$B^0 \to K^* \mu^- \mu^+$
EvtGen Model

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Acceptance correction

$\Rightarrow$ The decay of $B^0 \to K^* \mu^- \mu^+$ is described by 3 helicity angles and the invariant mass squared of two leptons (q^2).

$\Rightarrow$ In order to model the detector acceptance we have used a large MC sample of PHSP simulated events.

$\Rightarrow$ There is a caveat: the q^2 distribution.

$\Rightarrow$ We had to reweight it to make it flat.

Reweighted to be flat in q^2
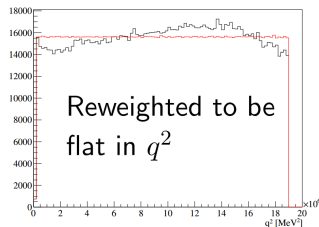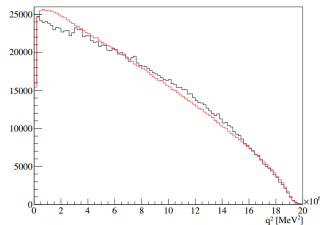
Can we optimize it?

$\Rightarrow$ It would be nice if we could generate not only the flat angle distributions but also a flat q^2.

$\Rightarrow$ There exists already a model for it: FLATQ2.

$\Rightarrow$ It basically reweighs the distribution by $1/p_T^{\mathrm{had}}$.

$\Rightarrow$ The problem is that it was design to generate the flat distribution of decays $B \rightarrow X\ell\nu$:

```cpp
void EvtFlatQ2::init(){

  // check that there are 0 arguments
  checkNArg(0);
  checkNDaug(3);

  //We expect B->X l nu events
  checkSpinParent(EvtSpinType::SCALAR);
  checkSpinDaughter(1,EvtSpinType::DIRAC);
  checkSpinDaughter(2,EvtSpinType::NEUTRINO);

}
```

$\Rightarrow$ Will not work in current version for $B \rightarrow K^*\mu\mu$.

Modifying the `FLATQ2` 1

⇛ I wrote a mirror model that requires that the two leptons are `DIRAC`, and called it `FLATQ2EWP`.
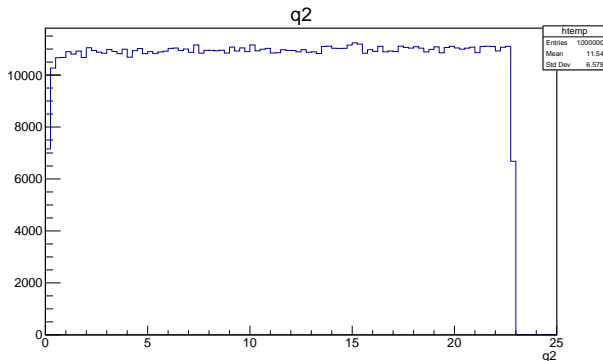
⇛ And improves the situation a lot:
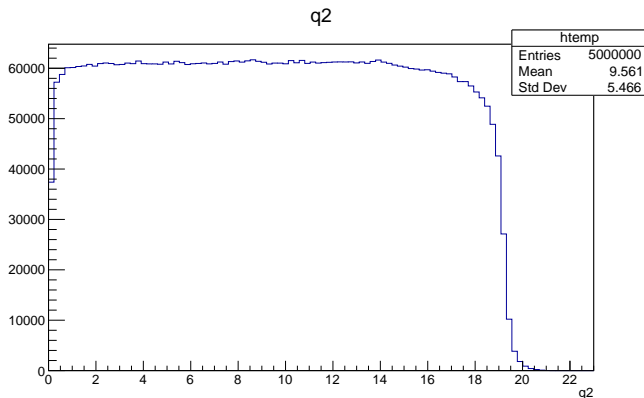
⇛ So much flatter but the and and the begging still not flat.

⇛ End of the spectrum is due to K^* width? ⇸ Lets test it with B →

Modifying the `FLATQ2` 1

$\Rightarrow$ `FLATQ2EWP` use to simulate the $B \to K \mu\mu$:
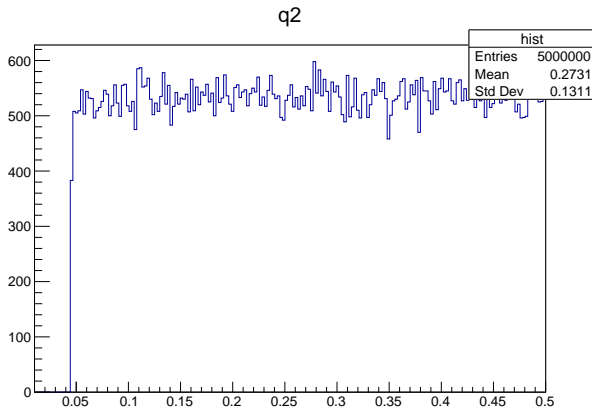

$\Rightarrow$ Oki so end of the spectrum is understood and not much can be done there.

$\Rightarrow$ Now the low q^2: Can this be just Phase space suppression: $\sqrt{1 - 4m_\ell^2/q^2}$

Modifying the `FLATQ2` 2

⇛ `FLATQ2EWP` with phase space suppression factor.

⇛ Now it's perfect.

Update since last week

⟹ Discussion was made via: JIRA

⟹ It was suggested my Michal to incorporate the new model into the current one to save the code.

⟹ Thanks to John for merging the two codes:

```cpp
void EvtFlatQ2::init(){

    // check that there are 3 daughters
    checkNDaug(3);

    // We expect B -> X lepton lepton events
    checkSpinParent(EvtSpinType::SCALAR);

    EvtSpinType::spintype d1type = EvtPDL::getSpinType(getDaug(1));
    EvtSpinType::spintype d2type = EvtPDL::getSpinType(getDaug(2));

    if (!(d1type == EvtSpinType::DIRAC || d1type == EvtSpinType::NEUTRINO)) {
        EvtGenReport(EVTGEN_ERROR,"EvtGen") << "EvtFlatQ2 expects 2nd daughter to "
                                            << "be a lepton" <<std::endl;
        EvtGenReport(EVTGEN_ERROR,"EvtGen") << "Will terminate execution!"<<std::endl;
        ::abort();
    }

    if (!(d2type == EvtSpinType::DIRAC || d2type == EvtSpinType::NEUTRINO)) {
        EvtGenReport(EVTGEN_ERROR,"EvtGen") << "EvtFlatQ2 expects 3rd daughter to "
                                            << "be a lepton" <<std::endl;
        EvtGenReport(EVTGEN_ERROR,"EvtGen") << "Will terminate execution!"<<std::endl;
        ::abort();
    }

    // Specify if we want to use the phase space factor
    _usePhsp = false;
    if (getNArg() > 0) {
        if (getArg(0) != 0) {_usePhsp = true;}
    }

    EvtGenReport(EVTGEN_INFO,"EvtGen") <<"EvtFlatQ2 usePhsp = "<<int(_usePhsp)<<std::endl;

}
```

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⟹ Thanks to John for merging the two codes:

```cpp
void EvtFlatQ2::decay( EvtParticle *p){

  p->initializePhaseSpace(getNDaug(),getDaugs());

  EvtVector4R p4Xu = p->getDaug(0)->getP4();

  EvtVector4R p4ell1 = p->getDaug(1)->getP4();
  EvtVector4R p4ell2 = p->getDaug(2)->getP4();

  double pXu_x2 = p4Xu.get(1)*p4Xu.get(1);
  double pXu_y2 = p4Xu.get(2)*p4Xu.get(2);
  double pXu_z2 = p4Xu.get(3)*p4Xu.get(3);
  double pXu = sqrt(pXu_x2+pXu_y2+pXu_z2);
  double prob(0.0);
  if (fabs(pXu) > 0.0) {prob = 1/pXu;}

  // Include the phase space factor if requested
  if (_usePhsp) {

    double Lambda = lambda((p4ell1+p4ell2).mass(), p4ell1.mass());
    if (Lambda > 0.0) {prob=prob/sqrt(Lambda);}

  }

  if (pXu > 0.01) {setProb(prob);}

  return;
```

FLATQ2 Conclusion

⇛ The new model was tested by me and John.

⇛ Changes won't have any influence on the existing DEFILES as the flag is by default switched off.

⇛ The commit was mearge to master by Gloria today.

⇛ We thank all people involved action

Backup