Status of `Geometry` service changes to accommodate pixel readouts

Part 2 of N

Kyle J. Knoepfel

LArSoft coordination meeting

29 November 2022

Motivation

- **LArSoft intends to support pixel geometries**
  - To do this, some adjustments to the Geometry service/system are required.
    - *Will likely be separating readout-specific concepts from those of geometry.*
  - A few of us are meeting weekly to determine how best to proceed.
  - While analyzing geometry code, it became apparent that much of the interface serves as “legacy” code to support older coding patterns

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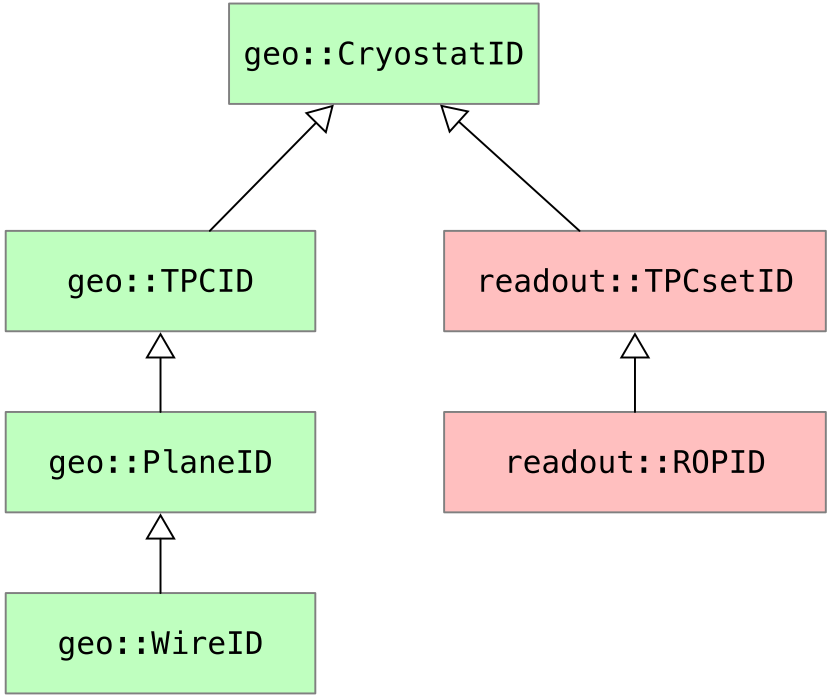
- **Maintenance issues**
  - We will need to rearrange some parts of the code to support pixel geometries—***it's less work to adjust only the code that's required***.
  - Recently we removed a lot of "deprecated" code.
  - **I'd now like to address the large number of overloads** (+ some missed deprecations), **and the geometry iteration patterns.**

Geometry IDs

- The `larcorealg` repository provides an inheritance-based system for identifying elements of a LArTPC geometry.
- Any ID object can access the ID properties of its base class.
- Provides degree of extensibility.
- Used consistently, this type of system lends itself to simple APIs.
- It is also the basis for smart iteration through geometry elements.



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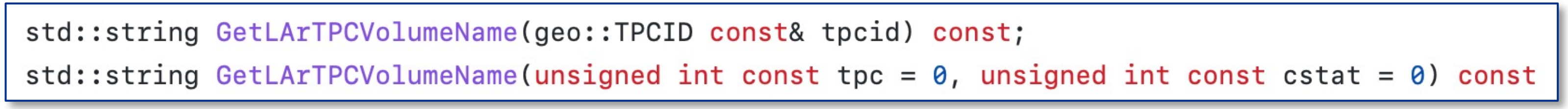

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std::string GetLArTPCVolumeName(geo::TPCID const& tpcid) const;
std::string GetLArTPCVolumeName(unsigned int const tpc = 0, unsigned int const cstat = 0) const
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Use:

```
geom->GetLArTPCVolumeName(TPCID{1, 2}); // or
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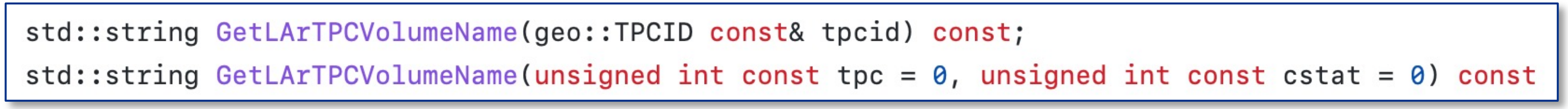

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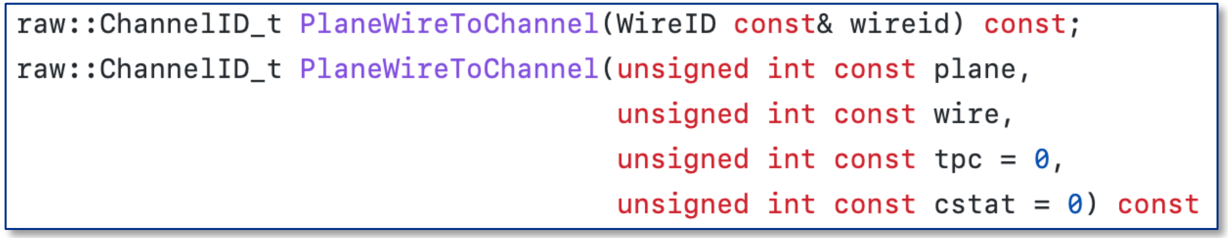

```
raw::ChannelID_t PlaneWireToChannel(WireID const& wireid) const;
raw::ChannelID_t PlaneWireToChannel(unsigned int const plane,
                                    unsigned int const wire,
                                    unsigned int const tpc = 0,
                                    unsigned int const cstat = 0) const
```

Use:
```
geom->PlaneWireToChannel(WireID{1, 2, 3, 4}); // or
geom->PlaneWireToChannel(      3, 4, 2, 1 );
```

Change 1: Only Geometry IDs will be used for geometry interface

Fermilab

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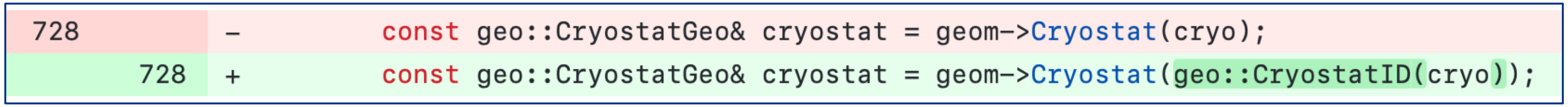

```diff
-       const geo::CryostatGeo& cryostat = geom->Cryostat(cryo);
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```

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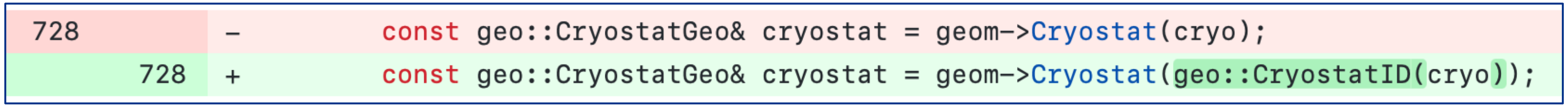

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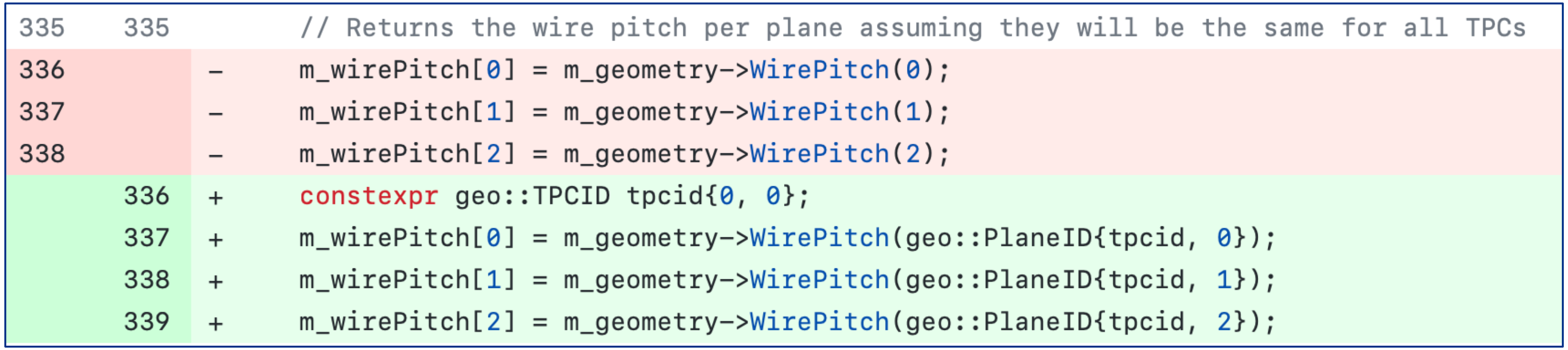

```
      // Returns the wire pitch per plane assuming they will be the same for all TPCs
-     m_wirePitch[0] = m_geometry->WirePitch(0);
-     m_wirePitch[1] = m_geometry->WirePitch(1);
-     m_wirePitch[2] = m_geometry->WirePitch(2);
+     constexpr geo::TPCID tpcid{0, 0};
+     m_wirePitch[0] = m_geometry->WirePitch(geo::PlaneID{tpcid, 0});
+     m_wirePitch[1] = m_geometry->WirePitch(geo::PlaneID{tpcid, 1});
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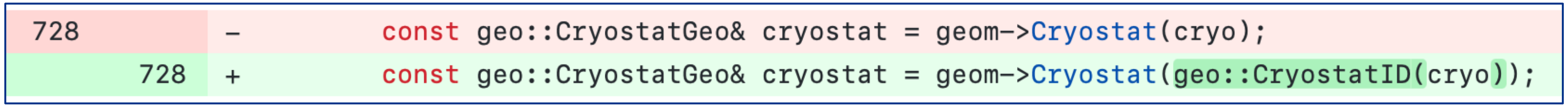

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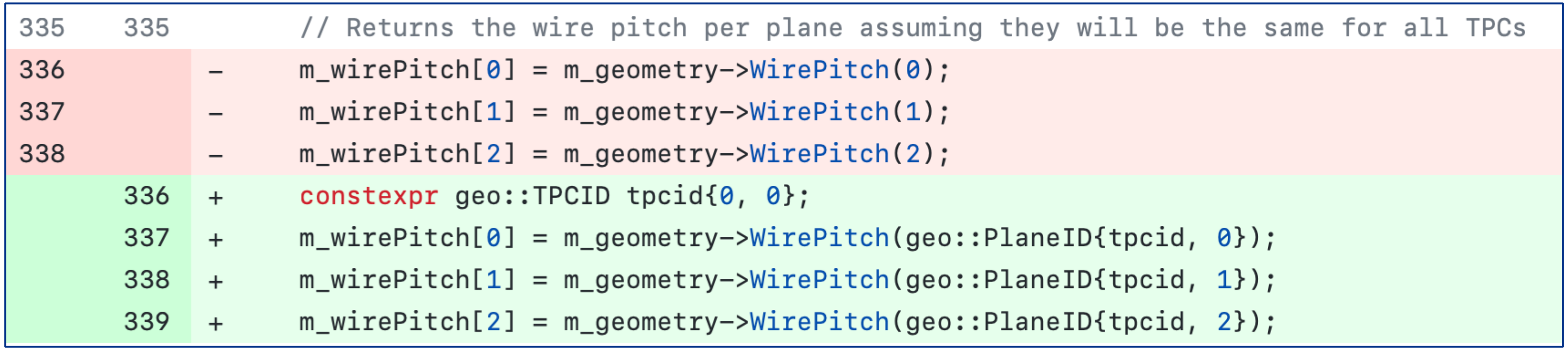

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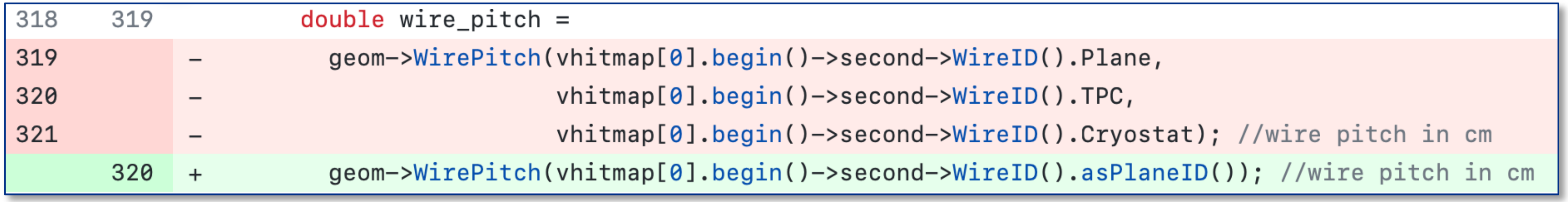

```diff
     double wire_pitch =
-      geom->WirePitch(vhitmap[0].begin()->second->WireID().Plane,
-                      vhitmap[0].begin()->second->WireID().TPC,
-                      vhitmap[0].begin()->second->WireID().Cryostat); //wire pitch in cm
+      geom->WirePitch(vhitmap[0].begin()->second->WireID().asPlaneID()); //wire pitch in cm
```

Vector overloads

- There are many point or vector geometry functions with overloads that support:
    - `double const*/double[3]`
    - `TVector3 const&`
    - `geo::Point_t const&`
    - `geo::Vector_t const&`

- **Change 2:** Only `geo::Point_t` and `geo::Vector_t` function arguments will be supported.

Geometry iterators and iteration patterns

- The `GeometryCore.h` file contains many lines of code to support smart iteration through geometry elements (e.g.):

```
geometry->begin_wire_id(); // Get iterator to first wire ID
for (geo::TPCGeo const& tpc : geometry->IterateTPCs())
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- This code can be rearranged to use templates so that iterating through elements *does not* require a member function with element names hard-coded into the function name.

- This is a step toward factorizing geometry and readout constructs.

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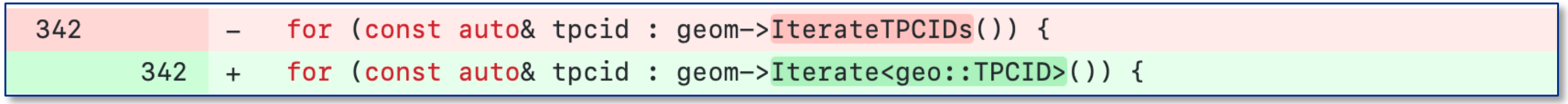

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-   for (const auto& tpcid : geom->IterateTPCIDs()) {
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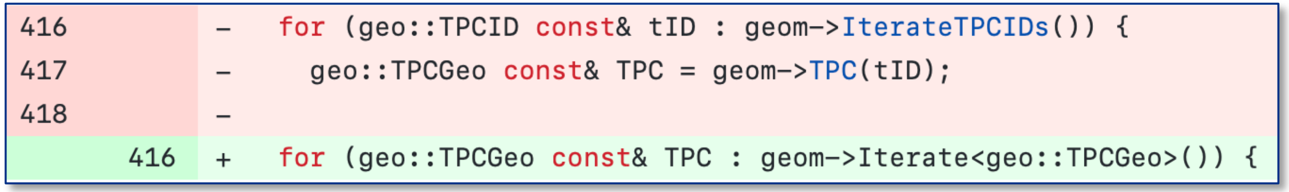

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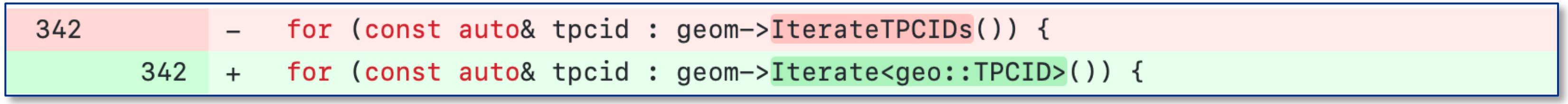

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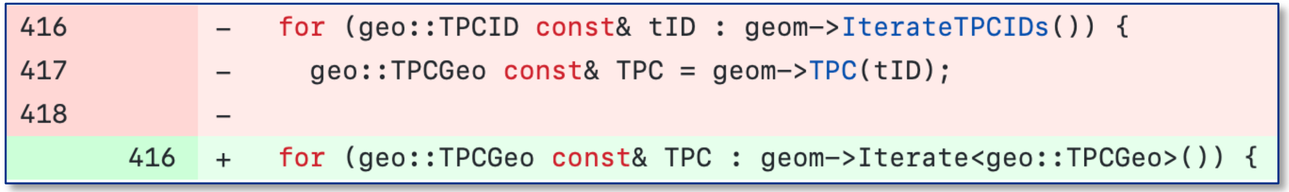

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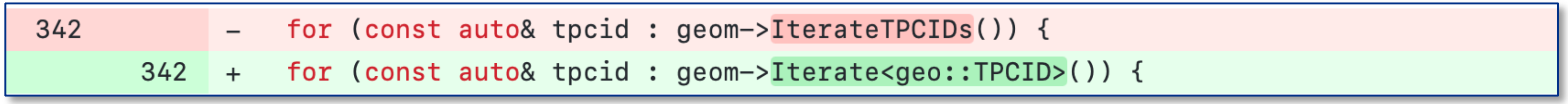

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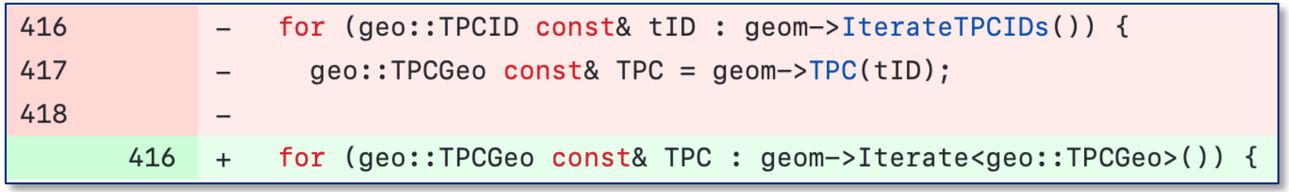

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- Removes 1-2k LOC from `larcorealg`.

Conclusion

- We are continuing the effort to clean up/pare down the geometry interface.
- The next raft of PRs will remove remaining obsolete interface and will introduce a slightly different iteration pattern that is more conducive to a factorized geometry/readout system.

- **Status**

  I have LArSoft feature branches ready, where almost all of the deprecated functionality has been removed and is no longer used.

  I have started feature branches for the experiments.