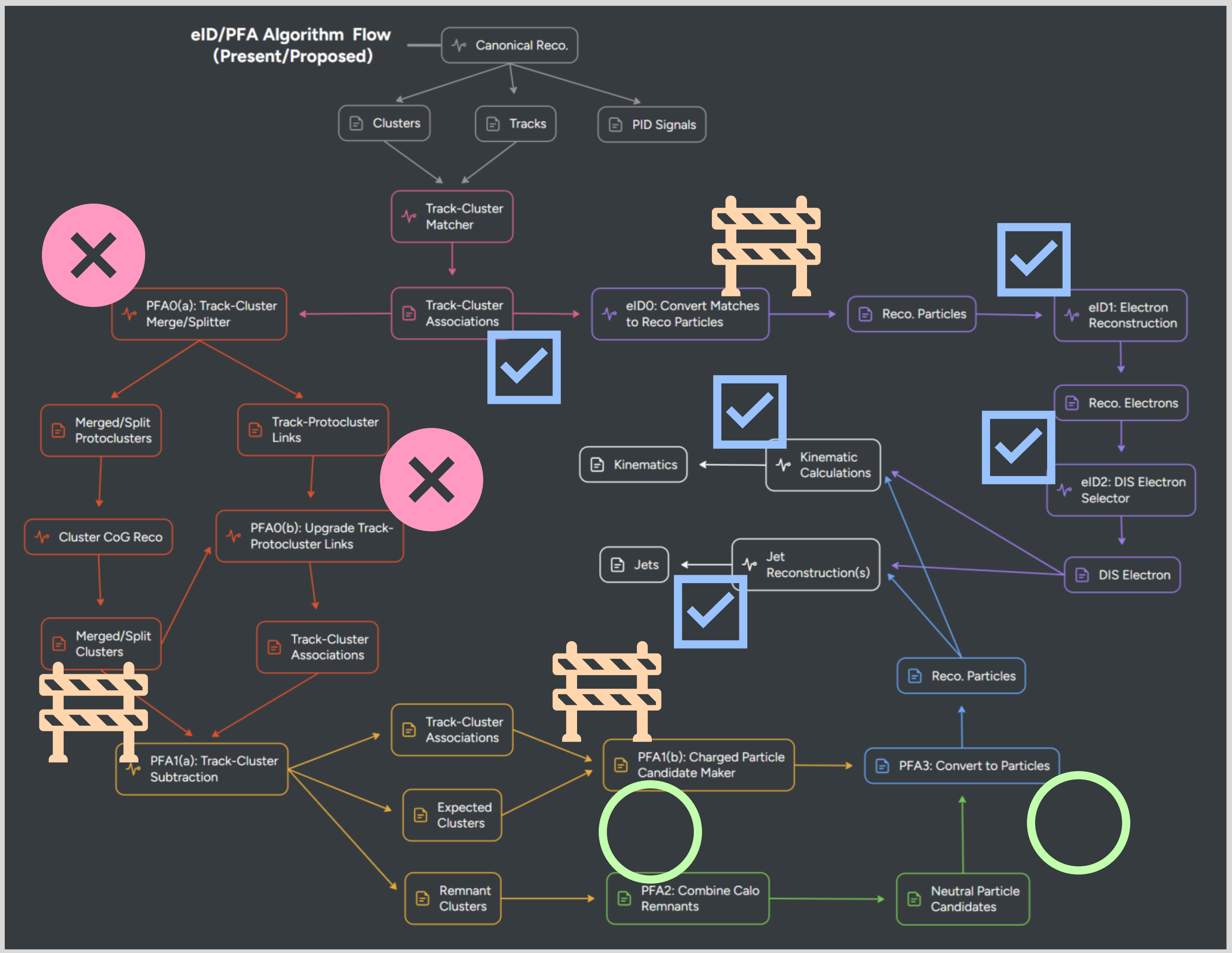
PF Development | Roadmap & Tracking

- **Right:** Current PF roadmap
  - Minor updates since Physics Readiness Workshop…
- Spreadsheet for tracking tasks can be found here
  - Huge thanks to Shujie for sharing the template!
  - Task list at end of slide deck

○ = To-do
🚧 = In progress
☑ = Done/already in EICrecon
☒ = Blocked



eID/PFA Algorithm Flow (Present/Proposed)

Canonical Reco.
Clusters
Tracks
PID Signals
Track-Cluster Matcher
PFA0(a): Track-Cluster Merge/Splitter
Track-Cluster Associations
eID0: Convert Matches to Reco Particles
Reco. Particles
eID1: Electron Reconstruction
Reco. Electrons
Merged/Split Protoclusters
Track-Protocluster Links
Kinematics
Kinematic Calculations
eID2: DIS Electron Selector
Cluster CoG Reco
PFA0(b): Upgrade Track-Protocluster Links
Jets
Jet Reconstruction(s)
DIS Electron
Merged/Split Clusters
Track-Cluster Associations
Reco. Particles
Track-Cluster Associations
PFA1(a): Track-Cluster Subtraction
PFA1(b): Charged Particle Candidate Maker
PFA3: Convert to Particles
Expected Clusters
Remnant Clusters
PFA2: Combine Calo Remnants
Neutral Particle Candidates

PF Development | Contributing

- Set up branch of my EICrecon fork for development testing
  - Check it out with:

    ```
    git clone git@github.com:ruse-traveler/EICrecon.git
    git checkout –B pfa-dev-base
    ```

  - Has blank plugin and empty directories for where new PF code should go

- PF code will be collected into a new **particle** category:
  - Algorithms go in

    src/algorithms/particle
  - Factories in

    src/factories/particle
  - Factory generators should be added to

    src/global/particle/particle.cc
  - And output collections should get added to list at line 388 of

    src/services/io/podio/JEventProcessorPODIO.cc

- **FYI:** still juggling PRs, so particle category hasn't been introduced to EICrecon main yet
  - Recommend following these steps when making a PR:

    ```
    git clone git@github.com:eic/EICrecon.git [if needed]
    git checkout –B <my-pfa-contribution>
    [copy code from test area into appropriate directories]
    [commit changes and push to <my-pfa-contribution>]
    ```

- **Reminder:** for anyone who hasn't done EICrecon development recently
  - Adding a new algorithm making these changes:
    - Making ***.cc**, ***.h**, and ***Config.h** files in **src/algorithms/particle**
    - Making a ***_factory.h** file in **src/factories/particle**
    - Adding appropriate generators to **particle.cc** plugin
    - Adding appropriate collection so **JEventProcessorPODIO.cc**
  - Examples can be found here

PF Development | PFA2 | Notes

- **Calo Remnant Combiner:** combines remnant clusters from subtractor into neutral particle candidates
  - **Assignee:** Subhadip

- **The algorithm:**
  1) Combine nearby ECal, HCal clusters
     a) Identify seed ECal cluster
     b) Merge all ECal, HCal clusters in Δr^{em}_{add}, Δr^{h}_{add} of seed and create neutral candidate
     c) Repeat until no ECal clusters are left
  2) Combine remaining HCal clusters
     a) Identify seed HCal cluster
     b) Add all HCal clusters in Δr^{h}_{add} of seed and create neutral candidate
     c) Repeat until no HCal clusters are left

Inputs:

- Remnant ECal clusters
- Remnant HCal clusters

Outputs:

- Neutral particle candidates

Note: maybe make inputs vectors of collections?

Parameters:

- $\mathbf{\Delta r^{em}_{add}}$: window to add ECal clusters
- $\mathbf{\Delta r^{h}_{add}}$: window to add HCal clusters

PF Development | PFA3 | Notes (1/2)

- **Particle Converter:** takes candidate particles and turns them into reconstructed particles
  - **Assignee:** TBD

- **The algorithm:**
  1) Assign preliminary PID based on what info is available (next slide)
  2) Calculate track energy

$$E_{trk} = p_{trk} \oplus m_{pid}$$

  3) Calculate calorimeter energy

$$E_{cal} = N_{cal}\left(\sum w_{em}E_{em} + \sum w_h E_h\right)$$

  4) If charged particle and $k_{use\ \sigma ?}$, calculate resolution-weighted average of E_{cal} and E_{trk}
  5) Calculate remaining kinematics and create reconstructed particle

Inputs:

- Candidate charged/neutral particles
- Reconstructed charged particles (for PID)
- Primary vertices (for neutral candidates)

Outputs:

- Reconstructed particles

Parameters:

- $\boldsymbol{k_{use\ \sigma ?}}$: turn on/off using resolution in energy calculation for charged candidates
- $\boldsymbol{N_{cal}}$: normalization of calo energy
- $\boldsymbol{\sigma_{trk}}$: tracking resolution to use in energy calc
- $\boldsymbol{\sigma_{cal}}$: calo resolution to use in energy calc

PF Development | PFA3 | Notes (2/2)

- **Particle Converter:** takes candidate particles and turns them into reconstructed particles
  - **Assignee:** TBD

- **The algorithm:**
  1) Assign preliminary PID based on what info is available (sub-routine to right)
  2) Calculate track energy

$$E_{trk} = p_{trk} \oplus m_{pid}$$

  3) Calculate calorimeter energy

$$E_{cal} = N_{cal}\left(\sum w_{em}E_{em} + \sum w_h E_h\right)$$

  4) If charged particle and $k_{use\ \sigma?}$, calculate resolution-weighted average of E_{cal} and E_{trk}
  5) Calculate remaining kinematics and create reconstructed particle

Sub-routine: what PDG to assign?

1) Check what info is present:
   a) **If** at least 1 related track, **hasTrk = TRUE**
   b) **If** at least 1 EMCal cluster, **hasECal = TRUE**
   c) **If** at least 1 HCal cluster, **hasHCal = TRUE**
2) **If hasTrk**
   a) Use track to retrieve reco charged particle
   b) PDG = chrgPar.getPDG()
3) **Else**
   a) **If hasECal and !hasHCal,** PDG = <Photon>
   b) **If hasECal and hasHCal,** PDG = <Neutron>
   c) **If !hasECal and hasHCal,** PDG = <???>

Note: for initial pass electron/muon and pi0/gamma discrimination deferred to downstream

☞ Also can refine neutral PID by checking relative ECal vs. HCal contribution

PF Development | Task List (1/3)

Tasks	Issue/PR/Note	Est. labor time*	Assignee
PFA-1: deprecate MatchClusters, replace w/ pure reco equivalent	EICrecon#1956	2 weeks	Tristan
PFA0(a): complete merge/splitter update (requires JANA2 2.4.3)	EICrecon#1699	1 week	**BLOCKED**
PFA0(b): implement track-protocluster link promotion algorithm	EICrecon#1886	2 weeks	**BLOCKED**
PFA1(a): revive and finish track-cluster subtractor	EICrecon#1627	1 week	Derek
PFA1(b): track-cluster converter (synergy w/ PFA-1)	EICrecon#2124	1 week	Derek
EDM: flagging ecal vs. hcal clusters	EICrecon#2078	1 week	Derek
PFA2: implement calo remnant combiner	To-do	2 weeks	Subhadip
PFA3: implement particle regressor/convertor	To-do	2 weeks	**OPEN**

* Assuming 50% FTE, including code review time

PF Development | Task List (2/3)

Tasks	Issue/PR/Note	Est. labor time*	Assignee
PFA-1 Benchmark - **input:** Sum eClust, sum pTrk, nClust, nTrk, E/p matched clusters, sum eGenPar, eGenPar, nGenPar - **output:** Sum eRecPar, eRecPar, ePar, nRecPar, nPar, PES/R of reco pars	To-do	1 day	**OPEN**
PFA0 Benchmark - **input:** Sum eClust, eClust, pTrk, nTrk, nClust, E/p matched clusters - **output:** Sum eSMClust, eSMClust, nSMClust, E/p SM clust, dRct SM	Some work done	1 day	Olaiya, Derek (nom.)
PFA1 Benchmark - **input:** Sum eClust, eClust, sum pTrk, pTrk, nTrk, nClust, E/p matched clusters, sum pChrgPar, pChrgPar, nChrgPar - **output (expected):** sum eEXClust, eEXClust, nEXClust, E/p EX clust, dRct EX - **output (remnant):** sum eREClust, eREClust, nREClust - **output:** sum eEXClust + eREClust	To-do	2 days	Derek (nom.)

* Assuming 50% FTE, including code review time

○ **Notes:**
- PES/R = Particle Energy Scale/Resolution
- SM = Split/Merge, EX = Expected, RE = Remnant
- dRct = distance b/n cluster & matched track

PF Development | Task List (2/3)

Tasks	Issue/PR/Note	Est. labor time*	Assignee
PFA2 Benchmark **- input:** sum eREClust (EM, H), eREClust (EM, H), nREClust (EM, H), sum eNeuPar, eNeuPar, nNeuPar **- output:** sum eRecPar, nRecPar	To-do	1 day	Subhadip (nom.)
PFA3: **- input:** Sum eClust, sum pTrk, nClust, nTrk, E/p matched clusters, sum eGenPar, eGenPar, nGenPar **- output:** Sum eRecPar, eRecPar, ePar, nRecPar, nPar, PES/R of reco pars	To-do	1 day	Win
PHYS Benchmark: JES/R	To-do (just need wiring)	0.5 day	Dener
PHYS Benchmark[a,b]: Jets - E, mass, FFs (jt, z), Substructure (dRcst, angularity, EECs)	To-do	2 days	Dener
PHYS Benchmark[a]: Events - TEECs, NECs	NECs in progress (see here)	3 weeks	Derek (NECs)

* Assuming 50% FTE, including code review time

a) Desirable, but not required

b) Could do inclusive, HF-tagged, etc.

○ **Notes:**
- EM = “Electromagnetic”, H = “Hadronic
- dRcst = constituent delta-R