Technicolor in SHERPA

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Outlook

- A quick overview of Technicolor

- The basic phenomenology of the Minimal Walking TechniColor (MWTC)

- The MC-NET project:
  - The implementation in Sherpa
  - The ATLAS interface to Sherpa

Technicolor overview (1)

◆ The QCD pion is a pseudo-goldstone boson which can cause electroweak symmetry breaking, but yields wrong gauge bosons masses

◆ Technicolor was originally a QCD like mechanism explaining the existence of new bound states breaking the EW symmetry

◆ This kind of model has a complex phenomenology, but the Higgs is absent.

◆ Technicolor has evolved into a complex theory (Extended TC, Walking TC, TC2, etc.).

◆ Walking Technicolor is the key to achieve high fermion masses while keeping low FCNC.
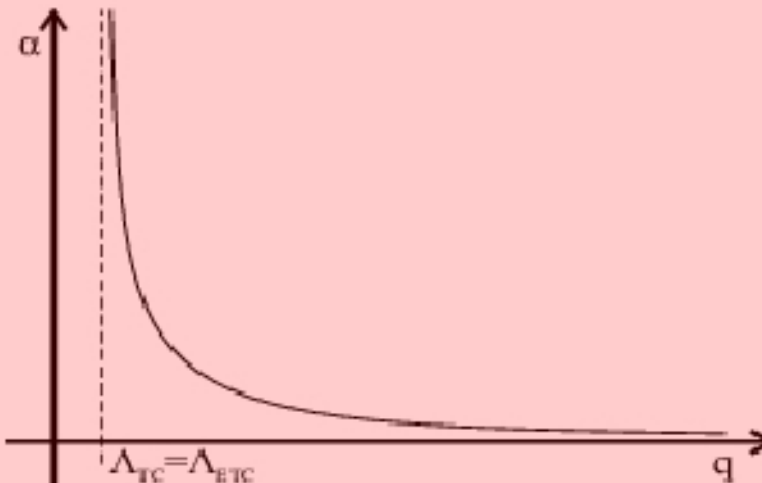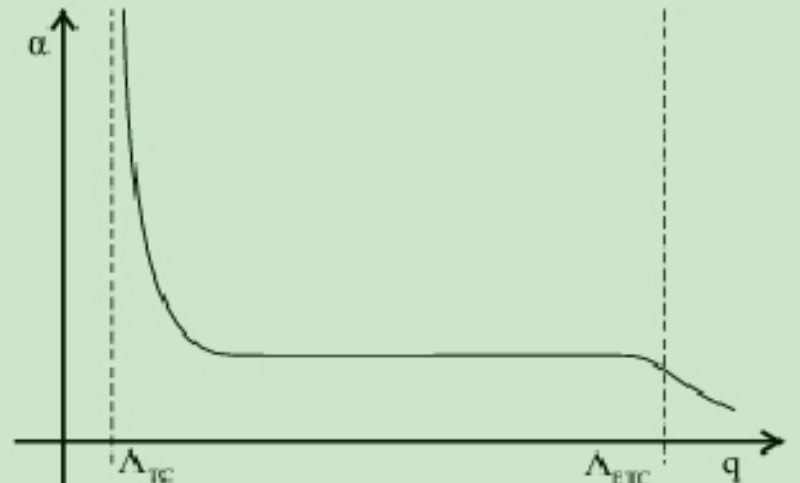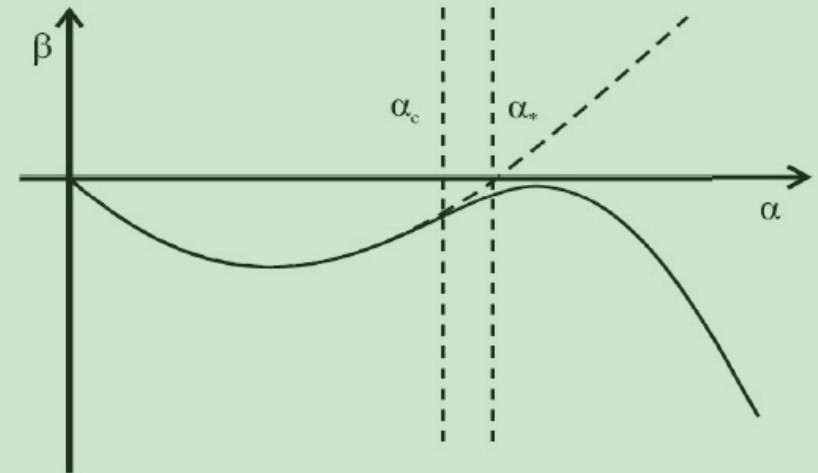
Technicolor overview (2)

Techni-gluons and Techni-fermions will contribute to the Technicolor coupling β function with a different sign.

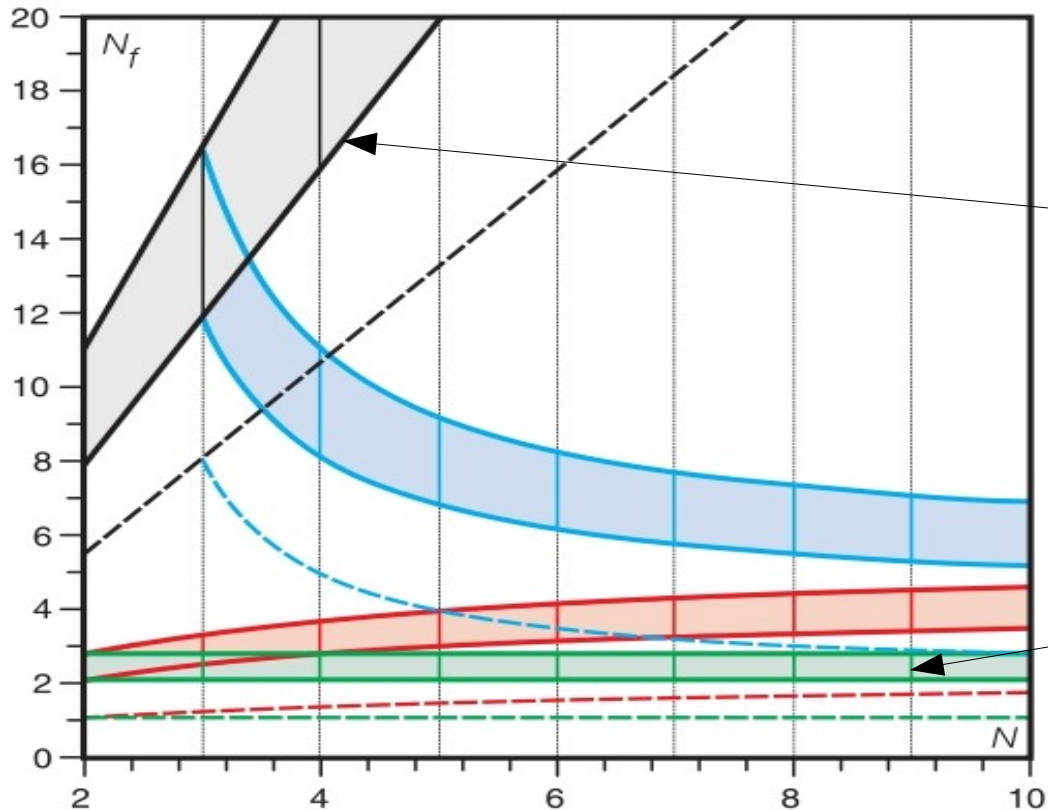If the numbers of particles, doublets, etc is chosen correctly one can have a fixed point

Fixed point

QCD like

Technicolor overview (3)

Many ways to achieve walking

representation/model

fundamental / StrawMan or low scale technicolor

adjoint / Minimal walking technicolor (MWTC)

Upper line is limit for loss of asymptotic freedom
Lower line is limit for loss of chiral symmetry breaking
shaded region is the conformal window (presence of fixed point)

MWTC (1)

- Model developed by F. Sannino et al. Appeared for the first time around 2006. Exist in Calchep and being implemented in SHERPA

- 2 new technifermions are in a weak doublet and are in adjoint representation of SU(4)

- To cure Witten anomaly, one needs a complete family, so one extra lepton doublet is present.

- One does not want to write down a complete ETC model. Then the ETC sector is parametrized by Yukawa coupling

- Low energy effective Lagrangian exists
  See : arxiv:0706.1696 (hep-ph)

MWTC (2)

Techni-mesons :

	J	P	
H	0	+	$\longrightarrow$ Is similar to QCD σ, Higgs like coupling
η	0	-	$\longrightarrow$ Can be light, 100's GeV
$\pi^{0,\pm}$	0	-	$\longrightarrow$ Eaten by W,Z
$A_0^{0,\pm}$	0	+	$\longrightarrow$ Can be light: 100's GeV
$\rho^{0,\pm}$	1	-	
$A_1^{0,\pm}$	1	+	mass : Close in mass ~ TeV
V4	1	-	

Techni-baryons :

	J	P	
uu,ud,dd,UU,UD,DD	0	-	
uu,ud,dd,UU,UD,DD	0	+	mass : ~M_{etc}
uu,ud,dd,UU,UD,DD	1	+	
ud,UD	1	-	mass : ~M_{etc}

MCNET Project

The original project was to implement MWTC model in Sherpa

The project was in Durham with Frank Krauss.

It last 4 months, but is still ongoing.

At the end of the project, I became one of the ATLAS responsible for Sherpa (together with Wolfgang Mader).

MWTC in Sherpa (1)

The authors of the model wrote their Lagrangian, parameters and field definitions inside LANHEP.

- This program calculates a list of Feynman rules and outputs them in CALCHEP format.

We can use this CALHEP implementation to study the model and to validate the Sherpa implementation

- The model has ~3000 Feynman rules
- New Lorentz function unavailable inside Sherpa. Needed to implement them.

Sherpa now allows the user to create an external model, and to compile it against Sherpa.

- No need to modify Sherpa code. Only need to create a shared library that contains the functions needed in order to allow Sherpa to retrieve your model.

MWTC in Sherpa (2)

I created a script to translate CALCHEP to Sherpa.

- Only works if the files have been produced by LANHEP with the correct options. This is because the Feynman rules need be in a simple format(using variables).
- Only the needed Lorentz structure for MWTC are included in the script. Would need to implement them if new one appears
- Doing small utility for the user, like reducing the list of variables, make shorter c++ files to allow faster compilation, etc.
- Still not a final version. Need more validation.

After the script is run, need to read the code carefully and make sure there is no mistake.

- check signs, function definition, etc.
- Need to implement the parameters and spectrum definition. The script produced most of it, but always need to implement the matrix orthogonalization

MWTC in Sherpa (3)
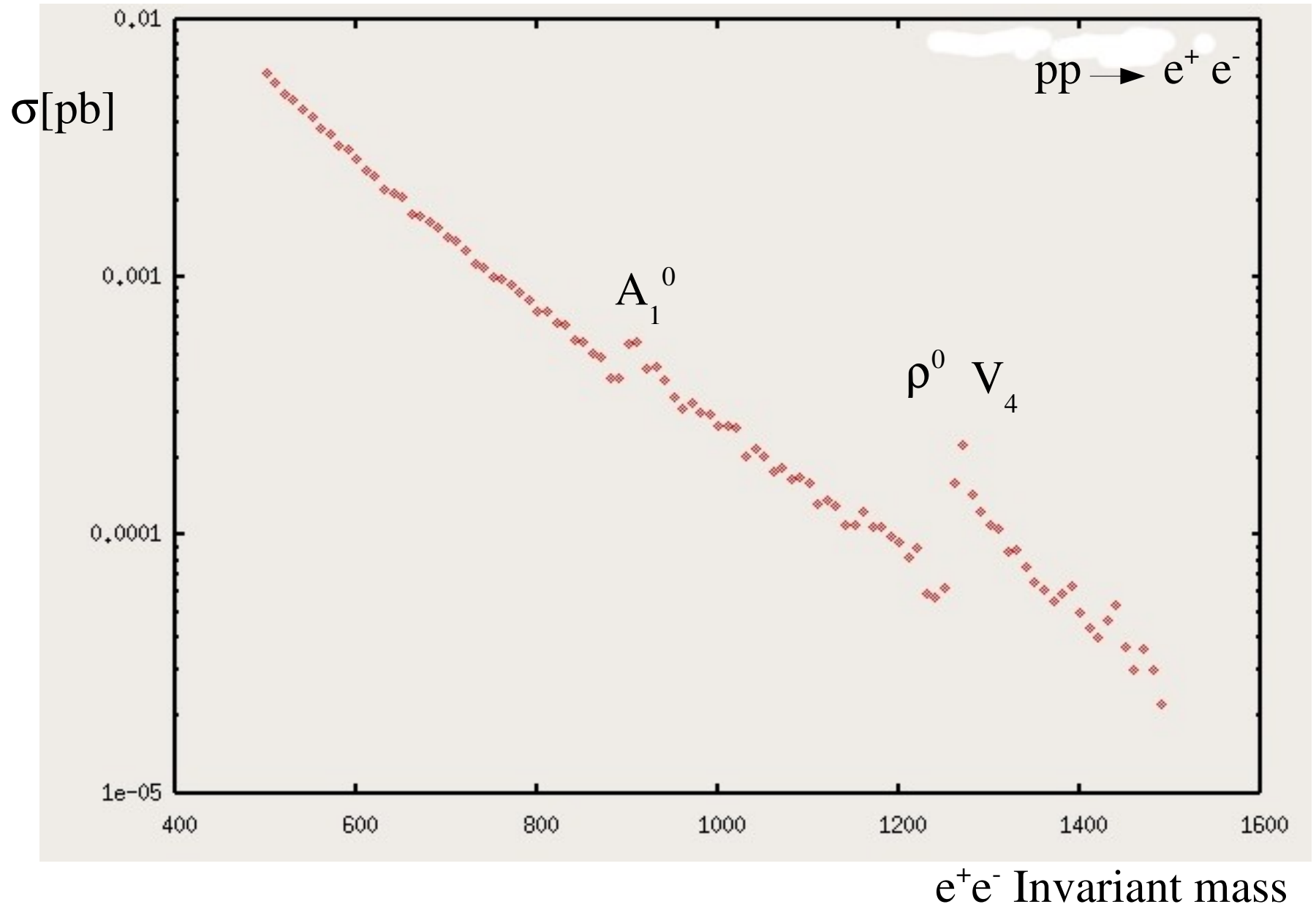
MWTC in Sherpa (4)

The model used was not complete and contained bugs/inconsistency.
- A new model version is now available, but not in Sherpa yet.
- Implementation will start when the model is validated.

The plan for the short term is:
- Use CALCHEP to make sure this version of the model is usable.
- Once we trust the model implementation in LANHEP/CALCHEP, we will use it to write its equivalent in Sherpa.
- Validate the Sherpa implementation against the CALCHEP one
- Distribute/use this code.

ATLAS interface to Sherpa (1)

The ATLAS software has built an interface to Sherpa long time ago.

- It allows to read in events only.
- Was correcting pdg ids to be pdg compliant

With the new Sherpa releases, it had become clear an upgrade was needed :

- Need to deal with different release event format(pdg code)
- Request to use the ATLAS random generator services.
- Would be nice to run on the fly

ATLAS interface to Sherpa (2)

→ The Sherpa Team provided a nice way to use external random numbers.

→ Sherpa team provided advice about how to use their code on the fly in the ATLAS framework.

→ They also change the event header to help distinguish the release used to produce these events :

```
# created by SHERPA 1.1.0
```

→ The new interface now allows to correct the pdg ids when needed, but also allows to run on the fly using ATLAS random numbers.

http://atlas-sw.cern.ch/cgi-bin/viewcvs-atlas.cgi/offline/Generators/Sherpa_i/

ATLAS interface to Sherpa (3)
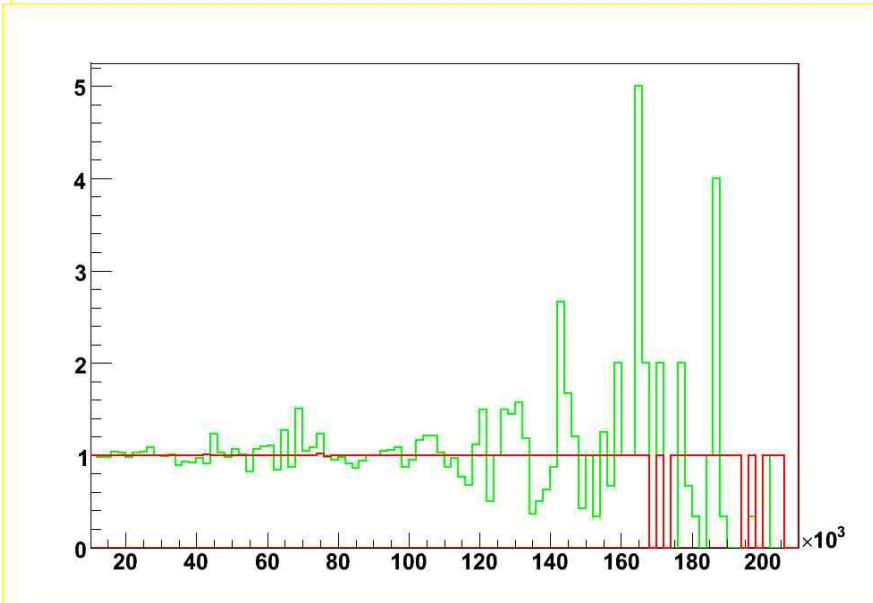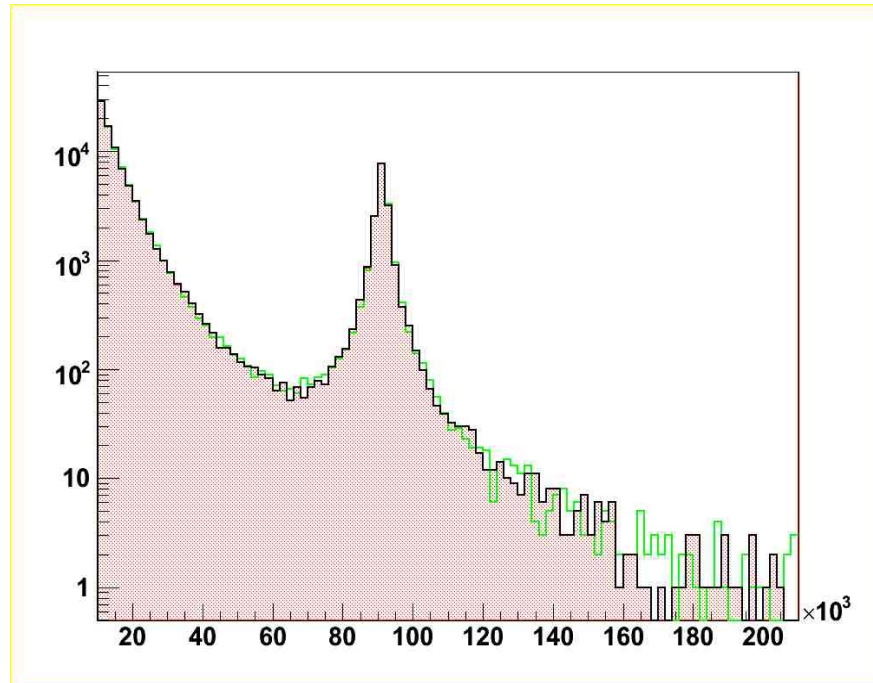
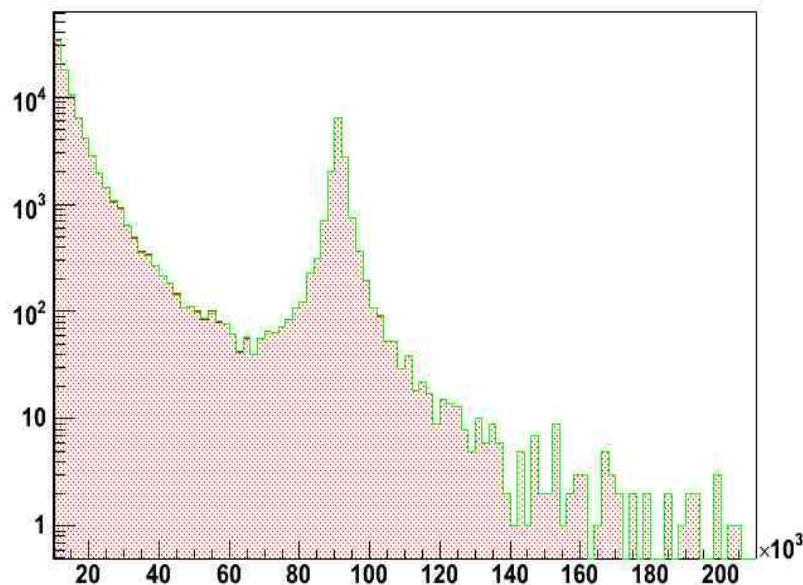## On the fly validation

From Sherpa within the interface

After the interface (same seed)

Standalone(different seed)

Ratio of the red line to the black one on the previous plot

Ratio of the green line and the black one on the previous plot

ATLAS interface to Sherpa (4)
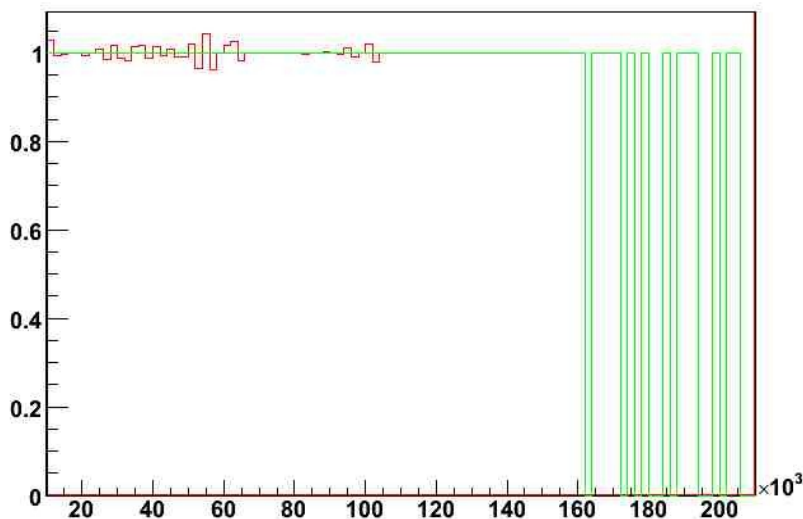
Read interface validation

From Sherpa standalone 1.0.11
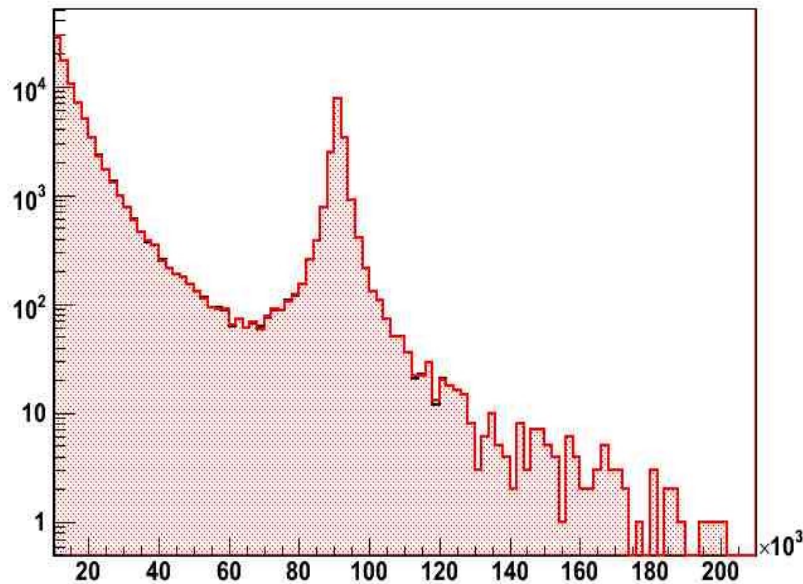After the new interface (using same events)
After the old interface (using same events)

Ratio of the red line to the black one on the previous plot

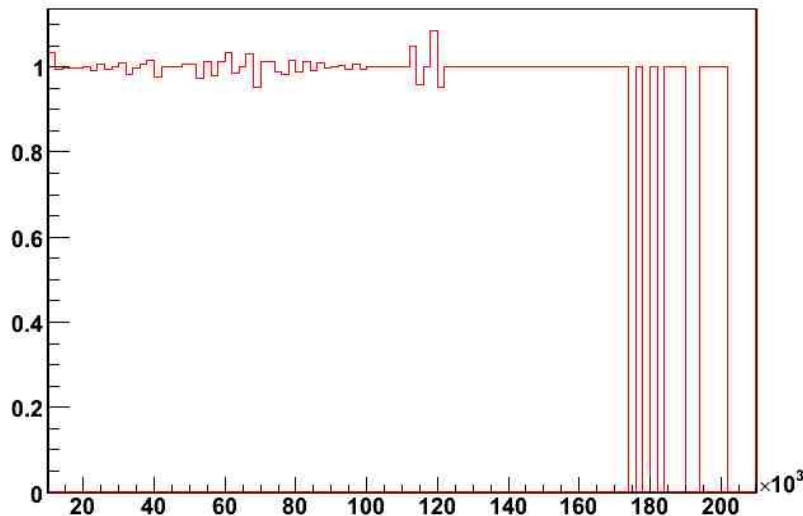Ratio of the green line and the black one on the previous plot

ATLAS interface to Sherpa (5)

Read interface validation

From Sherpa standalone 1.1.0
After the new interface (using same events)

Ratio of the red line to the black one on the previous plot

Conclusion

- The Sherpa interface to ATLAS software is now ready and in use.

- The needed software infrastructure to allow implementation of new exotic model is now available in Sherpa.

- The MWTC model implementation in Sherpa is still ongoing and should be completed soon.

Thank you!