

New Fast Simulation Module in FairRoot

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Motivation

- Simulation of particular detector using traditional stepping may cost considerable CPU time (e.g. calorimeters)
- Need to simulate parametrized response, so called “fast simulation”
- Simple way to mix full and fast simulation in same run
- Should be usable with both Geant 3 and 4

Implementation

1. Implement Fast Simulation detector class by inheriting from framework base class (FairFastSimDetector)
2. A detector in fast simulation mode is represented by one single volume that has the medium FastSimMedium
3. The parametrized response and particle transport have to be implemented in the overloaded method **FastSimProcessParticle()**
 - User can have his own propagation
 - Can use the framework propagators (Runge Kutta propagator or Geane)

User Interface

- **FairStack::FastSimMoveParticleTo(x, y, z, t, mom_x, mom_y, mom_z, energy)** allows user to transport particle out of the detector
- **FairStack::FastSimStopParticle()** allows user to stop current particle

Geant 3 and 4

- Because of different stack treatment there are internally 2 implementations
 - Geant3: the particle is killed, and a new particle at different position is put on stack
 - Geant4: the fast simulation user model allows moving the same particle
- **No change for the user - the interface is the same**

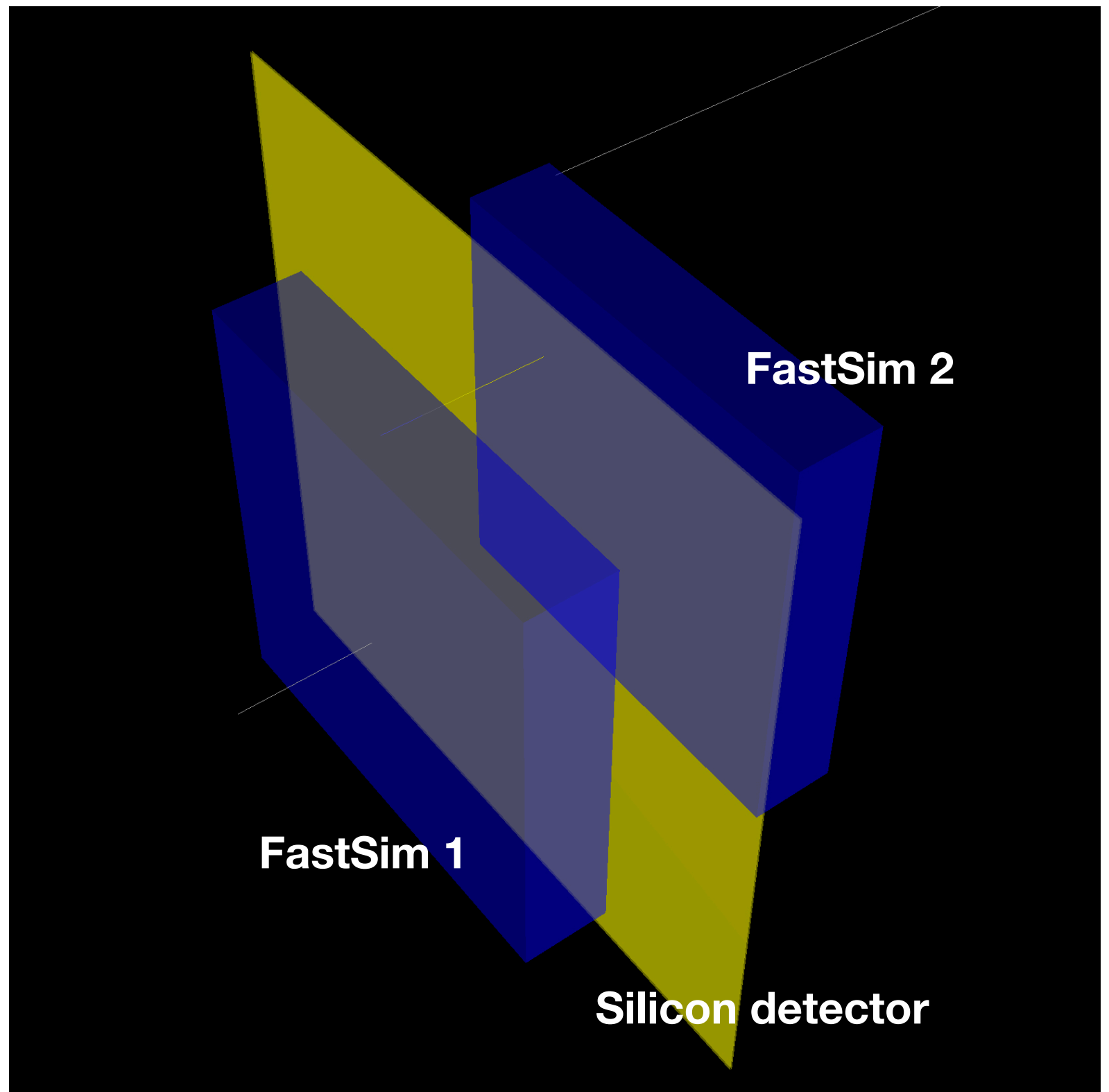
Changes to the experiment stack

- Some of the methods are dependent on experiment specific classes for MC tracks and MC points
- In case of Geant3 the particle is stopped and a new particle is added to the stack: need to match the particle indices
 - The stack of the experiment framework needs implementation of these new methods:
 - `FairStack::FastSimGetMovedIndex()`
 - `FairStack::FastSimClearMovedIndex()`
- Currently under development: whole functionality implemented in `FairGenericStack`

Example

In the example
a MC point is scored
and the particle is shifted
in both regions for fast
simulation

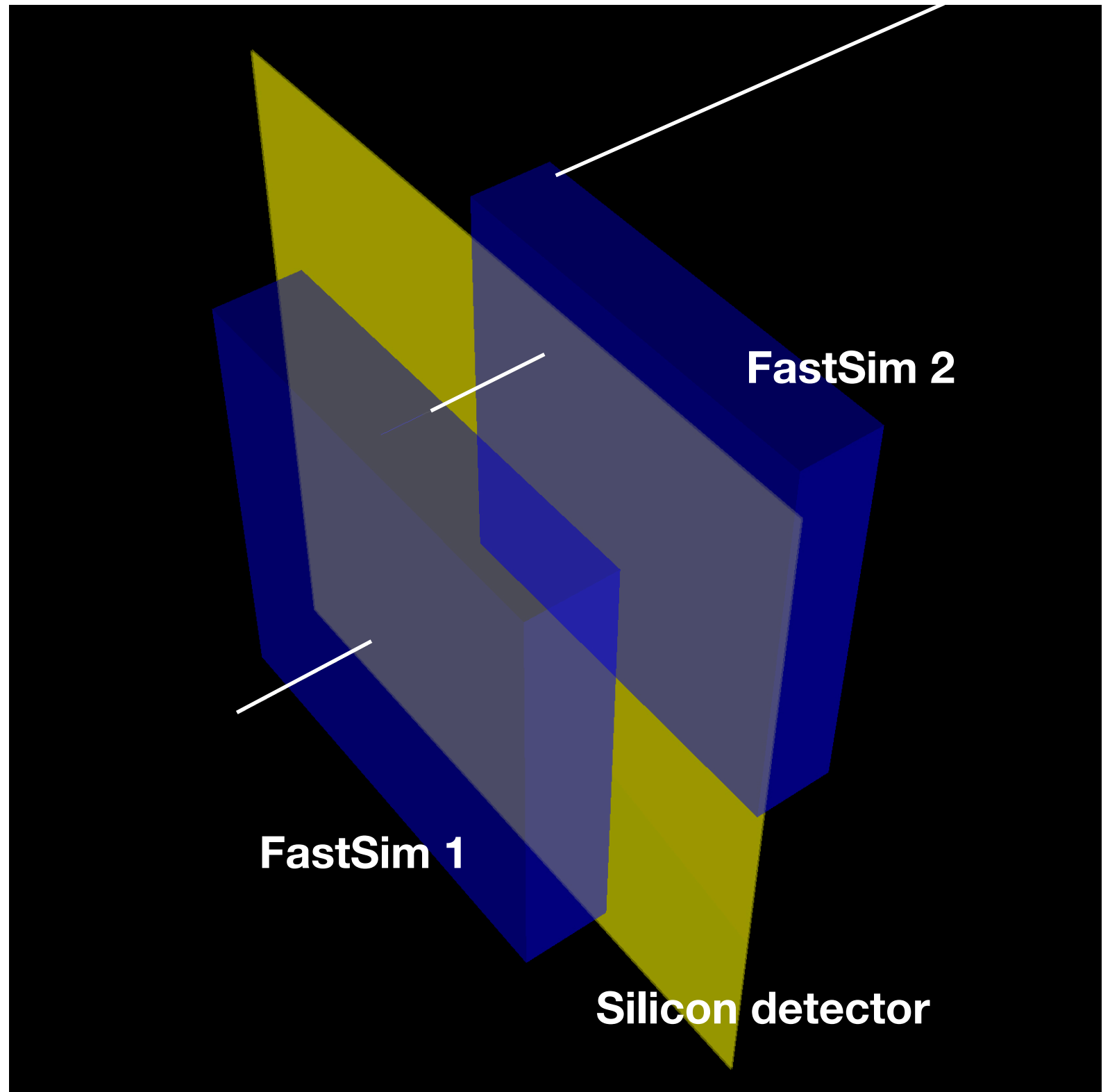
`FairRoot/examples/
simulation/Tutorial1/
macros/run_tutorial1_fastsim.C`



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Summary

- Fast Simulation module in FairRoot offers a tool that works transparently with Geant 3 and 4
- User can mix fast and full simulation in the same run
- All particles which are entering the region are given to fast simulation
- Creation of secondaries is currently under development
- Code example is available:

<https://github.com/FairRootGroup/FairRoot/tree/dev/examples/simulation/Tutorial1>

Example

```
void FairFastSimExample::FastSimProcessParticle()
{
    TVirtualMC::GetMC()->TrackPosition(fPos);

    TVirtualMC::GetMC()->TrackMomentum(fMom);

    FairStack* stack = static_cast<FairStack*>(TVirtualMC::GetMC()->GetStack());

    stack->FastSimMoveParticleTo(
        12.5, 12.5, 20. + 5. + 0.1, TVirtualMC::GetMC()->TrackTime(), fMom.X(),
        fMom.Y(), fMom.Z(), fMom.E());

    fTrackID = TVirtualMC::GetMC()->GetStack()->GetCurrentTrackNumber();

    fVolumeID = 0;

    fTime = TVirtualMC::GetMC()->TrackTime() * 1.0e09;

    fLength = TVirtualMC::GetMC()->TrackLength();

    fELoss = 0.;

    AddHit(fTrackID, fVolumeID, TVector3(fPos.X(), fPos.Y(), fPos.Z()),
        TVector3(fMom.Px(), fMom.Py(), fMom.Pz()),
        fTime, fLength, fELoss);

    // Increment number of tutorial det points in TParticle
    stack->AddPoint(kTutDet);
}
```