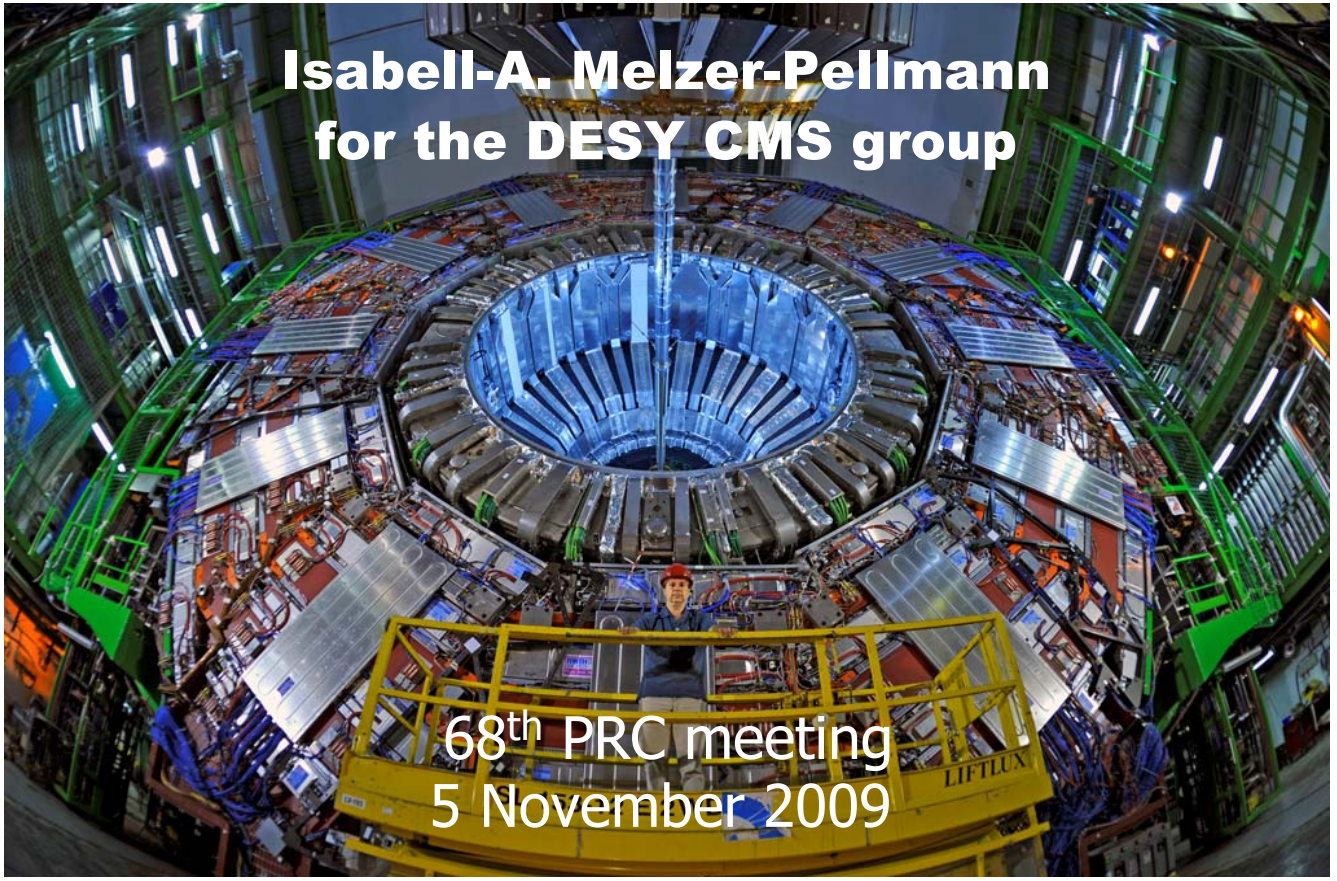
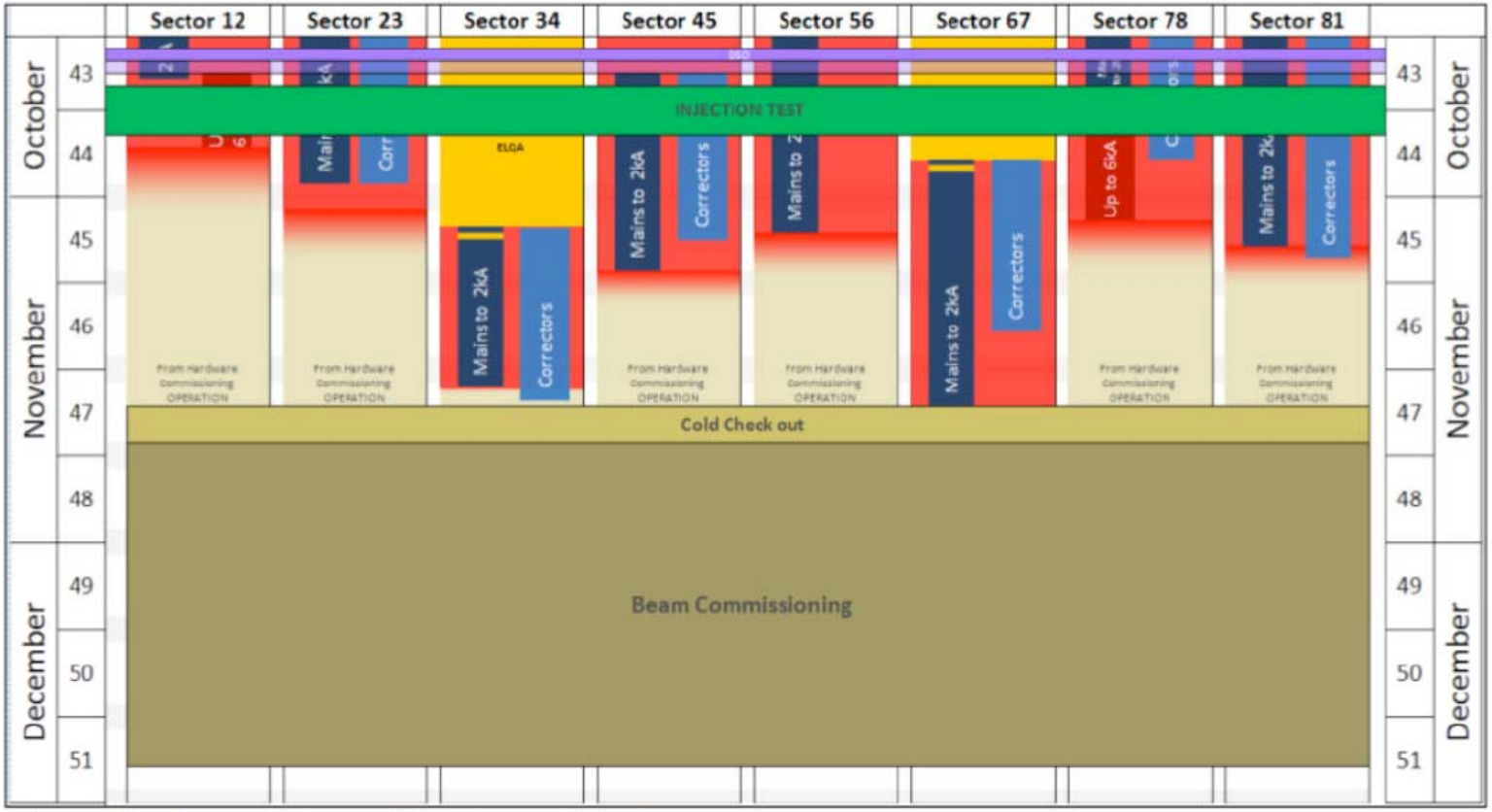
Status of CMS at DESY



LHC Status

First injection tests: 23-25 Oct:

- Clockwise: Ion beam successfully taken into LHC, beam traversed ALICE and went straight to Point 3 w/o correction
- Anti-clockwise: Proton beam successfully through LHCb to dump (Point 7)



Near Future Milestones for CMS

Beam splash events in CMS

- Nov. 7, 8. Hopefully of order 50 shots onto collimators for synchronization and calibration purposes

First beam circulation

- Week of Nov. 16 **?**
- Based on last year's experience, sporadic periods of beam in the machine during capture attempts and scans of machine settings
- Halo muons for synchronization and alignment

900 GeV collisions

- Week of Nov. 30 **?**
- Few LHC shifts. Target first physics measurements if possible, Field ON

?.? TeV collisions

- Week of Dec. 14 **?**
- Few LHC shifts. Target first physics measurements if possible, Field ON

7 TeV collisions

- After Phase 2 powering test completion. January/February 2010 **?**
- Start of the long run…

- All dates approximate!
- Reasonable machine availability assumed…

CMS Status

- CMS is closed after a 10-months long and successful maintenance period and is essentially in "beam-ready" state
- Round-the-clock operation has started
- Beam-pipe pump-down is proceeding well
- Magnet is at operational field
- CMS is in the best state ever – hardware and software
  - Major improvements during last shutdown almost everywhere
  - Detector, infrastructure, safety, operation, reliability…
- CMS data quality has further improved w.r.t. 2008
- The remaining time before beam will be used to optimize the operation procedures

DESY at CMS

- **Group structure:**
  20 staff physicists, 16 PostDocs, 9 PhD students,
  Technical help: engineers & technicians & workshops

- **Physics activities:**
  - Top Physics
  - SUSY Searches
  - Higgs Search
  - QCD Studies ⇔ HERA

  Common physics analysis interest:
  Jet energy calibration, b-tagging studies

DESY at CMS

Technical activities and coordinating responsibilities:

- Technical coordination: W. Zeuner, Deputy Technical Coordinator (L1) and CMS Management Board
- Computing:
  - M. Kasemann, Coordinator (L1) and CMS Management Board
  - C. Wissing, Grid SW Deployment Coordinator (L3)
- CMS-ECOM (Evolution of the Computing Model): R. Mankel, Chair
- Data Quality Monitoring and Data Certification:
  - A. Meyer, Convener (L2)
  - J. Olzem, DQM for Monte Carlo simulation (L3)
- Alignment and Calibration:
  - R. Mankel, Convener (L2)
  - G. Flucke, Alignment Software Coordinator (L3)
- CASTOR Calorimeter: K. Borras, Project Leader, HCAL Steering Committee and CMS Financial Board
- High Level Trigger & Data Acquisition
- Beam Condition Monitor

The DESY CMS group is well represented in the management and in long term projects $\rightarrow$ high visibility

Detectors

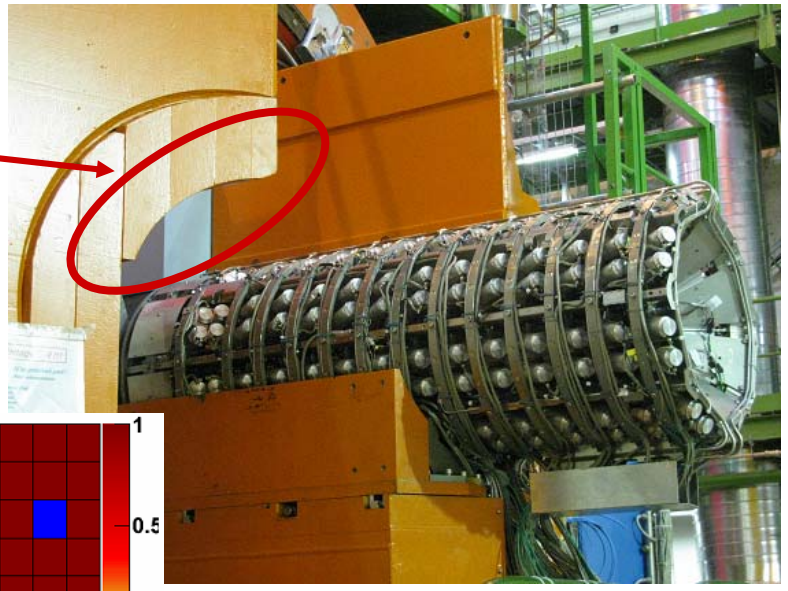
Castor Calorimeter - Production

Assembly & testing in shifts

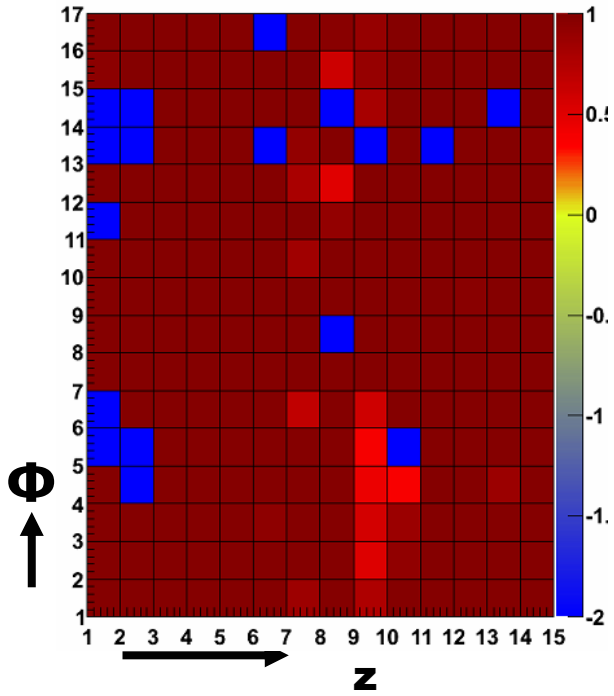
→ 99% channels ok

Castor Calorimeter – Operation in Magnetic Field

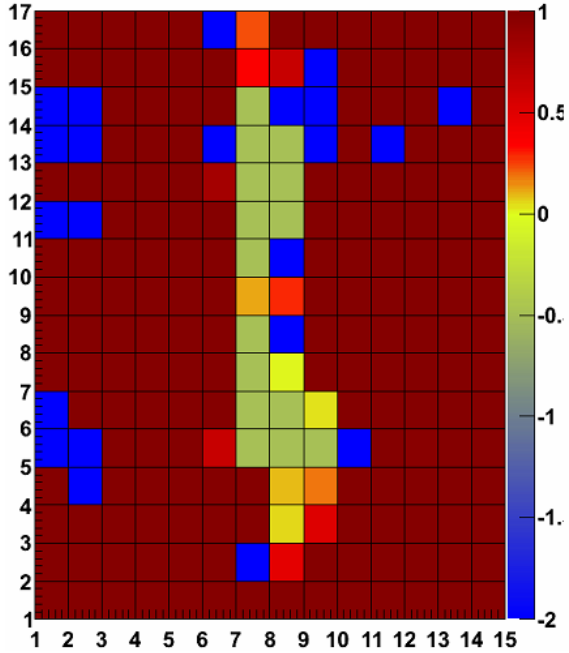
Edge effects at collar shield
→ orientation of magnetic stray field lines such that fine mesh PMT's are not working.



Ratio 0.42T / 0T
PMT HV @ 1000V



Ratio 3.8T / 0T
PMT HV @ 1700V



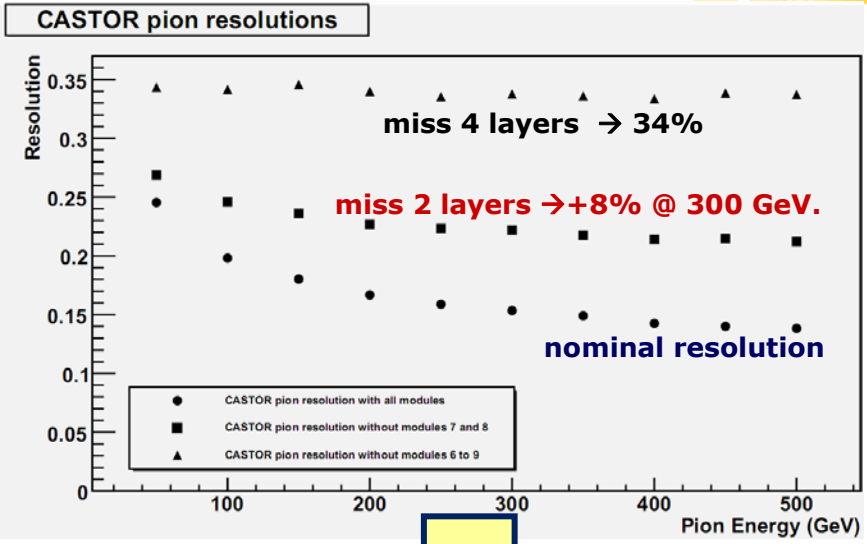
good data

no data

no signal

➔loosing signals in layers close to gap

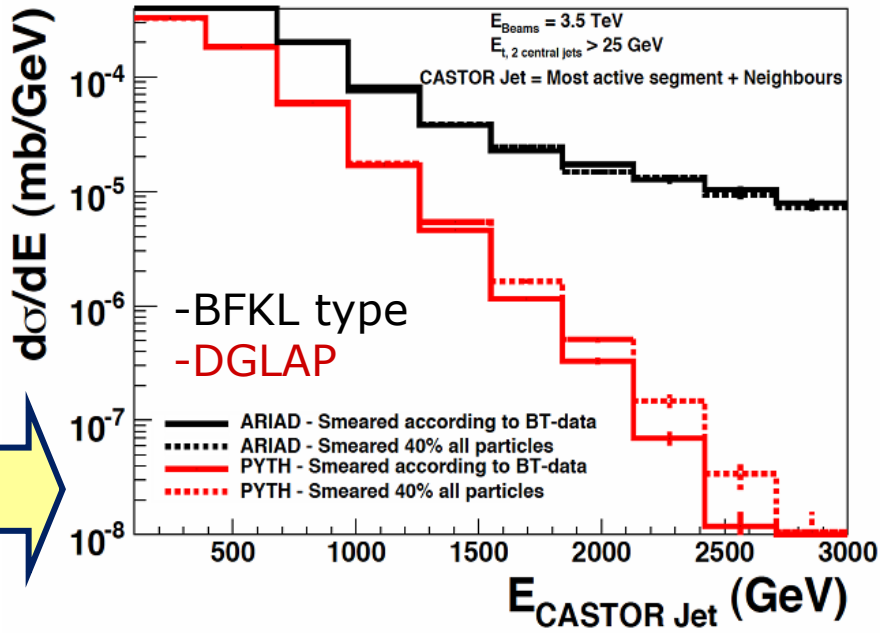
Castor Calorimeter – Physics Prospects



→ Assume worst case:
40% resolution for all energies

→ Repeat forward jet study for 3.5 TeV beam and higher E_T > 25 GeV for central jets

→ Result for 1 pb^{-1} good data



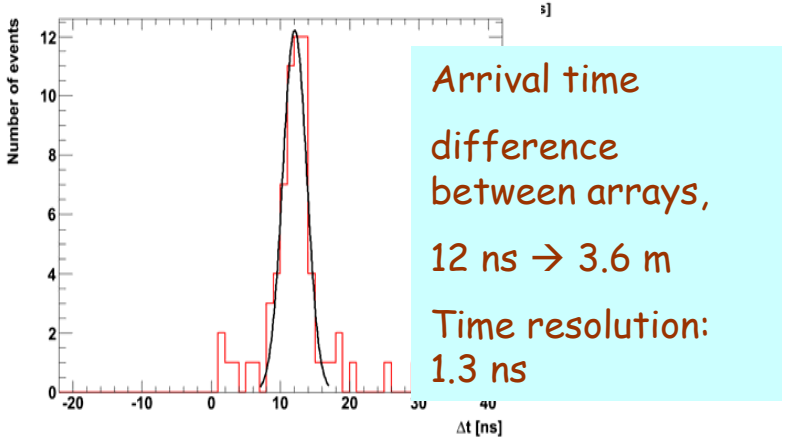
Physics goals for pp still possible
Castor has already participated in global runs
Looking forward to the first beams in LHC ☺

Beam Condition Monitor

BCM1F:

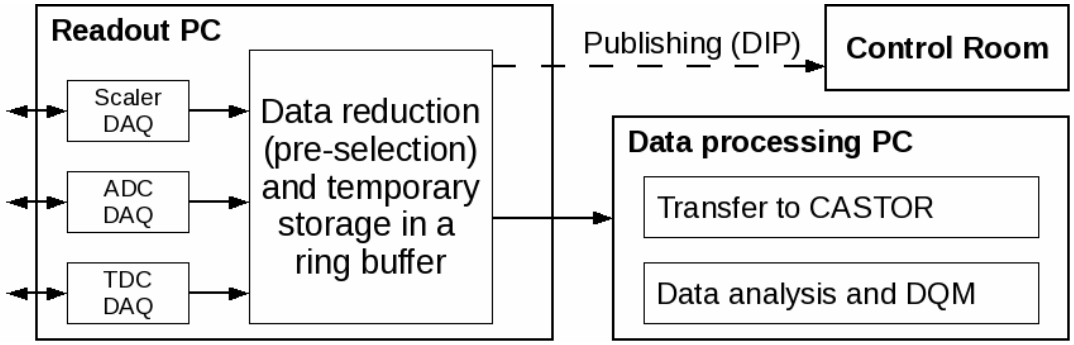
- One out of the 6 subsystems of BRM (Beam Conditions and Radiation Monitor)
- two arrays of four diamond sensors located outside of pixel tracker endcaps (spin-off from ILC FCAL R&D)

Analysis of last year's data (to be published)

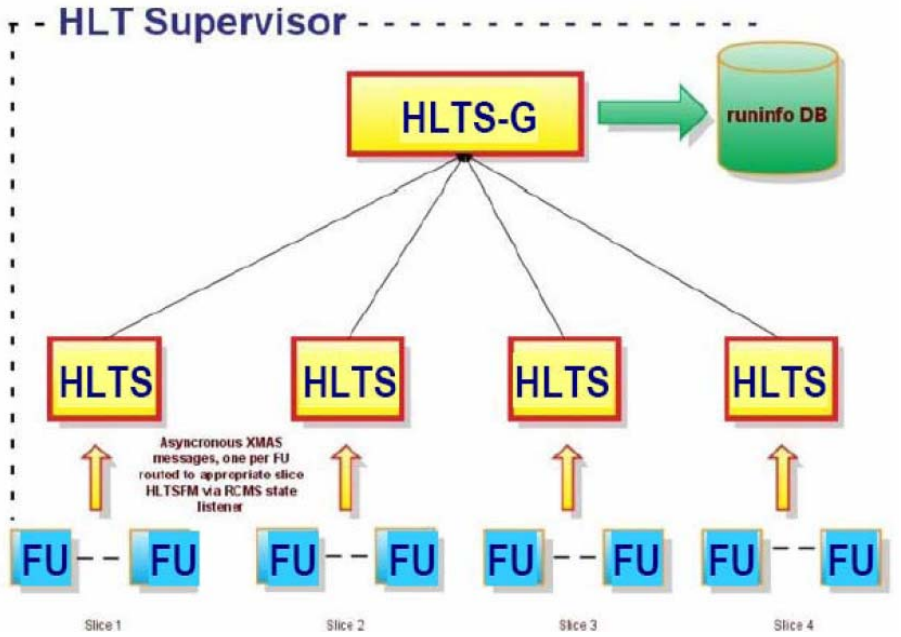


Current activity:

Commissioning of the readout, data storage and processing (independent from the CMS DAQ)



High Level Trigger and DAQ



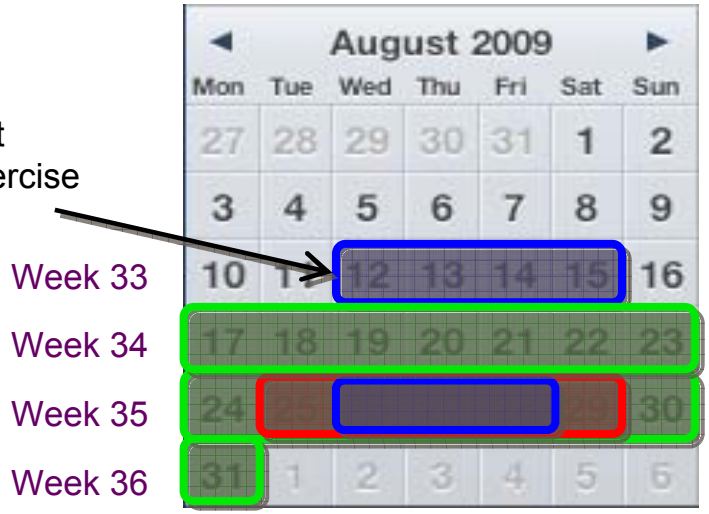
New DESY-PostDoc fellow joined

- HLT Supervisor system performance very successful
  → now included in all global runs
- Addition of L1 scalars in final test phase
  → release for global runs this week
- Data acquisition (DAQ): Changes for end of luminosity section signaling from event manager to filter units in test phase

Alignment and Data Quality

Prompt Calibration/Alignment

Start of Prompt Calibration Exercise

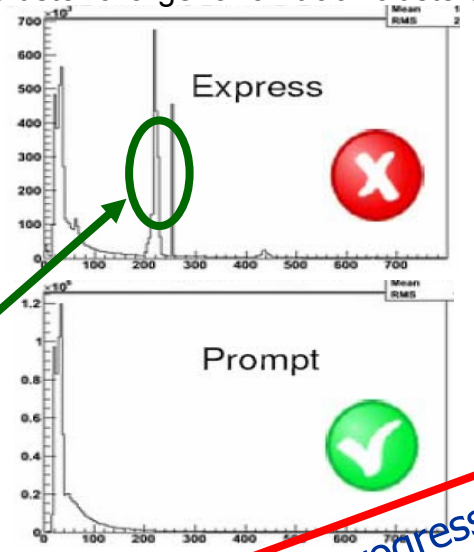


DT time pedestals calibration

SiStrip bad components identification

Tracker alignment

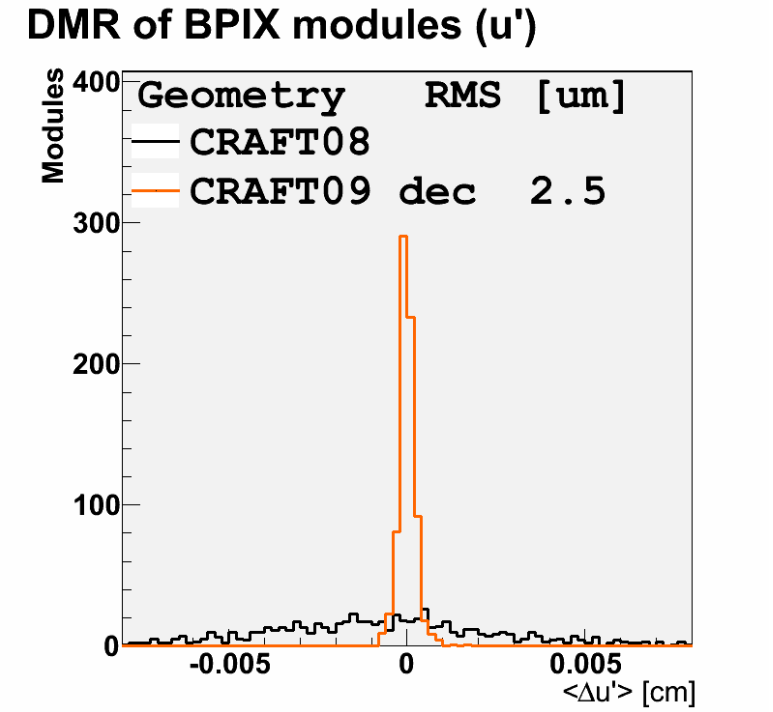
Cluster charge for off-track clusters

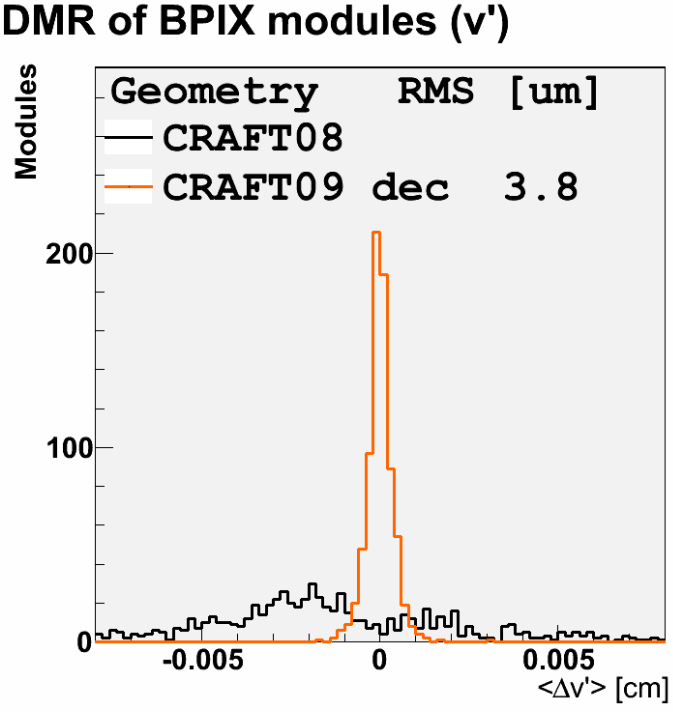


work in progress

- Three prompt alignment & calibration workflows were successfully exercised
- Constants uploaded to database promptly
- Prompt reconstruction uses improved constants:
  - removal of tracker hot channels clearly visible

Tracker alignment in CRAFT '09





Pixel detector alignment has changed significantly compared to CRAFT'08:

- Shown are distributions of the medians of the module-level residual distributions for the barrel pixel modules (using 2.3M tracks, of which 81k have hits in the pixel tracker)
- Changes of ~100(250) μm for BPIX (FPIX) due to intervention on the Pixel systems during the shutdown between CRAFT'08 and CRAFT'09

Alignment performed with combination of Millepede-II and HIP algorithms

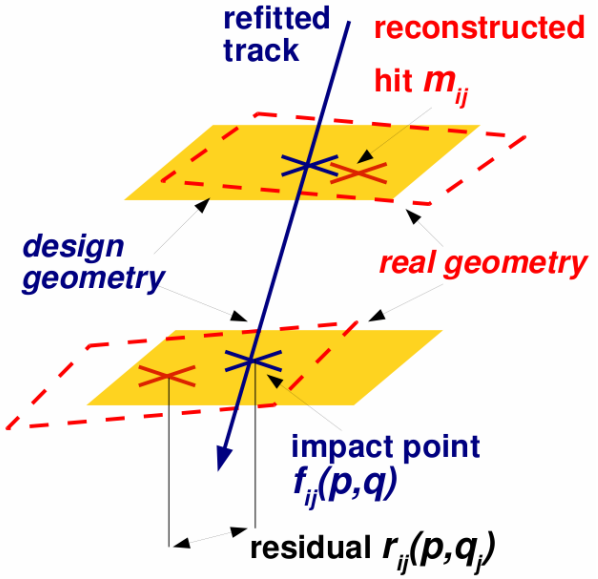
Tracker alignment @ DESY

Validation of tracker alignment streams

Assessment of alignment effects on track resolution

Millepede-II-based alignment with beam halo particles

Rigorous treatment of multiple scattering in Millepede-II-based alignment



Cooperation with Statistics Group of Analysis Center

PHYSICS AT THE TERA SCALE
Helmholtz Alliance

Data Quality Monitoring

DQM comprises monitoring for:

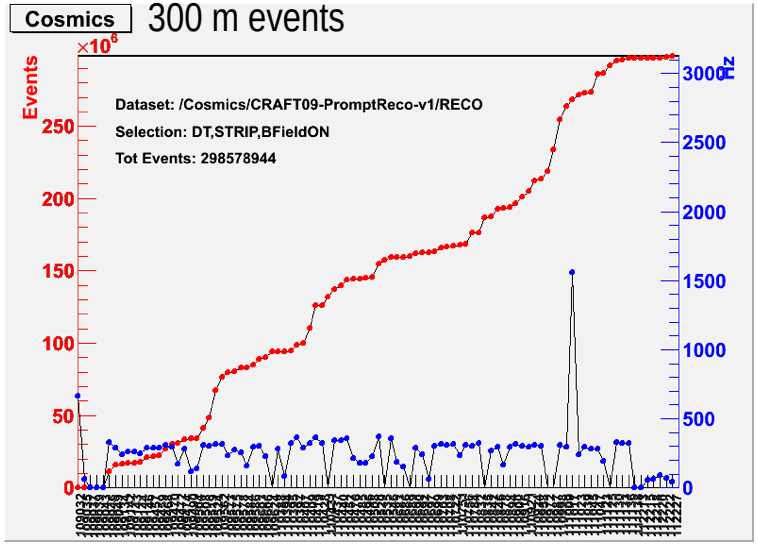
- Online data taking ← New DESY-PostDoc fellow
- Offline reconstr. (prompt and re-reco)
- Alignment & Calibration
- MC prod. & Release Valid. ← Coordinated by new DESY- PostDoc fellow

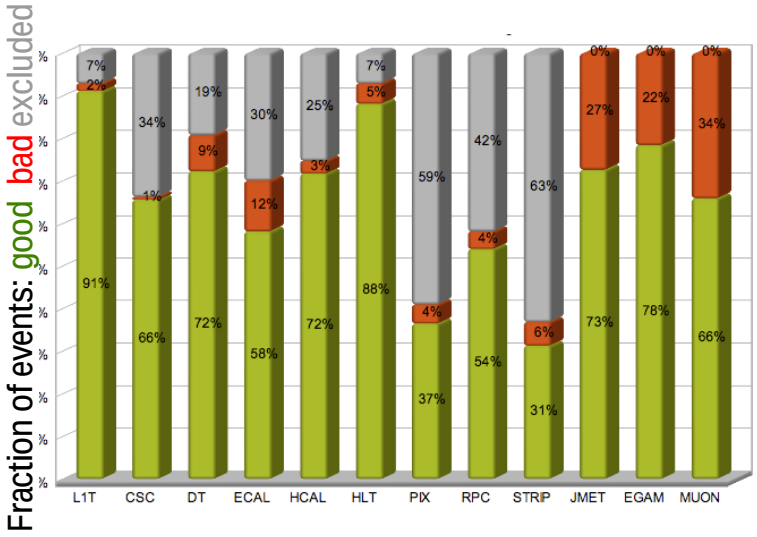
Central developments since April 09:

- Upgraded, much faster version of histogram browser
- New Run Registry database and GUI

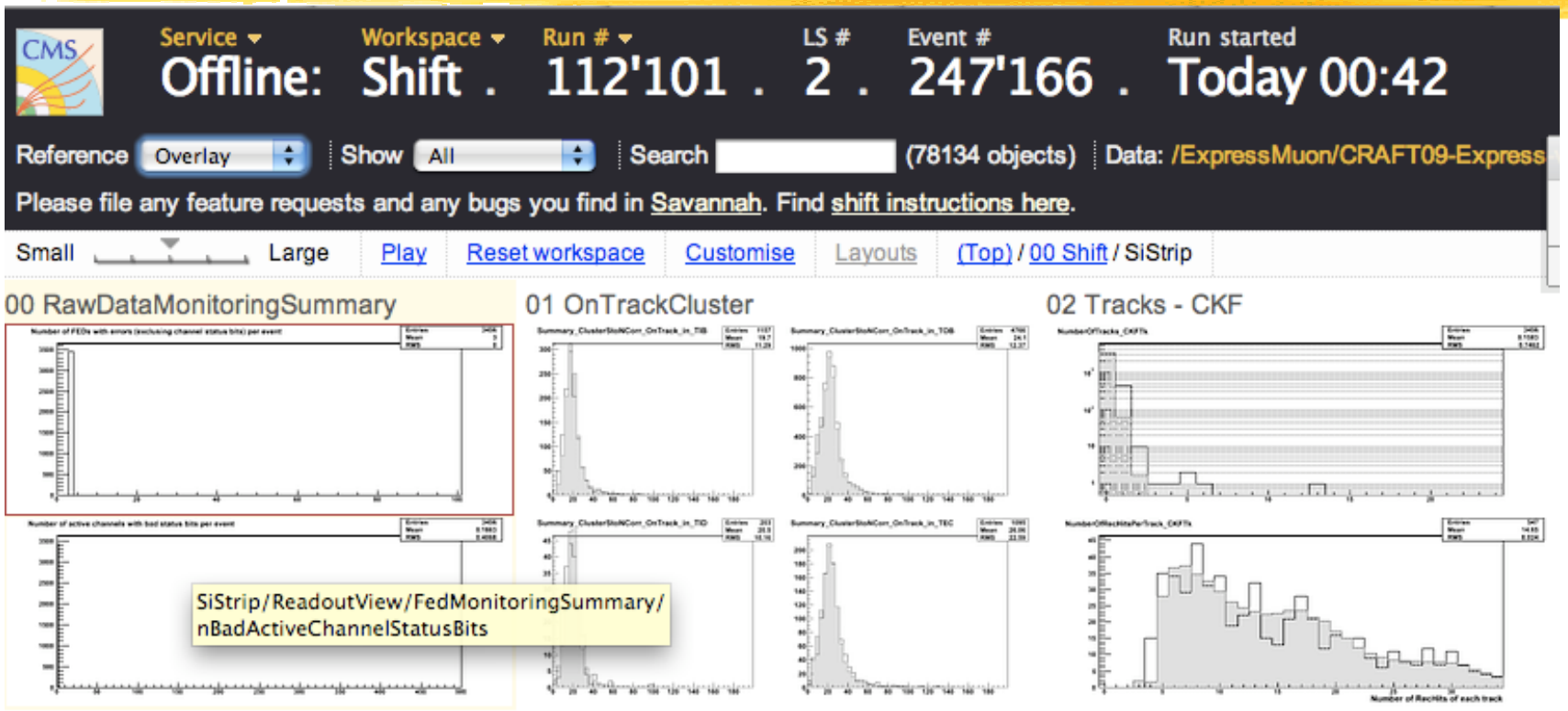
CRAFT '09:

- Test of readiness for sustained operation during LHC beams and collisions
- ~400 runs monitored, certified and good-run list published
- DESY remote center: valuable and reliable help





DQM: Upgrade of DQM GUI

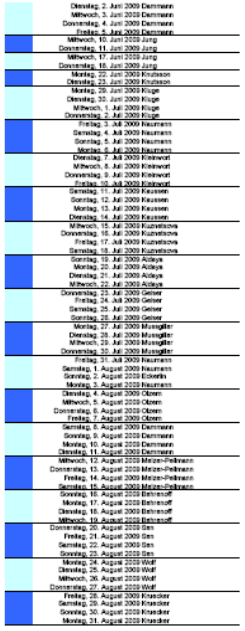


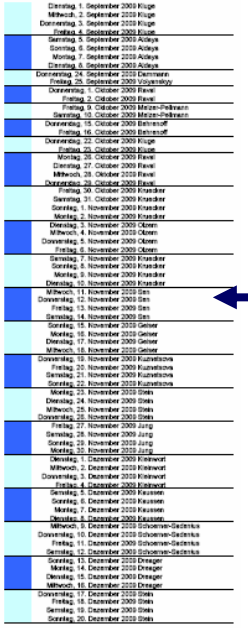
- Improved file indexing scaling to large number of histograms for each run and dataset
- Navigation of different datasets (including MC)
- Reference histograms

Remote Center

DESY valuable and reliable help for the online data quality monitoring shift:

- All data quality monitoring shifts filled during cosmic runs including CRAFT'09, mid-week global runs until end of 2009





shift list 2009

- Computing operation shifts are planned to start (first tests soon)

Computing

October Exercise

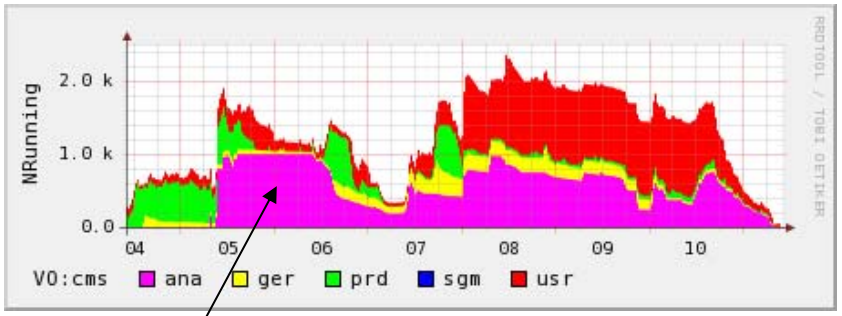
Focused on:

- Production of physics groups data sets
- Using grid submission tools
- Load Tier2s with analysis jobs
- Check store/results and export to global DBS

Status of hosted data after 10 days:

Top	**38 TB**	**100 %**
JetMET	**18 TB**	**98 %**
QCD	**25 TB**	**100 %**
Forward	**7 TB**	**100 %**
Analysis	**39 TB**	**97 %**

Jobs slots used by CMS at DESY (1st week of exercise):

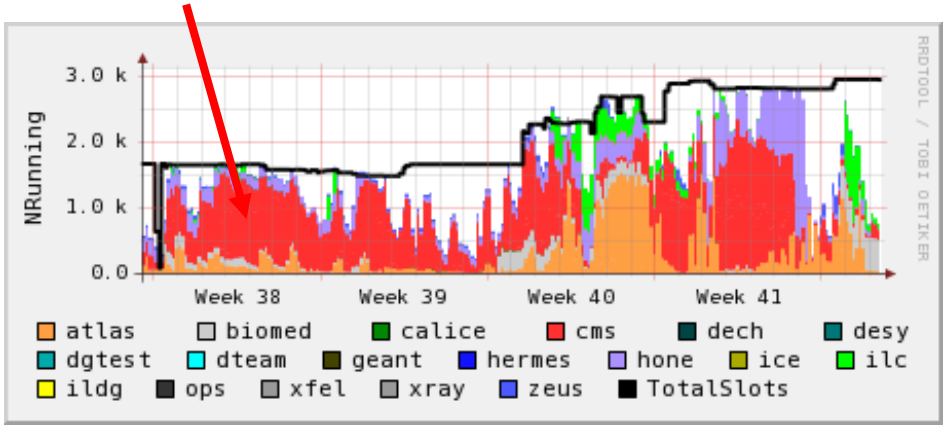


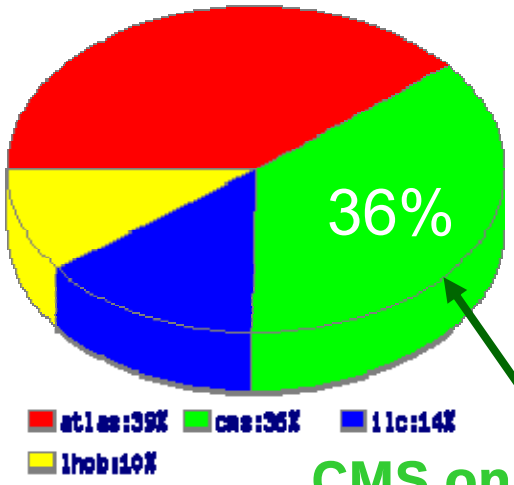
priority user
= "production users of a group"

CMS Tier 2 and NAF usage

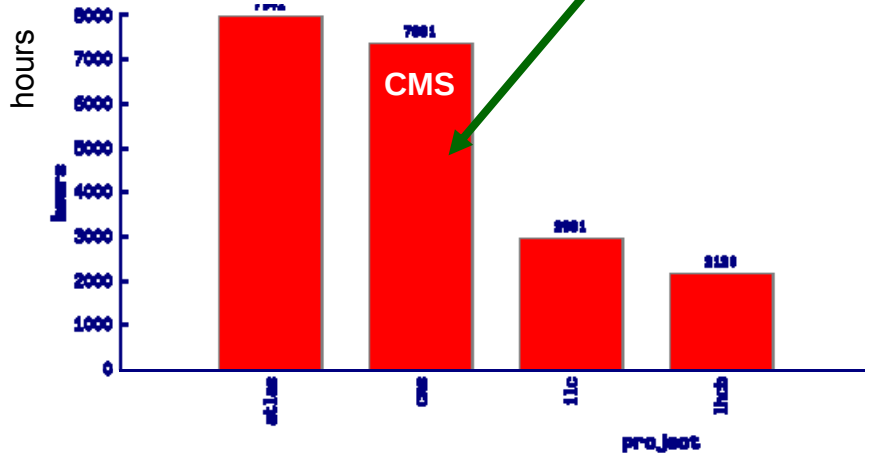
DESY Tier 2 in production mode
NAF in production mode, also for CMS users

CMS on Tier 2





CMS on NAF (12.-14.Oct)



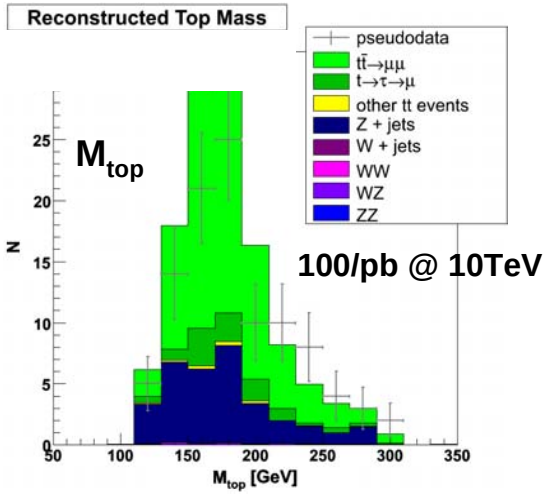
dCache disk storage:
300TB, ~200TB used

Physics

Top Group (incl. YIG)

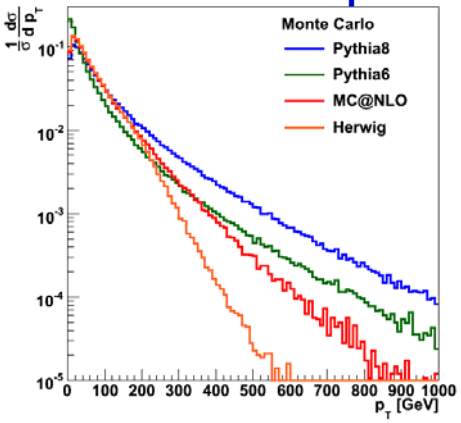
Activity in 2009: Preparation for physics analysis

- **ttbar cross-section determination in dimuon channel**
  - Event selection for early data (√s = 7 and 10 TeV)
  - Kinematic reconstruction of ttbar events
  - Use of data-driven methods for background estimation
  - Validation of b-tagging efficiency using reconstructed jets from ttbar events

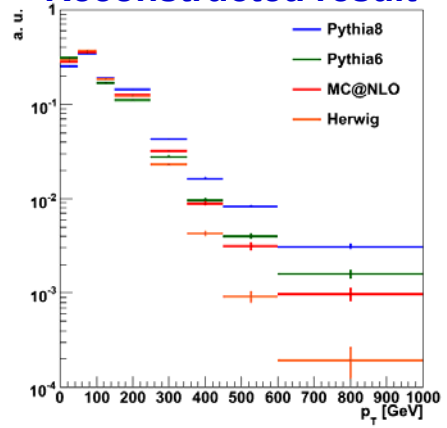


- **QCD radiation in top pair production (PhD thesis defended in Aug09)**
  - Different QCD radiation models:
    → significant differences for top pair observables
  - Model discrimination possible

Monte Carlo input



Reconstructed result

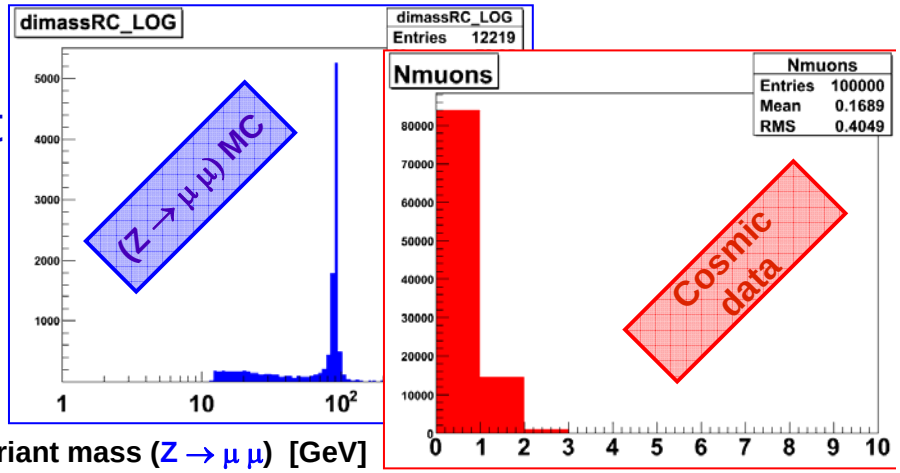


Top Group (incl. YIG)

- **Online/Offline ttbar monitoring in the μμ/μe channel**

Prompt data validation:

- Monitoring and checks of lepton trigger efficiencies from dileptonic top-like events at HLT level ('tag & probe' approach)
- Monitoring of dilepton reconstruction & efficiencies at reconstructed object (RECO) level and HLT level for simple physics feedback (→ dilepton mass spectrum)



- **Secondary Vertex (SV) validation (YIG)**

In context of measuring top quark mass via B-hadron lifetime (Lxy method):
Development of official tools to classify and analyze **secondary vertices**
(SV reconstruction, SV-based b-tagging algorithms, verification of new software releases)

Goals for 2010: First physics measurements with early LHC data (7,10 TeV): Top quark rediscovery, production cross-section measurement in dileptonically decaying ttbar pairs, measurement of top quark properties

Supersymmetry (mainly YIG)

Group established in May

- 1st postdoc started in June, 2nd position still open
- 1st PhD student started in August, 2nd will start in December
  3rd PhD student (who started in December 2008) also joined the group

Data analysis:

- Participation in leptonic „Reference Analyses" – see also here:
  https://twiki.cern.ch/twiki/bin/view/CMS/SusyPagReferenceAnalyses
- Main focus on measurement of missing transverse energy (MET)

CMS contribution:

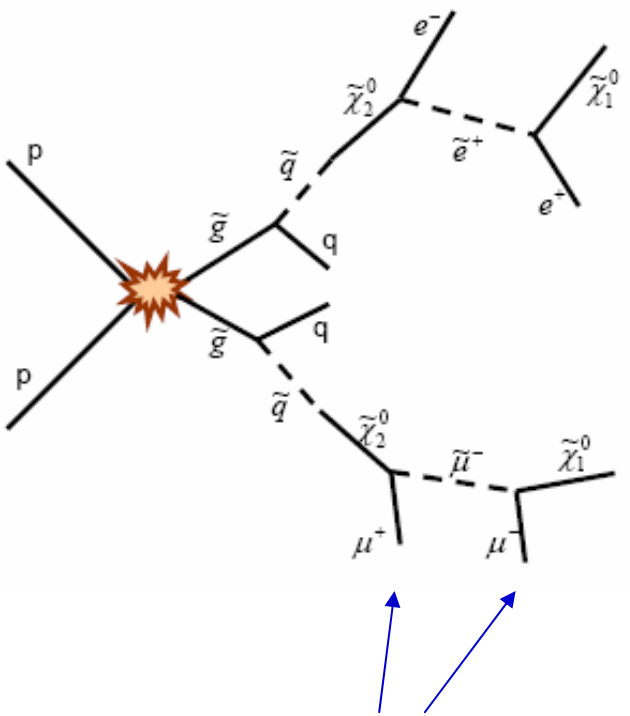
- Development of offline data quality monitoring (DQM) tools within the SUSY Prompt Validation and Physics Commissioning team
- Studies for the upgrade of the HCAL
- Shifts at DESY (CMS Center) and CERN

Planned SUSY Analyses

Jets + E_T^{miss} + 2 (same-sign) muons/electrons
- Trigger quite simple (at least for muons)
- Small QCD background

Jets + E_T^{miss} + 1 muon
- Relative clean signature due to muon
- Trigger quite simple, but larger background than for 2-muon signatures
- Background: top quark production, QCD events with jets, elektroweak boson production

Jets + E_T^{miss} + 2 (odd-sign) muons/electrons
- Characteristic invariant mass distribution of the two muons

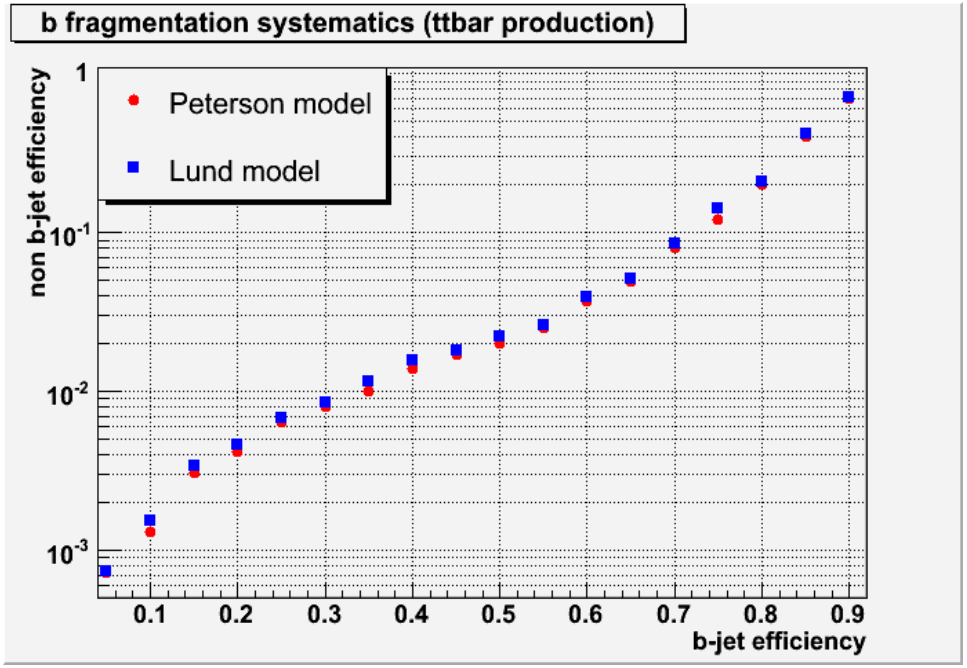


Goal for 2010:
development of several leptonic analyses on 2010 data

Higgs group (mainly YIG)

Achievements:

Tools for evaluation of systematic effects on b-tagging developed and delivered to the CMS B-Tag POG



Ongoing activities & plans for March 2010:

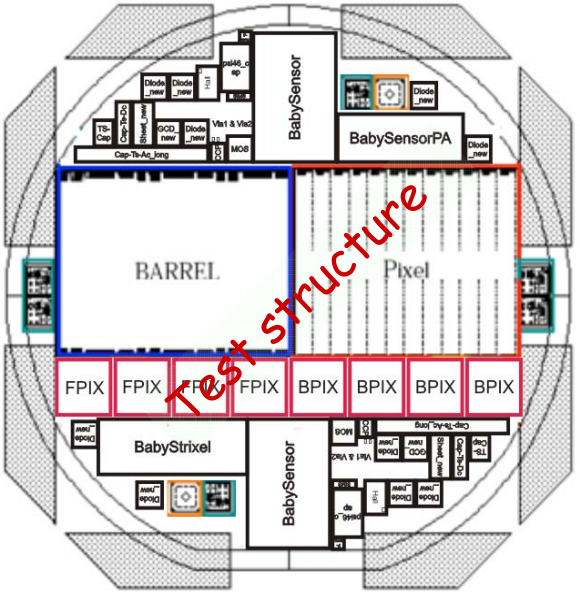
- Establishing analysis for the MSSM Higgs $\rightarrow \tau\,\tau$
- Refinement of jet energy scale calibration at lower energies exploiting Z production with one or two jets
- Development of the software for publishing of the Beam Condition Monitor (BCM) status

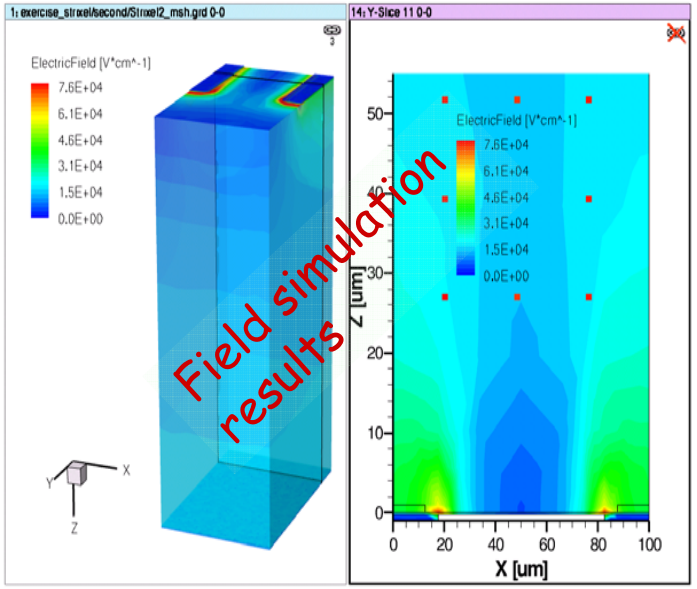
SLHC Upgrade

Tracker Upgrade – Sensor R&D

Within CEC including the German universities

- Challenge at sLHC: higher fluences and occupancy
- Study radiation tolerance of several sensor materials and layout technologies (130 samples)
- Coordinated effort, create common standards
- Create a solid basis for final choice of material and technology





- Participation in a "calibration campaign"
- Upgrade of the silicon lab at DESY (Z.) to be a "Measurement Center"
- Field simulations
- Data base for sensors and measurements

Tracker Upgrade - Module

Main goal: reduce material budget

Sensors:

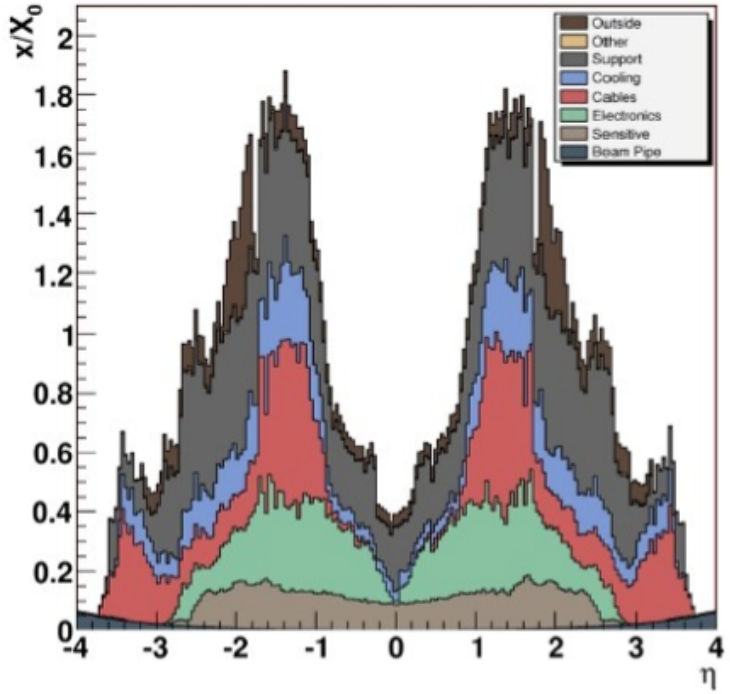
- reduce thickness to 200um
- higher leakage current
  → higher power consumption

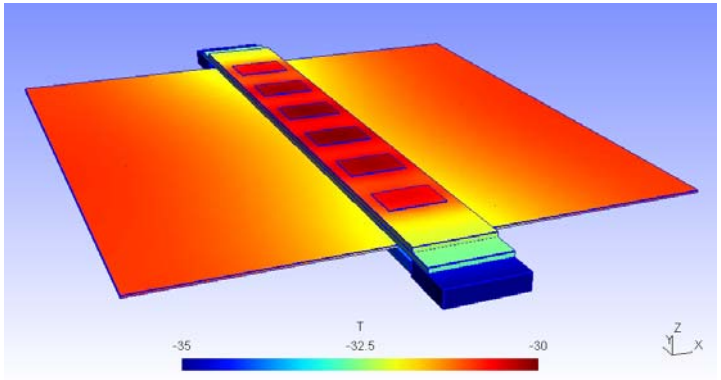
Electronics:

- thinner & smaller front-end chips
- integrate Pitch-Adapter in Sensor
- larger number of read-out channel
  → higher power consumption

Cooling

- switch to CO_2 cooling: smaller pipe diameters

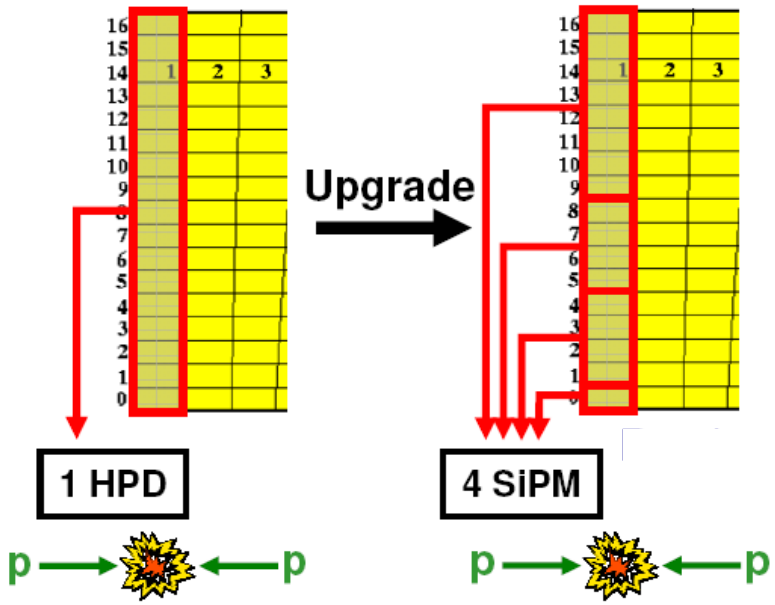


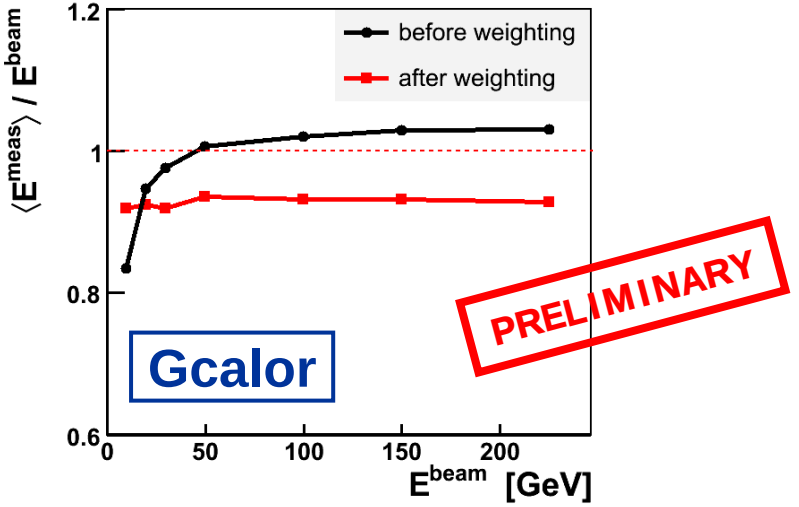


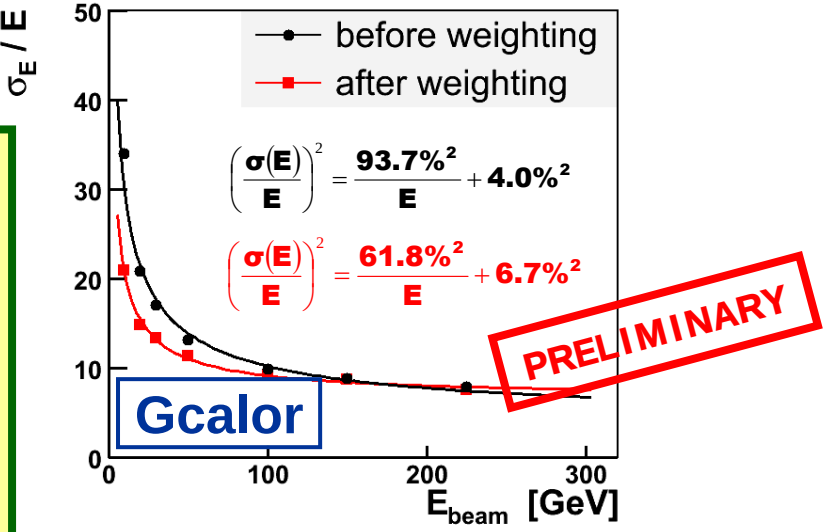
Main activity: Thermal Design

- based on FE calculations
- search for new materials
- tests with prototypes
  → lab is being set up

Weighting method for HCAL Upgrade







Longitudinal segmentation allows weighting procedure (spin-off from H1) for compensation of $e/\pi \approx 1.2$

➔ improve linearity

➔ improve energy resolution

- Shown to work for single pions
- Next step: apply weighting to jets

Summary and Outlook

The DESY CMS group is in good shape:

Detectors:

- All detectors are installed and ready for data taking

Alignment and Data Quality well established:

- Prompt alignment and calibration: improved fast reconstruction
- Data Quality Monitoring tools improved/ready for data taking

Computing:

- DESY and many other T2 are ready for data taking
- NAF well accepted and used

Physics:

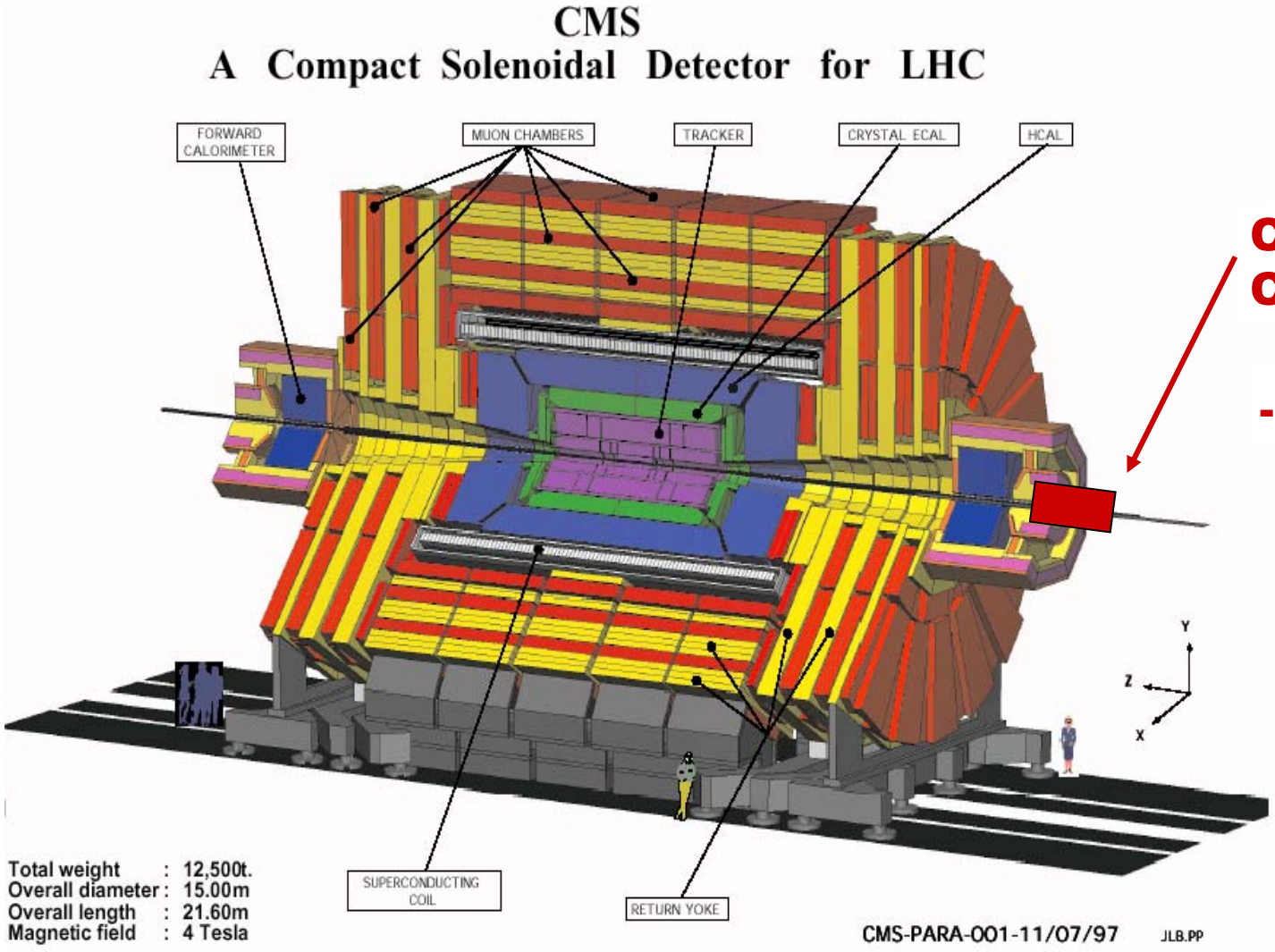
- Two new Young Investigator Groups just started enlargening the scope for physics
- DESY is working on key issues for LHC physics
- All physics groups are intensively preparing for first data

We are eagerly waiting for beam, collisions and luminosity

Backup

Castor

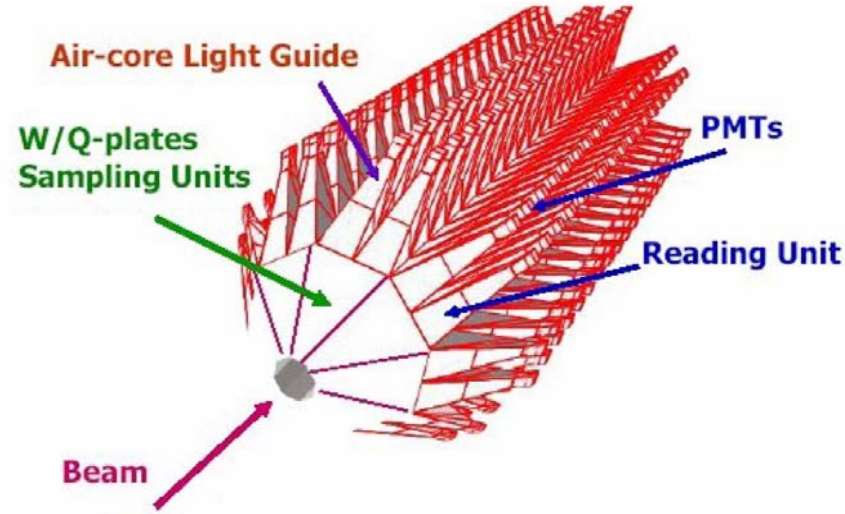
Castor Position



CASTOR Calorimeter

$-6.6 < \eta < -5.2$

Castor Layout

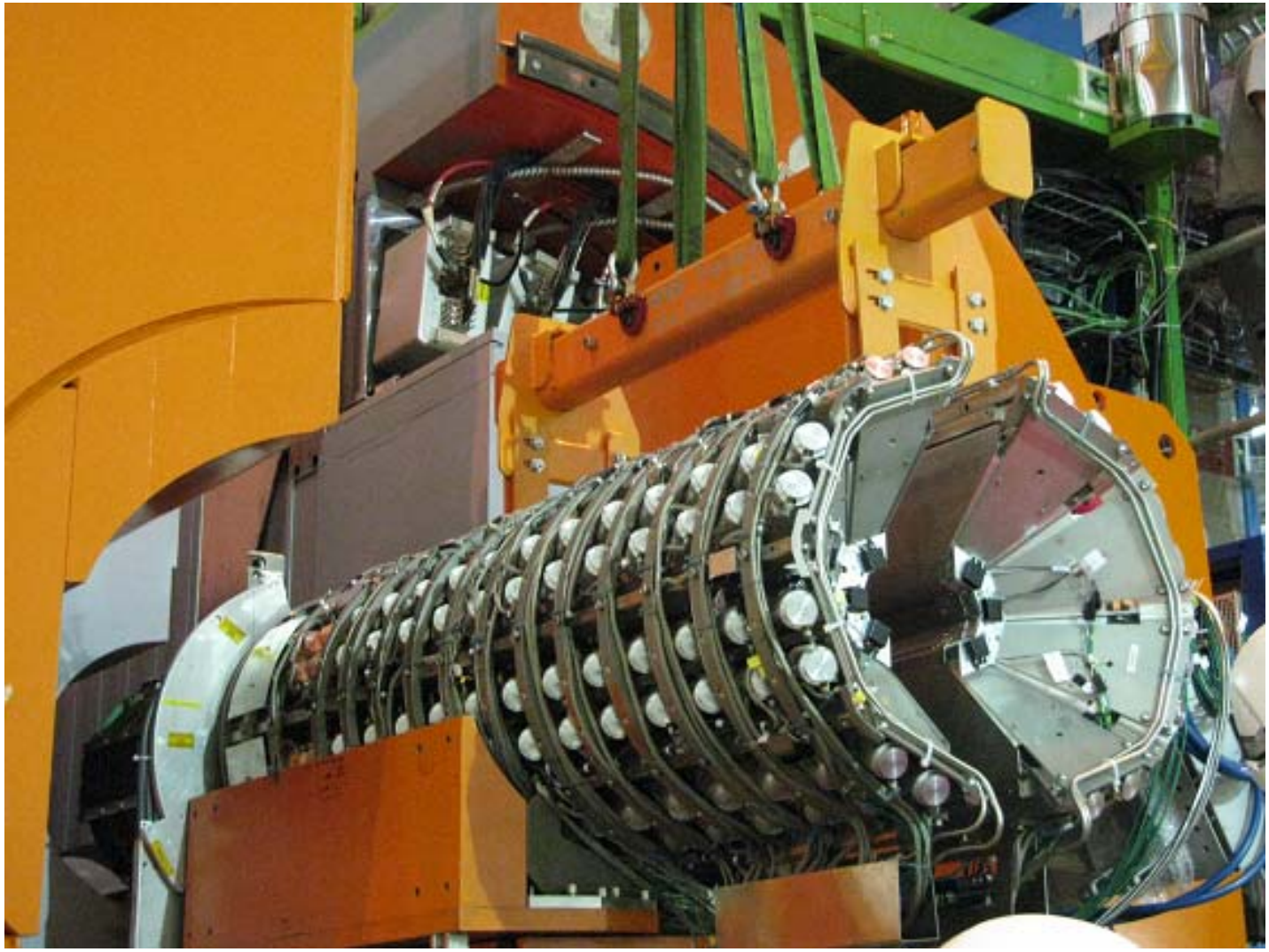


- 14 segments in length of 1.6m,
- 16 segments in Φ for radius of 0.3m
- 2 EM segments: 2x 10 X_0 → 0.77 λ
- 12 HAD segments: 12x 0.77λ → 9.24λ
- In total: 224 channels and 10λ

Air core light guide, covered inside with reflecting foil

- CASTOR is fully equipped: all 224 channels !
  99.5 % of the channels give signals (miss 1 ch)
  92.0 % of the channels see LED calibration
- 3 (out of 8) LED pulse fibers broken at Pt5
  → two octants no LED signal → under repair
- Integration of DAQ system into CMS data stream underway
- Still suffering from high magnetic stray field

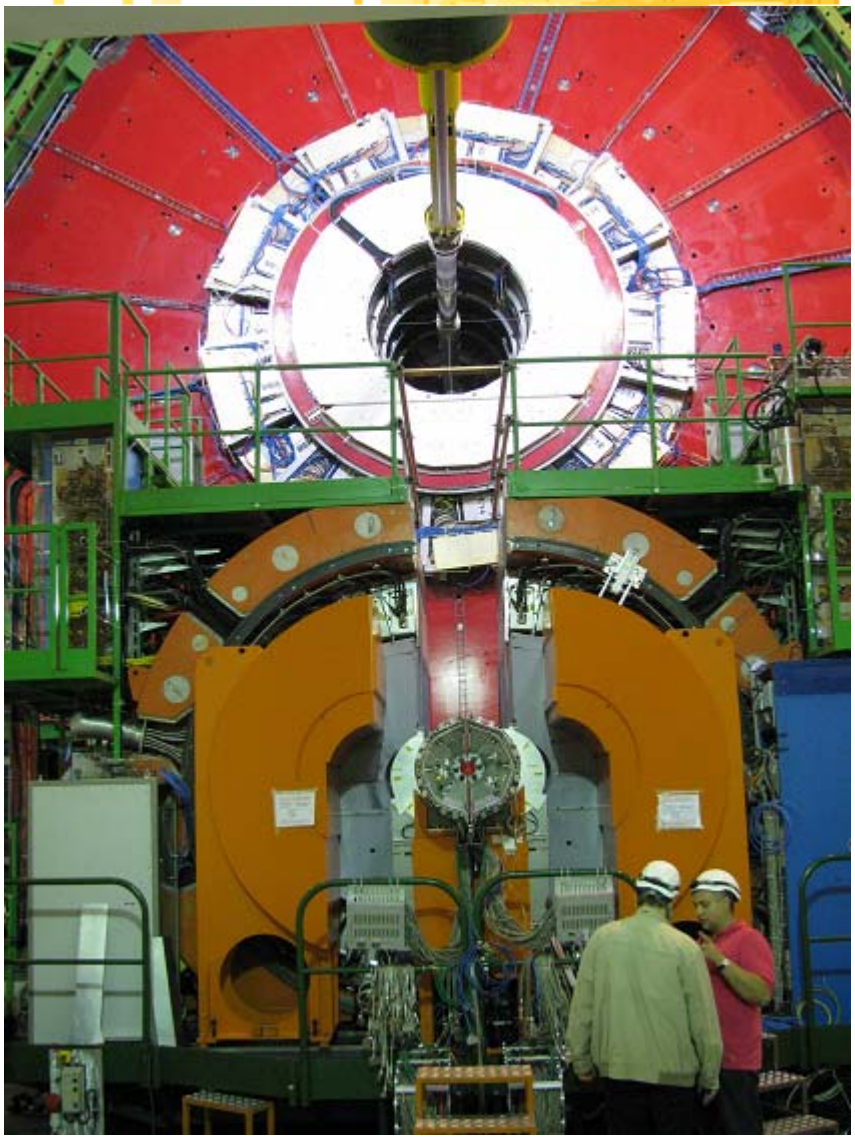
Castor Pictures



Lowering of 2nd CASTOR half (right)

25th of June 2009

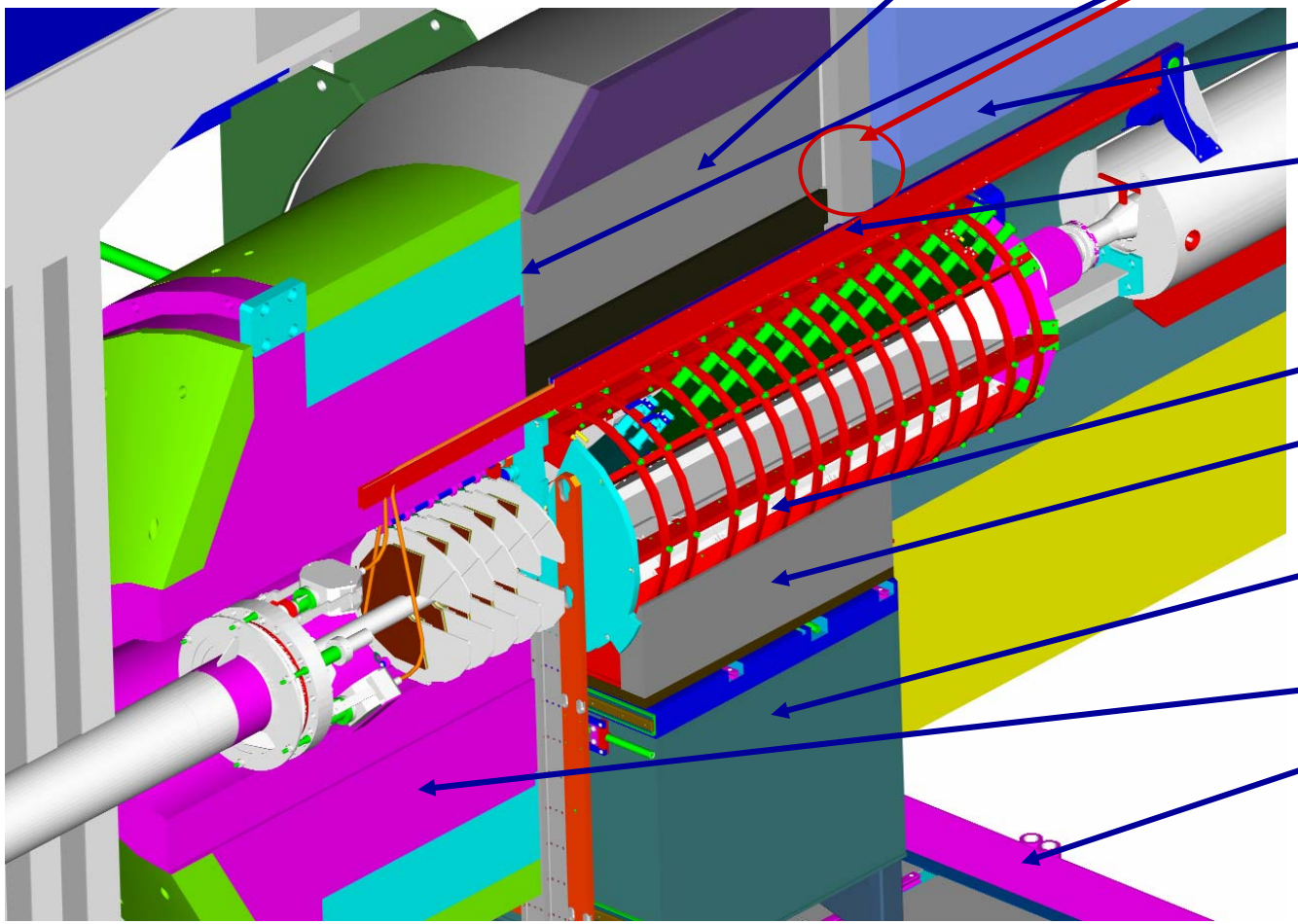
Castor Pictures



Fully equipped CASTOR Calorimeter installed in CMS

25th of June 2009

Configuration in CMS



Recovery with higher voltage

3.8T AFTER vs 0T; (112209 vs run 103935)

L1-5	1000V	1000V
L6-8	1990V	1000V
L9	1700V	1000V
L10-14	1000V	1000V

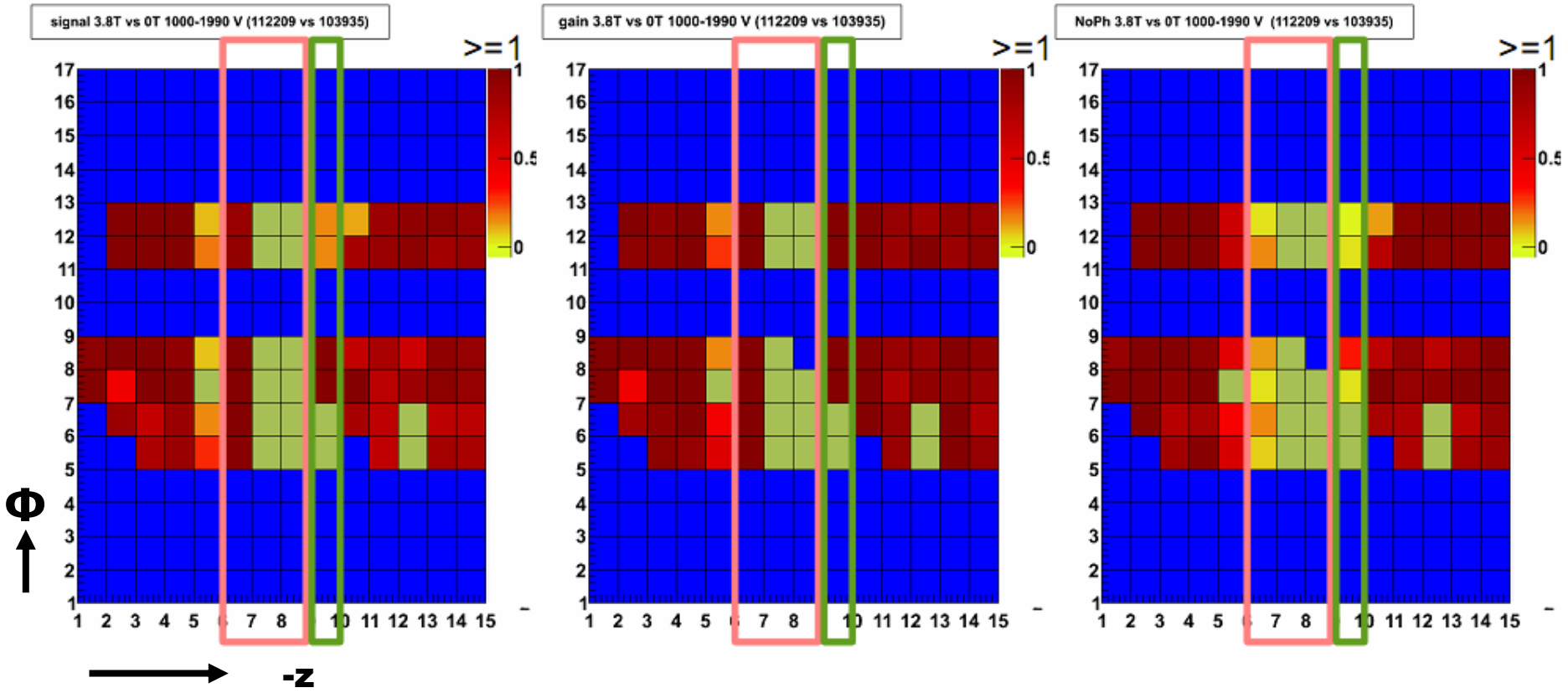
8.8 and 16.5 – problem of gain estimation in 0T run

no signal found

no data

➔Recover 2 layers

➔2 layers remaining silent.



Alignment

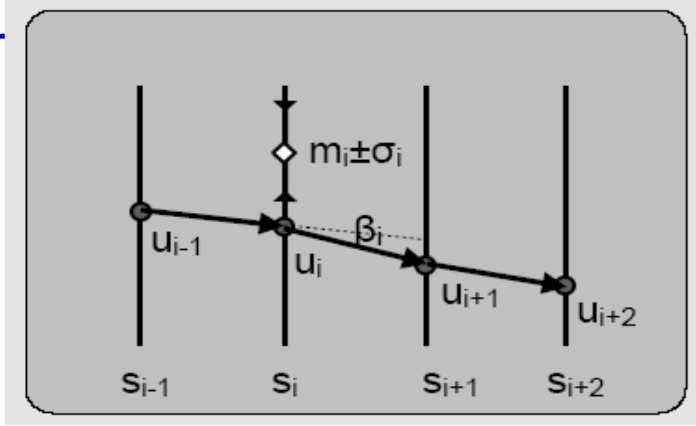
Improved Tracker Alignment

Principle of Millepede: fit all tracks and all alignment parameters simultaneously

- Track fit requires accurate implementation of trajectory model
- Current implementation: helix-based models without rigorous treatment of multiple scattering
- Problem: multiple scattering important in an all-silicon tracker

New: introduce "broken lines" trajectory = stepwise curved lines with kinks at measurement planes

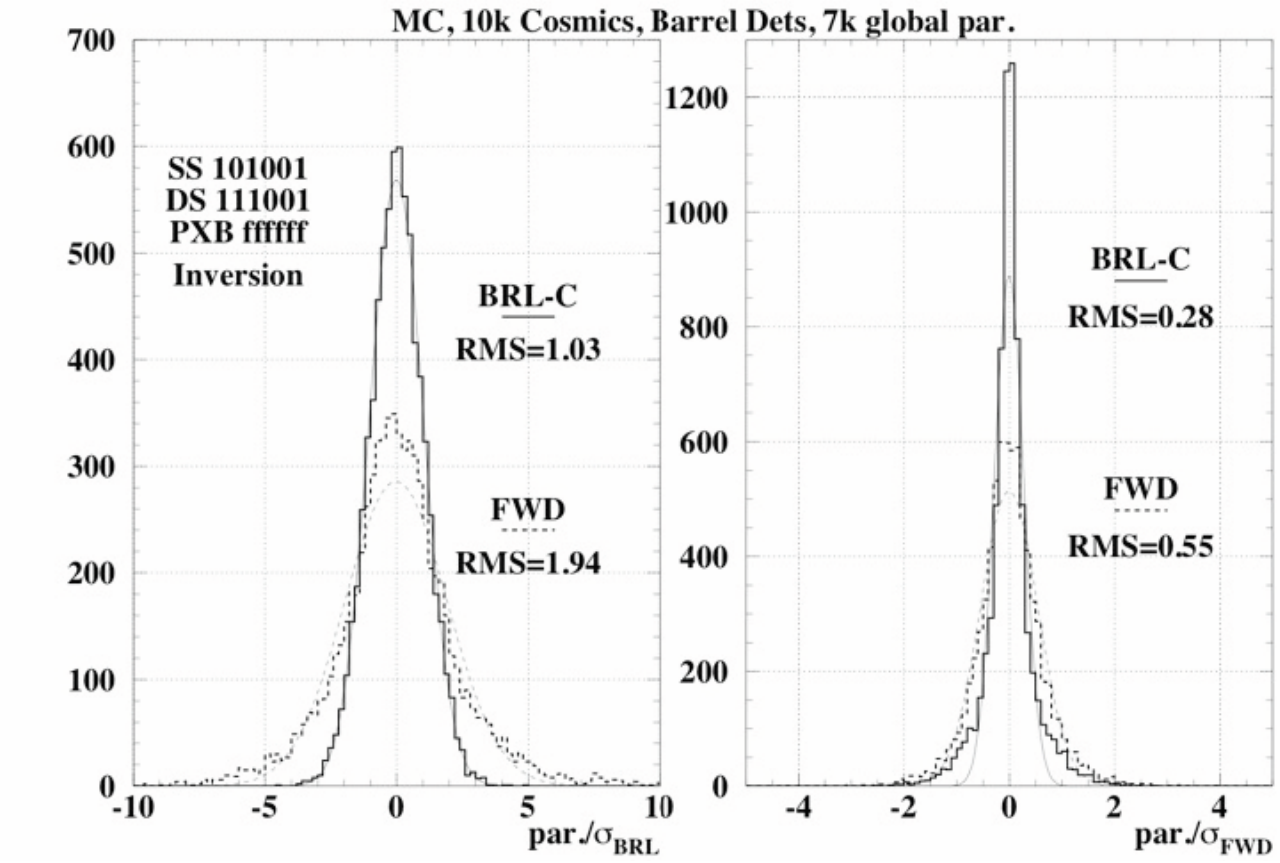
- Time for solution of corresponding linear equation system (band matrix structure) proportional to number of planes
- Recently implemented in CMSSW
- Uses new Millepede II-B version
- In close collaboration with the Statistics Group of the Analysis Center (based on code by V. Blobel)



Tests of the new method ongoing with promising first results

Alignment

Cosmics, barrel strip detector alignment



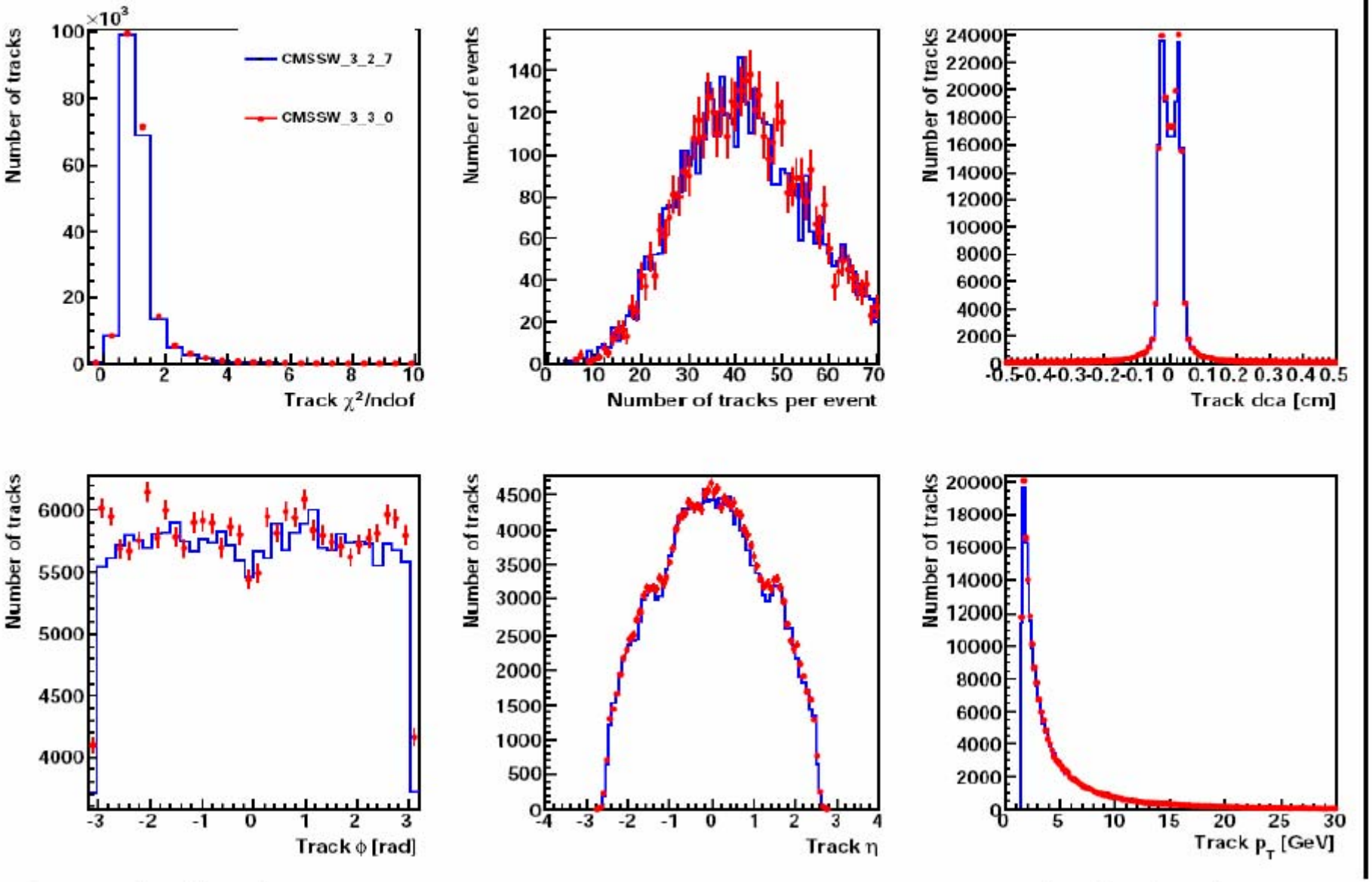
if we use this for the PRC, Claus will need to provide more information

Tested with alignment of CMS barrel strip detector modules in cosmic muon MC

Millepede with broken lines fit gives ~ 2x better resolution of geometry parameters

Justyna Tomaszewsl

Validation of the releases

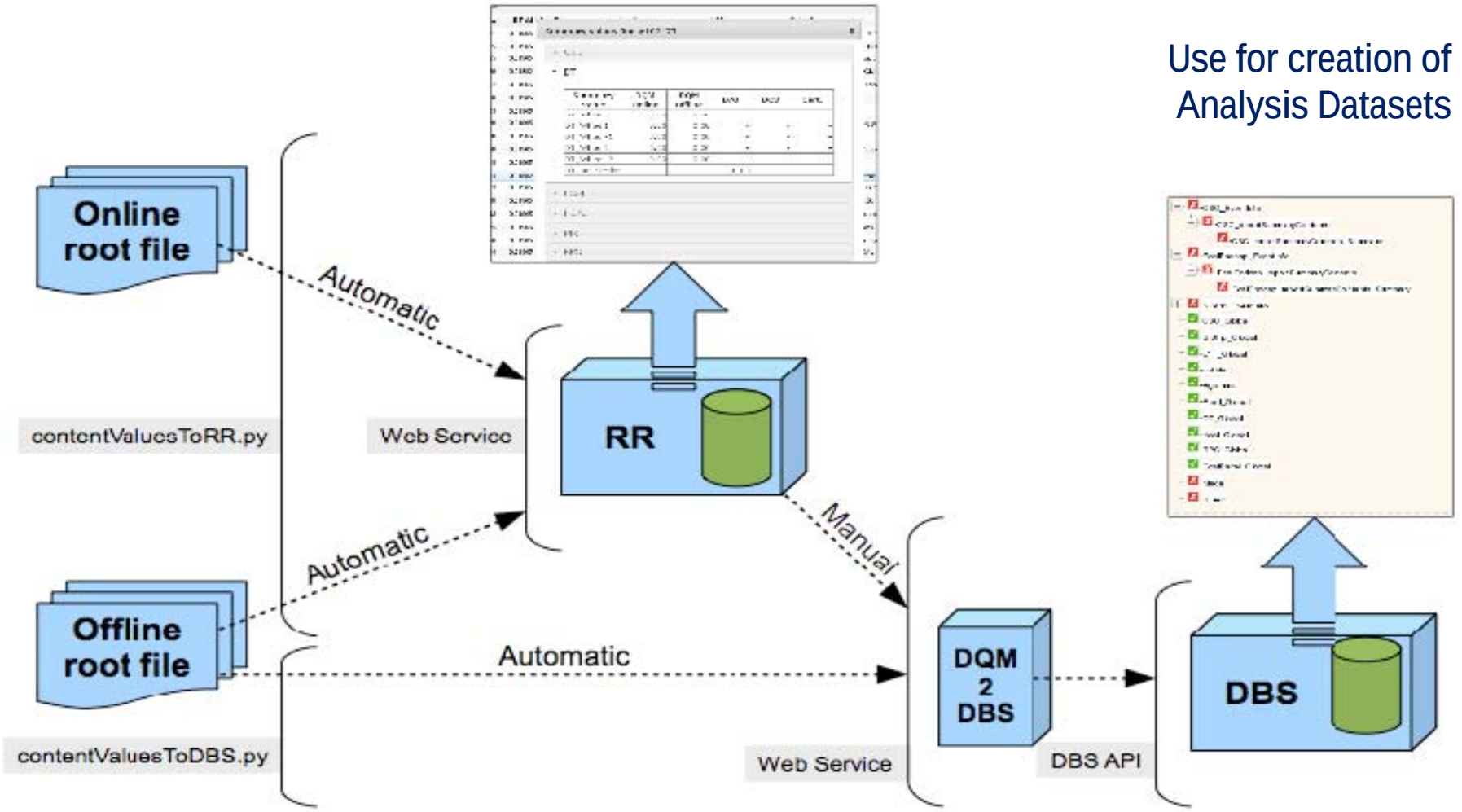


ample: RelValTTbar_CMSSW_3_3_0-MC_31X_V9_StreamTkAlMinBias

DQM

DQM: Publication of Data Certification Results

DQM Histograms → produced by shifts → RunRegistry → signed off by experts → DBS



Computing

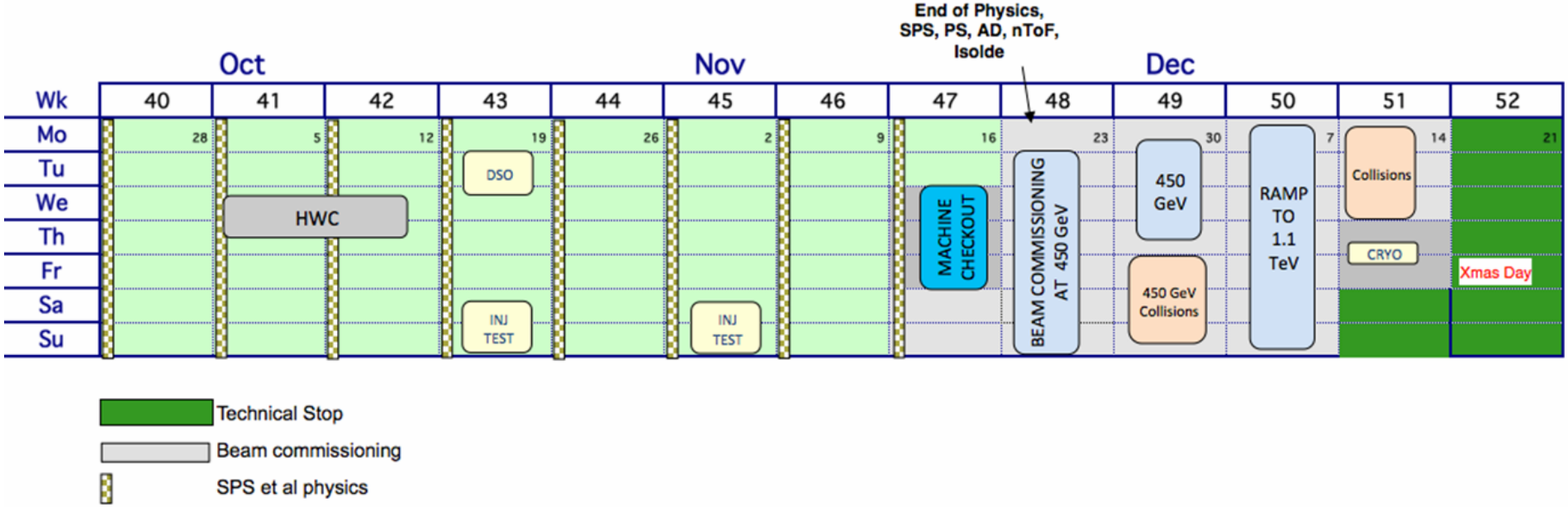
LHC Status

LHC Status

- Splices will continue to require attention:
  100% protection against all scenarios only possible by clamping or shunting
- Energy step up to 4-5 TeV require additional studies
- Machine group would like to start with flat machine before introducing a crossing angle and exploiting 50ns bunch spacing

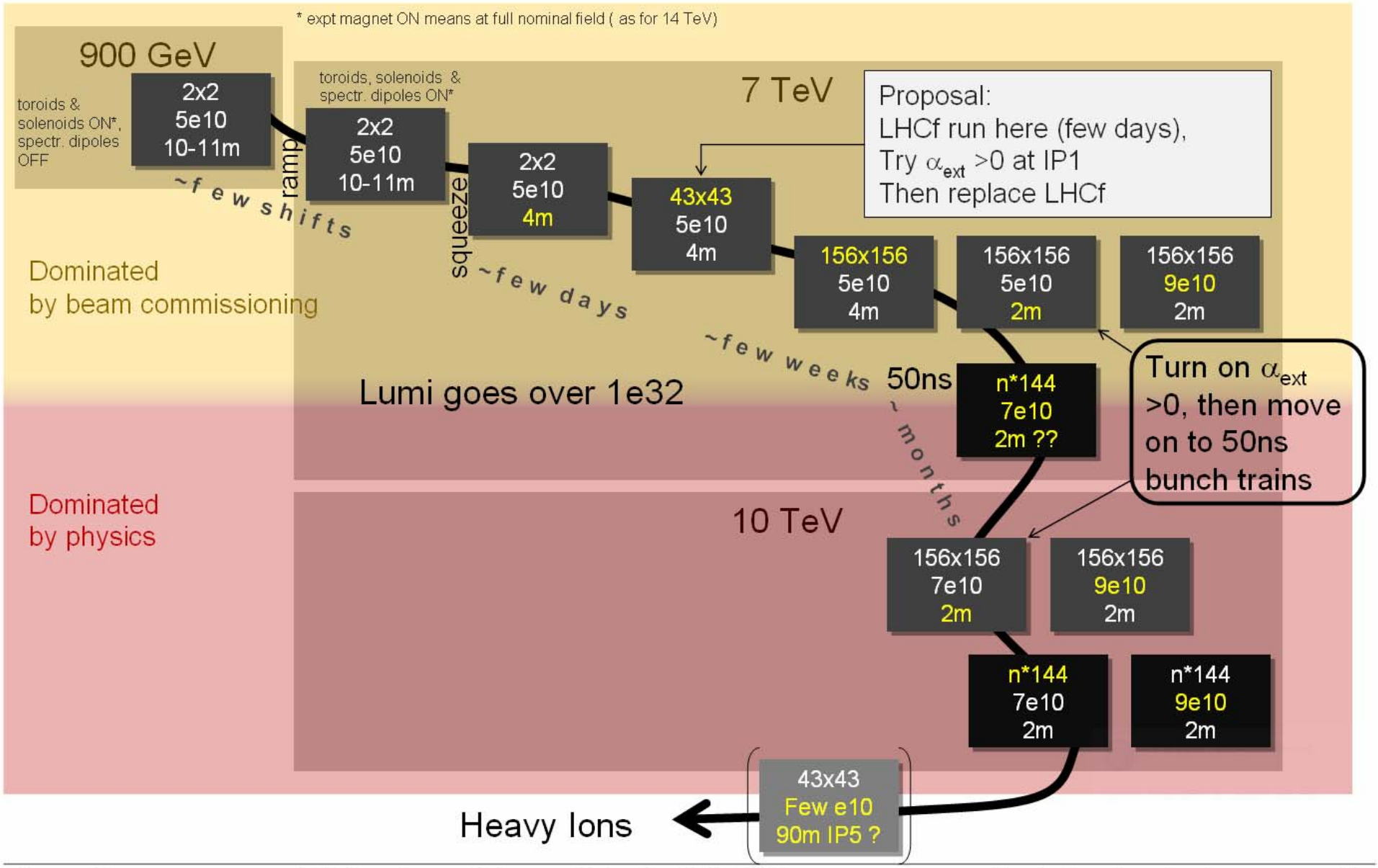
Up to date schedule till end of 2009

- completing HW cmg to 6 kA (3.5 TeV) turns out to be icompatible with making collisions this year
- complete HW cmg to 2 kA (1.1 TeV) by ~16 Nov and make beams

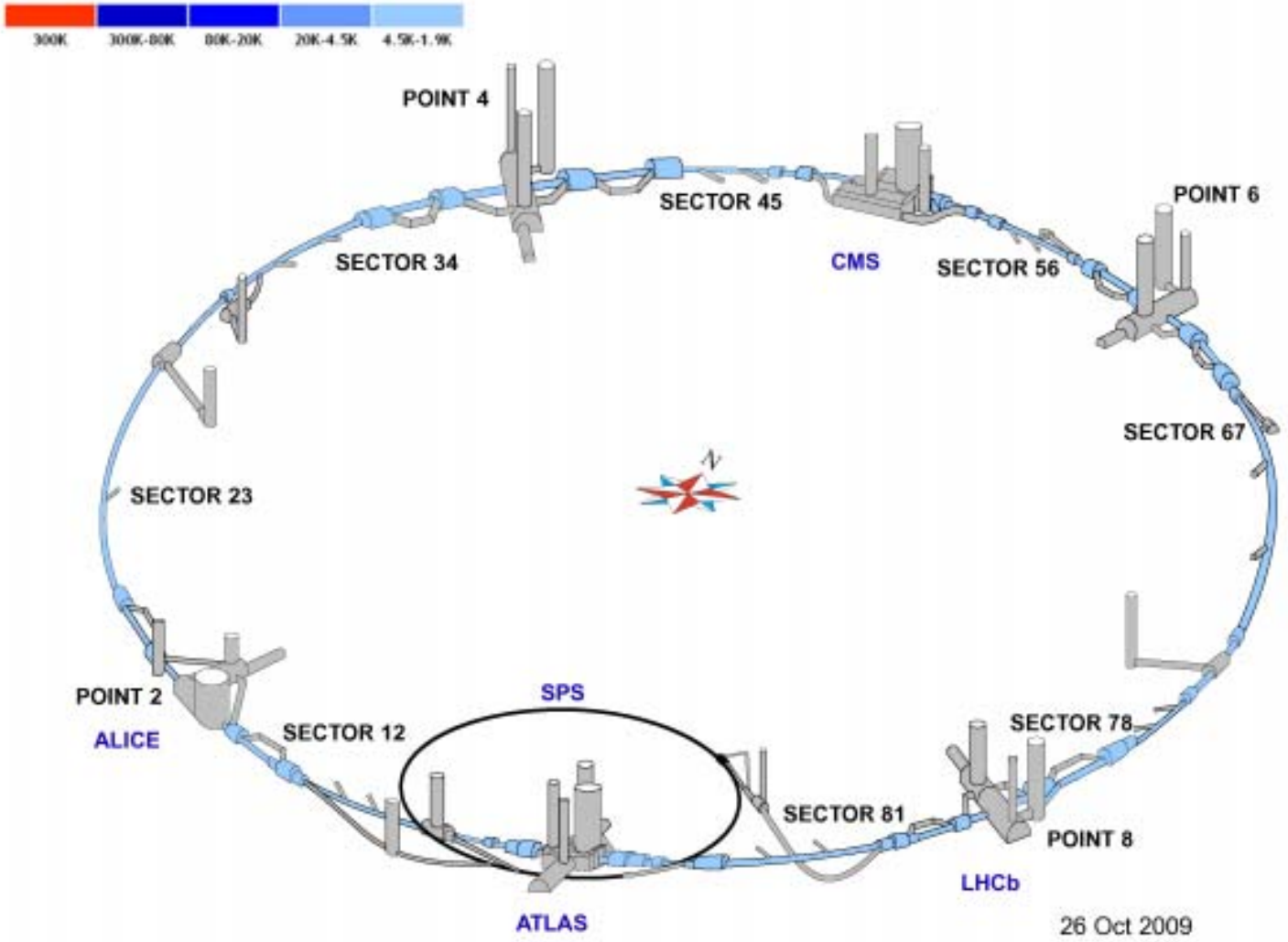


- how to move up to 3.5 TeV (after Xmas break) is being addressed

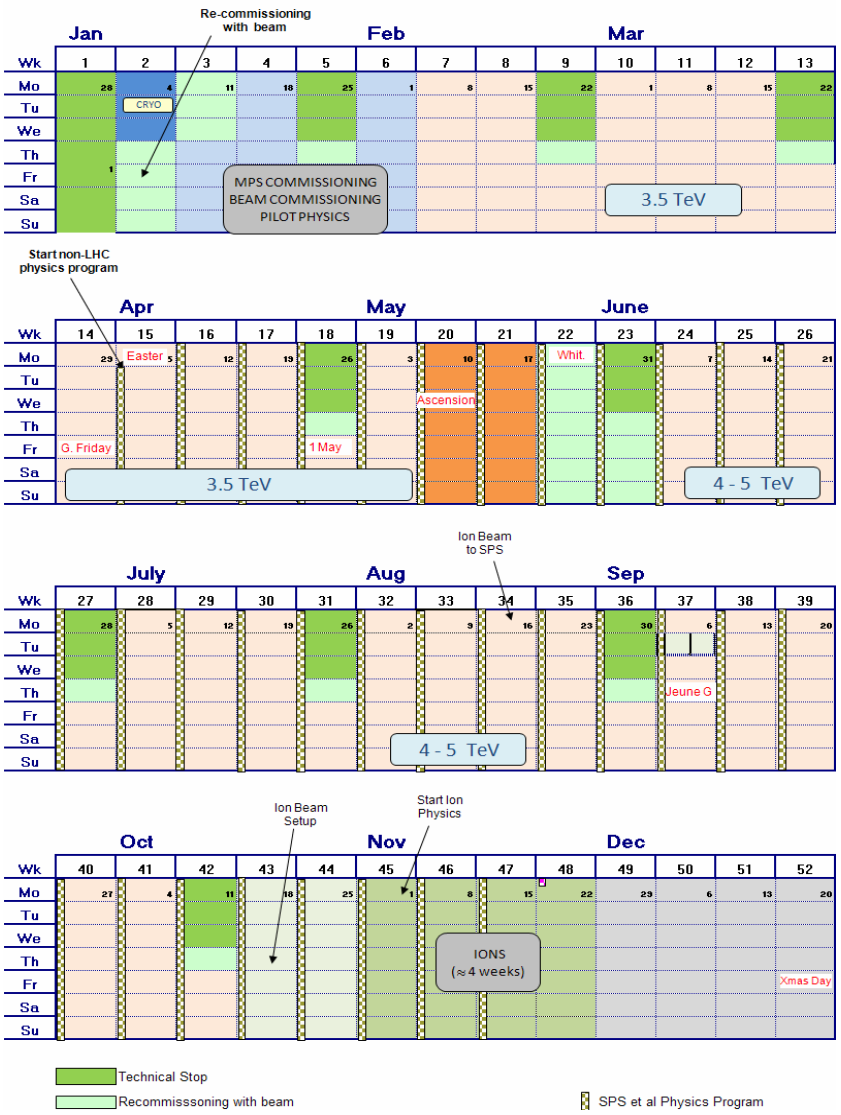
Grand plan


* expt magnet ON means at full nominal field (as for 14 TeV)
900 GeV
toroids & solenoids ON*, spectr. dipoles OFF
2x2 5e10 10-11m
~few shifts
ramp
toroids, solenoids & spectr. dipoles ON*
2x2 5e10 10-11m
squeeze
2x2 5e10 4m
~few days
43x43 5e10 4m
~few weeks
7 TeV
Proposal:
LHCf run here (few days),
Try α_{ext} >0 at IP1
Then replace LHCf
156x156 5e10 4m
156x156 5e10 2m
156x156 9e10 2m
Turn on α_{ext} >0, then move on to 50ns bunch trains
Dominated by beam commissioning
Lumi goes over 1e32
50ns
~ months
n*144 7e10 2m ??
Dominated by physics
10 TeV
156x156 7e10 2m
156x156 9e10 2m
n*144 7e10 2m
n*144 9e10 2m
43x43 Few e10 90m IP5 ?
Heavy Ions

The LHC is cold



LHC 2010 – VERY draft



- **2009**:
  - 1 month commissioning
- **2010**:
  - 1 month pilot & commissioning
  - 3 month 3.5 TeV
  - 1 month step-up
  - 5 month 4 - 5 TeV
  - 1 month ions

From S. Bertuolucci