```
filename: WZFitter-detailed.cxx
commented printout of gfitter/GSM/WZFitter.cxx, J. Haller, 2011-03-03
"The 1 function calculated here is not quoted, but copied from zfitter/dizet "
==================================================================================================
Correct references:

D. Bardin, G. Passarino, "The Standard Model in the Making", Oxford University Press, 1999

D. Bardin, P. Christova, O. Fedorenko (Dubna, JINR)
"ON THE LOWEST ORDER ELECTROWEAK CORRECTIONS TO SPIN-1/2 FERMION SCATTERING, (II). The one-loop
amplitudes"
Nucl. Phys. B197 (1982) 1-44

D. Bardin, S. Riemann, T. Riemann (Dubna, JINR)
"Electroweak One Loop Corrections To The Decay Of The Charged Vector Boson"
D.Yu. Bardin, S. Riemann, T. Riemann (Dubna, JINR).
JINR-E2-86-169. Mar 1986. 10 pp., Published in Z.Phys. C32 (1986) 121-125

==================================================================================================
original file begins here, with insertions from zfitter and coments from zfitter group
==================================================================================================

/*****************************************************************************
 * Project: GSM - Electroweak fitting package                                *
 * Package: GSM                                                              *
 * Class  : WZFitter                                                         *
 *                                                                           *
 * Description:                                                              *
 *      Auxiliary Theory for electroweak formfactor for W decay              *
 *      W Boson decay / total width                                          *
 *                                                                           *
 * Sources:                                                                  *
 *      The Standard Model in the Making, Oxford 1999                        *
 *                                                                           *
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 *                                                                           *
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 *      CERN, Switzerland,                                                   *
 *                                                                           *
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 * modification, are permitted according to the terms listed in LICENSE      *
 * (http://mva.sourceforge.net/license.txt)                                  *
 *                                                                           *
 * File and Version Information:                                             *
 * $Id: WZFitter.cxx,v 1.11 2007/10/25 13:07:28 haller Exp $
 *****************************************************************************/
#include "TMath.h"

#include "Gfitter/GMath.h"
#include "Gfitter/GConstants.h"
#include "Gfitter/GTheory.h"
#include "Gfitter/GTheoryRef.h"
#include "Gfitter/GParameterRef.h"
#include "Gfitter/GReference.h"

#include "GSM/WZFitter.h"
#include "GSM/ZFitterFermionPart.h"
#include "GSM/ZFitterBosonPart.h"
#include "GSM/Vertex.h"

using namespace Gfitter;
using std::complex;

ClassImp(GSM::WZFitter)

  GSM::WZFitter::WZFitter()
    : Gfitter::GAuxTheory(),
      m_isUpToDate_Update( kFALSE )
{
   SetTheoryName( GetName() );
   SetExistDerivative( kFALSE );
```

```
   BookParameter( "MZ"      , & m_MZ );

   BookTheory   ( "GSM::MW"                    , & m_MW );
   BookTheory   ( "GSM::ZFitterFermionPart"    , & t_fermionPart );
   BookTheory   ( "GSM::ZFitterBosonPart"      , & t_bosonPart );
   BookTheory   ( "GSM::Vertex"                , & m_Vertex );
}

void GSM::WZFitter::UpdateLocalFlags( GReference& /* ref */ )
{
   m_isUpToDate_Update = kFALSE;
}

void GSM::WZFitter::Update()
{
   if (m_isUpToDate_Update) return;

   // now, it is uptodate (I mean... it will be)
   m_isUpToDate_Update = kTRUE;

   Double_t MW  = GetMW();
   Double_t MZ  = m_MZ;
   Double_t MW2 = MW*MW;
   Double_t MZ2 = MZ*MZ;

   m_R          = MW2/MZ2;

   // bosonic + ferminoic contribution
   m_W_MW  = real( GetBosonPart().GetWbAtMW()  + GetFermionPart().GetWfAtMW() );
   m_W0    = real( GetBosonPart().GetWbAt0()   + GetFermionPart().GetWfAt0() );
   m_WF_MW = real( GetBosonPart().GetWbFAtMW() + GetFermionPart().GetWfFAtMW() );

   // now, parameters are up-to-date
   SetUpToDate();
}

// rho for W decay, just 1-loop, because it is impossible
// to define QED-gauge invariant subset of diagrams
Double_t GSM::WZFitter::GetRhoW( Double_t Charge )
{
   Update();
   Double_t ChUpDo = Charge*(1.0 - Charge);

   // eq. (10.71) of The Standard Model in the Making
   // one and two point functions are replaced
   // by fermionic and bosonic contribution
   Double_t rho    = ( 1.0 + GConstants::alphaQED()/(4.0*TMath::Pi()*(1.0-m_R))
                       *(m_W_MW - m_W0 + m_WF_MW - 7.0 + 5/8.0*m_R*(1.0+m_R)
                         - 9/4.0*m_R/(1.0-m_R)*TMath::Log(m_R)
                         + 0.75/m_R + 3.0*m_R - 3.0/m_R*(1.0-m_R)*(1.0-m_R)*ChUpDo
                         + (0.5/m_R - 1.0 - 2.0*(1.0-m_R)*(1.0-m_R)/m_R*ChUpDo)*GetVertex().GetV1WZ()
                         + 2.0*m_R*GetVertex().GetV2WWZ() + 2.0*(1.0-m_R)
                         *(77/12.0 - 2/3.0*GMath::IPow( TMath::Pi(),2 ) + 109/36.0 - 3/2.0*ChUpDo)) );
   return rho;
}

"-----------------------------------------------------------------------------------------------------"
"compare to zfitter/dizet6_42.f  lines 3411 ff.:"

   ROW=1.D0+AL4PI/R1*(WM1A-W0A+WFM1A-7.D0/1.D0+5.D0/8.D0*R*R1W
     *   -9.D0/4.D0*R/R1*ALR+3.D0/4.D0/R+3.D0*R-3.D0/R*R12*QIQJ
     *   +(1.D0/2.D0/R-1.D0-2.D0*R12/R*QIQJ)*V1WZ
     *   +2.D0*R*V2WWZ+2.D0*R1*(77.D0/12.D0-2.D0/3.D0*PI2+109.D0/36.D0
     *   -3.D0/2.D0*QIQJ))

The eq. (10.71) of "The Standard Model in the Making" looks quite different, written with A_), B_), C_)
etc, see file:
"WZFitter-eq-10.71-standard-model-in-the-making.pdf"

The formula is very close to eq. (A.5,6) of Bardin,Riemann,Riemann, see file:
"WZFitter-e2-86-169-bardin-riemann-riemann.pdf"
"-----------------------------------------------------------------------------------------------------
```

```
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taken from Vertex.cxx:   m_V1WZ, m_V2WWZ
taken from ZFitterBosonPart.cxx and from ZFitterFermionPart.cxx: GetWb.. and GetWf..
=== end of file ====
```