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Apologies for being a bit late after my promise in last week's meeting. But the number of proposed corrections is quite large.

line 1: performance of \rightarrow particle identification with
 \rightarrow Done

line 15: for a 1 m track \rightarrow per 1 m of track length
 \rightarrow Done

line 17: proposal for change of "the template fit" is
"successive hit distance fit"
or some other name, but I do not insist

\rightarrow added "using the successive distances between the hits"

line 22: "resolution", what is exactly meant by this?

\rightarrow For the abstract "resolution" is fine IM0, in the paper details are given.

line 23: using circular tracks \rightarrow using full circular tracks
(as all tracks in B=1 T data are circular)

\rightarrow not all circles are "full" contained in the detector

lines 24/25: not clear (yet) what you mean with

1) "incident angle"? At which point of the full circular track?

\rightarrow ϕ in the xy plane of the circle and orientation wrt the detector fixed

2) "within an uncertainty of 16 μm "? Is this the single point
resolution? in the ILD experiment

\rightarrow it is the uncertainty on the resolution: maximum deviation of the
constant value as a function of ϕ .

line 26: of \rightarrow for

\rightarrow Done

now line 27: NOT DONE

line 27: in ILD \rightarrow in the proposed ILD experiment at a future
ILC e^+e^- collider

\rightarrow Done

now line 29:

was presented \rightarrow is presented

line 36: of 55x55 \rightarrow 256 x 256 pixels of 55 x 55

\rightarrow Done

new line 39:

efficiency about \rightarrow efficiency of about

new line 42:

planes \rightarrow planes [add ref]

line 37: ionisation vs. ionizing (in line 51): make consistent spelling
->Done

lines 43-44: paper [3]. The paper -> paper [3], which
->Done

NOT DONE
now lines 46,47:
of our paper [3]. The paper explains ->
of our paper [3], which explains

line 46: REMOVE, as I propose the following sub-sections to sections with the appropriate numbering
->Done

line 53: in the ILD experiment -> in the proposed ILD experiment at ILC
->Done

line 55: 2.1 -> 2.
->Done

new line 57:
Identification -> Identification (PID)

It seems you have (not yet) defined the quantity "dE/dx" as a measure of the energy loss of the beam particle (i.e. the number of track hits per chip?)
-> Added

"Particles can be identified by their characteristic energy loss per unit of track length dE/dx loss and/or the number of primary clusters dN/dx produced along the track.
In a GridPix detector one can measure the number of hits produced along the track and their relative distance."

new line 59:
length dE/dx -> length, dE/dx
clusters dN/dx -> clusters, dN/dx

new line 60:
a long -> along
measure the number -> measure both the number

new line 65:
hits is measured -> hits per chip were measured

lines 58-64: Are there any (further) selections/cuts on these (combined) long tracks, i.e. (e.g.) angle, curvature, ...?
-> "In order to measure the track performance of dE/dx or dN/dx , a track selection was applied selecting tracks crossing the central chips - defined in ref \cite{Beuzekom:2024part1}. The individual chips were calibrated to give the same mean number of hits per chip."

line 59: hits is -> hits per chip were
->Done

line 60: are -> were
->Done

line 63: to the track -> to a track from several events
->Done

new line 73:

3

guard -> guard plate OR -> plane

line 67-68: what is "consecutive pixels" here exactly:

a) associated to and along the track? or...

b) inside a box of e.g. 5x4 or 5x 10?

line 68: pixels -> pixels along the track

-> Added two lines

"Both methods project the hits along the track in the \$xy\$ plane. This gives a distribution of hits as a function of the distance along the track in pixels.

new line 77:

pixels -> pixel units

The first method rejects large multi-electron clusters with more than in total 6 hits in 5 consecutive pixel bins .."

line 71: what is "minimum" here? projected along the track?

-> the distances between all hits can be calculated but only the minimum is used.

Text is now: "The second method exploits the distribution of the minimum distance between consecutive hits in the \$xy\$ precision plane."

line 76: by the -> by the traversing beam

-> Done

new line 95:

Fig. 5.15 -> Fig. 5.19

I would still prefer to have an example distribution in THIS paper

line 81: At lower distance -> At lower distance,

-> Done

line 83: per 1 m track -> per 1 m of track length

-> Done

to distance -> to the distance

-> Done

formula (1): slope $d_{\{xy\}}$ -> $slope_d_{\{xy\}}$

-> ?? change notation?

Equation (1):

write exponent in exponential as $-A \cdot d_{xy}$

Then write new lines 101/102 as:

The slope A and the normalisation N_0 are left free in the per track fit. The weights

new line 102:

"using the whole data set" ?

Do you mean "through the whole analysis". If YES, would prefer the latter

ADD here a figure with an example distance distribution for a single track and template fit superimposed

-> We cannot show an individual fit ... likelihood

page 4, Table 1:

1) make columns left-aligned

- 2) line "Method": remove resolution (2 times)
- 3) remove the line with the two single "%" symbols
- 4) line "1" and line "2": remove these method numbers
- 5) add the "%" symbols after the result numbers

-> Done

line 88: provides -> provide

->Done

new line 107:
could be -> was

new line 118:
sizable -> sizeable

new line 120:
Fig. 1 -> Fig. 1,
MIPs -> MIPs and

new page 6, Table 1

1) in title: would it not be good to have (just one more time)
"relative resolution" her in the table caption?

2) REMOVE the % unit in the "Method" line

3) ADD the % unit after the result numbers

4) would like bit more space between the columns (or else vertical lines)

new line 122:
inverse (pixel) distance -> inverse pixel (unit) OR inverse pixel

new line 124:
method 1 -> the truncation method

new line 125: method 2 -> the template method

new line 125: "can be corrected" OR "have been corrected" ?

new line 131:
particle identification -> PID

Then the BIG question at the end of this section is:
what is the CORRELATION between the track-by-track results of the
two methods and could the OR of the two give even a
(slightly) better result?

lines 92-93: should it be LINEAR?

-> No one can correct for non-linearities; if it is linear no correction has
to be applied

page 7, new Figure 1:

if you keep the new arrangement (one above the other) then in caption:

line 1: selected hits -> selected hits per track

line 2:
(left) -> (top)
(right) -> (bottom)

line 3:
MIP -> MIP,
coverage -> coverage,

new line 132:
sectionSingle -> (in bold) 3. Single...

Figure 1:

- 1) make (a bit) larger, i.e. use full horizontal space
-> Done
- 2) inside figure: make larger axes numbers, titles and captions
- 3) right plot axis title: the fitted slope is given in units of [1/pixels]
-> 2-3 I don't know. In a journal you can zoom. Figures are large and separate.

This is NEW unit and not described in the text.

Ofcourse, if you accept suggestion to make a figure with an example distance distribution, that can be explained there that its horizontal axis is in 'pixels'

and not in um

-> The unit of the fitted slope is inverse (pixel) distance, as is clear from the formula in Eq.~\ref{eq:expo}.

- 4) in caption: and MIP 1 m long -> and for a MIP of 1 m long
-> Done

line 114: 2.2 -> 3.
-> Done

line 116: threshold -> threshold (TOT)

lines 119-121, i.e. "The track selection ...performance." ->
-> Rephrased as: "The track selection is the same as the one that was described in section 2.

However, there is not a real description of the track selection there

-> The track selection is the same as in section 2. It is described in paper + section 2 "central chips".

lines 121-122: the run numbers are meaningless (they are also not mentioned in the part I paper. Just call them '6 GeV' and '5 GeV' runs and maybe add the number

of analysed 'events' or better 'tracks'

-> If one wants to reproduce the results run numbers are relevant to quote.

Well, could be, but is very unlikely that one would get exactly the same results.

Anyway, now I will give some comments (later) related to these run numbers

line 123: for values -> in the interval
-> Done

line 126: time over threshold -> TOT (and also in rest of paper)
-> Done

line 128: half -> half (in x)
-> Done

line 130: "by the total run time" - do you take the duty cycle of the machine into account?

As these are different for the 5 and 6 GeV runs.

-> No it is just the data taking time. So it is NOT the max instantaneous rate.

new lines 147-149:

For the 6 GeV/c runs the duty cycle is even SMALLER. Would be nice to add also this number here?

lines 130-131: 6934 and 6935 -> at 5 GeV

-> Added 5 GeV/c

lines 133-134: remove "due to the high statistics"

-> Done

new line 154:

-1.2% (upper) -> -1.3% (upper half)

new line 155:

(lower) -> (lower half)

new line 157:

+1% -> +1.1%

+1.7% -> +1.8%

new lines 155, 157 and 158:

remember: these numbers will change after you have moved to REAL rates

new lines 159-166:

I am not sure I fully understand this!

new line 162:

mention also the figure number in [2] you are referring to

Table 2:

1) title: time OF threshold -> TOT

-> Done

2) in 2nd line of table, put units in [..]

-> Well: now it is clear these are then units; 10^3 s (now) OR [10^3 s] or 10^3 [s]

3) as mentioned above, replace run number by beam energy

-> See answer/discussion above

4) number of triggers for line '6935' must be similar to the previous line

-> Corrected: indeed 7.34 k trigger are in run 6934 (in stead of 73.4)

now in new Table 2:

NO, the 'correct' number of triggers is indeed 73k (according to logbook)

I will give my (many) comments to the Table 2, separately later.

But one of the comments will be to give rates in REAL instantaneous rates, BOTH for trigger and hit rates

5) should mention somewhere that our actual beam trigger rate is HIGHER because of

the inefficiency of our 2-fold scintillator coincidence OR correct the numbers for this

-> The exact values of instantaneous beam rate and trigger efficiencies, don't go

8

7

in the raw hit rate of the chips (that is measured trigger less).

But you have used in the denominator the clock time in seconds,
but for a correct mean Rate number you should divide by the real beam time,
thus correcting for the duty cycle of about 30%

But you mention in table also the "trig rate".
So you SHOULD mention in the table (with a *, i.e
trig rate -> trig rate^*

and then a small footnote at the end of the table:
"the measured trigger efficiency turned out to be only 31%"
OR else correct the numbers in the table with this factor
(which I prefer)

Figure 2:

1) what is the definition of "event" here? I see only green and blue hits

-> An event is defined by the trigger number (so all hits after the trigger
till the next trigger are show).

Indeed I used in the histogram $toa = t_trigger - t_hit$. Instead of $toa = t_hit - t_trigger$.

Plot should be remade.

2) in caption: run 6969 event 2 in a -> a 5 GeV beam energy run at
also : xy plane in colour -> xy plane; in colour,

-> Rephrased as:

"An event display for run 6969 event 2 taken at a 5 GeV/c beam momentum in a
 $B = 1$ T field. The hits are shown in the xy plane in colour the time of
arrival is shown."

small caption change:

plane in colour -> plane, in colour

line 148: 2.3 -> 4

new line 167:

3. -> 4.

new line 168:

hit burst -> hit bursts,

lines 150-151: in run 6969 with -> at 6 GeV beam momentum and

-> "An example event in run 6969 is shown in figure"

line 151: remove 'field'

-> Still I give the information in the caption:

-> "An event display for run 6969 event 2 taken at a 5 GeV/c beam momentum in
a $B = 1$ T field"

line 152: energetic particles ???? ALL are very low energy w.r.t. the beam
energy

so say here the order of magnitude of the momentum of these (half) circles

-> Rephrased:

"A large variety of hit patterns can be observed: large radii (open) circles,
smaller size radius circles from low momentum particles, curlers and more
confined bursts."

-> Added to text

"A track with a momentum of 1 MeV/c will have a typical radius of 121 pixels."

IF possible: add an artificial circle that just fits between top and bottom and

give the momentum of this example track. Ofcourse that can also be mentioned with one line in the main text
-> Done with one line see above

new lines 173-174:
characterize -> characterise

new line 176, at end:
remove 2nd dot

line 157: run 6969 -> a run at was -> were

line 157 and following AND figure 3:
in re-reading this paragraph carefully now, I have quite a bit of remarks/questions to the content and the figure 3:
first of all, please make the line thickness of the histograms MUCH thinner

-> Will be done

as you remark further on in line 170, a radius of 50 pixels around the burst center corresponds to an area of 7854 pixels. So requiring >100 hits in such an area means you look at an occupancy from only ~1%. So that is not (yet) really a "burst"

-> That is correct. In the core of the distribution one may have a large occupancy.
-> That is why I give characteristics for > 100 > 200 and > 400 hits in a burst.

Is there a "burst" present in figure 2? e.g. at x,y ~ 600,850 ?
If so, would be nice to add to the figure a small "arrow" pointing to that "burst" and add few words in figure caption

-> I don't think it helps ... bursts with more than 100 hits?

Figure 3:

- 1) reduce histograms line thickness (a lot)
- 2) reduce the number of hor. axis scale numbers, e.g. 0, 10, 20, etc. and 0, 40, 80 etc.
- 3) hor. axes labels: radius 90 -> radius90 and time 90 -> time90
- > 1)-3) Will be done

4) in caption: for run 6969 event 2 in a -> for a 5 GeV beam energy run at
-> Changed

new in caption figure 3:
time90 -> time90,
burst -> bursts
in line 2: hits for -> hits, in

new line 182:
characterized -> characterised

line 169: might stay -> may remain
-> Done

NOT fully DONE, so
new line 190:
might -> may

new line 190:
Still the detector -> Still, the detector

line 170: run 6969 -> the run used in figure 3
-> Changed

NOT CHANGED, therefore now in new line 192:
in run 6969 -> in the run used in Figure 3

lines 172-176:

1) I wonder whether it would be better to move this to the next section?

-> NO this why burst finding - using the characteristics show in this paper - IS relevant for tracking.

Also: what do you mean by "One could" in line 174?

Is it "done" or "not done"?

-> The pattern recognition for ILD should be changed (so One could)

-> Rephrased:

"In the pattern recognition one could run a burst finding algorithm and down weight in the track fit the hits associated to bursts."

new line 195:

In the pattern recognition -> Therefore, in future pattern recognition

line 177: 2.4 Resolution study ->

5. Track resolution as function of track angle

-> Done

NOT FULLY DONE

new line 198:

of the angle -> of the track angle

OR

of the angle -> of the local track angle

(I proposed in an earlier meeting to leave this section out:

I am still in favour of this, but do not insist)

line 180: incident angle -> incident angle of the track,

-> Done

new lines 199-200:

of the incident angle of the track -> of the local track angle

new line 200:

will be measured -> has been measured

new lines 201:

incident angle -> local angle

new line 202:

incident track angle -> (local) track angle

line 181: is minimal if the incident track angle is parallel to the strip ->

is best for track angles parallel to the pad strip

-> Done

line 182: remove "This is due ...layout."

-> Done

line 185: at non-zero B field ALL tracks are circular (unless they interact).

So better say "full circle" tracks ? (2 times)

The needs more text:

"For circles, the incident ϕ angle of the track depends on the position of the individual hits on the circle in the xy plane. The range of ϕ angles depends on the radius. For radii smaller than 500 pixels a large ϕ range can be probed. Using the residuals in the xy plane, it is possible to measure the resolution of the hits as a function of the incident ϕ angle of the track."

(by the way, this study could have been done also with "beam" tracks at different angles of the detector)

-> That is correct. BUT ... in that case we need may to be able to rotate the detector up to $\pm \pi/2$... and that is not trivial

new line 208:
incident -> local

new line 212:
incident -> (local)

line 190:
1) again, what is the definition of "event" here?
-> See above defined by the trigger

2) circles large clusters -> circles, large clusters
-> Done

3) what is meant by "down weighted"? Should be more explicit.
Then you can end sentence and start new sentence with
"Hits within 15 pixels ..."

->Will add a sentence

lines 191-192:
1) this is all very ARBITRARY
2) 4 pixels -> 4 pixels (220 um)

-> No it matches the approximate resolution
-> Rephrase: "In the circle fit, the resolution in xy was estimated to be about 4 pixels and in z it was 1 mm."

line 194: dof -> d.o.f. (2 times)
-> Done

new line 218 at end:
was -> were

new line 220:
, at least -> and at least

line 196: 0.4 MeV/c -> 0.8 MeV/c (please check my number!)

-> I think 0.4 is OK ... A track with a momentum of 1 MeV/c will have a typical radius of 121 pixels.

line 197: $\pi/4$ to $7\pi/4$ corresponds to 0.785 to 5.498
but in figure 4 the plotted range is from ~ 0.5 to 5.7
-> That is right should be:

-> "The ϕ hits below $\pi/8$ and above $15\pi/8$ were removed."
new lines 222-223:

12

11

This sentence shows that I might not have understood the whole procedure and would invalidate all my proposed changes from "incident angle" into "local angle".

Because I realise now (in my understanding) that the range of this Φ should could run from 0 to 2π .

Hence no reason to exclude the two end edges in Fig. 4

In fact, in new lines 229-230, the sentence seems to say that in the plot in Fig. 4, you enter ALL hits at the SAME "incident angle"

Please tell me what is wrong in my reasoning.

line 200: which "resolution" do you refer to?

Finally, the resolution in σ_{xy} was extracted - using a Gaussian fit to the track residuals in the range of $\pm 2\sigma$ around the centre.

line 201: I just don't understand this statement, because if the above mentioned "resolution" is single point xy resolution, then I don't see why it should depend on the radius?

Rephrased this:

"Because the resolution depends on the radius (i.e. the momentum) and small radii span a large phi range, the data was re-weighted as a function of the circle radius."

line 201: data was -> data were

lines 202-203: strictly speaking this sentence is un-understandable, "by using a Gaussian fit".

A fit to what?

I assume it is again the fit of the residuals to the expression that was given in the part I paper, but is not obvious here

-> Indeed. Rephrased

"Finally, the resolution in σ_{xy} was extracted - using a Gaussian fit to the track residuals in the range of $\pm 2\sigma$ around the centre."

line 203: be consistent with the spelling of centre vs center

-> Done

new line 235:

incident -> local

(but maybe no longer applicable in view of my remarks above)

line 210: change title to:

6. Projected particle identification performance for a Pixel-TPC in the proposed experiment ILD at a future ILC

Also: I think it would be good to have this section following the (renumbered) section 2.

line 211-212: remove this first sentence

-> Done

line 212: ILD -> ILD [4]

-> Done

-> "The TPC of the proposed ILD detector \cite{Behnke:2013}"

line 213 (middle) - 215: make this as first sentence in this section 6, but

modifying the first part:

The electron resolution from the test beam → The particle ID for electrons in the test beam

→ Redone as proposed:

" The particle identification performance of electrons in the test beam for momenta of 5–6 GeV/c was measured to 2.9% for the template fit and 3.6% for the dE/dx truncation method at $B = 1$ T for 1 m long tracks with 60% coverage.

new line 239:

to 2.9% → to be 2.9%

The TPC of the proposed ILD detector \cite{Behnke:2013} has an inner radius of 329 mm, an outer radius of 1770 mm and a half length of 2350 mm.

In the ILD TPC this will correspond to an expected electron resolution of 2.4% (fit) and 3% (truncation) at polar angles of $\theta = \pi/2$ ($\cos\theta = 0$) and a track length (l_{length_0}) of 1441 mm."

page 10, Figure 4:

1) vertical axis label: σ_{xy} → σ_{xy}

2) caption line 2:

a) curved → curve

→ Done

b) Eq. 3 → Eq. (3)

→ NOT Done paper has Eq. everywhere

line 215: for a 1 m long → for 1 m long

→ Done

lines 216–217: I am afraid that the tracklength at 90 degr. is shorter than 1441; there will be space needed for 'services' on the inside (both on inner and outer)

→ Could be but this a calculation

new lines 243–244:

propose to re-shuffle a bit as:

The electron PID resolution in this ILD TPC is then expected to be 2.4% (template fit) and 3.0% (truncation method) at polar

lines 219–220: you say "similar or worse" but this is NOT true.

If we run T2K at driftvoltage of 280 V/cm (maximum of drift velocity) the transverse diffusion is not optimal, but at $B=3.5$ T, the diffusion constant is $\sim 30_{-40}$ $\mu\text{m}/\sqrt{\text{cm}}$

But maybe you mean in line 219 "the actual amount of transverse diffusion" in the beam test and in ILD? Please improve wording.

→ A more accurate sentence would be

"Depending on the B field value (3.5 T – foreseen at ILC – or e.g. 2 T), the resolution in the transverse plane after drifting to the endplate will be similar or worse than the test beam situation. The resolution for a GridPix TPC in ILD will therefore lie between 2.4 and 3% at $\cos\theta = 0$."

→ I took out the sentence because it discusses something complex:

the impact of the xy resolution ("diffusion process") on the dE/dx performance...

Basically, the range we give is correct.

line 220, 221 and 225: the resolution → the PID resolution

14

-> Done

equation (4): $\sigma =$ -> $\sigma_i =$
-> Done

equation 4:
insert multiplication 'dots' between l and E

line 225-226: largest track length 0.85. ->
largest track length, which corresponds to $\cos\theta = 0.85$
in ILD.
-> Done

line 227: for the energy loss -> of the energy loss
-> Done

line 228: were used [6] -> were used as given in [6]
-> Done

page 11, Figure 5:
1) vertical axis label: (σ) -> [σ]
-> Still to do

2) caption:
line 1: projected separation -> projected PID separation
line 2: line corresponds -> lines correspond
line 2: electron resolution -> electron PID resolution
-> Done

line 230: The separation -> the PID separations
line 230: w.r.t. pions is -> w.r.t. pions are
line 235: do NOT start a new line
-> All Done

new line 255:
for the e, K and p is defined ->
for e, K and p are defined

new line 256:
the separation -> the PID separation

new line 257:
particle for -> particle, for

new lines 260-261:
do not split over two lines the number '100' and the unit 'GeV/c'

line 249: 1 m track -> 1 m long track
-> Done

NOT DONE:
now new line 273:
1 m track -> 1 m long track

line 251: impressive. It is currently, the best ->
impressive, and is currently the best
new line 275:
currently, the best -> currently the best
so remove ,

new line 280:
characterized -> characterised

13

14

new line 282 and also in 284:
The resolution -> The PID resolution

line 259: circular -> full circle
-> Rephrased "using reconstructed circle tracks."

line 268: CEPC collider a Pixel TPC ->
proposed CEPC collider in China, a Pixel TPC
(and ADD a reference)

line 271: at the EIC -> at the Electron Ion Collider (EIC)
at Brookhaven National Lab
(and ADD reference)a

line 271: DRD1 collaboration (add reference)
DRD1 Extended R&D Proposal, Colaleo, Anna, <https://cds.cern.ch/record/2885937>

-> I don't agree that we can quote meaning references for these items.

The are NO official publications:

- CEPC no publised detector TDR (CDR is old)
- EIC on published detector TDR (status "white paper")
- DRD1 has no publication either

§

Table 2

142 tail of the distribution.

Table 2: Mean ToT and rates for different runs

run	B	ToT1	ToT2	triggers	run time	Hits1	Hits2	trig rate	Rate1	Rate2	
	[T]	[μ s]	[μ s]	10^3	[10^3 s]	10^6	10^6	[Hz]	[hits/s]	[hits/s]	
6 GeV 5	6916	0	0.628	0.653	16.8	23.2 5.7	6.25	13.1	0.72 2.7	269	565
5	6934	0	-	0.651	7.34 73.4	2.41 0.6	-	20.5	30.4 121.7	-	8479
5	6935	0	0.620	-	7.39 115.0	2.41 0.6	6.95	-	30.6 191.7	2878	-
6	6969	1	0.650	0.666	7.94 11.19	13.8 3.42	1.93	2.16	0.57 3.3	139	156
5	6983	1	0.657	0.678	6.79 100.9	2.83 0.7	11.6	14.1	24.1 146.4	4110	4986

143 The results for the measured average ToT for different runs and hit
 144 rates are summarised in Table 2. ToT1(2) denotes the mean ToT for up-
 145 per and lower half (in x) of the module and Hits1(2) corresponds to number
 146 of recorded raw hits. The mean Rate1(2) was calculated dividing the total
 147 number of raw hits by the total run time. The instantaneous rate in runs
 148 6934, 6935 and 6983 taken at 5 GeV/c is about a factor 3 higher (due to the
 149 duty cycle of the machine). For the $B = 0$ T data, two high rate runs 6934
 150 and 6935 taken at a beam momentum of 5 GeV/c had to be analysed be-
 151 cause the beam crossed either the upper or the lower part of the module and
 152 therefore no measurement could be performed (denoted by -). The statistical
 153 uncertainties are negligible.

154 The relative change in the mean ToT for the $B = 0$ data is -1.2% (upper)
 155 and -0.3% (lower). In this case the rate goes up to 8.5 kHz for 6 chips or 1.4
 156 kHz per chip. The relative change in the mean ToT for the $B = 1$ T data
 157 is +1% (upper) and +1.7% (lower) The rate goes up to 5 kHz for 6 chips or