Many, many thanks to all the conveners for providing slides and to all the people in the trenches this weekend and prior weeks and months for producing the nice results shown here!

Make sure to attend the Physics plenary meetings Thursday to get the details from the people doing the work.

http://indico.cern.ch/conferenceDisplay.py?confId=75339
Paris said it many times...
  “We will prepare in a series of successive approximations…”

And so we did...

Past 3 years...
  Transition from studies for 10’s or 100’s fb^{-1} to...
    - Physics accessible with < 1 fb^{-1}
      - Data-driven methods
      - Improved Object ID
    - Tracking down to ~100 MeV
    - Tracking jets (JPT), tcMET, Particle flow
    - Lean trigger table, primary and secondary datasets defined
    - October Exercise, Physics accessible with < 1 pb^{-1}
    - 900 GeV 1^{st} paper(s)
  ...Physics accessible with <1 nb^{-1}

Top-level view of 2007

- **Goal:** create physics menu for 10, 100 & 1000 pb^{-1}
  - Physics menu includes trigger menu, full set of physics topics for each luminosity, list of publications for each analysis

- **Tools I: HLT**
  - Complete HLT algorithms for each object
  - CPU measurements, efficiency vs rate

- **Tools II: physics object reconstruction**
  - Complete and validate full set of objects (software)
  - Identify all data samples (triggers) which will be needed for measuring all efficiencies (from data)

This talk mainly covers the last stretch CRAFT09, Oct X and 900/2360 GeV Physics and prep. for 2010 (7 TeV?)
- Final preparations for the real thing
  - October Exercise: Oct 4\textsuperscript{th}-19\textsuperscript{th}
    - What worked and what didn’t
  - Current running – Physics Operations
    - Build on OCT X lessons and learn some new ones
  - 1\textsuperscript{st} Paper task force & other fast track analyses
    - Goals: public release by end of year & end of January, resp.
Purpose

- Deploy T2 analysis model & start working with new AnOps group
  - Test our organizational readiness to produce high quality results
- Begin work with CMSSW 31X samples & Secondary Datasets (SD)

Scale-test (October 5\textsuperscript{th} - 19\textsuperscript{th}): 10 TeV 1\textsuperscript{st} week, 7 TeV 2\textsuperscript{nd} week

- Analysis jobs exercising early analyses by as many people as possible
  - T1-T2 transfers of 31 Secondary Datasets to Central Space by AnOps and subscriptions of MC and CRAFT samples to Analysis Group Spaces
  - Group Skims by priority users at T2 and T2-T2 transfers by some groups
- Fix problems, eliminate bottlenecks ...
  - Daily meeting + E-Logs recording steps + HN for problems + Twiki:
    - https://twiki.cern.ch/twiki/bin/view/CMS/OctoberX

Follow-up all-day review in physics days on Oct. 22\textsuperscript{nd} and the following week in Offline-Computing Week
- Reviewed lessons learned and what should be changed ahead of real data
Unprecedented level of activity

DataOps produced large number of SDs in record time before the start.

Jobs submitted & run broke all CMS records.
  - The most intense test of our Tier-2 system to date

- Final Scorecard:
  - ~2000 data sample subscriptions
  - ~900 TB: T1 to T2
  - ~77 exercises
    - 45 exercises 100% complete
    - 553 steps
    - 230 people listed
      - ~500 in total
    - ~700k more jobs than usual for a 2 week period
  - Group Skims & T2-T2 transfers
    - 11 promised
    - > 200 delivered

But ~20% of steps weren’t completed!

- Problems related to new StoreResults service:
  - Registering in local DBS
  - Elevating to global DBS

- Mixture of issues have been identified, being addressed
  - Not an issue for current data-taking but need it for 2010
- Initially had problems in ~all areas!
  - Large job failure rates in the first 2 days
- Quick reaction from computing
  - Daily meetings helped us to identify problems & share remedies
  - Steady improvement
- StoreResults improved, not yet ideal

StoreResults service – First 2 days of the exercise

Last 2 days of the exercise
- A valuable learning exercise for all groups
  - First major studies with CMSSW 3XY series
  - Many improvements, some new features found
- Fast turn-around of key POG inputs to early physics analyses
  - Jet corrections, T&P efficiency measurements, b tagging/mistagging (35 tables!)

Electron efficiencies
Using SC probes

- Efficiency is about the same as in SD_Ele15 10 TeV sample.
- Simple sideband-subtraction method underestimates the efficiency by ~% in presence of high background.

JPL Mistags vs. jet $p_T$
Examples of results (1st week)

Track multiplicity vs pseudorapidity, produced from Secondary Datasets on the second day

Leptoquark search: invariant mass of electron-jet combinations, produced from Secondary Datasets on the second day

CMS Preliminary

$\frac{dN}{d\eta}$ vs $\eta$

- Red: Reconstructed (1st+2nd layers)
- Grey: Reconstructed (1st+3rd layers)
- Light blue: Reconstructed (2nd+3rd layers)

$N$ entries (10 pb$^{-1}$)

- LQ eej 300 GeV
- QCD EMEnriched
- QCD BCtoE
- PhotonJet_Pt15
- Zee
- TTbar
- All Bkgnd

Mej-all 4 combos (GeV)
First $\gamma$ TeV studies: $B^0 \rightarrow J/\psi K^{*0}$

$\mathcal{L} dt = 1.1 \text{ pb}^{-1}$

SD_DoubleMu3 $pp \rightarrow \mu\mu X$

$ct = 442 \pm 57 \mu m$

PD_HLTMu $pp \rightarrow \mu\mu X$

$ct = 459 \pm 42 \mu m$
**Key element of program**
- Distribute SD to T2
  - Run Group skim
  - Transfer skim to T2’s assigned to group

- Many T2’s linked for Oct X
  - 30 in summer to 400 now!

**End of September**

**Exotica (left) and B tag (below)**

**End of October exercise**
- **T1-T2 distribution**
  - Getting $\geq 1$ copy of all data out to T2’s went well
    - We would benefit from having multiple copies which implies higher/smoother transfer rates or smaller datasets.
      - We are making plans to have both

- **Skimming at T2 and T2-T2 transfers**
  - Now have a base of $\sim 2$ priority users per group who are pretty well trained
  - Problems with stageout were quickly fixed
  - Site problems an issue throughout OCT X, but continually improved
    - First widespread use of CRAB servers.
      - Some improvements to routing of jobs but more improvements needed!

- **Main problem was with new StoreResults service**
  - Group Skim outputs to local DB then elevated to global DB
    - Many very technical and subtle problems arose in each step.
      - Addressed in part during OCT X, and some afterwards
    - Once in Global DB, Phedex transfers were possible but not always easy.
What next from Physics perspective:

- **High priority: A plan for SDs**
  - Revise OCTX set with all groups & prepare to evolve!

- **From Computing (& Offline)**
  - Improved tools, training, documentation
  - Improve T2-T2 transfer capacity

- **More communication & synchronization across all areas**
  - DPGs, TRG, Offline, Computing, DQM, PVT, Physics...

Physics Ops meeting (like the OCT X daily meeting)

- **M&F ~18.00-19.00 & 14.00-15.00 now ongoing**
- **Mainly involves DPG-POGs but some PAG work**
  - 5-10’ Presentations of work in progress
  - Discussions of real and MC datasets and skims, conditions, data formats and placement at T2’s etc.

- [https://twiki.cern.ch/twiki/bin/viewauth/CMS/PO900GeV](https://twiki.cern.ch/twiki/bin/viewauth/CMS/PO900GeV)
Physics with 2009 Data

Most October Exercises went well and completed quickly provided the data was accessible. But this was with pure MC data.

How well can we do with real data?
Main goals for 2009 data

- Commission as many workflows as possible
  - Prompt skimming, DQM, Physics Validation, MC tuning...
- Refine selection & understanding of physics objects
  - Full tracking, jets, possibly some Muons, electrons & photons in min bias data etc.
- Perform some early physics analyses
  - Charged hadron multiplicities, PT spectra in bins of $\eta$
  - Jet PT spectra
  - Underlying event studies
  - Low mass resonances in muons, photons, tracks
- Prepare for higher energy in 2010
  - Study fake rates, b tagging, etc.
POGs
Tasks with 900GeV collision data:

- **Characterization of**
  - Super Clusters, Electron reconstruction, Isolation

- **Study conversions, Trigger, di-electron mass...**
  - Much useful work to be done, despite the fact that (to good approximation) only have background to work with (Luminosity < 1 nb\(^{-1}\)) – namely photons from \(\pi^0\)’s and electrons from conversions

- As the luminosity increases the tasks will evolve
- ECAL control of “local reconstruction” is an important precondition
  - Timing/synchronization – first data (23rd Nov) required “cosmic” (amplitude fit) reconstruction
  - Selective Readout – still issues with timing and noise of TPs
- ECAL DPG was able to rapidly reconstruct $\pi^o$ peaks in barrel and endcaps
  - NB: energy scale is uncorrected
    - $\pi^o$s an inter-calibration source
  - Data and MC agree very well
Invaluable experience

- Tested the full chain from Raw to full $\mu$ ID and applied it to (astro-)physics studies with $\mu$’s
  - Performance paper(s) on muon reconstruction and identification
  - Three AN on cosmic analysis
- Strong links w/ all DPGs
- Good connection to POG/PAG also (B, EWK, EXO, SUSY)
- Exercised the computing resources made available to the muon community

900 and 2360 GeV runs provide much fewer muons

- Mesons decays in the endcaps
- A handful of $J/\psi$ will add spice

Study muon reconstruction and identification in detail

Goals will depend on how many muons we get

- Track quality, muon multiplicity, $p_T$ spectra, angular distributions
  - Comparisons with Monte Carlo and cosmics (where meaningful).
- Work with PAGs (e.g. Quarkonia group)
STA is without the constraint at the VTX (and APE=0)

CRAFT '08 data

CMS Simulation

$0 < \eta < 0.8$
Muons in Min Bias

- Starting sample has 11M simulated events of MinBias at 900GeV
Tracking & Vertexing

- New task force: Tracker + Tracking + B tag
  - Commission tracking and vertexing.
- There’s a very long task list*
  - Tracks, PVs, SVs, Muons

* [https://twiki.cern.ch/twiki/bin/viewauth/CMS/TrackingBTagging900GeVTasks](https://twiki.cern.ch/twiki/bin/viewauth/CMS/TrackingBTagging900GeVTasks)
After a long night waiting for stable colliding beams, around 5.20 am saw the first reconstructed tracks in the ExpressStream to be analyzed at the CMS-Center.
Track transverse Impact parameter vs phi

People at Fermilab and CERN started fitting the beam-spot immediately.

Preliminary mean values

<table>
<thead>
<tr>
<th>Lumis</th>
<th>69-89</th>
<th>90-109</th>
<th>110-113</th>
</tr>
</thead>
<tbody>
<tr>
<td>X0 [cm]</td>
<td>0.1862</td>
<td>0.1782</td>
<td>0.1715</td>
</tr>
<tr>
<td>Y0 [cm]</td>
<td>0.1238</td>
<td>0.1343</td>
<td>0.1437</td>
</tr>
<tr>
<td>Z0 [cm]</td>
<td>-2.6964</td>
<td>-2.6982</td>
<td>-2.6808</td>
</tr>
<tr>
<td>sigmaZ [cm]</td>
<td>4.1654</td>
<td>4.5103</td>
<td>4.4802</td>
</tr>
</tbody>
</table>

luminous region very stable during this run

primary vertex reconstruction in agreement with beam spot
Tracking is on a roll

Standard iterative tracking, high-purity tracks
(preliminary result)

---

Fit: 123 ±13 events
M=496.7 ± 0.7 MeV
\(\sigma = 6\) MeV

Fit: 28 ±7 events
M=1115.7 ± 0.4 MeV
\(\sigma = 1.5\) MeV
• Ran the Secondary Vertex (SV) INCLUSIVE search
  • Also find $K_s$ peak

• Ran track counting B tagger (on something akin to jets)
  • TrackCounting High Efficiency discriminator (which is just the significance of the second track associated to a jet), with
    • Trackjets, JetPt>3 (doubtful these really jets ...)

• Should not assume that b tagging will not be available relatively quickly in 2010
Jets, MET and Particle Flow
JetMET Collision Data Studies

- Studies of collision data
  - This weekend’s data is cleanest to date

- Studies of jets and MET
  - MEx and MEy centered at $\bar{\Phi}$ (good)
  - Raw Jet $P_T$ out to 6 GeV after ID cuts
    - Jet ID cuts actively being studied.
  - Dijet event found (raw $P_{T1}=5.2$, $P_{T2}=4.4$)

- Hours after we found this event, we also found a better one . . .
High $P_T$ Dijet Event from Express Stream

Jet1: Raw $p_T = 13$ GeV, Corr $p_T = 24$ GeV, PF $p_T = 16$ GeV, phi = -0.69, eta = 1.96, EMF = 0.66
PF constituents: Jet 2: 6 charged hadrons, 6 photons, 1 neutral hadron

Jet2: Raw $p_T = 12$ GeV, Corr $p_T = 23$ GeV, PF $p_T = 19$ GeV, phi = 2.48, eta = 0.27, EMF = 0.50
PF constituents: 6 charged hadrons, 7 photons, 0 neutral hadron

Run 123596, Event 6732761
JetMET plans

- Commission MET
  - Study METx & γ, MET, METphi, SumET, etc
  - For CaloMET, tcMET, PFMET
  - Cleanup
    - HCAL Noise, ECAL Noise/dead towers
    - Beam Halo / Cosmic Muons

- Commission Jets
  - JET ID cuts for CaloJets, JPT and PFJets
  - Isolate first sample of real dijet events
  - Measure basic distributions \( p_T \), etc.
    - \( 1 \mu b^{-1} (nb^{-1}) \) should give jets up to 35 (75) GeV \( p_T \)

- Measurement from data for conferences
  - Jet \( p_T \) dist compared to MC normalized to data
    - A joint effort between JetMET and QCD.
- Real data, 598 tracks turn into Charged Hadron PF Candidates
  - 516 have no link to any cluster
    - Expected: 517
  - 71 (13) have a link to an ECAL (HCAL) cluster, 2 have a link to both
    - Expected 73 (10) with link to ECAL (HCAL) cluster, 2.5 have a link to both
- Tested 3 of 4 building blocks
  - Calorimeter noise, ECAL clusters and their energies, Track-cluster link
  - Initial studies indicate that the core Particle-Flow reconstruction works as well on data as it does on MC
- Excellent agreement with MC
Calibrations from MC appear to be reasonable as seen in $\pi^0$ peak

Next steps with magnetic field are underway (see Thursday plenary session)

- Check hadron-cluster calibration from the momentum of the linked charged particle
  - 4th piece of the core algorithm

A week or so to finish the commissioning of the basic ingredients and then attack the higher level objects (jets, met, taus) used in physics.

- See Patrick’s presentation at the Dec 2. Wednesday Plenary meeting for more details:
  - [http://indico.cern.ch/getFile.py/access?contribId=10&sessionId=0&resId=0&materialId=slides&confId=75717](http://indico.cern.ch/getFile.py/access?contribId=10&sessionId=0&resId=0&materialId=slides&confId=75717)
PAGs
High $p_T$ Jets: Expectations for First Collisions

- Limited reach at high-$p_T$ with 900 and 2360 GeV collision data

- Working closely with JetMET to help commission jets
  - Study jet identification and trigger performance
  - Confront jet response and resolution with MC expectations

Predicted jet yields at 900 and 2360 GeV
Many early results planned in QCD

- With 900, 2360 GeV data
  - Charged hadron multiplicities
  - Underlying Event
  - Jet $p_T$ distributions
- And at higher energies in 2010
  - “Measurement of the Central Transverse Thrust in pp Collisions at 10 TeV”
  - “Dijet Azimuthal Decorrelations in pp Collisions at 10 TeV”
  - “Measurement of the Ratio of Dijet Production in Two Pseudorapidity Regions in pp Collisions at 10 TeV”
  - “Measurement of the Dijet Mass Cross Section in pp Collisions at 10 TeV”
  - “Measurement of the Dijet Mass Distribution and Search for New Particles in pp Collisions at 10 TeV”
- New: Measurement of the 3-jet/2-jet ratio vs $H_T$
- Prompt Photons
Charged Hadron Spectra

- Joint paper using first 900 GeV data
  - $dN_{ch}/d\eta$ and $dN_{ch}/d\eta$ from inelastic and non-single-diffractive proton-proton collisions (QCD-09-010)
  - Three analysis methods
    - Pixel hit counting
    - Pixel tracklets
    - Full tracks
  - Will go for a fast track approval
• Effects of background?
  – Mix MC events with 20% beam halo and beam-gas
  – Final result is not sensitive
Pixel counting: PV-z distribution

Cluster size along the beam line

-2.2<\eta<-2.0

Data, run #123592, bit41 && BPTX coinc

all cluster
all cluster if vtx

-2.2<\eta<-2.0
Event selection: run 123596, LS 130-144.
BSC minbias $th=2$ (TT41), BH rejection (!TT36 !TT37 !TT38 !TT39), BPTX coinc

**dN/d\eta result from cluster counting**

**Figure 1:**
- **X-axis:** Cluster size along the beam line
- **Y-axis:** Arbitrary

**Figure 2:**
- **Legend:**
  - MC
  - Data, BPTX coinc.
  - Data, bit41, BPTX coinc., veto on BH

**Inelastic collisions**
- $\sqrt{s}=900$ GeV

**Graphs:**
- **Rec. dN/d\eta, 1. layer**
- **Rec. dN/d\eta, 2. layer**
- **Rec. dN/d\eta, 3. layer**
- **UA5**

**Note:** PRELIMINARY!
$dN/d\eta$ distribution from tracklets

Raw, tracklets

CORRECTED, tracklets
Inelastic $p+p$ collisions
- Paper draft is prepared
  - ARC has been formed
- See QCD meeting tomorrow morning
  - Methods and paper contents to be discussed: 1st step in the approval process
  - http://indico.cern.ch/conferenceDisplay.py?confId=75996
- And Thursday’s physics plenary
  - Status report of analyses
  - Presentation of paper
  - http://indico.cern.ch/conferenceDisplay.py?confId=75339
Looking for J/ψ’s in CMS

CMSSW / Pythia : J/ψ x-sec x BR = 2640 nb at 900 GeV and 6110 nb at 2.36 TeV
1 nb^{-1} \rightarrow \sim 40 J/ψ dimuons at 900 GeV and \sim 95 at 2.36 TeV, with global and tracker muons only

Dimuon yields depend on quality cuts on the tracker muons.
Tuning of cuts still ongoing.

<table>
<thead>
<tr>
<th></th>
<th>without cuts</th>
<th>with cuts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2360</td>
<td>J/ψ</td>
<td>Bg</td>
</tr>
<tr>
<td>gl-gl</td>
<td>19</td>
<td>2.4</td>
</tr>
<tr>
<td>gl-tr</td>
<td>51</td>
<td>53</td>
</tr>
<tr>
<td>tr-tr</td>
<td>21</td>
<td>110</td>
</tr>
</tbody>
</table>

Note: numbers and figure from STARTUP samples

\sim 70 J/ψ dimuons per nb^{-1} with global and tracker muons (after quality cuts)
Most J/ψ dimuons will be collected in the endcaps, given their low $p_T$...

Tracker muons help access lowest $p_T$ J/ψ’s ... down to ~ 0.5 GeV!

For more details, see Twiki: /CMS/QuarkoniaFirstCollisions
Looking for the first $J/\psi$ dimuon in CMS

We are scanning the data files, looking for events with two muons.

This is an opposite-sign dimuon with $M = 4$ GeV and $p_T = 9$ GeV/c 😊
Opposite-sign dimuon with $M = 3$ GeV and $p_T = 12$ GeV/c
High $p_T$ PAGs and early data

- Expect $\sim 1$ W in nb$^{-1}$, no Drell-Yan events ($\sqrt{s} = 2.36$ TeV)
  - All PAGs working with DPG-POGs to understand first data.

- Obvious things to study:
  - Muon/electron identification/reconstruction and features in hadronic events.
    - Isolation variables
  - MET behavior at low intrinsic hadronic activity (for W's)
  - Cosmic backgrounds (for mu)

- In parallel, continue to prepare for $\sqrt{s} = 7$ and beyond
  - EWK: For early 2010 plan to establish strategies to study the first W events in the absence of significant number of Z events. Have preliminary studies for the W$\rightarrow$$\mu\nu$ case.
  - Top: Implementing missing pieces, e.g. efficiency (corr.) MC vs. Data with T&P using Z$\rightarrow$$ll$; here an example from e+jets
- **Study of HCAL Noise Filters**
  - CaloMET after different HCAL Noise Filters in run 122294
  - Observe that HCAL noise filters cleans MET tail
  - Very promising start!

- **Comparison of MET and MHT**
  - Compare MET after noise filter to MHT with 2 GeV jets and jet ID cuts applied
  - Start commissioning quantities for SUSY analyses

**Effect of HCAL noise filter**

- White: all MET
- Yellow: NoiseFilterStatus = 0

**Run 122294**

- MET + filter
- Compare MET after noise filter to MHT with 2 GeV jets and jet ID cuts applied
- Start commissioning quantities for SUSY analyses
A Few Recent Highlights

Photon fake rate determination and validation in October Exercise [Duong Nguyen]

Raw HT in a EXOHT skim from first collisions [Patrick Tang]

Electron t-n-p efficiency in October Exercise [Matthias Mozer et al.]
Over the past 3 years we have prepared for real data-taking in a series of successive steps.

Results of the past few weeks show that while we did not prepare for everything, we are nevertheless very well prepared.

Finally – special thanks to all the people who made these results possible – it has been a real pleasure!
- Over the past 3 years we have prepared for real data-taking in a series of successive steps.
- Results of the past few weeks show that while we did not prepare for everything, we are nevertheless very well prepared.

- Finally – special thanks to all the people who made these results possible – it has been a real pleasure!
- Many many thanks to Paris and Roberto
  - It has been a great experience.
Additional Info
The planning has to start asap
- Realistically we will not be able to address this fully in meetings during the remaining 2 weeks of 2009 but it is important for all groups to start preparing already now.

Basic guidelines
- What we distribute will evolve with time
  - In the beginning we will distribute PD in RECO, AOD
  - Later we expect to mainly distribute SDs and at some point (June 2010?) we will mainly distribute AODs
- We’ll commission more PD and SD as we gain experience.
  - May start with $O(10)$ of each. Currently plans are to reach $\sim 15$ PD and maybe $\sim 60$ SD by end of 2010 run.
- Much to be gained by merging SD ideas across groups
- SDs will have some advantages
- Some Central Skims are necessary and are anticipated
  - Exotica has some new physics channels that could be showing things early so we have to make sure they get the data they need to rule them out...or discover!

Mainly though, as we have always repeated, and as is very clear from running the past couple of weeks; What we will do will depend very much on what we learn from the data!
- So it is important to start with a small number of samples that are easily distributed and viewed by many eyes.
- Then we can define the right SDs and skims in general, and test them thoroughly before putting them into the Tier-1 workflows for which we cannot afford to risk problems.
2009 Data: 900 GeV, 2.36 TeV
- Lots of work has gone into preparing to skim physics datasets.
- It is not as easy as it seems.

3 SDs from the MinBias PD:
- SD1: All the events (gated with the PhysicsDeclared bit)
  - The rate will be $O(100)$ Hz
  - Will be distributed at $O(5)$ T2s
- SD2: 10% of the SD1 (1 event every 10) + all the “InterestingEvents”
  - Will be distributed very broadly
- SD3: All the “Interesting Events”
  - Expect little rate, $O(1)$ Hz + noise.
  - Will be distributed very broad
  - Can even fit on your laptop

2 SDs from the ZeroBias PD:
- SD4: All the events (gated with the PhysicsDeclared bit)
  - The rate will be $O(100)$ Hz
- SD5: 10% of the SD4 (1 event in 10)

2010 Data-taking:
- Need a broader suite of PDs and SDs, plus some CS
  - A lot of work. Oliver Buchmuller will be organizing this effort (taking over for Roberto R and I)
  - Will form a larger group because the key will be to be ready to react to a rapidly changing trigger table!
- All groups need to prepare to present their dataset needs
  - Can start from 31 SDs used in OCT X

https://twiki.cern.ch/twiki/pub/CMS/OctoberX/SD_DetailedTable_20090928.xls
Data distribution plans

- **ECoM data-distribution model (IMF and JI)**
  - This has been partly based on what was learned in OCT X
  - Can distribute PDs up to ~2^{nd} reprocessing, then switch to SDs
  - Transition to AODs around time shutdown for $\sqrt{s} \sim 10$ TeV (hopefully) we will avoid very long refresh times and remain very nimble

**Figure 1:** Total Volume of Data in PD and SD

**Figure 2:** Average size of a single PD or SD as RECO and AOD format

Beyond this area, we soon get into storage problems with PDs (keeping in mind multiple data and copies & MC).

Assumes ~60 SD here. Average SD is only a few TB in AOD format.