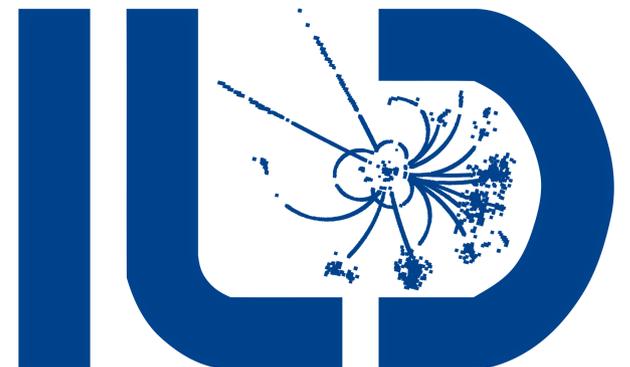


# Simulation and Software

- IDR highlights
- next large production @ 250 GeV
- longer-term future

Daniel Jeans, KEK



# core ILD software group

Coordinator: F. Gaede  
deputy: D. Jeans

subgroups & coordinators:

## **GENERATOR**

M. Berggren  
J. Tian

## **SIMULATION**

D. Jeans  
[S. Lu]

## **RECONSTRUCTION**

R. Ete  
[L. Tran]

## **PRODUCTION**

A. Miyamoto  
H. Ono

significant contributions from other ILD members

share common tools with others e.g. CLICdp

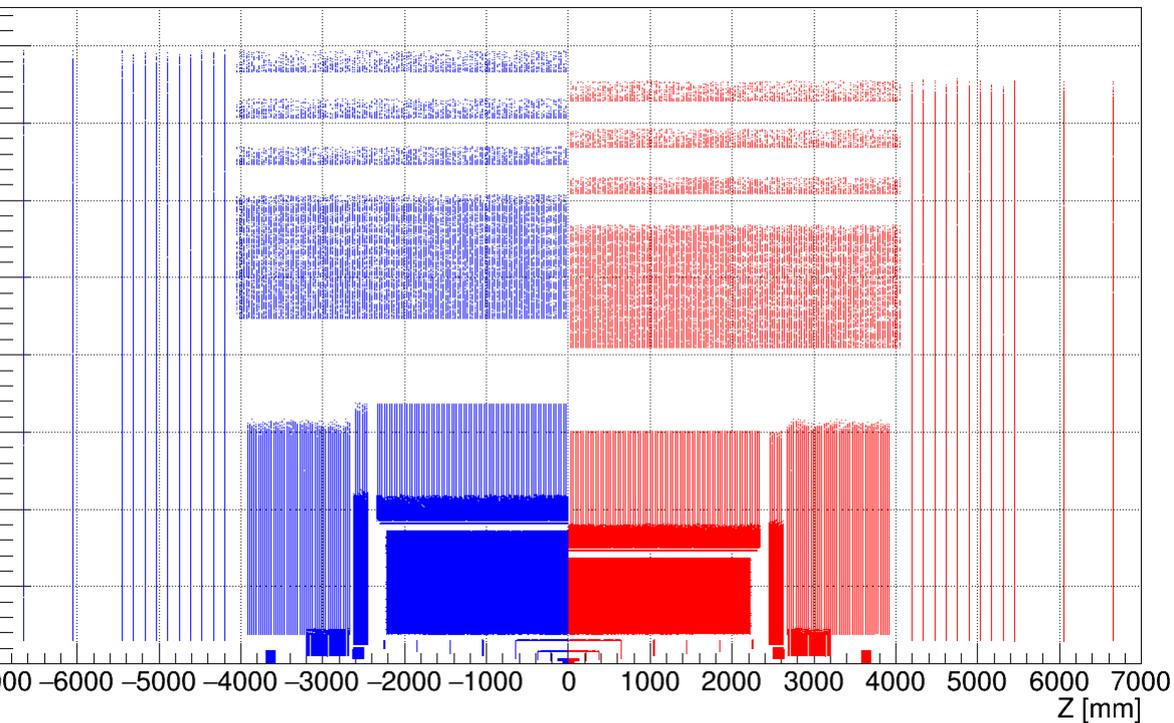
*person-power is limited, but we do our best!*

IDR was based on dedicated samples of simulated data (mostly at 500 GeV)

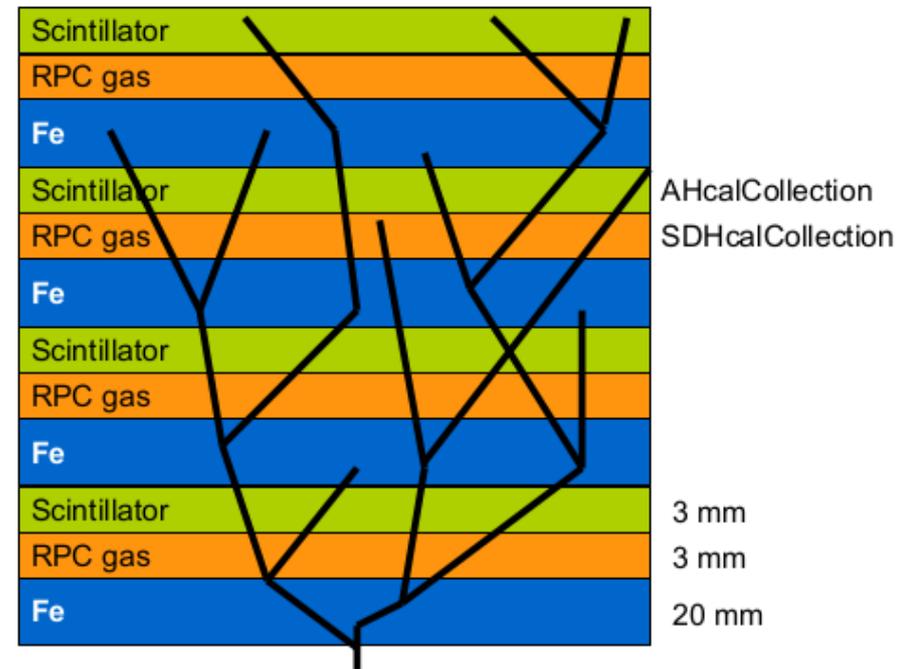
two detector models

**LARGE**

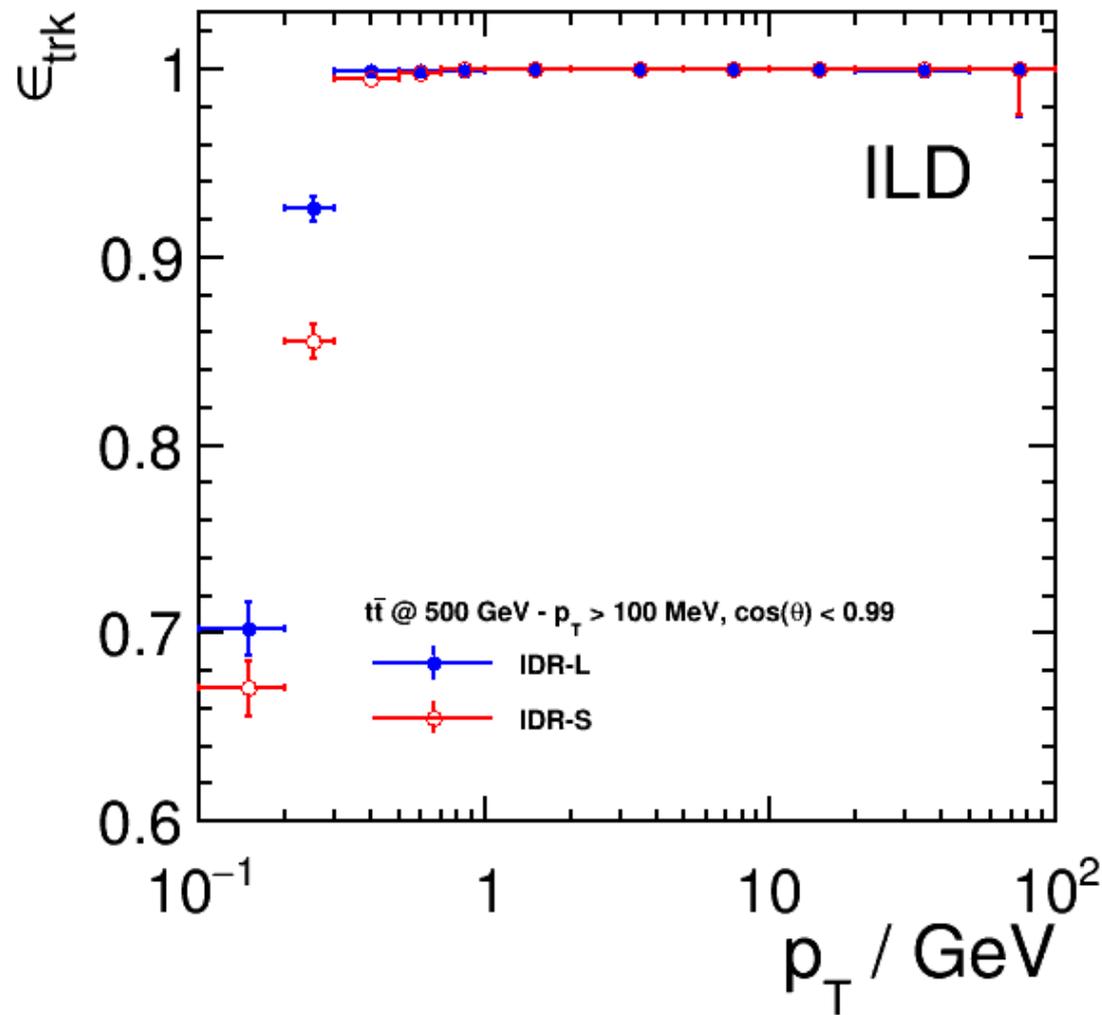
**SMALL**



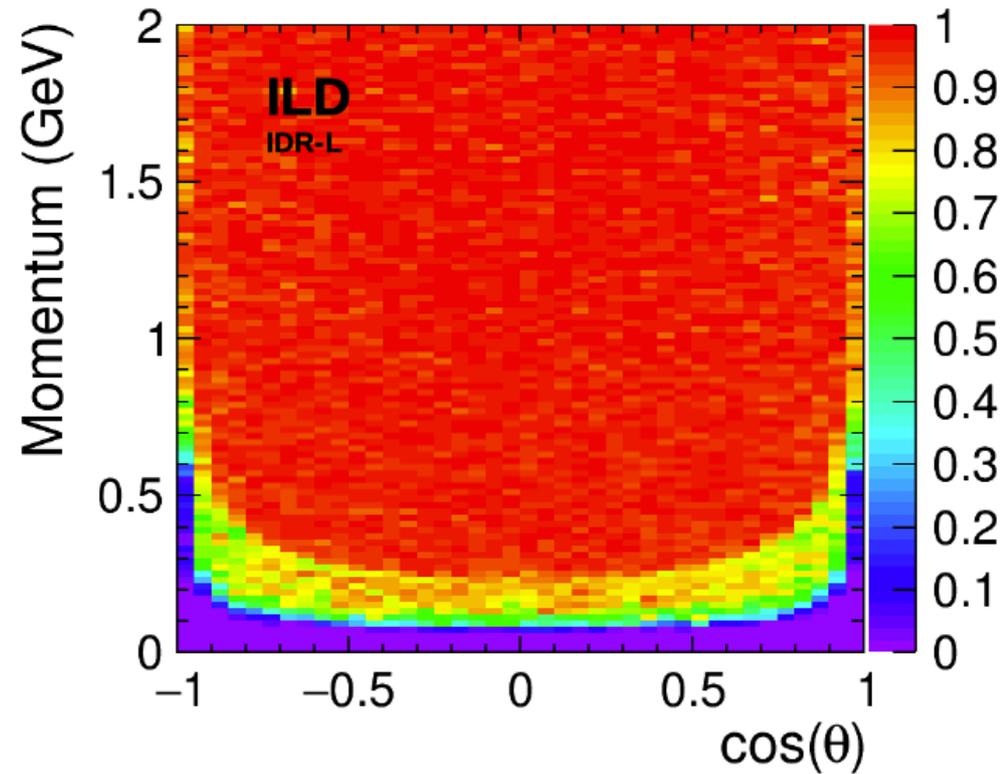
multiple calorimeter technologies



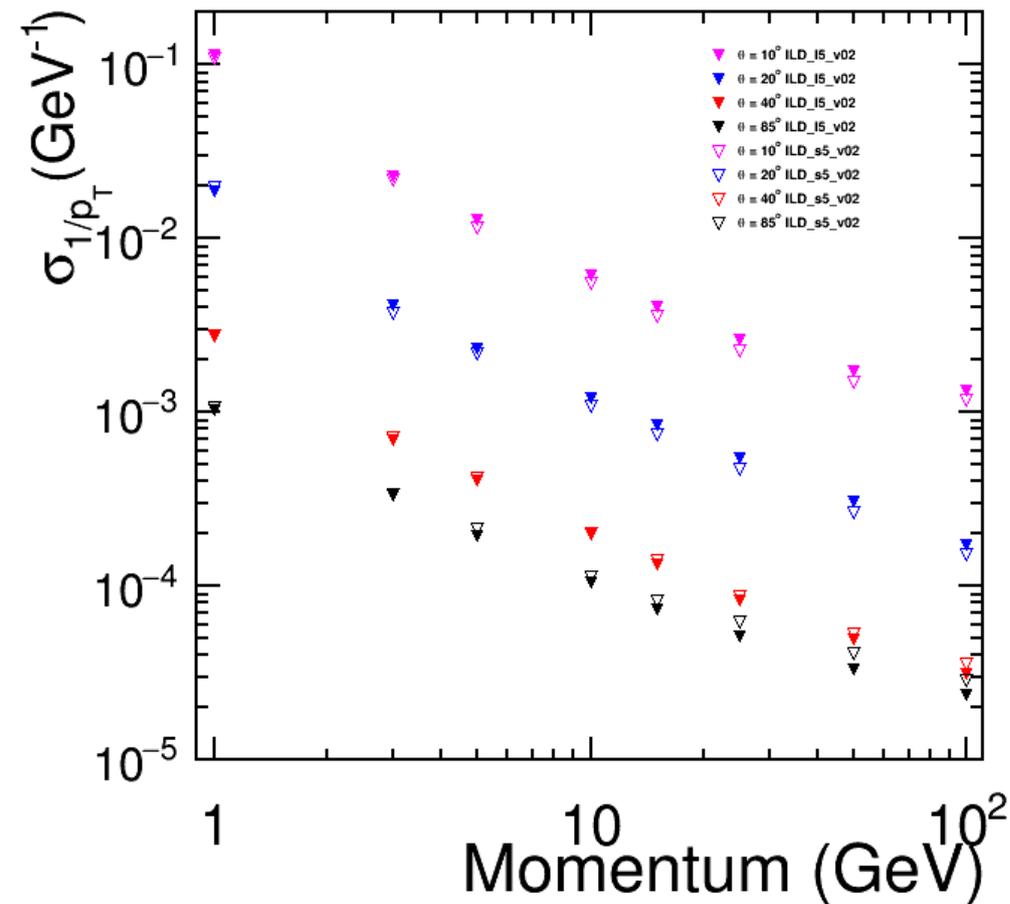
# highlights from the IDR reconstruction performance



tracking efficiency:  
t-t events at 500 GeV

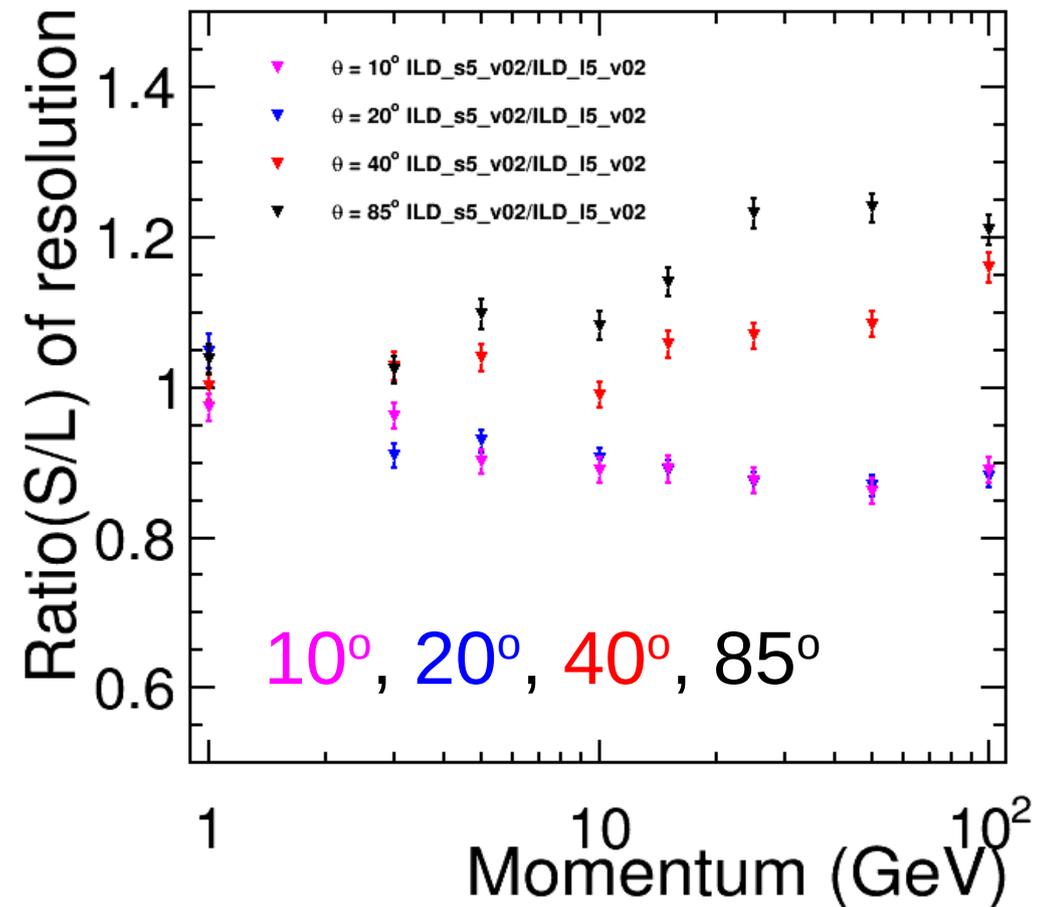


## Momentum Resolution

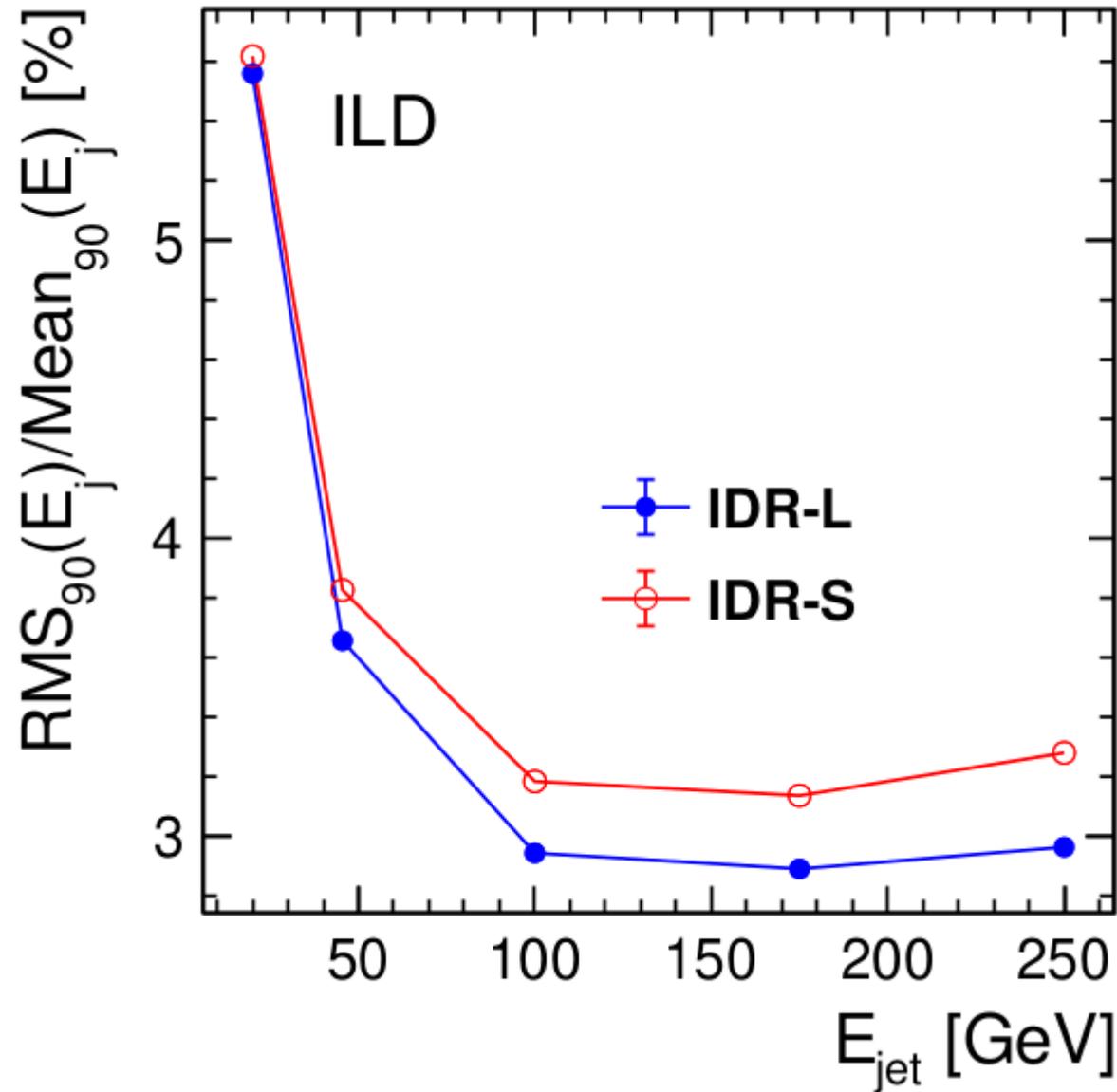


# single muon momentum resolution

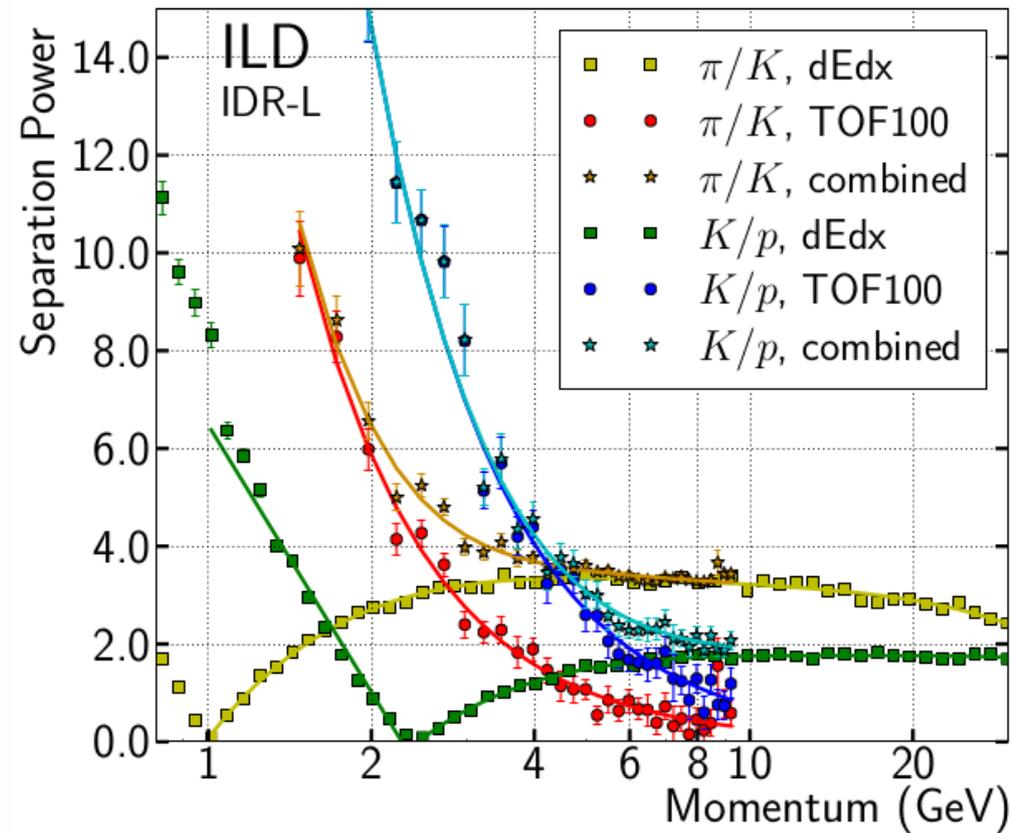
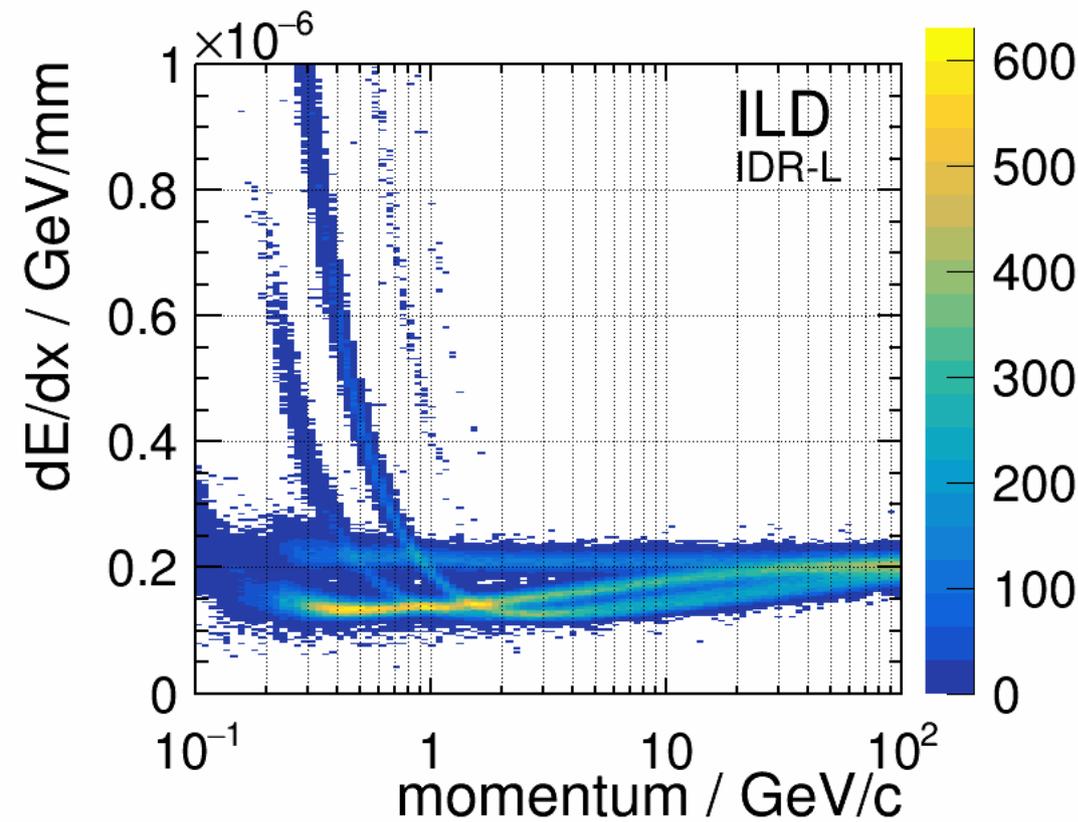
## Momentum Resolution Ratio



# hadronic jet energy resolution



# particle identification: TPC dE/dx and timing [e.g. in calorimeter]



near-term plans

now preparing to  
produce large full-SM  
samples at 250 GeV

strengthen and develop ILC250 physics case

- current set of 250 GeV samples from DBD era
- beam parameters changed since DBD
- significant improvements in many reconstruction tools over last almost 10 years
- often rather statistically limited, especially for SM backgrounds
- aiming for  $\sim ab^{-1}$  data samples [less for very high x-sec processes]

# generation

decided to re-generate process  
with latest version of WHIZARD [1.9.x → 2.8.x]

latest ILC250 beam parameters

some modest grouping of processes,  
hopefully more convenient for analysers

detailed checks have been done,  
a few problems found:

→ generator group + Whizard authors meeting  
in Tokyo next week

# simulation

use exactly the same the “large” detector model  
used for the IDR benchmarking studies

# reconstruction

a few issues identified in reconstructed IDR samples  
muon identification in pandora in some regions,  
high energy photon PFO energy  
→ fixed, or being fixed

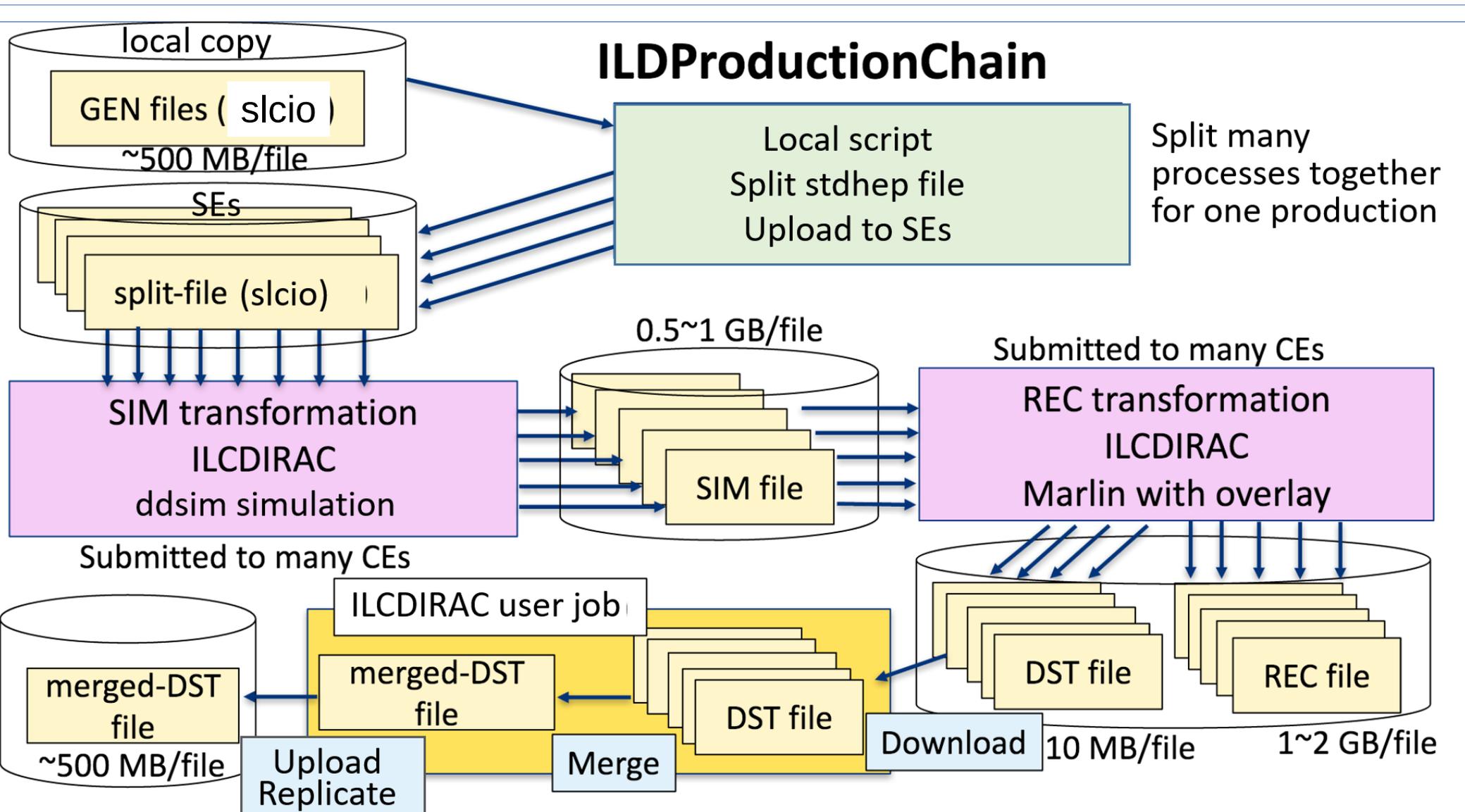
new feature:

fit tracks with [ $\pi/K/p$ ] mass hypotheses  
→ significantly improved fit pulls especially at lower momenta  
code ready, to be fully integrated

# MC production

production system is set up & ready to go

→ need to ensure sufficient storage resources



# estimate of resource needs

	ReqLumi (fb-1)	ReqEvt [kevt]	today_sim	today_rec	totGB_sim	totGB_rec	totGB_dst
2f_eL.pR	5,000	1,071,641	21,780	78,788	160,559	225,588	10,949
2f_eR.pL	5,000	492,267	96,429	61,645	1,046,729	1,057,992	23,425
2f total		1,563,908	118,210	140,433	1,207,287	1,283,580	34,374
			<u>TotalDay_sim</u>	<u>TotalDay_rec</u>	<u>Total_sim_TB</u>	<u>Total_rec_TB</u>	<u>Total_dst_TB</u>
		1 detector	118,210	140,433	1,207	1,284	34

	ReqLumi (fb-1)	ReqEvt [kevt]	today_sim	today_rec	totGB_sim	totGB_rec	totGB_dst
4f_eL.pL	1000	3,647	651	434	5,737	5,869	108
4f_eL.pR	5000	280,195	67,808	44,618	750,156	767,137	14,973
4f_eR.pL	5000	16,797	4,675	2,881	50,003	53,173	1,072
4f_eR.pR	1000	3,570	702	487	6,203	6,081	90
4f total		304,209	73,837	48,420	812,098	832,261	16,243
			<u>TotalDay_sim</u>	<u>TotalDay_rec</u>	<u>Total_sim_TB</u>	<u>Total_rec_TB</u>	<u>Total_dst_TB</u>
		1 detector	73,837	48,420	812	832	16

keep mostly just the DST format [on disk for convenient access]

→ enables high statistics samples for physics studies

keep full SIM files for relatively small fraction [on tape]

→ e.g. new reconstruction studies, technology comparisons, ...

# code versions

two options for upcoming 250 GeV production:

1. minimal patch of IDR code [v02-00-xx],  
keeping same versions of root, g4, compiler, etc
2. update packages on which ilcsoft is built  
to less antiquated versions

- **Compiler:** gcc 8/9
- **CXX standard:** 11 to 17
- **CMake:** 3.6 -> 3.15
- **Geant4:** 10.3.2 -> 10.5.1
- **ROOT:** 6.08.06 -> 6.18.04
- **DD4hep:** v01-07-02 -> v01-11 (not created yet)
- **Qt:** 4.7.4 to 5.13.1
- **PandoraPFANew:** v03-09-09 -> v03-13-02
- **Boost:** system -> 1.65

we plan to try option (2), fall back to (1) if necessary

# mid/long-term future

support/development of current tools (e.g. Marlin)  
for next generation of  
simulations, reconstructions, analyses

example of current developments/tests:  
multi-threaded Marlin, to  
make efficient use of today's CPUs

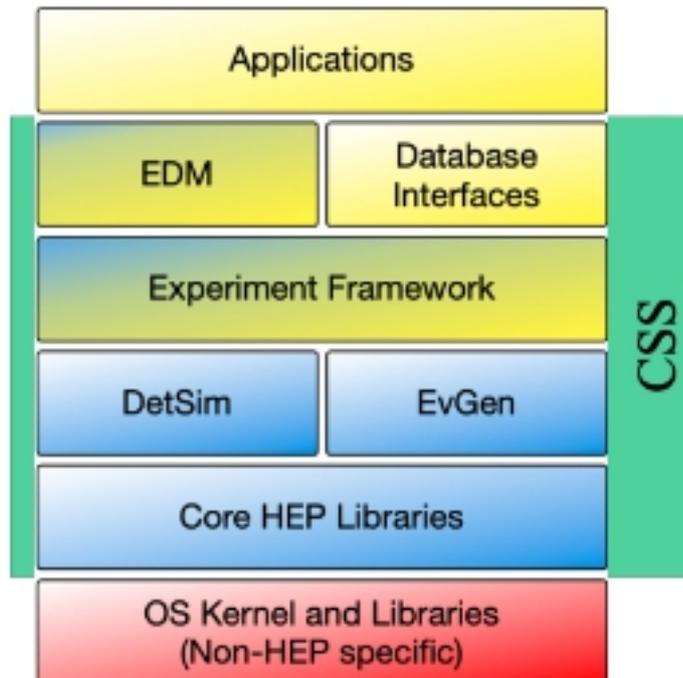
# possible further-future

recent discussions about “common software stack” for future experiments CEPC, CLIC, ILC, FCC

- more efficient use of limited SW human resources
- less painful migration to realised project(s)

## TurnKey Software Stack

### Content of a CSS



### List of components:

- HEP de-facto standard: ROOT, Geant4, HepMC, ...
- New HEP libraries: VecCore, VecMath, VecGeom, ...
- Externals: Boost, GSL, Eigen, ...
- EDM and Geo libraries: DD4Hep, PODIO,
- Rec/Tracking libraries: ACTS, ...
- Framework: Gaudi/Marlin

# summary

samples produced for IDR heavily used

short-term:

preparing for large production for ILC-250

medium-term:

develop & support current software

far-term:

towards more common tools